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On Possible Causes of Year-class Variability of Scotian Shelf Silver Hake (*Merluccius bilinearis*)

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Abstract

The abundance of 1-year-old silver hake (*Merluccius bilinearis*) on the Scotian Shelf (Div. 4VWX) and indices of temperature change in the Northwest Atlantic during the period 1962–88 were compared. Tendencies of direct and indirect dependence of silver hake recruitment and the abundance of 1-year-olds on these environmental factors are revealed.

Introduction

In this report an attempt is made to explain the fluctuations of year-class size of silver hake (*Merluccius bilinearis*) on the Scotian Shelf (Div. 4VWX) based on an examination of variability in water temperatures. The selection of temperature variability was based on the assumption that they reflect climatic changes in the Labrador Current and Gulf Stream system, within which the Scotian Shelf area is an integral part. It was also assumed that the life cycle of the silver hake in the shelf area progresses in warm slope waters and the temperature variations of those waters directly or indirectly influence the reproduction, survival and distribution of the silver hake. The thermal structure of the shelf water results, to a great extent, from the interaction of the warm slope waters and the cold Labrador waters. The relative proportions of these water masses determine the formation of favourable or unfavourable environmental conditions for the silver hake, including the conditions for survival.

Materials and Methods

To illustrate fluctuations in year-class strength of the silver hake over the period 1963–87, the data on 1-year-old silver hake abundance were obtained from three sources. For the period 1963–70 data from Clay and Beanlands (MS 1980) were used and from 1971 to 1985 data from Waldron *et al.* (MS 1988) were used (Fig. 1). Separate data were available for the period 1977 to 1987 (Rikhter, MS 1989). As is evident from Fig. 1, there was good agreement between the data of Waldron *et al.* (MS 1988) and Rikhter (MS 1989).

Three indices were used to show advective changes in thermal shelf water structure. The first index was the mean summer and autumn values of the minimum water temperature in the cold intermediate layer in Emerald Basin (Sigaev, MS 1969). The changes in the index from 1962 to 1982 are shown in Fig. 1. The second index which was the position of the cold shelf water boundary on the surface, is depicted for the period 1982–88, and the third (Sigaev, 1986) was the position of the slope water boundary on the surface (Fig. 1). 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. Since oceanographic conditions on the Scotian Shelf correlated with the conditions observed in the adjacent northeastern areas, another index was selected which reflects winter conditions in those areas. Here the mean monthly temperatures of the water in January to Climate Station 27, St. John's, Newfoundland (Akenhead, MS 1983, and pers. comm.), are plotted for the period 1962–86 (Fig. 1). None of the temporal series were subject to smoothing, since this initial analysis was aimed at identifying qualitative relationships 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 patterns of silver hake recruitment estimates and oceanographic indices showed a qualitative similarity between the temporal variability of year-class size and the temperature indices for the intermediate cold layer, cold shelf water boundary and slope water boundary. The silver hake abundance and the values of the above-mentioned characteristics decreased during the periods of 1963–66 and 1972–81, although the decrease of the third index, position of the slope water boundary, stopped in 1978. The abundance of 1-year-olds and the values of the same characteristics increased during the periods of 1966–72 and 1981–82 to 1987. If the curves were smoothed, the direct qualitative relationship would have been more obvious. If tendencies of indices and abundance changes are traced from year to year with the abundance patterns shifted a year ahead, it can be noted that in most cases greater (or lower) abundance values were matched

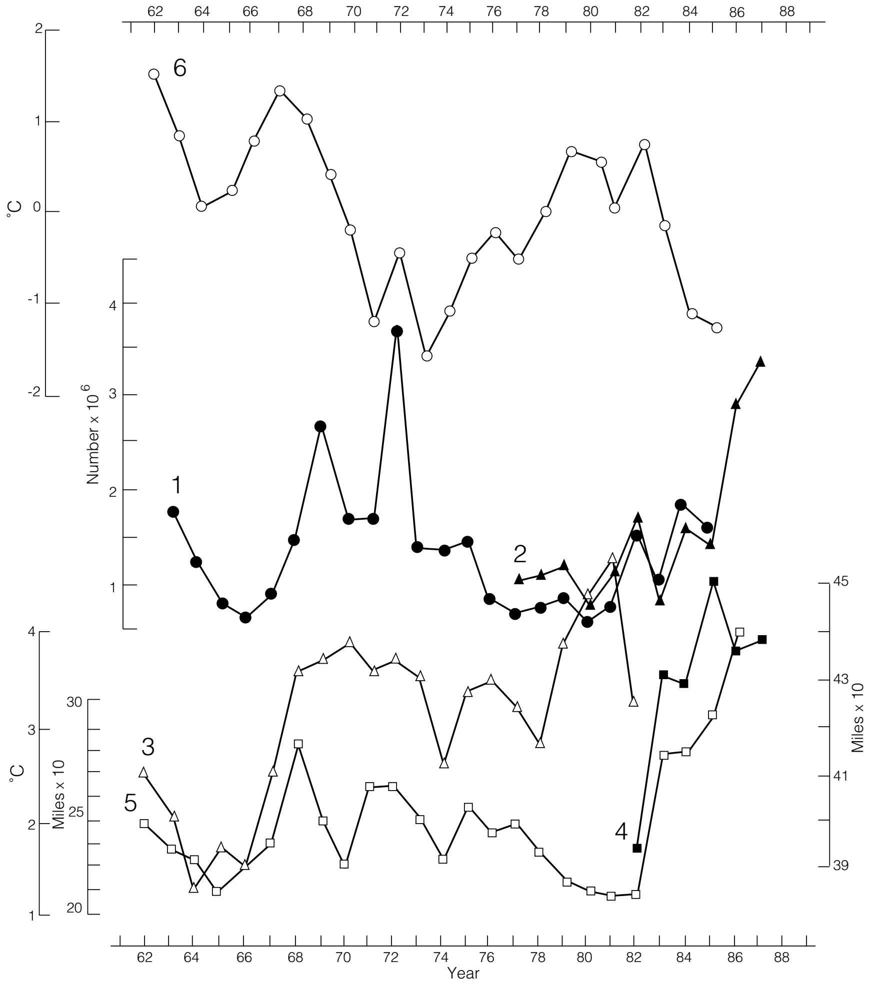

Fig. 1. Variations of 1-year-old silver hake abundance on the Scotian Shelf over 1963–87 and of environmental characteristics over 1962–87: (1) abundance of 1-year-old silver hake according to Clay and Beanlands (MS 1980) before 1970, and Waldron *et al.* (MS 1988) after 1970, (2) abundance of 1-year-old silver hake according to Rikhter (MS 1989), (3) minimum values of the water temperature, in the 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 in January at Climate Station 27, St. John's, Newfoundland.

by greater (or lower) index values for the preceding year. This is indicative of the possible direct relationship between advective temperature changes, and other correlated environmental factors, as constituents of conditions of year-class formation and abundance of 1-year-olds.

As distinct from the indices considered above, the January temperatures at Station 27 (Fig. 1) appear to be inversely related to year-class strength, i.e. the periods of increased abundance correspond to those of decreased temperature and *vice versa*. This peculiarity can be explained by the influence of atmospheric and oceanographic processes in the area of interaction between the Labrador Current and Gulf Stream. In years of increased winter temperatures, the amount of precipitation and ice melting in spring must increase in the areas situated northeastward of the Scotian Shelf which may cause a greater transfer of cold waters to the Scotian Shelf area and increase the volume of the cold interstitial layer in summer. The latter circumstance may result in worsening of environmental conditions for the period of spawning: during June–August. Similarly the periods of decreased winter temperatures may lead to opposite tendencies.

In conclusion, it can be stated that these are the first results of a qualitative analysis of the silver hake abundance fluctuations in relation to some environmental factors. The results obtained should encourage further research in this direction to obtain quantitative estimates of the relationships, which could be used for the purpose of forecasting silver hake abundance.

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References

AKENHEAD, S. A. MS 1983. Mean temperatures and salinities from an Ocean Climate Station off Newfoundland. *NAFO SCR Doc.*, No. 30, Serial No. N682, 28 p.

CLAY, D., and D. BEANLANDS. MS 1980. Silver hake (*Merluccius bilinearis*) in Divisions 4VWX: a stock assessment and estimate of the total allowable catch (TAC) for 1981. *NAFO SCR Doc.*, No. 87 (rev.), Serial No. N141, 14 p.

RIKHTER, V. A. MS 1989. Preliminary assessment of the Scotian Shelf silver hake stock size (Div. 4VWX) for 1988 and prospects for 1990. *NAFO SCR Doc.*, No. 14, Serial No. N1590, 10 p.

SIGAEV, I. K. MS 1969. Annual variations in water temperature in the shelf area of Georges Bank and Nova Scotia in 1962–1968. *ICNAF Res. Doc.* No. 53, Serial No. 2200, 12 p.

1986. Synoptical variability of hydrological front localization in energy active Gulf Stream zone in 1984. *In:* Fisheries-oceanological research in the Atlantic Ocean and south-eastern Pacific. Coll. of scientific papers of the Atlantic Scientific Research Institute of Marine Fisheries and Oceanography, Kaliningrad, p. 4–13.

WALDRON, D. E., L. P. FANNING, M. C. BOURBONNAIS, and M. A. SHOWELL. MS 1988. Size of the Scotian Shelf silver hake population in 1987. *NAFO SCR Doc.*, No. 51, Serial No. N1491, 33 p.

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