Northwest Atlantic Fisheries Organization

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Assessment of Stock Size and Allowable Catch of Silver Hake

(*Merluccius bilinearis*) on Scotian Shelf for 1985

by

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Abstract

In 1983 the total catch of silver hake at Nova Scotia was
33 thous. tons, with the total allowable catch estimated at
80 thous. tons. Based on the age composition of the catches
taken in 1983, and the assumption that in 1984 the fishing
intensity will maintain at the 1983 level, and in 1985 at the
optimum fishing mortality level, the commercial stock size for
1985 is given as 1 060 thous. tons, and the allowable catch as
115 thous. tons.

Materials and Methods

As in previous communications, the silver hake stock
size in Subarea 4 at Nova Scotia was estimated using the
V.P.A. Massive measurements were taken and otolith sampling
made regularly by observers on the Soviet commercial ships
for determination of age composition of the catches. The
value of total instantaneous mortality rate was produced
from the age composition of the Soviet catches taken in 1981
to 1983. The recruitment was estimated from the data of
trawling surveys of silver hake fry abundance, which have
been conducted under the joint USSR-Canada program each fall
since 1978. The natural mortality of 0.5 was adopted from
the previous studies (ICNAF Res. Doc. 76/VI/57, ICNAF Res.
Doc. 76/XII/157). The mean weight by age class was determi-
ned for the 1983 season (table 1).

Results

a. State of fishery

In 1983, with the total allowable catch of 80 thous.tons,
the USSR was allocated by Canada 43 thous. tons. The catch
by all countries in that year made up 33.2 thous. tons, and
the Soviet catch amounted to 27.4 thous. tons, which account-
ed for 63.7% of the quota. Favourable conditions persisted
through April and May until mid-June, and in the third ten-
day period of June silver hake moved from the zone open for
foreign fishery to the shallow waters, which resulted in
closure of the fishing by the Soviet and Cuban ships.

As in the previous years, the 1983 catches turned out to
be significantly under the allowable catches recommended by
NAFO (table 2).

b. Age composition of catches

Age composition of the catches for 1981-1983 is presented
in table 3. As is evident from the table, the 1983 catches
were predominated by the strong 1981 year class at the age of
two years. The proportion of this year class averaged to
42.6%. Then come the 1980 and 1979 year classes at the age of
three and four years (table 3).

c. Estimating total, natural and fishing mortality rates

Values of total mortality and initial values of fishing
mortality rates for 1983 could not be obtained from the data
showing age composition of catches per hauling hour for 1982
and 1983 because of anomalously large catches per hauling hour
in 1982. Therefore the data of age composition of catches per
hauling hour for 1980 and 1983 were used to estimate the total
mortality rate. The fishing mortality rate was calculated
based on the known values of total mortality rates for fully
exploited year classes, and natural mortality rates on the
larvae. For the purpose of verification of natural mortality
rates, the method of random solution search using the computer
was attempted. The used data were the catch per effort by age,

and fishing effort by year for the 1977 to 1983 period. The input data involved the extreme values of natural mortality rates from 0.1 to 1.5, and of fishing mortality rates from 0.01 to 2.0. The results showed that the natural mortality rate for one, two and three year olds was 0.1 on the average, ranged from 1.10 to 1.40. The fishing mortality rate values for one and two year olds fluctuated between 0.001 and 0.015, for three year olds between 0.12 and 0.25, for four year olds between 0.02 and 0.04, for five year olds between 0.02 and 0.03, etc. These mortality values are not real, for the stock size estimated using thse data will be two large. The unreal results were also obtained by Waldron and Sinclair (NAFO SCR Doc. 83/VI/59). Therefore the natural mortality rate for two year olds and older specimens was taken as 0.5 on the average. This value might differ from real values for the other age classes. So, in the future, it seems reasonable to calculate natural mortality rates by age class. Proceeding from the total mortality rate estimated from the 1980 and 1981 catches, and provided that the natural mortality rate is 0.5 and that the stock size value for the beginning of 1983 is given, the initial value of the fishing mortality rate will be 0.150 for four year olds, 0.250 for five year olds and 0.400 for six, seven year olds and older fish. The VPA method gave the values of 0.002 and 0.050 for two and three year olds respectively.

d. Assessment of silver hake fry abundance from the trawling survey data for the 1978-1983 period

As is estimated from the data of trawling surveys of distribution and abundance of silver hake fry conducted annually in October, the 1978, 1981 and 1983 year classes are relatively strong, the 1982 year class is not numerous (65 times as low as the 1981 year class), and the rest year classes can be regarded as average (table 4).

e. Assessment of stock size and allowable catch

The abundance and biomass of the silver hake stock for two year olds and older fish for the beginning of 1983 were

calculated from the well-known Baranov's formula

$$N = \frac{e^Z}{F(1^{-1-z})}$$

using the age composition data for the 1983 catches, natural
and fishing mortality rates, and the mean weight by age. The
stock size for the beginning of 1984 for three year olds and
older age classes was derived from the formula

$$N_i + 1 = Ni \cdot e^{-Z} ,$$

and the abundance of two year olds of the poor 1982 year class
was two times as low as the mean long-term abundance determined
earlier as $20 \cdot 10^5$ sp. by the V.P.A. When estimating the
allowable catch for 1984 it was assumed that the fishing inten-
sity in that year would maintain at the 1983 level. The
abundance of two year olds of the strong 1983 year class was
estimated at $35 \cdot 10^5$ sp. for 1985, and that of the other
year classes was calculated judging by their size and loss in
1984. The fishing intensity for 1985 was adopted as $F_{0.1}$.
As a result, for 1985, the total abundance of the exploitable
stock amounted to $57 \cdot 10^8$ sp., the biomass to 1 060 thous.tons,
and the allowable catch to 115 thous.tons (the data and the
course of calculations are presented in table 5).

References

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TABLE 1. Age and weight of silver hake in 1983.

Age, years	:	1	2	3	4	5	6	7	8	9
Weight, kg		0.044	0.136	0.188	0.246	0.362	0.476	0.588	0.848	1.137

TABLE 2. Total allowable catches and catches taken in 1975 to 1983, thous. tons.

Years	1975	1976	1977	1978	1979	1980	1981	1982	1983
TAC	120	100	70	80	70	90	80	80	80
Catch	116	97	37	48	52	45	41	60	33

TABLE 3. Age composition (%) of silver hake in 1981-1983.

Year	1	2	3	4	5	6	7	8	9	10	Total
1981	0.7	9.9	42.6	33.0	10.3	2.6	0.7	0.1	0.1	3.5	100%
1982	4.9	14.9	24.1	37.6	12.8	4.1	1.1	0.4	0.1	3.6	100%
1983	1.4	42.6	27.0	20.6	5.8	1.9	0.5	0.1	0.1	3.0	100%

TABLE 4. Minimum abundance of silver hake fry (10^7 sp.) from the data of trawling surveys conducted in October 1978-1983.

Years	1978	1979	1980	1981	1982	1983
Minimum abundance	48.2	12.2	5.3	110.9	1.7	34.3

TABLE 5. Silver hake catches and stocks (10^5 sp. and thous. tons) in the Nova Scotia area in 1983-1985.

	Age, years						Total 2+	
	2	3	4	5	6	7	10^5 sp.	thous.t
C_{83}	673	467	362	126	35	14	1 696	33
F_{83}	0.002	0.050	0.150	0.250	0.400	0.400		
N_{83}	33 650	12 289	3 291	716	133	53	50 132	800
N_{84}	10 000	20 392	7 091	1 718	338	54	39 563	775
F_{84}	0.002	0.050	0.150	0.250	0.400	0.400		
C_{84}	20	775	780	302	89	14	1 980	50
N_{85}	35 000	6 060	11 766	3 702	811	136	54 475	1 060
F_{85}	0.003	0.070	0.200	0.600	0.600	0.600		
C_{85}	70	321	1 694	1 348	295	49	3 777	115
$\overline{W}$	0.136	0.188	0.246	0.362	0.476	0.588		

Notes: N - abundance

F - instantaneous mortality rate

C - catch

$\overline{W}$ - mean weight