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Preliminary Assessment of the Scotian Shelf Silver Hake Stock Size (Div. 4VWX) for 1988 and Prospects for 1990

by

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INTRODUCTION

The experience of silver hake stock assessment gained over the years that followed the introduction of the 200-mile zone shows that the data on the catch composition being obtained by the observers on one or two ships fishing for the hake significantly differs from that being collected on a greater number of ships, especially so on all the ships in the recent two years, within the framework of the Canadian "International observer program" (IOP). This is one of the reasons why the Soviet TAC values do not always coincide with those presented by the Scientific Council which are based on all the available information. In this context, it was decided not to draw any project of the future catch this time, but limit ourselves to a preliminary assessment of the state of the stock in the last fishing year and to general considerations on the trends of the change of the stock size and fishery prospects for 1990.

MATERIALS AND METHODS

In 1988, the length-age samples of the silver hake were collected by the observers in June and early in July. A total of 43.7 thous. specimens was measured and about 900 pairs of otoliths were sampled for ageing. As in the previous similar document (Rikhter, 1988a), the materials used for V.P.A. were the Canadian data on the catch size, mean weight of the hake by age and stan-

dardized catches per unit effort for the 1977 to 1987 period (Waldron et al., 1988). The data on the age composition and mean weight of the hake by age in 1988 are based exclusively on the materials of the Soviet observers. The catch statistics was adopted from the NAFO Circular Letters. According to these data, the Soviet catch amounted to 64.7 thous. tons in 1988. As the information on the total hake catch by all countries is missing, we, as before, had to resort to an assumption that it constituted approximately 90 thous. tons. The Soviet catches by age were converted to the total catch value:

Age	1	2	3	4	5	6	7	8
Catch, mill.sp.	0.39	346.72	337.65	113,34	19,63	1.12	0.37	0.02
Catch,%	0.05	42.32	41.21	13.83	2.40	0.14	0.04	+
Mean weight,kg	0.045	0.113	0.187	0.250	0.360	0.487	0.554	0.617

The V.P.A. tuning was made by means of the algorithm suggested by Rivard (1983) Computations were made according to the program worked out in the Sector of mathematical methods of stosk assessment directed by P.S.Gasjukov. The latter two age groups (8 and 9) were eliminated from computations due to their extreme scantiness and possible inaquracies in ageing.

The natural mortality rate (M) equal to 0.50 for all age groups was used for calculations (Rikhter, 1988b). The starting values of fishing mortality rates were at the level of M. The mean catch per unit effort (hauling hour) for 1988 was taken to be 5 tons, i.e. large enough, but somewhat lower than the standardized 1987 catch, which has been dictated by worsening of the fishing situation in the end of June. A preliminary value of the 1988 year class was estimated from the results of the Soviet-Canadian young silver hake trawling survey. For calculation of partial recruitment (PR) coefficients, the procedure used by Waldron and Fanning (1986) was applied in addition to Rivard's algorithm. The analysis of catch per recruit was made according to Tomson and Bell (1934).

VIRTUAL POPULATION ANALYSES

The results of calculation of fishing mortality rates, abundance and biomass are presented in tables 1, 2 and 3. Due to a

large value of correlation between the hake biomass size at the age of 1-7 and standardized catches per unit effort ($r = 0.85$), the use of the Rivard's method seems to be well-grounded. In this case, unlike the results gained by the methods used by the Scientific Council, the standardized catch per unit effort for 1982 does not look anomalous and is not omitted in calculations. Neither a disproportion between coefficients of terminal fishing mortality (F_t) on older age groups and fishing mortality rates (F) in the previous years is observed. However, despite the advantages of the V.P.A. tuning by the Rivard's method, large values of F_t beginning at age 4, and a high, with some exceptions, fishing mortality rate for older age groups beginning in 1979 give rise to a certain distrust. The second circumstance takes place irrespective of the tuning methods used. What is striking here is the contradiction between a seemingly obvious growth of rate of commercial exemption of the older age groups of the hake and a sharp increase of the silver hake abundance in the eighties at a reduced amount of the fishing effort (Waldron et al., 1988). Possible reasons of such a lack of correspondence are considered in another work presented to the Session (Rikhter, 1989). On the whole, the impression is formed that large values of fishing mortality rates for older age groups can rather be attributed to the specificity of the initial data obtained under the conditions of limited fishery entailed by introduction of the 200-mile zone than to actual increase of the rate of commercial exemption. Hence an assumption suggests itself that the retrospective estimates of the silver hake stock that are being calculated using direct methods for the V.P.A. tuning (Rivard's method and a group of methods adopted in the ICES) may turn out to be underestimates. The obviously underrated abundance of the 1987 year class at the age of 1 can be most likely explained by inadequate data on age composition of the hake from the 1988 commercial catches.

The recruitment abundance values calculated according to Rivard and the procedure used by the Canadian scientists, and averaged for the 1977 to 1986 period are given below:

Age	1	2	3	4	5	6	7
Rivard	0.028	0.146	0.425	0.618	0.767	1.000	0.883
Waldron and Fanning	0.045	0.294	1.000	"	"	"	"

As, according to the NAFO Scientific Council, the silver hake enters the fishery in mass at the age of 3, and the fluctuations of PR values for older age groups are most likely caused by the changed accessibility of the large size hake to fishing gears, by the influence of the increased fishing mortality rate with age and, finally, by possible errors in ageing the oldest fish, it seems to be reasonable to use the PR values calculated by the second method.

The analysis of the catch per recruitment was based on the above-stated PR values (second method), weight by age for the 1977-1988 period and M = 0.50. The results of calculations are as follows:

Fishing mortality	Catch per recruitment, kg
0.1	0.016
0.2	0.027
0.3	0.035
0.4	0.041
0.5	0.045
0.6	0.048
0.7	0.050
$F_{0.1}$ → 0.74	0.051
0.8	0.052
0.9	0.054
1.0	0.055

The fishing mortality at the $F_{0.1}$ level was 0.74, and the corresponding catch per recruitment amounted to 0.051 kg.

RECRUITMENT ASSESSMENT

In 1988, the fishery was based on two strong 1986 and 1985 year classes. As per data of the joint Soviet-Canadian young silver hake survey, the 1987 year class belongs to average year classes in terms of abundance. As far as the results of the recent survey are concerned, the 1988 year class abundance is close to

that of 1986:

Year class	1981	1982	1983	1984	1985	1986	1987	1988
Abundance sp. x 10^7	110	2	34	11	62	32	20	32

Another attempt was made to establish a quantitative correlation between the 0-group abundance and that of one-year-olds calculated by the V.P.A. The survey data collected before 1981 were rejected as the survey methods radically changed in 1981. The results of the 1981 survey were also rejected because the anomalously high value of abundance of the year class born in that year was not confirmed in the future. Therefore the parameters of the regression equation were calculated only for the following observation series;

Year class, year	1982	1983	1984	1985	1986
0-group abundance, 10^7 sp.	2	34	11	62	32
One-year-olds abundance, mill.sp.	829	1551	1492	2870	3383

CALCULATION RESULTS

Correlation factor - 0.72

$Y = 32.90\ X + 1097.35$

where y is hake abundance at the age of 1, mill.sp.

x is index of 0-group abundance, 10^7 sp.

Certainly, the mathematical groundlesness of the equation is evident (a sample from five points). However the existence of the clearly seen qualitative correlation between the 0-group abundance and the subsequent values of year class abundance from the Canadian trawling surveys and commercial catches (table 4) suggests the presence of a real quantitative correlation between the considered features.

The abundance of the 1987 and 1988 year classes at age 1 calculated from the formula constitutes 1755.35 and 2150.15 mill.sp. respectively.

TENDENCIES OF CHANGES OF THE STOCK SIZE AND TAC IN THE NEAREST FUTURE

If a supposition that the 1987 year class is average in terms of abundance holds true, a certain decrease of the commercial stock size and, consequently, of the TAC must be expected.

However due to appearance of a strong 1988 year class according to the preliminary data, the total catch size will evidently maintain at the high level of 1986-1989. No distinct signs of coming poor year classes have been observed yet. A preliminary analysis of the "stock-recruitment" relationship for the Scotian shelf silver hake (Rikhter, 1988 c) did not yield any regularity resembling the known functional forms. Over the considered period (1970-1982), just a feebly marked trend to the increase of the recruitment with the growth of the spawning biomass was observed.

ADDENDUM

The data given in SCR Doc. 89/5 allows to suggest that retrospective estimates of F at older ages are too high. As a result the estimates of F_t and biomass for the last fishing year which were made by method of Rivard might appear not true: higher and lower respectively. Obviously other methods should be looked for, which would give estimates of F_t closer to reality. It should be noted that the ad hoc methods which have been used so far by Scientific Council with regards to Silver hake appear to have given rather a true picture of the level of stock and TAC for this species.

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Table 1

Silver hake fishing mortality rates

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0028	0.0347	0.0101	0.0099	0.0019	0.0145	0.0051	0.0845	0.0331	0.0563	0.0069	0.0465
2	0.0977	0.2210	0.1029	0.1107	0.0525	0.1079	0.1107	0.1074	0.2941	0.1041	0.1892	0.2407
3	0.3498	0.4218	0.3687	0.3566	0.4305	0.3583	0.2068	0.5463	0.3685	0.7828	0.2945	0.7020
4	0.2886	0.4724	0.5902	0.4785	0.4024	0.7378	0.3577	0.7245	0.8379	1.2995	0.6885	1.0192
5	0.1971	0.4471	1.1129	0.5727	0.5133	1.2489	0.4437	0.6436	0.8189	1.1639	1.9452	1.2667
6	0.1421	0.5711	1.5073	1.2022	0.6190	1.1265	0.7599	0.4785	1.1440	2.3635	2.3398	1.6505
7	0.1695	0.5087	1.3090	0.8869	0.5661	1.1876	0.6017	0.5610	0.9814	1.7635	2.1421	1.4581
F weight. (2-5)	0.2019	0.3256	0.2790	0.2303	0.2592	0.3157	0.1609	0.4031	0.4056	0.4231	0.2503	0.4280

Table 2

4VWX silver hake abundance, mill. sp.

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	953.08	1067.91	1217.43	805.84	1056.10	1737.76	829.03	1550.63	1491.55	2870.07	3383.02	10.94
2	591.90	576.43	625.63	730.96	483.94	639.36	1038.83	500.27	864.30	875.22	1645.53	203.75
3	332.02	325.59	280.29	342.36	398.88	278.50	348.14	564.03	272.53	390.65	478.37	826.03
4	148.05	141.94	129.52	117.58	145.36	156.51	118.06	171.71	198.12	114.35	108.31	216.14
5	49.19	67.28	53.68	43.54	44.20	58.96	45.39	50.07	50.46	51.99	18.91	33.00
6	19.11	24.50	26.10	10.70	14.89	16.04	10.26	17.67	15.96	13.50	9.85	1.64
7	3.91	10.06	8.39	3.51	1.95	4.86	3.15	2.91	6.64	3.08	0.77	0.58
1+	1097.26	2213.71	2341.04	2054.49	2143.32	2891.99	2392.86	2857.29	2899.56	4318.86	5644.76	3126.0
2+	1144.18	1145.80	1123.61	1248.65	1087.22	1154.23	1563.83	1306.66	1408.01	1448.79	2261.74	3115.1
3+	552.28	569.37	497.98	517.69	603.28	514.87	525.00	806.39	543.71	573.57	616.21	1077.3
4+	220.26	243.78	217.69	175.33	206.40	236.37	176.86	242.36	271.18	182.92	137.84	251.3

Table 3

4VWX silver hake biomass, thous. tons

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	59.09	52.33	74.26	33.04	38.02	97.31	44.77	97.69	114.85	177.94	152.24	0.49
2	87.01	63.41	96.35	103.07	69.20	93.99	135.05	73.54	134.83	139.16	208.98	240.45
3	69.72	56.65	56.06	72.92	76.60	62.11	70.67	107.17	56.14	78.52	83.24	154.47
4	42.93	32.08	31.73	32.92	36.05	45.23	29.04	42.76	47.55	26.19	24.14	54.03
5	19.53	19.04	15.30	14.02	14.05	19.40	13.75	13.92	13.93	14.14	4.94	11.88
6	9.86	8.06	8.98	3.92	5.50	6.40	3.71	6.47	5.20	4.05	2.95	0.80
7	2.61	3.84	3.45	1.82	1.31	2.34	1.22	1.32	2.77	1.24	0.33	0.32
1+	290.75	235.41	286.13	261.71	240.13	326.78	298.21	342.87	375.27	441.24	476.83	462.44
2+	231.66	183.08	211.87	228.67	202.71	229.47	253.44	245.18	260.42	263.3	324.59	461.95
3+	144.65	119.67	115.52	125.60	133.51	135.48	118.39	171.64	125.59	124.14	115.61	221.50
4+	74.93	63.02	59.46	52.68	56.91	73.37	47.72	64.47	69.45	45.62	32.37	167.47

Table 4

Comparison of silver hake abundance indices from the trawling survey data (0-group and age 1) and catches per unit effort at age 2 by year class

Indices	Year classes				
	1981	1982	1983	1984	1985
0-group, 10^7 sp.	110	2	34	11	62
Age 1, 10^3 sp.	191940	114006	189724	99810	560759
Age 2, sp.	7298	2586	12274	4962	21752