

Northwest Atlantic



Fisheries Organization

Serial No. N1327

NAFO SCR Doc. 87/42

SCIENTIFIC COUNCIL MEETING - JUNE 1987

Assessment of the Scotian Silver Hake (*Merluccius bilinearis*)

Stocks and Allowable Catch in 1988

by

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Abstract

In 1986, the Scotian silver hake catches constituted 72 thous. tons out of the recommended TAC of 100 thous. tons. Assessment of the stocks using the VPA, and assessment of the recruitment from the trawling survey data suggest that the stock size in the beginning of 1988 will be 1030 thous. tons, which allows for exemption of 200 thous. tons of TAC in 1988.

I. Materials and methods

As in the previous years, the stock assessment was made using the VPA. The data on the silver hake total catch from Div. 4 WVX were adopted from the NAFO Statistical Bulletins and Circular Letters of the NAFO Secretariat. The catch per effort data were based on the Soviet catch statistics for the ships of the BMRT class. The materials for the determination of the size and age composition of the catches were collected by the observers on the Soviet ships. The age was determined from the otoliths (ageing technique had been agreed upon with the Canadian scientists). The recruitment of two year old fish was estimated based on the data of the joint USSR-Canada surveys that have been conducted annually, beginning in 1978, on the Soviet ships.

## II. Results

### a. State of fisheries

Silver hake catches in Div. 4WVX in 1986 constituted 72 thous. tons out of the recommended TAC of 100 thous. tons. The Soviet catches made up 66.4 thous. tons, i.e. 92% (Table 1).

Fishing conditions in 1986 were quite favourable due to dense and stable silver hake concentrations on the shelf slopes in the area open by Canada for foreign fishery.

Formation of hake concentrations on the southern slopes of the Scotian Shelf can be attributed to the influx of cold waters to near-bottom layers, which resulted in that silver hake had to keep to the Shelf slopes with warmer waters.

### b. Age composition of catches

Age composition of the Soviet silver hake catches is presented in Table 3. As is evident from the Table, in 1986, the bulk of the catches was made of a relatively strong 1983 year class at the age of three. In 1985 the proportion of the 1983 year class in the catches was also considerably high. Then came the four year old fish of a relatively poor 1982 year class. The proportion of five-year-olds and older fish amounted to only 6%. In general, the silver hake population, as well as the Georges Bank silver hake, is characterized by a sharp decline after four years of life, which, as had been indicated earlier, results from massive mortality of the fish after spawning. The majority of females attains the sexual maturity at the age of four, and of males at the age of three (Noskov, 1985).

### c. Assessment of mortality rates

Natural mortality rates determined earlier are identified by age (Noskov, 1985). They are 0.20 for two-year olds, 0.50 for three-year olds, and 1.00 for four-year olds and older fish (Table 4). To determine the starting values of natural mortality rates, various methods for tuning VFAs described in the paper by Pope and

Shepherd (1983), and other methods (mean long-term values, equation of regression between natural mortality rates and fishing effort) were used. Correlation factors characterizing the closeness of correlation specified in the methods or a correlation factor between the fishing effort and fishing mortality rate determined from VPA were used as the criteria of application of one or another method or tuning results. The obtained correlation factors from the results of tuning did not exceed 0.2-0.4 for all 3 to 6 age groups, and were negative for two- and seven-year-olds and older fish. With regard for this evidence the method of mean long-term values was selected as a method of tuning the VPA. The errors in starting values of the fishing mortality are given in Table 5.

From the values of  $F$  starting and its errors the confidence intervals were determined, and the mean value of  $F$  starting was used for the stock assessment (Table 4). The obtained estimates for 1977-1986 are given in Table 6. The abundance of two-year-olds of the 1984 year class in 1986 was calculated from the results of inventory surveys of the young-of-the year and amounted to  $2000 \times 10^6$  sp., that is below the mean value (Table 7).

For the commercial stock biomass assessment for 1986 the data on the mean weight by age in 1986 were used. The stock biomass estimates for 1987 and 1988 were based on the mean weight data for the 1980 to 1986 period (Table 8). In the beginning of 1986, the estimated stock size was  $4055 \times 10^6$  sp., and the biomass amounted to 676 thous. tons.

The estimate of the 1987 stock size has resulted from the stock size in the beginning of 1986 and the natural and fishing mortality rates in 1986 by age. The abundance of two-year-olds of the 1985 year class was estimated at  $3000 \times 10^6$  sp., that is above the mean value (Table 9).

The probable 1987 catch will be 75 thous. tons. With this level of fishing, the fishing mortality rate will be 0.05 in two-year-olds, 0.15 in three-year-olds, 0.20 in four- and five-year-olds, and 0.30 in six- and seven-year-olds. With the 1987 stock size, the fishing mortality in this year and the abundance of two-year-olds

on the order of  $2500 \times 10^6$  sp., the 1988 stock can be estimated at  $5927 \times 10^6$  sp. or 1030 thous. tons, which, at the optimum fishing mortality rate, will allow to catch 200 thous. tons in 1988 (Table 9)

High estimates of the silver hake abundance in the recent years are consistent with the results of trawling surveys, which have been conducted by the Canadian scientists every July (Waldron and Fanning, 1986). According to the data of these surveys, the silver hake stocks in 1984 and 1985 considerably exceeded the 1973 level, when the silver hake catches constituted 296 thous. tons.

References

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3. D.E.Waldron and L.P.Fanning. Assessment of the Scotian Shelf Silver Hake Population in 1985. NAFO SCR Doc. 86/62.

TABLE 1. Scotian silver hake catches (thousand tons) in 1975-1986.

Years	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
TAC	120	100	70	80	70	90	80	80	80	100	100	100
Total catch	116	97	37	48	52	45	41	53	36	71	75	72
Soviet catch	113	82	33	44	45	41	40	46	27	56	56	66

TABLE 2. Fishing efforts of the USSR ships of BMRT type during the Silver Hake fishing in Nova Scotia.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
	3	4	5	6	7	8	9	10	11	12	13	14	15
1976	No. of fishing days	67	306	269	356	689	527	182	161	228	145	213	3184
	Catch per fishing day, t	33.9	33.1	35.3	33.8	22.2	25.6	34.0	39.4	37.2	33.3	34.9	31.2
1977	No. of fishing days	-	217	369	280	408	550	97	38	12	10	-	1979
	Catch per fishing day, t	-	24.5	26.9	26.5	27.1	27.3	26.8	123.6	11.1	18.8	-	26.6
1978	No. of fishing days	-	-	108	495	608	701	374	38	2	-	-	2326
	Catch per fishing day, t	-	-	18.4	16.5	19.9	27.9	31.3	20.7	4.0	-	-	23.4
1979	No. of fishing days	-	-	101	566	631	503	172	31	4	-	-	2008
	Catch per fishing day, t	-	-	22.3	25.8	26.5	35.8	29.8	32.4	21.0	-	-	28.8
1980	No. of fishing days	-	-	85	546	732	710	413	9	-	-	-	2500
	Catch per fishing day, t	-	-	22.5	20.8	21.0	24.9	16.4	15.1	-	4.6	-	21.3
1981	No. of fishing days	-	-	50	473	656	552	41	-	-	-	-	1772
	Catch per fishing day, t	-	-	14.4	29.3	22.6	21.8	32.1	-	-	-	-	27.2
1982	No. of fishing days	-	-	48	427	533	191	-	-	-	-	-	1211
	Catch per fishing day, t	-	-	50.2	40.8	40.2	37.2	9.3	-	-	-	-	40.0
1983	No. of fishing days	-	-	157	439	481	24	-	-	-	-	-	1101
	Catch per fishing day, t	-	-	36.8	31.7	19.4	11.8	-	-	-	-	-	26.6
1984	No. of fishing days	-	-	-	372	580	646	72	-	-	-	-	1670
	Catch per fishing day, t	-	-	-	45.2	33.4	36.4	43.8	-	-	-	-	37.6
1985	No. of fishing days	-	-	-	244	698	1031	137	-	-	-	-	2100
	Catch per fishing day, t	-	-	-	40.2	42.7	16.5	45.4	-	-	-	-	29.8

TABLE 3. The Scotian silver hake catches in 1975-1986 ( $10^6$  sp.)

Age	Years											
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
2	110	299	14	43	58	29	14	27	67	37	100	49
3	227	194	71	67	76	65	74	50	47	137	116	157
4	157	64	58	59	53	60	59	89	36	117	89	122
5	45	23	12	19	22	17	18	27	13	38	36	20
6	11	4	2	4	4	4	5	10	4	7	5	1
7	5	2	0.3	1	1	1	1	2	1	2	1	+
8	2	0	0.1	0.7	0.2	1	0.4	1	0.4	0.3	0.1	+
Total	557.0	586.0	157.4	193.7	214.2	148.0	171.4	206.8	168.4	338.3	347.1	349.0
Thous. tons	116.7	97.2	37.1	48.4	51.8	44.5	44.6	60.2	35.8	74.3	75.4	72.2

TABLE 4. Fishing mortality rates in Scotian silver hake in 1977-1985

Age group	Natural mortality rate	Years									
		1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
2	0.20	0.01	0.05	0.07	0.042	0.02	0.03	0.08	0.02	0.06	0.04
3	0.50	0.13	0.13	0.13	0.16	0.12	0.10	0.28	0.14	0.15	
4	1.00	0.32	0.28	0.25	0.27	0.30	0.56	0.21	0.72	0.56	0.39
5	1.00	0.33	0.40	0.39	0.29	0.29	0.61	0.35	1.03	1.75	0.60
6	1.00	0.13	0.39	0.33	0.29	0.31	0.73	0.33	0.92	1.06	0.50
7	1.00	0.23	0.40	0.36	0.29	0.30	0.67	0.34	0.98	1.41	0.55

TABLE 5. Error in  $F_{start}$  and in correlation factor between fishing mortality and effort.

Age, years	Error in $F_{start}$ .	Correlation factor between F and fishing effort
2	0.015	0.054
3	0.035	0.061
4	0.119	-0.162
5	0.327	0.174
6	0.215	-0.013
7	0.265	0.006

TABLE 6. The Scotian silver hake stock size in 1977-1986 ( $10^6$  sp. and thous. tons).

Age group	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
2	853	947	862	772	671	783	918	1385	1826	2000
3	701	685	736	653	606	538	617	691	1101	1406
4	319	371	364	388	346	311	288	338	315	578
5	62	85	103	104	108	94	65	85	60	66
6	19	16	21	26	28	30	19	17	11	4
7	22	6	4	5	7	8	5	5	2	1
Total, sp.	1976	2110	2080	1948	1768	1762	1912	2521	3315	4055
Total, thous. tons	352	372	376	359	332	320	329	418	523	676

TABLE 7. Abundance ( $10^7$  sp.) of Scotian 0-group silver hake from the results of trawling surveys in 1978-1986.

Years	1978	1979	1980	1981	1982	1983	1984	1985	1986
Nos.	48	12	5	110	2	34	11	62	32

TABLE 8. Mean weight of Scotian silver hake by age-group for 1980-1985.

Year	Age, years									
	1	2	3	4	5	6	7	8	9	10
1980	39	123	190	250	360	452	640	810	1236	1536
1981	47	112	171	229	329	406	564	862	1214	1501
1982	43	124	200	267	380	431	640	729	1087	1538
1983	44	136	188	246	362	476	588	848	1137	-
1984	44	110	156	207	307	392	454	709	874	-
1985	54	131	189	253	367	472	633	813	1178	1700
1986	46	119	177	258	375	457	634	957	1177	1562
Mean for 1980-1985	45	122	182	244	354	441	593	818	1129	1567

TABLE 9. Catches and stocks ( $10^6$  sp. and thous. tons) of Scotian silver hake.

Age	2	3	4	5	6	7	Total of older than 2+	
							$10^6$ sp.	thous. tons
Stock, 1986	2000	1406	577	66	4	1	4055	676
M, 1986	0.20	0.50	1.00	1.00	1.00	1.00		
F, 1986	0.04	0.15	0.40	0.55	0.55	0.55		
Stock, 1987	3000	1574	734	143	14	1	5466	882
F, 1987	0.05	0.15	0.20	0.20	0.30	0.30		
Catch, 1987	132	173	85	17	2	+	409	75
Stock, 1986	2500	2357	822	221	43	4	5927	1030
F, 1988	0.05	0.30	0.60	0.60	0.60	0.60		
Catch, 1988	110	484	246	66	13	1	920	197