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## the Northwest Atlantic Fisheries

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Report of Assessments Subcommittee, April 1975

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REPORT OF ASSESSMENTS SUBCOMMITTEE, APRIL 1975

Chairman: D. J. Garrod

I. INTRODUCTION

The Subcommittee met at Woods Hole, USA, during 8-18 April 1975 to review the state of marine resources in the ICNAF Area, to recommend TAC levels for 1976, and to advise on the scientific aspects of certain proposals which the Commission will consider at its Annual Meeting in Edinburgh, Scotland, in June 1975. The review of TAC levels was carried out in small Working Groups of the Subcommittee as follows: groundfish stocks in SA<sup>1</sup> 0, 1, 2 and 3 (A. T. Pinhorn, Canada); groundfish stocks in SA 4, 5 and 6 (E. G. Heyerdahl, USA); mackerel stocks throughout the ICNAF Area (Ø. Ulltang, Norway); and herring stocks in SA 4, 5 and 6 (V. C. Anthony, USA). The various sections of this report are set out to correspond as far as possible to the manner in which they will be considered by the Panels and their Scientific Advisers.

In preparing its advice, the Subcommittee kept in mind the desirability of maintaining TACs that have already been agreed for 1975, except where there is clear evidence that adjustment is necessary for conservation reasons. In some instances, where earlier advice was based on average catch levels, and where the Commission reached agreement at slightly different levels but in conformity with the advice, the Subcommittee has adjusted its advice to the agreed level, except where there is new evidence that this is contrary to the biological objective of management.

Throughout its discussions, the Subcommittee has had to assume that the statistics reported by Member Countries represent the total catches. However, it should be noted that in at least one area (SA 3) substantial quantities of flatfish of a commercially valuable size to some countries may be caught and discarded by other countries in which these fish have no value (Res.Doc. 75/28). This would lead to an under-estimate of stock size and of the potential of the resource, and it may cause unexplained fluctuations in the fishery. In the silver hake fishery in SA 5 (Res. Doc. 75/62), substantial quantities of young fish are discarded at sea, causing the subsequent supply of recruits to commercial landings to fall short of expectations. Discarding of fish of less than commercial size will influence the efficiency of the regulatory regime, and this is believed by the Subcommittee to be more widespread throughout the ICNAF Area than is apparent from the data available. Both circumstances remove important quantities of the resource from the regulatory regime and have an influence on subsequent advice in a way which cannot easily be measured, except to say that it detracts from precision. It is thus absolutely essential that the catches of species be fully reported, and the Subcommittee had this in mind when it considered the potential benefits of the Observer Program proposed by STACTIC at its Special Meeting in Leningrad, USSR, in March 1975 (Summ.Doc. 75/9) and referred to STACRES for comment (see Section IX below).

Consideration of the TACs led to the general problem concerning the management area of individual stocks in relation to the collection of the statistics. A Canadian proposal (Comm.Doc. 75/9) requested that consideration be given to establishing TACs for smaller management areas in respect of certain stocks believed to be composed of several small units. A similar problem has arisen in respect of other stocks (e.g. mackerel) not subject to a specific proposal of this kind, and, in view of the generality of the issue, the Subcommittee has adopted a consistent approach to the point raised. The Subcommittee recognizes that several of the present management units may contain groups of fish which could probably be regarded as separate 'stocks' when they reach the exploited age-groups. Although there is a measure of overlap, the Subcommittee, having in mind the importance of the stock-recruitment relationship and the uncertainties concerning the distribution of very young fish within these areas, considers that, unless the subdivision into separate TACs could be shown to offer the prospect of an increase in yield by more efficient management, such a group of 'stocks' should be assessed as a single biological unit with a single TAC. At the same time it is apparent that some areas are sufficiently large that the stocks do not become fully mixed each year, with the result that fishing could concentrate in a part of the stock area, causing local depletion and an imbalance in the stocks and the fisheries. It may therefore be desirable to augment the single TAC with regulations to ensure an appropriate distribution of the fishery on the basis of biological and practical considerations, as have been applied to the regulation of capelin fisheries in 1975. Stocks to which this principle might usefully be applied are identified in the appropriate sections below in conjunction with the review of species' TACs.

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

<sup>1</sup> The abbreviation 'SA' is used throughout the text in referring to both 'Subarea' and 'Statistical Area'.

confined to species stocks under present or prospective catch quota regulation. Comments on the overall trend are therefore deferred to the 1975 Annual Meeting. However, the advance preliminary statistics for the stocks under regulation are essentially complete, and these were used to update the assessments.

III. SUMMARY OF CATCHES AND TACs

Recent catches and TACs for all stocks regulated in 1975 and for which regulation is proposed for 1976 are summarized in Table 1. In almost all cases the TACs recommended for 1976 are based on the assumption that TACs agreed by the Commission for 1975 are taken, as the Subcommittee cannot prejudge countries' intentions in this respect. The implication of this assumption is pointed out in the species' reviews where failure to reach 1975 TACs might influence the advice for 1976.

Table 1. Nominal catches (1971-74) and TACs (1973-76) of species for possible regulation at the 1975 Annual Meeting.

Species	Stock area	Nom. catches(000 tons)				TACs (000 tons) <sup>2</sup>				Assessment category
		1971	1972	1973	1974 <sup>1</sup>	1973	1974	1975	1976	
Cod	1	121	111	63	46	- (102)	107.0 (80)	60.0 (55)	(<45)	1
	2GH	13	14	+	6	-	20.0 (20)	20.0 (20)	(20)	1
	2J+3KL	432	458	355	362	665.5 (650)	656.7 (650)	554.0 (550)	(300)	1
	3M	34	58	23	23	-	40.0 (35)	40.0 (40)	(40)	1
	3NO	126	103	80	71	103.5 (70)	101.1 (85)	87.7 (85)	(85)	1
	3Ps	64	44	53	50	70.5 (70)	70.0 (70)	62.4 (60)	(60)	1
	4T+4Vn <sup>3</sup>	57	68	50	42	-	63.0 (60)	50.0 (50)	(45)	1
	4Vn <sup>4</sup>	11	9	7	6	-	10.0 (10)	10.0 (10)	(10)	1
	4VsW	54	62	54	43	60.5 (60)	60.0 (60)	60.0 (60)	(40)	1
	4X(offshore)	9	7	7	6	-	- (8)	5.0 (5)	(4)	1
	5Y	8	7	6	7	10.0 (10)	10.0 (10)	10.0 (10)	(8)	4
	5Z	28	25	29	28	35.0 (35)	35.0 (35)	35.0 (35)	(35)	2
Haddock	4VW	13	5	4	2	4.0 (0)	0.0 (0)	0.0 (0)	(0)	1
	4X	18	13	13	13	9.0 (0)	0.0 (0)	15.0 (15)	(0)	1
	5	12	7	6	5	6.0 (0)	0.0 (0)	6.0 <sup>5</sup> (0)	(0)	1
Redfish	2+3K	19	20	39	30	-	30.0 (25)	30.0 (30)	(30)	2
	3M	8	42	22	32	-	40.0 (..)	16.0 (16)	(16)	2
	3LN	34	29	33	21	-	28.0 (20)	20.0 (20)	(20)	2
	3O	20	16	9	12	-	16.0 (15)	16.0 (16)	(16)	2
	3P	28	26	18	22	-	25.0 (23)	25.0 (25)	(20)	2
	4VWX	62	50	40	32	-	40.0 (30)	30.0 (30)	(30)	4
	5	20	19	17	11	30.0 (30)	30.0 (30)	25.0 (25)	(17)	2
Silver hake	4VWX	129	114	299	96	-	100.0 (50-100)	120.0 (120)	(100)	1
	5Y	8	7	9	5	10.0 (10)	10.0 (10)	15.0 (15)	(10)	3
	5Ze	72	78	62	65	80.0 (80)	80.0 (80)	80.0 (80)	(50)	1
	5Zw+6	28	35	65	61	80.0 (80)	80.0 (80)	80.0 (80)	(43)	1
Red hake	5Ze <sup>6</sup>	9	39	25	14	-	20.0 (20)	20.0 (20)	(26)	1
	5Zw+6 <sup>6</sup>	31	36	41	34	40.0 (40)	50.0 (50-70)	45.0 (45)	(16)	1
Pollock	4VWX	12	20	30	25	} 50.0 (50) <sup>7</sup>	55.0 (50)	55.0 (55)	(55)	4
	5	14	13	13	13					
American plaice	2+3K	5	9	5	5	-	10.5 (8)	8.0 (8)	(8)	1
	3M	1	1	1	2	-	2.0 (2)	2.0 (2)	(2)	4
	3LNO	68	59	53	45	60.5 (60)	60.0 (60)	60.0 (60)	(47)	1
	3Ps	7	7	15	7	-	11.0 (10)	11.0 (11)	(8)	1
Witch	2J+3KL	16	17	24	15	-	22.0 (17)	17.0 (17)	(17)	1
	3NO	15	9	7	8	-	10.0 (10)	10.0 (10)	(10)	1
	3Ps	2	2	3	2	-	3.0 (3)	3.0 (3)	(3)	4
Yellowtail	3LNO	37	39	33	24	50.0 (50)	40.0 (40)	35.0 (35)	(<10)	1
	5(E69°)	} 31	39	31	10	16.0 (16)	16.0 (16)	16.0 (16)	(16)	2
	5(W69°)+6					10.0 (10) <sup>8</sup>	10.0 (10) <sup>8</sup>	4.0 <sup>9</sup> (0)	(0)	2
A. plaice, witch and yellowtail	4VWX	34	23	28	25	-	32.0 (32)	32.0 (32)	(28)	4
Flounders (except yellowtail)	5+6	28	24	22	21	25.0 (25)	25.0 (25)	25.0 (25)	(20)	3
Greenland halibut	0+1	4	14	10	14	-	-	-	(20)	4
	2+3KL	25	30	29	27	-	40.0 (30)	40.0 (40)	(30)	1

Table 1. (Continued)

Species	Stock area	Nom. catches(000 tons)				TACs (000 tons) <sup>2</sup>				Assessment category
		1971	1972	1973	1974 <sup>1</sup>	1973	1974	1975	1976	
Roundnose grenadier	0+1	8	8	5	12	-	-	10.0	(12)	4
	2+3	75	24	18	33	-	32.0 (30)	32.0 (32)	(32)	1
Herring	Option 1					(Seasonal - Jul to Jun)				
	4V							(15) <sup>10</sup>	(11) <sup>10</sup>	1
	4WX(adults)							-	(115) <sup>11</sup>	1
	Option 2					(Seasonal - Jul to Jun)				
	4VW(a)	72	32	30	44	-	45.0	30.0 <sup>12</sup>	-	
	4VW(a)					90.0	90.0 (90)	45.0 (45) <sup>10</sup>	(36) <sup>10</sup>	
	4XW(b)	70	75	91	89	90.0	90.0 (90)	90.0 (90)	(81) <sup>13</sup>	
	5Y(adults)	39	43	16	18	25.0	25.0 (25)	16.0 (25) <sup>14</sup>	(9)	1
	5Z+6	267	174	202	149	150.0	150.0 (150)	150.0 (150)	(60)	1
Mackerel	3+4	24	22	38	44	-	55.0 <sup>15</sup>	70.0 (70)	(310)	1
	5+6	349	387	381	304	450.0	304.0 (251-312)	285.0 (285)		
Argentine	4VWX	7	6	1	18	-	25.0 (25)	25.0 (25)	(25)	3
	5				23	-	25.0 (25) <sup>16</sup>	-	-	4
Capelin	2+3K	+	46	136	111	-	110.0 <sup>17</sup>	160.0 <sup>18</sup>	(300)	3
	3L	1	1	4		-	-	45.0		3
	3NO	1	21	127	156	-	148.0 <sup>17</sup>	126.0 <sup>19</sup>	(200)	3
	3Ps	1	3	1		-	-	9.0		3
Squid-Illex	3+4	9	2	10	+	-	-	25.0	(15)	3
" -Illex	5+6	25	49	57	21	-	71.0 (50-80)	71.0 (71) <sup>20</sup>	(30)	3
" -Loligo	5+6				34	-			(44)	3
O. finfish <sup>21</sup>	5+6	156	168	155	144 <sup>22</sup>	-	125.0 (125)	150.0 (125)	(150)	4
Overall 2nd tier <sup>23</sup>	5+6	1136	1165	1154	998	-	923.9	850.0 (850)	(650+)	

<sup>1</sup> Advance provisional statistics for April 1975 assessments.  
<sup>2</sup> TACs include quantities estimated to be taken outside the Convention Area; quantities in parentheses are TACs recommended by STACRES and the Assessments Subcommittee.  
<sup>3</sup> Div. 4T(Jan-Dec)+4Vn(Jan-Apr).  
<sup>4</sup> Div. 4Vn(May-Dec).  
<sup>5</sup> Solely for by-catch allocation (see Summ. Doc. 75/1).  
<sup>6</sup> TACs for 1973 to 1975 pertain to 5Z(E69°) and 5Z(W69°)+6 respectively; TACs recommended for 1976 pertain to 5Ze and 5Zw+6.  
<sup>7</sup> TAC for 1973 pertains to 4X+5 only.  
<sup>8</sup> TACs for 1973 and 1974 pertain to 5(W69°) only.  
<sup>9</sup> See Summ. Doc. 75/1 (Proc. 5th Spec. Comm. Mtg., Nov 1974).  
<sup>10</sup> TACs recommended pertain to the period July to June for 1975/76 and 1976/77 respectively.  
<sup>11</sup> TAC to be reduced by whatever catch is to be taken in Div. 4W(a) in the period 1 Jul-31 Dec 1975.  
<sup>12</sup> TAC pertains to Jan-Jun 1975 only.  
<sup>13</sup> An appropriate amount has to be deducted from this TAC to allow for the inshore fishery, if the TAC is to be set according to the principle used in previous years.  
<sup>14</sup> Reduction to 16,000 tons agreed at Spec. Comm. Mtg., Nov 1974 (Summ. Doc. 75/1).  
<sup>15</sup> TAC pertains to 4VWX.  
<sup>16</sup> TAC included with "Other finfish" after 1974.  
<sup>17</sup> Countries without specific allocations may each take up to 10,000 tons, no more than 5,000 of which may be taken from Div. 3LNOPS.  
<sup>18</sup> Countries without specific allocations may each take up to 10,000 tons.  
<sup>19</sup> Countries without specific allocations may not take more than 1,000 tons from Subdiv. 3Ps or more than 5,000 tons from Div. 3L; countries with specific allocations may add to their Div. 3NO allocations any part of their Subdiv. 3Ps and Div. 3L allocations not taken in the two last-mentioned areas.  
<sup>20</sup> Scientific recommendation was intended to pertain to Squid-Loligo only.  
<sup>21</sup> Excludes all TAC species and also menhaden, billfishes, tunas and large sharks (except dogfish).  
<sup>22</sup> Excludes Argentine (23,000 tons) as a separate TAC was set in 1974 only.  
<sup>23</sup> All finfish species (except menhaden, billfishes, tunas and large sharks) and squids.

IV. SUBAREA 1 AND STATISTICAL AREA 0

1. Fishery Trends (deferred to 1975 Annual Meeting)
2. Species Review

Table 2 contains a summary of recent catches and TACs as well as those recommended for 1976 for the stocks under consideration for management in SA 1.

Table 2. Subarea 1: summary of nominal catches (1971-74) and TACs (1973-76) by species and stock area.

Species	Stock area	Nominal catches(000 tons)				TACs(000 tons) <sup>2</sup>			
		1971	1972	1973	1974 <sup>1</sup>	1973	1974	1975	1976
Cod	1	121	111	63	46	- (102)	107 (80)	60 (55)	(<45)
G. halibut	0+1	4	14	10	14	-	-	-	(20)
R. grenadier	0+1	8	8	5	12	-	-	10	(12)

<sup>1</sup> Advance preliminary statistics.

<sup>2</sup> Actual TACs include quantities estimated to be taken outside the Convention Area; quantities in parentheses are TACs recommended by Assessments Subcommittee.

a) Cod in Subarea 1 (Res.Doc. 75/31)

Since 1968, when the nominal catch of cod in SA 1 was close to 400,000 tons, catches have declined drastically to 63,000 tons in 1973, and provisional statistics for 1974 show a further decline to 46,000 tons or only 10% of what was considered to be the MSY level in the 1950's and 1960's. The catch obtained in 1974 is only 58% of the recommended TAC of 80,000 tons for 1974 and only 43% of the TAC of 107,000 tons agreed to by the Commission.

The decline in catches is due primarily to the present low stock size, which makes cod fishing in the subarea less attractive than formerly. Most countries seem to have reduced their activity further in 1974, and, although there are not yet many data available on catch per effort in 1974, the decline in catch and fishing activity is believed to have caused a reduction in fishing mortality.

More than 50% (by number as well as by weight) of the catch in 1974 is based upon the 1968 year-class. At present, all year-classes after 1968 seem to be poor. The 1968 year-class now has its main distribution in Div. 1C-E, i.e., overlapping the boundary between the two stock components of 1A-D and 1E-F. The analyses have therefore been carried out for the SA 1 stock as a whole. This 1968 year-class is now recruiting to the spawning stock, resulting in some temporary increase in the spawning biomass compared to the very low level in 1973. However, from the present poor recruitment prospects, the spawning stock will gradually decrease to a lower level, but the rate of the decrease and the level is, to a great extent, dependent on the actual exploitation.

The analyses indicate that the catch in 1976 corresponding to  $F_{0.1}$  would be about 60,000 tons. A catch of 45,000 tons in 1976 would maintain the spawning stock size at its 1974-75 level into 1977-78 and improve the possibility of stronger year-classes. However, this depends very much on environmental conditions as well as spawning stock size, and the Subcommittee cannot be certain that even complete closure of the fishery would ensure increased recruitment. The Subcommittee therefore recommends that the 1976 TAC be not more than 45,000 tons in order to maintain the present spawning stock level, and notes that reduction below this level would further improve the chances of recovery of the stock.

Part of the 1968 year-class is expected gradually to emigrate to waters off East Greenland and to contribute to the spawning there. Spawning off East Greenland does, to some extent, supply recruits to the SA 1 stock. The Subcommittee, therefore, again points out that the matter of managing the SA 1 cod fisheries, so as to take stock/recruitment relationship into account, also involves regulation of the fisheries off East Greenland (in the NEAFC Area).

b) Greenland Halibut in Subarea 1 and Statistical Area 0

In its advice to the Commission in 1974, the Subcommittee expressed the view that, although there might be a single stock of Greenland halibut in the waters from Greenland to Baffin Island and southward to Labrador and northern Newfoundland, it would be better to partition this stock for management purposes. It was suggested that one of the management areas could be SA 0 and 1 combined. No new evidence has been presented to suggest a revision of previous advice regarding TAC or management area.

Provisional statistics for 1974 indicate a total catch of 14,000 tons from SA 0 and 1, an increase of 4,000 tons over that of 1973. The Subcommittee considers 20,000 tons to be an appropriate level of catch for the area, if the Commission should wish to implement a precautionary quota for 1976.

The Subcommittee noted that, although some sampling data were reported for the area, they were of limited value for assessment purposes, as they were not all reported for males and females separately as required (*Redbook* 1974, page 128).

c) Roundnose Grenadier in Subarea 1 and Statistical Area 0

Some new data collected in 1974 were reported by German Democratic Republic and USSR (Summ. Doc. 75/29, 30). However, information on the distribution of this species does not at present give reason to change the view that SA 0 and 1 be combined for practical management purposes. Age-reading methods are at present being developed, and with improved sampling (reporting of males and females separately) it is possible that a preliminary assessment can be provided within a few years.

Pending further information, the Subcommittee can only reiterate its advice of last year that a precautionary quota for SA 0 and 1 combined be set at a level close to the level of catches in recent years. Since the catch averaged about 7,000 tons annually in 1971-73 and increased to 12,000 tons in 1974, a precautionary TAC of 12,000 tons is recommended for 1976.

d) Capelin in Subarea 1 (Res.Doc. 75/53)

New information on the distribution and abundance of capelin at West Greenland indicated that the SA 1 stocks are considerably smaller than the Barents Sea stock, perhaps of the order of only 5-10% as large.

V. SUBAREAS 2 AND 3

1. Fishery Trends (deferred to 1975 Annual Meeting)
2. Species Review

Table 3 contains a summary of recent catches and TACs as well as the TACs recommended for 1976 for stocks under consideration for management in SA 2 and 3.

a) Cod in Divisions 2G and 2H

The TAC of 20,000 tons recommended for 1975 was less than the MSY level (30,000 tons) to allow for rebuilding of this stock which had experienced high levels of fishing in the period 1965-69. In addition, the recruitment of the 1964-66 year-classes was poor. Owing to severe ice conditions, catches since 1971 have been quite low and the preliminary estimate for 1974 was about 6,000 tons. Sampling data for 1972-74 are quite scanty and no new assessment could be done. The Subcommittee therefore recommends that the TAC for 1976 should remain at 20,000 tons.

b) Cod in Divisions 2J, 3K and 3L

i) Consideration of 1976 TAC. The catch in 1973 was 355,000 tons and preliminary statistics for 1974 indicate a catch of about 362,000 tons. Severe ice conditions since 1970 have hampered the fishery and have tended to divert fishing effort increasingly to the southern part of the area. In 1973, about 84% of the catch was taken in Div. 3KL and only 16% in Div. 2J.

Results of research vessel surveys by Fed.Rep. Germany, Canada and USSR show a severe reduction in the catch per unit effort of cod in this area since 1971, which may be due to either decreased abundance or a change in availability. The change in abundance could have been caused by an increase in natural mortality as a result of the unfavourable environmental conditions in recent years. The catch per day fished by the fleets of a number of countries also show a decline since 1969 and confirm the recent reduction in apparent stock size. The young fish surveys carried out by USSR indicate that no strong year-classes have appeared since that of 1968.

The change in fishing conditions and reduced stock size appear to have been associated with a change in catchability. Taking this in conjunction with the level of fishing effort indicates that the fishing mortality has remained close to the level of recent years. An analysis of the catch data was completed using a fishing mortality of 0.30 in 1974. It appears that the size of the 1968 year-class was over-estimated in the previous assessment, and this year-class has already been exploited fairly heavily since its entry into the fishery. Since recruitment of new year-classes has been poor since that of 1968, the fishery in 1976 will depend largely on fish of 8 years and older, and the 1971, 1970 and 1969 year-classes as 5-7 year old fish will contribute considerably less than average to the catch because of their low abundance. Therefore, a sharp reduction in TAC is indicated.

Table 3. Subareas 2 and 3: summary of nominal catches (1971-74) and TACs (1973-76) by species and stock area.

Species	Stock area	Nominal catches (000 tons) <sup>1</sup>				TACs (000 tons) <sup>2</sup>			
		1971	1972	1973	1974 <sup>3</sup>	1973	1974	1975	1976
Cod	2GH	13	14	+	6	-	20.0 (20)	20.0 (20)	(20)
	2J+3KL	432	458	355	362	665.5 (650)	656.7 (650)	554.0 (550)	(300)
	3M	34	58	23	23	-	40.0 (35)	40.0 (40)	(40)
	3NO	126	103	80	71	103.5 (70)	101.1 (85)	87.7 (85)	(85)
	3Ps	64	44	53	50	70.5 (70)	70.0 (70)	62.4 (60)	(60)
Redfish	2+3K	19	20	39	30	-	30.0 (25)	30.0 (30)	(30)
	3M	8	42	22	32	-	40.0 (..)	16.0 (16)	(16)
	3LN	34	29	33	21	-	28.0 (20)	20.0 (20)	(20)
	3O	20	16	9	12	-	16.0 (15)	16.0 (16)	(16)
	3P	28	26	18	22	-	25.0 (23)	25.0 (25)	(20)
A. plaice	2+3K	5	9	5	5	-	10.5 (8)	8.0 (8)	(8)
	3M	1	1	1	2	-	2.0 (2)	2.0 (2)	(2)
	3LNO	68	59	53	45	60.5 (60)	60.0 (60)	60.0 (60)	(47)
	3Ps	7	7	15	7	-	11.0 (10)	11.0 (11)	(8)
Witch	2J+3KL	16	17	24	15	-	22.0 (17)	17.0 (17)	(17)
	3NO	15	9	7	8	-	10.0 (10)	10.0 (10)	(10)
	3Ps	2	2	3	2	-	3.0 (3)	3.0 (3)	(3)
Yellowtail	3LNO	37	39	33	24	50.0 (50)	40.0 (40)	35.0 (35)	(<10)
G. halibut	2+3KL	25	30	29	27	-	40.0 (30)	40.0 (40)	(30)
R. grenadier	2+3	75	24	18	33	-	32.0 (30)	32.0 (32)	(32)
Capelin	2+3K	+	46	136	111	-	110.0 <sup>3</sup>	160.0 <sup>4</sup>	(300)
	3L	1	1	4	156	-	148.0 <sup>3</sup>	45.0	5
	3NO	1	21	127		-		126.0	
	3Ps	1	3	1		-		9.0	
Mackerel	3+4	24	22	38	44	-	55.0 <sup>6</sup>	70.0 (70)	} (310)
	5+6	349	387	381	304	450.0	304.0 (251-312)	285.0 (285)	
Squid	3+4	9	2	10	+	-	-	25.0	(15)

<sup>1</sup> Advance preliminary statistics.

<sup>2</sup> Actual TACs in some cases include quantities estimated to be taken outside the Convention Area; quantities in parentheses are TACs recommended by the Assessments Subcommittee.

<sup>3</sup> Countries without specific allocations may take up to 10,000 tons from the stocks, no more than 5,000 tons of which may be taken from Div. 3LNOPs.

<sup>4</sup> Countries without specific allocations may each take up to 10,000 tons.

<sup>5</sup> Countries without specific allocations may not take more than 1,000 tons from Subdiv. 3Ps or more than 5,000 tons from Div. 3L; countries with specific allocations may add to their Div. 3NO allocations any part of their Subdiv. 3Ps and Div. 3L allocations not taken in the two last-mentioned areas.

<sup>6</sup> TAC pertains to Div. 4VWX.

The expected catch in 1976 at  $F_{max}$  (0.35) would depend on the catch in 1975, as follows:

Catch in 1975	Expected 1976 catch at $F_{max}$
300,000 tons	360,000 tons
400,000 tons	330,000 tons
500,000 tons	305,000 tons
550,000 tons	290,000 tons

If, in fact, the fishery fails to take the TAC of 554,000 tons in 1975 with recent levels of fishing activity, then this will reinforce the view that estimates of population size and fishing mortality in 1974 have been too optimistic. However, the Subcommittee considers that it should assume that the 1975 TAC of 554,000 tons will be caught (implying an increase in fishing mortality from the 1974 level) and, therefore, recommends a TAC of 300,000 tons in 1976.

ii) Advice relating to quota boundary areas for Div. 2J+3KL stock (Comm.Doc. 75/9). The Subcommittee considered the possible subdivision of the cod management area of Div. 2J+3KL into smaller units. A summary of the present knowledge on biological characters and migrations within the large stock complex was presented, indicating that results of research on meristics, parasites, etc., taken over many years, have shown a cline from north to south in this area, with significant differences in these characters occurring between the northern and southern entrances of the range. Extensive tagging data have indicated that most of the recaptures from cod tagged in a particular locality are, in fact, from the vicinity of that locality but some recaptures do occur throughout the entire range. Also, growth rates are considerably different between the northern and southern part of the area. It was concluded that free mixing does not take place throughout the area, and if the portion of the stock complex in one division were reduced because of heavy fishing in that division, recovery by migration from other divisions could not be expected for a number of years. The possibility of heavy fishing on a portion of the stock complex is more likely in this area than in others because of the heavy ice cover in some years, resulting in diversion of fishing effort to southern divisions. Catches indicate that this has taken place in recent years.

The Subcommittee concluded that for the present the TAC should be applied to Div. 2J+3KL cod as a whole, but that, if the Commission wished to prevent the possible local effects indicated above in one or other of the divisions, it should subdivide the TAC to limit the amount of catch in each division.

c) Cod in Division 3M

The catch in 1974 was 23,000 tons, compared with 1972 and 1973 catches of 58,000 and 23,000 tons respectively. The TAC in 1975 was 40,000 tons and no new data were available to suggest a change. Therefore, the TAC recommended for 1976 is 40,000 tons.

d) Cod in Divisions 3N and 3O

The catch in this area has declined from a high of about 225,000 tons in 1967 to about 80,000 tons in 1973. The provisional catch in 1974 is 71,000 tons. A significant difference in age compositions between 1973 and 1974 was apparently caused by differences in age-reading techniques between the countries submitting samples. In view of this uncertainty, no new assessment was done, and it is recommended that the TAC for 1976 remain at 85,000 tons as indicated by the assessment in 1974.

e) Cod in Subdivision 3Ps (Res. Doc. 75/63)

The provisional catch in 1974 was 50,000 tons compared with a catch in 1973 of 53,000 tons. First recaptures of cod tagged in early 1975 by France tend to confirm migrations of cod between the eastern Gulf of St. Lawrence and the area off Newfoundland, extending at least as far east as Burgeo Bank. In addition, a specimen tagged on Burgeo Bank was recaptured on Sable Island Bank. The relationship between these stocks will be reviewed when further results of this experiment are available for comparison with the results of earlier work on which previous advice to the Commission was based.

The assessment of the previous year was updated using an  $F$  of 0.3, since the catch in 1974 was at about the same level as in 1973. Using recruitment estimates based on research vessel surveys, results show that fishing at  $F_{max}$  (0.3) in 1976 would yield a catch of about 60,000 tons and this is the recommended TAC for 1976.

f) Redfish in Subarea 2 and Division 3K

General production analyses indicate that this stock can sustain catches of 40,000-45,000 tons per year under equilibrium conditions but the stock has been in a depressed condition in recent years. Catches in 1966 to 1972 were well below the equilibrium curve. The 1973 catch at 39,000 tons was the largest since 1965 and was taken in about 2,300 standard days fished. Effort in 1973 increased substantially in response to the improved catch per unit effort which, at 16.8 tons per day fished, was greater than that obtained in 1971 and 1972 but only slightly better than the 13.2 to 15.0 tons per day obtained during 1967-70.

Total allowable catches for 1974 and 1975 were limited to 30,000 tons to permit the stock to rebuild. There is a possibility of improved recruitment prospects over the next several years. Since redfish is a slow-growing, long-lived species, it is recommended that the TAC for 1976 be maintained at the 1975 level of 30,000 tons to take advantage of improved recruitment prospects and permit rebuilding of the stock.

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 yield-per-recruit analysis indicated an  $F_{0.1}$  level of 0.2 to 0.3 and suggested that the average level of mortality during 1963-1973, when catches averaged approximately 13,000 tons annually, may have been at or beyond  $F_{0.1}$  for the average recruitment levels during this period. Commercial catch-per-unit-effort values indicate an increase in recruitment during 1968 to 1971.

The 1972 catch of 42,000 tons was almost five times the average catch of 8,500 tons annually during 1963-71, and estimated fishing effort in 1972 was more than triple the 1963-71 average annual fishing effort. The catch declined in 1973 to 22,000 tons, about half of the 1972 catch, but increased again to about 32,000 tons in 1974. Catch per day fished by vessels of the standard tonnage category 151-500 tons declined from 4.4 tons in 1971 to 4.0 tons in 1972 and 3.4 tons in 1973. The estimated level of fishing mortality during 1972-73 of 0.8 to 1.0 was considerably beyond the  $F_{0.1}$  level of 0.2 to 0.3.

Catches of the magnitude of those taken during 1972-74 cannot be sustained without risking stock depletion. The Subcommittee recommends that the TAC for 1976 be maintained at the 1975 level of 16,000 tons, the level of the estimated maximum sustainable yield and approximately the level of the long-term average catch.

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 considerably in excess of the estimated MSY level of 20,000 tons. Provisional catch statistics indicate that the 1974 catch was substantially lower at about 21,000 tons.

Virtually no commercial length or age data have been available for this stock since 1967 despite the increased catches of recent years, and it has not been possible to determine whether the recent increase in catches has been supported by improved recruitment. The Subcommittee therefore recommends that the TAC be limited to the estimated MSY level of 20,000 tons as in 1975, until such time as adequate data become available to permit a reassessment of this stock.

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; provisional catch statistics indicate an increase to about 12,000 tons in 1974, less than the total allowable catch of 16,000 tons. Catch per standard hour fished fluctuated from 1.00 tons in 1969 to 0.79 tons in 1970, 0.71 tons in 1971, 0.83 tons in 1972 and 1.1 tons in 1973, with a decrease in estimated fishing effort from about 19,500 standard hours fished in 1972 to about 7,900 standard hours fished in 1973. The decline in catch appears to have resulted from decreased fishing effort rather than decreased abundance.

Virtually no commercial length or age data have been available for this stock since 1968. In view of this, the Subcommittee recommends that the 1976 TAC from this stock be limited to 16,000 tons, the level of estimated MSY, until such time as adequate data become available to permit a reassessment of this stock.

j) Redfish in Division 3P (Res.Doc. 75/45)

Nominal catches of redfish from this stock have been at a relatively high level in recent years, averaging approximately 31,000 tons during 1969-72. The catch declined from 27,500 tons in 1971 and 26,000 tons in 1972 to 18,000 tons in 1973; provisional catch statistics indicate an increase to 22,000 tons in 1974. Assessments of this stock based on a general production study and a yield-per-recruit model previously indicated a maximum sustainable yield of about 23,000 tons at the recruitment levels experienced during 1965-71. Catch per hour fished by Canadian vessels of 151-500 tons has exhibited a steady decline from a high of more than 0.9 tons per hour in 1965 to less than 0.5 tons per hour in 1974; there was a slight levelling off in 1972 but a continued decline in 1973 and 1974. The 1974 catch per hour fished was the lowest experienced since 1962. The slight increase in catch from 1973 to 1974 was apparently attained by an increase in fishing effort to about the 1969 and 1971 levels, considerably above the 1973 level (approximately 45,000 hours compared with about 30,000 hours). This 50% increase in effort yielded only a 20% increase in catch. At the level of catch per unit effort experienced during 1974 (0.49 tons per hour), the 1974 TAC of 25,000 tons could only be attained with fishing effort 30% in excess of that required to attain MSY under equilibrium conditions. If the 1974 catch rates are maintained in 1975, it would appear that the 1975 TAC of 25,000 tons can be taken only by fishing considerably beyond  $F_{max}$ .

Standardized commercial catch per unit effort values point to a high level of redfish abundance in Div. 3P during the mid-to-late 1960's with above-average recruitment during this period. Therefore, the estimated maximum sustainable yield of 23,000 tons derived from 1965-71 data probably represents an over-estimate of the long-term MSY for this stock. Only about half as many redfish were caught in 1973 and 1974 research surveys in this area as during a comparable 1965 survey at the onset of the recent period of increased exploitation.

The 1965 and 1966 year-classes, upon which the fishery will become more dependent during 1976-77, appear to be substantially less abundant than those which supported the fishery during 1965-74. Accordingly, it is recommended that the TAC for this stock be reduced from 25,000 tons in 1975 to 20,000 tons for 1976. If recruitment is substantially diminished, as expected during the next several years, then a further reduction in total allowable catch can be anticipated.

k) American Plaice in Subarea 2 and Division 3K

Nominal catches from this stock ranged between 5,000 and 9,000 tons since 1971. Preliminary statistics indicate that 5,000 tons were taken in 1974. A TAC of 8,000 tons for 1975 was recommended at the 1974 Annual Meeting and, since no new information is available, the Subcommittee recommends that the 1976 TAC remain at 8,000 tons.

l) American Plaice in Division 3M

Nominal catches from this stock have remained at the relatively low level of 1,000 tons, increasing slightly to about 1,600 tons in 1974. The Subcommittee recommends that the TAC remain at the 1975 level of 2,000 tons for 1976.

m) American Plaice in Divisions 3L, 3N and 3O (Comm.Doc. 75/9; Res.Doc. 75/28, 52)

i) Consideration of 1976 TAC. Nominal catches from this stock have continued to decline from 94,000 tons in 1967 to 53,000 tons in 1973 and to about 45,000 tons in 1974. A TAC of 60,000 tons was established for 1973 and this has remained in effect for 1974 and 1975.

The value of  $F$  calculated from 1973-74 research vessel surveys was about at the level of  $F_{0.1}$ , but the average value of  $F$  for 1973 from the virtual population analysis was somewhat above this level. The updated assessment indicates an apparent reduction in stock abundance. This is supported by a decline in catch per unit effort from research vessel surveys. Also commercial catch per hour fished declined by about 20% in 1974 from the 1973 level. Based on these data, the Subcommittee therefore recommends that the TAC be reduced to 47,000 tons in 1976 in order to reduce the fishing mortality to the  $F_{0.1}$  level.

ii) Advice relating to quota boundary areas for Div. 3LNO stock (Comm.Doc. 75/9). The Subcommittee considered the material presented in Res.Doc. 75/52 which indicated that, while vertebral and other meristic characters did not show any significant difference between American plaice in Div. 3L, 3N and 3O, tagging results indicated that plaice on the Grand Bank moved very little, most being recaptured near the area of tagging. Also, size-at-age differences exist between the plaice in Div. 3L, 3N and 3O and more especially between the northern part of the Grand Bank area and the southern part. It was considered that the Grand Bank stock could possibly receive recruitment from larval drift from the north as well as from local spawning, although the evidence to support this is lacking.

Discussion centered on the biological and practical implications of subdividing quota areas. With free mixing of fish within a stock area, concentration of fishing effort in one or other of the portions of that area will not be expected to produce local effects on the fish in that portion. With lack of free movement of fish within a stock area, random distribution of fishing effort within the area will also not be expected to produce local effects on the fish in any given portion of the stock area. However, with lack of free mixing of fish within a stock area, concentration of fishing effort in one or other portion of the area for an extended period will be expected to produce local effects. Thus, the concentration of fishing effort in one part of the area would be expected to permit the stock component in another part of the area to recover. It was felt that this might tend to randomize fishing effort over the area, because of the tendency for fleets to fish where the catch per unit effort is highest. Effort figures presented showed wide fluctuations in the proportion of effort in one or other of the Div. 3L, 3N and 3O, but with no observable trend.

The biological advantage of managing on a finer breakdown of the area depends on the relative biological productivity of the fish in these finer units as well as on the tendency of the fleet to concentrate or randomize its fishing effort. If productivity varies between areas, then management on a yield-per-recruit basis might only be achievable if each area is managed separately. On the other hand, practical difficulties result when the species being considered is fished in conjunction with other species as is the case in Div. 3LNO.

The Subcommittee considered that the information available at the present time did not allow a finer breakdown of Div. 3LNO for American plaice and advises that the quota boundary area remain as Div. 3LNO combined. The Subcommittee also considered that data, collected on a finer area breakdown than the ICNAF division, would aid in future in such considerations of stock boundaries and proposed that the reporting of catch and effort and eventually sampling data by 30-minute squares be examined by the Statistics and Sampling Subcommittee at the 1975 Annual Meeting.

n) American Plaice in Subdivision 3Ps (Res.Doc. 75/22)

Except for 1973, when 15,000 tons were removed, landings of 7,000 tons annually have been recorded for the period 1971-74. A TAC of 10,000 tons for 1974 based on catch statistics was recommended by the Subcommittee and established at 11,000 tons by the Commission at the January 1974 Special Commission Meeting, and this TAC was also recommended for 1975. A new assessment is now available indicating that the rate of removals in recent years generated a value of fishing mortality slightly beyond  $F_{0.1}$ . Therefore, in order to hold the fishery at  $F_{0.1}$ , a reduction of the TAC to 8,000 tons for 1976 was recommended.

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

Nominal catches from this stock declined from 24,000 tons in 1973 to about 15,000 tons in 1974. A TAC of 17,000 tons based on recent catch statistics was recommended for 1974 but this was set at 22,000 tons by the Commission. On the basis of a new assessment, a TAC of 17,000 tons was established for 1975. No new information was available to update the assessment, and the Subcommittee recommends that the TAC of 17,000 tons be maintained for 1976.

p) Witch in Divisions 3N and 3O (Res.Doc. 75/23, 25)

Recent nominal catches have ranged from 15,000 tons in 1971 to 7,000 tons in 1973 and 8,000 tons in 1974. A TAC of 10,000 tons was established for 1974 and 1975, based on recent catch statistics. A yield-per-recruit assessment of this stock indicates that fishing at  $F_{0.1}$  in 1976 would allow a TAC of 10,000 tons.

q) Witch in Subdivision 3Ps

Nominal catches from this stock have remained at the 2,000-3,000 ton level since 1971. A TAC of 3,000 tons, based on catch statistics, was established for 1974 and 1975. Since no new information is available for this stock, the Subcommittee recommends that the TAC be maintained at 3,000 tons for 1976.

r) Yellowtail in Divisions 3L, 3N and 3O (Res.Doc. 75/28)

The yellowtail fishery in Div. 3LNO increased dramatically from very low levels of catch in 1964-65 to a peak of 39,000 tons in 1972. The 1973 catch was 33,000 tons and the 1974 provisional catch was 24,000 tons. A TAC of 50,000 tons was recommended and allocated for 1973 to control the expansion of the fishery. This was reduced to 40,000 tons in 1974, based on an assessment of the stock, and to 35,000 tons in 1975, based on an updating of the assessment.

The stock was increasing in abundance and expanding its range of distribution during the late 1960's. Indications from the 1973 data were that the expansion had probably ceased during the early 1970's. Predictions for the 1975 TAC were based on optimistic levels of recruitment and it was advised that, if these were not realized, the potential of this fishery could be considerably reduced (Redbook 1974, p. 87).

Total mortality values for 1973-74 calculated from both Canadian survey data and Canadian commercial catch per unit effort data were in the region of 1.5 to 1.6. In addition, catch per unit effort in the Canadian commercial fishery decreased by about 30% between 1973 and 1974. Indices of abundance for yellowtail from Canadian surveys declined by over 95% in Div. 3L between 1971 and 1974 and by almost 40% in Div. 3N between 1972 and 1974. USSR young fish surveys indicated declines of 60% in Div. 3L, almost 30% in Div. 3N and 80% in Div. 3O between 1971 and 1974.

The relative contribution of environmental factors and fishing intensity to these declines was discussed. Bottom temperatures during the spring season of 1972-74 were unusually low in this area, and this may have had some effect on the behaviour of the fish in relation to the survey trawl or may have contributed to a high natural mortality.

If these events observed in the stock were caused mainly by availability due to environment, the catch rate could conceivably improve again in 1975-76. But if, as seems likely, they result from decreased abundance, then it would be prudent to restrict catches to as low a level as practicable

to provide for adequate spawning stock for future recruitment. Preliminary information on possible discard rate for countries whose reported statistics contain almost solely cod indicate that there could be very large unreported removals from the stock, and management advice based on such incomplete statistics may have caused the sudden unexplained changes that have been observed in this fishery.

The uncertainty as to the relative effects of the environment and the fishery on this stock, and the further uncertainty as to the 1975 catch, indicate that the stock has been changing too rapidly to be properly assessed by current techniques. For example, the stock assessment carried out at this meeting indicates that previous estimates of recruitment were excessively optimistic and the projected stock in the current year indicates that it is impossible to catch the 1975 TAC of 35,000 tons, unless a major portion of the decreased catch rate has been due to decreased availability. If the 1975 catch is assumed to be approximately equal to the 1974 catch of 23,000 tons, the result will be a very high fishing mortality far above  $F_{0.1}$ , as previously predicted, and a drastically reduced stock size in 1976. If, as the Subcommittee expects, the stock cannot support the 1975 TAC and the actual catch in 1975 is as low as 10,000-12,000 tons, then it should be possible to remove 10,000 tons in 1976 at  $F_{0.1}$ .

The Assessments Subcommittee may well wish to review this stock at the end of 1975 when further data become available from the 1975 fishery and 1975 surveys.

s) Greenland Halibut in Subarea 2 and Divisions 3K and 3L (Res.Doc. 75/24)

Nominal catches from this stock have averaged about 28,000 tons since 1971 and approximately 27,000 tons were reported for 1974. A TAC of 30,000 tons was recommended by the Subcommittee for 1974, but this was increased to 40,000 tons by the Commission to account for possible non-reported incidental catches. At the 1974 Annual Meeting, the Subcommittee recommended a TAC of 40,000 tons for 1975, pending clarification of the incidental catch-reporting problem.

A yield-per-recruit assessment is now available and this indicates that, if the stock is exploited at the  $F_{0.1}$  level, not more than 30,000 tons should be removed in 1976. No new information was available on by-catches of this species, and the Subcommittee therefore recommends that the TAC for 1976 be reduced to 30,000 tons.

t) Roundnose Grenadier in Subareas 2 and 3 (Res.Doc. 75/26)

Provisional catch statistics indicate that the 1974 TAC of 32,000 tons was taken. This represents an increase in catch from the level of 24,000 and 18,000 tons during 1972 and 1973 respectively. The Subcommittee reviewed information presented on the distribution and relative abundance of grenadiers in the Northwest Atlantic in relation to area, depth and temperature, but it was unable to update the preliminary estimates of sustainable yield for this species in SA 2 and 3 because of lack of data on age composition of recent catches. Difficulty of ageing this species was noted and countries fishing the species indicated that further data would be forthcoming next year. The Subcommittee also identified a need for further clarification of the stock relationships of roundnose grenadier in SA 0, 1, 2 and 3.

The 1974 and 1975 TACs for SA 2+3 are based on preliminary estimates of sustainable yield for that part of the stock presently exploited. There was no indication that the fishery is at present conducted at greater depths than before. The Subcommittee recommends that the TAC for 1976 should be maintained at 32,000 tons, the same level as in 1974 and 1975.

u) Capelin in Subareas 2 and 3 (Res.Doc. 75/2, 3, 4, 5, 6, 7, 8; considered at Spec. Mtg. Jan 1975)

The Subcommittee reviewed the advice given to the Commission at its Sixth Special Meeting held in Bergen, Norway, 13-18 January 1975 (ICNAF Summ.Doc. 75/5). No new data were presented at this meeting that would warrant modifying the advice given by STACRES in Bergen, i.e. a maximum TAC of 500,000 tons, not to be exceeded for three years and split into 300,000 tons for SA 2 and Div. 3K and 200,000 tons for Div. 3LNOPs, no more than 10,000 tons of which should be taken in Subdiv. 3Ps and no more than 50,000 tons in Div. 3L. It was also considered desirable to institute a closed area in Div. 3L to provide additional protection to that component of Div. 3L capelin migrating inshore to spawn in coastal waters.

v) Mackerel in Subareas 3 and 4

The status of the mackerel fisheries in SA 3 and 4 is considered in conjunction with the overall assessment of the stocks in SA 3 to 6 (see under Mackerel in Section VII(o)).

w) Squid-Illex in Subareas 2 to 4

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

VI. SUBAREA 4

1. Fishery Trends (deferred to 1975 Annual Meeting)

2. Species Review

Table 4 contains a summary of recent catches and TACs, as well as the TACs recommended for 1976, for stocks under consideration for management in SA 4. Also included is pollock which overlaps SA 4 and 5.

Table 4. Subarea 4: summary of nominal catches (1971-74) and TACs (1973-76) by species and stock area.

Species	Stock area	Nominal catches(000 tons)				TACs(000 tons) <sup>2</sup>			
		1971	1972	1973	1974 <sup>1</sup>	1973	1974	1975	1976
Cod	4TVn <sup>3</sup>	57	68	50	42	-	63 (60)	50 (50)	(45)
	4Vn <sup>4</sup>	11	9	7	6	-	10 (10)	10 (10)	(10)
	4VsW	54	62	54	43	60 (60)	60 (60)	60 (60)	(40)
	4X(offshore)	9	7	7	6	-	- (8)	5 (5)	(4)
Haddock	4VW	13	5	4	2	4 (0)	0 (0)	0 (0)	(0)
	4X	18	13	13	13	9 (0)	0 (0)	15 (15)	(0)
Redfish	4VWX	62	50	40	32	-	40 (30)	30 (30)	(30)
Silver hake	4VWX	129	114	299	96	-	100 (50-100)	120 (120)	(100)
Pollock	4VWX	12	20	30	25	-	50 (50) <sup>5</sup>	55 (55)	(55)
	5	14	13	13	13	-	-	-	-
Flounders <sup>6</sup>	4VWX	34	23	28	25	-	32 (32)	32 (32)	(28)
Herring (1)	4V 4WX(adults)					(Seasonal - Jul to Jun)		(15) <sup>7</sup>	(11) <sup>7</sup>
								-	(115) <sup>8</sup>
or (2)	4VW(a) 4XW(b)(adults)	72	32	30	44	-	45 (45)	30 <sup>9</sup>	-
		70	75	91	89	90	(Seasonal - Jul to Jun)	45 (45) <sup>7</sup>	(36) <sup>7</sup>
Mackerel	3+4	24	22	38	44	-	55 <sup>11</sup>	70 (70)	} (310)
	5+6	349	387	381	304	450	304 (251-312)	285 (285)	
Argentine	4VWX	7	6	1	18	-	25 (25)	25 (25)	(25)
Squid- <i>Illex</i>	3+4	9	2	10	+	-	-	25	(15)

- 1 Advance preliminary statistics.
- 2 Quantities in parentheses are TACs recommended by Assessments Subcommittee.
- 3 Div. 4T(Jan-Dec)+4Vn(Jan-Apr).
- 4 Div. 4Vn(May-Dec).
- 5 TAC pertains to 4X+5.
- 6 American plaice, witch and yellowtail.
- 7 TACs for the season July to June in 1975/76 and 1976/77 respectively.
- 8 TAC to be reduced by the quantity estimated to be taken inshore in 4W(a) during 1 Jul-31 Dec 1975.
- 9 TAC pertains to 1 Jan-30 Jun 1975 only.
- 10 TAC to be reduced by the quantity of adults estimated to be taken inshore, if the TAC to be set according to the principle used in previous years.
- 11 TAC pertains to 4VWX.

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

Nominal catches in 1974 from the southern Gulf of St. Lawrence migrating stock were estimated to be 42,000 tons, substantially below the TAC of 63,000 tons and almost the lowest recorded catch since the early 1950s (41,000 tons in 1967). Cohort analysis and Canadian research

vessel surveys indicate that F in 1971-74 ranged between 0.40 and 0.60. The 1968 year-class, which was the best since that of 1965, has supported the fishery in 1972-74. the 1969 year-class appears to be the poorest on record and the 1970 year-class seems to be of average size. The 1971 year-class is predicted to be good but not as strong as that of 1968.

Year-to-year fluctuations in growth rate prevent the accurate determination of a definite level of  $F_{max}$ , but it fluctuates between 0.4 and 0.5. The 1975 TAC of 50,000 tons will generate a fishing mortality of 0.6, and the maintenance of catches at this level in 1976 would again generate an F of about 0.6. The Subcommittee therefore recommends that the 1976 TAC be reduced to 45,000 tons in order to bring the fishing mortality within the range of  $F_{max}$ .

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

The 1973 catch from this stock was 7,000 tons and preliminary statistics for 1974 indicate a catch of 6,000 tons which is well below the TAC of 10,000 tons. Total catches since 1962 have averaged 8,800 tons and have exceeded 10,000 tons in only three years: 1964, 1965 and 1971. While a new assessment was not available for this fishery, the question of stock boundaries in relation to the Div. 4VsW stock was considered. The two stocks mix somewhat during the summer months when the Div. 4VsW stock migrates northward, but the main component of the Subdiv. 4Vn fishery is based on inshore stocks. As such, it was considered more appropriate to maintain the current stock boundaries. The Subcommittee recommends that the 1976 TAC be maintained at 10,000 tons.

c) Cod in Subdivision 4Vs and Division 4W

Preliminary 1974 statistics indicate a nominal catch of 43,000 tons, substantially below the TAC of 60,000 tons. The 1973 nominal catch of 54,000 tons was likewise less than the TAC of 60,500 tons. Increased levels of biological sampling of catches in the most recent years indicate that catches are composed of younger cod than was previously thought, with fish of ages 2 to 5 comprising the bulk of the catch with some age 1 fish being taken as well.

Both cohort analysis and Canadian research vessel surveys indicate that fishing mortality averaged 0.60 in 1970-74. The 1975 TAC of 60,000 tons will generate an F of 0.70 and a reduction in TAC to 40,000 tons in 1976 is required to reduce F to the level of  $F_{max} = 0.45$ . The Subcommittee therefore recommends a TAC of 40,000 tons for 1976.

d) Cod in Division 4X (offshore)

The total nominal catch from Div. 4X declined slightly to 21,300 tons in 1974 from 22,200 tons in 1973. The nominal catch from the offshore stock, for which the 1975 TAC is 5,000 tons, declined to 5,800 tons in 1974 from 7,200 tons in 1973. Research vessel survey results indicate that fishing mortality remained about twice the level giving maximum yield per recruit in 1973-74, and there are no indications of improved recruitment in the immediate future. The 1975 TAC is expected to bring about a reduction in fishing mortality, and a further reduction to  $F_{max} = 0.35$  should be achieved by a catch of 4,000 tons in 1976. The Subcommittee therefore recommends that the TAC for 1976 should be reduced to 4,000 tons. It should be noted, however, that this will not allow a substantial rebuilding of the stock in 1976 toward the level giving the MSY.

e) Haddock in Divisions 4V and 4W

Haddock catches declined from 4,200 tons in 1973, when the catch quota of 4,000 tons pertained to Div. 4W only, to about 2,000 tons in 1974 under a zero catch quota. Research vessel surveys gave no indication than an improvement in stock size has occurred and recruitment is expected to be poor in 1976. The Subcommittee again recommends a zero TAC for the directed haddock fishery in order that removals from the stock be minimized to increase the possibility of recovery (MSY = 25,000 tons). Experience from the 1974 fishery suggests that unavoidable by-catches are in the order of 2,000 tons at the present low stock level.

f) Haddock in Division 4X

(i) Consideration of 1976 TAC. A nominal catch of 13,000 tons in 1974, similar to that for 1973, was taken under a zero TAC for a directed fishery in 1974. Catches depended heavily on the 1963, 1969 and 1971 year-classes.

Research vessel surveys indicate that fishing mortality is probably about  $F = 0.35$ . Sufficient data are now available to establish that the strength of the 1969 year-class at age 2 was about 20 million fish. Thus, the strength of more recent year-classes are estimated from research vessel surveys with decreasing reliability as follows: 2.5 million in 1970, 40.0 million in

1971, 20.0 million in 1972, and 15.0 million in 1973. It is estimated that the 1975 TAC of 15,000 tons will generate a fishing mortality of 0.40. A catch of 15,000 tons in 1976 would also generate a mortality of  $F = 0.40$ , whereas fishing at  $F_{\max} = 0.50$  would generate a catch of 18,500 tons. However, spawning stock size was the lowest on record in 1974. While spawning stock size will increase in 1975 and 1976 with maturation of the 1971 and 1972 year-classes, it will decrease again in 1977 due to the weaker 1973 year-class although not to a level as low as that in 1974. It is desirable to increase spawning stock size to 60,000 - 70,000 tons, the level which would prevail under stable stock conditions and under optimal exploitation. The level in 1975-77 will be between 40,000 and 50,000 tons.

The situation regarding this stock is essentially the same as in 1973 and 1974; removals should be minimized to rebuild spawning stock, and the Subcommittee therefore recommends a zero quota in directed fisheries for 1976, while realizing that incidental catches are likely to be about 15,000 tons. The entry in Table 4 has therefore been changed to zero for 1976 compared with the recommendation of 15,000 tons for 1975, although the advice is essentially the same as that given last year for 1975.

(ii) Consideration of closed area and season (Res.Doc. 75/57). Haddock concentrate along the slopes of Browns and LaHave banks in overwintering and spawning concentrations. Particularly in March and April, these concentrations extend from 50 fm (90 m) to deeper than 100 fm (180 m) on the southern edge of the banks between 64° and 67° longitude. Silver hake and argentine concentrations occur in deeper water from 80 fm (150 m). Thus, the distributions of these species overlap to some extent, particularly in March and April. The extent of overlap of fishable concentrations of these species is unknown but could be insignificant. Haddock concentrate on Browns and LaHave banks in February and May also, but normally in shallower water than in the intervening months.

The haddock closed area/season regulations have resulted in a reduction in fishing mortality during the months of closure, and the regulations in force for 1975 encompass almost all of the area in which haddock concentrate. This inevitably interferes with fisheries for argentine, silver hake, cod and, to some extent, pollock. Minimization of haddock mortality is important to its management. Should present closed area/season regulations prove an unacceptable interference with other fisheries, the Commission should consider alternative methods of regulating haddock mortality

g) Redfish in Divisions 4V, 4W and 4X

The nominal catch of redfish from the Scotian Shelf declined to 32,500 tons in 1974 (TAC was 40,000 tons) from 40,000 tons in 1973, 50,000 tons in 1972 and 62,000 tons in 1971. Catch rates of Canadian and US otter trawlers declined in 1974. Canadian and US research vessel surveys indicate that redfish abundance increased about 1970 and remained high through 1973. However, both surveys show a 55% decline in catch per tow between 1973 and 1974.

Stock status cannot yet be analyzed in detail. However, it is apparent that abundance has declined to, or below, the level of the 1965-69 period when landings averaged about 23,000 tons annually. Canadian surveys in 1974 indicate a moderate abundance of pre-recruits (16-17 cm) which will begin to contribute to the Canadian and US fisheries in 1976. However, since the length at entry to the USSR fishery is lower (approximately 17-18 cm), these fish may be heavily exploited in 1975. Uncertainties about present abundance and potential recruitment levels do not allow a revision of the TAC at this time. In recommending that the TAC for 1976 be set at the 1975 level of 30,000 tons, the Subcommittee notes that a reduction may be required in 1977. It was further noted that the harvesting of redfish less than 20 cm in size almost certainly results in yields less than that giving the maximum yield per recruit.

h) Silver hake in Divisions 4V, 4W and 4X

The 1973 nominal catch was 299,000 tons. Preliminary data for 1974 indicate a catch of 96,000 tons against the TAC of 100,000 tons. The 1975 TAC is set at 120,000 tons. While discussions of the available data failed to produce agreement concerning age compositions and mortality rates, it was agreed that the 1973 year-class, which contributes to the fishery in the years 1974 to 1976, was poorer than those of 1971 and 1972, and the success of the fishery in 1976 therefore will be heavily dependent on the strength of the 1974 year-class, but there was insufficient information to allow agreement on the strength of this year-class. On the assumption that it will be of moderate strength, the Subcommittee recommends a TAC of 100,000 tons for 1976, subject to revision at the 1975 Annual Meeting if new information concerning the stock assessment for 1976 becomes available.

1) Flounders in Divisions 4V, 4W and 4X

The total catch of flatfish (American plaice, witch and yellowtail combined) in 1973 was 27,900 tons compared with a preliminary catch of 25,000 tons in 1974, considerably less than the TAC level of 32,000 tons. The commercial catch per unit effort of American plaice and witch has remained stable in the period 1965-74, but yellowtail has shown a dramatic decline (Table 5).

Table 5. Div. 4VWX flatfish: catch rates of Canadian side otter trawlers of 151-500 gross tons (kg/hr. fished).

YEAR	4Vn	4Vs	4W	4X	4VWX	Plaice	Witch	Yellowtail
1965	196	487	86	6	151	43	35	73
1966	154	535	32	6	140	68	22	50
1967	226	436	62	8	134	58	29	47
1968	173	478	61	10	142	62	31	50
1969	152	454	50	11	130	74	32	25
1970	135	393	31	8	108	73	21	14
1971	136	339	61	9	107	61	31	15
1972	112	321	71	7	105	55	35	15
1973	315	119	80	5	77	37	35	4
1974	160	251	45	5	82	40	36	5

An assessment was presented for American plaice but none was available for witch or yellowtail. The plaice assessment indicated that  $F_{0.1}$  was 0.48 for males and females combined. Furthermore, it was suggested that this stock is being over-exploited in Div. 4W but under-exploited in Div. 4V due to a disproportionate distribution of fishing effort. The level of catch associated with  $F_{0.1}$  for American plaice is about 11,700 tons, only slightly less than the 13,600 tons previously estimated. However, the observed reduction in abundance of yellowtail and the need to redistribute fishing effort within the American plaice fishery justifies a recommendation that the overall TAC for flatfish be reduced. The Subcommittee therefore recommends that the 1976 TAC be set at 28,000 tons, noting that work should continue with the aim to provide separate assessments for these species.

j) Pollock in Divisions 4V, 4W and 4X and in Subarea 5

Nominal catches averaged approximately 35,000 tons annually during 1955-66 but declined to a low of 19,500 tons in 1970; since then catches increased to 43,100 tons in 1973. Preliminary statistics for 1974 indicate that about 38,000 tons were taken from this stock, of which 13,500 tons were reported from SA 5. Thus the nominal catch is again well below the 1974 TAC of 55,000 which was set in 1974 on the basis of commercial catch and bottom trawl survey data. Commercial catch rates have increased in recent years from 49 kg/hr fished to 259 kg/hr in 1974 for Canadian otter trawlers (151-500 GRT) in Div. 4VWX and from 41 to 55 kg/hr for US trawlers in Div. 4VWX and SA 5 over the same period. However, survey indices of abundance (Res. Doc. 75/65) fluctuated considerably during the period and indicate at best only a slight increase in biomass. It seems therefore that shifts in directed effort associated with recent declines in the SA 4 and 5 haddock stocks were primarily responsible for the increases in nominal catches and catch rates observed in recent years.

At present, there is no evidence to suggest that the Div. 4VWX and SA 5 stock is declining under current catch levels, and recruitment seems to have ranged from average to strong in recent years. The Subcommittee therefore recommends that the TAC be maintained at 55,000 tons in 1976.

k) Argentine in Divisions 4V, 4W and 4X and in Subarea 5

Although USSR scientists indicated that studies on the delineation of this stock are in progress, no new information was available to suggest a change in past advice. Catches in 1974 were 18,000 tons in Div. 4VWX and 23,000 tons in SA 5, both markedly up from catches of 1,400 and 2,500 tons for the two areas in 1973. In the absence of new information, the Subcommittee recommends that the 1976 TAC be maintained at 25,000 tons for Div. 4VWX. A catch of 25,000 tons is also recommended for SA 5, but this amount is included in the recommended TAC for the "other finfish" category (see Section VII). The total catch from Div. 4VWX and SA 5 should not exceed 50,000 tons.

l) Herring in Subarea 4 (see also Summ.Doc. 75/19)

(1) Banquereau stock (Divisions 4V and 4W(a)) (Res.Doc. 75/39). The total catch in 1974 from Div. 4W(a) was 44,000 tons, an increase of 43% from that in 1973. The 1970 year-class again

sustained the Canadian fisheries in both Subdiv. 4Vn and Div. 4W(a), comprising over 50% of the catch in numbers in both areas. The 1972 year-class make a strong appearance in Div. 4W(a), comprising 24% of the catch in numbers. The catch per unit effort data indicate radically different trends in the two areas (Table 6). In Subdiv. 4Vn the CPUE has decreased by 39% in the past three years while for the same period in Div. 4W(a) it has increased by 97%.

Table 6. Catch per unit effort (metric tons) for the Canadian herring fishery in Subdiv. 4Vn and Div. 4W(a) for the 1971/72 to 1974/75 seasons. (Units of effort are given in parentheses.)

Area	1971/72	1972/73	1973/74	1974/75
4Vn	115.2 (56)	93.8 (149)	78.6 (193)	70.4 (183)
4W(a)	74.5 (270)	73.6 (97)	132.0 (194)	146.5 (129)

Tagging studies (Res.Doc. 75/38) have suggested that the Div. 4W(a) fishery should be combined with Div. 4XW(b) for management purposes and is assessed with Div. 4XW(b) in this report. No larval concentrations were found in recent larval surveys in Div. 4VW and this adds support to the hypothesis that the Div. 4W(a) fishery is not on a separate stock. A decision to combine Div. 4W(a) with Div. 4XW(b) for management purposes would leave the Div. 4V fishery to be managed separately. No analytical assessment is available for this fishery. However, in view of the continuous decline in CPUE for this area during 1971-75, a decrease in the catch level should be considered. The average catch for the last three seasons has been about 16,000 tons, and a reduction to about 11,000 tons would seem appropriate for 1976.

(ii) Southwest Nova Scotia stock (Divisions 4W(b) and 4X). This assessment is based on catches from Div. 4XW(b) as in previous years, in the event that the Commission will wish to continue regulating catches in 1976 as in the past. An additional assessment is given in Subsection (iii) which combines the catches from Div. 4XW(b) and Div. 4W(a).

The total catch of herring in Div. 4XW(b) was about 142,700 tons in 1974, an increase of 6% over that of 1973. Approximately 89,200 tons were taken against the 1974 TAC of 90,000 tons. The remaining 53,500 tons were taken in the traditional juvenile and fixed gear fisheries. The assessment was made using the catches of all fisheries off southwest Nova Scotia, which include all non-Canadian catches in Div. 4XW(b), Canadian catches in the Nova Scotia purse seine, weir, trap and gillnet fisheries, but excludes gillnet catches along eastern Nova Scotia which are assumed to be from local spawning stocks.

The assessment to recommend a TAC for 1976 was made with the following assumptions:

- (1) The 1975 TAC of 90,000 (plus 15,000 tons estimated for the fishery in Nova Scotia inshore waters which has so far been excluded from the TAC) will be taken.
- (2) The size of the 1970 year-class is twice the size of the 1966 year-class at age 1, as was assumed in 1974.
- (3) The 1971 year-class is of similar size to the 1969 year-class, which was one of the poorest on record.
- (4) The size of the 1972 year-class is one-half the size of the 1966 year-class at age 1. (Catches of the 1972 year-class at age 2 in the Canadian fisheries support the assumption that it is of reasonable size).
- (5) The size of the 1973 and 1974 year-classes are  $400 \times 10^6$ . This is the conventional size of year-classes entering this fishery as agreed in 1974 (*Redbook* 1974, page 109).

Based on the assumptions as to the sizes of year-classes, the catch for 1976 and stock size for 1977 were calculated using values of F from maximum yield per recruit considerations (*Redbook* 1974, page 109). The assessment indicates a decline in stock size of 25% from the beginning of 1975 to 1977, and a reduction in catch in 1976 of about 25,000 tons (from 106,000 to 81,000 tons). Since the inshore catches (estimated at 15,000 tons for 1975 and not under TAC regulation) were included in the assessment, these estimated catches have to be removed from the predicted catch before the TAC is determined. With the reduction in stock size predicted for 1976, the inshore catches should also decrease (probably 11,000 tons in 1976); the total predicted catch in 1976 is 81,000 tons, from which the appropriate amount has to be deducted for the inshore fishery, if the TAC is to be set according to the principle used in previous years. Only by

raising the fishing mortalities on all age-groups substantially above optimum levels in 1976 can the TAC remain at 90,000 tons. It must be stressed, however, that, if the 1972 year-class is not as strong as assumed, the stock size could be severely reduced even with the recommended reduction in the 1976 TAC. If the 1973 and 1974 year-classes are less abundant than assumed ( $400 \times 10^6$ ), and optimum F levels are maintained on all age-groups, an even greater reduction in catch will be required for 1977.

(iii) Southwest Nova Scotia and Chedabucto Bay combined (Divisions 4W and 4X): a new assessment. Tagging experiments in 1974 indicated a strong connection between Div. 4W(a) and Div. 4XW(b) stock components. It was decided therefore that an assessment, based on the two fisheries combined, should be made.

The total catch in 1974 from Div. 4WX was 170,000 tons. The 1970 year-class comprised about 67% of the catch.

Catches used in the assessment include Canadian catches off southwest Nova Scotia (Div. 4X(a), the non-Canadian catches in Div. 4XW(b) as in the Div. 4XW(b) assessment in the preceding subsection, the Canadian catches in Div. 4W(a) since 1969 when the fishery began, and USSR catches in 1974 from Div. 4VW(a). Catches in earlier years from Subdivision 4Vs were not included as they were assumed to be from the same stock as catches from Subdivision 4Vn.

The new assessment was made using the following assumptions:

- (1) The rate of fishing is the same in both areas, and thus the population size was calculated using the same starting Fs as in the Div. 4XW(b) assessment.
- (2) The size of the 1970 year-class is twice the size of the 1966 year-class at age 1.
- (3) The sizes of the 1973 and 1974 year-classes are  $750 \times 10^6$  fish. This is the conventional year-class assumption for Div. 4XW(b) taking into account the addition of Div. 4W(a).

The resulting prediction indicates a reduction in catch from 1975 to 1976 of about 4,000 tons in Div. 4W(a) and a reduction of 16,000 tons in Div. 4XW(b) to achieve  $F_{max}$ . A reduction in biomass of 47% between 1974 and 1976 is indicated. The total reduction in catch for the combined areas is thus very similar to the prediction resulting from the assessment for Div. 4XW(b) alone.

At the 1974 Annual Meeting, the 1975 TAC for Div. 4VW(a) was partitioned to allow the regulation to be based on a fishing season commencing on 1 July 1975. As a consequence, a January to June 1975 TAC was set at 30,000 tons for Div. 4VW(a). The 1975 TAC for Div. 4XW(b) was set at 90,000 tons. Thus the TAC for the combined area of Div. 4XW(b) and 4W(a) will allow a 1975 catch of 120,000 tons (plus an estimated inshore catch of 15,000 tons in Div. 4XW(b), for a total catch of 135,000 tons). The analysis indicates that a total catch for 1976 from the combined area of 115,000 tons can be taken, a reduction of 20,000 tons from that of 1975. An appropriate amount of catch in the inshore fishery would need to be deducted, if the Commission wishes to set the TAC on the same basis as in previous years (an inshore catch of 11,000 tons is estimated for 1976).

(iv) Management strategy in Divisions 4V, 4W and 4X. At the 1974 Annual Meeting, the TAC for the Div. 4VW(a) fishery was set on a fishing season basis, i.e. 1 July to 30 June. The TAC for the 1975/76 season was set at 45,000 tons. The 1975 TAC for the 4XW(b) fishery was set at 90,000 tons for the calendar year, excluding 15,000 tons estimated to be taken in the inshore fisheries.

Recent tagging studies have indicated the need for adjustments in the management areas and the following procedure is recommended:

Option 1. Recognizing that the Commission has already agreed on a TAC for the stock in Div. 4VW(a) for the season 1 July 1975 to 30 June 1976, the Subcommittee considers that the management area should be adjusted to give TACs as follows:

Div. 4V	1 July 1975 to 30 June 1976	15,000 tons
	1 July 1976 to 30 June 1977	11,000 tons
Div. 4WX	1 Jan 1976 to 31 Dec 1976	115,000 tons

The 115,000 tons for Div. 4WX should be reduced by whatever catch is to be taken in Div. 4W(a) in the period 1 July 1975 to 31 Dec. 1975.

Option 2. If the Div. 4VW(a) fishery continues to be managed as a unit (as in previous years), the recommended TAC for that area for 1976/77 season is 36,000 tons (on the basis of 11,000 tons for Div. 4V and 25,000 tons for Div. 4W(a)). This reduction in Div. 4W(a) is justified on the basis that the combined assessment predicted catches in Div. 4W(a) of 25,000 tons. If no

reduction is made for this area, an even larger reduction will be required in 1977. If the fishery in Div. 4XW(b) continues to be managed as a unit (as in previous years), the predicted catch in 1976 is 81,000 tons, which include an estimated 11,000 tons to be taken in the inshore fisheries.

m) Mackerel in Subareas 3 and 4

The status of the mackerel fisheries in SA 3 and 4 is considered in conjunction with the overall assessment of the stocks in SA 3 to 6 (see under Mackerel in Section VII(o)).

n) Squid-Illex in Subareas 2 to 4

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

VII. SUBAREA 5 AND STATISTICAL AREA 6

1. Fishery Trends (deferred to 1975 Annual Meeting)

2. Species Review

Table 7 contains a summary of recent catches and TACs, as well as the TACs recommended for 1976, for stocks under consideration for management in SA 5 and 6.

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

The TAC for the Gulf of Maine stock has been set at 10,000 tons since 1973, based on historical catch information only. While an assessment for this stock has yet to be completed, several points presented to the Subcommittee suggest that the current TAC is too high. A tabulation of catches in Div. 5Y since 1932 shows that the catch exceeded 10,000 tons only three times (1934, 1944 and 1945) and averaged only 6,130 tons over the entire period (1932-74). In addition, there is an unknown but considerable sport fish harvest of cod from this area. Estimates of abundance (mean weight/tow) from US autumn bottom trawl surveys indicate that a declining trend has been consistent since 1968 (Res. Doc. 75/65). Mortality estimates for Gulf of Maine fish indicate that the current fishery is generating  $F$  values of about 0.5, (assuming  $M = 0.2$ ). When compared to yield-per-recruit curves for the whole of SA 5, the current estimates of  $F$  appear to exceed that for  $F_{\max}$  at 0.3. The Subcommittee therefore recommends that the 1976 TAC should be reduced to 8,000 tons.

b) Cod in Division 5Z (Res.Doc. 75/46)

The TAC for the Georges Bank stock since 1973 has been set at 35,000 tons, which was considered to be the MSY (Res.Doc. 72/117). No new assessment has been completed for this stock. Total nominal catches over the past 10 years (1965-1974) have averaged 34,300 tons but they have been below 30,000 tons since 1970. Estimates of abundance calculated from autumn R/V *Albatross IV* surveys indicate a relatively stable population since 1963. Length frequency samples for both bottom trawl survey and commercial fishery samples indicate a strong 1971 year-class which appeared to be fully recruited to the US fishery by the last quarter of 1974. Year-classes following 1971 are also present although not as abundant. Estimates of mortality rates for Georges Bank fish suggest that the current fishery is generating  $F$  values around 0.35 (assuming  $M = 0.2$ ), which exceed the estimate of  $F_{\max}$  at 0.3 ( $M = 0.2$ ) calculated for the whole of SA 5. Moreover, a refit of the generalized production model with updated catch-effort data since 1973 indicates a lower MSY value of around 32,500 tons. However, the data presented were not felt to be sufficient to warrant a change in the current TAC, although it was noted that continued harvest at the TAC level may in fact be too high. A TAC of 35,000 tons is therefore recommended for 1976.

c) Haddock in Subarea 5 (Res.Doc. 75/48)

The TAC was set at zero in 1974, allowing for by-catch only. The 1975 TAC was set by the Commission at 6,000 tons (an estimate of by-catch) to allow each nation to formulate its own regulations to meet internal quota allocations and thus hold the catch at the lowest possible level. Provisional catch data indicates the 1974 incidental catch to be approximately 4,800 tons.

Table 7. Subarea 5 and Statistical Area 6: summary of nominal catches (1971-74) and TACs (1973-76) by species and stock area.

Species	Stock area	Nominal catches (000 tons)				TACs (000 tons) <sup>2</sup>			
		1971	1972	1973	1974 <sup>1</sup>	1973	1974	1975	1976
Cod	5Y	8	7	6	7	10 (10)	10 (10)	10 (10)	(8)
	5Z	28	25	29	28	35 (35)	35 (35)	35 (35)	(35)
Haddock	5	12	7	6	5	6 (0)	0 (0)	6 <sup>3</sup> (0)	(0)
Redfish	5	20	19	17	11	30 (30)	30 (30)	25 (25)	(17)
Silver hake	5Y	8	7	9	5	10 (10)	10 (10)	15 (15)	(10)
	5Ze	72	78	62	63	80 (80)	80 (80)	80 (80)	(50)
	5Zw+6	28	35	65	60	80 (80)	80 (80)	80 (80)	(43)
Red hake	5Ze <sup>4</sup>	9	39	25	14	-	20 (20)	20 (20)	(26)
	5Zw+6 <sup>4</sup>	31	36	41	34	40 (40)	50 (50-70)	45 (45)	(16)
Pollock	4VWX	12	20	30	25	50 (50) <sup>5</sup>	55 (50)	55 (55)	(55)
	5	14	13	13	13				
Yellowtail	5(E69°)	31	39	31	16	16 (16)	16 (16)	16 (16)	(16)
	5(W69°)+6				10	10 (10) <sup>6</sup>	10 (10) <sup>6</sup>	4 <sup>7</sup> (0)	(0)
Flounders except Yellowtail	5+6	28	24	22	21	25 (25)	25 (25)	25 (25)	(20)
Herring	5Y(adults)	39	43	16	18	25	25 (25)	16 (25) <sup>8</sup>	(9)
	5Z+6	267	174	202	149	150	150 (150)	150 (150)	(60)
Mackerel	3+4	24	22	38	44	-	55 <sup>9</sup>	70 (70)	(310)
	5+6	349	387	381	304	450	304 (251-312)	285 (285)	
Argentine	5				23	-	25 <sup>10</sup> (25)	-	-
Squid <i>Illex</i>	5+6	25	49	57	21	-	71 (50-80)	71 (71) <sup>11</sup>	(30)
" <i>Loligo</i>	5+6				34				
O. finfish <sup>12</sup>	5+6	156	168	155	144 <sup>13</sup>	-	125 (125)	150 (125)	(150)
Overall 2nd tier <sup>14</sup>	5+6	1136	1165	1154	998	-	923.9	850 (850)	(650+)

<sup>1</sup> Advance preliminary statistics for April 1975 assessments.  
<sup>2</sup> Quantities in parentheses are TACs recommended by the Assessments Subcommittee.  
<sup>3</sup> Solely for by-catch allocation (see Summ.Doc. 75/1).  
<sup>4</sup> TACs for 1973 to 1975 pertain to Div. 5Z(E69°) and Div. 5Z(W69°)+ SA 6 respectively; TACs recommended for 1976 pertain to Subdiv. 5Ze and Subdiv. 5Zw+SA 6 respectively.  
<sup>5</sup> TAC for 1973 pertains to Div. 4X and SA 5 only.  
<sup>6</sup> TACs for 1973 and 1974 pertain to SA 5(W69°) only.  
<sup>7</sup> See Summ.Doc. 75/1 (Proc. Fifth Spec. Comm. Mtg., November 1974).  
<sup>8</sup> Reduction to 16,000 tons agreed at Fifth Spec. Comm. Mtg., November 1974 (Summ.Doc. 75/1).  
<sup>9</sup> TAC pertained to Div. 4VWX.  
<sup>10</sup> TAC included with "Other finfish" after 1974.  
<sup>11</sup> Scientific recommendation was intended to pertain to *Loligo* only.  
<sup>12</sup> Excludes all TAC species and also menhaden, billfishes, tunas and large sharks (except dogfish).  
<sup>13</sup> Excludes 23,000 tons of argentine, as a separate TAC was set for 1974.  
<sup>14</sup> All finfish species (except menhaden, billfishes, tunas and large sharks) and squids.

*Albatross IV* autumn bottom trawl survey data and US commercial indices of abundance (adjusted to eliminate effects of closed areas and seasons) both indicate declining trends to a very depressed state since the late 1960's. Recruitment has remained poor; the 1972 year-class has shown some strength in recent autumn surveys, although it appears to be only one-half the average size of the 1935-1960 year-classes. Young-of-year indices again indicate very poor year-classes for 1973 and 1974. Analyses of commercial data indicate additional disturbing trends. Growth rates of younger fish have increased sharply since 1970, implying a considerable reduction in age at recruitment. Also, the strong 1962 and 1963 year-classes are now disappearing from the fishery. These year-classes contributed approximately 75% of the total landings (by weight) for this stock during the 1967-1970 period, but by 1973 and 1974 yield from these year-classes approximated only 24% of the total. Taken together, these factors have serious implications relative to stock and recruitment and further indicate that every effort should continue to limit fishing mortality on this stock.

Stock abundance and recruitment estimates for Georges Bank haddock for the period 1968-76 are given in Table 8. It appears that the stock declined to an overall low in 1972 and has since gradually increased. However, most of the observed upswing is associated with recruitment of the 1972 year-class. Current data indicate a levelling off of the trend, due to poor recruitment in 1973 and 1974.

The Subcommittee recommends that removals in 1976 should be kept to the lowest possible level, with the understanding that unavoidable catches approaching 6,000 tons can be expected to occur under a zero TAC regulation. Even this level of by-catch is considered to be a serious hindrance to the recovery of the stock.

Table 8. Stock abundance and recruitment estimates for Georges Bank (Subdiv. 5Ze) haddock, 1968-76.

	1935-60	Yearly estimates (millions of fish)								
		1968 <sup>1</sup>	1969	1970	1971	1972	1973	1974	1975	1976
Population (age 2+)	145	70	36	24	23	12	20	42	48	48
<u>Removals:</u>										
total	63	35	16	9	9	4	6	10	11	12
fishing	41	25	11	5 <sup>2</sup>	5 <sup>2</sup>	2 <sup>2</sup>	3 <sup>2</sup>	3 <sup>2</sup>	3 <sup>2</sup>	3 <sup>2</sup>
natural	22	10	5	4	4	2	3	7	8	8
Recruits (age 2)	54	15	1	4	8	-	12	28	16	11

<sup>1</sup> Population size estimated with F = 0.5 and M = 0.2 during 1968.

<sup>2</sup> Under regulation; numbers computed on basis of mean weight in US commercial landings.

d) Redfish in Subarea 5 (Res.Doc. 75/59)

The TACs of 30,000 and 25,000 tons, recommended by the Subcommittee for 1974 and 1975 respectively, were derived from an analysis of catch and effort trends. A new preliminary assessment for the stock was presented.

During the developing years of the fishery (1935-1951) the SA 5 catch reached a maximum of 59,783 tons in 1941 but rapidly declined from this high level to 16,791 tons in 1953. The catch continued to decline until 1968 when only 6,777 tons were taken. During this period of declining catch, the stock appeared to be rebuilding as indicated by a rise in the US commercial and survey abundance indices in the mid-1960's, but a shift in fleet composition also occurred. Following 1968, landings from SA 5 rose to 20,035 tons in 1971 and 19,905 tons in 1972. A provisional catch of 10,600 tons is indicated for 1974.

Recent research cruise catch-per-tow indices and length frequency data indicate a lower abundance of larger redfish and increased abundance of smaller pre-recruit redfish between 1971 and 1974. This trend is also evident in US commercial catch per unit effort and length frequency sampling data.

Equilibrium yield curves were fitted using total catch statistics and the US commercial catch-per-unit-effort index from 1942 to 1973. These values varied between 20,000 and 28,000 tons, depending on the model and the averaging period used in the analyses. Because of the large number of years in which a single year-class may be subject to exploitation in the fishery, averaging periods of 6, 8 and 12 years were used in the analyses. The model which gave the best fit of observed data was the Gompertz with an 8-year average effort using the catch and effort data from 1942 to 1973. The estimated MSY from this analysis was 20,000 tons. When the data during the earlier period of expansion (1942-1951) were excluded from the analysis, the resulting MSY values were considerably lowered, varying between 16,000 (Gompertz) and 18,000 (logistic) tons. These estimates fall well below the catches observed during the developing years of the fishery but this can be attributed to the initial harvest of an accumulated stock at that time, a condition well known for such slow-growing and long-lived species as redfish. Considering the declining trend in abundance, the MSY values derived from the equilibrium yield model, and the long period needed for recovery of redfish stocks, the Subcommittee recommends that the 1976 TAC be set at 17,000 tons.

e) Silver Hake in Subarea 5 and Statistical Area 6 (Res. Doc. 75/13, 63)

i) Stock identification. The question arose at the 1974 Annual Meeting concerning stock differentiation and the definition of management areas for silver hake in SA 5 and 6 (Res. Doc. 74/100). It was agreed that the stocks be delineated as Div. 5Y, Subdiv. 5Ze, and Subdiv. 5Zw plus SA 6 until such time that there is sufficient evidence to suggest otherwise, and it was recommended that research be conducted to resolve this issue. However, no new evidence relating to stock identification was presented to this meeting.

ii) Age determination. A new method of age determination developed by US scientists using thin sections of otoliths (Res.Doc. 75/13) resulted in age-length tables differing markedly from those presented by the USSR. Difficulties involved in accurate age determination from silver hake otoliths undoubtedly result in the disagreement between the US and USSR data. Since accurate ageing is essential for valid stock assessments and the estimation of TACs, it is recommended that US and USSR scientists resolve the ageing differences as soon as possible.

iii) Division 5Y stock. The nominal catch declined from 8,900 tons in 1973 to 5,200 tons in 1974. These catches were substantially below the 1955-66 annual average of 28,500 tons for this area. Both the US commercial catch/effort index and the US survey abundance index declined in 1974. Estimates were available for the first time of the amount of discarding of ages 0 and 1 fish in the US silver hake and shrimp otter trawl fisheries, which employ nets with codend meshes of 45-50 mm. These estimates indicated that discards were as high as 12,500 tons in 1972, about twice the level of the landed catches. The 1974 discards were estimated at about 7,200 tons. High discarding seems to coincide with the appearance of strong year-classes. The inclusion of discard estimates result in actual catches which greatly exceed the reported nominal catches in recent years.

US survey data indicated a strong 1971 year-class, above-average 1972 and 1973 year-classes, and a strong 1974 year-class. Based on expected strong recruitment from these year-classes but not including the discard of small fish, the TAC was increased from 10,000 tons in 1974 to 15,000 tons in 1975 in anticipation of the imminent recovery of the stock to former levels. Analyses indicated that the earlier stock decline had resulted from catches exceeding recruitment during the 1960's. The present assessment indicates that failure of the stock to recover, in spite of the production of recent strong year-classes, can be attributed to excessive levels of fishing mortality exerted on the incoming year-classes at ages 0 and 1 fish. The stock, therefore, does not contain sufficient numbers of fish older than age 2 at the present time to support increased catches. The Subcommittee therefore recommends that the 1976 TAC be reduced to 10,000 tons. Previous mesh selection experiments for silver hake (ICNAF Res. Bull. No. 3, p. 86) indicated that a minimum mesh size of 64 mm would largely avoid the catching of ages 0 and 1 fish.

iv) Subdivision 5Ze stock. The nominal catch increased from 62,200 tons in 1973 to an estimated 64,700 tons in 1974. Estimates of the amount of discards of ages 0 and 1 fish in the US fishery were 3,400 tons in 1971 (approximately equal to US landings) but decreased to 300 tons in 1974. The US commercial catch/effort index dropped 50% from 1973 to 1974, whereas the US autumn survey abundance index decreased 38% from 1973 to 1974 to its lowest point since 1967. The survey indicated a strong 1974 year-class, although a close correlation has not existed in the past between survey predictions and actual year-class strength. Nevertheless, it was assumed that the 1974 year-class was equal to the mean of the strong 1971-1973 year-classes.

Virtual population analysis indicated that  $F$  ranged from 0.93 to 0.95 in 1973-1974. A similar level of fishing mortality would be required in 1975 to take the full TAC of 80,000 tons. Anticipating that the USA will take only a portion of its allocation, the total catch in 1975 was assumed to be 75,000 tons with  $F$  at 0.86. Earlier mesh selection studies by Jensen and Hennemuth (ICNAF Res. Bull. No. 3, p. 86) indicate that the 40 mm mesh used in the USSR fishery for silver hake results in a mean selection age of 1.25 years for which  $F_{max} = 0.45$ .

Alternative consequences for stock size in 1977 were calculated, assuming a 1975 catch varying between 50,000 and 80,000 tons: (1) if  $F$  in 1976 is maintained at the expected 1975 level, then a catch of 80,000 tons could be achieved but the stock size would decrease; (2) if the stock size is to be maintained, then the 1976 catch should be 65,000 tons; and (3) if, however, the objective is to reduce fishing mortality to  $F_{max}$ , then the 1976 catch should be 50,000 tons which would result in an increase in stock size. The latter approach, although resulting in an immediate drop in catch, would achieve a marked gain in yield within several years while holding fishing mortality at the level of  $F_{max}$ .

The best advice would, therefore, appear to be to recommend a 1976 TAC of 50,000 tons. However, the USSR scientists felt that evidence was insufficient to justify reducing the TAC below the current level of 80,000 tons, since a critical 1974 year-class actually could be much more abundant than assumed in the estimates. Additional information concerning the strength of this year-class will be available in the autumn of 1975.

v) Subdivision 5Zw and Statistical Area 6 stock. The nominal catch decreased from 65,100 tons in 1973 to 61,400 tons in 1974. The TACs for 1973 to 1975 were set at 80,000 tons. The US commercial catch/effort index has declined since 1972 with the 1974 value being the lowest on record (1964-74). The US autumn survey abundance index dropped 73% from 1971 to 1974, the last value being the lowest observed during the period of the surveys. Survey data suggest that the 1973 year-class is not strong but that the 1974 year-class is stronger than average.

Fishing mortality (F) in 1974 was estimated to be 0.68. Since the USA is not expected to take its full share of the 1975 TAC, the virtual population analysis was carried out using a 1975 catch of 70,000 tons and this would require an F of 0.85. A 1976 catch of 43,000 tons would occur at  $F_{max} = 0.45$  and this would maintain stock size in 1977 as in 1976. The Subcommittee therefore recommends that the 1976 TAC be set at 43,000 tons.

f) Red Hake in Subarea 5 and Statistical Area 6

The recommended TACs for 1973 to 1975 were based on management areas separated by the 69°W longitude line as being the boundary between the Georges Bank and southern New England-Middle Atlantic stocks. The advice for 1976, however, assumes that the two stocks are divided by the 70°W longitude line (which is the boundary between Subdiv. 5Ze and 5Zw), as was agreed at the 1974 Annual Meeting.

i) Subdivision 5Ze stock. The catch from the Georges Bank area (east of 69°W) decreased from 21,500 tons in 1973 to about 14,400 tons in 1974. The 1974 and 1975 TACs were set at 20,000 tons for Div. 5Z (E69°). US autumn survey data showed a 50% decline in relative stock abundance from 1973 to 1974; however, the 1974 level was equivalent to the 1964-1974 mean abundance. The survey does suggest that the 1973 and 1974 year-classes may be strong. Assuming strong recruitment from these year-classes to the 1975 and 1976 fisheries, a USSR assessment indicated that optimum fishing mortality ( $F = 0.7$ ) would produce a 1976 catch of 26,000 tons. This procedure (Res.Doc. 74/64) utilized virtual population analysis to determine present year-class size and survey results to predict future year-class sizes, assuming  $M = 0.6$  and  $F = 0.2$  at age 2 and  $M = 0.4$  and  $F = 0.7$  at ages 3 and older. The method, however, does not consider the effect of the 1975 catch on the stock. Since there was no other advice available, the Subcommittee recommends a 1976 TAC of 26,000 tons for Subdiv. 5Ze.

ii) Subdivision 5Zw and Statistical Area 6 stock. The catch from the area west of 69°W decreased from about 44,700 tons in 1973 to about 34,500 tons in 1974. These catches are slightly different from those given in Table 7 owing to the boundary adjustment between the two stocks. The 1973, 1974 and 1975 TACs were set at 40,000, 50,000 and 45,000 tons respectively for the management area Div. 5Z(W69°)+SA 6. US survey data indicate a very large decrease (90%) in relative stock abundance from 1972 to 1974, the value for 1974 being the lowest recorded during the period of the US surveys. Survey catches of age 0 fish in this area have not been useful in predicting the subsequent strength of year-classes recruiting to the fishery. Therefore, no reliable estimate of recruitment was available.

A USSR assessment (following the same procedure as was used for predicting the TAC in Subdiv. 5Ze) indicated a 1976 catch of 16,000 tons. The low level of stock abundance in 1974, as shown by the survey data, suggests that, if the 1975 TAC of 45,000 tons is taken, the stock size at the beginning of 1976 will be quite low. Since the USSR prediction procedure did not take into account the 1975 catch, the estimate of 16,000 tons for 1976 may in fact be optimistic. However, USSR scientists suggested that a catch of 20,000 tons should be considered to take into account an anticipated catch of older age-groups (greater than age 6) not included in the prediction analysis. The Subcommittee finally decided to recommend a 1976 TAC of 16,000 tons for the management area Subdiv. 5Zw + SA 6, with the provision that a review of this value be considered at the 1975 Annual Meeting should new data or analyses become available.

g) Pollock in Subarea 5

A review of the pollock stock in Div. 4VWX and SA 5 is given under "Pollock" in the preceding Section VI.

h) Yellowtail in Subarea 5 East of 69°W Longitude

Stock abundance, estimated from catch-per-tow data of *Albatross IV* autumn cruises and from catch per unit effort of US commercial fisheries, seemed to have stabilized under TAC regulation during 1971 to 1973. In 1974, however, both sets of abundance indices showed a decline in stock size (Res.Doc. 75/65) with the latter one indicating a decrease of 15%. The Subcommittee considered that this was not sufficient evidence to recommend a reduction in the TAC, as a new assessment of the stock was not available, and recommends that the 1976 TAC be maintained at 16,000 tons, noting that the by-catch of yellowtail, particularly immatures, should be held to the lowest possible level.

1) Yellowtail in Subarea 5 West of 69°W Longitude and in Subarea 6.

Three groups of yellowtail are located in the management area west of 69°W longitude. The Cape Cod stock and the southern New England stock have been under a collective TAC regulation since 1971, and the group found in SA 6 was also included in the TAC established for 1975.

(i) Cape Cod stock. The catch increased from 1,700 tons in 1973 to 2,200 tons in 1974 (30% increase), while there was no increase in the US commercial catch per unit effort. Historic levels of catch taken in conjunction with the indication of a stable stock suggest that removals in 1976 should remain at 2,000 tons.

(ii) Southern New England stock. Although TAC regulations have greatly decreased removals since 1970, the US commercial catch per unit effort continued to decrease during the period. Catch per tow indices from US autumn cruises by *Albatross IV* for the southern New England cruise strata indicate a drastic decrease (90% since 1969) in abundance of pre-recruit (age 1) fish, with the catch per tow in 1974 being the lowest value observed during the entire series of years for which data are available. Assuming that the 1975 pre-recruit index is equal to that for 1974, the index of stock size will have decreased by about 80% from 1970 to 1975 (Table 9). Surplus production in 1976 is estimated to be at best only 1,000 tons.

Table 9. Catch per tow (age 1+) of pre-recruits and associated stock abundance indices for southern New England and SA 6 yellowtail from *Albatross IV* 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	0.69	21.6
1974	1.1	20.1	0.04	7.5
1975		11.9		2.8
1976		9.0		0.8

(iii) Statistical Area 6 stock. Stock abundance indices (Table 9) show a 90% decrease in stock size from 1970 to 1975. If the 1974 year-class is assumed to be the same size as that of 1973, the stock size in 1976 is estimated to remain extremely low, about 70% less than the 1975 level, and the surplus production is estimated to be zero in 1976.

(iv) Combined yellowtail stocks in Subarea 5 (west of 69°W) and Statistical Area 6. In the absence of information delineating the relationships between the yellowtail stock components in this area, a single management regime should be maintained. Recognizing the depressed condition of the stocks in this area, the Subcommittee recommends that removals in 1976 should be held to the lowest possible level with the knowledge that unavoidable catches may approach 4,000 tons under a zero TAC regulation.

j) Flounders except Yellowtail in Subarea 5 and Statistical Area 6 (Res.Doc. 75/69, 70).

Preliminary statistics for 1974 indicate a nominal catch of 21,000 tons of 'other flounders' in SA 5 and 6. Catches of these species have declined almost continuously since 1969, when 30,443 tons were taken. Bottom trawl survey data also indicate a steady decline in biomass over the same period. When taken together, the survey indices for the group show a decline of about 36% since 1963, while indices for individual species show declines up to 90%. Also, examination of length frequency data for sand flounder, winter flounder, summer flounder, with and American plaice taken in autumn bottom trawl surveys since 1963 reveals consistent declines in modal length.

A new assessment was presented for summer flounder in SA 5 and 6, which suggest that a sustainable catch level of 20,000-22,000 tons might be possible for this component of the flounder group. However, this species is a very popular one in the US sport fishery, and,

estimates of these catches are combined with the reported commercial catch, the total harvest of 27,000 tons is considerably above the estimate of sustainable yield.

The TAC for this group of species was originally established in 1973 at 25,000 tons, based on historical catches, research survey trends and general biology. Considering the declining trends observed in the survey estimates (Res.Doc. 75/65) and in commercial landings, and the implications of additional fishing mortality contributed by the US sport fishery on these species, The Subcommittee recommends a TAC of 20,000 tons for 1976, stressing that every effort should be made to reduce by-catch of these species in other directed fisheries in the area.

k) Argentine in Subarea 5.

For a review of Argentine in Div. 4VWX and SA 5, see under Argentine in the preceding Section VI.

l) Herring in Division 5Y (Gulf of Maine Stock) (see also Summ.Doc. 75/19)

The catch of adult herring in the Div. 5Y fishery increased in 1974 to about 17,800 tons from 16,900 tons in 1973, with the 1970 year-class contributing 60% (10,600 tons) to the total catch. The catch in the juvenile fishery increased from 16,400 tons in 1973 to 19,100 tons in 1974, with 50% of the total being age 3 and older herring.

In predicting the catch for 1976, the following assumptions were made:

- (1) The 1975 catch of 15,000 tons (TAC 16,000 tons less 1,000 tons not to be taken by Federal Republic of Germany and German Democratic Republic; see Proc. 5th. Spec. Mtg., Nov. 1974, Summ. Doc. 75/1) will be taken.
- (2) The size of the 1970 year-class is twice the size of the 1966 year-class at age 3.
- (3) The size of the 1971 year-class is equal to the size of the poorest observed in the fishery (1969 year-class at age 3 of 60 million fish).
- (4) Based on *Albatross IV* surveys in Div. 5Y and catches of this year-class in 1973 and 1974, the 1972 year-class is equal to the size of the 1969 year-class at age 3 (64 million fish).
- (5) The 1973 year-class is probably small but the available data are conflicting and consequently this year-class is equated to the size of the 1969 year-class at age 3 (64 million fish) and alternately to the conventional year-class size of 150 million fish (*Redbook* 1974, page 110).

Projected stock sizes in 1977 are given in Table 10 and illustrated in Fig. 1. Constraints provided by the Commission (Proc. 24th. Ann. Mtg., June 1974, page 240) state that the 1976 catch in Div. 5Y must be such as to maintain the adult (age 4 and older) stock size at a minimum of 60,000 tons and that the 1976 TAC must not exceed the 1975 TAC unless the adult stock size has reached a level that will provide the maximum sustainable yield by the end of 1976. Assessment results indicate that the adult stock size will not reach the level required to provide the maximum sustainable yield in 1976, and the 1976 TAC cannot therefore exceed that set for 1975. To maintain an adult stock size of 60,000 tons in 1976, a catch of 9,000-21,000 tons could be taken in 1976 (Table 10), depending on the size of the 1973 year-class. Maintaining the adult stock at 60,000 tons in 1977, however, allows a further decline in stock size from the 63,000 tons in 1976.

Table 10. Resultant stock size (age 4 and older) in 1977 as a function of 1976 catch (age 3 and older) for the Div. 5Y adult herring fishery, assuming that the 1970 year-class at age 3 is twice the size of the 1966 year-class, the 1972 year-class is equal to the 1971 and 1969 year-classes at age 3 (63.5 million fish), for two options on the size of the 1973 year-class at age 3 and for a range of fishing mortality in 1976.

Stock size at start of 1975 (10 <sup>6</sup> ) (000 t)	Total catch in 1975 (000 tons)	Stock size at start of 1976 (10 <sup>6</sup> ) (000 t)	Recruitment of 1975 y.c. (10 <sup>6</sup> fish)	F in 1976 (100%)	Predicted 1976 catch (000 tons)	Stock size at start of 1977 (000 tons)
350	76	15	276.3	63.6	63.5	59.8
						52.0
						45.3
						39.7
						72.1
						63.9
						60.0
						56.8
						50.8
						50.8

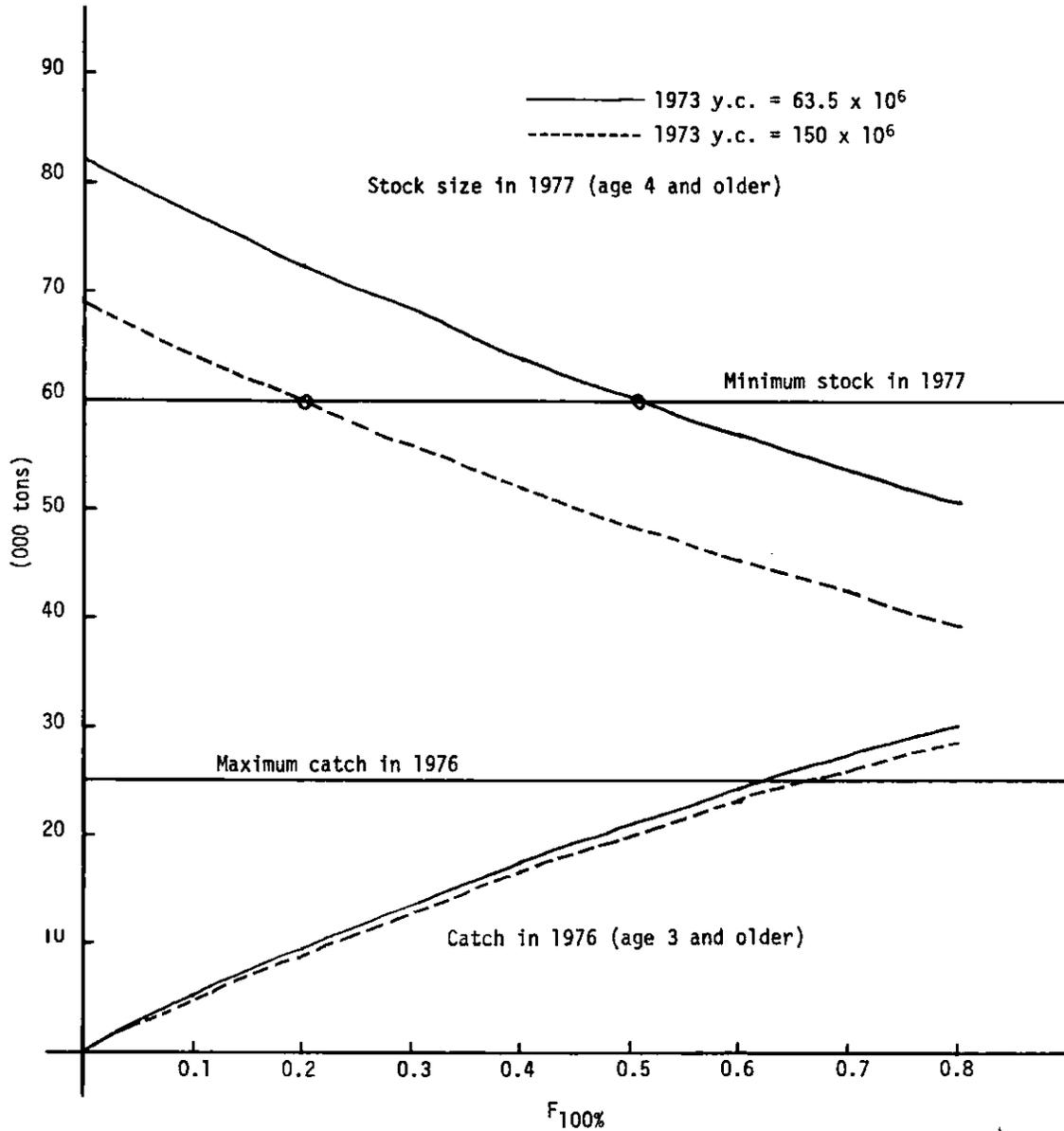


Fig. 1. Stock size of herring in the Div. 5Y adult fishery (age 4 and older).

It can be noted from Table 10 that a TAC of 21,000 tons in 1976 would just maintain the minimum stock size of 60,000 tons with no allowance for over-estimation of the size of the 1973 year-class. However, a TAC of 9,000 tons in 1976 would maintain the stock size at 60,000 tons in 1977, if the 1973 year-class recruits at the lower level, and this would allow some rebuilding of the stock if that year-class recruits at the higher level.

In view of the present state of the stock, the Subcommittee therefore recommends that the 1976 TAC should be set as close as possible to the 9,000 ton level. Only by setting the TAC at the lower level can any increase in stock size be anticipated by 1977.

m) Herring in Division 5Z and Statistical Area 6 (Georges Bank Stock) (see also Summ. Doc. 75/19)

The preliminary statistics for 1974 indicate a nominal catch of 149,000 tons (TAC = 150,000 tons), the lowest since 1966. Nominal catches in 1972 and 1973 were 174,000 and 202,000 tons respectively, when the TAC of 150,000 tons was also in effect. The 1970 year-class accounted for 82% of the 1974 catch in both numbers and weight. The US bottom trawl surveys indicate a rapid decline in stock abundance, but such is not the case for catch per unit effort data of two countries with major fisheries for herring.

The predicted catch for 1976 and stock sizes in 1976 and 1977 are based on the following assumptions:

- (1) The 1975 TAC of 150,000 tons will be fully taken.
- (2) The size of the 1970 year-class at age 3 is twice the size of the 1966 year-class as estimated in the previous assessment (*Redbook* 1974, page 44).
- (3) The sizes of the 1971 and 1972 year-classes at age 3 are equal to the poorest year-class observed in the fishery, i.e. 1969 (*Redbook* 1974, page 44).
- (4) The size of the 1973 year-class is equal to 800 million fish at age 3 or approximately one-half of the 1966 year-class and 25% below the 1964-69 average. The size of this year-class was chosen at a conventional level, as the information on its abundance is very limited. Since this level of recruitment (800 million fish) may be somewhat optimistic, an alternative assessment was done based on the assumption that the 1973 year-class at age 3 is equal to the size of the two preceding year-classes (i.e. 550 million fish), in order to demonstrate the effect on the 1977 stock size of over-estimating the size of the 1973 year-class.

The results of the assessments are given in Table 11 and illustrated in Fig. 2. The two constraints provided by the Commission (Proc. 4th. Spec. Mtg., Jan 1974, App. II) specify that an adult stock of at least 225,000 tons be maintained to the beginning of 1977 and that the 1976 TAC can only be increased if the adult stock size at the end of 1975 will reach the level of 500,000 tons which will provide the maximum sustainable yield. This level of stock size cannot be reached by the end of 1975 and the TAC for 1976 cannot therefore be advised to exceed 150,000 tons. Under the two assumptions as to recruitment of the 1973 year-class, a catch of 150,000 tons in 1976 would leave an adult stock size of 137,000 tons or 176,000 tons at the beginning of 1977 (Table 11). These levels of stock size are well below the minimum level of 225,000 tons agreed by the Commission. In order to prevent a decline in stock size below this minimum level by the end of 1976, the TAC should not exceed 100,000 tons if the higher level of recruitment of the 1973 year-class is assumed. For the lower level of recruitment of the 1973 year-class, the TAC for 1976 should be about 60,000 tons.

Table 11. Resultant stock size (age 4 and older) in 1977 as a function of 1976 catch (age 3 and older) for the Georges Bank (Div. 5Z and SA 6) herring stock, for two assumed levels of the 1973 year-class at age 3 and for a range of fishing mortality in 1976.

Stock size at start of 1975 (10 <sup>6</sup> ) (000 t)	Total catch in 1975 (000 tons)	Stock size at start of 1976 (10 <sup>6</sup> ) (000 t)	Recruitment of 1975 y.c. (10 <sup>6</sup> fish)	F in 1976 (100%)	Predicted 1976 catch (000 tons)	Stock size at start of 1977 (000 tons)		
1337	298	150	948	217	550	0.20	34	254
						0.38	60	225
						0.60	87	200
						0.70	96	188
						1.00	125	161
						1.26	142	142
						1.35	150	137
				800	0.20	35	293	
					0.38	61	265	
					0.60	89	236	
					0.70	100	225	
					1.00	129	196	
					1.26	150	176	
					1.35	156	170	

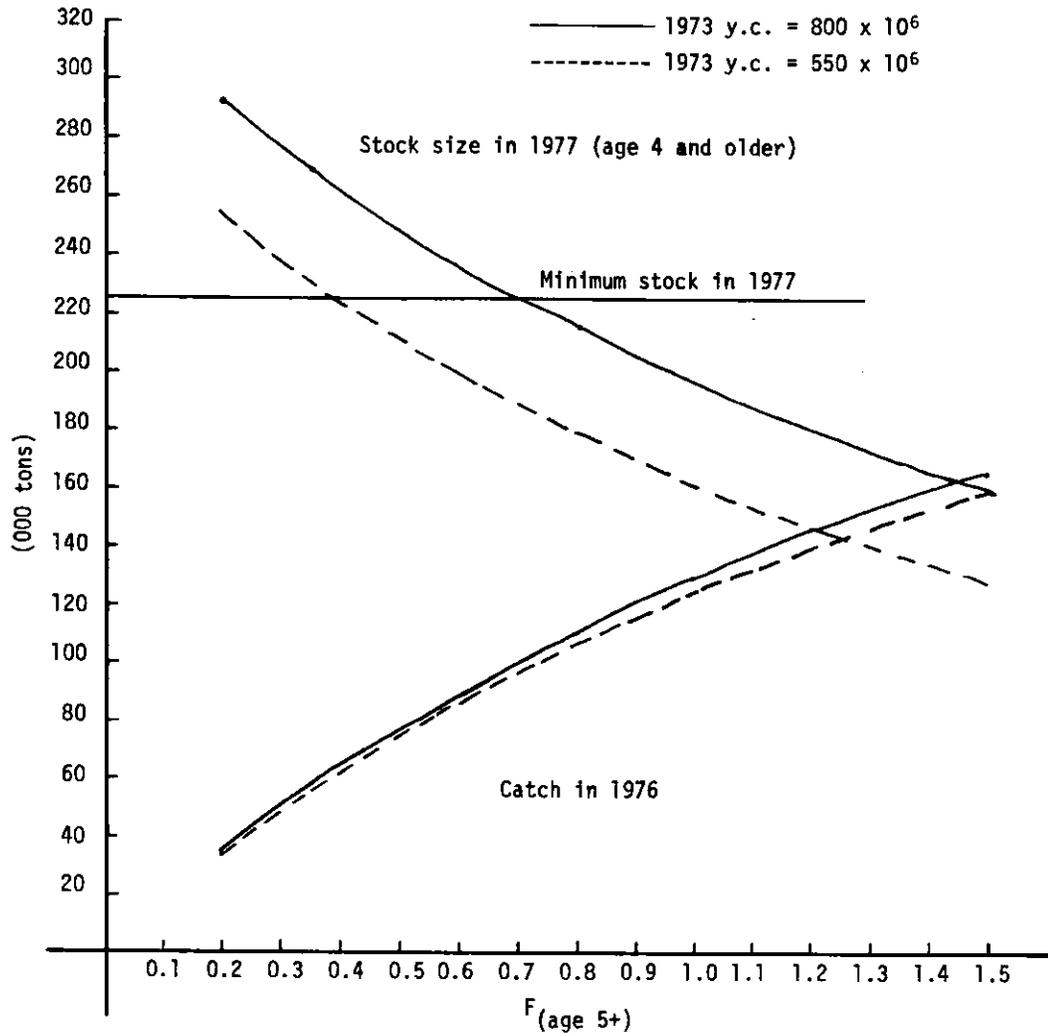


Fig. 2. Predicted stock size in Div. 5Z and SA 6 for 1977 in relation to catch in 1976 for two assumed levels of recruitment.

A TAC of 100,000 tons in 1976 implies a fishing mortality of 0.7 on fully recruited year-classes in that year. This level of  $F$  is equal to that of 1974 but below the level to be expected for 1975 if the 1975 TAC is fully taken ( $F = 0.8$ ). A TAC of 60,000 tons in 1976, based on the assumption as to the lower level of recruitment of the 1973 year-class, implies a fishing mortality of 0.38, which is slightly higher than the level of  $F_{0.1}$  from yield-per-recruit considerations. A TAC of 100,000 tons would merely maintain the size of the resulting stock at the current low level without any safeguard for over-estimation of the 1973 year-class. A TAC of 60,000 tons would also maintain the stock at the low level of 225,000 tons if recruitment of the 1973 year-class is at the lower of the two assumed levels, but it would reduce the probability that the stock size at the end of 1976 will be further decreased due to over-estimation of the 1973 year-class size. If the size of the 1973 year-class is larger than anticipated, then the stock size in 1977 will increase to about 250,000-300,000 tons, which would still be well below the estimated MSY level of 500,000 tons.

In view of the present state of the stock, the Subcommittee recommends that the 1976 TAC be set as close as possible to 60,000 tons. Only by imposing such a TAC level for 1976 can any increase in stock size be anticipated in accord with the management objective of the Commission to increase the stock size. If evidence should become available indicating a high level of abundance for the 1973 year-class, a TAC of 100,000 tons would maintain the stock size at 225,000 tons in accordance with the Commission's constraint as to the minimum stock size.

n) Preliminary Consideration of Effect of Juvenile Fisheries on Herring Yields in Subareas 4, 5 and 6.

Although the stock relationship between herring exploited in juvenile fisheries and those in adult fisheries is not clear, the Subcommittee was concerned about the potential of excessive mortality being placed on the herring resources from both the juvenile and adult fisheries. This has not yet been fully evaluated for all of the Canadian fisheries, but the very preliminary assessment given below illustrates the importance of the juvenile fisheries to the overall conservation of the herring resources.

Herring catches in both of the juvenile fisheries in the Gulf of Maine (along the Maine coast and the New Brunswick side of the Bay of Fundy) were combined with the catches from the Div. 5Y adult fisheries and from the Div. 5Z and SA 6 fisheries over the period of 1956 to 1973. Fishing mortality rates were then calculated from cohort analysis. The average fishing mortalities for the entire period (1956-73) were estimated as 0.09, 0.72 and 0.41 for age-groups 1 to 3 respectively, and for the period 1961 to 1973 they were 0.09, 0.47 and 0.28 for the same age-groups.

The fishing mortality on age 2 herring declined substantially during the 1960s from that indicated for the late 1950s but still accounted for an average annual catch of 45,000 tons during the 1960s. If caught at age 5, these fish would have produced an average annual catch of 176,000 tons. This is equivalent to 94% of the catches (by weight) that were taken from the Georges Bank stock over the 1961-73 period (i.e. almost a doubling of the catch).

More important than increasing the catch over that period, however, is the long-term effect of the juvenile fisheries on the size of the stock. Starting with the stock in 1961, three sets of fishing mortalities were applied for each year up to 1972. One set describes the present average situation, the second set utilizes an F of 0.25 for ages 2 and 3 fish, and the third set implies no fishing mortality on juveniles. From the Set 1 analysis, the stock declines to 216,000 tons by 1972 and gives a catch of 113,000 tons for that year. With F reduced on age 2 and 3 herring (Set 2), the stock size is estimated at 506,000 tons for 1972 with a catch of 223,000 tons in that year. With no juvenile fishing mortality (Set 3), a stock size of 938,000 tons is indicated for 1972 giving a catch of 372,000 tons in that year (Fig. 3). Over the period from 1961 to 1972, the average annual catch would have been:

- Set 1: 199,000 tons for the current situation.
- Set 2: 289,000 tons for  $F = 0.25$  on ages 2 and 3 fish.
- Set 3: 375,000 tons for no juvenile fishery.

o) Mackerel in Subareas 3, 4 and 5 and Statistical Area 6 (Res.Doc. 75/14, 15, 32, 33, 40)

i) Catches in 1974. Nominal catches in SA 3 and 4 increased from 38,000 tons in 1973 to 44,000 tons in 1974, whereas in SA 5 and 6 they declined from 381,000 tons in 1973 to 304,000 tons in 1974. The TACs for 1974 were 55,000 tons for Div. 4VWX and 304,000 tons for SA 5+6. TACs for 1975 were set at 70,000 tons for SA 3 and 4 and 285,000 tons for SA 5 and 6.

ii) Stock identity. Additional tagging data relating to the recaptures of tagged mackerel in SA 5 and 6 from releases in SA 3 and 4 confirmed the migration of at least a portion of the northern contingent of mackerel to over-wintering areas off the New England coast. However, the nature and magnitude of the tagging results do not allow estimates of the relative contribution of the northern and southern mackerel components to the fisheries in SA 3 to 6. Extensive tagging studies coupled with biological investigations, such as that initiated by Polish scientists on bi-modality of the first-year otolith annuli, will be necessary before first estimates of relative recruitment of the two components become available. It was generally agreed, however, that a combined assessment was the more appropriate stock evaluation approach.

iii) Abundance indices for 1974 and 1975. Results of research vessel surveys in 1974 and early 1975 were too variable to permit definitive evaluation of the abundance trends since 1973. However, surveys in both years indicate that the 1973 year-class and to a limited extent the 1974 year-class are dominant in the age compositions; whether this is due to strong recruitment or to a sharp decline in the abundance of older age-groups is not clear. Commercial length frequencies for the first quarter of 1975 (Res.Doc. 75/40) indicate that the major portion of the catches is now being derived from ages 1 and 2 fish. Catch per unit effort of the US mackerel fleet declined significantly in 1974 (70%). The catch/effort data for the German Dem.Rep. fleet decreased by 25% in 1974, while the overall catch/effort data for the Polish fleet remained at the 1973 level.

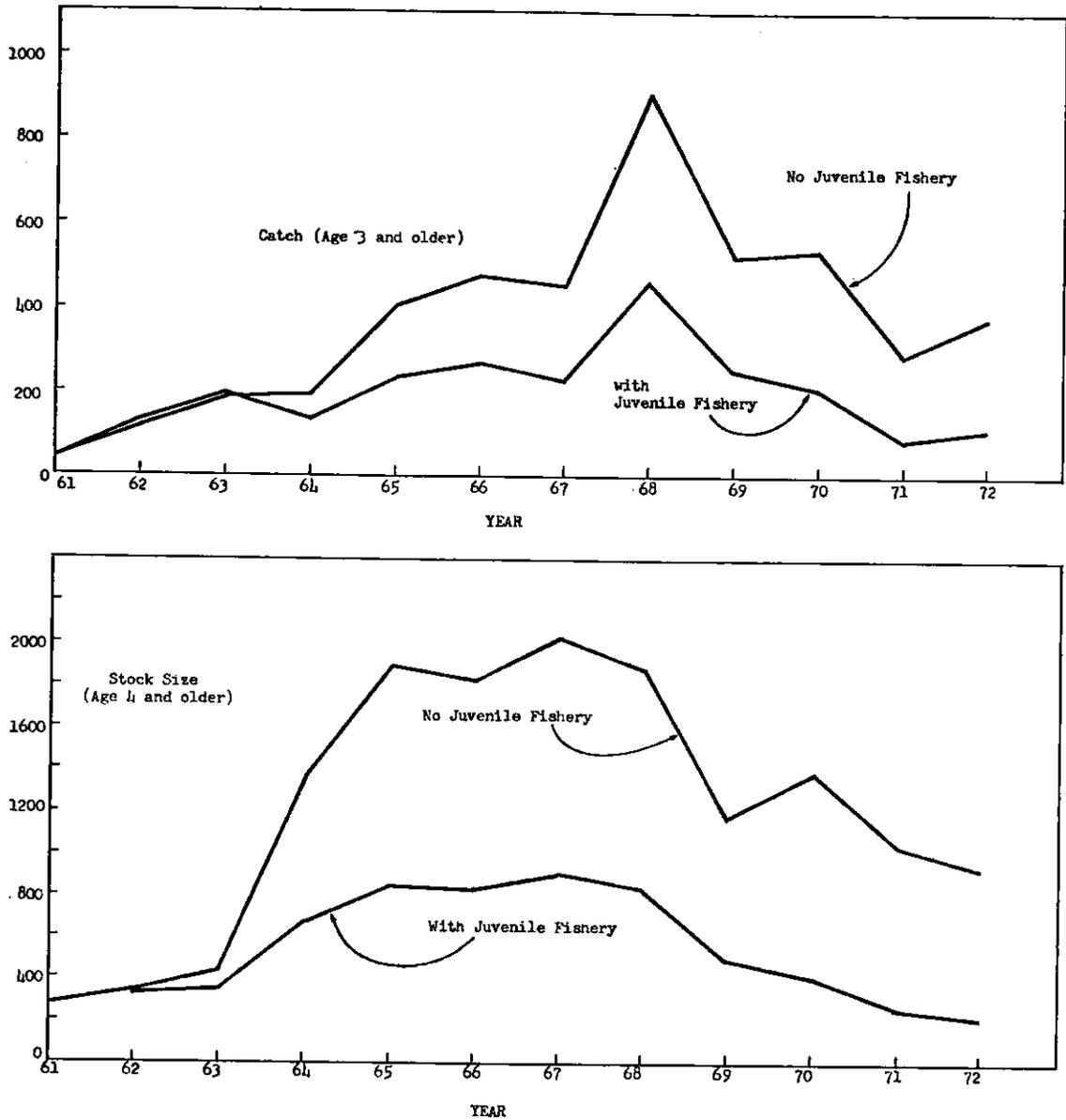


Fig. 3. Catch and stock size for herring in Div. 4Wb, Subarea 5 and Statistical Area 6 with and without a juvenile fishery.

iv) Evaluation of 1974 assessment parameters. The following parameters were agreed for use in the assessment of overall stock size and projected catch in SA 3 to 6:

- (1) It was agreed that, where possible, the actual age composition data should be used in converting catches to numbers by age-group. This was also done for SA 3+4 catches instead of prorating SA 5+6 catches by number as had been done in the preliminary assessments (Res.Doc. 75/14, 40).
- (2) Both the Polish preliminary assessment (Res.Doc. 75/40) and the US assessment (Res. Doc. 75/14) indicated that the fishing mortality rate for fully recruited ages was in the range of 0.6-0.7. A regression of  $F$  (for age 4+) on fishing effort for the period 1968-72, with the assumption that there was a 25% decline in catch per unit effort in 1974, indicated a value of  $F$  (for age 4+) at 0.6 in 1974. This value was agreed as a reasonable one for 1974 and was used in the assessment.

- (3) For age-groups 2 and 3 a regression of partial recruitment rate on age 4+ stock size was used to estimate partial recruitment rates for 1974-76 as follows:

Age-group	Partial recruitment (%)		
	1974	1975	1976
0		0	0
1		18	18
2	42	50	57
3	82	90	96
4	100	100	100

- (4) The 1973 and 1974 year-classes are both predicted to be strong from stock-recruit curves in relation to environmental parameters. It was agreed that the 1973 year-class was relatively strong, perhaps of the order of 50% of the 1967 year-class at age 1. The 1974 and 1975 year-classes were assumed to be equal to the average strength of the 1967-72 year-classes. If these 1974 and 1975 year-classes are under-estimated, no loss in yield will result, because they will reach their maximum potential in 1977 and 1978 respectively.
- (5) There was insufficient evidence to justify a change in M from the value agreed for previous assessments ( $M = 0.3$ ).
- v) Results of assessment. The analysis of the available data, using the parameters as agreed above, indicates the following (Table 12):
- (1) The 1975 TAC of 355,000 tons, if taken, will generate an F of 0.7.
  - (2) An F of about 0.6 in 1976 will provide a catch of 310,000 tons in SA 3 to 6. This fishing mortality will allow 99% of the maximum yield per recruit to be achieved and will also maintain the stock biomass (age 2 and older) in 1977 at the level which provided maximum recruitment in the past 10 years, adjusting for environmental variations.
  - (3) The stock, as predicted for 1976 (Table 12), will be comprised mainly of very young fish (age 2 and younger), and thus there is the possibility of substantially increased fishing mortality on those age-groups, resulting in the loss in yield-per-recruit.

On the basis of the above analysis, the Subcommittee strongly recommends that the 1976 TAC be set at 310,000 tons, accompanied by a size limit of 25 cm total length. Such a minimum size limit would effectively exclude the capture of 1-year-old mackerel. The recommended TAC pertains to SA 3 to 6 as a whole and should be partitioned to ensure a practicable distribution of the fishery.

vi) Future research requirements. Tagging projects in SA 5 and 6 are essential for further clarification of the migration patterns of mackerel and for estimates of the relative contributions of the two major components in the SA 3 to 6 fisheries. Such tagging studies will require substantial inputs of research effort and time, if difficulties associated with weather conditions and mackerel distribution during the winter period are to be overcome.

Divergent opinions as to the level of natural mortality indicates the need for further investigation of M.

The variability in time, space and density of mackerel schools requires that resource inventory surveys be well planned and stratified to reflect spatial heterogeneity in size and density. A first approach to such an expanded survey program might be a detailed examination of past surveys to elucidate the distribution pattern of mackerel in SA 5 and 6 during the winter period.

Table 12. 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
Catch (10 <sup>6</sup> )	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	0.2	
	1963	14.3	6.8	14.1	11.1	13.5	4.9	0.8	0.4	
	1964	15.3	7.8	15.2	14.1	8.6	7.4	2.0	0.9	
	1965	57.4	26.1	43.6	48.6	37.2	15.3	8.2	3.7	
	1966	99.0	99.9	190.2	234.7	114.2	41.6	26.0	11.8	
	1967	94.5	189.9	408.9	566.2	432.7	217.1	116.1	52.8	
	1968	2.2	139.5	34.7	110.7	226.5	182.9	116.0	52.7	
	1969		3.2	143.0	288.7	287.7	261.3	117.3	53.3	
	1970			3.2	101.2	76.3	237.1	103.3	47.0	
	1971				1.1	41.8	356.3	267.7	158.7	
	1972					11.0	95.3	258.1	317.6	
	1973						0.3	101.9	680.5	
	1974							5.1	256.5	
Total (10 <sup>6</sup> )		301.6	496.8	906.8	1395.9	1262.9	1421.3	1123.0	1636.1	
Weight (000 t)		80.8	131.8	230.6	373.0	409.7	419.3	336.2	355.1	
Fishing mortality (F)	1959	0.037	0.600							
	1960	0.116	0.308	0.632	0.554	1.636	0.600			
	1961	0.024	0.082	1.213	1.785	0.317	0.290	0.600		
	1962	0.078	0.078	0.468	0.452	1.293	0.772	0.600	0.700	
	1963	0.099	0.069	0.222	0.306	0.864	1.106	0.600	0.700	
	1964	0.091	0.068	0.204	0.332	0.392	0.802	0.600	0.700	
	1965	0.102	0.069	0.174	0.335	0.526	0.486	0.600	0.700	
	1966	0.049	0.071	0.210	0.490	0.536	0.430	0.600	0.700	
	1967	0.015	0.042	0.131	0.302	0.451	0.487	0.600	0.700	
	1968	0.001	0.053	0.019	0.084	0.277	0.425	0.600	0.700	
	1969		0.001	0.058	0.177	0.301	0.557	0.600	0.700	
	1970			0.002	0.089	0.100	0.570	0.600	0.700	
	1971				<0.001	0.024	0.325	0.490	0.700	
	1972					0.005	0.059	0.250	0.630	
	1973						<0.001	(0.036)	0.350	
	1974								0.126	
Weighted $\bar{F}$ (age 4+)		0.087	0.087	0.238	0.346	0.408	0.494	0.600	0.700	
Stock size (10 <sup>6</sup> fish)	1959	3.2	2.3							
	1960	87.3	57.6	31.4	12.3	5.3	0.8			
	1961	62.6	45.3	30.9	6.8	0.8	0.5	0.3	0.1	
	1962	141.5	97.0	66.5	30.8	14.5	3.0	1.0	0.4	
	1963	175.8	118.0	81.6	48.4	26.4	8.3	2.0	0.8	
	1964	202.5	136.9	94.8	57.2	30.4	15.2	5.1	2.1	
	1965	680.6	455.1	314.8	196.0	103.9	45.5	20.7	8.4	
	1966	2373.1	1673.4	1154.3	692.9	314.5	136.4	65.7	26.7	
	1967	7398.1	5397.8	3837.0	2493.2	1365.1	644.4	293.5	119.3	
	1968	4175.8	3097.1	2175.1	1582.2	1077.4	605.3	293.2	119.2	
	1969		3942.1	2934.6	2051.6	1273.4	698.5	296.5	120.5	
	1970			1863.0	1370.0	929.1	623.1	261.1	106.2	
	1971				2709.6	2039.9	1475.8	790.2	358.6	
	1972					2609.8	1921.9	1342.2	774.4	
	1973							(3700.0)	(2644.1)	
	1974								(1380.3)	
1975								(2500.0)		
Total (10 <sup>6</sup> ) <sup>1</sup>		11124	111081	10721	8542	7180	6179	7071	6781	
Wt (000 t) <sup>1,2</sup>		1330.6	1715.8	1969.2	1871.8	1590.9	1293.0	1153.3	1084.6	
									971.0	

<sup>1</sup> Total number and weight are for age 1+ fish.

<sup>2</sup> Determined using previously-accepted mean weight at age data and adjusted by the procedure described in Redbook 1974, p. 34.

p) Other Finfish (including Argentine) in Subarea 5 and Statistical Area 6 (Res.Doc. 75/65, 70, 74).

The "other finfish" group consists of an aggregation of finfish species for which individual assessments are lacking or are at best available only in preliminary form. A TAC of 125,000 tons was established for this group (argentine excluded) for 1974, based on historical catch data and information from bottom trawl surveys. The 1975 TAC for the group (including argentine) was set at 150,000 tons. Preliminary data for 1974 indicate a total nominal catch of 167,000 tons (including 23,000 tons of argentine). This total is somewhat above the 1964-73 average of 159,000 tons.

Commercial catches of "other finfish" have remained relatively stable in recent years. However, bottom trawl survey data indicate that stocks are declining and that a reduction in TAC may be necessary in the immediate future, although the information available is not judged sufficient to warrant a reduction at the present time. The Subcommittee therefore recommends that the 1976 TAC for "other finfish" (including argentine) remain at 150,000 tons, noting that a reduction may soon be necessary if the declining trend in fishable biomass continues.

q) Squid-Illex in Subareas 2 to 5 and Statistical Area 6 (Res.Doc. 75/27, 58, 60, 61, 64)

Considerable discussion of available research data indicated that, while stock relationships have not been fully elucidated, there appears to be a single stock complex, ranging from SA 2 to 6. There is a northward migrant component which occurs in SA 2 and 4 on a seasonal basis only, probably over-wintering in SA 5 and 6. The species occurs in SA 5 and 6 throughout the year, suggesting that a component of the stock remains resident there.

Preliminary estimates of stock size were made from the results of USSR R/V *Argus* trawl surveys in June 1972, using a systematic coverage of the area from the Scotian Shelf to Southern New England (100,000 tons minimum stock size) and from Polish commercial data (90,000 tons). Analyses of yield-per-recruit and stock/recruitment considerations indicated that removals could be about 50% of the stock biomass. However, there is considerable uncertainty in the estimates of nominal catches in recent years and 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 uncertainty as to the catch statistics of recent years, the Subcommittee considered that pre-emptive quotas should be instituted to regulate the orderly development of the fishery, and that TACs should be set for SA 2-4 and SA 5-6 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 SA 5 and 6 and about 10,000 tons in SA 2 to 4. The Subcommittee therefore recommends that pre-emptive 1976 TACs be set at 15,000 tons for SA 2-4 and 30,000 tons for SA 5-6.

r) Squid-Loligo in Subarea 5 and Statistical Area 6 (Res.Doc. 75/44, 60, 61, 64).

The information available for assessment of squid-*Loligo* include: (1) 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; (2) US research survey indices which also indicate no discernible change in abundance in the same period; (3) a virtual population analysis which indicated a stock size of about 88,000 tons at the start (October) of the 1972/73 fishing season; (4) US research survey catch data which indicate a minimum biomass estimate (70,000 tons) in reasonable agreement to the estimate from the virtual population analysis; and (5) yield-per-recruit and stock-recruitment considerations which indicate that removals of 50% of the stock biomass would seem reasonable.

Although there is an urgent need for more accurate estimates of removals of this species and for considerable refinement in the determination of the parameters used in the virtual population analysis and in the yield-per-recruit/stock-recruitment model, these preliminary studies suggest a TAC of 44,000 tons for 1976. This figure compares with an estimated 1974 nominal catch of 34,000 tons. The catch was also close to 30,000 tons in 1973, but lower at about 20,000 tons in 1971 and 1972. Since there appears to be no significant change in stock abundance in recent years, the Subcommittee recommends a 1976 TAC of 44,000 tons, which, if realized in 1976, would represent a 30% increase above the 1974 nominal catch.

a) Second Tier Overall TAC in Subarea 5 and Statistical Area 6 (Res.Doc. 75/18, 65, 68, 70).

At its Special Meeting in Ottawa, Canada, 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 SA 5 and 6 to recover to a level which will produce the maximum sustainable yield.

The Subcommittee reviewed the time series of trends in stock biomass indicated by commercial fishery statistics and by US autumn groundfish surveys, the latter being the surveys which provide the best data series. The catch per unit effort statistics of offshore trawler fleets show no marked decline in recent years, but these are not adjusted for improvements in fishing technique, variation in species sought, or learning in the development of new fisheries which took place during the 1960's. Research vessel surveys provide a series of more comparable results, and these show a progressive decline in total stock abundance. This would be expected in any fishery as the level of exploitation increases, but it is crucial to decide whether or not this has progressed beyond the level of biomass capable of sustaining the MSY. In the context of the Commission agreement, it is also important to decide whether or not the decline in stock abundance has been arrested by regulations implemented by ICNAF in the more recent years.

Previous analyses of this fishery (*Redbook* 1973, Part I) and more recent reviews indicate that the level of exploitation, and hence the decline in stock biomass, did exceed the level associated with the MSY in the early 1970's. Although there will always be some uncertainty concerning the precision of estimates from research surveys for the most recent years, the indications are that biomass continued to decline in 1974 as might be expected since the broad regime of TACs was not implemented until that year. Data are not yet available for the most recent years, and there is no way to judge whether the regulatory regime has yet had an impact on the state of the stocks. The preliminary statistics for 1974 indicate that the 2nd tier TAC was exceeded by about 75,000 tons. In considering the 2nd-tier TAC for 1976, the Subcommittee had to assume that the decline in stock abundance continued into 1975. This assumption is justified on the basis of reductions in some of the individual TACs recommended for 1976.

The sum of the recommended TACs for 1976 is about 825,000 tons, 76% of the sum of the TACs in 1974. These reductions in part reflect improved analytical assessments but may reflect a 19% reduction in biomass from 1974 to 1975. Generalized production model interpretations of this mixed fishery indicate an MSY in the region of 1,000,000 tons, but, since this is an overall assessment of all species, the sum of individual species TACs at MSY stock levels would be rather higher. With this in mind, the Subcommittee concluded that, during the period when exploitation exceeded the MSY level, the stock biomass was reduced by at least 20 to 25% below the stock level that would support a catch of 1,000,000 tons at a level of fishing corresponding to the overall MSY. Reduction of fishing activity to the  $F_{MSY}$  on individual stocks is now estimated to yield a summed TAC of 825,000 tons. It follows, therefore, that, if the Commission wishes to follow a policy which will allow the stock to recover to the level associated with the overall MSY and give the corresponding catch, the fishing mortality must be reduced below the level estimated to give 825,000 tons.

The appropriate degree of reduction in fishing mortality below the MSY level is related to the period over which recovery is expected to take place. Other (environmental) things being equal, the larger the reduction below the summed TAC level, the more rapid the recovery will be, although there is likely to be a biological lag of at least 3 years.

The Subcommittee reconsidered evidence of biological interactions between species that could expedite or delay recovery, but it is not yet able to offer any firm advice on this point.

The Subcommittee then reviewed the effect of by-catch in mixed fisheries on the degree of compatibility between individual species quotas. Analyses have shown some significant trends in by-catch ratios of individual national species fisheries, but overall there are no significant trends with time in the by-catch matrix of all countries during the 1970-73 period. Data for any one year would provide an equally satisfactory estimate of by-catch ratios in a future year for fisheries conducted in the same manner as in those years. It is pointed out, however, that regulations recently implemented in SA 5 and 6 should reduce the by-catch ratios for 1974 and subsequent years. Indeed, this is one objective of the fishery regulations.

Application of linear programming techniques to optimize catches within the TAC allocations and by-catch characteristics of each national fishery indicates an overall TAC at about 66% of the summed TACs. If applied to the sum of the TACs recommended for 1976 (825,000 tons), a 2nd tier TAC of about 550,000 tons is implied, but, having in mind the influence of recent regulations, the difficulty of identifying true incidental catches in the reported statistics, and efforts by countries to minimize by-catch, the Subcommittee considered 650,000 tons to be a realistic minimum level for the 2nd tier TAC in 1976, to correct for the by-catch problem.

The Subcommittee noted that the by-catch problem cannot be attributed equally to all species and that STACREM has considered methods of allocation which could recognize the degree of by-catch in different fisheries. Since no absolutely pure directed fishery exists, the Subcommittee concluded that it would be impossible to estimate the degrees of benefit that would be achieved by excluding one or another species from the 2nd tier TAC.

Having considered the points raised, and having in mind that as yet it is not possible to see whether or not the stock biomass as a whole has become stabilized, the Subcommittee concluded (i) that the 2nd tier TAC should be reduced below 825,000 tons, and (ii) that the reduction need not exceed 200,000 tons (i.e. a 2nd tier TAC of 650,000 tons) to ensure a reduction in fishing mortality and a start towards recovery of the stock biomass.

The Subcommittee then took an estimate of the biomass of the stock at the long-term MSY level of 4,000,000 tons, and, judging this to have been depleted by 1,000,000 tons (25%) by over-exploitation in 1970-72 (i.e. about 300,000 tons per year for 3-4 years), estimated the period of recovery to the MSY level, assuming (i) that the 2nd tier TAC is maintained, and (ii) that there would be a 3-year lag in biological response. The recovery times are estimated as follows:

2nd tier TAC (000 tons)	Gear to recovery including 1976
800	13
750	11
700	9
650	7

The smaller the reduction, the longer will be the time required to recover the 1,000,000 ton deficiency and the lower will be the probability of achieving a significant improvement. The situation is a direct consequence of over-exploitation in 1969-72.

#### VIII. THE OVERALL LEVEL OF FISHING IN SUBAREAS 2, 3 AND 4

A Canadian proposal (Comm.Doc. 75/8) requested STACRES to estimate the long-term effect of specified reductions in fishing mortality on the catch and stock size of groundfish resources in Subareas 2, 3 and 4. The Commission is asked to consider reductions in fishing mortality in the range of 20 to 50% below the 1973 level of fishing, while maintaining the Canadian fishery at its 1975 level (of catch), and it is further proposed that the reduction be implemented by control of the amount of fishing by each vessel category and division.

Res.Doc. 75/43 and 75/55 reviewed trends in the various fisheries over the last decade, documenting the statistical evidence from the commercial fisheries of variations in the abundance of the stocks as the level of catch and fishing has changed. As always, the true relationships are obscure, owing to inadequacies in statistical reporting, particularly in the earlier years, by the choice of effort unit used to estimate the changes and by undetected trends in efficiency of the effort unit. The scale of the changes also varied between areas and there have been fluctuations during the period. For example, in terms of catch, the fisheries as a whole were more productive in the late 1960s, owing to relatively good recruitment, and the fishery in Div. 4VWX (excluding silver hake) peaked slightly earlier (1965-66) and maintained a more consistent trend than the fisheries in SA 2 and 3. The decrease in catch and stock abundance at a maintained level of fishing since the productive period (1968-70) may accentuate the changes, but, from a broad view of the fisheries in the three subareas, the catch in 1973 was rather similar (in quantity) to that of the early 1960s. Production models of the total groundfish resource, in fact, indicate that the sum of the species TACs was close to the overall MSY level. However, bearing in mind the changes in efficiency, it is estimated that fishing effort has doubled and the stock abundance declined by one-half in the period 1961-73 (Fig. 4).

Again, taking a broad view, if the level of exploitation was approaching the level associated with the MSY in the early 1960, it certainly passed beyond that level later in the decade. These general relationships suggest that a significant reduction in fishing effort will not reduce the total catch in the long term, but a specific reduction in one year would inevitably cause an immediate loss. The status of particular stocks and the effect upon them of different degrees of reduction (as specified in Comm.Doc. 75/8) are summarized as far as possible in Table 12. For some minor stocks, it is impossible to state categorically that they have been fished beyond the MSY level, and for these there is no definitive evidence that a reduction is necessary for conservation reasons. On the other hand, if after an interim period the same catch can be taken with reduced fishing, catch rates will improve and the increase that this implies must be biologically beneficial and reduce the risk to the stock. The Subcommittee is not competent to judge the economic impact of such a change.

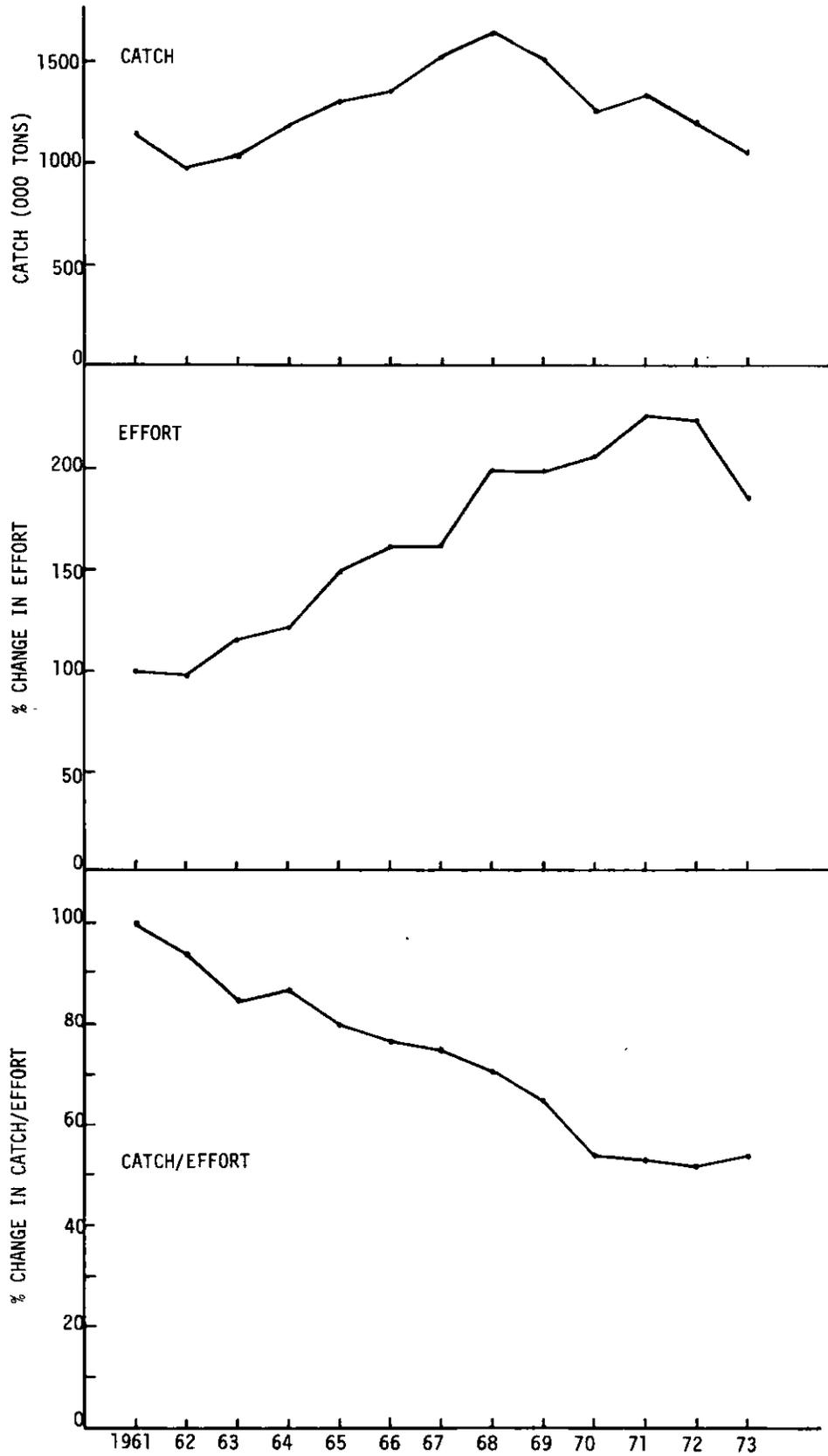


Fig. 4. Changes in catch, effort and catch/effort in SA 2 and 3 and Div. 4V, 4W and 4X, 1961-73.

Table 12. Required reduction in fishing mortality from 1976 TAC level to achieve specified reductions below 1973 level of fishing mortality.

Species	Stock area	Reference levels				% reduction from F76 to achieve			
		FMSY	F0.1	F76	F73	F73-20%	F73-30%	F73-40%	F73-50%
Cod	2J+3KL	0.35	0.20	0.35	0.27	38	46	54	61
	3Ps	0.30	0.15	0.30	0.30	20	30	40	50
	4T+4Vn <sup>1</sup>	0.30	0.20	0.50	0.45	28	36	46	54
	4VsW	0.45	0.30	0.45	0.65	0	0	13	27
	4X(offshore)	0.35	0.25	0.45	0.80	0	0	0	11
American plaice	3LNO	-	0.5 ♂ 0.45♀	0.5 ♂ 0.45♀	0.5 ♂ 0.45♀	20	30	40	50

<sup>1</sup> Div. 4T(Jan-Dec)+Subdiv. 4Vn(Jan-Apr).

Table 13A. Longer term changes in catch and stock size resulting from specified reductions in fishing mortality compared with the catch and stock size at the level of F used as the basis for TAC recommendations (years to equilibrium in parentheses).

Species	Stock area	TAC 1976	Catch at MSY			
		(000 tons)	(000 tons)			
Cod	2J+3KL	300.0	550.0			
	3Ps	60.0	60.0			
	4T+4Vn <sup>1</sup>	45.0	50.0			
	4VsW	40.0	60.0			
	4X(offshore)	4.0	15.0			
American plaice	3LNO	47.0	60.0			
Total		496.0	795.0 <sup>2</sup>			

Species	Stock area	% change in catch (Yr)			
		F73-20%	F73-30%	F73-40%	F73-50%
Cod	2J+3KL	-5(8)	-9(8)	-14(9)	-19(9)
	3Ps	-5(6)	-8(7)	-13(8)	-20(8)
	4T+4Vn <sup>1</sup>	-3(6)	-2(8)	0(9)	0(10)
	4VsW	-2(8)	0(8)	0(9)	0(10)
	4X(offshore)	-7(5)	-5(6)	-2(7)	-1(8)
American plaice	3LNO	-6(6)	-11(6)	-16(7)	-22(7)

Species	Stock area	Stock relative to MSY (=100)			
		F73-20%	F73-30%	F73-40%	F73-50%
Cod	2J+3KL	136(8)	150(8)	166(9)	178(9)
	3Ps	115(6)	124(7)	133(8)	145(8)
	4T+4Vn <sup>1</sup>	78(6)	85(8)	94(9)	106(10)
	4VsW	85(8)	91(8)	100(9)	111(10)
	4X(offshore)	70(5)	77(6)	84(7)	96(8)
American plaice	3LNO	109(6)	115(6)	120(7)	126(7)

<sup>1</sup> Div. 4T(Jan-Dec) + Subdiv. 4Vn(Jan-Apr).

<sup>2</sup> This is approximately equivalent to 60% of the MSY of the total stocks considered in Tables 13A and 13B.

Table 13B. 1973 stock status and expected changes in catch and stock (for species lacking analytical assessments) with specified reductions in fishing mortality.

Stock status 1973	Species	Stock	TAC 1976 (000 tons)	Changes in stock and catch at	
				F73-20% to F73-30%	F73-40% to F73-50%
Exploited at slightly less than MSY level	A. plaice	2+3K	0.8	Significant decrease in catch and greatly increased stock size	Under-exploitation of stock
	Witch	2J+3KL	17.0		
		3NO	10.0		
	Pollock	4VWX	(55.0) <sup>1</sup>		
	Argentine	4VWX	25.0		
Exploited around MSY level	Cod	3M	40.0	Some decrease in catch compared with MSY level with increase in stock size	Decrease in catch and significant increase in stock size
		4Vn <sup>2</sup>	10.0		
	A. plaice	3Ps	8.0		
	G. halibut	2+3KL	30.0		
	Redfish	30	16.0		
	R. grenadier	2+3	32.0		
Flatfishes	4VWX	28.0			
Exploited beyond MSY level	Cod	2GH	20.0	Improvement in stock and catch possibility to MSY level	Improvement in stock and catch probably to MSY level
		3NO	85.0		
	Redfish	2+3K	30.0		
		3LN	20.0		
		3P	20.0		
	Haddock	4VWX	30.0		
4X		(15.0) <sup>2</sup>			
Overexploited	Yellowtail	3LNO	(10.0) <sup>3</sup>	Increase in stock and catch	Greater increase in stock and catch towards MSY level
	Redfish	3M	16.0		
	Haddock	4VW	0.0		

<sup>1</sup> TAC for Div. 4VWX+SA 5.

<sup>2</sup> Recommended TAC; estimated catch is 15.0 tons.

<sup>3</sup> Recommended maximum TAC.

The widespread reduction in TACs recommended for 1976 in this Report support the need for a cautious approach, and the Subcommittee is aware that the lag in providing information (e.g. 1976 TACs set on the basis of 1974 data reflecting changes in the fishery from 1973) may prevent a sufficiently rapid (adequate) response to secure the management objective.

Table 12 considers the reduction in fishing mortality; it assumes that the Canadian catch in 1976 may remain at the 1975 level and gives the proportionate reduction in fishing by countries other than Canada which would then be necessary to achieve the specified levels. Table 13 provides a basis for interpreting this percentage in terms of the reduction in TAC allocations for 1976. This has necessarily assumed the 1976 TACs would be allocated on the 1975 pattern, but nevertheless, provides a baseline. Assuming that this 1975 pattern applied in 1976, but maintaining the catch by Canada, national allocation for particular degrees of reduction can be obtained by applying the percentage reduction for "Other Countries" in Table 14 to the allocations in Table 15.

Table 16 summarizes the statistics of fishing effort in the reference year 1973. These are given as days fished by country and vessel category, the "days fished" being the unit most widely reported and, following earlier discussions in STACREM, the unit that might be most effective in implementing control of fishing effort.

Table 14. 1976 catches (000 tons) corresponding to reductions in fishing mortality from 1976 level (TACs) to achieve fishing mortality equal to 1973 - 20%, -30%, -40%, and -50%, but maintaining Canadian share as in 1975. (Illustration only.)

Species	Stock area	F76			F73 - 20%			F73 - 30%			F73 - 40%			F73 - 50%		
		Total catch	Canadian catch	Others Catch	% Reduction Total	Total catch	Canadian catch	Others catch	% Reduction Total	Total catch	Canadian catch	Others catch	% Reduction Total	Total catch	Canadian catch	Others catch
Cod	2J+3KL	300	88	212	38	186	88	98	54	46	162	88	74	65		
	3Ps	60	35.9	24.1	20	48	35.9	12.1	50	30	42	35.9	6.1	75		
	4T+4Vn <sup>1</sup>	45	37.7	7.3	28	32.4	37.7	0	100	36	28.8	37.7	0	100		
	4Vw	40	24.3	15.7	0	40	24.3	15.7	0	0	40	24.3	15.7	0		
	4X (offshore)	4	3.2	0.8	0	4	3.2	0.8	0	0	4	3.2	0.8	0		
American plaice	3LNO	47	47	0	20	37.6	47	0	-	30	32.9	47	0	-		
Species	Stock area	% Reduction Total	F73 - 40%			F73 - 50%			F73 - 30%			F73 - 20%				
		Total catch	Total catch	Canadian catch	Others catch	% Reduction Total	Total catch	Canadian catch	Others catch	% Reduction Total	Total catch	Canadian catch	Others catch	% Reduction Total		
		54	138	88	50	76	61	117	88	29	86	117	88	29		
		40	36	35.9	0.1	100	50	30	35.9	0	100	30	35.9	0		
		46	24.3	37.7	0	100	54	20.7	37.7	0	100	20.7	37.7	0		
13	34.8	24.3	10.5	33	27	29.2	24.3	4.9	69	29.2	24.3	4.9				
0	4	3.2	0.8	0	11	3.6	3.2	0.4	50	3.6	3.2	0.4				
American plaice	3LNO	40	28.2	47	0	-	50	23.5	47	0	-	50	23.5	47		

<sup>1</sup> 4T(Jan-Dec)+4Vn(Jan-Apr).

NOTE: For some stocks and changes in fishing mortality the specified reductions cannot be achieved without some adjustment from the Canadian allocation in 1975.

Table 15. National allocations (000 tons) of 1976 TACs (from Table 1) distributed according to the 1975 allocations but maintaining the Canadian share. (Illustration only.)

SPECIES	STOCK AREA	CAN	OTHER COUNTRIES														1976				
			BUL	DEN	FRA	FRG	GDR	ICE	ITA	JAP	NOR	POL	POR	ROM	SPA	USSR	UK	USA	OTHERS	TAC	
Cod	2CH	1.0	-	-	0.5	4.0	1.0	-	-	-	-	0.9	4.5	3.2	0.4	0.5	2.6	0.8	-	6.0	20.0
	2J+3KL	88.0	-	4.0	18.1	18.0	11.3	-	-	-	-	5.8	16.9	47.9	-	36.3	40.8	6.3	-	6.5	300.0
	3M	3.0	-	7.2	7.0	0.5	-	-	-	-	-	1.4	0.8	10.4	-	2.2	5.2	2.2	-	0.1	40.0
	3NO	12.7	-	0.8	0.8	-	-	-	-	-	-	2.0	-	5.3	-	38.2	21.0	1.3	-	2.9	85.0
	3Ps	35.9	-	-	4.4	-	-	-	-	-	-	1.4	-	-	-	14.1	1.6	-	-	4.0	60.0
	4T+4Vn <sup>1</sup>	37.7	-	0.8	3.9	-	-	-	-	-	-	-	-	0.4	-	2.0	-	-	-	0.2	45.0
	4Vn <sup>2</sup>	7.8	-	-	0.4	-	-	-	-	-	-	-	-	0.4	-	0.9	-	-	-	0.5	10.0
4VnW	24.25	-	0.5	0.6	-	-	-	-	-	-	-	-	0.2	-	12.6	1.3	-	-	0.55	40.0	
4X(offshore)	3.2	-	-	-	-	-	-	-	-	-	-	-	-	-	0.49	0.9	-	0.13	0.09	4.0	
Haddock	4VW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0
	4X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(15.0) <sup>3</sup>
Redfish	2+3K	3.5	-	-	-	-	2.5	-	-	-	-	-	4.0	2.5	-	12.0	-	0.75	4.75	30.0	
	3M	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	12.6	-	-	2.4	16.0	
	3LN	1.3	-	-	-	-	1.0	-	-	-	-	-	-	1.0	-	13.8	-	-	2.9	20.0	
	3O	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	14.3	-	-	1.2	16.0	
	3P	12.5	-	-	1.2	-	-	-	-	-	-	-	-	-	-	5.3	-	-	1.0	20.0	
	4VWX	14.8	-	-	0.74	-	-	-	-	-	-	-	0.97	-	-	4.9	-	7.43	1.1	30.0	
Silver hake	4VWX	4.0	-	-	-	-	-	-	-	-	-	-	-	-	89.0	-	-	7.0	100.0		
Pollock	4VWX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(55.0) <sup>4</sup>	
A. plaice	2+3K	3.5	-	-	-	-	-	-	-	-	-	-	-	-	-	4.2	-	-	0.3	8.0	
	3M	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0	-	-	0.5	2.0	
	3LNO	47.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47.0	
	3Ps	8.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.0	
Witch	2J+3KL	6.6	-	-	-	0.4	-	-	-	-	-	-	4.6	-	-	4.9	-	-	0.5	17.0	
	3MO	5.0	-	-	-	-	-	-	-	-	-	-	-	-	-	4.9	-	-	0.1	10.0	
	3Ps	2.5	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	3.0	
Yellowtail	3LNO	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10.0) <sup>5</sup>	
Flounders <sup>6</sup>	4VWX	20.0	-	-	0.2	-	-	-	-	-	-	-	-	-	-	7.0	-	0.3	0.5	28.0	
R. grenadier	2+3	-	-	-	-	4.0	-	-	-	-	-	-	-	-	-	24.0	-	-	4.0	32.0	
G. halibut	2+3KL	14.0	-	-	-	1.8	-	-	-	-	-	-	5.2	-	-	5.5	-	-	3.5	30.0	
Argentine	4VWX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.5	-	-	2.5	25.0	

1 Div. 4T(Jan-Dec)+4Vn(Jan-Apr).  
 2 Subdiv. 4Vn(May-Dec).  
 3 Recommended TAC; expected catch is 15.0.  
 4 TAC pertains to 4VWX+5.

5 Maximum; other alternatives are suggested.  
 6 American plaice, witch and yellowtail.

Table 16. Subareas 2 and 3 and Divisions 4V, 4W and 4X combined: number of days fished<sup>1</sup> by country and vessel tonnage class in 1973.

Country	Vessel tonnage categories						Total
	0-49.9	50-149.9	150-499.9	500-999.9	1000-1999.9	2000+	
Bulgaria	-	-	-	-	-	3	3
Canada	?	5,114	8,235	9,600	-	-	22,949+
Denmark <sup>2</sup>	-	-	17	64	-	-	81
France	?	-	425	-	977	-	1,402+
FR Germany	-	-	-	-	256	1,166	1,422
German DR	-	-	-	4	805	306	1,115
Iceland	-	-	-	-	-	-	-
Italy	-	-	-	-	-	-	-
Japan	-	-	-	-	25	250	275
Norway <sup>2</sup>	-	-	571	133	73	-	777
Poland	-	-	-	-	72	2,567	2,639
Portugal	-	-	-	682	4,791	1,722	7,195
Romania	-	-	-	-	-	198	198
Spain	-	-	7,436	2,741	810	-	10,987
USSR	-	-	-	269	-	22,341	22,610
UK	-	-	-	24	1,012	-	1,036
USA	-	-	632	-	-	-	632
Total	?	5,114	17,316	13,517	8,821	28,553	73,321+

<sup>1</sup> Effort pertains to catches in which groundfish were caught.

<sup>2</sup> No effort available for 775 tons of groundfish caught by Norway in SA 2, and 4,514 tons by Denmark in Div. 4VWX.

#### IX. OTHER MATTERS

##### 1. Stock and Recruitment (Res.Doc. 75/10, 32, 33)

The uncertainty surrounding the relationship between spawning stock size and subsequent recruitment is one of the major constraints on management advice at the present time, owing to its implication for estimates of MSY catch levels when these are measured in terms of "yield-per-recruit". The Subcommittee discussed a new model of these relationships based on a multivariate synthesis of environmental and biological interactions in the egg, larval and juvenile stages of cod, mackerel, and herring in the Gulf of St. Lawrence. The model provided a satisfactory description of the data on which it was based, indicating a marked density dependent relationship between the biomass of the spawning stock and the number of eggs produced in all three species modulated by environmental effects as measured by temperature. The relationship between the number of eggs and subsequent numbers of larvae showed little density dependence for cod and herring, however, density dependence through competition and predation was extremely important in determining the final numbers of mackerel larvae. The model also implies an interaction between the total biomass of mackerel and herring and the abundance of herring larvae in producing herring year-class strengths. The hypothesis was that this density dependence was predominant at juvenile stage when pelagic biomass was low. At higher pelagic biomasses, predation of adult mackerel on herring larvae was considered an additional component.

The Subcommittee agreed the model is a numerically satisfactory description of the existing information but considered that uncertainties in the data base should be resolved and the time series extended before decisive conclusions can be drawn. Because of the enormous importance of the relationships involved, the Subcommittee expressed the hope that further work would be undertaken to develop the model as soon as possible. This significance is illustrated by one implication of the results presented, that the margin in fishery mortality between a maintained MSY and rapid collapse of a fishery may be very narrow indeed, especially in view of the sensitivity of the system to environmental parameters. As a consequence, it calls for a re-evaluation of larval surveys as an estimator of recruitment, it emphasizes the need for improved experimental design and data analyses, and it reinforces the general need for caution in regard to the permitted level of exploitation. The simulation also suggests potential benefit in management based on stock constraints (e.g. herring in SA 5) rather than mortality constraints, particularly because this might provide control of species interactions at the biological level.

It is clearly necessary for all countries to explore these possibilities with the utmost virour!

2. Estimation of Parameters

a) New Techniques (Res.Doc. 75/35, 42, 51)

The Subcommittee reviewed briefly descriptions of 3 new developments in technique to improve the speed and precision in estimating parameters used in current assessment models.

b) Level of Sampling in Various Stocks (Summ.Doc. 75/11)

The Subcommittee considered the status of sampling the various stocks and noted the summary of sampling efficiency for the major fisheries in the ICNAF Area in 1973. For many stocks, the level of sampling for country-gear-quarter categories was below the minimum level recommended by STACRES, and for some stocks no sampling data were reported. It was emphasized that the accuracy of the advice provided to the Commission is very heavily dependent on the adequacy of the data base upon which the assessments are based. The Subcommittee urges scientists of the various countries to make every effort to improve the sampling efficiency in future years.

c) Reporting of Length and Age Data by Sex for Certain Species

The Subcommittee noted that some samples for the various flatfish species and for roundnose grenadier were not being reported by sex. It was emphasized that the use of unsexed length measurements and age samples for such species makes their assessment much less precise. Growth rates, mortality rates, age at maturity, etc., are so different for males and females that to combine them for assessment purposes is as meaningless as combining such data for different species. The Subcommittee, therefore, urges scientists in the various countries to provide, if at all possible, length and age data by sex for these species.

d) Recommendation for Ageing Workshop on Subareas 2 and 3 Cod.

Differences in age determination of cod between Canada and Spain in Div. 3NO, as shown by otolith exchanges in 1974, prevented a detailed updating, incorporating 1974 data, being completed for this stock. Also, anomalies in actual landed weight and calculated weight and difference in average lengths at age between countries, which could have been caused by age reading differences, were noted for cod in Div. 2J+3KL. The Subcommittee concluded that these differences were serious enough to warrant a cod ageing workshop in 1975.

The structure and duration of the workshop was discussed and it was decided that at least one week would be required to consider the age reading of cod in Div. 2J+3KL and 3NO in order to resolve the differences that exist. It was felt that limiting the workshop to these two stocks would provide a level of participation that would be small enough to achieve the objective. The Subcommittee therefore recommends (i) that an ageing workshop on Div. 2J+3KL and Div. 3NO cod be conducted in 1975, (ii) that countries fishing those stocks provide otolith samples and participate in the workshop, and (iii) that the participants should include the persons who actually do the age reading.

Although the workshop will focus on cod in Div. 2J+3KL and Div. 3NO, this does not preclude consideration of other cod stocks in SA 2 and 3 where age reading difficulties are suspected. The St. John's (Nfld) Laboratory offered to host the Workshop if the number of participants is not too large for its facilities.

3. Resolution Relating to the Enforcement of the Commission's Fishery Regulations: Implementation of an International Observer Program (Spec.Mtg. of STACTIC, Leningrad, USSR)

The use of an international observer program for the collection of additional scientific information could be of immense value if, and only if, the presence of international observers does not alter the pattern of fishing of the vessels concerned. Such changes, however, are almost inevitable if the data are ever used for enforcement purposes.

The information collected could help to ensure (i) that the assessments incorporate the total catches of each species, (ii) that all of the catches are sampled, (iii) improved estimation of the abundance of young fish, and (iv) better appraisal of the "mixed fishery" problem.

The Subcommittee also considers that the scheme, if given a scientific role, would have to be carried out by officers with the appropriate training to collect adequate sampling data. It was felt that the Subcommittee on Statistics and Sampling should consider this matter and specify the data requirements.





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ICNAF Summ. Doc. 75/18  
ADDENDUM 1

ANNUAL MEETING - JUNE 1975

Addendum to the Report of the Assessments Subcommittee

The Subcommittee met on 3 June during the STACRES Meeting to review trends in the fisheries in 1974 and to discuss points arising from assessments carried out in April.

1. Fishery Trends

A. General

The total nominal catch of all finfish and shellfish declined from 4.5 to 4.0 million tons. Reduced catches of silver hake in SA 4 and of herring and mackerel in SA 5 account for 70% of this deficit and follow the implementation of TAC regulations. The remainder was caused mainly by a decline in catches of redfish in SA 4 but flounder landings also showed a reduction which, though small in relation to the overall total, nevertheless reflects a decline in productivity of these resources. Nominal catches of other species remained close to but generally slightly below 1973 levels and have in many cases been influenced by Commission regulations in 1974. The most significant changes of individual species within each subarea are outlined below.

B. Statistical Area 0

Total nominal catch in 1974 was about 3,500 tons or slightly more than in 1973. However, whereas in 1973 two-thirds of the catch consisted of Greenland halibut, the major part (about 2,700 tons) of the catch in 1974 was made up of roundnose grenadier.

C. Subarea 1

The total nominal catch of all species increased by about 5,000 tons to 111,000 tons in 1974 and has thus been rather constant in the last three



years. However, for individual species great fluctuations have occurred over these years.

Catches of cod showed a further decrease from 111,000 tons in 1972 and 63,000 tons in 1973 to only 48,000 tons in 1974. This decrease has, however, been counterbalanced by increased catches of some other groundfish (Greenland halibut, roundnose grenadier, wolffish and Greenland cod) and of shrimps.

Landings of shrimps rose from 12,000 tons in 1973 to above 18,000 tons in 1974 as a result of increased activity.

D. Subarea 2

Provisional figures indicate that cod in Subarea 2 increased from 58,000 tons in 1973 to 125,500 tons in 1974, possibly because of slightly improved ice conditions. A large proportion of the catch came from Div. 2J with no catch reported in Div. 2G.

The redfish catch declined from 11,500 tons in 1973 to about 6,400 tons in 1974; flatfish catches, however, increased slightly from about 17,500 to 20,800 tons in 1974 and were again made up largely of Greenland halibut. Catches of other groundfish, principally roundnose grenadiers, increased from 8,400 tons in 1973 to approximately 10,800 tons in 1974. Capelin catches increased from 59,800 to 85,300 tons for 1973 and 1974, respectively, and this largely accounted for the increase in the catch of other fish to 96,000 tons in 1974, compared to 62,000 tons in 1973.

E. Subarea 3

Provisional statistics for 1974 indicate that the total groundfish catch was about 10% below the 1973 level (681,000 tons compared with 753,000 tons in 1973). The cod catch decreased from 462,000 tons in 1973 to 409,000 tons in 1974, the decline being mainly accounted for by decreases in Div. 3KL (247,000 tons in 1974 compared with nearly 300,000 tons in 1973). The redfish catch increased slightly from 111,000 tons in 1973 to just over



114,000 tons in 1974; the most marked changes were in Div. 3M where the catch increased from 22,000 tons in 1973 to 35,000 tons in 1974 and Div. 3LN where the catch declined from 34,000 tons in 1973 to 22,000 tons in 1974. Yellowtail catches in Div. 3LNO declined sharply from 33,000 tons in 1973 to 24,000 tons in 1974; American plaice catches also declined in 1974, particularly in Div. 3LNO (47,000 tons in 1974 compared with 53,000 tons in 1973) and Subdiv. 3Ps (7,000 tons in 1974 compared with 15,000 tons in 1973).

The herring catch increased slightly from 17,000 tons in 1973 to 20,000 tons in 1974.

The total catch of other fish, mainly capelin, increased from 217,000 tons in 1973 to 227,000 tons in 1974. There was a significant change in the pattern of capelin fishing in 1974; in 1973 nearly all the catch south of Div. 3K was taken on the southern part of Grand Bank (Div. 3NO) but in 1974 a substantial fishery developed on the northern part of Grand Bank (Div. 3L) where 60,000 tons were taken compared with just 4,000 tons in 1973.

F. Subarea 4

Preliminary statistics indicate that total catch from Subarea 4 declined in 1974 to 874,000 tons from 1,139,000 tons in 1973.

Silver hake showed the most substantial decline (299,000 to 96,000 tons), the 1974 catch being limited by quota. Redfish catches also declined substantially (170,000 to 96,000 tons), the largest decline occurring in the Gulf of St. Lawrence (130,000 to 63,000 tons). Significant decreases (i.e. >5,000 tons) also occurred in catches of cod (188,000 to 176,000 tons), witch (16,000 to 11,000 tons), and squid (9,300 to 400 tons).

These decreases were partially compensated by increases in catches of American plaice (20,000 to 28,000 tons), sea robins (zero to 9,000 tons), mackerel (36,000 to 43,000 tons), alewife (9,000 to 18,000 tons), and argentines (1,000 to 17,000 tons).



G. Subarea 5 and Statistical Area 6

The total nominal catch of all species (including shellfish) decreased from 2,051,000 tons in 1973 to 1,803,000 tons in 1974. For finfish and squids, the corresponding 1973 and 1974 catches were 1,491,000 tons and 1,196,000 tons, respectively. The catches of menhaden in 1973 and 1974 were 331,000 and 249,000 tons, respectively. The 1974 catch of finfish and squid, except for menhaden, large pelagics and billfishes, was 940,000 tons and 1,154,000 tons in 1973. The catch of groundfish decreased from 369,000 tons in 1973 to 307,000 tons in 1974; the catches of pelagic fish decreased from 975,000 tons to 748,000 tons; the catches of other fish decreased from 91,000 tons to 81,000 tons; and the catch of invertebrates increased from 617,000 tons in 1973 to 667,000 tons in 1974.

Species which showed decreases in catch from 1973 to 1974 were mackerel (381,000 tons in 1973 to 295,000 tons in 1974), herring (235,000 tons to 185,000 tons), redfish (17,000 tons to 11,000 tons), red hake (67,000 tons to 34,000 tons), yellowtail flounder (31,000 tons to 25,000 tons), angler (7,000 tons to 1,000 tons), sculpins (9,000 tons to 3,000 tons), butterfish (19,000 tons to 13,000 tons), alewives (17,000 tons to 13,000 tons) and menhaden (331,000 tons to 250,000 tons).

Few species showed increases in catch, notably argentine (2,500 tons to 20,000 tons), dogfish (14,000 tons to 18,000 tons) and sea scallops (55,000 tons to 73,000 tons). The silver hake catches showed a slight decline (132,000 tons in 1973 to 130,000 tons in 1974) but squid catches levelled off at 56,000 tons (57,000 tons in 1973).

2. Further Comments on Stock Assessments

A. Subarea 4 Silver Hake - Div. 4V, 4W and 4X (Res.Doc. 75/104)

New information concerning age determination of silver hake and the relationship between year-class strength and sea temperature confirm previous estimates of the present composition of the stock in Div. 4VWX.



However, there remain differences of opinion on the level of natural and fishing mortality and age at first capture that will achieve the MSY for this resource. For example, the 1976 recommended TAC of 100,000 tons is based on a value of natural mortality  $M = 0.4$  but higher values would justify increased exploitation of the youngest age groups and an increased TAC. The Subcommittee discussed Soviet scientists' data that  $M = 0.7$  which would permit a TAC of 125,000 tons in 1976, but since this means 50% of the stock should die 'naturally' each year, the Subcommittee concluded that tangible evidence for it must be presented, e.g. heavy predation by another marine organism, before such an extreme estimate could be accepted, and it endorsed its previous recommendation that the TAC for 1976 be 100,000 tons.

B. Mackerel in Subareas 3, 4 and 5 and Statistical Area 6 (Res.Doc. 75/103)

Recommended TACs are based on expected catches of particular numbers of fish of each age group under specified conditions of exploitation. For example, the TAC for 1975 for mackerel includes an expected catch of certain numbers of one and two-year-old fish. A provisional interpretation of catches taken in the first quarter of 1975 suggest that catches of 1-year-old mackerel from the 1974 year-class, when taken over the whole year, will eventually prove to be higher than expected. This will have been caused either by the 1974 year-class being more abundant than expected, (and this is possible) or by a disproportionate concentration of fishing on young mackerel in the absence of suitable concentrations of older fish. Lack of the older age groups in research vessel survey catches indicate this could also be true but it is not technically possible to distinguish between the two effects. If the 1974 year-class is more abundant than previously assumed then the recommended TAC for 1976 will be conservative, but if the exploitation of 1-year-old mackerel in 1975 has increased then the stock in 1976 will be reduced below the level used as a basis for the



1976 TAC of 310,000 tons and will have to be followed by a further reduction of the TAC in 1977 if the presently agreed F and stock size are to be maintained. This emphasizes the need to implement a minimum size regulation for mackerel: a higher yield-per-recruit could be achieved by delaying first capture until mackerel are at least 2 years old and this would protect both the stock and future TACs from the adverse effect of an excessive proportion of a TAC being taken from the youngest age groups simply because they form the most commercially attractive fishing concentrations.

C. Subarea 5 and Statistical Area 6 - 2nd Tier Quota (Res.Doc. 75/117)

The Subcommittee took note of a method for judging the likely success of different possible levels of 2nd tier TAC in achieving the Commission objective of enabling the total stock biomass to recover. The accuracy of the estimates involved in this overall assessment do not admit a high level of precision in statistical interpretation but results of the study in Res.Doc. 75/117 confirm that the larger the reduction in the overall TAC, the greater the probability of success of the regulation.



Table . Nominal catches (000 tons) in 1973 and 1974. (The symbol + indicates less than 500 tons.)

	SA 1		SA 2		SA 3		SA 4		SA 5		SA 6		TOTAL	
	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974
Cod	63	48	59	126	462	409	188	176	35	34	+	1	808	794
Haddock	+	+	+	+	2	2	18	16	6	5	+	+	26	23
Redfish	3	4	12	6	111	115	170	96	17	10	+	+	313	231
Silver Hake	-	-	-	-	-	+	299	96	120	118	12	12	435	226
Red Hake	-	-	-	-	+	+	2	3	50	21	17	12	68	36
Pollock	+	-	+	+	+	1	30	25	13	12	+	1	44	39
Flounders	9	16	18	21	155	120	48	49	41	37	11	10	284	253
Other Groundfish	10	22	8	11	23	33	33	40	32	20	9	14	118	140
Herring	+	+	+	+	17	20	233	227	220	172	14	12	485	429
Mackerel	-	-	+	-	3	2	36	42	315	201	66	93	420	338
Other Pelagics	-	-	-	-	+	3	1	2	42	49	312	220	359	274
Other Fish	6	6	62	96	217	227	36	66	51	45	50	36	412	476
Shellfish	10	18	+	1	4	5	46	36	121	130	461	533	680	723
ALL Species	101	114	160	261	994	937	1139	874	1063	854	953	944	4452	3981



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Corrigendum

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Report of Assessments Subcommittee, April 1975

Page 36, last para, line 6: "in Table 12" should read: "... as far as possible in Tables 13 and 14."

Page 38: Table 12 should be numbered Table 13; Table 13A should be numbered Table 14A.

Page 39: Table 13B should be numbered Table 14B.

Page 39, 2nd para, line 1: "Table 12" should read "Table 15 considers....."

line 3: "Table 13" should read "Table 16 provides a basis...."

line 8: "... in Table 14 to the allocations in Table 15" should read:

"... in Table 15 to the allocations in Table 16."

Page 39, 3rd para, line 1: "Table 16" should read: "Table 17 summarizes....."

Page 40: Table 14 should be numbered Table 15.

Page 41: Table 15 should be numbered Table 16.

Page 42: Table 16 should be numbered Table 17.

