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On Age Changes in Natural Mortality Rates of Silver Hake on the Scotian Shelf

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ABSTARCT

An attempt has been made to approximately estimate silver hake natural mortality rate by age starting from age 4 and older. The calculations are based on the assumption that the fishing efficiency for silver hake is relatively constant after the age of full recruitment into the fishery (at age 3 for the species in question). The supposition is made that the results obtained in this study together with the estimates calculated by Waldron (1989) for younger age-groups will make it possible to estimate stock size more accurately than it has been done for many years using a constant natural mortality rate.

INTRODUCTION

It is a commonly accepted idea now that the natural mortality rate (M) in fish changes with age. However, the problem of reliable estimation of those rates has not been solved as yet and it makes the researchers to use the constant M values as before which questions the reliability of stock and likely catch estimates. Most significant errors may arise in the calculations for fish species with short life spans. As to silver hake, an attempt to get the variable M values and to use them for stock assessment was first made by Noskov (1984). However, the Scientific Council (NAFO) didn't consider it possible to give up the usage of constant M value since the result obtained appeared to be mathematically unreliable and the calculation procedure-poorly documented. Paper by Waldron (1989) became a first relatively successful attempt to calculate the variable values for the silver hake natural mortality rates. In the paper the author having studied the effect of the silver hake cannibalism on its population abundance on the Scotian Shelf, was able to calculate M-estimates for age-groups 1, 2, 3 and 4. The present paper is an attempt to at least approximately calculate the M-values for age-groups 4 and older.

MATERIALS AND METHODS

The revized Canadian data on the hake age composition of the commercial catches in 1977-1988 (Waldron et al., 1989) as well as the revized Soviet data for 1989 were the basis of the analysis.

Age	Catch, '000 fish
1	25 916
2	102 264
3	208 493
4	104 291
5	22 458
6	3 920
7	369
8	33
9	4

Standardized catch per unit effort (CPUE) data were taken from Gassuikov (1990). Recalculated by age starting from age 4 the CPUE's in numbers are presented in Table 1. Natural logarithm differences were calculated for each year of fisheries and each year-class; then they were summed over the whole observation period after which the mean values of the total mortality rate (Z) were calculated. Further considerations were based on the hypothesis that starting from age of full recruitment into the fishery (PR=1.000) the fishing mortality remains relatively stable and even goes down judging from the papers presented at NAFO Scientific Council Meeting in June 1990, this hypothesis seems to get or has gotten already the international acceptance. A methodical approach used in the present paper was first tried by the auther when he made an attempt to determine natural mortality rate for red hake (Rikhter, 1972).

RESULTS AND DISCUSSION

The estimates calculated using the above described methods are given in Tables 2 and 3. From Table 2 it is seen that the total mortality rate goes up between ages 4 and 7 and goes down in 8-year-old fish. The latter can be explained by both the sharp decrease in the silver hake catchability at the oldest age and the errors in age readings in most old fish. Estimates obtained using age compositions of CPUE (Table 3) well enough correlate with the previous ones for age-groups 4, 5 and 6 but noticably differ from those for the 7-year-old fish. The question arises: which of the estimates are more reliable here? In this situation the nature of the information on CPUE should be taken into consideration which estimates don't always show the correct status of the stock due to the changes in the silver hake behaviour and distribution from year to year. This may result in the erroneous estimates of the mortality rate in the adjoining age-groups from the same year-class not to mention the negative ones. For this reason, in futher analysis we prefered to use mean values of Z presented in Table 2 . When analysing the assumption was made that the fishing mortality remains constant starting from age-group 3, i.e. a carefull approach was chosen. In our case it seems that a decrease in fishing mortality with age would result in a more significant increase in natural mortality rates for older fish.

According to Waldron (1989) M for the 3-year-old fish is 0.236 while the increments of the total mortality rate values (Table 2) are as follows:

Age	4	5	6
Increment	0.096	0.189	0.023

According to the assumption accepted those increments are totally caused by the increase in natural mortality rate which values for the above mentioned age-groups are 0.332, 0.521 and 0.544, respectively. For the older fish it seems possible to take actually any M value without any significant effect on the stock estimate.

Thus, our natural mortality rates for silver hake on the Scotian Shelf with the account of those presented by Waldron (1989) are as follow:

Age	1	2	3	4	5	6
r	0.733	0.642	0.236	0.332	0.521	0.544

As it has been mentioned above M-values for age 4 and older may be underestimated alittle. Nevertheless, it is very likely that the natural rates presented here will make it possible to get the estimates of the stock size which are closer to the actual ones than those obtained from constant M=0.4 used for many years.

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Table 1

Standardized catches per hour hauling by age and year, fish

Age	Year												
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
4	923	1546	1686	4392	1648	5705	1991	4261	2724	6681	5656	2344	8070
5	212	550	218	574	500	2646	769	1001	1543	2314	957	1294	1737
6	32	228	450	202	121	475	247	233	419	672	740	195	145
7		85	143	51	43	165	55	70	114	112	43	146	36
8			20	17	9	41	14		19	37		24	
9					9								

Table 2

Total mortality rates (Z) of silver hake on the Scotian Shelf from age compositions of commercial catches in 1977-1989

Yaer	Natural logarithm diffeerence				
	4	5	6	7	8
1977	1.983	1.278	1.991	0.668	
1978	1.028	0.896	1.007	0.525	1.356
1979	0.497	0.826	1.147	1.821	0.433
1980	0.810	1.043	1.304	1.177	1.384
1981	1.197	1.400	1.025	1.337	0.358
1982	0.772	1.712	1.090	1.557	2.089
1983	0.945	1.169	1.467	1.246	1.259
1984	1.449	1.441	1.298	1.725	2.476
1985	1.318	1.283	1.377	2.251	1.252
1986	1.060	1.239	1.925	0.761	1.069
1987	1.769	0.273	2.421	1.191	0.298
1988	0.593	1.907	0.256	2.294	0.293
1989	1.536	1.746	2.363	2.414	2.110
Z	1.151	1.247	1.436	1.459	1.198

Table 3

Total mortality rates (Z) of silver hake on the Scotian Shelf from age compositions of standardized catches per unit effort in 1973-1983

Year-class	Natural logarithm difference			
	4	5	6	7
1973	0.518	0.719	2.177	1.735
1974	1.959	0.076	1.547	0.047
1975	1.077	1.557	-0.310	2.467
1976	2.173	0.052	2.156	
1977	-0.474	2.372	1.261	1.304
1978	2.004	1.203	0.715	1.125
1979	0.687	0.871	1.320	
1980	1.011	0.831	2.749	0.583
1981	0.163	1.140	1.623	
1982	1.943	1.591	1.689	
1983	1.475	2.188		
Z	1.140	1.145	1.493	1.210