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Report of Assessments Subcommittee, April 1976

Contents

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REPORT OF ASSESSMENTS SUBCOMMITTEE, APRIL 1976

Chairman: A. T. Pinhorn

The Subcommittee met at Dartmouth, Canada, during 31 March to 10 April 1976 to review the state of the marine resources in the ICNAF Area, to recommend TAC levels for 1977, and to advise on the scientific aspects of certain proposals which the Commission will consider at its Annual Meeting in Havana, Cuba, in June 1976. Representatives attended from all Member Countries except Bulgaria, Iceland, Italy and Portugal. The review of TAC levels was carried out in Working Groups of the Subcommittee as follows: groundfish stocks in Subareas 1, 2 and 3, including Statistical Area 0 (Sv. Aa. Horsted, Denmark); groundfish stocks in Subareas 4 and 5 including Statistical Area 6 (R. C. Hennemuth, USA); and pelagic fish stocks (capelin, herring and mackerel) throughout the ICNAF Area (Ø. Ulltang, Norway). The various sections of this report are set out to correspond as far as possible with the way in which they will be considered by the Panels and their Scientific Advisers.

I. INTRODUCTORY REMARKS

In the past, the Subcommittee has generally recommended TACs (total allowable catches) which were aimed at controlling the fishing mortality at F_{max}, thus maximizing yield per recruit, or at F_{MSY}, thus maximizing total yield. A full discussion on possible alternative management objectives other than those associated with F_{max} and F_{MSY} and their implications to the management of fish stocks is contained in the Report of STACRES to the Seventh Special Commission Meeting in September 1975 (Summ. Doc. 76/I/1). Similar discussions have taken place in other fora, such as the ICES Report of the *ad hoc* Meeting on the Provision of Advice on the Biological Basis for Fisheries Management (C.M.1976/Gen:3) and the FAO Advisory Committee on Marine Resources Research (FAO Fisheries Report No. 142, Suppl. 1). The Subcommittee therefore considered that a general discussion of this subject was not necessary at the present meeting.

The Subcommittee did, however, consider it necessary to decide whether its advice at this meeting should be on the same basis as used previously in recommending TACs or whether in fact it should recommend TACs for 1977 with management objectives different from those associated with F_{max} or F_{MSY}. Several reasons for managing stocks at a level of fishing mortality less than F_{max} or F_{MSY} were pointed out. The errors associated with TACs are certainly very large and the inherent losses of over-exploiting a stock (including possible loss of the stock) are likely to be much greater than any losses due to under-exploiting a stock. Also, fishing at higher levels of fishing mortality reduces the number of age-groups in the stock and causes the fishery, and hence the calculated TACs, to be heavily dependent on recruiting age-groups, thus rendering the calculation of TACs more difficult and more prone to serious error. The objective in recent years has been generally one of managing at F_{max}, and, although it may be too early to fully assess the effects of these regulations, it is apparent in many cases that the stocks are continuing to decline. The Subcommittee therefore decided that, although a single management objective could not be recommended to cover all stocks because the objective may vary from stock to stock, TACs for 1977 should generally be recommended with the aim of achieving $F_{0.1}$ rather than F_{max}, but that the consequences of different levels of F on total stock biomass, spawning stock biomass, relative age compositions, etc., should be examined. Thus, in general, the TACs recommended for 1977 for many of the stocks are those which will control the fishing mortality at a level less than F_{max}, in most cases at $F_{0.1}$, or those which will control fishing effort at a level less than that associated with F_{MSY}. In other cases, of course, the aim is to rebuild spawning biomass, and the TAC is not necessarily associated with $F_{0.1}$ or any other specified level of fishing mortality but is aimed at rebuilding the spawning stock at an appropriate rate.

In addition to recommending TACs for 1977, STACRES was requested to examine, for as many groundfish stocks as possible in Subareas 2, 3 and 4, a range of TACs lower than that associated with the maximum sustainable yield, and to indicate the long-term implications regarding stock size, the time scale of the changes and the long-term yield or any other measures that STACRES might consider desirable (Comm. Doc. 76/VI/22). This has been done for as many stocks as possible in the ICNAF Area, and various management options are presented for those species. For those stocks, for which it was not possible to provide the detailed advice requested, the Subcommittee wishes to draw attention to the conclusions of STACRES at the September 1975 Special Commission Meeting (Summ. Doc. 76/I/1) that from general production models, although the regulation of stocks at MSY levels results in a biomass of about one-half of that of the virgin stock, a biomass constraint at a level of two-thirds of that of the virgin stock would provide an adequate biomass buffer for maintaining stock stability and resilience against depletion in the presence of large fluctuations in recruitment.

II. GENERAL FISHERY TRENDS

Statistics of landed catches of all species taken in the Northwest Atlantic were not available at the time of the Subcommittee Meeting, as the request for advance statistics for assessment purposes was confined to species under present or prospective catch quota regulation. Comments on the overall fishery

trends are therefore deferred to the 1976 Annual Meeting. However, the advance preliminary statistics for the stocks under regulation were essentially complete, and these were used to update the assessments.

III. SUMMARY OF CATCHES AND TACs

Recent catches and TACs for all stocks under regulation in 1976 and for which regulation is proposed for 1977 are summarized in Table 1. In almost all cases the TACs recommended for 1977 are based on the assumption that the TACs agreed by the Commission for 1976 are taken, as the Subcommittee cannot prejudge countries' intentions in this regard. The relevant parts of this Table are also given in summary tables near the beginning of each section dealing with update of TACs.

Table 1. Nominal catches (1971-75) and TACs (1973-77) by species and stock area, with TACs recommended by the Assessments Subcommittee at its April 1976 Meeting in parentheses.

Species	Stock area	Nominal catches (000 tons) 1971	1972	1973	1974	1975[2]	TACs (000 tons)[1] 1973	1974	1975	1976	1977
Cod	1	121	111	63	48	46	-	107.0	60.0	45.1	(0.0)
	2GH	13	14	+	4	6	-	20.0	20.0	20.0	(20.0)
	2J+3KL	432	458	355	373	277	665.5	656.7	554.0	300.0	(160.0)
	3M	34	58	23	25	23	-	40.0	40.0	40.0	(25.0)
	3NO	126	103	80	73	45	103.5	101.1	87.7	43.0	(30.0)
	3Ps	64	44	53	47	36	70.5	70.0	62.4	47.5	(32.0)
	4Vn(Jan-Apr)+4T	57	68	51	49	39	-	63.0	50.0	30.0	(0.0)[21]
	4Vn(May-Dec)	11	9	6	6	4	-	10.0	10.0	10.0	(3.5)
	4VsW	54	62	54	44	31	60.5	60.0	60.0	30.0	(7.0)
	4X(offshore)[3]	9	7	7	6	7	-	-	5.0	4.0	(4.0)
	5Y	8	7	6	8	9	10.0	10.0	10.0	8.0	(3.2)
	5Z	28	25	29	27	24	35.0	35.0	35.0	35.0	(15.0)
Haddock	4VW	13	5	4	2	2	4.0	0.0	0.0	2.0[4]	(0.0)
	4X	18	13	13	13	18	9.0	0.0	15.0	15.0	(0.0)
	5	12	7	6	5	7	6.0	0.0	6.0[4]	6.0[4]	(0.0)
Redfish	2+3K	19	20	39	30	23	-	30.0	30.0	30.0	(30.0)
	3M	8	42	22	35	16	-	40.0	16.0	16.0	(16.0)
	3LN	34	29	33	22	17	-	28.0	20.0	20.0	(16.0)
	3O	20	16	9	13	14	-	16.0	16.0	16.0	(16.0)
	3P	28	26	18	22	28	-	25.0	25.0	18.0	(18.0)
	4VWX	62	50	40	27	28	-	40.0	30.0	20.0	(20.0)
	5	20	19	17	10	11	30.0	30.0	25.0	17.0	(9.0)
Silver hake	4VWX	129	114	299	96	112	-	100.0	120.0	100.0	(63.0)[22]
	5Y	8	7	9	5	9	10.0	10.0	15.0	10.0	(5.0)
	5Ze	72	78	62	66	57	80.0	80.0	80.0	50.0	(70.0)
	5Zw+6	28	35	65	58	54	80.0	80.0	80.0	43.0	(50.0)
Red hake	5Ze	9	39	25	10	14	-	20.0[5]	20.0[5]	26.0	(16.0)
	5Zw+6	31	36	41	24	26	40.0[5]	50.0[5]	45.0[5]	16.0	(28.0)
Pollock	4VWX	12	20	30	25	25	50.0[6]	55.0	55.0	55.0	(20.0)
	5	14	13	13	12	13					
A. plaice	2+3K	5	9	5	6	6	-	10.5	8.0	8.0	(8.0)
	3M	1	1	1	2	2	-	2.0	2.0	2.0	(2.0)
	3LNO	68	59	53	46	43	60.5	60.0	60.0	47.0	(47.0)
	3Ps	7	7	15	7	4	-	11.0	11.0	8.0	(6.0)
Witch	2J+3KL	16	17	24	16	13	-	22.0	17.0	17.0	(17.0)
	3NO	15	9	7	8	6	-	10.0	10.0	10.0	(10.0)
	3Ps	2	2	3	2	1	-	3.0	3.0	3.0	(3.0)
Yellowtail	3LNO	37	39	33	24	23	50.0	40.0	35.0	9.0	(12.0)
	5(E69°)	31	39	31	25	14	16.0	16.0	16.0	16.0	(7.0)
	5(W69°)+6					6	10.0[7]	10.0[7]	4.0	4.0	(0.0)
G. halibut	0+1	4	14	10	14	26	-	-	-	20.0	(20.0)
	2+3KL	25	30	29	27	28	-	40.0	40.0	30.0	(30.0)
A. plaice, witch and yellowtail	4VWX	34	23	28	25	22	-	32.0	32.0	28.0	(28.0)
Flounders (except yellowtail)	5+6	28	24	22	21	23	25.0	25.0	25.0	20.0	(20.0)

Table 1. (Continued)

Species	Stock area	Nominal catches (000 tons) 1971	1972	1973	1974	1975[2]	TACs (000 tons)[1] 1973	1974	1975	1976	1977
R. grenadier	0+1	8	8	5	12	5	-	-	10.0	13.5	(8.0)
	2+3	75	24	18	28	28	-	32.0	32.0	32.0	(35.0)
Herring(Option 1)	4V(Jul-Jun)[8]	13	19	17	20	7[9]	-	-	-	(11.0)[23]	(11.0)[23]
	4WX(total)	(146)	(177)	(140)	(173)	(184)					
	4WX(adults)	113	109	97	125	132	-	-	-	(92.5)[24]	(109.0)[25]
(Option 2)	4VW(a)	72	32	30	44	33	-	45.0	30.0[10]		
	4VW(a)(Jul-Jun)[8]	...	...	...	...	20[9]	-	-	45.0[11]	36.0[11]	(33.5)[26]
	4XW(b)(total)	(114)	(160)	(135)	(141)	(145)					
	4XW(b)(adults)	70	75	91	97	95	90.0	90.0	90.0	(89.2)[27]	(84.0)
	5Y(total)	(51)	(62)	(32)	(37)	(37)					
	5Y(adults)	39	43	16	18	21	25.0	25.0	16.0	7.0	(0.0)
	5Z+6	267	174	202	150	145	150.0	150.0	150.0	60.0	(50.0)
Mackerel	3+4	24	22	38	45	37	-	55.0[12]	70.0	56.0	(0.0)[28]
	5+6	349	387	381	295	246	450.0	304.0	285.0	254.0	
Argentine	4VWX	7	6	1	17	15	-	25.0	25.0	25.0	(20.0)
Capelin	2+3K	+	46	136	127	189	-	110.0[13]	160.0[14]	160.0[14]	(200.0)[29]
	3L	1	1	4	58	30			45.0	45.0	
	3NO	1	21	127	101	122	-	148.0[13]	126.0[15]	126.0[15]	(300.0)[29]
	3Ps	1	3	1	2	2			9.0	9.0	
Other finfish[16]	5+6	159	172	157	132	96	-	150.0	150.0	150.0	(150.0)[30]
Shrimp	1	9	10	13	18	39	-	-	-	-	(26.0)[31]
Squid-*Illex*	3+4	9	2	10	+	17	-	-	25.0	25.0[17]	(25.0)
	5+6	25	49	59	56	46[18]	-	71.0[19]	71.0[19]	30.0	(30.0)
Squid-*Loligo*	5+6									44.0	(44.0)
Overall 2nd tier[20]	5+6	1,140	1,171	1,159	942	833	-	923.9	850.0	650.0	(500.0)

1 TACs include quantities estimated to be taken outside the Convention Area.
2 Provisional statistics compiled for the April 1976 Meeting of the Assessments Subcommittee.
3 That part of Div. 4X south and east of straight lines joining the coordinates in the order listed: 44°20'N, 63°20'W; 43°00'N, 65°40'W; 43°00'N, 67°40'W.
4 TACs for by-catch with no directed fishery.
5 TACs pertain to 5Z(E69°) and 5Z(W69°)+6 for 1973 to 1975.
6 TAC pertains to 4X+5 only.
7 TACs pertain to 5(W69°) only for 1973 and 1974.
8 Catches and TACs pertain to fishing season July to June (e.g. 1973 = 1973/74 season).
9 Catches for Jul-Dec 1975 only.
10 TAC pertains to Jan-Jun 1975 only.
11 TACs pertain to fishing seasons 1975/76 and 1976/77 respectively.
12 TAC pertains to 4VWX only.
13 In addition, countries without specific allocations may each take up to 10,000 tons from these stocks, no more than 5,000 tons of which may be taken in Div. 3LNOPs.
14 In addition, countries without specific allocations may each take up to 10,000 tons.
15 In addition, countries without specific allocations may each take up to 5,000 tons in Div. 3LNOPs, but no more than 5,000 tons in aggregate from Div. 3L and no more than 1,000 tons in aggregate from Subdiv. 3Ps.
16 Excludes all TAC species and also menhaden, billfishes, tunas and large sharks (except dogfish).
17 In addition, countries without specific allocations may each take up to 3,000 tons.
18 Catches not yet available from all countries by *Illex* and *Loligo* separately.
19 TACs pertain to *Illex* and *Loligo* combined.
20 Includes squids and all finfish species, except menhaden, billfishes, tunas and large sharks other than dogfish.

Footnotes relevant to TACs recommended at the April 1976 Meeting of Assessments Subcommittee

21 Recommended TAC is subject to management strategy for 4Vn winter fishery and 4T summer fishery, as indicated in Section VI. 2(a).
22 Recommended TAC not agreed to by scientists from Cuba, GDR and USSR.
23 Recommended TAC for fishing seasons 1976/77 and 1977/78 respectively.
24 Recommended TAC for the period 1 Apr-31 Oct 1976.
25 Recommended TAC for fishing season 1 Nov 1976 to 31 Oct 1977.
26 Recommended TAC for fishing season 1 Jul 1977 to 30 Jun 1978.
27 This TAC is now recommended for 1976, although 81,000 tons was provisionally agreed by the Commission at the January 1976 Special Meeting (see Section VI. 2(ℓ)).
28 TAC is subject to reassessment at the 1976 Annual Meeting (see Section VII. 2(p)).
29 Not more than 50,000 tons should be taken in Div. 3L nor more than 10,000 tons in Subdiv. 3Ps.
30 Within this recommended TAC, advisory TACs are proposed for the following species: 25,000 tons of argentine, 40,000 tons of dogfish, 18,000 tons of butterfish, and 10,000 tons (including inshore fishery) of river herrings (*Alosa pseudoharengus* and *A. aestivalis*).
31 Recommended TAC pertains to offshore fishing grounds (in the Convention Area).

IV. STATISTICAL AREA 0 AND SUBAREA 1

1. Fishery Trends

(This subsection to be completed when more complete statistics become available from STATLANT 21A returns.)

2. Species Review

Table 2 contains a summary of recent catches and TACs, including those recommended for 1977, for stocks under consideration for management in Statistical Area 0 and Subarea 1. The TACs listed include quantities, if any, estimated to be taken outside the Convention Area.

Table 2. Statistical Area 0 and Subarea 1: summary of nominal catches (1971-75) and TACs (1973-77) by species and stock area. (Nominal catches for 1975 are based on advance provisional statistics for April 1976 assessments, and TACs in parentheses are those recommended by the Assessments Subcommittee.)

Species	Stock area	Nominal catches (000 tons)					TACs (000 tons)				
		1971	1972	1973	1974	1975	1973	1974	1975	1976	1977
Cod	1	121	111	63	48	46	-	107.0	60.0	45.1	(0.0)
G. halibut	0+1	4	14	10	14	26	-	-	-	20.0	(20.0)
R. grenadier	0+1	8	8	5	12	5	-	-	10.0	13.5	(8.0)
Shrimp	1	9	10	13	18	39	-	-	-	-	(26.0)[1]

[1] Recommended TAC pertains to offshore fishing grounds in Convention Area.

a) Cod in Subarea 1 (Res. Doc. 76/VI/17; Summ. Doc. 76/VI/7)

Provisional statistics for 1975 indicate that the nominal catch of cod was slightly less than the very low 1974 level of 48,000 tons. The 1975 catch (46,000 tons) is 76% of the TAC of 60,000 tons adopted by the Commission for that year, but is about the same as the 1976 TAC of 45,100 tons. Analysis of effort trends, country by country, indicates that by 1974 the overall effort had dropped to one-third of the 1968 level. Catch-per-unit-effort figures for the same span of years indicate that stock abundance has also decreased to about one-third of the 1968 level. The analyses indicate an instantaneous fishing mortality in 1974-75 of about 0.35, which is slightly below the $F_{0.1}$ level previously estimated to be about 0.40.

In 1974 the important 1968 year-class accounted for about 50% of the nominal catch by number as well as by weight. In 1975 the proportion of this year-class in the total catch dropped to about 35% by number and about 40% by weight. The size of this year-class seems to have been somewhat over-estimated in previous analyses or that it is disappearing more rapidly from the Subarea than was expected, probably due to spawning migration to East Greenland where the year-class accounted for about 50% of the 1975 catch by number. The year-class forms the most important part of the spawning stock, which has shown some temporary improvement, compared to the low 1973 level predicted in the 1975 assessment of this stock.

If the TAC for 1976 is fully utilized, the spawning stock size will inevitably decrease somewhat, due to the poor 1969 and 1970 year-classes. However, recruitment prospects for some of the later year-classes, especially that of 1973, are better than for the very poor 1969 and 1970 year-classes. The 1975 year-class also seems to be relatively stronger than the poor year-classes around 1970 and is expected to contribute to improving the stock condition in due time, but the Commission should not yet take this into any account as the statement is based only on larval occurrence and temperature observations.

The likely improvement in recruitment over the next few years may be the result of improved environmental conditions, but the Subcommittee stresses the importance of regulating the fishery so that a higher stock size is maintained than would likely be the case in an unregulated fishery. It is therefore strongly advised that the likely improvement of stock recruitment in 1977 not be used to raise the 1977 catch level with a resulting high mortality on the new recruits, but that the catch level be as low as possible to allow for as many of these new recruits as possible to contribute to future spawning stock size, thereby increasing the possibility of rebuilding the stock. In order to harvest the 1973 year-class properly, the exploitation of these age 4 fish in 1977 should be kept to a minimum so as to allow the individual fish to grow to a better commer-

cial size before more intensive exploitation starts. There is, therefore, every reason to keep the 1977 catch level as low as possible. The Subcommittee consequently recommends that the 1977 TAC be set at zero.

Table 3 illustrates the various levels of spawning biomass by 1978 and 1979 that will result from various levels of fishing in 1977 and 1978 respectively. If the TAC for 1976 is fully taken, the spawning biomass will be about 130,000 tons in Subarea 1 at the beginning of 1977. In order to maintain this level of spawning stock at the beginning of 1978, the 1977 catch level should be about 31,000 tons. A catch lower than this will lead to further improvement of spawning stock size, whereas a catch above 31,000 tons will reduce spawning biomass to a further low level by 1978, although some improvement will occur thereafter when the 1973 year-class enters the spawning stock in 1979.

Table 3. Predicted catches (tons) of Subarea 1 cod in 1977 and 1978 for various levels of exploitation, and resultant spawning biomass at the beginning of 1978 and 1979. (TAC of 45,000 tons for 1976 is assumed to be fully utilized.)

F in 1977-78	Spawning biomass 1 Jan 1977	Catch 1977	Spawning biomass 1 Jan 1978	Catch 1978	Spawning biomass 1 Jan 1979
0	130,000	0	160,000	0	270,000
0.24	130,000	31,000	131,000	37,000	200,000
0.35(1976)	130,000	44,000	120,000	44,000	175,000
0.40($F_{0.1}$)	130,000	50,000	115,000	48,000	155,000

Maintenance of the present level of F(0.35) would lead to catches of about 44,000 tons in 1977 and 1978 and a spawning stock biomass of about 120,000 tons at the beginning of 1978 and about 175,000 tons at the start of 1979. Fishing at the $F_{0.1}$ level (0.40) in 1977 should lead to a catch of about 50,000 tons but would reduce the spawning biomass to about 115,000 tons by 1978. Close to 50% of the predicted catches for 1977 and somewhat more than 50% of the spawning biomass by 1978 would consist of cod of the 1971-75 year-classes, i.e. those year-classes for which estimation of recruitment has been used in doing the analysis.

In its last two reports to the Commission, the Subcommittee has pointed out that the matter of managing the Subarea 1 cod fisheries, so as to take possible stock-recruitment relationships into account, also involves regulation of the fisheries off East Greenland. The question of the inter-relationship between cod stocks at Iceland and at Greenland has recently been discussed in the ICES North-Western Working Group, whose provisional report (Summ. Doc. 76/VI/7) was discussed by the Subcommittee. The report confirms both the emigration of part of the mature cod from West Greenland to East Greenland and Iceland and the dependency of the West Greenland cod on spawning off southeast Greenland and probably also more northeastward between East Greenland and Iceland. The Subcommittee endorses the statement by the ICES Working Group that, from a biological viewpoint, the cod stock in Div. 1E and 1F may be considered to be just as much related to cod off East Greenland as to cod in Div. 1A to 1D.

The two North Atlantic fisheries commissions may, therefore, wish to consider ways to include the cod stock off East Greenland in the regulation of the Greenland cod stocks. The Subcommittee noted that the ICES Working Group had given no special advice on management of the East Greenland cod. However, analyses presented to the Subcommittee (Res. Doc. 76/VI/17), using the same data for catch by age-groups off East Greenland as was considered by the ICES Working Group but with revised F-values (and assuming that recruitment to East Greenland is equal to recruitment to Div. 1E and 1F), suggest that a catch for the Greenland area as a whole (ICNAF Subarea 1 + ICES Subarea XIV) would be about 25% greater than that at West Greenland for the same level of F at East and West Greenland. Thus, for a 1977 catch of 31,000 tons at West Greenland, a catch of 8,000 tons would apply for East Greenland. This figure of 8,000 tons is about 1,400 tons above the 1974 catch of cod off East Greenland and also somewhat above the provisionally reported catch in 1975, but it is less than one-third of the high catches in 1970-72, when the average annual yield was about 26,000 tons.

Should the Commission wish to consider a breakdown of the total Greenland area for management purposes, it would be appropriate to consider Div. 1A-1D separately from Div. 1E-1F and East Greenland combined. In that case, about 75% of an adopted TAC for Subarea 1 could be allocated to Div. 1A-1D and the remainder of the Subarea 1 TAC added to whatever TAC might be set for East Greenland (estimated to be about 25% of the Subarea 1 TAC), thus constituting a TAC for the region Div. 1E-1F + ICES Subarea XIV.

b) Greenland halibut in Statistical Area 0 and Subarea 1

Nominal catches from these areas increased from 10,000 tons in 1973 to 14,000 tons in 1974 and to nearly 26,000 tons in 1975, the last figure being based on provisional statistics reported to the present meeting and on information in the USSR Research Report (Summ. Doc. 76/VI/20). In 1975, the Subcommittee considered 20,000 tons to be an appropriate level as a precautionary TAC for 1976. At the present meeting, the Subcommittee, while expressing the need for caution because of a possible by-catch problem in connection with the shrimp fishery in Subarea 1, recommends that the TAC for 1977 remain at 20,000 tons.

c) Roundnose grenadier in Statistical Area 0 and Subarea 1 (Res. Doc. 76/VI/27, 28); Summ. Doc. 76/VI/18, 20)

Nominal catches of grenadier in these areas ranged from 5,000 to 12,000 tons during the 1967-75 period, the average annual catch being about 6,000 tons. The provisional 1975 catch was 5,000 tons, a decrease from the 1974 catch of 12,000 tons. New data were reported by German Democratic Republic and USSR (Summ. Doc. 76/VI/18,20).

Previously it was not possible to calculate the stock size because of the lack of data on the age composition of catches. Two new methods of age determination are described in Res. Doc. 76/IV/28, and the GDR samples for the years 1973 and 1974, together with length samples for previous years, were used in the stock assessment given in Res. Doc. 76/VI/27. Stock size and fishing mortality were calculated by cohort analysis, based on age-groups as well as length-groups. Two options for M were used, 0.1 and 0.2, between which the actual value is likely to be found.

The results indicate that the fishing mortalities and catches of the more recent years are in the range of the calculated $F_{0.1}$ (0.3 and 0.5), and the sustainable yields are calculated to be 7,400 tons for M=0.1 and 9,800 tons for M=0.2. The Subcommittee accordingly recommends a TAC of 8,000 tons for 1977.

d) Shrimp in Subarea 1 (Comm. Doc. 76/VI/20; Summ. Doc. 76/VI/19; Res. Doc. 76/VI/15, 16, 50)

Shrimp (*Pandalus borealis*) is known to occur along most of the West Greenland coast both offshore and inshore. It is fished mainly in depths below 150 m, with most shrimp fishing grounds having a depth of 250-500 m. Most of the offshore grounds occurs in Div. 1A-1C. Disko Bay is by far the most important inshore ground, with catches accounting for about 70-80% of the inshore catches.

The species has protandric hermaphrodism, i.e. it starts its mature life period as male but, as it grows further, a change of the gonads occurs and the animal remains female for the rest of its life. The growth rate in Greenland waters is very slow compared to more southern regions of the area of distribution. The change from male to female occurs at an age of 4-5 years. The females are oviferous from spawning in July-August until hatching in April-May, and their growth rate is thereby so slow that it is difficult to distinguish older age-groups from each other in length frequency diagrams. However, the major part of the catches consist of age-groups 4 and older (i.e. females) but also of some 3-year-old males.

At least some of the observed fluctuations in abundance on individual grounds have been shown to be connected with environmental changes, indicating that considerable migration, including passive transportation with the currents, occurs regularly. The species is found mainly in the deeper and warmer water masses originating from the Irminger current. After hatching the larvae are found in the plankton and can be carried over long distances. The stock on one ground may, therefore, well get a considerable part of its recruits from larvae hatched on another ground. The stock in the Disko Bay area is thus thought to be rather dependent on stocks to the south and to the west of the bay, and there are some indications that, besides the larval drift, inflow of adult shrimp to Disko Bay and other inshore grounds occurs more or less regularly.

Greenland has gradually built up a shrimp fishery and the industry is based mainly on inshore grounds from Nanortalik (Div. 1F) to Disko Bay (Div. 1A), with the latter area accounting for 70-80% of the Greenlanders' catches. There was some fishing in the late 1930's at Holsteinsborg (Div. 1B), but the development of the Greenland shrimp fishery started about 1950. By 1970 the total catch of the Greenlanders had reached a level of 8,400 tons annually, and it has been further increased to a level of about 10,000 tons in 1974-75 (Table 4). The existence of offshore grounds has been known for several years, and mapping and research sampling on them started in the early 1960's. Apart from some occasional fishing by Greenlanders on grounds close to the shore, the offshore grounds were, however, not fished (for shrimps) before 1969 when Faroese vessels started a fishery. Norway has participated since 1972, and in the last year or two Spain and USSR have also participated in the fishery. Also, some of the larger Greenland vessels

are now fishing mainly offshore. The development of the fishery is shown in Table 4 together with the Greenlanders' fishery. No discarding occurs in the Greenlanders' fishery but some may occur in the offshore fisheries.

Table 4. Annual nominal catches of shrimp from West Greenland, 1970–75. (Figures for 1975 are provisional; the Spanish catch is a rough estimate as given in Res. Doc. 76/VI/50; the catch for Denmark (M) is at present a rough estimate; the USSR catch is taken from Summ. Doc. 76/VI/20, reported as "other shellfish".)

	1970	1971	1972	1973	1974	1975
Greenland	8,429	8,941	7,368	8,135	10,243	9,885
Faroes	130	496	755	1,371	2,023	5,300
Denmark(M)	-	-	-	196	308	1,000
Norway	-	-	1,409	2,940	5,616	8,678
Spain	-	-	-	-	?	8,500
USSR	-	-	-	-	-	6,033
Total Offshore	130	496	2,164	4,507	7,947+	29,511
Grand Total	8,559	9,437	9,532	12,642	18,190+	39,396

Compared to other North Atlantic areas where shrimp fishing is taking place, Subarea 1 now accounts for by far the largest catch, followed by the Gulf of Maine. In 1975 the Greenland catch was more than three times the highest catch ever achieved in the Gulf of Maine (12,766 tons taken by the USA in 1969) where the USA catch by 1974 had decreased to 8,000 tons with a further decrease in 1975 and 1976. The 1975 catch at Greenland is of the same magnitude as the USA catch in Alaska for 1970 and about 60% of the highest USA catch recorded there (65,000 tons in 1973).

Noting the rapid development of the offshore fishery in 1975 and the Danish proposal to regulate the fishery (Comm. Doc. 76/VI/20), the Subcommittee agreed that the fishery should be regulated and therefore discussed some analyses carried out to estimate the stock size. An analysis, based on some Faroese vessels' catch and effort in 1975 (Res. Doc. 76/VI/15) and the present knowledge of the extension of the grounds, indicated that the stock size on the offshore grounds is 80,000–90,000 tons. A similar analysis for some of the Spanish trawlers (Res. Doc. 76/VI/50) and some special areas gave results for these areas, which were similar to the Faroese data for the same areas. The stock size in question refers only to those age-groups in the stock which are recruited to the fishery. Most of the factors involved in the analyses will tend to underestimate the stock size. However, it is a basic assumption that the catch per unit effort of the vessels, for which data are included in the analyses, do apply also to other parts of the areas considered rather than just to those grounds actually fished. These analyses together with the catch figures indicate that about one-third of the recruited stock was removed by the fishery in 1975. It should be noted that offshore fishing in 1975 took place on a nearly virgin stock with several accumulated year-classes of adult shrimp. In the absence of a better knowledge of natural and fishing mortality, stock-recruitment relationship, and year-class fluctuations, the Subcommittee considers that the maintenance of a catch level like that in 1975 is too risky and could lead to depletion of the (female) stock below that required to ensure the maximum sustainable yield.

Another analysis (Res. Doc. 76/VI/16), aimed at supplying a proposal for a precautionary quota, should the Commission wish so, was discussed by the Subcommittee. One of the basic assumptions in this analysis is that the recent catch level in the Disko Bay area (about 8,000 tons) is close to the long-term MSY level for this area. The area of Disko Bay is about 8,000 km^2, including grounds not actually fished but regarded as supply areas. The other basic assumption is that the yield per unit area (i.e. 1 ton per km^2 per year) applies also to the offshore fishing grounds and their supply areas, if any. However, for areas adjacent to Disko Bay (west and southwest of the bay), the yield figure used in the analysis was reduced to 0.5 tons per km^2, thereby taking into account the likely importance of these areas for the recruitment to Disko Bay, including the possible intrusion of adult shrimp from these areas to the bay. If the basic assumptions hold, then the analysis indicates that a probable MSY level for the offshore grounds as a whole is about 26,000 tons annually. It should be stressed that this figure applies to the total catch including possible discards.

The basic assumption that the recent catch level in the Disko Bay area represents the MSY level was considered. In the absence of proper information on long-term trends in catch per effort, the Subcommittee was not able to make an analysis of this question. It was noted, however, that gear improvement has taken place and that fishermen report that they have to switch more

frequently than formerly between grounds to maintain their daily catch rate. It was also shown that the stock density on the offshore grounds in Div. 1C-1E is not as high as in Div. 1B (Res. Doc. 76/VI/15, Table 2). Thus the long-term catch level per unit area for these southern grounds probably cannot be taken to be as high as for Disko Bay area. It was also noted that there might be a relationship between the present high stock density of shrimp and the rather low level of the cod stock, since the cod is known to be one of the important predators on shrimp. After considering all of the available data, the Subcommittee recommends that the Commission limit shrimp fishing in Subarea 1 so that the total catch on offshore grounds (Convention Area) should in any case not exceed 26,000 tons annually, including all discards.

The Subcommittee discussed the biological aspects of the desirability of breaking a possible overall TAC down by areas (ICNAF divisions or specific fishing grounds). Quite clearly, if the possible TAC is not broken down, overfishing may occur locally and could be critical if it occurred in areas important for recruitment. If the Commission wishes to consider a breakdown of an overall TAC, the Subcommittee advises that, in addition to the caution mentioned for the areas close to Disko Bay, attention should be placed on the stock-recruitment relationship in connection with the likely drift of larvae northwards. It would thus seem advisable to have a relatively light exploitation rate of stocks in Div. 1E-1D and southern part of Div. 1C. Stock density on these grounds seems to be less than one-half of that in Div. 1B (Res. Doc. 76/VI/15, Table 2) so that the MSY level here may be overestimated by applying the Disko Bay unit to these areas. On the other hand, apart from the possible precaution to be taken for areas supplying recruitment to the Disko Bay, grounds in the northernmost part of the subarea may be more heavily fished. This would apply specifically to grounds so far to the north that there is a possibility that larvae from these stocks are lost through drift to unfavourable environments.

In connection with a discussion of a break-down of a possible TAC the Commission may wish to consider an effort regulation combined with or instead of a TAC. The Subcommittee did not discuss this matter in any detail due to the lack of adequate data for most gear/vessel categories.

The Subcommittee discussed the desirability of a mesh size regulation. Data available suggest that the most proper mesh size in the trawl codend is 22 mm knot to knot (approximately 44 mm stretched mesh) (Res. Doc. 76/VI/16). Such a mesh size would diminish catch of small shrimp of age-group 3 and would not reduce catch of larger shrimp to any great extent compared to catches obtained by smaller mesh sizes.

It was also pointed out that special nursery grounds may exist, especially in more shallow water than the actual grounds fished, but no such specific areas can at present be described.

The Subcommittee stresses that information on catch and effort in the shrimp fisheries should be recorded through the adopted STATLANT reporting system in the form applicable to ICNAF. The Subcommittee further urges countries participating in the fishery to supply all relevant information on by-catches and discards, and that samples of catches and landings be taken and reported to ICNAF.

V. SUBAREAS 2 AND 3

1. Fishery Trends

(This subsection to be completed when more complete statistics become available from STATLANT 21A returns.)

2. Species Review

Table 5 contains a summary of recent catches and TACs, including those recommended for 1977, for stocks under consideration for management in Subareas 2 and 3. The TACs listed include quantities, if any, estimated to be taken outside the Convention Area.

a) Cod in Divisions 2G and 2H

Catches of cod in this area declined from an average of 70,000 tons in the period 1965-69 to 10,000 tons in the period 1970-74. Part of this decline may be attributed to severe ice conditions during the latter period. The provisional catch in 1975 was about 6,000 tons. An analytical assessment of this stock, presented in 1973, showed the catch corresponding to F_{max} assuming average recruitment to be in the order of 40,000 tons. Because of the very large catches in the late 1960's, the older fish had been severely depleted. In addition, the younger year-classes were apparently poor. For these reasons, a TAC of 20,000 tons was adopted by the Commission for 1974, 1975 and 1976 to allow the stock to rebuild. Since 1973, data have not been sufficient to allow an updating of the assessment. Sampling data (length and age compositions) and catch rates are urgently needed to properly assess this stock.

Table 5. Subareas 2 and 3: summary of nominal catches (1971-75) and TACs (1973-77) by species and stock area. (Nominal catches for 1975 are based on advance provisional statistics for April 1976 assessments, and TACs in parentheses are those recommended by the Assessments Subcommittee.)

Species	Stock area	Nominal catches (000 tons) 1971	1972	1973	1974	1975	TACs (000 tons) 1973	1974	1975	1976	1977
Cod	2GH	13	14	+	4	6	-	20.0	20.0	20.0	(20.0)
	2J+3KL	432	458	355	373	277	665.5	656.7	554.0	300.0	(160.0)
	3M	34	58	23	25	23	-	40.0	40.0	40.0	(25.0)
	3NO	126	103	80	73	45	103.5	101.1	87.7	43.0	(30.0)
	3Ps	64	44	53	47	36	70.5	70.0	62.4	47.5	(32.0)
Redfish	2+3K	19	20	39	30	23	-	30.0	30.0	30.0	(30.0)
	3M	8	42	22	35	16	-	40.0	16.0	16.0	(16.0)
	3LN	34	29	33	22	17	-	28.0	20.0	20.0	(16.0)
	30	20	16	9	13	14	-	16.0	16.0	16.0	(16.0)
	3P	28	26	18	22	28	-	25.0	25.0	18.0	(18.0)
A. plaice	2+3K	5	9	5	6	6	-	10.5	8.0	8.0	(8.0)
	3M	1	1	1	2	2	-	2.0	2.0	2.0	(2.0)
	3LNO	68	59	53	46	43	60.5	60.0	60.0	47.0	(47.0)
	3Ps	7	7	15	7	4	-	11.0	11.0	8.0	(6.0)
Witch	2J+3KL	16	17	24	16	13	-	22.0	17.0	17.0	(17.0)
	3NO	15	9	7	8	6	-	10.0	10.0	10.0	(10.0)
	3Ps	2	2	3	2	1	-	3.0	3.0	3.0	(3.0)
Yellowtail	3LNO	37	39	33	24	23	50.0	40.0	35.0	9.0	(12.0)
G. halibut	2+3KL	25	30	29	27	28	-	40.0	40.0	30.0	(30.0)
R. grenadier	2+3	75	24	18	28	28	-	32.0	32.0	32.0	(35.0)
Capelin	2+3K	+	46	136	127	189	-	110+[1]	160+[2]	160+[2]	(300.0)
	3L	1	1	4	58	30			45+	45+	
	3NO	1	21	127	101	122	-	148+[1]	126+[3]	126+[3]	(200.0)[4]
	3Ps	1	3	1	2	2			9+	9+	
Mackerel	3+4	24	22	38	45	37	-	55.0[5]	70.0	56.0	(0.0)[6]
	5+6	349	387	381	295	246	450.0	304.0	285.0	254.0	
Squid-*Illex*	3+4	9	2	10	+	17	-	-	25.0	25.0[7]	(25.0)

[1] Countries without specific allocations may each take up to 10,000 tons from the stocks, no more than 5,000 tons of which may be taken in Div. 3LNOPs.
[2] Countries without specific allocations may each take up to 10,000 tons.
[3] Countries without specific allocations may each take up to 5,000 tons in Div. 3LNOPs, but no more than 5,000 tons in aggregate from Div. 3L and no more than 1,000 tons in aggregate from Subdiv. 3Ps.
[4] No more than 50,000 tons of which should be taken in Div. 3L and no more than 10,000 tons in Subdiv. 3Ps.
[5] TAC pertains to Div. 4VWX only.
[6] Recommended TAC subject to re-assessment at 1976 Annual Meeting (see Section VII, 2(p)).
[7] Countries without specific allocations may each take up to 3,000 tons.

Although catch rates of FRG trawlers showed an improvement in 1974-75 over the low levels of 1971-73, it was not possible to determine whether the increase was due to increased abundance or to changes in fishing pattern and availability. In view of the uncertainties in determining the status of this stock, the Subcommittee recommends that the TAC for 1977 remain at the level of 20,000 tons.

b) Cod in Divisions 2J, 3K and 3L (Res. Doc. 76/VI/53; Summ. Doc. 76/VI/17, 18, 20)

Average annual catches of cod in this area declined from about 650,000 tons in the period 1965-69 to about 425,000 tons in 1970-74. The provisional catch in 1975 was about 280,000 tons. Catch rates for GDR and FRG fisheries in 1975 tend to show a decline in abundance in comparison with those for 1974. The bottom trawl survey conducted by USSR shows a decline in the number of cod per hour trawling in Div. 3K and 3L from 72 fish in 1974 to 53 fish in 1975.

Age composition data for 1975 indicate that the catches consisted of older fish than in 1974, with the 1967 and 1968 year-classes predominating. The USSR young fish survey shows the 1970,

1971 and 1972 year-classes to be poor. However, the FRG groundfish survey, conducted later in the year, indicates that the 1972 year-class is stronger than those of 1970 and 1971.

Estimates of recruitment were derived from a consideration of the results of the USSR young fish surveys. It was noted that the correlation between values of year-class strength derived from the young fish surveys and values for these year-classes from the virtual population analysis is not good, indicating that the recruitment estimates are subject to a great deal of variation.

Weight-at-age data were reviewed and considered appropriate for use for the stock as a whole.

A virtual population analysis and catch projections based on the results of this analysis were considered, assuming that the TAC for 1976 will be caught and using recruitment values derived as described above. A catch at F_{max} of 260,000 tons in 1977 would result in a spawning stock size of about 600,000 tons at the end of the year, compared to a level of 1.2 million tons for the 1969-72 period. In view of the current low level of stock size and the very poor recruitment of year-classes younger than that of 1969, concern was expressed that the spawning stock may now be at a level which would result in wide fluctuations in recruitment and, consequently, a series of years of poor recruitment might well be the result. At the level of $F_{0.1}$=0.2, the yield in 1977 would amount to about 160,000 tons. Continued fishing at this level, assuming average recruitment over the period 1970-74, would result in catch and spawning biomass levels (000 tons) as follows:

	1977	1980	1983	1986
Spawning biomass at start of year	680	930	1,200	1,400
Catch	160	250	300	325

Fishing at $F_{0.1}$ in 1977, the spawning stock at the end of the year would not be reduced below the level at the start of the year, whereas fishing at F_{max} during 1977 would result in a spawning stock at the end of the year about 12% lower than that at the beginning of the year. In view of the poor recruitment in recent years and the low level of spawning stock size, and considering that the 1972 year-class may be moderately strong, the Subcommittee considered that a reduced catch in 1977 was appropriate to preserve the spawning stock and to allow the incoming year-classes to contribute more fully to the fishery. The Subcommittee therefore recommends that the TAC in 1977 be set at 160,000 tons, the yield corresponding to fishing at $F_{0.1}$.

c) Cod in Division 3M (Res. Doc. 76/VI/33, 55; Summ. Doc. 76/VI/20)

Catches of cod in this area declined from an average of about 42,000 tons in the period 1965-69 to about 33,000 tons in 1970-74. The catches in 1973, 1974 and 1975 were each in the order of 25,000 tons. An analytical assessment presented in 1973 indicated that the average long-term yield is about 40,000 tons annually. This estimate is comfirmed by a general production model assessment presented at this meeting, which indicates that, following the high fishing activity in 1972, the stock was in a somewhat depressed condition.

Sampling data have been exceedingly scanty over the past few years, and no updating of the analytical assessment has been possible. Length frequencies for the fourth quarter of 1975, submitted by Portugal and United Kingdom, show that catches were composed predominantly of cod smaller than 50 cm. Sampling data, submitted by Canada, indicate that catches in June by commercial pair trawlers were composed of larger cod (mean length at 60 cm) and also that a considerable increase in growth rate may have occurred over the past few years. USSR surveys in the area demonstrate wide fluctuations in recruitment but a remarkably strong 1973 year-class is indicated. Catch rate data indicate a downward trend in stock abundance since 1963, but there was some improvement in 1974. This improvement may well continue in the immediate future as the strong 1973 year-class enters the fishery.

The Commission has adopted a TAC of 40,000 tons for this stock since 1974. The decline in catch rate, the fact that catches in the last 3 years have been considerably below 40,000 tons, and the evidence showing that the stock is now composed mainly of smaller and younger cod suggest that the stock at present is not in a condition to support the continued fishery at the MSY level. A TAC at a lower level would provide the opportunity for the younger fish, including the apparently strong 1973 year-class, to grow and contribute greater catches over a longer period of time. The Subcommittee considered that the TAC for 1976 was rather high and accordingly recommends that the TAC for 1977 be set at 25,000 tons, corresponding to the level of catches in the last three years.

d) Cod in Divisions 3N and 3O (Summ. Doc. 76/VI/8, 20)

Nominal catches of cod in this area have shown a sharp decline from a high of 227,000 tons in 1967 to 73,000 tons in 1974. Provisional statistics for 1975 indicate a further decline to 45,000 tons. The 1975 catch represents a shortfall of 43,000 tons on the 1975 TAC of 87,700 tons.

Due to the paucity of sampling data, it was impossible to construct satisfactory estimates of catch-at-age in 1975. Only two length frequency samples were available, and to use these to convert the catches of all countries to numbers caught by age-groups might well result in serious biases. It was possible to make an assessment using 1974 catch-at-age data (Summ. Doc. 76/VI/8), but, due to the depleted state of the older age-groups, the catches predicted for 1977 were based largely on assumptions about the sizes of the incoming year-classes. This is clearly an unsatisfactory basis for predicting TACs.

Catch rates of Spanish pair trawlers showed a substantial decline during 1968-74. On the basis of changes in Spanish and USSR fishing effort between the late 1960's and 1973 and in the correlation between fishing effort and fishing mortality in the 1960's, a fishing mortality of 0.7 (well in excess of F_{max} at 0.25) was estimated for 1974. Comparable catch rate data are not yet available for 1975. USSR trawl surveys (Summ. Doc. 76/VI/20) and Canadian surveys in the area suggest that the stock in 1975 was at a low level of abundance similar to that in 1974. If this is the case, the decline in catch between 1974 and 1975 is due to a decrease in fishing effort, and the F-value applicable to the 1975 fishery is about 0.5. At the September 1975 Special Commission Meeting, the total biomass of cod (age 4 and older) at the beginning of 1975 was estimated to be about 234,000 tons, or about 60% of the average biomass in the 1960's. The Subcommittee affirms its conclusions of that meeting that, in order to safeguard future productivity, it is desirable to restore the total biomass to at least the earlier level.

At the September 1975 Special Commission Meeting, the Subcommittee recommended a TAC of 43,000 tons for 1976. Insufficient data are available at the present time to provide an adequate reassessment of this stock, and no particular figure could be determined for the yield in 1977. The Subcommittee noted that the TACs adopted by the Commission for 1973 and 1974 were well above those recommended by STACRES and that the adopted TACs were not fully utilized. The shortfalls in catch with respect to the TACs in 1973, 1974 and 1975 were 24,000, 28,000 and 43,000 tons respectively. Because of the lack of sampling data for this stock, the Subcommittee recommends that the 1977 TAC be reduced 25% below the 1976 TAC and be set at 30,000 tons for 1977. This level of catch is consistent with the calculation that it was possible to make for this stock with the very limited data available.

e) Cod in Subdivision 3Ps

Nominal catches of cod in this area declined from 53,000 tons in 1973 to 46,700 tons in 1974, and provisional statistics for 1975 indicate a further decline to 36,000 tons.

At its April 1975 Meeting, the Subcommittee concluded that fishing at F_{max} (0.3) in 1976 would yield a catch of 55,000 tons, but, since this figure was not substantially different from the TAC of the previous year, a TAC of 60,000 tons was recommended for 1976. At the September 1975 Special Commission Meeting, a re-examination of the data considered at the April 1975 Meeting together with additional information indicated a catch of 47,500 tons for 1976 by fishing at F_{max}, the TAC subsequently adopted by the Commission.

An updating of the virtual population analysis, using the 1975 provisional catch of 36,000 tons, indicated a catch for 1977 of 45,000 tons at F_{max}=0.3. Continued fishing at F_{max} under average recruitment conditions would result in an improvement in biomass from about 220,000 tons in 1977 to about 260,000 tons in 1986. Fishing at $F_{0.1}$ (0.2) in 1977 would provide a catch of 32,000 tons, but with continued fishing at this level, again assuming average recruitment, there would be a substantial increase in biomass to 325,000 tons by 1986. A catch of 45,000 tons at F_{max} in 1977 would result in a spawning stock size of about 160,000 tons at the beginning of 1978 compared to the average level of 140,000 tons during 1969-72. Assuming average recruitment and continued fishing at F_{max}, the spawning biomass would reach a level of about 170,000 tons by 1984. Fishing at the $F_{0.1}$ level in 1977 would result in a spawning biomass of about 175,000 tons at the beginning of 1978, and continued fishing at that level, assuming average recruitment, would lead to a spawning stock size of about 225,000 tons by 1984.

The Subcommittee noted that about one-third of the catch by weight in 1977 would depend on year-classes for which only average recruitment estimates were used in the analysis. In view of this uncertainty, the Subcommittee considers it prudent to fish at a level lower than F_{max} and therefore recommends that the TAC for 1977 be set at 32,000 tons, the yield corresponding to fishing at $F_{0.1}$ using the assumed average recruitment values.

f) Redfish in Subarea 2 and Division 3K

Previous general production analyses indicated that this stock can sustain catches of 40,000-50,000 tons per year under equilibrium conditions, but the stock has been in a depressed condition in recent years. Catches in relation to fishing effort during 1966-74 were below the equilibrium curve. Catches increased from 20,000 tons in 1972 to 39,000 tons in 1973, the largest catch since 1965, but subsequently declined to 30,000 tons in 1974 and to 23,000 tons in 1975 under quota regulation. The increased catch in 1973 resulted from increased effort directed toward the stock in response to improvement in catch per unit effort. Effort declined from 2,300 standard days fished (days fished by 2000+ GRT trawlers) in 1973 to 1,840 days in 1974. Catch per standard day fished was 16.4 tons in 1974 compared with 16.8 tons in 1973, both of which were above the 1971-72 level but only slightly better than the 13.2-15.0 tons per day during 1967-70. Commercial length frequency data indicate that catches in 1975 contained a higher proportion (in numbers) of 22-30 cm fish than during 1972-74. However, there was a marked absence of younger age-groups (fish less than 20 cm) in 1974 and 1975 research surveys by Federal Republic of Germany, using small-meshed liners in the survey trawl.

The TACs for 1974-76 were limited to 30,000 tons in order to permit the stock to rebuild from the depressed level of the late 1960's and early 1970's. Since redfish is a slow-growing, long-lived species, the Subcommittee recommends that the TAC for 1977 be maintained at 30,000 tons to take advantage of somewhat improved recruitment, which began to enter the fishery in 1975, to permit rebuilding of the stock. This level of catch is expected to control the fishing mortality below F_{MSY}.

g) Redfish in Division 3M

Maximum sustainable yield estimates of 13,000-17,000 tons were derived previously from a general production study of this stock. A previous yield-per-recruit analysis indicated an $F_{0.1}$ level of 0.2-0.3 and suggested that the average level of fishing mortality during 1963-73, when catches averaged 13,600 tons, may have been at or greater than $F_{0.1}$ for the average recruitment levels during that period. The catch declined from 43,000 tons in 1972 (almost five times the average 1963-71 level of 8,500 tons) to 22,000 tons in 1973, increased to 35,000 tons in 1974 and declined to 16,000 tons in 1975 under quota regulation. The catch per standard day fished by 150-499 GRT otter trawlers increased substantially from 3.4 tons in 1969 to 7.8 tons in 1972 and subsequently declined to 6.6 tons in 1973 and 5.5 tons in 1974. For the first time, substantial quantities of redfish (about 13,000 tons) were reported taken by midwater trawl in 1974. USSR vessels (2000+ GRT) reported midwater trawl catch rates of 33 tons per day fished in 1974. According to information noted at the January 1976 Special Commission Meeting, significant quantities of redfish may have been taken by midwater trawl in both Div. 3M and Div. 3LN during 1972 and 1973 but reported as caught by otter trawl without distinction between bottom and midwater fishing. Canadian vessels of 500-999 GRT, on the basis of limited midwater trawling for redfish in Div. 3M during 1975, reported catch rates of 16.6 tons per day fished.

The available evidence indicates that catches of the magnitude of those taken during 1972-74 could not be sustained without risking stock depletion. Because it is not possible to specify the level of catch in 1977 corresponding to $F_{0.1}$ or alternative levels of fishing mortality, the Subcommittee recommends that the TAC for 1977 remain at 16,000 tons, approximately the level of the estimated maximum sustainable yield.

h) Redfish in Divisions 3L and 3N

The 1973 redfish catch from this area was 33,000 tons, approximately the same as the 1971-72 average of 32,000 tons but in excess of the estimated MSY level of 20,000 tons, derived previously from a general production analysis of effort data from the redfish fishery in Div. 3N and extrapolated to include Div. 3L. The 1974 and 1975 catches under quota regulation at TACs of 28,000 and 20,000 tons respectively were substantially lower at 22,000 and 17,000 tons. For the first time in 1974 significant quantities (8,100 tons) were reported taken by midwater trawl, chiefly in Div. 3L. Because of the apparent lack of a direct bottom trawl fishery for redfish in 1974, it has not been possible to update the general production assessment, upon which the earlier MSY estimate was based. Bottom trawl catch rates had been relatively stable during 1966-73 with a slight increase during 1972-73. Canadian vessels of 500-999 GRT, based on limited midwater fishing for redfish in Div. 3L during 1975, reported midwater trawl catch rates of 15.9 tons per day fished.

No commercial length or age data were available for this stock during 1967-74, despite the increased catches of 1971-73. However, some sampling data were available for 1975 midwater trawl catches. These indicated that the redfish caught by midwater trawl were of a considerably larger size (36-40 cm for males and bimodal for females at 30-34 cm and 40-46 cm with the larger-sized fish predominating) than those normally taken by bottom trawl. The Subcommittee noted the possibility that this new midwater fishery may be exploiting the oceanic pelagic redfish instead

of the North American shelf redfish which are fished traditionally by bottom trawl. The predominance of very large redfish in 1975 midwater trawl catches could be due to fishing the coastal fringe of the oceanic redfish which occur pelagically between North America and West Greenland and which are much faster-growing, attaining a considerably large size than the North American redfish. If the same species or stock fished previously by bottom trawl primarily in Div. 3N is now being taken by midwater trawl, the occurrence of these very large fish at high catch rates would suggest that this stock has not been subjected to a high rate of exploitation in recent years.

An examination of catches in relation to fishing effort, calculated from catches and bottom trawl catch rates during 1971-73, indicated that fishing effort during those years was beyond the F_{MSY} level. In view of the uncertainty about the level of fishing effort directed toward redfish in this area during 1974-75 and assuming that the same stock complex is being fished by midwater trawl as by bottom trawl, the Subcommittee recommends a TAC of 16,000 tons for 1977 to reduce effort below the F_{MSY} level in order to compensate for the fact that fishing effort was beyond the F_{MSY} level during 1971-73. Priority should be given to stock-species identification studies for redfish in this area in order to resolve the uncertainties that have arisen as a result of the recent development of a midwater fishery.

i) Redfish in Division 3O

Catches from this stock declined from approximately 20,000 tons in 1971 to 16,000 tons in 1972 and 9,000 tons in 1973, but subsequently increased to 13,000 tons in 1974 and 14,500 tons in 1975 under quota regulation. Catch per standard hour fished has increased significantly from 0.7 tons in 1971 to 1.2 tons in 1974. The decline in catch during 1972 and 1973 apparently resulted from decreased fishing effort rather than decreased abundance, since the upward trend in catch per unit effort indicates an increase in abundance or availability during 1971-74.

No commercial length or age data have been available for this stock since 1968. The upward trend in commercial catch per unit effort suggests that this stock may have been experiencing good recruitment in recent years. In view of the lack of adequate data to permit a more detailed assessment of this stock, the Subcommittee recommends that the 1977 TAC for this stock remain at 16,000 tons.

j) Redfish in Division 3P

Nominal catches from this stock were at a relatively high level during 1969-72, averaging about 31,000 tons. The catch declined from 27,500 tons in 1971 to 26,000 tons in 1972 and 18,000 tons in 1973. There was an increase to 22,000 tons in 1974, when a TAC of 25,000 tons was first applied to this stock. The provisional 1975 catch of 28,000 tons was in excess of the TAC of 25,000 tons. The catch per unit effort of Canadian bottom trawlers (150-499 GRT), which had exhibited a steady decline from more than 0.9 tons per hour in 1965 to 0.5 tons per hour in 1974, levelled off at 0.5 tons per hour in 1975. The catch rates of Canadian midwater trawlers (500-999 GRT) declined from 1.48 tons per hour in 1973 to 0.92 tons per hour in 1975. The increase in catch from 18,000 tons in 1973 to 23,000 tons in 1974 and 28,000 tons in 1975 was accomplished only through substantial increases in fishing effort, beyond that required to attain the MSY under equilibrium conditions.

Commercial catch rate data indicated a high level of redfish abundance in this area during the mid-to-late 1960's with above-average recruitment to the fishery. Only about one-half as many redfish older than age 6 were caught in research surveys of the area in 1973, 1974 and 1975 as in a comparable survey in 1965 at the onset of the recent period of increased exploitation. These moderately good year-classes (1964-66), which are expected to enter the fishery over the next several years, appear to be only one-half as abundant as those of the mid-to-late 1950's, which supported the fishery during 1965-75. The yield from these year-classes of 1964-66 would therefore be expected to be substantially less than that supported by the earlier level of recruitment. Canadian commercial age composition data for 1975 indicate a shift to exploitation of slightly older fish in 1975, possibly due to some shift in fishing activity from Subdiv. 3Pn to 3Ps. The year-classes of the mid-1960's are not yet contributing as significantly to the fishery as expected, but they were present to a very limited extent in bottom trawl catches in 1975.

On the basis of revised estimates of MSY (20,000-23,000 tons) and preliminary indications that the catch per unit effort in 1975 would be at about the same level as in 1974, the Subcommittee at the September 1975 Special Commission Meeting concluded that a TAC of 18,000 tons would maintain fishing effort at the MSY level in 1976. Estimates of fishing mortality from commercial age composition data during 1973-75 indicate that fishing mortality during that period, when catches averaged 22,500 tons, was at the $F_{0.1}$ level. Because catch per unit effort apparently stabilized in 1975, similar considerations suggest that a TAC of 18,000 tons would maintain fishing effort at the MSY level in 1977. In view of some uncertainty about the degree of dependence to be expected in 1977 upon the mid-1960's year-classes and about the relative strength of these

recruiting year-classes, it is not possible to specify the level of catch in 1977 corresponding to $F_{0.1}$ and alternative levels of fishing mortality. Therefore, the Subcommittee recommends that the TAC for 1977 be 18,000 tons, the same level of TAC as adopted for 1976.

k) American plaice in Subarea 2 and Division 3K

Nominal catches since 1973 have averaged about 5,500 tons annually, with a provisional catch of 5,700 tons for 1975. TACS of 8,000 tons for 1975 and 1976 were set by the Commission at the 1974 and 1975 Annual Meetings, aimed at managing the stock at the $F_{0.1}$ level of fishing mortality (0.45 for males and 0.30 for females). This fishery is to a large extent a by-catch fishery, but it is of considerable importance to the Canadian inshore gillnet fishermen, whose catches have declined somewhat in recent years, attributable in part to adverse ice conditions. No new data for this stock were available at this time, so the Subcommittee recommends that the TAC for 1977 remain at 8,000 tons.

ℓ) American plaice in Division 3M

Nominal catches for this stock were 504 tons in 1973, 1,928 tons in 1974 and approximately 1,700 tons in 1975. Based on average catch statistics, the Subcommittee again recommends that the TAC for 1977 be maintained at the 1976 level of 2,000 tons.

m) American plaice in Divisions 3L, 3N and 3O

Nominal catches from this stock have declined from 94,000 tons in 1967 to 68,000 tons in 1971 and to 46,000 tons in 1974. Provisional statistics indicate a catch of 43,400 tons in 1975. The TAC for the years 1973 to 1975 was set at 60,000 tons annually and this was expected to regulate the fishery at $F_{0.1}$ (0.50 for males and 0.45 for females). However, an updated assessment presented at the April 1975 Meeting of the Subcommittee indicated a fairly major reduction in stock abundance, especially in the Div. 3L segment of the stock area, and the Subcommittee recommended a reduction in the TAC for 1976 to 47,000 tons, which was calculated on the basis of 35,000 tons for Div. 3LN and an estimate of 12,000 tons for Div. 3O.

Catch rates have declined in recent years, but data for 1975 from commercial trawlers in Div. 3LN indicate that stock abundance has stabilized somewhat and data from research surveys indicate a slightly upward trend compared with the level in 1974. On the basis of the virtual population analysis presented at the present meeting, the Subcommittee recommends that the TAC for 1977 remain at 47,000 tons, corresponding to fishing at $F_{0.1}$, calculated on the basis of 37,000 tons for Div. 3LN and 10,000 tons for Div. 3O. The latter value for Div. 3O is slightly lower than that estimated for 1976 because of a decrease in catch rate in this division in 1975.

Some indication of the condition of the stock is given in the following table, with reference to the relative size of the spawning biomass of females in Div. 3L and 3N, using average recruitment values for 1971-73. Females are 50% mature at age 10.5 years in Div. 3L and at age 8.5 years in Div. 3N. No information was available to calculate comparable values for Div. 3O. The associated F-values for fully recruited age-groups are given in parenthesis.

	Spawning biomass of females (000 tons)						
Div.	1965-70	1973	1974	1975	1976	1977	1981
3L	120 (0.57)	55 (1.20)	51 (0.41)	63 (0.50)	73 (0.45)	80 (0.45)	90 (0.45)
3N	78 (0.40)	90 (0.90)	63 (0.40)	65 (0.60)	71 (0.45)	78 (0.45)	100 (0.45)

These trends in spawning biomass indicate that, if recruitment remains at the average level, the present regime of managing the fishery at $F_{0.1}$ (0.45 for females) should restore the stock to a higher level of abundance than is the case at present.

n) American plaice in Subdivision 3Ps

Except in 1973, when 15,000 tons were taken, nominal catches from this stock for 1971-74 averaged about 7,000 tons annually. Provisional statistics for 1975 indicate a catch of 4,200 tons. To a large extent this is a by-catch fishery with cod being the species sought. On the basis of an assessment in 1975, the previous TAC of 11,000 tons was reduced to 8,000 tons for 1976, in order to regulate the catch at $F_{0.1}$ (0.35 for males and 0.20 for females). The average annual catch of 5,500 tons for 1974-75 generated a fishing mortality of $F_{0.1}$. The Subcommittee therefore recommends that the TAC for 1977 be set at 6,000 tons in order to maintain the fishing mortality at $F_{0.1}$.

o) Witch flounder in Divisions 2J, 3K and 3L

Nominal catches from this stock declined from 24,000 tons in 1973 to 16,000 tons in 1974, and provisional statistics indicate a further decline to about 12,500 tons in 1975. This fishery is to a large extent a by-catch fishery, but it is of considerable importance to the Canadian inshore fishermen, whose catches in recent years have been somewhat reduced due to local ice conditions, especially in Div. 3K. On the basis of a yield-per-recruit assessment presented at the 1974 Annual Meeting, a TAC of 17,000 tons was recommended which would regulate the fishery at $F_{0.1}$ (0.30 for males and 0.25 for females). Since no new data are available at present, the Subcommittee recommends that the TAC for 1977 remain at 17,000 tons.

p) Witch flounder in Divisions 3N and 3O

Recent nominal catches have ranged from 15,000 tons in 1971 to 8,000 tons in 1974, and provisional statistics indicate a further decline to 6,000 tons in 1975. This is mainly a by-catch fishery associated with the cod and American plaice fisheries. A TAC of 10,000 tons was recommended for 1976 based on a yield-per-recruit assessment presented in 1975, indicating that fishing at $F_{0.1}$ (0.45 for males and 0.40 for females) would allow this yield. In the absence of any new information, the Subcommittee recommends that the TAC for 1977 remain at 10,000 tons.

q) Witch flounder in Subdivision 3Ps (Res. Doc. 76/VI/39)

Nominal catches have remained at the level of 2,000-3,000 tons in 1971-74 but declined to 1,400 tons in 1975. This is primarily a by-catch fishery. A yield-per-recruit assessment presented at the present meeting indicates a yield of 3,000 tons by fishing at $F_{0.1}$ (0.25 for males and 0.20 for females). The Subcommittee accordingly recommends a TAC of 3,000 tons for 1977.

r) Yellowtail flounder in Divisions 3L, 3N and 3O (Res. Doc. 76/VI/67)

Nominal catches from this stock increased from extremely low levels in 1964-65 to a maximum of 39,000 tons in 1972, and subsequently declined to 24,000 tons in 1974. Provisional statistics indicate that about 23,000 tons were taken in 1975. TACs for the years 1973 to 1975 were established at 50,000, 40,000 and 35,000 tons respectively. An assessment presented in 1975 indicated that fishing mortality was extremely high and that the expected levels of recruitment were not being realized. Indications of a decline in stock abundance came from both research surveys and catch rate data for the Canadian fishery, with the latter showing a decline of 30% between 1973 and 1974. The Subcommittee at its 1975 Meeting accordingly recommended a TAC of 10,000 tons for 1976, a yield slightly greater than the TAC of 9,000 tons subsequently established by the Commission.

A major difficulty in assessing this stock is due to the fact that the fishery is composed almost entirely of 6 age-groups (5-10 years). Thus there is a high dependence on the recruiting year-class at age 5 in making catch projections for 1977 based on stock size in 1974. At present the method of determining the strength of the recruiting year-classes is very crude and results in approximate values only, and thus the catch projected for 1977 is based almost entirely on approximate recruitment values. In view of this problem, the Subcommittee decided to present a range of predicted catches, based on the average recruitment of age 5 fish in 1971-73 (84 million fish) as a value for 1974 and a range of recruitment values for 1975 to 1977.

Recruitment at age 5 (10^6 fish)	Catch in 1976 at F=0.50 (tons)	Catch in 1977 at F=0.55 (tons)
80	10,539	15,450
70	9,753	13,741
60	8,962	12,034
50	8,170	10,327

It should be noted that the removal of 23,000 tons in 1975 was achieved at an apparent high fishing mortality, well above the $F_{0.1}$ level (0.55). In spite of this, there were general indications that the stock size in 1975 was beginning to stabilize, with catch rate data from the commercial fishery and research surveys being similar to those recorded for 1974. The Subcommittee had some difficulty in advising on an appropriate TAC for 1977, because of doubt concerning the recruitment for 1975, 1976 and 1977, but considered that a recruitment level of 60 million fish would be appropriate. Accordingly, the Subcommittee recommends a TAC of 12,000 tons for 1977.

s) Greenland halibut in Subarea 2 and Divisions 3K and 3L .

Nominal catches for this stock have remained relatively stable since 1972 at about 28,000 tons, and the provisional catch for 1975 is at the same level. An assessment presented in 1975 indicated that not more than 30,000 tons should be removed in 1976 if the stock is to be exploited at $F_{0.1}$ (0.6 for males and 0.2 for females). Although some new information indicates that the present level of fishing mortality may be slightly above $F_{0.1}$, fairly good recruitment prospects are indicated in Canadian and Federal Republic of Germany research surveys. Consequently, the Subcommittee recommends that the TAC for 1977 remain at 30,000 tons.

t) Roundnose grenadier in Subareas 2 and 3 (Res. Doc. 76/VI/27, 28; Summ. Doc. 76/VI/18, 20)

Nominal catches decreased from 75,000 tons in 1971 to 18,000 tons in 1973 but increased to 28,000 tons in 1974. Provisional statistics indicated a catch of about 28,000 tons in 1975. New data were reported by German Democratic Republic and USSR (Summ. Doc. 76/VI/18, 20). Methods of age determination and stock size calculation were the same as described for Stat. Area 0 and Subarea 1 (Res. Doc. 76/VI/27, 28). The assessment indicates that catches in the last two years were slightly below the sustainable yield (31,800 tons) at $F_{0.1}$ (0.2) for M=0.1. For M= 0.2, the sustainable yield at $F_{0.1}$ (0.4) is 40,800 tons. Accordingly, the Subcommittee recommends a slight increase in the TAC (32,000 tons in 1976) to 35,000 tons in 1977.

u) Capelin in Subareas 2 and 3 (Res. Doc. 76/VI/9, 20, 23, 51, 54, 62)

Provisional statistics indicate a nominal catch of 343,000 tons from these stocks in 1975 compared with 288,000 tons in 1974 and 265,000 tons in 1973. Additional biological data on food and feeding (Res. Doc. 76/VI/20), age distributions (Res. Doc. 76/VI/62), commercial catch characteristics in 1975 (Res. Doc. 76/VI/9,23) and biomass estimates from acoustic surveys (Res. Doc. 76/VI/51,54) were presented at this meeting. The acoustic surveys, conducted in Div. 3N in June 1975 and in Div.2J and 3K in October 1975, indicated biomass levels in the order of 1,000,000 tons in each area. These estimates are comparable with previous ones from acoustic surveys.

At the January 1975 Special Commission Meeting, STACRES recommended increasing the TAC for Subareas 2 and 3 from 250,000 tons in 1974 to a maximum of 500,000 tons per year for the three-year period 1975-77, during which time the capelin resources and their major predators would be monitored to determine the effects of this TAC on their critical population parameters (recruitment, growth and mortality). It was also recommended that the TAC be divided into 300,000 tons for Subarea 2 and Div. 3K and 200,000 tons for Div.3LNOPs, with no more than 10,000 tons to be taken in Subdiv. 3Ps and no more than 50,000 tons in Div. 3L. At the 1975 Annual Meeting, STACRES recommended the continuation of the conservation measures adopted at the January 1975 Meeting. New data presented at the present meeting did not warrant any modification to the previous advice, and the Subcommittee accordingly recommends the same conservation measures for 1977 as previously recommended for 1976.

The Subcommittee noted that it will be necessary at its 1977 Meeting to thoroughly review the data accrued over the three-year period in order to advise the Commission on the TAC for 1978.

The Subcommittee therefore recommends

i) that countries involved in the capelin fishery collect and analyze the appropriate data for presentation to the 1977 Meeting of the Assessments Subcommittee, and

ii) that the Scientific Advisers to Panels 2 and 3 discuss at the 1976 Annual Meeting what types of data are now available and what are necessary to be collected before the 1977 Meeting of the Subcommittee.

v) Mackerel in Subareas 3 and 4

The status of the mackerel fishery in Subareas 3 and 4 is considered in conjunction with the overall assessment of the stocks in Subareas 3 to 6 (see under Mackerel in Section VII, 2(p)).

w) Squid-*Illex* in Subareas 2 to 4

The assessment of *Illex* in Subareas 2 to 4 is considered together with the stock component in Subareas 5 and 6 (see under Squid-*Illex* in Section VII, 2(r)).

VI SUBAREA 4

1. Fishery Trends

(This subsection to be completed when more complete statistics become available from STATLANT 21A returns.)

2. Species Review

Table 6 contains a summary of recent catches and TACs, including those recommended for 1977, for stocks under consideration for management in Subarea 4. The TACs listed include quantities, if any, estimated to be taken outside the Convention Area.

Table 6. Subarea 4: summary of nominal catches (1971-75) and TACs (1973-77) by species and stock area. (Nominal catches for 1975 are based on advance provisional statistics for April 1976 assessments, and TACs in parentheses are those recommended by the Assessments Subcommittee.)

Species	Stock area	Nominal catches (000 tons) 1971	1972	1973	1974	1975	TACs (000 tons) 1973	1974	1975	1976	1977
Cod	4Vn(Jan-Apr)+4T	57	68	51	49	39	-	63.0	50.0	30.0	(0.0)[1]
	4Vn(May-Dec)	11	9	6	6	4	-	10.0	10.0	10.0	(3.5)
	4VsW	54	62	54	44	31	60.5	60.0	60.0	30.0	(7.0)
	4X(offshore)[2]	9	7	7	6	7	-	-	5.0	4.0	(4.0)
Haddock	4VW	13	5	4	2	2	4.0	0.0	0.0	2.0[3]	(0.0)
	4X	18	13	13	13	18	9.0	0.0	15.0	15.0	(0.0)
Redfish	4VWX	62	50	40	27	28	-	40.0	30.0	20.0	(20.0)
Silver hake	4VWX	129	114	299	96	112	-	100.0	120.0	100.0	(63.0)[4]
Pollock	4VWX	12	20	30	25	25	50.0[5]	55.0	55.0	55.0	(20.0)
	5	14	13	13	12	13					
Flounders	4VWX	34	23	28	25	22	-	32.0	32.0	28.0	(28.0)
Herring (Opt.1)	4V(Jul-Jun)	13	19	17	20	7[6]	-	-	-	(11.0)[7]	(11.0)[7]
	4WX(total)	(146)	(177)	(140)	(173)	(184)					
	4WX(adults)	113	109	97	125	132	-	-	-	(92.5)[8]	(109.0)[9]
(Opt.2)	4VW(a)	72	32	30	44	33	-	45.0	30.0[10]		
	4VW(a)(Jul-Jun)	...	...	...	...	20[6]	-	-	45.0[11]	36.0[11]	(33.5)[11]
	4XW(b)(total)	(114)	(160)	(135)	(141)	(145)					
	4XW(b)(adults)	70	75	91	97	95	90.0	90.0	90.0	(89.2)[12]	(84.0)
Mackerel	3+4	24	22	38	45	37	-	55.0[13]	70.0	56.0	(0.0)[14]
	5+6	349	387	381	295	246	450.0	304.0	285.0	254.0	
Argentine	4VWX	7	6	1	17	15	-	25.0	25.0	25.0	(20.0)
Squid-*Illex*	3+4	9	2	10	+	17	-	-	25.0	25.0[15]	(25.0)

[1] Recommended TAC subject to management strategy for 4Vn winter fishery and 4T summer fishery (see Section VI, 2(a)).
[2] That part of Div. 4X south and east of straight lines joining the coordinates in the order listed: 44°20'N, 63°20'W; 43°00'N, 65°40'W; 43°00'N, 67°40'W.
[3] TAC for by-catch with no directed fishery.
[4] Recommended TAC not agreed to by scientists from Cuba, GDR and USSR.
[5] TAC pertains to 4X+5 only.
[6] Catches pertain to the period Jul-Dec 1975 only.
[7] Recommended TACs for fishing seasons Jul 1976-Jun 1977 and Jul 1977-Jun 1978 respectively.
[8] Recommended TAC for the period 1 Apr-31 Oct 1976.
[9] Recommended TAC for the fishing season 1 Nov 1976-31 Oct 1977.
[10] TAC pertains to Jan-Jun 1975 only.
[11] TACs for fishing seasons Jul 1975-Jun 1976, Jul 1976-Jun 1977 and Jul 1977-Jun 1978 respectively.
[12] TAC now recommended for 1976, although 81,000 tons was provisionally agreed by the Commission at its Jan. 1976 Special Meeting.
[13] TAC pertains to 4VWX only.
[14] TAC subject to re-assessment at 1976 Annual Meeting (see Section VII, 2(p)).
[15] Countries without specific allocations may each take up to 3,000 tons.

a) Cod in Subdivision 4Vn(Jan-Apr) and Division 4T

Nominal catches from this southern Gulf of St. Lawrence stock have fluctuated but they show a declining trend from 66,300 tons in 1962 to a provisional figure of 39,000 tons in 1975, considerably below the TAC of 50,000 tons. The spawning stock biomass dropped to an all time low level of 83,000 tons. The TAC for 1976 was reduced to 30,000 tons, which is expected to generate an F of 0.35 and allow for the spawning stock to rebuild to a desired level of 150,000 tons (ICNAF Sel. Pap. No. 1: 171-193). The system simulation presented in 1975 was used as the basis for the assessment, but new analyses have elucidated the positive relationship between spawning stock production and the catch of pelagic eggs, coupled with the effects of temperature on egg mortality. Also a positive relationship was found between the numbers of eggs and the numbers of larvae. Previously it had been hypothesized that an additional predator was necessary to describe the variations in year-class size, not accounted for by cannibalism of older cod (age 4 and older) on the juvenile cod as they become demersal. Evidence was presented that this additional predator is mackerel which feed on cod larvae. It was concluded that the management of the cod stock through regulation of exploitation may only be partially successful in achieving the objective.

Catch projections were presented using the latest partial recruitment values which are more indicative of the winter fishery, since this fishery is presently taking about two-thirds of the catch from this stock. The average value of recruitment predicted for the size of the 1973 year-class at age 2 from juvenile surveys is 76 million fish, and recruitment of about 60 million fish is implied by the egg and larvae models for the 1974 and 1975 year-classes. For a catch of 32,000 tons in 1977 at $F_{0.1}$=0.35, assuming that the 1976 TAC of 30,000 tons is taken, the spawning stock will initially decline to 72,000 tons in 1976 and then increase to 80,000 tons in 1977 (Table 7), still slightly below the level of 83,000 tons in 1975.

When the lower fiducial limit of recruitment from the abundance of age 2 cod in juvenile surveys is considered, and all of the other parameters remain constant, the spawning stock biomass continues to decline to 66,000 tons in 1977 with a catch of 26,000 tons at F=0.35 predicted for that year (Table 8). This level of spawning stock biomass is critically low, and TACs of 10,000 tons at F=0.11 and 15,000 tons at F=0.17 were considered for 1977. A TAC of 10,000 tons is required to maintain the spawning stock at a level equivalent to that in 1975. In view of poor recruitment prospects and the uncertainty associated with egg and larvae models, the Subcommittee advises extreme caution in setting the TAC for 1977, especially if the winter fishery is permitted to continue.

Table 7. Stock size and catch projections for southern Gulf of St. Lawrence cod stock, assuming average recruitment. (Figures for stock size and catch by age are numbers of fish × 10^{-3}.)

Age (yr)	Weight (kg)	Partial recruitment	1975		1976		1977	
			Stock size	Catch	Stock size	Catch	Stock size	Catch
2	0.18	0.00	76,574	0	59,000	0	60,000	0
3	0.45	0.19	34,095	2,450	62,694	3,736	48,305	2,817
4	0.75	1.00	29.925	9,621	25,704	7,045	47,958	12,911
5	1.19	1.00	18,423	5,923	15,872	4,350	14,718	3,962
6	1.78	1.00	7,102	2,283	9,771	2,678	9,088	2,447
7	2.30	1.00	9,589	3,083	3,767	1,032	5,595	1,506
8	2.62	1.00	3,778	1,215	5,086	1,394	2,157	580
9	2.99	1.00	3,122	1,004	2,004	549	2,912	784
10	3.63	1.00	2,230	717	1,656	453	1,147	309
11	4.23	1.00	1,726	555	1,183	324	948	255
12	6.75	1.00	342	110	916	251	677	182
13	9.26	1.00	142	46	181	50	524	141
14	6.44	1.00	121	39	75	21	104	28
15	6.55	1.00	7	3	64	18	43	12
Fishing mortality (F)			0.434		0.358		0.350	
Catch (tons)			39,085		30,000		32,347	
Stock biomass (age 3+) (tons)			133,484		131,528		137,171	
Spawning biomass (age 4+) after the winter fishery (tons)			82,699		72,321		80,803	

Table 8. Stock size and catch projections for souther Gulf of St. Lawrence cod stock, assuming low recruitment. (Figures for stock size and catch by age are numbers of fish × 10^{-3}.)

Age (Yr)	Weight (kg)	Partial recruits	1975		1976		1977		1977	
			Stock size	Catch	Stock size	Catch	Stock size	Catch	Stock Size[1]	Stock size[2]
2	0.18	0.00	32,796	0	59,000	0	60,000	0	60,000	60,000
3	0.45	0.19	34,095	2,450	26,851	1,662	48,305	2,820	48,305	48,305
4	0.75	1.00	29,925	9,620	25,704	7,278	20,485	5,515	21,287	21,529
5	1.19	1.00	18,423	5,923	15,872	4,494	14,511	3,907	17,761	18,852
6	1.78	1.00	7,102	2,283	9,771	2,767	8,960	2,412	10,967	11,641
7	2.30	1.00	9,589	3,083	3,767	1,067	5,516	1,485	6,752	7,166
8	2.62	1.00	3,778	1,215	5,086	1,440	2,127	573	2,603	2,763
9	2.99	1.00	3,122	1,004	2,004	567	2,871	773	3,514	3,730
10	3.63	1.00	2,230	717	1,656	469	1,131	305	1,384	1,469
11	4.23	1.00	1,726	555	1,183	335	935	252	1,144	1,215
12	6.75	1.00	342	110	916	259	668	180	817	868
13	9.26	1.00	142	47	181	51	517	139	632	672
14	6.44	1.00	121	39	75	21	102	28	125	133
15	6.55	1.00	7	2	64	18	43	12	51	55
Fishing mortality (F)			0.434		0.372		0.350		0.170	0.110
Catch (tons)			39,085		30,000		26,499		15,000	10,000
Stock biomass (age 3+) (tons)			133,484		115,399		115,457		129,368	139,683
Spawning biomass (age 4+) after the winter fishery (tons)			82,699		72,321		65,603		75,342	82,561

[1] Alternate estimate for 1977 catch of 15,000 tons.
[2] Alternate estimate for 1977 catch of 10,000 tons.

Table 9. Stock size and catch projections for southern Gulf of St. Lawrence cod, assuming low recruitment in 1975 and moderate recruitment in 1976 and 1977. (Figures for stock size and catch by age are numbers of fish × 10^{-3}.)

Age (Yr)	Weight (kg)	Partial recruits	1975		1976		1977		1977
			Stock size	Catch	Stock size	Catch	Stock size	Catch	Catch
2	0.18	0.05	32,796	662	59,000	974	60,000	1,077	541
3	0.45	0.12	34,095	1,626	26,254	1,028	47,425	2,016	1,020
4	0.75	0.58	29,925	6,258	26,447	4,619	20,567	3,875	2,045
5	1.19	0.88	18,423	5,496	18,872	4,753	17,495	4,733	2,566
6	1.78	1.00	7,102	2,350	10,151	2,847	11,181	3,363	1,842
7	2.30	1.00	9,589	3,173	3,708	1,040	9,755	1,731	948
8	2.62	1.00	3,778	1,250	5,006	1,404	2,102	632	346
9	2.99	1.00	3,122	1,033	1,972	553	2,838	854	468
10	3.63	1.00	2,230	738	1,630	457	1,118	336	184
11	4.23	1.00	1,726	571	1,164	327	924	278	152
12	6.75	1.00	342	113	901	253	660	199	109
13	9.26	1.00	142	47	179	50	511	154	84
14	6.44	1.00	121	40	74	21	101	30	17
15	6.55	1.00	7	2	63	18	42	13	7
Fishing mortality (F)			0.450		0.368		0.400		0.200
Catch (tons)			39,085		30,000		31,329		17,016
Stock biomass (age 3+) (tons			139,565		112,081		131,996		
Spawning biomass (age 4+) after the winter fishery (tons)			82,698		71,187		77,459		

The winter fishery in Subdiv. 4Vn has taken an increasing proportion of the catch from about 30% in the 1960's to 63% in 1975. It is in this fishery that the greater proportion of immature fish (ages 3, 4 and 5) are caught. In 1975, about 66% of the catch from the winter fishery consisted of fish less than age 6, with only 40% of the catch being mature individuals. In contrast, the catch from the summer fishery in Div. 4T comprised 53% of fish less than age 6. This difference is due to the different partial recruitments in the two fisheries. If a catch of 30,000 tons were taken in Div. 4T only, the resultant spawning stock size would be equivalent to that which would allow a catch of only 10,000 tons from Div. 4T and Subdiv. 4Vn combined, given the present pattern of fishing (Table 9). The Subcommittee therefore considers it imperative that the catch of immature fish be severely reduced, requiring measures to further regulate the winter fishery in Subdiv. 4Vn. If such action is not taken, the Subcommittee must recommend a zero TAC for 1977 to ensure an increase in spawning stock size. If this problem can be resolved for 1977, a catch of 30,000 tons can be taken from the stock without reducing the spawning stock size below its present level. Theoretically, a continuum of options exists between zero and a TAC of 30,000 tons, when the proportion of the catch taken in Subdiv. 4Vn is varied from 63% to zero.

Potentially, other options are available, such as changing the mesh size regulation to avoid the catching of immature fish and perhaps allow a TAC up to 30,000 tons. However, the appropriate mesh size cannot be advised at this time, nor can the difficulties in enforcing a larger mesh size regulation be envisaged for such a small area as Subdiv. 4Vn and over such a short period of the year. Another alternative would be to establish closed areas where there are potential concentrations of immature fish. The problem of managing this stock is a difficult one with many options requiring further detailed simulation studies of the fishery. The results of these will be available for consideration at the 1976 Annual Meeting. The effects of certain options are illustrated in Table 10. It must be pointed out that fishing at F_{max}=0.45 or at $F_{0.1}$=0.40 are not considered options to be followed for this fishery, since the management strategy must be aimed at rebuilding the spawning stock.

Table 10. Cod in Div. 4T and Subdiv. 4Vn (spring): implications of alternative management options on long-term catch and the 1977 TACs associated with each option.

	Fishing mortality	1977 TAC (tons)	Comments on management objectives and options
Partial recruitment as at present	0.00	0	Increase stock by 9%
	0.10	10,000	Maintain 1975 stock
	0.35	26,500	Decrease stock by 20%
Partial recruitment as in summery fishery	0.00	0	Increase stock by 14%
	0.20	16,000	Increase stock by 10%
	0.40 ($F_{0.1}$)	30,000	Maintain 1975 stock

b) Cod in Subdivision 4Vn (May-Dec)

Nominal catches in this area during the summer and autumn fishery were 7,000 tons in 1973 and 6,000 tons in 1974. Provisional statistics indicate that the catch in 1975 was about 4,400 tons, the lowest recorded for the area in recent years. Catches in this area during May to December are partly based on local inshore stocks, which historically have provided for approximately one half of the total catch. In addition, the offshore catches are based partly on cod which belong to the Div. 4T stock, these being early arrivals to or late departures from the overwintering area in Subdiv. 4Vn (mainly between January and April), and partly on cod belonging to the Div. 4VsW stock which migrate northward and spend the summer in Subdiv. 4Vn.

Catches in both the offshore and inshore fisheries have declined significantly in recent years, indicating that stock abundance may have declined as well. Considering the serious condition of adjacent stocks (in Div. 4VsW and in Div. 4Vn (Jan-Apr)+4T), the catch in Subdiv. 4Vn during May to December should be kept as low as possible. The TAC for this area was initially set slightly above recent catches in order to prevent any large increase in fishing from occurring on one or the other stock component in the area. With the recent declines both in catches and stock abundance, the equivalent TAC is now 5,000 tons. However, to be relatively certain that no increase in exploitation rate will occur in 1977, the TAC should be reduced below the 1976 level of catches. The Subcommittee accordingly recommends a TAC of 3,500 tons for 1977 in order to achieve this objective.

c) Cod in Subdivision 4Vs and Division 4W (Res. Doc. 76/VI/46, 63)

Nominal catches from this stock averaged 60,000 tons during 1960-74. However, catches have declined since 1972 to 54,000 tons in 1973, 44,000 tons in 1974 and to 30,000 tons in 1975 (provisional data). TACs of 60,500, 60,000 and 60,000 tons were adopted for the years 1973 to 1975, and the TAC for 1976 is 30,000 tons. Catch rates of Spanish pair trawlers (150-499 GRT) declined steadily from 2.38 tons per hour in 1968 to 0.51 in 1974. Analysis of age compositions of commercial catches indicated that the stock biomass declined from about 250,000 tons in the late 1960's to about 100,000 tons in 1975.

Since 1971, fishing mortality rates have exceeded F_{max}=0.35. However, the observed levels of fishing mortality were not sufficient to explain the rapid decline in stock size in recent years, the major cause being the recruitment to the fishery of the poor 1971 to 1973 year-classes. In view of the large silver hake fishery conducted in this area with small-meshed trawls during the period when the cod stocks declined, the Subcommittee examined the consequences of relatively small by-catches of young cod (ages 1 and 2) in the silver hake fishery on the subsequent recruitment of cod. It was estimated that by-catches of about 4,000 tons annually, equally divided between ages 1 and 2 fish, explained the reduced recruitment of cod observed in recent years, and that by-catches of 10,000 tons of age 1 fish could virtually eliminate the cod stock.

The 1976 TAC of 30,000 tons corresponds to a fishing mortality of 0.8-0.9. Fishing at F_{max}=0.35 in 1977 would give a catch of 12,500 tons, while fishing at $F_{0.1}$=0.2 would yield 7,500 tons. The rebuilding of the stock is contingent on recruitment at higher levels than have been experienced in the 1970's. Table 11 shows how the stock might be expected to recover from a biomass of 90,000 tons in 1976 in five years, with recruitment of 75 million fish at age 1 and various combinations of by-catches at ages 1 and 2. With no by-catch, recovery to 200,000 tons (desired stock size) in five years is possible, even when fishing at F_{max}=0.35. With by-catches of 10,000 tons, recovery of the stock size to 200,000 tons is not possible.

In view of the extremely serious consequences of relatively small by-catches of ages 1 and 2 fish, it is a matter of prime importance to reliably determine the magnitude of such by-catches and whether they are indeed the primary cause of declines in recruitment to this stock. Assuming a moderate by-catch of 4,000 tons, fishing at $F_{0.1}$=0.2 in 1977 would produce a catch of 7,000 tons and provide for increasing the spawning stock. The Subcommittee therefore recommends that the TAC for 1977 be set at 7,000 tons as the best option. The Subcommittee further notes that, if by-catches can be reduced by 1977, the TAC could be increased in subsequent years and still achieve the same objective.

Table 11: Cod in Div. 4VsW: five-year projections showing the effect of by-catches of ages 1 and 2 cod on catch in the directed fishery and on stock size for various levels of fishing mortality. ($F_{0.1}$=0.2; F_{max}=0.35.)

Assumed by-catches by age (tons)			Projected catches and biomass (tons) for F levels in directed fishery			
Age 1	Age 2		F=0.00	F=0.10	F=0.20	F=0.35
0	0	Catch 1st year (1977)		4,396		14,050
		Catch 5th year		18,230		37,110
		Biomass 5th year		305,662		203,160
2,000	2,000	Catch 1st year (1977)		3,929	7,000	12,510
		Catch 5th year		13,340	18,000	26,650
		Biomass 5th year		224,260	200,000	148,974
5,000	5,000	Catch 1st year (1977)	0	3,223		
		Catch 5th year	0	5,950		
		Biomass 5th year	135,757	95,734		
4,000	0	Catch 1st year (1977)		3,741		11,890
		Catch 5th year		11,370		22,450
		Biomass 5th year		188,466		124,136
10,000	0	Catch 1st year (1977)	0			
		Catch 5th year	0			
		Biomass 5th year	0			

d) Cod in Division 4X (offshore)

Nominal catches from this offshore stock declined from 9,000 tons in 1971 to 6,000 tons in 1974. Since the TAC does not apply to the whole of Div. 4X, provisional statistics were not available in sufficient detail to determine the 1975 offshore catch with accuracy. However, in order to advise the Commission on the status of this stock, the 1975 catch is estimated at 6,700 tons. Most of the cod taken in Div. 4X come from relatively sedentary inshore stocks which are not regulated by the Commission. Cod on the offshore banks appear to be a separate stock and do not intermix with the inshore stocks to any significant degree. The TAC was set at 5,000 tons for 1975 and 4,000 tons for 1976.

Research surveys indicate that 1972 and 1973 year-classes are weak, probably only half as strong as the recent average year-class size, i.e. 3.5 million fish at age 2. Fishing at an estimated F=0.65 in 1975, catch projections indicate that the TAC set for 1976 (4,000 tons) will generate an F=0.30 and allow an increase in stock size. Yield-per-recruit calculations indicate that F_{max}=0.35 and $F_{0.1}$=0.25. Projections for 1977 at these F levels indicate catches of 5,500 and 4,000 tons respectively with further increases in stock size over the 1974 level in both cases.

At present the stock is depressed due to growth overfishing. If subjected to fishing at $F_{0.1}$ (0.25), the stock could be expected to yield at least 9,500 tons and be maintained at a level over 30,000 tons at recent recruitment levels. If subjected to fishing at F_{max}(0.35), the equivalent values are 10,000 tons for the catch and 30,000 tons for the stock size. However, the stock size in 1975 is only 12,000 tons, but, if fishing at $F_{0.1}$ is adopted as the management policy, the stock size will recover to 20,000 tons in 1977. Given the uncertainties about 1975 catches and the accelerated rate of recovery of the stock if fished at $F_{0.1}$, the Subcommittee recommends that the TAC for 1977 be maintained at the 1976 level of 4,000 tons.

e) Haddock in Divisions 4V and 4W (Res. Doc. 76/VI/26)

Provisional statistics indicate that the nominal catch in 1975 was about 1,800 tons, down slightly from 2,300 tons in 1974. Research surveys show a slight improvement in stock size in 1975 due to the appearance of a moderately-sized 1974 year-class. However, variation among years in survey results is such that a single observation, as in the case of the 1974 year-class, is not particularly reliable. On the basis of present information, it appears this year-class is of comparable strength to an average, or slightly less than average, year-class by the standard of those which occurred in the 1950's and early 1960's.

Stock biomass is still at a very low level, possibly 15,000-20,000 tons in the last few years, for a stock which was capable of sustaining catches over 25,000 tons in the 1950's and early 1960's. Should the 1974 year-class prove to be larger than others in the past several years, it should not be harvested but should be allowed to contribute to the spawning stock. The Subcommittee therefore recommends a zero TAC for 1977 and that every effort be made to minimize removals in fisheries directed at other species. A TAC of 2,000 tons was set for 1976 to allow for by-catch. Should the 1974 year-class be stronger than other recent year-class, by-catches will likely increase in 1976 and 1977, if present fishing patterns are maintained. However, it is recommended that the 2,000-ton TAC for by-catch not be increased, and that member countries make additional efforts to reduce by-catch rates in order to prevent catches from exceeding the present level.

f) Haddock in Division 4X (Res. Doc. 76/VI/60)

Provisional statistics indicate a nominal catch of 18,300 tons in 1975. The 1969, 1971 and 1972 year-classes all made significant contributions to the catch and the 1973 year-class also contributed fairly substantially in terms of numbers but less so in weight. Whereas the size of the poor 1964 to 1968 year-classes ranged from 7 million to 15 million fish at age 2, the 1969 year-class contained 22 million fish at this age. This was followed by the poorest year-class on record (4 million fish). However, the 1971 year-class contained 38 million fish at age 2. Abundance estimates of juvenile haddock from research surveys agree well with estimates of year-class size at age 2 from cohort analysis, and, on the basis of these surveys, the strengths of year-classes at age 2 subsequent to that of 1971 were estimated and used in the catch projections:

Year-class	1972	1973	1974	1975
Size (millions)	22	10	17	(20)

The present regulations require that there be no directed fishery for haddock, but allowance is made for unavoidable by-catch of 15,000 tons. The maintenance of this regime for 1977 (and for 1978) will result in some decline in spawning stock in each year. Spawning stock was at a minimum of 31,000 tons in 1974, but improved recruitment from the 1971 and 1972 year-classes resulted

in increases to 44,500 and 47,500 tons in 1975 and 1976 respectively. However, the poorer 1973 and 1974 year-classes will result in a decline in spawning stock to 39,000 tons by 1978, if the catch remains at 15,000 tons. Spawning biomass in the early 1960's, when the stock was providing stable yields, was in the order of 80,000 tons, and the objective of the present management is the rebuilding of the spawning stock to at least this level. Since the stock size will not increase toward this level in 1977, the Subcommittee advises that the present management policy be maintained, i.e. that no directed fishery for haddock be allowed in 1977. The Subcommittee accordingly recommends a zero TAC for 1977 and that removals be kept at the lowest possible level.

g) Redfish in Divisions 4V, 4W and 4X (Res. Doc. 76/VI/25)

Provisional statistics indicate a nominal catch of 28,100 tons in 1975, down slightly from 32,800 tons in 1974, and slightly below the 1975 TAC of 30,000 tons. Catch rates of Canadian and USA trawlers declined further in 1975 as they have in each year since 1971. It is apparent from length frequency data that a good year-class entered the fishery in 1970-71 resulting in a substantial increase in catch rate and total catch. While catches declined after 1971, fishing mortality during 1971-74 was about 0.30, substantially above F_{max}(0.18). Research surveys in 1974 gave indications of improved recruitment about to enter the fishery, but these potential recruits did not show up strongly in 1975 surveys. Substantial catches of these small 13-21 cm fish were made by USSR in 1975. While these fish will probably contribute to USSR catches again in both 1976 and 1977 and may begin contributing to USA catches in 1977, they will probalby not contribute significantly to the Canadian catches until 1978 due to the preference in the Canadian fishery for larger fish.

On the basis of yield-per-recruit calculations and the assumption that the stock size in 1977 will be comparable to the average of those for 1971-74 due to increased recruitment, fishing at F_{max} in 1977 would produce a yield of 22,000 tons, while fishing at $F_{0.1}$(0.10) would give a catch of 16,000 tons. General production analyses suggest that the catch in 1977 would be about 26,000 tons if fishing is conducted at F_{MSY}. Given the uncertainties about recruitment and the fact that recruiting year-classes are being fished as small fish, the Subcommittee recommends that the TAC for 1977 be reduced to 20,000 tons, again pointing out that the harvesting of redfish less than 20 cm results in a significant loss in yield per recruit.

h) Silver hake in Divisions 4V, 4W and 4X (Res. Doc. 76/VI/21, 57, 59)

Provisional catches in 1975 were 112,000 tons, slightly below the TAC of 120,000 tons. A total of 108,000 tons was taken by USSR and small quantities were reported by Bulgaria, Cuba, FRG, Japan and USA. One of the major problems in assessing this stock is disagreement about ageing. A workshop on ageing was held during the present meeting to try to clarify this issue (Res. Doc. 76/VI/21). The USSR ageing expert was not able to attend and time was limited, but some progress was made towards agreement. The method of ageing, developed by USA, was studied and adopted as the agreed technique for further study. It was indicated that age determination using whole otoliths had a probable bias toward the older age-groups, but further study is required. However, ageing studies by USA and length frequency analysis by Canada did provide similar results for age-groups 1 and 2.

Stock assessments and catch projections for 1977 were provided by Canada and USSR. The USSR assessment estimated catches of 124,000 to 229,000 tons for F_{opt}=0.7 and M=0.5 and 0.8 respectively. The Canadian assessment estimated the 1977 catch at 63,000 tons for F_{max}=0.7 and M=0.4. The differences are due primarily to the different estimates assumed for the strengths of the 1973 to 1975 year-classes, values used for the age composition of catches, and growth rates. These differences could not be resolved. However, the Subcommittee noted that:

i) the Canadian virtual population analysis was more consistent with the probable age composition, i.e. a higher proportion of younger fish;

ii) the value of F_{opt}=0.7 estimated by USSR was based on the assumption that catches of fish less than 30 cm would be negligible, when in fact more than 40% of the 1975 catch by number was composed of smaller fish;

iii) the standard yield per recruit at M=0.4 indicates F_{max}=0.7 and $F_{0.1}$=0.35, but fishing in recent years have been at levels much higher than F=0.7, so that the choice of F=0.7 is a maximum option;

iv) the stock abundance in 1975 had decreased from that in 1974; and

v) the estimated catch in 1977 would be very dependent on the 1974 year-class, and, assuming a moderate size, would result in much less severe consequences in the event of an error than otherwise.

With the exception of scientists from Cuba, German Democratic Republic and USSR, the members of

the Subcommittee agreed that the evidence available indicates that the TAC for 1977 should be recommended at 63,000 tons, which corresponds to fishing at F_{max}=0.7.

The scientists from Cuba, German Democratic Republic and USSR disagreed with this advice. USSR trawling survey abundance indices indicate that the 1974 year-class is very abundant and that the 1972 and 1973 year-classes are of average abundance, but preliminary data show that the 1975 year-class is poor. According to the estimates of USSR scientists, mortality rates of M=0.5 and F_{opt}=0.7 should be applied to this particular stock, and they consider it possible to recommend a TAC for 1977 at the level of 100,000-120,000 tons. The estimates provided indicate that the silver hake stock in this area would be maintained at the level of 1975 (308,000 to 408,000 tons). Also, in the opinion of USSR scientists, comparison of age determination methods used by USSR and USA indicated that some ageing data were difficult to explain from a biological viewpoint (Summ. Doc. 76/VI/21). Therefore, data obtained from the actual age reading by USSR experts for many years appeared to be more accurate for virtual population stock assessment.

The Subcommittee noted that an agreed data base of catch age compositions was necessary and recommends

i) that the ageing problems be resolved and age compositions of catches be recalculated during this year, and

ii) that the relationship between pre-recruit survey indices and subsequent stock size of year-classes be determined.

i) Pollock in Divisions 4V, 4W, 4X and Subarea 5 (Res. Doc. 76/VI/47 and Addendum)

At the September 1975 Special Commission Meeting, STACRES was requested to provide for assessing the pollock in Subarea 4 and in Subarea 5 separately. The Subcommittee at the present meeting thoroughly reviewed the available information on this question and concluded that the assumption of a single major stock in Subareas 4 and 5 was still valid and that, therefore, the assessment had to be done for the stock area as a whole. The presence of local spawning stocks in Subarea 4 would provide some biological basis for allocating the TAC to the different areas, since harvesting the entire TAC from one area might have adverse stock implications. There is, however, no scientific basis as to what percentage should be used in proportioning the TAC to the two separate areas.

The nominal catch of pollock was maintained at about 40,000 tons from 1960 to 1964 but decreased to 23,000 tons in 1970 and increased again to nearly 40,000 tons in 1975. A preliminary assessment was presented at this meeting. Estimates of fishing mortality from both research survey and commercial data indicate that F has increased beyond the level of F_{max}=0.4 (M=0.2) in the most recent years (since 1973). USA autumn bottom trawl surveys have indicated a declining trend in abundance in the 1970's, and the Canadian index, which had been increasing, dropped sharply in 1975. The surveys indicate that the 1972-74 year-classes are weaker than those of 1968, 1969 and 1971 and that recruitment prospects for 1977 are less favourable than during 1968-73. If it is assumed that fishing mortality in 1975 was at F=0.5, then the stock size was about 121,200 tons. Assuming a modest decline in stock size to 100,000 tons for 1977, a catch of 30,000 tons would result from fishing at $F_{0.1}$=0.24. No information is available on the effects on stock size, but fishing at F_{max} in 1977 would probably result in a lower stock size in 1978 than in 1975. The Subcommittee, therefore, recommends a TAC for 1977 of 20,000 tons.

j) American plaice, witch and yellowtail in Divisions 4V, 4W and 4X

The provisional nominal catches of these species were 21,700 tons in 1975, somewhat below the TAC of 32,000 tons. Canadian commercial catch rates showed a small increase to 86 kg per hour fished in 1975, following a consistent decline from 151 kg per hour in 1965 to 76 kg per hour in 1974. Biomass estimates from research surveys also indicate that some small increase in stock size may have occurred.

The TAC was reduced to 28,000 tons for 1976, because of observed over-exploitation of American plaice in Div. 4W and substantial declines in the yellowtail stocks. The possibility of a small increase in abundance in 1975 does not significantly change the previous conclusions on the status of the stocks, and the Subcommittee recommends that the TAC for 1977 be maintained at 28,000 tons.

k) Herring in Division 4V (seasonal) (*Redbook* 1975, page 39; Res. Doc. 76/VI/20; Summ. Doc. 76/VI/5)

The fishery in this area is currently managed on a seasonal basis in conjunction with that in Div. 4W(a). At its 1975 Annual Meeting, STACRES recommended that the fishery in Div. 4W(a) be combined with that in Div. 4XW(b) for management, thus leaving the fishery in Div. 4V to be managed separately on a seasonal basis (July of one year to June of the next). This recommendation was reiterated by STACRES at the January 1976 Special Meeting and again by this Subcommittee at the present meeting.

During the 1971/72 to 1974/75 seasons, nominal catches averaged about 17,000 tons. Provisional statistics indicate that about 7,000 tons were taken in the last half of 1975. The Canadian fishery in this area (which recently comprised over 90% of the total catch) is now completed for the 1975/76 season with a catch of 5,500 tons. This catch represents a 69% decline from the 1974/75 season, and catch rates also declined. However, weather conditions severely hampered all fishing activity in Div. 4V during the season and fishing effort, both as the number of nights fished and as hours fished each night, was substantially reduced. Consequently, the additional data are insufficient to warrant changing the previous STACRES recommendation (*Redbook* 1975, page 39; Summ. Doc. 76/VI/5) for a TAC of 11,000 tons for 1976/77, or revise this recommendation of 11,000 tons for 1977/78.

ℓ) Herring in Divisions 4W and 4X (*Redbook* 1975, page 39; Summ. Doc. 76/VI/5; Res. Doc. 76/VI/21, 45)

STACRES at the January 1976 Special Commission Meeting reiterated its earlier recommendation (*Redbook* 1975, page 39) that the fisheries in Div. 4W(a) and 4XW(b) be combined for management purposes. Reconsideration of the 1976 TAC and consideration of the 1977 TAC is, therefore, restricted to an analytical assessment of the combined areas. New information since the January 1976 Special Meeting include an analysis of data from the Canadian 1975/76 winter fishery in Div. 4W(a), revisions to historical data and 1975 catch data in Div. 4XW(b), and re-evaluation of the size of the 1973 year-class (Res. Doc. 76/VI/45). Since the fishery commences in November in Div. 4W(a), the assessment is based on a fishing season from 1 November of one year to 31 October of the next. This change necessitated a recalculation of catch at age in numbers, as the previous assessment was based on calculations for the calendar year. Fig. 1 shows the approximate periods of fishing for Canadian (Cdn) and distant water fleets (DWF).

The size of the 1972 year-class was set at 1 billion fish (1.0×10^9) at age 2, as had been agreed at the January 1976 Special Meeting. The size of the 1973 year-class was revised from 1 billion fish at age 2 to 1.5 billion fish. This revision appears to be justified, as the F-values calculated from cohort analysis using 1 billion fish at age 2 were abnormally high (0.31), compared with a mean F of 0.19 for the 1966-72 year-classes at age 2, considering the history and present nature of the fishery (Res. Doc. 76/IV/45). Also, the catches of the 1973 year-class in 1975 in the Bay of Fundy weir fishery suggest that this year-class is better than previously assumed. The calculated stock sizes, catches and fishing mortalities are given in Table 12.

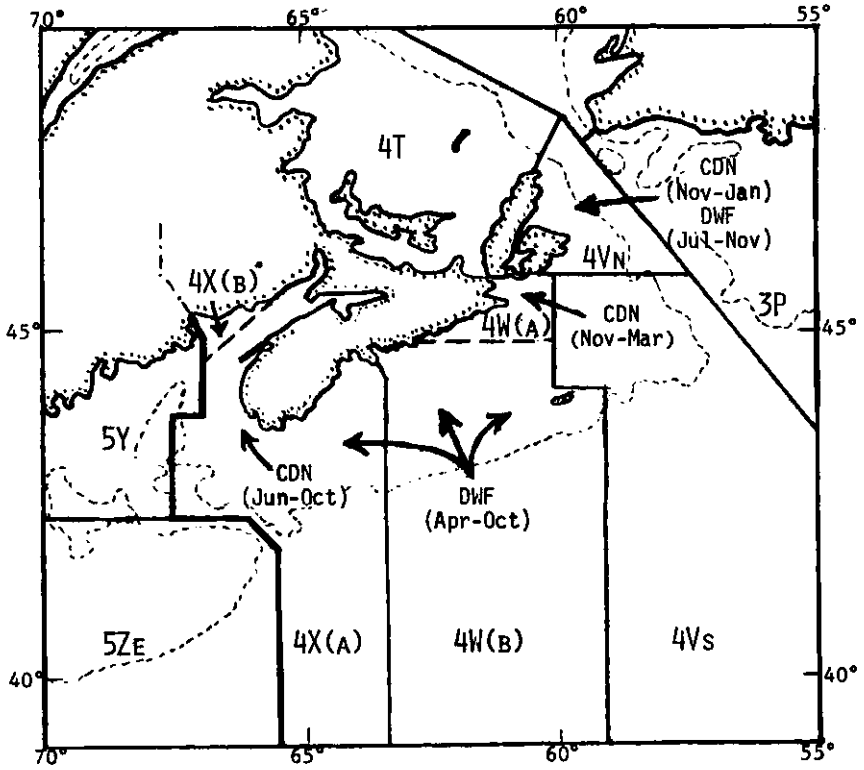

Fig. 1. Map showing the approximate times of fishing for herring in Div. 4VWX by Canadian (CDN) and distant water fleets (DWF). (For illustrative purposes only.)

Table 12. Herring in Div. 4WX: stock sizes, catches and fishing mortalities, 1966-77.

Year[1]	Age (years) 2	3	4	5	6	7	8	9	10	Age 2 and older Number	Age 2 and older Weight	Age 4 and older Number	Age 4 and older Weight
Stock size (millions)										(10^{-6})	(000 t)	(10^{-6})	(000 t)
1966	1,458	2,123	664	831	217	54	20	2	<1	5,369	678	1,788	377
1967	1,206	1,155	1,494	490	401	137	32	9	<1	4,924	708	2,563	527
1968	2,381	944	883	1,007	302	184	60	22	7	5,790	744	2,465	538
1969	610	1,269	701	664	576	182	69	20	4	4,095	672	2,216	503
1970	810	436	692	467	401	242	94	36	10	3,188	530	1,942	447
1971	897	566	305	313	211	222	105	42	12	2,673	399	1,210	297
1972	5,907	604	290	147	138	104	94	44	17	7,345	520	834	203
1973	753	4,236	428	104	55	46	40	31	12	5,705	665	716	155
1974	1,000	590	2,942	255	53	22	20	17	7	4,906	715	3,316	606
1975	1,512	712	442	1,851	160	30	11	12	4	4,734	685	2,510	541
1976	750	1,020	441	282	1,180	88	16	6	6	3,789	627	2,019	480
1977	750	553	723	277	168	681	51	9	2	3,184	545	1,912	454
Catch in numbers (millions)													
1966	43.6	270.1	58.6	308.8	45.5	14.0	7.7	1.7	.2	750.1		436.4	
1967	47.9	68.4	238.4	109.8	159.2	57.9	4.5	.4	.3	686.9		570.6	
1968	751.7	79.9	65.1	274.5	72.8	90.6	32.0	15.4	5.7	1,387.8		556.2	
1969	70.4	383.8	117.5	158.1	254.0	60.5	22.0	7.2	3.0	1,076.4		622.3	
1970	107.3	57.4	279.8	189.4	116.9	103.1	38.1	19.4	9.4	919.0		754.3	
1971	144.2	191.6	113.3	131.0	76.0	97.6	46.5	19.5	9.4	829.2		493.4	
1972	663.4	73.7	147.8	72.1	74.2	50.6	50.9	26.1	13.3	1,172.2		435.1	
1973	29.7	582.0	105.9	34.8	25.8	19.5	17.4	19.5	9.5	844.1		232.5	
1974	118.3	45.6	616.1	53.2	15.3	8.1	5.3	11.0	5.8	878.6		714.7	
1975	241.3	157.7	88.9	372.6	48.2	9.0	3.2	3.5	2.9	927.2		528.2	
1976	64.5	122.5	93.3	68.7	307.5	23.5	4.4	2.9	1.7	689.0		502.0	
Fishing mortality										Mean F^2(2+)		Mean F^2(4+)	
1966	0.034	0.152	0.103	0.529	0.263	0.336	0.558	1.613	0.700	0.181		0.334	
1967	0.045	0.068	0.194	0.284	0.578	0.631	0.171	0.050	0.700	0.180		0.294	
1968	0.429	0.098	0.085	0.358	0.310	0.786	0.898	1.518	0.700	0.325		0.311	
1969	0.136	0.407	0.205	0.305	0.667	0.459	0.439	0.509	0.700	0.356		0.387	
1970	0.158	0.157	0.592	0.594	0.389	0.636	0.594	0.894	0.700	0.404		0.562	
1971	0.195	0.469	0.529	0.620	0.507	0.664	0.673	0.707	0.700	0.434		0.594	
1972	0.133	0.145	0.829	0.781	0.900	0.770	0.917	1.074	0.700	0.215		0.845	
1973	0.045	0.165	0.320	0.464	0.727	0.635	0.667	1.217	0.700	0.186		0.457	
1974	0.140	0.089	0.263	0.262	0.380	0.529	0.349	1.309	0.700	0.224		0.273	
1975	0.193	0.279	0.250	0.250	0.400	0.400	0.400	0.400	0.700	0.243		0.263	
1976	0.105	0.144	0.266	0.315	0.350	0.350	0.350	0.764	0.350	0.234		0.328	

[1] Year refers to November-October fishing season, (i.e. 1966 = 1 November 1965 to 31 October 1966).
[2] Weighted by stock size.

i) Catch prediction for 1975/76 (Nov-Oct)

The catches in the fishery in Div. 4W(a) during November 1975 to March 1976 were analyzed (Res. Doc. 76/VI/21) and these data were used to calculate F-values for that sector of the 1976 fishery. M=0.1 was assumed and the stock size calculated as on 1 May 1976. Since the management strategy for the Div. 4WX fishery in 1976 is to fish at F=0.35, the F-values for the 6-month period (May-Oct 1976) were obtained by subtracting the F-values for the Div. 4W(a) winter fishery in 1975/76 from the annual F. However, an annual F higher than 0.35 had to be used for the 1967 year-class because of the high F-value calculated for the Div. 4W(a) fishery. M=0.1 was again used for this sector of the fishery.

The catch prediction indicates that the TAC in Div. 4WX for the period 1 April-31 October 1976 should be set at 92,500 tons (Table 13). This figure includes an estimate of 15,000 tons for inshore gear catches, which is greater than the estimate from the previous assessment due to the increased estimate of recruitment. The TAC of 92,500 tons for April-October 1976 corresponds to a total TAC for the 1975/76 season (1 November 1975 to 31 October 1976) of 129,600 tons, of which 37,100 tons have already been taken up to 31 March 1976 in Div. 4W(a).

The Commission had previously agreed to a 1975/76 TAC of 45,000 tons for Div. 4VW(a). Since not all countries have reported taking their 1975/76 allocations in Div. 4VW(a), and since effort has recently been concentrated in Div. 4W(a), up to 3,300 tons could still be taken in 4W(a) up to 30 June 1976. Therefore, if the Commission wishes to consider a 1976 TAC for only Div. 4XW(b) as previously, it should be set at 89,200 tons, corresponding to fishing at F=0.35. This TAC includes an estimate of 15,000 tons for inshore gear catches. The increase in TAC from that recommended at the January 1976 Special Meeting is due largely to the revised estimate for the 1973 year-class (a catch of 83,700 tons would result from the previous estimate of the 1973 year-class). A TAC of 81,000 tons for 1976, as provisionally agreed by the Commission at its January 1976 Special Meeting would regulate the fishery at $F_{0.1}$=0.30.

Table 13. Herring in Div. 4WX: catch projections for 1975/76 and stock size projections for 1976/77 with F = 0.35. (Assessment refers to fishing season from 1 November to 31 October.)

Age	Div. 4WX Stock size 1 Nov 1975	F	Div. 4W(a) Catch for period Nov 75 to Apr 76		Div. 4WX Residual stock in May 1976	F	Div. 4WX Projected catch May to Oct 1976		Div. 4WX Residual stock on 1 Nov 1976	
	(millions)		*(millions)*	*(000 t)*	*(millions)*		*(millions)*	*(000 t)*	*(millions)*	*(000 t)*
2	750	<0.001	0.1	-	678.5	0.105	64.4	2.7	552.8	23.2
3[1]	1,020	0.050	47.5	3.6	878.2	0.094	75.0	8.5	723.3	81.7
	(602)	(0.087)	(47.5)	(3.6)	(499.5)	(0.057)	(26.3)	(3.0)	(426.9)	(48.2)
4	441	0.116	46.1	6.1	355.4	0.150	47.2	8.3	276.8	48.4
5	282	0.130	32.7	6.3	223.7	0.185	36.0	7.8	168.2	36.7
6	1,180	0.067	72.7	16.2	998.9	0.283	234.8	60.8	681.1	176.4
7	88	0.145	11.3	2.9	68.9	0.205	12.2	3.6	50.8	15.1
8	16	0.200	2.8	0.9	12.1	0.150	1.6	0.5	9.4	3.1
9	6	0.609	2.5	0.8	2.8	0.155	0.4	0.1	2.2	0.9
10	6	0.191	1.0	0.3	4.7	0.159	0.7	0.3	3.6	1.4
Totals				37.1 (37.1)				92.5 (87.0)		387.1 (353.6)

[1] The two sets of figures refer to the two assumptions as to the size of the 1973 year-class: the set in parentheses are based on assuming 1 billion fish at age 2, as used in the January 1976 assessment; the set used in the present assessment are based on assuming 1.5 billion fish at age 2.

ii) Catch prediction for 1976/77 (Nov-Oct)

Assuming that the catch of 129,600 tons is taken in Div. 4WX during the 1975/76 season and that the 1973 year-class size at age 2 is about 1.5 billion fish, the stock size at the beginning of the 1976/77 season (1 November 1976) will be 454,000 tons (age 4 and older fish). Yield-per-recruit calculations indicate that $F_{0.1}$ is about 0.30. Using this management strategy and setting the 1975 year-class size at the conventional level of 750 million fish at age 2, a TAC of 109,000 tons is predicted for Div. 4WX for the 1976/77 season (1 November 1976-31 October 1977) (Table 14).

If the Commission wishes to manage these fisheries as previously, i.e. for Div. 4XW(b) on a calendar year basis, the recommended TAC for 1977 in Div. 4XW(b) is 84,000 tons, which includes an estimated 15,000 tons expected to be taken by inshore gears.

Table 14. Herring in Div. 4WX: catch projection for 1976/77 season (1 November to 31 October) at three levels of fishing mortality ($F_{0.1}$=0.30).

Age	Stock size 1 Nov 1976	Projected catch for fishing season Nov 1976 to Oct 1977 F = 0.35		F = 0.30		F = 0.25	
	(millions)	*(millions)*	*(000 t)*	*(millions)*	*(000 t)*	*(millions)*	*(000 t)*
2	750.0	67.9	2.9	58.6	2.5	49.2	2.1
3	522.8	67.1	7.6	58.1	6.6	48.9	5.5
4[1]	723.3	153.8	26.9	134.2	23.5	113.8	19.9
	(426.9)	(90.9)	(15.9)	(79.2)	(13.9)	(67.2)	(11.8)
5	276.8	68.1	14.9	59.6	13.0	50.7	11.1
6	168.2	45.3	11.7	39.7	10.3	33.9	8.8
7	681.1	183.3	54.6	160.8	47.9	137.1	40.9
8	50.8	13.7	4.5	12.0	4.0	10.2	3.4
9	9.4	2.5	0.9	2.2	0.8	1.9	0.7
10	2.2	0.6	0.2	0.5	0.2	0.4	0.2
Totals			124.2 (113.2)		108.7 (99.1)		92.5 (84.3)
Residual stock biomass (age 4 and older) in 1977			337.5 (304.9)		351.4 (317.6)		365.9 (330.8)
Stock biomass (age 4 and older) on 1 Nov 1977			382.5 (342.0)		398.6 (356.5)		415.4 (371.6)

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year-class: the figures in parentheses are based on assuming 1 billion fish at age 2, and the other set is based on assuming 1.5 billion fish at age 2 as used in the present assessment.

iii) Catch prediction for 1977/78 (Nov-Oct)

In order to arrive at the TAC for Div. 4VW(a) in 1977/78, it was necessary to predict the 1977/78 catch for Div. 4WX and then apportion it between Div. 4W(a) and 4XW(b). The predicted TAC for Div. 4WX for the 1977/78 season, using $F_{0.1}$=0.30 and setting the size of the 1976 year-class at the conventional level of 750 million fish at age 2, is 98,000 tons (Table 15)

Table 15. Herring in Div. 4WX: catch projection for 1977/78 season (1 November to 31 October) at three levels of fishing mortality ($F_{0.1}$=0.30).

Age	F = 0.35 Stock size 1 Nov 1977	F = 0.35 Projected catch for 1977/78		F = 0.30 Stock size 1 Nov 1977	F = 0.30 Projected catch for 1977/78		F = 0.25 Stock size 1 Nov 1977	F = 0.25 Projected catch for 1977/78	
	(millions)	*(millions)*	*(000 t)*	*(millions)*	*(millions)*	*(000 t)*	*(millions)*	*(millions)*	*(000 t)*
2	750.0	67.9	2.9	750.0	58.6	2.5	750.0	49.2	2.1
3	552.8	67.1	7.6	561.2	59.0	6.7	569.7	50.4	5.7
4	392.1	83.4	14.6	400.2	74.2	13.0	408.5	64.3	11.2
5[1]	453.9	111.7	24.4	471.5	101.6	22.0	489.7	89.8	19.6
	(267.9)	(66.0)	(14.4)	(278.3)	(59.9)	(13.1)	(289.1)	(53.0)	(11.6)
6	165.4	44.5	11.5	173.0	40.8	10.6	180.9	36.4	9.4
7	97.0	26.1	7.8	102.0	24.1	7.2	107.2	21.6	6.4
8	392.9	105.8	35.1	413.1	97.5	32.4	434.3	87.4	29.0
9	29.3	7.9	2.9	30.8	7.3	2.6	32.4	6.5	2.4
10	5.4	1.5	0.6	5.7	1.4	0.5	6.0	1.2	0.5
Total			107.3 (97.3)			97.6 (88.5)			86.3 (78.3)
Residual stock biomass (age 4 and older) in 1978			293.8 (269.5)			316.3 (290.0)			340.9 (312.3)
Stobk biomass (age 4 and older) on 1 Nov 1978			328.7 (299.9)			354.6 (323.3)			382.9 (348.9)

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year-class: the figures in parentheses are based on assuming 1 billion fish at age 2, and the other set is based on assuming 1.5 billion fish at age 2 as used in the present assessment.

iv) Management considerations

The Commission has set TACs for management areas that differ from those now recommended by STACRES. Consequently TACs have been set for Div. 4VW(a) in the 1975/76 and 1976/77 seasons and for Div. 4XW(b) in 1976. STACRES considered and recommended at the June 1975 Annual Meeting and again at the January 1976 Special Meeting that the management areas be changed to conform with those based on improved knowledge of the stock relationships. The Subcommittee again reiterates the need for the change and strongly recommends that the Commission set TACs for the management areas 4V and 4WX as indicated below:

Div. 4V (1 Jul-30 Jun)		Div. 4WX (1 Nov-31 Oct)	
Season	TAC	Season	TAC
1975/76	15,000[1]	1975/76	(92,500)[2,3]
1976/77	11,000[1]	1976/77	109,000[3]
1977/78	11,000		

1 From STACRES recommendations (*Redbook* 1975, page 39).
2 For remainder of 1975/76 season (1 April to 31 October 1976); includes 3,300 tons allocated but not yet reported as caught within the 1975/76 TAC for Div. 4VW(a).
3 If the Commission wishes to manage the fishery on a calendar year basis, the comparable TACs for 1976 and 1977 are 96,500 tons and 109,000 tons respectively.

If the Commission decides to continue managing the fisheries in Div. 4VWX as previously (i.e. Div. 4VW(a) and Div. 4XW(b)), the TACs are projected as follows:

Div. 4VW(a) (1 Jul-30 Jun)				Div. 4XW(b)[5]	
Season	4V	4W(a)	TAC	Year	TAC
1975/76	15,000[1]	30,000[1]	45,000[2]		
1976/77	11,000[1]	25,000[1]	36,000[2]	1976	89,200[6]
1977/78	11,000[3]	22,500[4]	33,500	1977	84,000[6,7]

1 From STACRES recommendations (*Redbook* 1975, page 39).
2 Already agreed by the Commission and allocated.
3 Recommended at the present meeting.
4 Catch in 4W(a) decreased proportionately to decrease in catch for 4WX (from 109,000 tons to 98,000 tons).
5 Although the assessment period is 1 Nov-31 Oct, the catch is normally taken during Apr-Oct period, so that the TAC can be assumed as a calendar year TAC for Commission purposes.
6 TACs include estimated catches of 15,000 tons by inshore gears.
7 The recommended TAC for Div. 4WX (Nov 1976-Oct 1977) is 109,000 tons; removing the Div. 4W(a) projected catch of 25,000 tons leaves 84,000 tons for this area.

In order to institute the change from the current management regime to the revised management areas, as recommended by STACRES, the Commission will have to take the following steps:

(1) For the remainder of the 1975/76 season (1 Apr-31 Oct 1976) in Div. 4WX, the recommended TAC of 92,500 tons would replace the agreed TAC for Div. 4XW(b) and be allocated, taking into consideration the residual quota of 3,300 tons in Div. 4VW(a).

(2) For the 1976/77 season (Jul-Jun) in Div. 4V, the fishery is already under regulation as part of 1976/77 TAC (36,000 tons) in Div. 4VW(a); this TAC would have to be supplanted by the recommended TAC of 11,000 tons in Div. 4V for 1976/77, and the Div. 4W(a) portion of the existing TAC taken into account in Div. 4WX.

(3) For the 1976/77 season (Nov-Oct) in Div. 4WX, the allocation of the recommended TAC of 109,000 tons would have to take into account the fact that a TAC of 36,000 tons for 1976/77 (Jul-Jun) in Div. 4W(a) has already been agreed to and allocated.

(4) For the 1977/78 season (Jul-Jun) in Div. 4V, the recommended TAC of 11,000 tons is to be considered by the Commission and nationally allocated.

m) Mackerel in Subareas 3 and 4

The status of the mackerel fishery in Subareas 3 and 4 is considered in conjunction with the overall assessment of the stocks in Subareas 3 to 5 and Statistical Area 6 (see under Mackerel in Section VII, 2(p)).

n) Argentine in Div. 4V, 4W and 4X (Res. Doc. 76/VI/56)

While catches were relatively low during 1971-73, averaging less than 5,000 tons, the nominal catch was 17,000 tons in 1974 and provisional statistics indicate a catch of 15,000 tons in 1975. The TAC was set at 25,000 tons for each of the years 1974, 1975 and 1976. New data on age validation and growth, which clarify earlier discrepancies in growth parameters, were presented. However, sufficient information has not been made available to make an accurate assessment of the yield potential of the stock in this area. The initial TAC of 25,000 tons was set above the estimated MSY catch, based on biomass estimates from research surveys and on general biological data, to allow for fishing-up of accumulated biomass from the lightly exploited populations. However, the catches were quite high in 1974 and 1975, and a further year with a potential catch of 25,000 tons (i.e. 1976) will likely reduce the stocks substantially below the relatively unexploited level of 1973. In view of the uncertainties about the status of the stocks, the TAC for 1977 should be reduced to the estimated MSY level. The Subcommittee therefore recommends that the TAC for 1977 be reduced to 20,000 tons.

Despite the regulation of this fishery with a precautionary TAC for almost three years, very little data have become available with which to determine the effects of fishing on these stocks. Without an adequate assessment, the catch in subsequent years should be reduced to ensure that the stocks are not overfished.

o) Squid-*Illex* in Subareas 2 to 4

The assessment of *Illex* in Subareas 2 to 4 is considered together with the stock component in Subarea 5 and Statistical Area 6 (see under Squid-*Illex* in Section VII, 2(r)).

VII. SUBAREA 5 AND STATISTICAL AREA 6

1. Fishery Trends

(This subsection to be completed when more complete statistics become available from STATLANT 21A returns.)

2. Species Review

Table 16 contains a summary of recent catches and TACs, including those recommended for 1977, for stocks under consideration for management in Subarea 5 and Statistical Area 6. The TACs listed include quantities, if any, estimated to be taken outside the Convention Area.

a) Cod in Division 5Y (Res. Doc. 75/46)

Nominal catches in this area have fluctuated between 2,700 and 14,500 tons since 1932 and have averaged 7,100 tons over the past 10 years (1966-75), the provisional catch in 1975 being about 9,000 tons. The TAC, which was set at 10,000 tons annually for 1973-75, was reduced to 8,000 tons for 1976, based on (i) a decline from 1968 in the mean catch (in weight) per tow from USA autumn bottom trawl surveys; (ii) average historical catch levels with implications of an unknown but assumed considerable sport fishing component; and (iii) estimates of mortality suggesting that the recent fishery (1970-74) generated F-values of about 0.48 (Res. Doc. 75/46) which with M=0.20 exceed F_{max}=0.30. Although an update of the survey data suggest that the declining trend has stablilized since 1973, knowledge of the component of mortality caused by sport fishing is needed to interpret the relationships between catch abundance and associated fishing mortality rates. In the absence of interaction between stocks supporting commercial and recreational fishing, the average commercial catch of 7,350 tons in 1970-74 generated an F of 0.48. If recruitment remains stable, fishing at F_{max}=0.30 would result in a catch of approximately 5,000 tons, and fishing at $F_{0.1}$=0.18 would produce a catch of about 3,200 tons. The Subcommittee therefore recommends that the TAC for 1977 be set at 3,200 tons.

Table 16. Subarea 5 and Statistical Area 6: summary of nominal catches (1971-75) and TACs (1973-77) by species and stock area. (Nominal catches for 1975 are based on advance provisional statistics for April 1976 assessments, and TACs in parentheses are those recommended by the Assessments Subcommittee.)

Species	Stock area	Nominal catches (000 tons)					TACs (000 tons)				
		1971	1972	1973	1974	1975	1973	1974	1975	1976	1977
Cod	5Y	8	7	6	8	9	10.0	10.0	10.0	8.0	(3.2)
	5Z	28	25	29	27	24	35.0	35.0	35.0	35.0	(15.0)
Haddock	5	12	7	6	5	7	6.0	0.0	6.0[1]	6.0[1]	(0.0)
Redfish	5	20	19	17	10	11	30.0	30.0	25.0	17.0	(9.0)
Silver hake	5Y	8	7	9	5	9	10.0	10.0	15.0	10.0	(5.0)
	5Ze	72	78	62	66	57	80.0	80.0	80.0	50.0	(70.0)
	5Zw+6	28	35	65	58	54	80.0	80.0	80.0	43.0	(50.0)
Red hake	5Ze	9	39	25	10	14	-	20.0[2]	20.0[2]	26.0	(16.0)
	5Zw+6	31	36	41	24	26	40.0[3]	50.0[3]	45.0[3]	16.0	(28.0)
Pollock	4VWX	12	20	30	25	25	50.0[4]	55.0	55.0	55.0	(20.0)
	5	14	13	13	12	13					
Yellowtail	5(E69°)	31	39	31	25	14	16.0	16.0	16.0	16.0	(7.0)
	5(W69°)+6					6	10.0[5]	10.0[5]	4.0	4.0	(0.0)
Flounders (except yellowtail)	5+6	28	24	22	21	23	25.0	25.0	25.0	20.0	(20.0)
Herring	5Y(total)	(51)	(62)	(32)	(37)	(37)					
	5Y(adults)	39	43	16	18	21	25.0	25.0	16.0	7.0	(0.0)
	5Z+6	267	174	202	150	145	150.0	150.0	150.0	60.0	(50.0)
Mackerel	3+4	24	22	38	45	37	-	55.0[6]	70.0	56.0	(0.0)[7]
	5+6	349	387	381	295	246	450.0	304.0	285.0	254.0	
Other finfish[8]	5+6	159	172	157	132	96	-	150.0	150.0	150.0	(150.0)[9]
Squid-*Illex*	5+6	25	49	59	56	46[10]	-	71.0[11]	71.0[11]	30.0	(30.0)
Squid-*Loligo*	5+6									44.0	(44.0)
Overall 2nd tier[12]	5+6	1140	1171	1159	942	833	-	923.9	850.0	650.0	(500.0)

1 TACs for by-catch with no directed fishery.
2 TACs pertain to 5Z(E69°).
3 TACs pertain to 5Z(W69°)+6.
4 TAC pertains to 4X+5 only.
5 TACs pertain to 5(W69°) only.
6 TAC pertains to 4VWX only.
7 TAC subject to re-assessment at 1976 Annual Meeting (see Section VII, 2(p)).
8 Excludes all TAC species and also menhaden, billfishes, tunas and large sharks (except dogfish).
9 Within this recommended TAC, advisory TACs are recommended for the following species: 25,000 tons of argentine, 40,000 tons of dogfish, 18,000 tons of butterfish, and 10,000 tons (including inshore fishery) of river herrings (*Alosa pseudoharengus* and *A. aestivalis*).
10 Catches not yet available for all countries by *Illex* and *Loligo* separately.
11 TACs pertain to *Illex* and *Loligo* combined.
12 Includes all finfish species (except menhaden, billfishes, tunas and large sharks) and squids.

b) Cod in Division 5Z (Res. Doc. 76/VI/42; 75/46)

Nominal catches of Georges Bank cod declined from 32,300 tons in 1937 to 8,100 tons in 1953, then increased rapidly from 10,400 tons in 1960 to 52,900 tons in 1966, and, after a sharp decline, stabilized around 26,000 tons annually during 1970-75. The TAC for this stock has been set at 35,000 tons since 1973, which was considered to be about the MSY level. Catch data from USA autumn bottom trawl surveys indicate a stable level of abundance since 1963, with good recruitment since 1970. A strong 1971 year-class became fully recruited to the fishery by 1974 and the 1975 year-class appears to be about equal in size to that of 1971. Although an analytical assessment (virtual population analysis) has not yet been completed for the stock, preliminary analyses suggest that the very high catches in the late 1960's may have generated F-values in the range of 0.55-0.65, which are considerably above the calculated value of F_{max}=0.3, with M=0.2. Catches averaging about 26,500 tons during 1970-74 generated F-values which averaged 0.36 (Res. Doc. 75/46). If recruitment remains stable, fishing at a level associated with F_{max} would result in a catch of about 24,000 tons. If fishing is conducted at $F_{0.1}$=0.18, the corresponding catch would be approximately 15,000 tons. The Subcommittee, therefore, recommends that the TAC for 1977 be set at 15,000 tons.

c) Haddock in Subarea 5 (Res. Doc. 76/VI/35)

Nominal catches declined precipitously from 127,000 tons in 1966 to 12,800 tons in 1970, the first year in which a TAC was adopted (12,000 tons). Since 1970, nominal catches have averaged 7,200 tons under TAC regulation. The Subcommittee has consistently advised a TAC of zero since 1972 (no directed fishery for haddock), and this was adopted by the Commission for 1974. However, the TACs for 1975 and 1976 were set at 6,000 tons to provide for by-catches up to that level. Provisional statistics for 1975 indicate a nominal catch of 6,700 tons.

Both commercial catch/effort data and USA autumn trawl survey data indicate a pronounced decline in abundance since 1967. Recruitment has been generally poor; however, the 1972 and 1975 year-classes were the strongest since that of 1967, although strength of the 1975 year-class is based only on one research survey and additional data will be required for a more definitive estimate. Both the stock size estimates (Table 17) and survey data indicate a decline in abundance in the late 1960's and early 1970's followed by an increase.

Table 17. Stock abundance, removals and recruitment estimates for Georges Bank haddock, 1968-77.

	Yearly estimates in millions of fish										
	1935-60[1]	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Stock size (age 2+)	145	70[2]	36	21	24	16	27	55	50	48	66[3]
Removals - total	63	35	16	8	9	5	8	12	12	12	14
- fishing[4]	41	25	11	5	5	2	3	3	3	4	4
- natural	22	10	5	3	4	3	5	9	9	8	10
Recruits (age 2)[5]	54	15	1	1	11	1	16	36	7	10	10

1 Average of yearly estimates from *Redbook* 1970, Part I, page 48.
2 Estimated assuming F=0.5 and M=0.2 during 1968.
3 Assuming that current TAC remains in effect for 1977.
4 Values computed on the basis of mean weight at age in USA data.
5 Values for 1968-75 computed using Hennemuth's (1969) index; values for 1976-77 estimated using Grosslein's (1969) index. From Hennemuth's common regression line, $Y_1 = 3.31 - 0.056(24) = 1.97$; Y_2 is estimated at t = 24 months from the fitted regression line for a given year-class, and estimated recruitment is $(e^{Y_2-Y_1}) \times 81 \times 10^6$ fish.

Projections for 1976 and 1977 indicate that, if recruitment continues at the average level observed during 1972-75 (approximately 15 million fish), maintaining the existing TAC level of 6,000 tons would lead only to a stabilization of stock size in the late 1970's at about one-half of the pre-1960 level, while an increased TAC could lead to a substantial reduction in abundance. Even with better than average recruitment, by-catches would be expected to increase, thereby delaying somewhat the projected improvement in stock size. The Subcommittee recommends that removals in 1977 should be kept to the lowest possible level to allow for the most rapid recovery of the stock to the MSY level and therefore advises a zero TAC for 1977.

d) Redfish in Subarea 5 (Res. Doc. 76/VI/43)

Provisional statistics indicate a nominal catch of 10,600 tons in 1975, about the same as the 1974 catch but substantially below the 1975 TAC of 25,000 tons. Catch rates of USA commercial vessels, whose catches consisted of 50% or more of redfish, continued the declining trend which has been evident since 1968. USA autumn trawl survey length frequency data indicate an increase in abundance of pre-recruit fish which began to enter the commercial fishery in 1974, and recruitment of these fish will continue over the next few years. The survey length frequencies also indicate that lower recruitment will prevail for a period of years thereafter. Projection from the yield model indicates that fishing at a level of effort associated with F_{MSY} in 1977 would result in a catch of about 10,000 tons, which is below the long-term MSY estimate of 17,000 tons. Consequently, the Subcommittee recommends a TAC of 9,000 tons for 1977 to ensure controlling fishing effort at a level below F_{MSY}.

e) Silver hake in Division 5Y

The nominal catch increased from 5,200 tons in 1974 to 9,100 tons in 1975. While USA commercial catch per unit effort increased by 24% from 1974 to 1975, fishing effort increased by 41%. Catch per tow data from both spring and autumn surveys indicate an increase in stock abundance in 1975. Also, survey data show that the 1971-75 year-classes were stronger than those produced during 1966-70.

Virtual population analyses indicate that stock biomass decreased to a low in 1971 as the result of catches exceeding recruitment during the 1960's. The stock size has since begun to increase as a result of improved recruitment and in 1975 was about twice the 1971 level. However, the capture and discarding of undersized silver hake in the USA trawl fisheries for silver hake and shrimp has been high in recent years and has thus been detrimental to the recovery of the adult stock. However, insufficient data are available to adequately estimate the catch and age composition of the unreported discards. The fishing mortality, estimated from the relationship between fishing mortality and fishing effort in previous years, was 0.50 in 1975, compared with F_{max}=0.60 and $F_{0.1}$=0.30. Full utilization of the 1976 TAC of 10,000 tons would generate an F of about 0.55. If fishing mortality is reduced to $F_{0.1}$(0.30) in 1977, a catch of about 5,000 tons would be taken. Bearing in mind the current low level of this stock and the desirability of rebuilding the stock to a higher level of abundance, the Subcommittee recommends a TAC of 5,000 tons in 1977.

f) Silver hake in Subdivision 5Ze

The nominal catch decreased from 66,400 tons in 1974 to about 56,500 tons in 1975. The USA commercial catch per unit effort increased by 50% from 1974 to 1975, following a 50% decrease from 1973 to 1974. The spring survey catch per tow index increased slightly in 1975 and the autumn index increased substantially to the highest level since 1968. Survey catches of ages 0 and 1 fish, as well as virtual population analyses, indicate that the 1971-75 year-classes are stronger than any produced during 1965-70, with the 1973-75 year-classes being estimated as the strongest observed since that of 1963. Improved recruitment has allowed the stock biomass to increase by about 2 to 3 times since the low level in 1969-70.

Fishing mortality in 1974-75 was estimated to be about 0.40-0.50 (about the level of F_{max}). Catch projection indicates that an F of 0.20-0.25 would be required to take the 1976 TAC of 50,000 tons. Fishing at the level of $F_{0.1}$=0.30 in 1977 would produce a catch of about 70,000 tons. Since the stock biomass appears to be at a satisfactory level in comparison with recent levels and in view of the evidence indicating that the 1973-75 year-classes are strong, the Subcommittee recommends a TAC of 70,000 tons for 1977.

g) Silver hake in Subdivision 5Zw and Statistical Area 6

The nominal catch decreased from 58,400 tons in 1974 to about 53,700 tons in 1975. The USA commercial catch per unit effort increased by 33% from 1974 to 1975. Both the spring and the autumn catch per tow indices indicate an increase in stock abundance in 1975. Virtual population analysis as well as the autumn survey catches of age 0 fish indicate that the 1971-72 year-classes were the strongest produced since 1964. Survey data also indicate that the 1973 year-class was poor but that the 1974 year-class is possibly stronger than those of 1971 and 1972. The 1975 year-class is estimated to be about twice as strong as the poor 1973 year-class but slightly weaker than those of 1971 and 1972. Recent recruitment has, therefore, resulted in an increase in stock biomass from the rather low levels in 1970-71.

Fishing mortality increased from about 0.33 in 1972 to 0.50-0.55 in 1974-75, compared with F_{max}= 0.45 and $F_{0.1}$=0.30 for this stock. Fishing mortality of 0.26-0.31 would be necessary in 1976 to take the TAC of 43,000 tons. If fishing is carried out in 1977 at a level of effort associated with $F_{0.1}$=0.30, a catch of about 50,000 tons could be taken. The Subcommittee therefore recommends that the TAC for 1977 be set at 50,000 tons.

h) Red hake in Subdivision 5Ze (Res. Doc. 76/VI/55)

The nominal catch increased from 9,500 tons in 1974 to a provisional figure of 14,000 tons in 1975, nearly all of which was taken by USSR. The TAC for 1975 was 20,000 tons.

A virtual population analysis, presented by USSR, projects a catch of 20,000 tons in 1977 by fishing at F=0.70 (F=0.20 for age 2 fish). The 1974 year-class, which would provide about one-half or more of the catch in 1977, was taken to be equal to the largest on record, based on survey indices, and the 1973 and 1975 year-classes were assumed to be about average size. Also, it was assumed that the full USSR allocation of 19,000 tons would be taken in 1976. The USA survey data indicate a sharp increase in stock size in 1975, due to the large 1973 and 1974 year-classes. USA yield-per-recruit studies (Res. Doc. 74/19) indicate that, at M=0.40, F_{max}=0.70 and $F_{0.1}$=0.35. Fishing at $F_{0.1}$ in 1977, using the USSR estimates of stock size, would result in a catch of about 12,000 tons. Given the uncertainty of the current assessment and the fact that the stock appears to have increased, the Subcommittee recommends a TAC of 16,000 tons in 1977.

The Subcommittee noted that adequate assessments could not be done until ageing techniques are improved and agreed age composition data are available, and accordingly recommends that the ageing of red hake be included in the silver hake ageing workshop proposed for 1976.

i) Red hake in Subdivision 5Zw and Statistical Area 6

The nominal catch increased slightly from 24,000 tons in 1974 to about 26,000 tons in 1975, with USSR taking 24,000 tons and the remainder by USA. The TAC for 1975 was 45,000 tons.

A yield-per-recruit assessment, presented by USSR, indicates a catch of 35,000 tons in 1977 by fishing at F=0.70. Research surveys indicated that the 1973 year-class was very large (about the same as the 1968-70 year-classes), and the 1974 and 1975 year-classes were assumed to be equal to the long-term mean of year-class size. Autumn trawl surveys indicated an increase in stock size in 1975 over the extremely low stock level measured in 1974 surveys. Also the abundance of age 0 fish in 1974 surveys was shown to be high. USA studies indicate that, at M=0.40, F_{max}=0.70 and $F_{0.1}$=0.35. Fishing at $F_{0.1}$ in 1977, using the USSR assumptions about year-class strength, would result in a catch of about 20,000 tons. Given the uncertainties about the validity of existing assessments and about the effects of fishing at either the F_{max} or the $F_{0.1}$ level on stock size, the Subcommittee recommends a TAC of 28,000 tons in 1977.

The Subcommittee noted that adequate assessments could not be done until ageing techniques are improved and agreed age composition data are available, and accordingly recommends that the ageing of red hake be included in the silver hake ageing workshop proposed for 1976.

j) Pollock in Subarea 5

The assessment of Pollock in Subarea 5 is considered together with the stock component in Div. 4VWX (see under Pollock in Section VI, 2(i)).

k) Yellowtail flounder in Subarea 5 (east of 69°W)

Provisional statistics indicate a nominal catch of 14,500 tons in 1975, in contrast with 16,800 tons in 1974. Stock abundance, as measured by autumn bottom trawl surveys and by the catch rates of USA commercial vessels, seemed to stabilize after 1971-73 under the TAC of 16,000 tons set to control fishing at F_{max}=0.8. The catch per day fishing was 1.7 tons in 1975 and 2.0 tons in 1974 in contrast to an average of 2.6 tons per day in the 1970-73 period. The bottom trawl survey indices in 1974-75 averaged 8.8, compared with 14.5 for 1970-73. Abundance indices of age 1 fish, estimated from the autumn bottom trawl surveys in terms of the stratified mean number caught per tow, are as follows:

Year	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
No./tow	11.60	2.64	1.29	9.76	6.96	10.59	7.64	4.75	3.82	2.42	2.71	3.50	4.05

These data indicate that the year-classes which will support the fishery in 1976-77 are less abundant than those which supported the fishery in 1970-73. Age compositions of catches in 1975 indicate a large contribution of age 2 fish, although survey data did not show the increased abundance of this year-class. In view of the abundance of this age-group in the catches, it can be assumed that fishing mortality on it approximately doubled. This is the age-group that the mesh regulation (130 mm, manila) was intended to conserve, because yellowtail double their weight between age 2 and age 3. If higher yields are desired from this fishery, the fishing mortality on two-year-old fish must be reduced.

Utilizing available data on age composition and estimated mortality for 1975, catch and stock size projections were made for 1976 and 1977 (Table 18). Using F=0.8 for fish of age 3 and older in the 1975 fishery and F=0.4 for age 2 fish (based on fishing mortality for 1964-72 as calculated by Penttila and Brown (ICNAF Res. Bull. No. 10)), stock sizes in 1975 and 1976 were estimated. Using the same F-values for 1976, a catch of 12,500 tons is predicted. This catch probably approximates that which will actually be taken in 1976, based on the experience of the 1975 fishery and provisional figures for the 1976 catch. The level of recruitment assumed for 1976 and 1977 (42 million fish at age 2) is equal to the lowest level since 1962, as estimated from preliminary virtual population analysis (the mean value for 1962-72 is 56 million fish). The lack of adequate estimates of discards, both in the directed fishery and in by-catches, make the estimation of stock size from virtual population analysis rather inaccurate.

If fishing is conducted at the level of F_{max} in 1977 for a predicted yield of 12,400 tons, the stock size will be maintained at about the relatively low level existing in 1975 and 1976. Fishing at $F_{0.1}$=0.4 for a projected catch of 7,000 tons would result in increasing the stock size by about 10%. If fishing is continued in future years at the $F_{0.1}$ level and recruitment remains at about the current level, annual yields should increase to about 12,000 tons in 5-6 years and the stock size (age 3 and older) should increase to about 61 million fish, a level similar to those which prevailed in the 1962-73 period. The Subcommittee therefore recommends a TAC of 7,000 tons for 1977.

Table 18. Yellowtail in Subarea 5 (east of 69°W): catch and stock size projections, 1975-77.

Year	Age	Stock numbers[1]	F	Catch Numbers	Catch Weight	Residual stock[2]
		(10^{-3})		(10^{-3})	(tons)	(10^{-3})
1975	2	40,100	0.4	12,030		
	3	20,900	0.8	10,450		
	4	12,198	0.8	6,099		
	5	4,150	0.8	2,125		
	6	1,060	0.8	530		
	7	542	0.8	271		
	8+	212	0.8	106		
	Total	79,162		31,611		
1976	2	42,000	0.4	12,600	3,037	
	3	21,979	0.8	10,987	4,582	
	4	7,689	0.8	3,845	2,284	
	5	4,487	0.8	2,243	1,671	
	6	1,527	0.8	763	658	
	7	392	0.8	196	188	
	8+	277	0.8	139	140	(age 3 and
	Total	78,341		30,773	12,568	older)
1977	2	42,000	0.4	12,600	3,034	-
	3	23,100	0.8	11,505	4,797	23,100
	4	8,084	0.8	4,042	2,400	8,489
	5	2,829	0.8	1,415	1,054	2,974
	6	1,660	0.8	830	716	1,040
	7	565	0.8	282	270	611
	8+	248	0.8	186	187	301
	Total	88,486		30,860	12,458	36,515
1977	2	42,000	0.2	7,140	1,721	-
	3	23,100	0.4	6,576	2,742	28,153
	4	8,084	0.4	2,425	1,440	12,678
	5	2,829	0.4	849	504	4,610
	6	1,660	0.4	498	430	1,552
	7	565	0.4	170	163	911
	8+	248	0.4	166	167	446
	Total	88,486		17,824	7,176	42,050

[1] Stock numbers refer to beginning of the indicated year.
[2] Residual stock (age 3 and older) at the start of the following year.

ℓ) Yellowtail flounder in Subarea 5 (west of 69°W) and Statistical Area 6

Three yellowtail populations are located in this management area. The Cape Cod and the southern New England stocks have been under a collective TAC regulation since 1971 and the Statistical Area 6 stock has been included since 1975. The provisional nominal catch from all three stocks was slightly less than 6,000 tons in 1975.

i) Cape Cod stock. The 1975 catch was about 2,000 tons which is similar to the long-term average. However, catch rates of USA commercial vessels declined from 1.9 tons per day in 1974 to 1.6 tons per day in 1975, indicating a possible decrease in stock size.

ii) Southern New England stock. Although the TAC regulations have greatly decreased removals since 1970, catch rates in the USA commercial fishery continued to decline during the period. Abundance indices from autumn surveys indicate a drastic decrease (90% since 1969) in pre-recruits (age 1), with the catch per tow in 1974 being among the lowest values observed during the entire series of years for which data are available (Table 19). Assuming that the 1976 pre-recruit index is equal to that for 1975, the stock size index will have decreased by about 80% between 1970 and 1977, and it is obvious that the current stock is extremely low. The catch per day fished by USA vessels has declined from well over 3.0 tons in each year during 1957-72 to 1.9 tons in 1974 and to 1.4 tons in 1975.

Table 19. Catch per tow (age 1+) of pre-recruits and associated stock abundance indices for yellowtail in southern New England and Stat. Area 6 from USA autumn surveys.

Year	Southern New England		Statistical Area 6	
	No. per tow (age 1+)	Abundance index	No. per tow (age 1+)	Abundance index
1963	16.3		11.1	
1964	18.6		5.3	
1965	11.5		19.2	
1966	35.5		14.2	
1967	20.0	102.5	12.5	64.4
1968	10.0	119.2	11.6	67.3
1969	12.8	92.6	0.6	59.0
1970	7.3	71.9	1.9	36.8
1971	6.3	53.6	11.0	11.7
1972	4.3	40.0	0.6	22.4
1973	1.9	30.8	0.7	21.6
1974	1.1	20.1	0.04	7.5
1975	1.7	11.9	0.46	2.7
1976		8.1		1.2
1977		7.8		1.6

iii) Statistical Area 6 stock. Abundance indices indicate a 90% decrease in stock size between 1970 and 1975 (Table 19). If the 1976 year-class is assumed to be about the same size as that of 1975, the stock size in 1977 is projected to be extremely low in contrast to earlier levels.

In the absence of sufficient information about relationships between the stock components in this area, the Subcommittee advises that a single management area should be maintained. Recognizing the depressed condition of the various stocks, the Subcommittee recommends that the TAC for 1977 be set at zero, with the knowledge that unavoidable catches may approach 4,000 tons. Without improved recruitment, even this level of removal will prevent the stock from recovering, and every possible measure should therefore be taken to reduce the level of by-catch. The decline in catch from about 10,000 tons in 1974 to less than 6,000 tons in 1975 is even greater than the decline in catch per unit effort. Also, the stock abundance indices indicate that fishing mortality is higher than 1.0 whereas $F_{0.1}=0.4$.

m) Flounders, except yellowtail, in Subarea 5 and Statistical Area 6 (Res. Doc. 75/65)

Provisional statistics indicate that the nominal catch was about 23,300 tons in 1975, slightly higher than the 1974 catch of 21,200 tons. The TAC for 1975 was 25,000 tons. While the bottom trawl surveys indicated a decline in biomass since 1963, no significant change was detected between 1974 and 1975. Examination of length frequency data for American plaice, witch flounder, winter flounder, summer flounder and windowpane flounder from the autumn trawl surveys indicates decline in modal lengths since 1963 but not in the most recent survey years.

The assessment for summer flounder, presented in 1975 suggested that a sustainable catch level of 20,000-22,000 tons might be possible for this component of the flounder group but that the estimates of the unreported catches in the sport fishery were probably at or above the sustainable yield. No new information was presented to update that assessment.

The TAC for flounders, except yellowtail, has been maintained at the level of 25,000 tons annually during 1973-75, on the basis of historical catches, research survey trends in abundance and general biological information. Considering the declining trends observed in the survey data (Res. Doc. 75/65) and in commercial catches, and noting the implications of additional fishing mortality on these species by the USA sport fishery, the Subcommittee recommended a TAC of 20,000 tons for 1976, stressing that every effort should be made to reduce the by-catches of these species in other directed fisheries in the area. The Subcommittee accordingly recommends that the TAC of 20,000 tons be maintained for 1977.

n) Herring in Division 5Y (Sum. Doc. 76/VI/5, 6)

i) Catch statistics and age composition. Provisional statistics indicate a nominal catch of about 20,500 tons in the 1975 fishery for adults out of a total catch of nearly 36,000 tons. Preliminary data for January to March 1976 show a catch of 3,800 tons which was slightly

less than for the same period in 1975. The 1970 year-class continued to dominate in the catches during the early months of 1976, the age composition for ages 3 to 6 being 5, 7, 3 and 78% respectively, compared with 18, 10, 64 and 5% for the same ages in January-March 1975.

ii) Year-class size and recruitment. Additonal information since the January 1976 Special Commission Meeting consists of statistics on catches during the first three months of 1976 and preliminary data on year-class abundance from the 1976 spring juvenile herring survey. Some details of the juvenile herring survey are given in the following section on herring in Div. 5Z and Stat. Area 6, indicating that all year-classes appear to be very low in abundance. Age 2 herring are generally not taken in the Div. 5Y adult herring fishery and less than 1% (by weight) of the 1976 catch in January to March consisted of the 1974 year-class. Considering the very poor catch in the juvenile survey, this year-class was assumed to be about the same size as the poor 1969, 1971 and 1972 year-classes at age 3 (i.e. 64 million fish). The size of the 1973 year-class could not be resolved and two levels of abundance were chosen, as was done in the previous assessment (Sum. Doc. 76/VI/5). The lower level was the conventional size of 64 million fish at age 3 for poor year-classes. A more optimistic assumption as to the size of this year-class was that it was equal to the average of the sizes of the 1968 and 1972 year-classes (i.e. 91 million fish). The strengths of the other year-classes were assumed to be the same as used in the previous assessment.

iii) The TAC level for 1976. At the January 1976 Special Meeting, the Commission set a TAC of 7,000 tons for 1976 . . . "or an amount which is decided at the Annual Meeting in June 1976 by unanimous vote . . ." (Sum. Doc. 76/VI/6). The additional information since that meeting does not change the assumptions on year-class size that were used in the previous assessment. It should be noted, however, that the results of the 1976 juvenile survey suggest that the 1970 to 1972 year-classes may have been reduced in size more than has been assumed. If a catch of 7,000 tons is taken in 1976 and if the lower level assumed for the 1973 year-class is the more correct one, the adult stock size would be reduced below the minimum stock size constraint of 60,000 tons to about 56,000 tons at the start of 1977.

iv) The TAC level for 1977. In assessing the probable state of the stock in 1977, it is assumed that the 1976 TAC of 7,000 tons will be taken. Also, the mean weight-at-age and partial recruitment values used in the previous assessment (Sum. Doc. 76/VI/5) were adopted. The projected stock sizes at the beginning of 1978 in relation to projected catches in 1977 for a range of F-values are given in Table 20 and illustrated in Fig. 2. Depending on the assumption as to the size of the 1973 year-class, the stock size at the beginning of 1977 would be in the range of 56,000-60,000 tons. Under either assumption, fishing at F=0.1 for a catch of about 4,500 tons in 1977 would result in maintaining the stock size at the beginning of 1978 to about the same level as at the start of 1977. If a catch of 7,000 tons is taken in 1977, the resultant stock size at the beginning of 1978 would be in the range of 53,750-57,750 tons. Fishing at $F_{0.1}$=0.38 in 1977 would yield a catch of 14,750-15,250 tons but the stock size at the start of 1978 would be reduced to 45,750-49,000 tons. Even a TAC of zero in 1977 would only increase the stock size to 61,000-65,000 tons, depending on the size of the 1973 year-class. Therefore, the Subcommittee recommends a TAC of zero for 1977.

Table 20. Div. 5Y adult herring: stock size (age 4 and older) in 1978 as a function of catch (age 3 and older) in 1977 for a range of F, assuming two levels of recruitment for the 1973 year-class in 1976. (Recruitment of the 1974 year-class is assumed to be 64 million fish.)

Stock size at start of 1976		Catch in 1976	Size of 1973 year-class	Stock size at start of 1977		F in 1977	Predicted 1977 catch	Stock size at start of 1978
(10^6)	(000 t)	(000 t)	(10^6)	(10^6)	(000 t)	(100%)	(000 t)	(000 t)
248	58	7	64	228	56	0.1	4.4	56.3
						0.2	8.4	52.3
						0.3	12.1	48.6
						0.4	15.5	45.2
						0.5	18.7	42.1
						0.6	21.5	39.2
248	58	7	91	250	60	0.1	4.6	60.0
						0.2	8.8	55.8
						0.3	12.6	51.9
						0.4	16.1	48.4
						0.5	19.4	45.1
						0.6	22.4	42.1

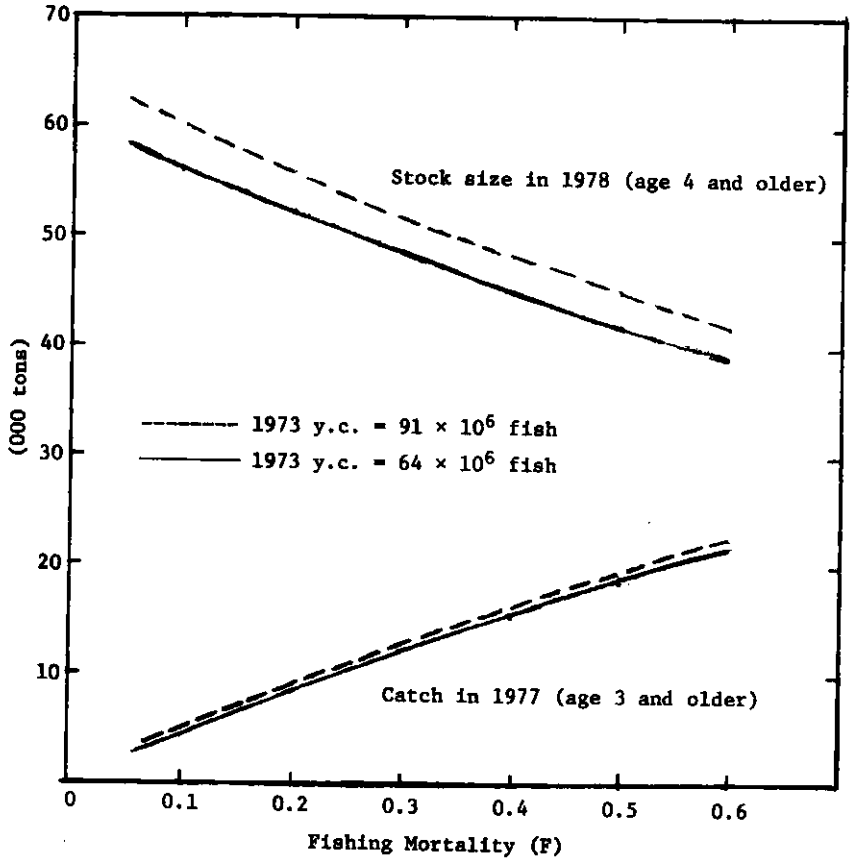

Fig. 2. Predicted herring catches in 1977 and stock sizes in 1978 for the Div. 5Y adult fishery at two levels of recruitment.

o) Herring in Division 5Z and Statistical Area 6

i) Catch statistics. Provisional statistics indicate a catch of about 144,600 tons in 1975, about 1,300 tons more than was reported at the January 1976 Special Commission Meeting. Consequently, the estimates of stock size at the start of 1976, as calculated for the previous assessment (Sum. Doc. 76/VI/5) were not changed. The TAC for 1975 was 150,000 tons. Catch data for the first two months of 1976 were incomplete.

ii) Year-class size and recruitment. The only additional information available since the January 1976 Special Meeting is data from the March 1976 juvenile herring surveys. Data from the USA spring survey by *Albatross IV* were not available at the time of the assessment. However, information from juvenile herring surveys by *Ernst Haeckel* from GDR and by *Anton Dohrn* from FRG suggests that all year-classes are very low in abundance. The relationship of the 1973 year-class at age 3 to other year-classes, in terms of catch in numbers per tow from the 1973 to 1976 surveys, is as follows:

Year-class	Georges Bank (Strata 13-23) *Walther Herwig*	Georges Bank (Strata 13-23) *Ernst Haeckel*	S. New England (Strata 1-12, 25) *Walther Herwig*	S. New England (Strata 1-12, 25) *Ernst Haeckel*	Total
1970	3,232		1,056		4,288
1971	924		608		1,532
1972	27	15	2	3	47
1973	4[1]	6	12[1]	22	44

[1] *Anton Dohrn* was used in 1976.

The relationship of the 1974 year-class at age 2 to other year-classes, in terms of catch in numbers per tow from the same surveys, is as follows:

Year-class	Georges Bank and S. New England	
	Walther Herwig	*Ernst Haeckel*
1971	5.40	-
1972	2.18	-
1973	0.62	0.32
1974	0.00[1]	0.00

[1] *Anton Dohrn* was used in 1976.

The 1970 year-class constituted only about 5% of the nominal catch in 1975. The 1971 and 1972 year-classes appear to be nearly fished out. Lacking further information on the size of the 1974 year-class, recruitment at age 3 was assumed to be 550 million fish, the conventional level for poor year-classes. Two levels of abundance were assumed for the 1973 year-class: 550 million and 620 million fish at age 3 in 1976. The level of 620 million was arbitrarily chosen from the average size of the 1968 and 1972 year-classes at age 3. The sizes of the other year-classes in 1976 were as estimated at the January 1976 Special Meeting (Sum. Doc. 76/VI/5). Survey abundance indices suggest that this procedure may be over-estimating the abundance in 1976-78 of the 1970, 1971 and 1972 year-classes. Although some information was available, it was not sufficient for the Subcommittee to alter the parameters that were used at the January 1976 Special Meeting, and, consequently, no change in the advice provided to the Commission at that meeting is recommended.

iii) The TAC level for 1977. The mean weight-at-age and recruitment values that were used in the previous assessment (Sum. Doc. 76/VI/5) were adopted for the current assessment. In calculating stock sizes for 1977, it was assumed that the 1976 TAC of 60,000 tons would be taken. The projected stock sizes at the beginning of 1978 in relation to projected catches in 1977 for a range of F-values are given in Table 21 and illustrated in Fig. 3.

At the January 1976 Special Meeting (Sum. Doc. 76/VI/6, Proc. No. 7, App. I), the Commission agreed to . . . "a level of catch for the herring stock in Division 5Z of Subarea 5 and in adjacent waters to the west and south within Statistical Area 6 for subsequent years which will maintain the adult stock at a level of at least 225,000 tons, and that the total allowable catch will be set at 60,000 tons or less per year, until such time as the adult stock reaches the level of 500,000 tons. Thereafter, the Commission will set the total allowable catch so as to maintain the adult stock at a level of at least 500,000 tons." Since the adult stock will not reach the level of 500,000 tons in 1977, the catch in 1977 must not

Table 21. Div. 5Z and Stat. Area 6 herring: stock size (age 4 and older) in 1978 as a function of catch (age 3 and older) in 1977 for a range of F, assuming two levels of recruitment for the 1973 year-class in 1976. (Recruitment of the 1974 year-class is assumed to be 550 million fish.)

Stock size at start of 1976		Catch in 1976	Size of 1973 year-class	Stock size at start of 1977		F in 1977	Predicted 1977 catch	Stock size at start of 1978
(10^6)	(000 t)	(000 t)	(10^6)	(10^6)	(000 t)	(100%)	(000 t)	(000 t)
978	204	60	550	995	218	0.1	17	263
						0.2	33	247
						0.3	48	232
						0.4	62	218
						0.5	74	205
						0.6	86	193
						0.7	96	177
						0.8	106	173
978	204	60	620	1,049	226	0.1	18	272
						0.2	35	255
						0.3	50	240
						0.4	64	225
						0.5	77	212
						0.6	89	200
						0.7	100	188
						0.8	110	178

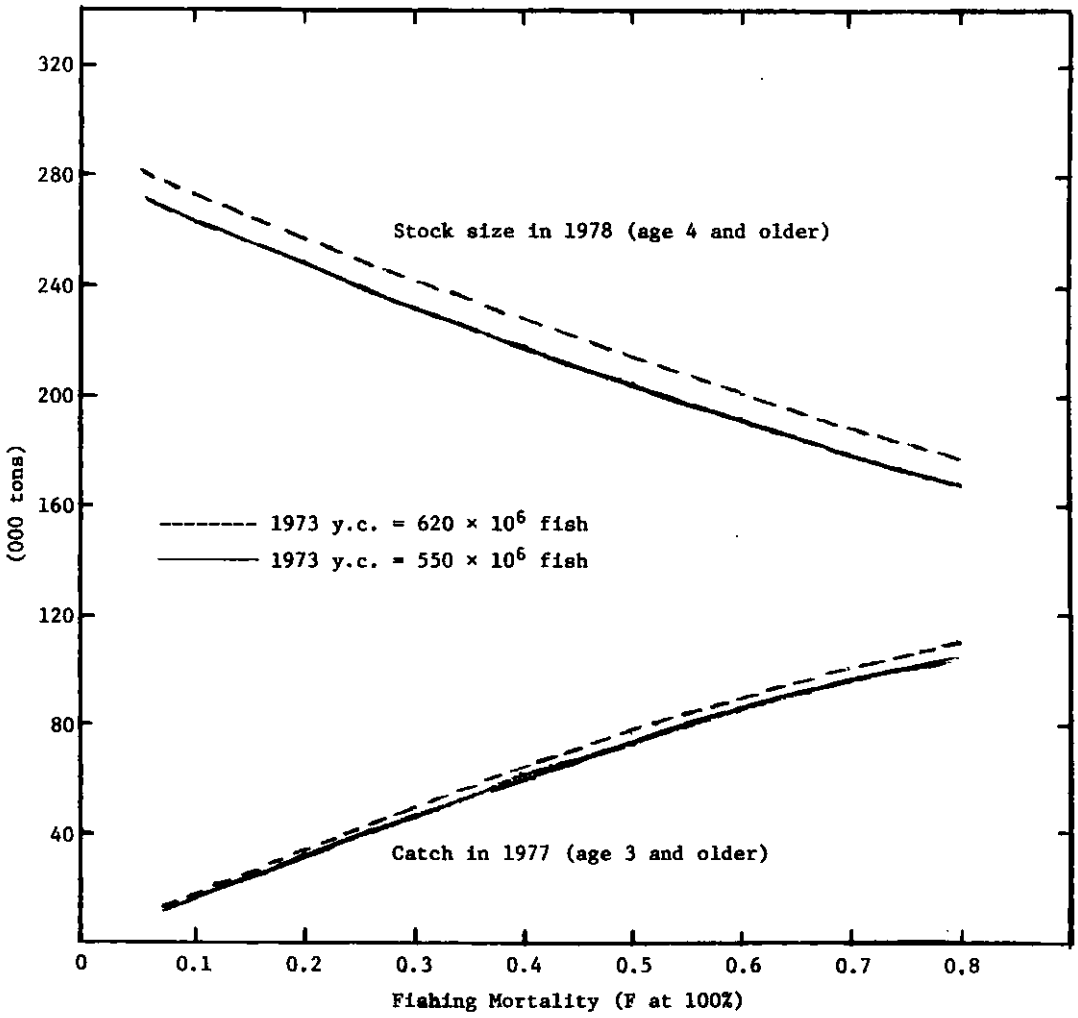

Fig. 3. Predicted herring catches in 1977 and stock sizes in 1978 for the Div. 5Z + Stat. Area 6 fishery at two levels of recruitment.

exceed 60,000 tons (Table 21). To maintain the stock size at the beginning of 1978 to the low level of 225,000 tons, fishing at F=0.35 and at F=0.40 in 1977 would yield a catch in the range of 56,000-64,000 tons, depending on the assumption as to the size of the 1973 year-class. Such a catch would be about the level associated with fishing at $F_{0.1}$=0.38, but it would not allow for any rebuilding of the stock in 1977. Furthermore, preliminary data from the March 1976 research surveys would indicate that such a catch in 1977 may cause a further reduction in stock size. In view of the uncertainties as to the actual abundance at the start of 1977, and noting the low abundance of the 1971-73 year-classes, the Subcommittee recommends that the TAC for 1977 be set below 60,000 tons at a level of 50,000 to allow the stock to rebuild by the same amount between 1977 and 1978 as between 1976 and 1977. This level of TAC would also reduce the probability that the size of the 1977 and subsequent year-classes will be adversely affected by a reduced spawning stock.

The Subcommittee requests STACRES at its 1976 Annual Meeting to examine more fully the effect on stock size of assumptions on year-class strength.

p) Mackerel in Subareas 3 to 5 and Statistical Area 6 (Res. Doc. 76/VI/13, 18, 29, 49, 52, 64; Summ. Doc. 76/VI/17, 18)

i) Catch statistics. Nominal catches in Subareas 3 and 4 decreased from 44,000 tons in 1974 to about 37,000 tons in 1975, and in Subarea 5 and Stat. Area 6 the decrease was from 295,000 tons in 1974 to 246,000 tons in 1975. The corresponding 1975 TACs for the two areas were 70,000 tons and 285,000 tons respectively. There was some question as to the accuracy of the reported nominal catch for 1975, it being suggested (Res. Doc. 76/VI/64) that the catch may be about 40,000 tons greater than that used in the assessment.

ii) Stock identity and biological characteristics. Additional tag returns in Subarea 5 and Stat. Area 6 in 1975 from releases in Subareas 3 and 4 (Res. Doc. 76/VI/49) confirm the north-south migration pattern of mackerel. The distribution pattern of returns during 1973-75 suggests a northerly shift in time of over-wintering from mainly Stat. Area 6 to Georges Bank. Data from USA research vessel surveys during 1968-75 indicate a similar trend (Res. Doc. 76/VI/13). New information from both USSR (Res. Doc. 76/VI/52) and Canadian (Res. Doc. 76/VI/18) research studies in 1975 indicates that about 50% of age 2 mackerel are mature with full maturity being reached at age 3.

iii) Abundance indices for 1975. The results of USA research surveys (Res. Doc. 76/VI/12) indicate a continuing decline in mackerel abundance in Subarea 5 and Stat. Area 6 in 1975. The USA spring survey catch per tow index declined by 96% from 1968 to 1975 and a decline of similar magnitude was observed in the autumn survey. The USA commercial standardized catch per day index increased steadily until 1968 before declining by 94% in 1974, but a moderate increase was evident in 1975. The distant water fleet (DWF) standardized catch per hour index increased from 1968 to 1970, declined in 1971 and 1972 and then increased in 1973 and 1974. The catch per day in the GDR fishery (Sum. Doc. 76/VI/18) declined in the spring fishery by 25% from 1974 to 1975. The catch per day in the Polish winter fishery (Sum. Doc. 76/VI/17) also showed some decline from 1974 to 1975. Preliminary results from the USSR fishery in 1976, in contrast with 1975, indicate a very slight decline in catch per hour. However, interpretation of the DWF catch-per-unit-effort data is complicated by changes in efficiency over the period under consideration.

iv) Catch composition in 1975. Mackerel catches in 1975 were characterized by a predominance of age-groups 1 to 3 and by a substantial reduction in the contribution of age-groups 4 and older (25% in 1975 compared to 44% in 1974). The decline in the percentage of older mackerel was evident in all subareas but particularly in Subarea 3 (Res. Doc. 76/VI/18) which has traditionally reflected an older age distribution of mackerel in the catches. The analyses presented below indicate that the severe reduction in the percentage of older fish (age 4 and older) in the catches has been due to the exertion of excessibe fishing mortality on these age-groups in recent years.

v) Assessment parameters for 1975. The following parameters were determined for use in the overall assessment of mackerel in the ICNAF Area:

(1) Catch at age in 1975. The numbers at age in the 1975 catch were derived from weighted age compositions of the catches by the various countries according to reported sampling data. Canadian age-length keys were used to convert USSR length frequencies from Subarea 4 to numbers at age. In the absence of reported catch statistics, it was assumed that Romania caught its 1975 quota allocation of 3,750 tons.

(2) Partial recruitment in 1975. Graphical plots of fishing mortality from virtual population analysis against age for several years indicated that recruitment was complete for age-groups 3 and older in 1975 and perhaps substantitally so for age-group 2.

(3) Fishing mortality in 1974 and 1975. Fishing mortality on the fully-recruited age-groups (3 and older) in 1975 was initially estimated by regression of F from virtual population analysis on DWF standardized effort for the period 1968-72 and by regression of F from virtual population analysis on indices of fishing effort from USA spring surveys for the same period. The fishing mortality estimated from the respective fishing effort measures in 1975 ranged from 0.5 to 1.4. Because of the wide variance associated with the effort based on survey indices and the confounding effect of efficiency changes on DWF effort, no resolution of the wide differences in estimates of F for 1975 could be achieved. It was decided, therefore, to accept the estimate of F in 1974 (0.80) from survey indices of effort in that year, since the F from virtual population analysis based on estimated effort from survey indices in 1973 and 1974 corresponded well with that predicted from the regression for the years 1968-72. The stock size (age 4 and older) at the start of 1975 was then computed from the estimated stock size and fishing mortality rate (age 3 and older) in 1974. The 1975 stock size, computed in this way, implied that the 1975 catch generated a fishing mortality of 1.1 for the fully-recruited age-groups (age 3 and older) in 1975.

As a check on the probability that the actual F-values were substantially lower in 1974-75 than estimated in this assessment, total mortalities for 1973-75 were also computed from numbers at age per tow in USA spring surveys. These analyses produced estimates of F=2.3 in 1973, 2.7 in 1974 and 2.7 in 1975 for age-groups 4 and older, suggesting that the actual fishing mortality rate in those years was high and of the order of magnitude used in this assessment.

vi) Recruitment estimates in 1975. Estimates of the stock size of age 1 fish (1974 and 1975 year-classes) and age 2 fish (1973 and 1974 year-classes) in 1975 and in 1976 (preliminary) were made using two independent approaches: (Method A) from regressions of year-class strength from virtual population analysis on USA research vessel indices of abundance (Res. Doc. 76/VI/29); and (Method B) from regressions of the relative abundance of ages 1, 2 and 3 fish in the mackerel stock (age 4 and over) on the proportional representation of these age-groups in the catches. The results are as follows:

	Estimated strength (millions)			
	Age 1		Age 2	
Year-class	Method A	Method B	Method A	Method B
1973	975-1522	-	436-637	1025-1250
1974	1612-1730	2460-2845	(980-1095)	-
(1975)	(426-1479)	-	-	-

Analysis of the age-specific distribution of fishing mortality in 1974 from virtual population analysis (assuming F=1.1 on age-groups 3 and older in 1975) suggested that 2-year-olds were almost fully recruited (95%), and, considering the continued decline of older mackerel in the 1975 catches, it was considered prudent to treat age-group 2 as being fully recruited in 1975. The 1973 year-class was therefore computed from virtual population analysis to be about the level of 795 million fish in 1975, a level intermediate between the range of estimates of that year-class at age 2 by the two methods shown above.

The strength of the 1974 year-class at age 1 in 1975 was also computed from virtual population analysis, with the assumption that the average partial recruitment of age 1 fish over the 1968-73 period (25%) also applied in 1975. This produced an estimate of 1,590 million fish for the 1974 year-class in 1975, a level at the lower part of the range of estimates by Methods A and B above. Preliminary results of the USA spring survey in 1976 suggest that the 1975 year-class is also weak.

In the absence of any firm information relating to the strengths of the 1975 and 1976 year-classes, these were assumed to be about equal to the poorest on record (850 million fish at age 1, as estimated for the 1972 year-class). This assumption is conservative in view of the decline in recruitment as evidenced since 1968 when the strong 1967 year-class recruited to the stock as 1-year-olds.

vii) Results of assessment. The analyses of the available data, using the parameters as indicated above, result in estimates of catch, fishing mortality and stock size, as given in Table 22, and the following points are indicated:

(1) In the 1975 assessment, the under-estimate of the fishing mortality on fully-recruited age-groups for 1974 (0.6 as compared with 0.8 now used) has resulted in a substantially greater under-estimate of the computed fishing mortality for 1975 (0.7 as compared with 1.1 now used).

(2) Estimates of the strengths of the 1972 to 1974 year-classes, used in the present analyses, are substantially less than those estimated or assumed for these year-classes in the 1975 assessment, the comparable values (in millions of fish with the new estimates in parentheses) being 774 (185), 2,644 (795) and 2,500 (1,590) for the 1972, 1973 and 1974 year-classes respectively.

(3) The combined effect of the under-estimation of fishing mortality and over-estimation of recruitment in the 1975 assessment means that the mackerel stock is now in such a drastically reduced state that the 1976 TAC, if fully utilized, will generate a fishing mortality of 4.50 on fully-recruited age-groups and will bring the spawning stock to near extinction in 1977.

(4) The severely depleted state of the mackerel, as indicated in Table 22 and Fig. 4, requires immediate and effective conservation measures, if the resource in Subarea 3 to 5 and Stat Area 6 is to be rebuilt to a level approximately that giving the optimum long-term yield. Of particular concern to the Subcommittee is the very low level of spawning stock predicted for 1977 (less than 2% of the 1970 level). The Subcommittee also stresses that, even with a zero TAC in 1977, a significant fishing mortality could be generated from by-catches of mackerel in other fisheries.

Table 22. Results of mackerel assessment for Subarea 3 to Statistical Area 6.

	Year-class	Catch, fishing mortality and stock size by year									
		1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Catch (10^6)	1959	0.1	0.9								
	1960	8.3	13.3	12.9	4.6	3.8	0.3				
	1961	1.3	3.1	19.3	5.1	0.2	0.1	0.1			
	1962	9.2	6.3	21.7	9.8	9.4	1.4	0.4			
	1963	14.3	6.8	14.1	11.1	13.5	4.9	0.8			
	1964	15.3	7.8	15.2	14.1	8.6	7.4	2.0	1.6	0.7	
	1965	57.4	26.1	43.6	48.6	37.2	15.3	8.3	3.4	1.3	
	1966	99.0	99.9	190.2	234.7	114.2	41.6	26.3	10.6	4.1	
	1967	94.5	189.9	408.9	566.2	432.7	217.1	117.3	41.8	16.2	
	1968	2.2	139.5	34.7	110.7	226.5	182.9	117.2	48.4	18.8	
	1969		3.2	143.0	288.7	287.7	261.3	118.5	57.1	22.1	
	1970			3.2	101.2	76.3	237.1	104.3	53.8	20.8	
	1971				1.1	41.8	356.3	270.4	86.4	33.5	
	1972					11.0	95.3	260.7	109.7	42.5	
	1973						0.3	102.9	470.8	182.3	
	1974							5.2	332.5	831.8	
	1975								2.1	391.4	
Total	(10^6)	301.6	496.8	906.8	1395.9	1262.9	1421.3	1134.4	1218.2	1565.5	
Weight	(000 t)	80.8	131.8	230.6	373.0	409.7	419.3	339.6	283.4	310.0	
Fishing mortality (F)	1959	0.006	(0.079)								
	1960	0.116	0.308	0.631	0.551	1.611	(0.575)				
	1961	0.024	0.083	1.226	1.876	0.361	0.348	(0.809)			
	1962	0.079	0.079	0.474	0.462	1.361	0.890	(0.809)			
	1963	0.100	0.070	0.226	0.313	0.903	1.250	(0.809)			
	1964	0.089	0.066	0.197	0.318	0.368	0.718	0.487	1.100	4.500	
	1965	0.106	0.071	0.181	0.354	0.573	0.562	0.795	1.100	4.500	
	1966	0.051	0.074	0.219	0.518	0.588	0.502	0.804	1.100	4.500	
	1967	0.016	0.044	0.140	0.327	0.506	0.590	0.873	1.100	4.500	
	1968	0.001	0.058	0.020	0.092	0.306	0.493	0.791	1.100	4.500	
	1969		0.001	0.060	0.185	0.317	0.606	0.711	1.100	4.500	
	1970			0.002	0.093	0.104	0.604	0.677	1.100	4.500	
	1971				0.001	0.032	0.470	0.937	1.100	4.500	
	1972					0.011	0.139	0.781	1.100	4.500	
	1973						<0.001	0.105	1.100	4.500	
	1974							0.003	0.275	4.500	
	1975									0.742	
	1976										
Weighted $\bar{F}$		0.095 (3+)	0.079 (3+)	0.247 (4+)	0.371 (4+)	0.411 (3+)	0.575 (3+)	0.809 (2+)	1.100 (2+)	4.500 (2+)	
Stock size (10^6 fish)	1959	18.6	13.7								
	1960	87.5	57.7	31.4	12.4	5.3	0.8				
	1961	62.3	45.0	30.7	6.7	0.8	0.4	0.2			
	1962	140.3	96.1	65.8	30.3	14.2	2.7	0.8			
	1963	173.4	116.2	80.3	47.4	25.7	7.7	1.6			
	1964	207.9	140.9	97.7	59.4	32.0	16.4	5.9	2.7	0.7	
	1965	658.7	438.9	302.8	187.1	97.3	40.6	17.2	5.7	1.4	
	1966	2300.9	1620.1	1114.7	663.6	292.9	120.5	54.0	17.9	4.4	0.1
	1967	6992.6	5101.9	3617.0	2330.3	1244.7	555.7	228.2	70.6	17.4	0.1
	1968	3859.9	2871.9	2008.5	1458.7	986.0	537.7	243.4	81.8	20.2	0.2
	1969		3820.5	2829.3	1973.3	1215.4	655.7	265.0	96.5	23.8	0.2
	1970			1782.6	1322.1	892.9	596.2	241.4	90.9	22.4	0.2
	1971				2021.8	1514.6	1086.5	502.9	146.0	36.0	0.3
	1972					1156.2	847.1	546.2	185.3	45.7	0.4
	1973						1579.0	1192.0	795.3	196.1	1.6
	1974							2144.9	1589.8	894.6	7.4
	1975									(850.0)	299.8
	1976										(850.0)
Total	(10^6)[1]	10642.2	10502.4	10178.2	8091.3	6321.8	4468.0	3298.8	3082.5	2112.7	1149.8
Wt.	(000 t)[1]	1974.4	2529.1	1986.3	1816.1	1555.9	1177.4	785.6	574.2	374.2	136.6
Spawning stock[2]	Total	2499.2	5079.6	6344.6	5782.6	4360.7	3077.6	1833.7	1095.0	815.4	160.4
	Wt.	880.3	1619.3	1599.2	1564.3	1359.6	1016.4	635.7	357.9	215.1	29.6

[1] Stock size, age 1 and older.
[2] Spawning stock, including 50% of age 2 fish and 100% of all older age-groups.

(5) The variance associated with research vessel survey data used to estimate recruitment and mortality may mean that the estimates of these parameters in the present assessment are conservative. However, unless these estimates are substantially pessimistic, the state of the mackerel stocks in 1977 will be essentially unchanged from that resulting from the present analyses. If these estimates are in fact only slightly conservative, the potential surplus production resulting from a zero TAC in 1977 would rebuild the mackerel population to levels providing the optimum yield, a policy which would also increase the yield per recruit of these year-classes. On the basis of the present assessment, a zero TAC for mackerel in 1977 is indicated. At the present time, therefore, the Subcommittee, with the exception of scientists from GDR, Poland and USSR, recommends a zero TAC for 1977.

(6) Scientists from GDR, Poland and USSR feel that the advice on the sharp decrease for the TAC level for 1977 was based on incorrect initial estimates used in the assessments. High fishing mortality and low recruitment figures were calculated using *Albatross IV* groundfish survey abundance indices. While agreeing that the general trend shown in these surveys is disturbing, they nevertheless feel that these surveys are likely to produce very variable results, since mackerel is a pelagic schooling species encountered in clusters. The groundfish survey data may have indicated a steeper decline in abundance than that which in fact occurred, and their use for estimating fishing mortality would therefore lead to an over-estimate. Since it was the opinion of the above-mentioned scientists that there was no strong scientific evidence for the enormous change in the 1975 initial assessment data in comparison to estimates used in previous years, these scientists were unable to agree with the opinions presented above by the Subcommittee. Scientists of the above-mentioned countries will, therefore, present to STACRES at the 1976 Annual Meeting a new assessment based on other estimates of initial data, also taking into account the information from the commercial fisheries during the early part of 1976.

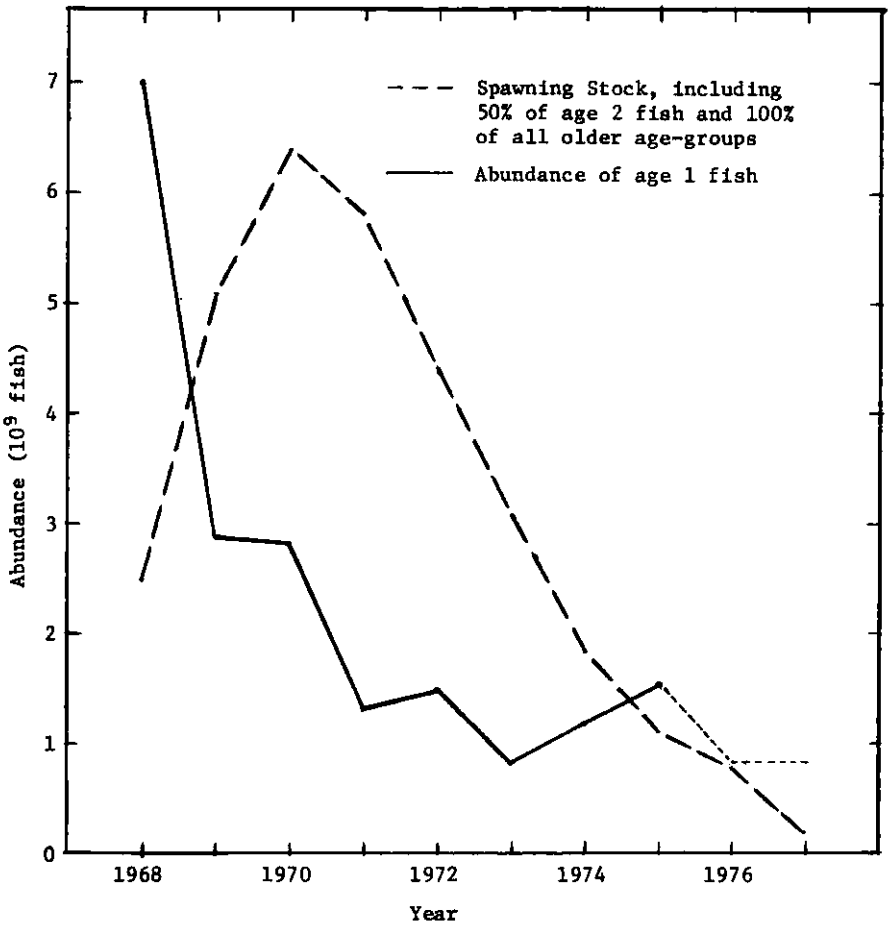

Fig. 4. Abundance of age 1 mackerel in relation to spawning stock size, 1968-77.

q) Other finfish in Subarea 5 and Statistical Area 6 (Res. Doc. 76/VI/61)

This category consists of an aggregation of finfish species (except menhaden, billfishes, tunas and large sharks), for which individual assessments are lacking or are available only in preliminary form. Preliminary data for 1975 indicate a total nominal catch of about 96,000 tons, in contrast to the 1975 TAC of 150,000 tons. No new assessments were available for any of the species, and nominal catches were not available by species or on a monthly basis. The Subcommittee noted that for some species there was the potential for development of an intensive directed fishery under the current regulations, and that such a development would not be known in time to advise the Commission on the consequences. It was agreed that advisory TACs should be set for certain species and that monthly catches of these species be reported to the Secretariat, so that member countries can be notified if catches approach these limits and so that the Subcommittee will have more detailed information on these species at its mid-term meetings. The Subcommittee, therefore recommends that the 1977 TAC for "other finfish" be set at 150,000 tons, with advisory TACs within this total as follows: 25,000 tons for argentine; 40,000 tons for dogfishes; 18,000 tons for butterfish; and 10,000 tons (including inshore fishery) for river herrings (*Alosa pseudoharengus* and *A. aestivalis*).

River herrings (Res. Doc. 76/VI/61). A study of the yield and abundance of *Alosa pseudoharengus* and *A. aestivalis* is Stat. Area 6 indicates that, since the advent of the offshore fishery in 1968, catches and catch rates in the traditional USA river fisheries have decreased markedly and the proportions of virgin fish in the rivers have increased. No age or length composition data were available for offshore catches, but it is certain that significant quantities of young fish (ages 2 to 4) would be available and be caught. The effects of even small catches of young fish offshore would be very significant in terms of stock size and yield. It is probable that, although the total catch (offshore and inshore) increased only in 1969, the offshore catch represents a factor which has led to decreased productivity rather than just a replacement yield for reduced inshore catches. The Subcommittee accordingly recommends that the offshore catches of river herrings be kept to a minimum and the inshore catches be limited to 10,000 tons, until an assessment of the productivity and the effect of fishing can be completed. It is important that this work be completed in 1976-77.

r) Squid-*Illex* in Subareas 2 to 5 and Statistical Area 6 (Res. Doc. 76/VI/3, 30, 31, 41, 65)

The breakdown of squid catches by *Illex* and *Loligo* separately was still not provided by all countries for 1975, and consequently it is not possible at this time to indicate what proportion of the squid catch of about 46,100 tons in Subarea 5 and Stat. Area 6 consisted of *Illex*. Assuming that only *Illex* is caught in Subareas 2 to 4, the catch in 1975 was 17,400 tons. Discussion of available research data indicated that, although stock relationships have not been fully elucidated, the approach chosen in 1975 to assess *Illex* as a single stock complex ranging from Subarea 2 southwestward to Stat. Area 6. As the species occurs in Subarea 5 and Stat. Area 6 throughout the year, suggesting that a component of the stock remains resident there, the effects of harvesting individual components of the stock must be considered. Stock structure studies are therefore needed to clarify this problem.

Preliminary estimates of stock size were made from the results of USSR trawl surveys in June 1972, using a systematic coverage of the area from the Scotian Shelf to southern New England (minimum estimate of 110,000 tons), and from a stratified random survey in 1975 (196,000 tons, but apparently including some *Loligo*). The spring and autumn bottom trawl surveys in 1975 indicated an increase in abundance, but, since this species has a one-year life cycle, the individuals observed in 1975 will not be available to the 1977 fishery. Analyses of yield-per-recruit and stock-recruit considerations indicated that removals could be about 40% of the stock biomass. However, there is considerable uncertainty about the actual quantities caught in recent years and thus in the subsequent estimation of stock size and also in the parameters used in the analyses. These estimates must be improved if the Subcommittee is to make more meaningful recommendations for the management of the fishery. In the absence of reliable estimates of stock size and in view of the uncertainty about the nominal catches, the Subcommittee agreed that preemptive quotas should be maintained to regulate the orderly development of the fishery and that TACs should be set for Subareas 2 to 4 and for Subarea 5 and Stat. Area 6 separately, so that fishing effort cannot be directed entirely to one or the other component of the stock complex. Recent removals are estimated to have been in the range of 20,000-22,000 tons in Subarea 5 and Stat. Area 6 and about 10,000 tons in Subareas 2 to 4, although 17,400 tons were reported from the latter area in 1975. The Subcommittee recommends that the TAC for 1977 be 55,000 tons for Subarea 2 to Stat. Area 6, with 25,000 tons for Subareas 2 to 4 and 30,000 tons for Subarea 5 and Stat. Area 6.

s) Squid-*Loligo* in Subarea 5 and Statistical Area 6 (Res. Doc. 76/VI/14, 30, 31, 41, 64, 65)

The breakdown of squid catches by *Illex* and *Loligo* separately was still not provided by all countries for 1975, and consequently it is not possible at this time to indicate what proportion of the squid catch of about 46,100 tons consisted of *Loligo*. Also, estimates of catches in

earlier years are not yet known to any degree of precision, although countries have been requested to provide the appropriate statistics.

The information available for assessment of *Loligo* includes (i) a series of minimum biomass estimates from Japanese commercial data for the fishing seasons 1968/69 to 1973/74 which indicate a stable population in the area; (ii) USA research survey indices which indicated an increase in abundance through 1975; (iii) a virtual population analysis, which indicated a stock size of about 92,000 tons (1,510 million individuals) at the start (October) of the 1972/73 fishing season and about 89,000 tons (1,430 million squid) at the start of the 1973/74 season; (iv) autumn survey catch data which indicate a minimum biomass estimate of 83,000 tons for the period 1972-75, being in agreement with the estimates from virtual population analyses; and (v) yield-per-recruit and stock-recruit considerations which indicate that removals of 40% of the stock biomass would seem reasonable if a moderate stock and recruitment relationship holds. If no such relationship holds, exploitation rate estimates range from 75 to 95% depending on the constants used. The Subcommittee feels that the assumption of a moderate stock and recruitment relationship is warranted until more specific information is available.

Although there is an urgent need for more accurate estimates of removals and for considerable refinement is the determination of the parameters used in the analyses, the studies available suggest that the TAC of 44,000 tons, which was set for 1976, will ensure the maintenance of current stock size. Rough estimates of catches since 1970 give an average of 33,000 tons annually. Since there appears to be no significant change in stock abundance in recent years, the Subcommittee recommends a TAC for 1977 of 44,000 tons, which, if realized, would represent a 30% increase above recent catches.

t) Second-tier overall TAC in Subarea 5 and Statistical Area 6

At its Special Meeting in October 1973, the Commission agreed that the total catch of finfish (except menhaden, billfishes, tunas and large sharks) plus squids should be regulated to an amount that will allow the biomass of stocks in the area to recover to a level which will produce the maximum sustainable yield.

In attempting to evaluate the effectiveness of these regulations in arresting the decline in stock abundance, the Subcommittee reviewed the time series of biomass levels indicated by research vessel surveys. These data were obtained from autumn surveys and should therefore be an indication of the biomass at the beginning of the following year. The survey indices indicated that the biomass estimate for 1976 was substantially higher than that for 1975 and somewhat higher than that for 1974. With all species included, the average biomass estimate for 1974-76 was still lower (23%) than the estimate for 1971-73, but, with herring and mackerel excluded, the biomass estimate for 1974-76 was about the same as that for 1971-73. The Subcommittee was unable to conclude at this point whether the increase in biomass estimated from the surveys reflects an actual increase in biomass in the area, given the fluctuations that occur in survey indices of abundance between years. However, it is encouraging that the decline in the survey estimate did not continue into 1976.

The Subcommittee also reviewed an analysis of the effects of by-catch on national catches in the area, from linear programming techniques. Using 1974 by-catch ratios to evaluate 1976 overall TAC in relation to by-catch indicated that an 18% reduction in the sum of the TACs would be required in 1976 to allow for by-catch, and hence the overall TAC of 650,000 tons recommended for 1976 by the Subcommittee in 1975 seemed appropriate. It was also noted that the by-catch ratios in directed fisheries had declined from about 30% in 1972 and 1973 to about 18% in 1974. It could not be determined whether a further decline had occurred in 1975.

Given the new information on by-catch rates and possible biomass changes and also the adoption by the Subcommittee of $F_{0.1}$ rather than F_{max} as an appropriate basis for recommending 1977 TACs for many stocks in all subareas, the Subcommittee discussed the need for continuation of the second-tier TAC. It was pointed out that the second-tier TAC was adopted by the Commission to resolve three problems: (i) to compensate for by-catch mortality which is difficult to quantify and control by more direct means; (ii) to take some account of species interactions which are not satisfactorily taken into account in single species stock assessments, and (iii) to allow recovery of the total biomass from the reduced level in recent years to a level giving the maximal or some optimal yield in a fairly short period of time.

It was noted that by-catch ratios in directed fisheries had declined between 1973 and 1974 and that recently introduced regulations, such as closed areas, could reduce these further by 1977. If the change in the basis of TAC regulation from F_{max} to $F_{0.1}$ affects all species more or less proportionately, then by-catches could be expected to change in about the same way. However, since it has been species with very restrictive TACs (e.g. zero TAC for haddock) that have caused the most serious by-catch problems, the general reduction in exploitation rate, implied by fishing at $F_{0.1}$, should ease these problems. There is, however, an increasing number of

stocks with recommended TACs of zero, which will create new by-catch problems. There is also the likelihood that not all by-catch problems are reflected in the Commission's statistics due to deficiencies in by-catch and discard reporting and that this problem is worse, perhaps substantially worse, than is apparent. Despite the many uncertainties regarding the by-catch situation in 1977, it is likely that significant by-catch problems will still exist and that this remains a valid rationale for retaining a restrictive second-tier TAC.

The implications of biological interactions on the estimated level of species TACs and on the relative level of a second-tier TAC to the sum of the species TACs remain a matter on which there is divergent opinion. To some extent, in assessing single stocks over an extensive historical period, interactions with other species are "built-in" to the assessment. These interactions may change, however, when substantial changes in stocks are induced by fishing, and these are not at present predictable. It is uncertain whether this will result in net increase or decrease in productivity. A further aspect is that, in assessing stocks with a short time frame of information (and a significant proportion of the resouces in Subarea 5 and Stat. Area 6 fall into this category), there is less likelihood that the assessment will take adequate account of inter-relationships with other species.

An objective of the management policy in this area has been to restore the biomass to a level of about 4 million tons, the level considered appropriate for removing the maximum sustainable yield. The implication of fishing at $F_{0.1}$ is that the biomass associated with this level in the long term would be somewhat higher than that at F_{max}. While it may be necessary to review the biomass objective, at the present level of biomass the exact level to be achieved is of little practical importance at this time, as neither level will be achieved in 1977. However, fishing at $F_{0.1}$ will result in a faster increase in absolute biomass and the level of 4 million tons will be reached faster. While fishing at $F_{0.1}$ reduces the dependence on the second-tier TAC for stock rebuilding, a restrictive second-tier TAC would provide an additional safeguard.

The Subcommittee agreed that the second-tier TAC was still a relevant management measure and that it should be set at some level lower than the sum of the recommended TACs. The TACs recommended by the Subcommittee sum to 505,000 tons, assuming that the 1977 TAC for mackerel is zero and that the 1977 catch of pollock in Subarea 5 and Stat. Area 6 is 7,000 tons, and it was agreed that 500,000 tons should be used as an upper reference point. Some downward adjustment is required to take by-catches into account. If the by-catch situation in 1977 were similar to that in 1974, a reduction of approximately 20% is indicated. However, given the substantial changes in regulations and TACs since 1974, and the yet to be decided national allocations for the 1977 second-tier TAC, this degree of adjustment may be inappropriate. It was therefore decided that a decision on the required percentage reduction be postponed to the 1976 Annual Meeting, pending new linear programming solutions based on the recommended TACs for 1977.

VIII. OVERALL GROUNDFISH FISHING EFFORT IN SUBAREAS 2 TO 4

The regulation of groundfish fishing effort in Subareas 2 to 4 was discussed in relation to the advice, if any, that could be given on appropriate levels of fishing effort in 1977. It was noted that in three of the effort management areas (Subareas 3 + Div. 3K, Div. 3LNOP, and Div. 4VWX) catch rates in 1975 showed no substantial change from the 1974 level, and that the overall decline in catch rates in the 1970's did not reflect any beneficial effects of catch quota regulations. The substantial reductions in some TACs recommended for 1977 and the recommendations for others based on $F_{0.1}$ rather than F_{max}, indicate that no increase in fishing effort can be recommended for 1977.

Recommendations of a more detailed nature cannot be made at this time, particularly since the precise objective(s) to be achieved by the regulation have not been stated by the Commission. If the objective is, for example, solely to provide the basis for more accurate surveillance and enforcement, then the Subcommittee should attempt to advise on the number of days required to be fished to attain the catches corresponding to the levels of TAC to be set. However, if the regulation is designed to provide a safeguard against the deleterious effects of overly optimistic TAC calculations or to provide an effective measure to discount by-catch problems, then different approaches should be taken. Also, it is necessary to know the Commission's intentions on the degree of flexibility in the transfer of effort among areas from one year to another in order to evaluate the likely effectiveness of the regulation in achieving a particular objective.

The Subcommittee discussed the effectiveness of effort regulation as a safeguard against overexploitation of a stock for which the TAC has been set too high. In such a case, if the effort has been set at a level approximating that which is likely to achieve the desired level of fishing mortality on the stock, this would prevent the TAC from being taken. Such would be the case if the effort regulation pertained to a particular species. In the case of cod in Subarea 2 and Div. 3K, for example, where cod is by far the most important species, the effort regulation could provide this safeguard. However, in situations where a number of species stocks are within the effort regulation area, sufficient flexibility would exist to divert enough effort to take full advantage of stock assessment errors to the serious detriment of the stocks. In this regard, the smaller the effort regulation areas are, the less likelihood there is of this happening. The amount of reallocation of effort allowed among areas is also a relevant factor.

The effects that the regulation may have on catch per unit effort are difficult to predict, but it is likely that catch rates under an effort regulation will not be directly comparable to those of previous years and hence they must be interpreted with caution. There will be an incentive to maximize catch rates by a wide variety of ways, and these have been dealt with in detail in previous reports of the Subcommittee and effort limitation working groups. Limitations to reallocation of fishing effort among areas could, however, have the reverse effect if vessels were limited to fishing in areas of low catch rate because they were not allowed to transfer to other areas where the catch rates were higher.

The effects of fishing the stocks at $F_{0.1}$ in 1977 will not have a significant effect on catch rates in 1977 but could be expected to result in observable increases in catch rates in 1978 and subsequent years. The level of fishing effort in each management area in relation to the fishing mortality that it would generate has not yet been accurately determined, and hence it remains to be demonstrated whether further adjustments in effort are required to achieve $F_{0.1}$. The Subcommittee points out, however, that the benefits of increasing catches and catch rates to be anticipated after 1977 is not a rationale for increasing the total effort, as these higher catches will be attainable at the same level of effort.

IX. OTHER MATTERS

1. Primary Productivity and Fisheries Yield (Res. Doc. 76/VI/11)

A research document summarizing results of plankton collections during a research vessel cruise in Subareas 3 and 4 was discussed. It was indicated that this type of primary productivity research was necessary to further our understanding of the relationship between fisheries and primary productivity. Correlation between plankton abundance and the amount of fish caught in individual hauls was indicated, but as pointed out it would be difficult to generalize from the data presented. The Subcommittee hopes that studies of this type are continued.

2. Estimation of Parameters

a) New techniques (Res. Doc. 76/VI/8)

A new approach to estimating natural mortality from the relationship of this parameter to age at sexual maturity was discussed. The Subcommittee noted that, although this approach might be useful as a first approximation of natural mortality especially in developing fisheries, such natural mortality estimates should be used with caution because of, among other things, the degree of variability inherent in such relationships, the degree of uncertainty in values of natural mortality estimated with present techniques, and the fact that natural mortality might change in response to fishing pressure and the effects of density-dependent growth, age at maturity, etc. In particular, values of natural mortality which are estimated as extremely high or extremely low should be carefully considered to determine the reasons for such high or low values.

b) Level of sampling in various stocks

Again in 1975, no sampling data were available for a number of stocks and the data that were available for some other stocks were so scanty that they could not be used in assessments of these stocks. As has been emphasized on many occasions before, the accuracy of the advice provided to the Commission is very dependent on the adequacy of the data base upon which the assessments are based. The Subcommittee again urges Member Countries to provide their scientists with the resources to improve their sampling efficiency in future years.

c) Reporting of length and age samples by sex for certain species

Although the absolute necessity of reporting length and age samples by sex for such species as the flatfishes and redfish, in which significant differences in growth rate, natural mortality rate, age at maturity, etc., are exhibited between the sexes, has been emphasized before by the Subcommittee (*Redbook* 1975, page 63) and recommended by the Statistics and Sampling Subcommittee, some sampling data were submitted to the present meeting for these species as unsexed fish. The Subcommittee once again urges scientists in the various countries to provide length and age data by sexes separately for these species, as unsexed data cannot be used in assessments. A complete list of these species is given in *Redbook* 1974, page 128, and also in *Sampling Yearbook*, Vol. 19, pages 9-10.

d) Ageing workshop for cod (Sum. Doc. 76/VI/13 + Addendum 1; Res. Doc. 76/VI/32)

A draft report of the Ageing Workshop, held in October 1975 at the Institute for Fisheries Investigations, Vigo, Spain, was discussed (Sum. Doc. 13 + Addendum 1) as well as another paper related to the problem of age determination of cod (Res. Doc. 76/VI/32). The report showed that, when the samples from different areas were combined to construct an age-length key for each reader, substantial differences in age composition could be observed among certain individual readers. Thus, differences in ageing between readers may have a significant effect on age compositions used in assessments, especially in those cases where data are scanty and age compositions are inconsistent from year to year. Where age compositions are consistent from year to year, even if biased, the effect on assessments is not as significant.

It was noted that there seemed to be a lack of clear guidelines when interpreting otoliths, and that this allowed for a high degree of subjectivity. Most of the differences observed arose from the difficulty of determining which rings were checks or splits. Other problems were associated with determining the first annulus and interpreting the edge of the otolith. The problems seemed to be greater for cod otoliths from Div. 2J, 3K and 3L than for otoliths from Div. 3N, 3O and 3P.

It was generally agreed that more studies are required (otolith structure in each area, deposition of material in the edge, etc.) in order to minimize the degree of subjectivity, and that clear guidelines for age reading for each area be formulated, perhaps in the form of a handbook on otolith interpretation. It was also suggested that all of the photographs, slides and otoliths used in the workshop should be filed with the Secretariat and be available for examination by

readers who were not able to attend the workshop. The results of these readings could be compared with those from the workshop.

The Subcommittee considered that the whole or a part of the samples used in the workshop should be circulated for re-reading by the workshop participants. This would permit the estimation of within-reader variance and a more accurate analysis of the observed differences between readers. It was noted that the results of such further studies would not likely be available until the 1977 Annual Meeting. It was also suggested that the final report should include the ageing experience of each participant in the workshop together with the nationality of each reader, the areas in which the reader is most expert and the number of years of experience in reading otoliths from each area.

The Subcommittee noted that, if the differences in age determination were random, the calculation of fishing mortalities would not be seriously affected, and the effects of these differences would not be severe if a sufficient number of age determinations were available so as to average out the biases. In any case, it was thought that the re-reading of the many thousands of otoliths for previous years would not be possible.

The Subcommittee observed that the results of the Vigo Workshop in October 1975, together with those of the Bergen Workshop in 1962, constitute a large volume of material suitable for a more vigorous analysis of ageing problems than has previously been possible.

e) Accuracy of catch statistics

All techniques for the calculation of TACs rely implicitly on the availability of accurate statistics of catches from both directed and by-catch fisheries. Any inaccuracy in the reported statistics produce errors in the stock assessments and hence in the recommended TACs. This would be particularly the case for those stocks which are assessed by virtual population analysis (cohort analysis), as an error in the level of catch affects not only the estimates of fishing mortality and recruitment for the year in which the error was made but also the estimates for the preceeding years. This may, in turn, lead to biases in the prediction of the TACs.

f) General production models (Res. Doc. 76/VI/34, 44)

Two papers were presented involving the use of the Schaefer stock production model. Res. Doc. 76/VI/34 describes the behaviour of a model subject to stochastic variation in its parameters. An interesting feature of this model was that the variations were autocorrelated. The model was intended to simulate the effects of environmental conditions which may tend to be good or bad for several years. It was suggested in the discussion that such a system might be better managed at a level below the MSY level of fishing effort. Res. Doc. 76/VI/44 presents methods for determining the parameters of a Schaefer stock production model in a disequilibrium situation.

g) Evaluation of abundance indices for pelagic species from research surveys

The Subcommittee considered that, although the results of survey data have been useful to indicate trends in abundance, they have not resulted in estimates of recruitment which are sufficiently precise for situations when the calculation of TACs are based principally on assumed values for recruiting year-classes. This problem could perhaps be resolved by further attention to survey design for pelagic species, and it was agreed that the Biological Surveys Subcommittee be requested to examine this matter further.

3. Documentation of Background Information for Stock Assessment (Sum. Doc. 76/VI/8)

The extent to which it is necessary to document background information on the assessment of each stock for use at subsequent meetings of the Subcommittee was discussed. It was indicated that, for many of the stocks assessed at this meeting, background data on stock size, fishing mortality and catch in numbers are not included in the Subcommittee's report because of the impractability of listing such detailed information for each of the many stocks under TAC regulation. This problem is further aggravated by the increasing practice of including such background information in working papers rather than in research documents, despite the agreed practice of not referring to working papers in the report. The Subcommittee discussed the usefulness of the stock record data in Sum. Doc. 76/VI/8 which lists the background information used at the 1975 meetings of the Subcommittee in assessing the stocks. It was concluded that these stock records, with appropriate modifications to make provision for including more extensive information for some stocks and more complete descriptions of, for example, the details of estimating catch at age from age-length keys, could provide the sort of detailed information on past assessments which is necessary when re-assessing the stocks at current Subcommittee meetings.

The situation could be further improved if agreement could be reached on permitting the reference to working papers in the Subcommittee's report, and it was recommended that STACRES consider further the status of working papers at the 1976 Annual Meeting. Also, it was noted that scientists should be

encouraged to use the Research Document series for reporting information which may need to be referred to in the report of the Subcommittee. It was concluded that the Chairman of the Assessments Subcommittee, in correspondence with the Conveners of the *ad hoc* Working Groups, should attempt to improve the stock record format to be used for summarizing the background assessment data from this meeting.

4. International Herring Tagging (Res. Doc. 76/VI/38, 48, 66)

The Assessment Subcommittee discussed the possibility of undertaking a major international herring tagging program to address the problem of herring stock intermixture. Management to date has been placed separately on fisheries harvesting the three major spawning stocks but under an overall regulation regime that would minimize adverse effects on the stocks if, in fact, a significant intermixture occurs. Currently, however, the extremely low level of the stocks in Subarea 5 and Stat. Area 6 and the declining stock size in Subarea 4 raise questions about the continued validity of the latter assumption. Knowledge of the stock(s) to which juvenile herring recruit has also become more critical to assessment as the adult stocks have declined. There is, thus, the need for obtaining information on the degree of intermixture so that appropriate management regulations can be developed. Herring tagging has been demonstrated to be technically feasible by Canadian biologists (Res. Doc. 75/38; 76/VI/48) and has already shown that there are inter-relations between herring from southwest Nova Scotia and Chedabucto Bay (Div. 4W), the Gulf of Maine (Div. 5Y), and Georges Bank (Div. 5Z). The Subcommittee, therefore, strongly recommends that a major international herring tagging study be conducted in several areas as soon as possible.

Tagging areas and numbers of tags to be released according to various objectives were discussed (Res. Doc. 76/VI/66). However, final details should be decided at the 1976 Annual Meeting and each country should be prepared to discuss their participation in detail. Such a large undertaking will require the assistance and cooperation of several countries (particularly on Georges Bank) in the tagging program and all countries in reporting the recaptures. Such an operation should provide information to improve the present management system, in so far as stock overlap is concerned, and will help to ensure that fishing effort is not concentrated on any one stock (such as the small Jeffreys Ledge stock in Div. 5Y). It may also indicate to which adult spawning populations the juvenile herring in Maine and New Brunswick recruit. This in turn might allow management of the complete stocks (by age and area).

International Commission for the Northwest Atlantic Fisheries

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ICNAF Summ.Doc. 76/VI/22
(Addendum)

ANNUAL MEETING - JUNE 1976

Addendum

to

Report of Assessments Subcommittee, April 1976

1. General Fishery Trends (to replace Section II of Summ.Doc. 76/VI/22, page 3).

Statistics of nominal catches of all species taken in the Northwest Atlantic were not available at the time of the Subcommittee Meeting in April, 1976, as the request for advance statistics for assessment purposes was confined to species stocks under present or prospective catch quota regulation. However, provisional nominal catches for 1975, as compiled from STATLANT 21A submissions, were available at the Annual Meeting in June, and these are summarized by Subarea in Table 1, together with comparative figures for 1974. Since the 1975 catch for Romania was not available at the time of the Annual Meeting, it was assumed that the 1975 catch was the same as the 1974 catch. It should be noted that catch figures used in the "Species Review" sections throughout this Report, based on preliminary advance statistics provided prior to the April 1976 Meeting, may differ slightly from the data listed in Table 1 and also from the figures mentioned in the "Fishery Trends" sections, these having been prepared at the Annual Meeting for insertion in the Report.

The total catch of all finfish and invertebrates declined from 4.0 million tons in 1974 to 3.8 million tons in 1975 after having declined from 4.45 million tons in 1973. About 85% of this decline between 1974 and 1975 occurred in the cod catches in Subareas 2, 3 and 4. Significant declines also occurred in mackerel catches and in other pelagic catches (mainly menhaden). Significant increases in catches occurred in capelin in Subareas 2 and 3, and "other fish" in Subarea 5. The total catch of salmon in 1975 was 4,288 tons, comprising 2,045 tons from the West Greenland fishery (Subarea 1) and 2,243 tons from Canadian home-waters (Subareas 2 to 4). Catches of other species were generally similar to but in total slightly below 1975 catches. The most significant changes of individual species by Subarea are outlined in the "Fishery Trends" section for each Subarea.

Table 1. Nominal catches (000 tons) in 1974 and 1975[1]. (The symbol + indicates less than 500 tons.)

	SA 0		SA 1		SA 2		SA 3		SA 4		SA 5		SA 6		Total	
Species	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975	1974	1975
Cod	+	-	48	48	125	89	410	314	172	145	34	33	1	1	790	630
Haddock	-	-	+	-	+	-	2	2	16	20	5	7	+	-	23	29
Redfish	+	+	3	9	7	15	116	88	96	94	10	11	+	+	232	216
Silver Hake	-	-	-	-	-	-	+	3	96	116	118	87	12	27	226	233
Red Hake	-	-	-	-	-	-	-	1	3	3	21	18	12	11	36	33
Pollock	-	-	+	+	+	+	1	+	26	26	12	14	+	+	39	40
Flounders	1	2	16	26	21	15	120	113	48	45	37	36	10	10	253	247
Roundnose Grenadier	3	+	10	5	6	12	23	16	-	-	-	+	-	-	42	33
Other Groundfish	-	+	10	11	4	2	12	13	40	40	20	16	13	10	99	92
Herring	-	-	+	+	+	1	18	24	228	238	174	178	13	5	433	446
Mackerel	-	-	-	-	-	-	2	4	43	32	152	169	143	89	340	294
Other Pelagics	-	-	+	+	-	-	-	+	2	1	49	34	222	182	273	217
Argentine	-	-	-	-	-	-	1	+	17	15	20	1	-	+	38	16
Capelin	-	-	3	1	85	145	202	220	+	+	-	-	-	-	290	366
Other Fish	-	-	3	5	7	8	23	21	48	43	23	41	36	36	140	154
Squids	-	-	-	-	+	-	+	4	+	14	29	17	26	30	56	65
Other Invertebrates	-	-	18	38	-	+	4	3	36	34	100	122	510	467	668	665
All Species	4	2	111	143	255	287	936	826	871	866	803	784	998	868	3978	3776

[1] Nominal catches for 1975 are based on STATLANT 21A reports compiled for the 1976 Annual Meeting from all countries except Romania. The 1975 catch by Romania was assumed to be the same as the 1974 catch.

2. Fishery Trends - Statistical Area 0 and Subarea 1 (to replace Section IV(1) of Summ.Doc. 76/VI/22, page 6).

Total nominal catches from Statistical Area 0 decreased from 3,565 tons in 1974 to 1,888 tons in 1975. The 1975 catch consisted of 1,648 tons of Greenland halibut and 2.3 tons of roundnose grenadier, while the catches for 1974 were 889 tons and 2,661 tons respectively.

Total nominal catches of all species in Subarea 1 increased from 111,000 tons in 1974 to 143,000 tons in 1975, mainly as a result of a sharp increase in catches of Greenland halibut from 13,000 tons in 1974 to 23,000 tons in 1975 and of shrimp from 18,000 tons in 1974 to 31,000 tons in 1975. It is noted that Spain and USSR reported substantial catches of shrimp from Subarea 1 for the first time in 1975. Cod catches showed no further decline from 1974 to 1975. There was a marked increase in catches of redfish, while the catches of roundnose grenadier decreased to the level prior to 1974. The catch of salmon was 2,045 tons, slightly greater than the 1974 catch of 1,960 tons. Catches from the offshore drift gillnet fishery were 260 tons by Faroes, 381 tons by Denmark (Mainland), and 217 tons by Norway, while 1,187 tons were taken by Greenland-based vessels using set gillnets inshore and drift gillnets offshore.

3. Fishery Trends - Subareas 2 and 3 (to replace Section V(1) of Summ.Doc. 76/VI/22, page 10).

The provisional nominal catches of all species in Subarea 2 in 1975, at 286,000 tons, were approximately 30,000 tons greater than in 1974 (255,000 tons), which continued the upward trend from the low level in 1973. The higher total production was mainly attributable to increases in the catches of redfish, roundnose grenadier and capelin. The cod catch, on the other hand, at 89,000 tons, was 30% lower than in 1974 (125,000 tons).

In Subarea 3, the total nominal catch of all species combined decreased by over 100,000 tons from 936,000 tons in 1974 to 826,000 tons in 1975. This was due principally to a marked decrease in the cod catch which, at 314,000 tons, dropped by almost 100,000 tons. This decline was most marked in the northern Div. 3K and 3L, and the Subarea 3 catch was substantially below the 1975 TAC for all cod stocks in the Subarea. The redfish catch (88,000 tons) was also lower than in 1974 (116,000 tons), in conformity with the lower TACs set in the quota regulations. This was particularly evident in Div. 3M, where the catch dropped from 35,000 tons in 1974 to 15,000 tons in 1975 (the TAC was 40,000 tons in 1974 and 16,000 tons in 1975). In Div. 3P, however, the catch (28,000 tons) was slightly greater than the TAC (25,000 tons). The catches of the other species subject to quota regulations in the Subarea were similar to those in 1974 and in all cases, they were less then the prescribed TACs, although the capelin catch, at 220,000 tons, reached its highest level since the capelin fishery commenced in the early 1970's.

4. Fishery Trends - Subarea 4 (to replace Section VI(1) of Summ.Doc. 76/VI/22, page 19).

Total preliminary nominal catches of finfish from Subarea 4 in 1975 were 818,000 tons, 2% below the 1974 total of 835,000 tons. Total catches of

invertebrates increased to 49,000 tons, a 34% increase from the 1974 level of 36,000 tons. The harvest of seaweeds declined to 40,000 tons from 66,000 tons.

Cod catches declined by 27,000 tons from 172,000 tons in 1974 to 145,000 tons in 1975. The declines in catch occurred in almost equal quantities in the stocks in Div. 4T-Subdiv. 4Vn and in Subdiv. 4Vs-Div. 4W. These declines are partly due to catch quota restrictions on Denmark, Portugal and Spain. American plaice catches declined by 6,000 tons to 22,000 tons in 1975 from 28,000 tons in 1974, due to reduced Canadian catches mainly in Div. 4S and reduced USSR catches on the Scotian Shelf. Reduced USSR catches were apparently due to catch quota restrictions. Reported catches of searobins on the Scotian Shelf again occur for 1975, although this species is not thought to occur in the area. The catch of 3,000 tons reported is substantially lower than that of 9,000 tons reported for 1974. Mackerel catches declined by 11,000 tons to 32,000 tons in 1975. The reduction in USSR catches was apparently due to catch quota restrictions, but lower Canadian catches were due to reduced availability of mackerel to inshore gear, particularly in Div. 4T. Alewife catches declined by 12,000 tons to 6,000 tons in 1975 due to unexplainable declines in both Canadian and USSR catches.

Silver hake catches in Div. 4VWX increased by 20,000 tons in 1975 to 116,000 tons due to an increase in the 1975 TAC by 20,000 tons over that of 1974. Catches of anglers increased by 6,000 tons to 18,000 tons in 1975 and catches of skates increased by 9,000 to 19,000 tons. Herring catches in Div. 4X increased by 12,000 tons to 147,000 tons, both Canadian and USSR catches increasing in this Division. Total Subarea 4 herring catches increased by 10,000 tons to 238,000 tons in 1975. Squid catches increased to 14,000 tons from 400 tons in 1974 due to initiation of a USSR fishery.

For all other species, changes in catch levels were relatively small (i.e., less than 5,000 tons). The influence of catch quota regulations make many of the changes in catch levels difficult to interpret.

5. Fishery Trends - Subarea 5 and Statistical Area 6 (to replace Section VII(1) of Summ.Doc. 76/VI/22, page 32).

The total nominal catch of species decreased 8% from 1,800,000 tons in 1974 to 1,650,000 tons in 1975, and the finfish catch declined 11% from 1,140,000 tons in 1974 to 1,016,000 tons in 1975. The 1975 catch of finfish (excluding menhaden, billfishes, tunas and sharks) and squid was 864,000 tons, a 8% decline over the 1974 level of 942,000 tons. Decreased in catch from 1974 to 1975 occurred in the following groups: groundfish (306,000 to 280,000 tons), pelagics (753,000 to 657,000 tons), and invertebrates (665,000 to 636,000 tons). The "other finfish" group remained about the same at 79,000 tons.

Species which showed declines of greater than 10% included yellowtail flounder (25,000 to 20,000 tons), red hake (33,000 to 29,000 tons), silver hake (130,000 to 114,000 tons), mackerel (295,000 to 258,000 tons), and "other fish" (132,000 to 119,000 tons). Within the "other fish" category the most norable declines occurred in butterfish (13,000 to 10,000 tons), sculpins (2,800 to 150 tons) and ocean pout (3,700 to 300 tons). Menhaden catches also declined (249,000 to 198,000 tons). Catches of cod and herring dropped moderately, from 36,000

to 34,000 tons for cod, and from 187,000 to 183,000 tons for herring. Species of which catches increased from 1974 to 1975 included haddock (5,000 to 7,000 tons), pollock (12,000 to 14,000 tons), and other flounders (21,000 to 27,000 tons).

The total catch of all species declined 3% in Subarea 5 from 805,000 tons in 1974 to 784,000 tons, and 13% in Statistical Area 6, from 998,000 to 868,000 tons.

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ICNAF Summ.Doc. 76/VI/22
Addendum II

ANNUAL MEETING - JUNE 1976

Addendum II to Assessments Subcommittee Report

The Assessments Subcommittee reconvened on 18 June at the request of the Chairman of the Commission to consider whether sufficient new information could be made available to a meeting in early December 1976, to allow resolution of scientific disagreement on the status of the mackerel resource and to specify the information required. Debate centred on what new data could be made available, its format, and the time scale on which it could be provided. It was indicated that more detailed data for years prior to 1976 (with the exception of some research vessel survey data) cannot be provided in time for the meeting. However, a variety of data for 1976 could be provided in sufficient detail to significantly increase the possibility of resolving some of the difficulties faced at this, and at the April, meeting. While all of the difficulties in reaching agreement on the mackerel TAC do not relate to the availability of 1976 data, it was agreed that, if the new data described below would be provided, they were sufficient to merit a reconsideration of mackerel stock status in 1977 at a meeting in early December 1976. The data and analyses required, and the formats and timetable for their provision are as follows:

1) Submission of individual mackerel length samples and individual age samples (to the extent possible) for the first and second quarters of 1976 obtained from catches of commercial, scouting and research vessels, fishing in Subareas 3-5 and Statistical Area 6, to arrive at the Secretariat by mid-October. These samples should each include weight at age or sample weight where possible.

2) Submission of mackerel catch and effort data for the first and second quarters for the commercial fleets by Division and month to arrive at the Secretariat by mid-October on standard STATLANT 21B forms, together with the sampling data.

3) Mackerel catch and effort data for the commercial fleets by month and Division for all of 1976 (i.e., including estimates for December) to be made available at the time of the meeting in early December on standard STATLANT 21B forms.

4) Due to technical difficulties, commercial sampling data from third quarter catches cannot be submitted to the Secretariat in time for the meeting in the normal way. Some arrangement similar to the International Observer Program whereby scientists from interested countries could be placed on board vessels of other countries engaged in the mackerel fishery to sample the catches and submit these samples directly to the Secretariat would ensure that samples from the third quarter fishery would be available by mid-October.

5) Additional analyses of research vessel data for abundance estimates, particularly for recruiting year-classes, and tow by tow catch data from research vessel surveys should be made available to the meeting.

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Corrigendum

ANNUAL MEETING - JUNE 1976

Report of Assessments Subcommittee, April 1976

Please note the following corrections which have been detected after the Report of the Assessments Subcommittee was printed and distributed:

1. Page 5, Table 1, capelin: the recommended TACs should be "300" for 2+3K and "200" for 3LNOPs.

2. Page 9, paragraph 3, last line: change "the maximum sustainable yield" to "a steady reasonably high catch level".

3. Page 12, (c), heading: the reference to Res. Doc. 76/VI/55 should be changed to Res. Doc. 76/VI/53.

4. Page 13, paragraph 2, line 2: change "length frequency" to "length and age".

5. Page 13, paragraph 4, lines 7-8: delete the sentence "Because of the lack of ... 30,000 tons for 1977." and replace by "In view of the lack of sampling data for this stock and in such cases where the stock is known to be depressed, a substantial reduction in TAC is is order so that the stock can be protected. The Subcommittee therefore recommends that the TAC be reduced 25% below the 1976 TAC (43,000 tons) and be set at 30,000 tons for 1977."

6. Page 14, (f), paragraph 1, line 2: change "50,000 tons" to "45,000 tons".

7. Page 14, (g), paragraph 1, line 5: after the sentence ending "... during that period.", insert the following: "Because of the lack of data on the age composition of the commercial catches during 1974-75, it has not been possible to update this assessment. However, it was noted that the estimated level of fishing mortality during 1972-73 of 0.8-1.0, with an average catch of 33,000 tons, was considerably beyond the $F_{0.1}$ level."

8. Page 22, (b), paragraph 2, line 3-4: change "the catch in Subdiv 4Vn during May to December should be kept as low as possible." to "essentially no catch should be taken from them in Subdiv. 4Vn during the May-December period."

9. Page 22, (b), paragraph 2, line 8: change "1976 level of catches" to "1975 catch".

10. Page 24, (d), paragraph 3, line 3: change "over 30,000 tons" to "over 39,000 tons".

11. Page 25, (g), paragraph 2, line 3: change "22,000 tons" to "28,000 tons".

12. Page 25, (h), heading: "(Res. Doc. 76/VI/21, 57, 59)" should read "(Res. Doc. 76/VI/57, 59; Sum. Doc. 76/VI/21)".

13. Page 25, (h), line 4: change "Res. Doc. 76/VI/21" to "Sum. Doc. 76/VI/21".

14. Page 26, paragraph 2, line 7: change "area" to "case"; change "(308,000 to 408,000 tons)" to "(380,000 tons in 1976 and 408,000 tons in 1977)".

15. Page 26, (i), paragraph 2, line 11: change "fishing at $F_{0.1}$=0.24." to "fishing at F_{max}=0.40 and a catch of 20,000 tons would result from fishing at $F_{0.1}$=0.24."

16. Page 26, (k), heading: change "Res. Doc. 76/VI/20" to "Res. Doc. 76/VI/22".

17. Page 32, line 3: change "Div. 4W(a)" to "Div. 4VW(a)".

18. Page 36, (k), paragraph 1: replace the table in the text by the following:

Year-class	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
No./tow	11.60	2.64	1.29	9.76	6.96	10.59	7.64	4.75	3.82	2.42	2.71	3.50	4.05
Log_e(No./tow+1)	1.774	0.760	0.568	1.344	1.492	1.451	1.322	1.074	0.970	0.641	0.670	0.839	0.617

19. Page 47, (r), paragraph 1, line 7: after "southwestward to Stat. Area 6" insert "should be continued".

20. Page 49, last paragraph, line 9: change "the 1977 second-tier TAC" to "the 1977 TACs".

21. Page 50, paragraph 1, line 3: change "Subarea 3" to "Subarea 2".