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On the Problem of Sliver Hake Stock Long-term Dynamics in the Scotian Shelf Area (Div. 4VWX)

by

V. A. Rikhter

Atlantic Scientific Research Institute of Marine Fisheries and Oceanography (AtlantNIRO)
5 Dm. Donskoy St., Kaliningrad, 236000 Russia
[e-mail: atlant@baltnet.ru]

Abstract

The analysis of silver hake stock dynamics has been carried out for the period from 1962 to 1996 using non-parametric approach proposed by Rivard (1998). The attempt was made to obtain the idea of the general trends in hake stock state during earlier years starting from 1920s when no systematic researches of the latter were performed. For this purpose the information on sea surface and air temperature during respective period was used (Drinkwater *et al*., 1999).

Introduction

As known, since 1998 silver hake of the Scotian Shelf had ceased to be the object of consideration by NAFO Scientific Council. However, being one of the most abundant demersal species of the NAFO area it is still interesting to the scientists involved in studying fish resources of the North-Western Atlantic Ocean. Certainly, the degree of hake knowledge is rather high since its systematic study had been commenced in the first half of 1960s. Nevertheless, there are still some unsettled problems relevant to biology and, in my opinion, especially to this species abundance dynamics. Thus, new fishery conditions and the level of researches, as appeared following 200-mile zone introduction by Canada in 1977, have extremely complicated the comparison of data on hake stock state and, particularly, stock absolute size before and after the above said year. As a result, the general process of abundance dynamics observed from the early 1960s had been artificially subdivided into 2 periods (before and after 1977). Besides, after accumulation of sufficiently long observation series the stock retrospective estimation had been made by the Scientific Council only for the second period, since application of data for previous years was considered non-correct. Indeed, based on the retrospective analysis results, the amplitude of the stock estimates fluctuations appeared evidently higher before 1977 as compared to those in subsequent years. Significant differences were also revealed in biomass and abundance values (Clay and Beanlands, 1980; Showell, 1997). Probable reasons of the above said differences have been assumed by Rikhter (1994, 1997). However no further researches in this direction have been made. Thus, this problem is still waiting for solution. Evidently, exclusion of the whole block of scientific and commercial data obtained as a result of 15-year researches, out of analysis process has not promote the progress in silver hake abundance dynamics research.

In this paper the attempt has been made to provide comparable data on the latter stock state from 1962 to 1996 inclusive as well as to obtain, at least, a general idea of abundance dynamics during the earlier period when no systematical researches of silver hake have been carried out.

Materials and Methods

Retrospective estimates of the total (TSB), spawning (SSB) stock biomass and recruitment (R) were used as input data. The data for the period 1962 to 1978 inclusive (Clay and Beanlands, 1980) and from 1979 to 1996

(Showell, 1997) were analyzed. It was considered non-correct to use data on total catch and catch per unit effort (CPUE) since the latter might disturb the picture of silver hake stock dynamics. Thus, while before 1977 total catches were determined mainly by the latter biomass level, subsequently the catch value has been more dependant on hake availability to the fishery. The same is true of CPUE. Non-parametric approach developed by Rivard (1998) has been chosen as a mean to attain the goal. To estimate the overall index (OI), the values from 1 through 4 according to the categories proposed by Rivard (1998) were assigned to every characteristic of the stock state. The values of OI were interpreted in compliance with the same as made by the author for the main cod stocks in the North-Western Atlantic Ocean. Taking into account that hake biomass and recruitment estimates for 1962-78 and 1979-96 differed significantly, the range and absolute values of the above said characteristics were assumed different for each of 4 categories:

Much worse than average		Worse than average		Better than average		Much better than average	
1		2		3		4	
1962-78	1979-96	1962-78	1979-96	1962-78	1979-96	1962-78	1979-96
Recruitment, mln. ind.							
to 500	to 500	500-1000	500-1000	1000-2000	1000-1500	>2000	>1500
Total biomass, thous. t							
to 300	to 150	300-400	150-200	400-500	200-250	>500	>250
Spawning biomass, thous. t							
to 200	to 100	200-300	100-150	300-400	150-200	>400	>200

Hydrometeorologic data relevant to the Scotian Shelf area (Drinkwater *et al*., 1999) were considered to reveal possibilities of the latter utilization in hake stock dynamics assessment during the period preceding its systematic researches.

Results and Discussion

Table 1 shows the distribution of hake stock characteristics by categories and estimates of OI are presented. Dynamics of the latter for the whole observation period is shown in Fig. 1. The data presented show that in the late 1960s – the first half of 1970s, the first half of 1980s and probably in the second half of 1990s the stock level was at the level "better and much better than average", while in 1960s, the late 1970s, the late 1980s-early 1990s it was at the level "worse and much worse than average".

Fluctuations of silver hake stock shown in the figure, as the results of the previous researches evident, correspond fairly close to the thermal regime variations on the Scotian Shelf. Thus, correlation coefficient (R) between one year old fish and sea surface temperature anomalies (SSTA) in the continental slope area amounted to 0.73 based on the data for 1977-1991 (Sigaev and Rikhter, 1996). In the earlier years quite good correspondence, at least at qualitative level, was also observed between hake stock and SST anomalies on the Scotian Shelf and near-bottom water temperature in Emerald Basin (Drinkwater *et al*., 1999).

Based on the above considerations it can be assumed that the temperature factor is in any case a good indication of hake stock state if not the main reason of hake population variability. Therefore, the idea appeared to use the same for the purpose of providing approximate pattern of hake abundance dynamics during the period when no stock assessment were made. For this purpose it seems possible also to use the data on air temperature anomalies (ATA) if the results of researches show the trends coincidence of the latter and SSTA dynamics. For example, Drinkwater *et al*. (1999) follow the similarity of curves on Fig. 5 (ATA, Sable Island) and Fig. 37 (SSTA, St. Andrews, Halifax). Based on this information, we may try, naturally only approximately, to extrapolate silver hake stock dynamics back to the early 1920s. Following the curves shape (Fig. 5 and 37, Drinkwater *et al*., 1999) it can be assumed that in the first half of 1920s and late 1930s – the first half of the 1940s the hake stock was in depression in spite of the absence of the target fishery, while in the second half of 1920s – the early 1930s and the late 1940s-1950s the abundance increase was observed. Short-term periods of stock decrease and increase probably occurred in the late 1950s-early 1960s.

Now we shall try to summarize our findings for the whole period considered.

The stock state

Worse and much worse than average	Better and much better than average
The first half of 1920s	The second half of 1920s-the early 1930s
The late 1930s-the first half of 1940	The late 1940s-1950s
1960s	The first half of 1970s
The late 1970s	The first half of 1980s
The late 1980s-the first half of 1990s	The second half of 1990s

The data presented, through being approximate, provide at least the basis of consideration and allow to make some conclusions. Thus, if the pattern of extrapolated trends of hake abundance dynamics is close to the true one, the hypothesis of considerable fishery impact upon the hake stock state may be rejected totally. Here we mean a normal, including rather high one, however not excessively high, theoretically possible rate of fishing. Further, taking into consideration that the periods of high and low hake abundance as observed, are not less than 5 years, we may with high probability assume that hake fishing and spawning biomass in the second half of 1990s was at the level "better and much better than average".

From the precautionary approach point of view the above said means that fishing mortality rate in the specified period may be kept at the constant level of $F_{0.1}$, and the latter value may be assumed as a target reference point.

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Table 1. Estimates of the overall index of silver hake stock state in the Scotian Shelf area by years.

Year	R	TSB	SSB	OI
1962	3	2	2	2.33
1963	3	2	2	2.33
1964	1	1	1	1
1965	1	1	1	1
1966	1	1	1	1
1967	2	1	1	1.33
1968	3	1	1	1.67
1969	4	3	2	3
1970	3	4	4	3.67
1971	3	3	3	3
1972	4	4	3	3.67
1973	3	4	4	3.67
1974	4	3	2	3
1975	4	4	3	3.67
1976	3	4	4	3.67
1977	2	3	4	3
1978	2	2	3	2.33
1979	2	3	3	2.67
1980	2	2	3	2.33
1981	2	2	2	2
1982	4	3	3	3.33
1983	2	3	3	2.67
1984	3	4	4	3.67
1985	2	3	4	3
1986	4	3	3	3.33
1987	2	2	3	2.33
1988	2	2	3	2.33
1989	3	2	2	2.33
1990	2	2	2	2
1991	2	1	2	1.67
1992	2	1	1	1.33
1993	2	1	1	1.33
1994	2	1	1	1.33
1995	3	2	1	2
1996	4	3	2	3

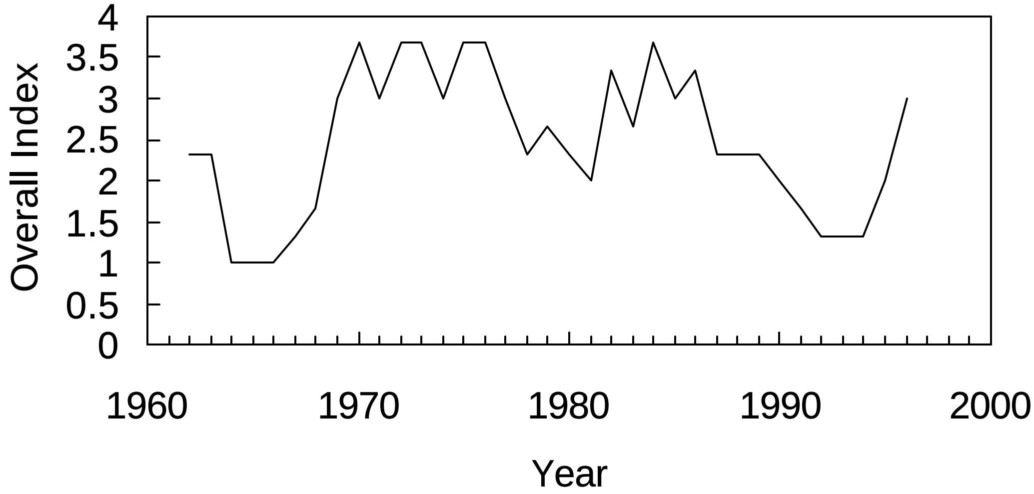

Fig. 1. Plot of the total index of silver hake stock state in the Scotian Shelf area 1962-96.