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Assessment of the Scotian Silver Hake (Merluccius bilinearis) Stocks and Allowable Catch in 1986

by

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Abstract

Silver hake catches in NAFO Divisions 4 VWX made up 70.5 thous.t in 1984 against the recommended TAC of 100 thous.t From stock size estimates derived from a VPA, and recruitment values obtained during inventory trawling surveys of the young silver hake, the population size of silver hake for the beginning of 1986 and the TAC have been estimated at 900 and 150 thous. tons, respectively.

Materials and methods

For assessment of the silver hake stock size in Divisions 4 VWX total catch statistics, catch per effort data for the USSR ships of a BMRT class, and age composition of the catches for 1975-84 were used. Total, natural and fishing mortality rates by age were determined from the analysis of catch per effort data by age, and by the method of random search. The recruitment at age 2 was estimated from the results of 0-group trawling surveys conducted by the USSR ships in the 1978 to 1984 period.

Results

a. State of fishery

Silver hake catches made up 70.5 thous. tons in 1984 against the TAC of 100 thous. tons. The USSR catch amounted to 57,4 thous. tons. Due to availability of stable silver hake aggregations the USSR has been able to catch their allocation of 56

thous. tons. Silver hake catches in the Scotian area considerably varied from year to year. The largest catch of 299,5 thous. tons was taken in 1973 (table 1). In the next years the catches decreased as a result of Canadian regulations of the total allowable catch; they have further decreased since 1977, when fishing areas and seasons were limited.

Before 1975, the silver hake fishery was conducted by the Soviet fleet, however, since 1975 it has been joined by Cuba fishing vessels.

Since 1975 the annual catches have been below the TAC. This can be explained by the fact that, firstly, Canadian allocation which can be regarded as a reserve is not caught, and, secondly, the USSR allocation has not always been caught due to unfavourable fishing conditions. For example, in 1983 the USSR caught 23,4 thous. tons of their allocation of 43 thous. tons (table 2). This was as a result of unfavourable fishing conditions in the end of June, when silver hake had migrated from the area open for foreign fishery. So, in the future, successful fishing for silver hake within the framework of allocations will largerly depend on conditions affecting the availability of the stocks to the fishery.

b. Age composition of catches

Otoliths were sampled on commercial ships to study age composition of the catches. Based on age determinations length-age keys have been derived. Massive measurements and length-age keys were used to determine age composition of the catches by month and for the fishing season. In commercial catches of the Scotian silver hake fish aged 3 and 4 predominated, except for the year 1983, when a very strong 1981 year class aged 2 prevailed in the catches (table 3).

Similar age composition of the catches was observed in 1963, the first year of intensive fishing for silver hake. The analysis of age composition shows that the relative and absolute abundance of fish aged 5 has sharply decreased compared with fish aged 4, notwithstanding the fluctuations of abundance of separate year classes. This is confirmed by Canadian data from

trawling surveys of silver hake abundance (Waldron and Harris, 1984). The only possible explanation can be natural causes, namely, a high natural mortality on four year old silver hake. Age composition of silver hake differs by sex (table 4). So, males aged 2-4, and females aged 3-5 predominate in the catches. Females aged 10-12 may occur in the catches, while the age-limit for males is 5 years. Males attain sexual maturity at the age of 3, and females at the age of 4. From the data on age composition and dates of massive sexual maturation it can be suggested that silver hake die in quantity on attainment of sexual maturity and after spawning. According to sexual cycles, the fish are classified as follows (Monastyrsky, 1953):

1. monocyclic - the fish dying after spawning
2. polycyclic - the fish with reiterating spawning
3. oligocyclic - the major part of the fish die after the first spawning

The Scotian silver hake is assumed to belong to the third group.

c. Calculation of maturity rates

To calculate total instantaneous mortality rates (Z) the data on the catch per hauling hour of the BMRT class ships converted to sex ratio, and total numbers of both sexes were used (table 5, 6 and 7). As is evident from the tables, the total mortality on males aged 3 to 4 averaged to 0.49 over the 1978 to 1984 period, and that on both sexes to 0.27. At the age of 4-5 the total mortality on males averaged to 1.85, on females to 0.73 and on both sexes to 1.06. At the age of 5-6 the mortality increased and constituted 1.61 on average. To calculate natural mortality rates by age group the computer analysis was made by the method of random search using age composition data per hauling hour of a BMRT class vessel and total fishing rate for 1977-84 with the extreme values of M set at 0.10-1.50, and of F at 0.01-2.00. The results of this analysis showed that natural mortality rates were 1.16 ± 0.01 on 4 year olds, and 1.33 ± 0.02 on 5 year olds. The results for the other age groups appeared to be far from reliable due to large dispersion. Natural mortality

values and the value of terminal fishing mortality by age group for assessment of stock sizes are presented in table 8.

d. Assessment of stocks and allowable catch

For assessment of stock size and allowable catch a VPA was used based on age composition of the catches for the 1976- to 1984 period (table 9).

The 1984 weight data by age group were used (table 10). These data indicate a good agreement between the converted catch sizes by age and the nominal catch in 1984.

Estimates of stock sizes and fishing mortality rates derived from a VPA are given in tables 11-13. From 1977 (when restrictions were imposed on fishing grounds) to 1983, the fishing mortality on fish aged 2 ranged from 0.01 to 0.05, and constituted 0.03 on average. Over the same period, the values of F averaged to 0.10 for fish aged 3, to 0.20 for fish aged 4, and to 0.22 for five- and six-year-olds. Average values of fishing mortality rates, especially those for the fish aged 4 and older, show a good agreement with the terminal mortality values by age adopted for 1984. Therefore, the data on fishing mortality for 1984 have been adjusted with regard for their mean values for the 1977 to 1983 period (table 15).

As is evident from the data of tables 12 and 13, the lowest recorded silver hake catches were in 1977 and 1978. Since then, they have been increasing and have exceeded one million tons in 1983 and 1984. The results of trawling surveys are also indicative of a marked increase of the stock size (Waldron, Harris, 1984). For assessment of the stock size in 1985 and 1986 the estimate of the 1984 stock size and the natural mortality rates by age were used. Fishing mortality rates by age for 1985 have been reset from the 1984 values, proceeding from the assumption that in 1985 the fishing intensity and catches would maintain at the 1984 level. The fishing mortality rate of 0.60 for 1986 is based on optimal values for fish aged 5 and older (Noskov, 1976). The recruitment at the age of 2 has been estimated from the results of the inventory trawling survey of 0+ group silver hake (table 14).

According to VPA data for the 1963 to 1984 period the mean abundance of fish aged 2 constituted 2 500 x 10^6 sp. Proceeding from the trawling survey data, the abundance of fish aged 2 of the 1982 year-class in 1984 is below average constituting 1 500 x 10^6 sp., the abundance of fish aged 2 in 1985 is estimated to be at the average level of 2 500 x 10^6 sp., and in 1986 it will be 2 000 x 10^6sp.

According to calculations (table 15), the 1985 stock has been estimated at 1 025 thous. tons, and the catch of 90 thous. tons can be taken if the fishing mortality maintains at the 1984 level.

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Table 1 Silver hake catches (thous. tons) in Division 4 VWX taken the USSR and other contries in 1962-84

Year	Other contries	USSR
I962	8.9	8.8
I963	I23.0	I23.0
I964	8I.I	8I.I
I965	50.0	50.0
I966	I0.3	I0.3
I967	2.5	2.5
I968	3.5	3.4
I969	46.3	46.3
I970	I69.0	I68.9
I97I	I28.7	I28.6
I972	II4.0	II3.8
I973	29[illegible],5	298.5
I974	95.7	95.3
I975	II6.3	II2.6
I976	97.2	8I.2
I977	37.I	33.2
I978	48,4	43,8
I979	5I.8	45.I
I980	44.5	4I.0
I98I	4I.0	40.2
I982	60.2	47,3
I983	35.8 1)	29,4
I984	70,5	57,4

1) Preliminary

Table 2 Actual and total allowable catches in 1975 - 1984

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
TAC, thous.t	I20	I00	70	80	70	90	80	80	80	I00
Actual catch, thous. t	II6	97	37	48	52	45	4I	53	33	7I
Actual catch, %	97	97	53	60	74	50	5I	67	4I	7I

Table 3 Age composition (%) of the Scotian silver hake catches in 1963 and 1980-84

Age, years	I963	I980	I98I	I982	I983	I984
I	0.2	I.4	0.7	4.9	I.4	5.0
2	II.5	I6.8	9.9	I4.9	42.6	I0.I
3	46.4	36.2	42.6	24.I	27.0	38.6
4	34.I	32.4	33.0	37.6	20.6	33.I
5	7.4	9.6	I0.3	I2.8	5.8	I0.5
6	0.4	2.2	2.6	4.I	I.9	2.0
7	+	0.6	0.7	I.I	0.5	0.6
8	+	0.5	0.I	0.4	0.I	0.I
9	+	0.2	0.I	0.I	0.I	-
I0	+	0.I	+	+	-	-
Mean age, years	3.4	3.I	3.5	3.6	3.0	3.4
Fishing gear	trawl	trawl	trawl	trawl	trawl	trawl
Mesh size	40	60	60	60	60	60

Table 4 Age composition (%) of silver hake commercial catches by age in 1984

Age, years	I	2	3	4	5	6	7	8	Total
♂ ♂	3.7	I5.0	46.5	30.7	4.I	-	-	-	I00.0
♀ ♀	3.6	5.4	32.I	36.5	I7.0	4.0	I.2	0.2	I00.0
♂ ♀	5.0	I0.I	38.6	3I.I	I0.5	2.0	0.6	0.I	I00.0

Table 5 Total mortality (Z) on silver hake males by catch per hauling hour by BMRT in 1978 - 1984

Years	Age						
	I-2	2-3	3-4	4-5	5-6	6-7	7-8
I978-I979	-3.00	-0.47	0.52	I.80	I.I0	-	-
I979-I980	-I.53	0.52	0.97	2.48	2.97	-	-
I980-I98I	-3.I4	-I.53	0.I0	I.94	0.43	0.69	-
I98I-I982	-3.66	-I.47	-0.48	0.47	0.6I	-	-
I982-I983	-I.60	-0.20	I.22	3.42	4.83	-	-
I983-I984	-2.20	-0.26	-0.36	I.00	-	-	-
Mean 1978-1984	-2.52	-0.68	0.49	I.85	I.99	-	-

Table 6 Total mortality (Z) on silver hake females catch per hauling hour by BMRT in 1978 - 1984

Years	Age						
	I-2	2-3	3-4	4-5	5-6	6-7	7-8
I978-I979	-2.I7	-I.I6	-0.34	0.72	I.50	I.85	2.73
I979-I980	-0.69	0.37	0.48	I.07	I.36	I.34	0.I4
I980-I98I	-0.96	-I.33	0.89	0.40	0.9I	0.73	0.90
I98I-I982	-3.63	-2.09	-0.85	-0.09	-0.I2	-0.28	-0.59
I982-I983	-2.08	-0.47	-0.30	I.55	2.33	2.56	2.76
I983-I984	-2.I2	-0.07	-0.93	0.0I	0.73	0.57	I.49
Mean I978-I984	-I.92	-0.95	-0.26	0.73	I.34	I.35	I.49

Table 7 Total mortality (Z) of silver hake males and females by catch per hauling hour by RMRT in 1977 - 1984

Years	Age						
	1-2	2-3	3-4	4-5	5-6	6-7	7-8
1977-1978	-4.44	-1.16	1.20	1.99	1.84	0.56	0.32
1978-1979	-2.43	-0.96	0.10	0.89	1.85	2.10	2.77
1979-1980	-1.21	0.34	0.79	1.35	1.59	1.14	-0.48
1980-1981	-2.40	-1.45	-0.38	0.70	0.84	0.67	0.78
1981-1982	-3.65	-1.59	-0.62	0.10	-0.07	-0.10	-0.55
1982-1983	-1.92	-0.44	0.43	1.93	2.45	2.40	2.45
1983-1984	-2.85	-0.09	-0.44	0.45	1.16	0.77	1.70
Mean 1977-1984	-2.70	-0.89	0.27	1.06	1.61	1.26	1.40

Table 8 Values of M and F adopted for estimating silver hake stocks using VPA

Age	2	3	4	5	6	7	8
M	0.20	0.50	1.00	1.00	1.00	1.00	1.00
F	0.01	0.05	0.15	0.25	0.25	0.25	0.25

Table 9 Silver hake catches 10^6sp. in Division 4 VWX in 1975-1984

Years	Age	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	2	110	299	14	43	58	29	14	27	67	37
	3	227	194	71	67	76	65	74	50	47	137
	4	157	64	58	59	53	61	59	89	36	117
	5	45	23	12	19	22	17	18	29	13	38
	6	12	4	2	4	4	4	5	10	4	7
	7	5	2	+	1	1	1	1	2	1	2
	8	2	-	+	1	+	+	+	1	+	+
	Total	558	586	157	194	214	177	171	208	168	338

Table 10 Mean weight (g) of silver hake by age in 1984

Age	1	2	3	4	5	6	7	8+
Weight	44	110	156	207	307	392	454	709

Table 11 Fishing mortality (F) of silver hake in Division 4 VWX in 1975-1984

Years	Age	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	2	0.1053	0.2078	0.0157	0.0475	0.0516	0.0257	0.0091	0.0108	0.0169	0.0100
	3	0.2876	0.3187	0.0805	0.1103	0.1271	0.0873	0.0989	0.0481	0.0271	0.0500
	4	0.7057	0.2117	0.2589	0.1512	0.2069	0.2458	0.1830	0.2865	0.0763	0.1500
	5	0.4579	0.5409	0.1257	0.2979	0.1790	0.2242	0.2519	0.3053	0.1397	0.2500
	6	0.8448	0.1469	0.1388	0.1154	0.2159	0.1095	0.2229	0.5848	0.1283	0.2500
	7	0.2500	0.9034	0.0349	0.4200	0.0793	0.1692	0.0943	0.4072	0.2403	0.2500
	8	0.2500	-	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500

Table 12 Assessment of silver hake stock size (10^6sp.) using VPA in 1975-1984 in Division 4 VWX

Years	Age	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	2	1208	1753	1010	1032	1268	1250	1653	2738	4431	1500
	3	1143	890	1166	814	806	986	998	1341	2218	3567
	4	465	520	392	653	442	430	548	548	775	1309
	5	187	84	155	111	206	132	124	168	151	264
	6	30	43	18	50	30	63	39	35	45	48
	7	37	5	14	6	16	9	21	11	7	15
	8	12	-	1	5	1	6	3	7	3	2
	Total	3081	3956	2756	2671	2770	2877	3384	4849	7631	7705

Table 13 Assessment of silver hake stock size (thous. tons) using VPA in 1975-1984

Year	Age	I975	I976	I977	I978	I979	I980	I98I	I982	I983	I984
	2	I33	I93	III	II4	I39	I38	I82	300	488	I65
	3	I78	I39	I82	I26	I26	I53	I56	209	346	556
	4	96	I08	3I	I35	92	89	II3	II4	I60	27I
	5	57	26	48	34	63	4I	38	52	46	8I
	6	I2	I7	7	20	I2	25	I5	I4	I8	I9
	7	I7	2	6	3	8	4	I0	5	3	7
	8	8	0	I	4	I	4	2	5	2	2
	Total	50I	485	436	436	44I	454	5I6	699	I063	II0I

Table 14 Abundance of silver hake fingerlings (10^7 sp.) from results of trawl surveys, 1978-1984

Years	I978	I979	I980	I98I	I982	I983	I984
Abundance	48	I2	5	110	2	34	II

Table 15 Silver hake catches and stock size (10^6sp. and thous. tons) in Division 4 VWX in 1984-1986

Age	2	3	4	5	6	7	8	Total 2 years and older	
								10^6sp.	thous.t
Stock, 1984	I500	3567	I309	264	48	I5	2	7705	II0I
M	0.20	0.50	I.00	I.00	I.00	I.00	I.00		
F 1984	0.03	0.I0	0.20	0.25	0.25	0.25	0.25		
Stock, 1985	2500	II92	I958	394	75	I4	4	6I37	I025
F 1985	0.03	0.I0	0.20	0.25	0.25	0.25	0.25		
Catch, 1985	68	89	227	56	II	2	I	454	92
Stock, 1986	2000	I987	654	589	II3	2I	4	5368	903
F 1986	0.05	0.20	0.40	0.60	0.60	0.60	0.60		
Catch, 1986	88	286	I4I	I76	34	6	I	732	I54