International Commission for the Northwest Atlantic Fisheries

Serial No. 3830
(D.c.3)

ICNAF Res.Doc. 76/VI/45

ANNUAL MEETING - JUNE 1976

Div. 4WX herring stock assessment

by

D.S. Miller and W.T. Stobo
Environment Canada
Fisheries and Marine Service
Biological Station
St. Andrews, N.B., Canada

The total catch of herring in Div. 4WX was 185,109 tons of which 149,268 tons were from the Div. 4WX stock, the remaining 35,841 tons were from the New Brunswick juvenile fisheries, miscellaneous gear fisheries, and small gill net fisheries on local inshore stocks. The 1970 year-class continued to support the fishery contributing 40% to the catch as numbers and 59% as weight. Catches by country are given in Table 1.

Revised catch statistics for the Canadian Div. 4X fisheries from 1965 to 1974 (Miller and Iles, 1975) were used to provide a new catch composition for the Div. 4Wb-X component of the stock (Table 2). The catch composition for the Div. 4Wa component of the stock is given in Table 3. Catch in numbers by age group for the entire stock was revised to incorporate a change in the definition of the fishery year from a 1 January-30 December season to a 1 November-31 October season. For purposes of age classification, the birth date of herring was changed from 1 January to 1 November. The catch composition for the stock based on the revised season is given in Table 4.

Cohort Analysis

A cohort analysis was run using the revised catch composition. The starting F's used were the same as those used for the assessment presented at the Special Meeting in January 1976 with the exception of those used for the 1972 and 1973 year-classes. The F for the 1972 year-class was changed from .270 to .279 to correspond to an assumed recruitment value of 1000 x 10^6 at age 2. Two options were used as starting F's for the 1973 year-class, an F of 0.308 corresponding to a recruitment at age 2 of 1000 x 10^6 and an F of 0.193 corresponding to a recruitment value of 1512 x 10^6. The value of 0.193 is the mean F at age 2 for the 1966 to 1972 year-classes inclusive. The starting F of 0.308 is abnormally high considering F's at age 2 for other year-classes. Catches of the 1973 year-class in both the New Brunswick and Nova Scotia weir fisheries (Table 5) suggest that this year-class is better than assumed at the January Meeting. The F of 0.193 is a more realistic value and is no lower than any F on a year-class at age 2 excepting the 1966 year-class which experienced a directed small fish fishery on age 2 fish (this has not been the case for any other year-class). The calculated fishing mortalities and year-class sizes from the cohort analysis are given in Table 6 and Table 7, respectively.

Catch Projection

The mean weights at age used in the catch projections were the same as those used for the assessment presented in January 1976. The catch and stock size predictions for 1976 are based on partitioning the Div. 4WX fishery into two six-month periods, 1 November 1975 to 30 April 1976 and 1 May to 31 October 1976. The Canadian Div. 4Wa fishery normally occurs in the first fishery period. The catch numbers for that portion of the Div. 4Wa fishery now completed were used to calculate F's for this sector of the fishery. F's used to predict catches for Div. 4WX for the second fishery period were set equal to the residals obtained by subtracting the Div. 4Wa F's from the annual 1976 F of 0.35. Partial recruitment values for the Div. 4WX fishery were the same as those used in January 1976. The F on the 1967 year-class in the Div. 4Wa fishery was 0.609 which exceeded the 0.35 level. The 1976 F for this year-class therefore had to be set above the 0.35 level and an F of .159 (mean of 1966 and 1968 year-classes in the second fishery period) was assumed in the summer fishery.

The catch projections for 1976 and residual stock sizes at the end of 1976 are given in Table 8. Depending on the assumed size of the 1973 year-class, the projected TAC for the Div. 4Wb-X fishery in 1976

would be 87,000 or 92,500 tons. Stock sizes at the beginning of the year for herring age 2+ and age 4+ are given in Table 9 for the period 1966 to 1977. Catch projections for 1977 and 1978 and resulting stock sizes at the beginning of 1978 and 1979 are given in Tables 10 and 11. The projections were run using three different F's of 0.25, 0.30, and 0.35. Recruitment at age 2 was set at 750 x 10^6 each year.

Stock size at age 4+ at the beginning of 1979 will decline to 328,000 tons with F = 0.35, to 354,000 with F = 0.30, and to 383,000 tons with F = 0.25. Catches from the stock will decline in 1977 and 1978 from that of 1976 even if F is kept at the higher level of 0.35. If F is set at 0.30 ($F_{0.1}$ for this stock) the catch in 1977 will be 109,000 metric tons and 98,000 tons for 1978 (assuming the 1973 year-class is 1500 x 10^6 at age 2). In order to prevent the serious decline in stock size experienced by other herring stocks in the ICNAF Area, F in 1977 and 1978 should not be higher than the $F_{0.1}$ level of 0.30.

Reference

MILLER, D.S., and T.D. ILES. 1975. Catch statistics for the Bay of Fundy herring Fisheries 1963-1974. *Fisheries and Marine Service Technical Report*, No. 594.

Table 1. 1975 herring catches in Div. 4Wx.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CAN													
4W-total	23,943	324	-	39	158	345	183	73	7	-	45	11,718	36,835
4W-stock[1]	23,943	324	-	-	-	-	-	-	-	-	45	11,718	36,030
4X-total	316	120	92	757	2,504	23,924	35,921	40,860	15,096	5,767	386	128	125,871
4X-stock[2]	-	-	-	53	1,956	22,036	30,893	30,317	4,095	1,388	61	36	90,835
FRG													
4W	-	-	-	-	-	-	-	-	773	336	20	-	1,129
4X	-	-	-	-	-	-	-	-	-	214	-	-	214
USSR													
4W	-	20	284	24	54	1,553	79	512	159	-	-	-	2,685
4X	-	-	256	876	3,465	5,734	2,959	1,066	2,001	1,227	791	-	18,375
Total 4WX	24,259	464	632	1,696	6,181	31,556	39,142	42,511	18,036	7,544	1,242	11,846	185,109
Total stock	23,943	344	540	953	5,475	29,323	33,931	31,895	7,028	3,165	917	11,754	149,268

[1] Winter purse seine catches.
[2] Includes catches from Nova Scotia weirs, Nova Scotia purse seines, and Bay of Fundy gill nets.

Table 2 . Herring in Div. 4Wb-4Xa: Catch in numbers ($x10^{-3}$) by age-groups.

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	30	393	0	13853	53	50	4510	7750	0	0	2838
2	210796	43630	47948	751706	65744	84833	11237	662087	12290	115470	239212
3	26450	270068	68430	79933	328582	14966	62733	37347	546167	27034	115306
4	232147	58591	238394	65107	53070	192818	46083	89514	83009	491161	71240
5	49752	308775	109814	274518	121730	165769	80144	57884	27883	33563	282317
6	10592	45479	159203	72827	223997	90670	41839	58603	22544	10162	39285
7	1693	13970	57948	90617	53043	94991	53095	41250	18347	4106	6236
8	561	7722	4497	31977	20284	33494	21000	38998	16683	2027	1189
9	54	1690	409	15441	6508	17599	9856	21172	18825	7235	965
10	37	215	296	5668	3022	7319	4277	8042	9405	2213	477

Table 3. Removals ($x10^{-3}$) in the Div. 4Wa herring fishery, 1969-75 based on a November 1 - October 31 season.

	YEAR							
Age	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
1	-	-	150	-	-	11	-	
2	4629	22389	132930	1280	17366	2819	2056	104
3	55175	42435	128914	36314	35789	18560	42432	47521
4	64423	87024	67227	58332	22927	124965	17644	46161
5	36343	23670	50885	14260	6907	19624	90324	32703
6	29988	26204	34146	15548	3243	5091	8945	72669
7	7452	8120	44548	9387	1185	4012	2736	11332
8	1760	4561	25498	11926	710	3286	1977	2830
9	665	1776	9598	4932	717	3729	2499	2520
10	27	290	5158	5279	124	3573	2380	1048

Table 4 . Herring in Div. 4WX: Catch in numbers ($x10^{-3}$) by age-groups based on November 1 to October 31 season.

Age	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	30	393	0	13853	53	50	4660	7750	0	11	2838
2	210796	43630	47948	751706	70373	107322	144167	663367	29656	118289	241268
3	26450	270068	68430	79933	383757	57401	191647	73661	581956	45594	157738
4	232147	58591	238394	65107	117493	279842	113310	147846	105936	616126	88884
5	49752	308775	109814	274518	158073	189439	131029	72144	34790	53187	372641
6	10592	45479	159203	72827	253983	116874	75985	74151	25787	15253	48230
7	1693	13970	57948	90617	60495	103111	97643	50637	19532	8118	8972
8	561	7722	4497	31977	22044	38055	46498	50924	17393	5313	3166
9	54	1690	409	15441	7173	19375	19454	26104	19542	10964	3464
10	37	215	296	5668	3049	7609	9435	13321	9529	5786	2857

Table 5 . Canadian removals of 2-year old herring ($x10^{-6}$) in Nova Scotia and New Brunswick weirs.

	Removals	
	Nova Scotia	New Brunswick
1966	2.0	138.2
1967	23.4	180.6
1968	117.6	694.5
1969	39.4	348.8
1970	42.1	313.6
1971	6.5	165.3
1972	107.2	609.8
1973	11.1	139.1
1974	65.2	228.6
1975	158.4	450.8

Table 6. Herring in Div. 4Wx: Fishing mortality by age groups based on a November 1 - October 31 season.

	AGE								
Year	2	3	4	5	6	7	8	9	10
1966	.034	.152	.103	.529	.263	.336	.558	1.613	0.700
1967	.045	.068	.194	.284	.578	.631	.171	.050	0.700
1968	.429	.098	.085	.358	.310	.786	.898	1.518	0.700
1969	.136	.407	.205	.305	.667	.459	.439	.509	0.700
1970	.158	.157	.592	.594	.389	.636	.594	.894	0.700
1971	.195	.469	.529	.620	.507	.664	.673	.707	0.700
1972	.133	.145	.829	.781	.900	.770	.917	1.074	0.700
1973	.045	.165	.320	.464	.727	.635	.667	1.217	0.700
1974	.140	.089	.263	.262	.380	.529	.349	1.309	0.700
1975[1]	.193 (.308)	.279	.250	.250	.400	.400	.400	.400	0.700
1976[1]	.105	.144 (.144)	.266	.315	.350	.350	.350	.764	.350

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year class: the higher assumption is 1.5×10^9 and the lower (in parentheses) is 1.0×10^9 fish at age 2 respectively.

Table 7. Herring in Div. 4Wx: Stock size ($x10^{-6}$) at the beginning of the fishing season by age groups based on a November 1 - October 31 season.

	AGE								
Year	2	3	4	5	6	7	8	9	10
1966	1458	2123	664	831	217	54	20	2	<1
1967	1206	1155	1494	490	401	137	32	9	<1
1968	2381	944	883	1007	302	184	60	22	7
1969	610	1269	701	664	576	182	69	20	4
1970	810	436	692	467	401	242	94	36	10
1971	897	566	305	313	211	222	105	42	12
1972	5907	604	290	147	138	104	94	44	17
1973	753	4236	428	104	55	46	40	31	12
1974	1000	590	2942	255	53	22	20	17	7
1975[1]	1512 (1000)	712	442	1851	160	30	11	12	4
1976[1]	750	1020 (602)	441	282	1180	88	16	6	6

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year class: the higher assumption is 1.5×10^9 and the lower (in parentheses) is 1.0×10^9 fish at age 2 respectively.

Table 8. Herring in Div. 4WX: catch projection for 1976 and stock size projections for 1977 for F = 0.35 and November 1 - October 31 season.

Age	Div. 4WX Stock Size 1 Nov. 1975 Nos. ($\times 10^{-6}$)	F	Div. 4Wa Nov.-April Catch Nos.($\times 10^{-6}$)	(000t)	Div. 4WX Residual Stock Nos. ($\times 10^{-6}$) May 1976	F	Div. 4WX Projected Catch May 1-Oct.31,1976 Catch($\times 10^{-6}$)	(000t)	Div. 4WX Residual Stock in 1976 Nos.($\times 10^{-6}$)	(000t)
2	750	<.001	.1	-	678.5	.105	64.4	2.7	552.8	23.2
3[1]	1020 (602)	.050 (.087)	47.5 (47.5)	3.6 (3.6)	878.2 (499.5)	.094 (.057)	75.0 (26.3)	8.5 (3.0)	723.3 (426.9)	81.7 (48.2)
4	441	.116	46.1	6.1	355.4	.150	47.2	8.3	276.8	48.4
5	282	.130	32.7	6.3	223.7	.185	36.0	7.8	168.2	36.7
6	1180	.067	72.7	16.2	998.9	.283	234.8	60.8	681.1	176.4
7	88	.145	11.3	2.9	68.9	.205	12.2	3.6	50.8	15.1
8	16	.200	2.8	0.9	12.1	.150	1.6	0.5	9.4	3.1
9	6	.609	2.5	0.8	2.8	.155	0.4	0.1	2.2	0.9
10	6	.191	1.0	0.3	4.7	.159	0.7	0.3	3.6	1.4
				37.1 (37.1)				92.5 (87.0)		387.1 (353.6)

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year class: the higher assumption is 1.5×10^9 and the lower (in parentheses) is 1.0×10^9 fish at age 2 respectively.

Table 9. Herring in Div. 4Wx: stock sizes at beginning of fishing year.

Year	Age 2 and older Nos. ($\times 10^{-6}$)	Wt. (000t)	Age 4 and older Nos. ($\times 10^{-6}$)	Wt. (000s)
1966	5369	678	1788	377
1967	4924	708	2563	527
1968	5790	744	2465	538
1969	4095	672	2216	503
1970	3188	530	1942	447
1971	2673	399	1210	297
1972	7345	520	834	203
1973	5705	665	716	155
1974	4906	715	3316	606
1975[1]	4734 (4222)	685 (663)	2510 (2510)	541 (541)
1976[1]	3789 (3371)	627 (580)	2019 (2019)	480 (480)
1977[1]	3184 (2888)	545 (493)	1912 (1615)	454 (402)

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year class: the higher assumption is 1.5×10^9 and the lower (in parentheses) is 1.0×10^9 fish at age 2 respectively.

Table 10. Herring in Div. 4WX: catch projection for 1977 at 3 levels of fishing mortality (F_{opt} = 0.30) based on November 1 - October 31 fishing year.

		F = .35		F = .30		F = .25	
November 1, 1976		Catch		Catch		Catch	
Age	Pop'n Nos. ($x10^{-6}$)	Nos. ($x10^{-6}$)	MT(000s)	Nos. ($x10^{-6}$)	MT(000s)	Nos. ($x10^{-6}$)	Mt(000s)
2	750.0	67.9	2.9	58.6	2.5	49.2	2.1
3	522.8	67.1	7.6	58.1	6.6	48.9	5.5
4[1]	723.3 (426.9)	153.8 (90.9)	26.9 (15.9)	134.2 (79.2)	23.5 (13.9)	113.8 (67.2)	19.9 (11.8)
5	276.8	68.1	14.9	59.6	13.0	50.7	11.1
6	168.2	45.3	11.7	39.7	10.3	33.9	8.8
7	681.1	183.3	54.6	160.8	47.9	137.1	40.9
8	50.8	13.7	4.5	12.0	4.0	10.2	3.4
9	9.4	2.5	0.9	2.2	0.8	1.9	0.7
10	2.2	0.6	0.2	0.5	0.2	0.4	0.2
Total			124.2 (113.2)		108.7 (99.1)		92.5 (84.3)
Residual stock biomass in 1977 (age 4 and older)			337.5 (304.9)		351.4 (317.6)		365.9 (330.8)
Stock biomass (age 4 and older) at beginning of next season (November 1)			382.5 (342.0)		398.6 (356.5)		415.4 (371.6)

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year class: the higher assumption is 1.5×10^9 and the lower (in parentheses) is 1.0×10^9 fish at age 2 respectively.

Table 11. Herring in Div. 4WX: catch projection for 1978 at 3 levels of fishing mortality (F_{opt} = 0.30) based on November 1 - October 31 fishing year.

	F = .35			F = .30			F = .25		
		Catch			Catch			Catch	
Age	Nov. 1, 1977 Pop'n Nos ($\times 10^{-6}$)	Nos ($\times 10^{-6}$)	MT (000s)	Nov. 1, 1977 Pop'n Nos.	Nos($\times 10^{-6}$)	MT(000s)	Nov. 1, 1977 Pop'n Nos.	Nos($\times 10^{-6}$)	MT(000s)
2	750.0	67.9	2.9	750.0	58.6	2.5	750.0	492.2	2.1
3	552.8	67.1	7.6	561.2	59.0	6.7	569.7	50.4	5.7
4	392.1	83.4	14.6	400.2	74.2	13.0	408.5	64.3	11.2
5[1]	453.9 (267.9)	111.7 (66.0)	24.4 (14.4)	471.5 (278.3)	101.6 (59.9)	22.1 (13.1)	489.7 (289.1)	89.8 (53.0)	19.6 (11.6)
6	165.4	44.5	11.5	173.0	40.8	10.6	180.9	36.4	9.4
7	97.0	26.1	7.8	102.0	24.1	7.2	107.2	21.6	6.4
8	392.9	105.8	35.1	413.1	97.5	32.4	434.3	87.4	29.0
9	29.3	7.9	2.9	30.8	7.3	2.6	32.4	6.5	2.4
10	5.4	1.5	0.6	5.7	1.4	0.5	6.0	1.2	0.5
Total			107.3 (97.3)			97.6 (88.5)			86.3 (78.3)
Residual stock biomass in 1978 (age 4 and older)			293.8 (269.5)			316.3 (290.0)			340.9 (312.3)
Stock biomass (age 4 and older) at beginning of next season (November 1)			328.7 (299.9)			354.6 (323.3)			382.9 (348.9)

[1] The two sets of figures refer to two assumptions as to the size of the 1973 year class: the higher assumption is 1.5×10^9 and the lower (in parentheses) is 1.0×10^9 fish at age 2 respectively.