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On Possible Causes of the Scotian Silver Hake Abundance Fluctuations

by

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ABSTRACT

The abundance of one-year-old Scotian silver hake and some temperature characteristics of the waters in the Northwest Atlantic area over 1962 to 1988 are compared. Tendencies to direct and indirect dependence of one-year-old hake abundance on environmental factors in the year of the year class birth have been revealed.

INTRODUCTION

In the present report an attempt is made to explain the fluctuations of the Scotian silver hake abundance based on the analysis of variability of some environmental factors, in particular, temperature changes. When selecting these factors, the author proceeded from the assumption that they reflect climatic changes in the Labrador Current and Gulf Stream system, with the Nova Scotian Shelf area as an integral part. Also it has been assumed that the life cycle of the silver hake in the shelf area proceeds in warm slope waters, the temperature variations of which directly or indirectly influence the reproduction, survival and distribution of the silver hake. As thermal structure of the shelf water results to a great extent from interaction of warm slope and cold Labrador waters their proportion may determine the formation of favourable or unfavourable environmental conditions for the silver hake including the conditions for survival and formation of the abundance. Those were general prerequisites which underlay the search and selection of characteristics considered below.

SPECIAL SESSION ON CHANGES IN FISH POPULATIONS

MATERIALS

To illustrate year-to-year fluctuations of the silver hake abundance over 1963-1987, the data on one-year-olds abundance for 1963 to 1970 period (Clay, 1980), for 1971 to 1985 period (Waldron et al., 1986), for 1971 to 1985 period (fig. 1/4) and for 1977 to 1987 period (Rikhter, 1989) (fig. 1/2) were used. As is evident from the figure, there is a good agreement between the data of Waldron and Rikhter.

Three indices were used to show advective changes in thermal shelf water structure. The first index is the mean summer and autumn values of the minimum water temperature in cold intermediate layer in Emerald Deep for the 1962 to 1982 period (fig. 1/3). The second index is the position of the cold shelf water boundary on the surface for the 1982 to 1988 period (fig. 1/4). The third index is the position of the slope water boundary on the surface (fig. 1/5). The latter two indices signify the distance of each boundary from 37°N in tens of miles (the mean of the sum of values at meridians between 59 and 65°W) averaged for August and October. The first index has been used by the author since 1969 (Sigaev, 1969) while the second and third indices were suggested in 1986 (Sigaev, 1986). As oceanographic conditions on the Scotian Shelf are genetically correlated with the conditions observed in the adjacent north-eastern areas, another index was selected which reflects winter conditions in those areas, namely, mean monthly values of the water temperatures in January at Climate Station 27 (Saint John's, Newfoundland) published partly by Dr. Akenhead (1983) and partly kindly presented by him personally. None of the given temporal series of data were subject to any smoothing as the first stage analysis was aimed at searching qualitative relations between the environmental conditions in the year of appearance of the new silver hake year class and its abundance at age 1.

RESULTS AND DISCUSSION

The comparison of the diagram of one year old silver hake abundance and oceanographic indices showed a qualitative similarity in temporal variability of abundance and temperature indices for an intermediate cold layer, cold shelf water boundary and slope water boundary. The abundance and the above-mentioned characteristic values decreased during the periods of 1963 to 1966 and 1972 to 1981, though the decrease of index 3 stopped in 1978. The abundance of one year olds and the values of the same characteristics increased during the periods of 1966 to 1972 and 1981-1982 to 1987. If we attempted to smoothen these curves, the direct qualitative relationship would have been more obvious. If tendencies of indices and abundance changes are traced from year to year with the shift of the latter a year ahead, it can be noted that in most cases greater (lower) abundance values were preceded by greater (lower) index values for the preceeding year. It is indicative of the availability of direct relationship between advective temperature changes and other correlated environmental factors as constituents of conditions of year class formation and one-year-olds abundance.

As distinct from the indices considered above, the January temperatures at St. 27 (fig. 1/6) are in generally in antiphase with fluctuations of one-year-olds abundance, i.e. the periods of increased abundance correspond to those of decreased temperature and vice versa. This peculiarity can be explaned by the influence of atmospheric and oceanographic hydrometeorological processes in the area of the Labrador Current and Gulf Stream interaction. In the years of increased winter temperatures, the amount of precipitations and ice melting in spring must increase in the areas situated north-eastward of the Scotian Shelf which may cause a greater transfer of cold waters to the Scotian Shelf area and increase the volume of cold interstitual layer in summer. The latter circumstance may result in worsening of environmental conditions for the period of spawning. The periods of decreased winter temperatures may lead to opposite tendencies.

In conclusion, it can be noted that the first results of qualitative analysis of the silver hake abundance fluctuations and of some environmental factors encourage further research in this direction so as to obtain quantitative estimates of the relationship for forecast-making.

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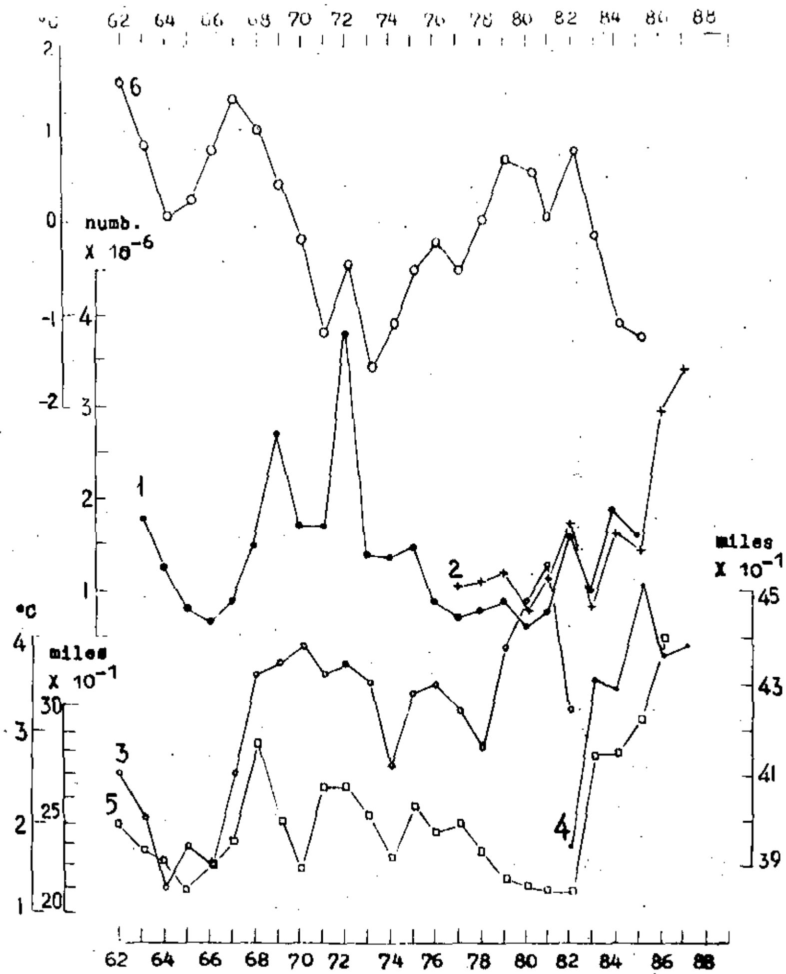

Fig. 1. Variations of one-year-old silver hake abundance on the Scotian Shelf (1, 2) over 1963-1987 and of environmental characteristics (3-6) over 1962-1987:

1 - abundance of one-year-old hake in bil. sp. according to Clay (1980) before 1970 and Waldron et al. (1988) after 1970;

2 - abundance of one year old hake abundance according to Rikhter (1989);

3 - minimum values of the water temperature, °C, in cold interstitial layer (means for summer and autumn);

4 - index of cold shelf water boundary localization on the surface (means for August and October);

5 - index of slope water boundary localization on the surface (means for August and October);

6 - mean temperature at Climate St. 27 in January, Saint John's, Newfoundland.