

Effect of environmental conditions on the stock structure and abundance of the Pacific saury, *Cololabis saira* in the Tsushima Warm Current region

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Abstract

Interannual and decadal scale body size of Pacific saury, catch and catch per unit effort were examined to investigate the environmental effects on the stock structure and abundance in the Tsushima Warm Current region. Interannual changes in thermal conditions are responsible for the different occurrence (catch) rates of sized group of the fish. Changes in body size due to environmental variables lead the stock to be homogeneous during the period of high abundance, while one of the reminder cohorts supports the stock during the period of low level of abundance.

Migration circuits of two cohorts of saury stock are hypothesized on the basis of short life span and spatio-temporal changes in stock structure in normal environmental conditions. Changes in upper ocean structure and production cycles by the decadal scale climate changes lead changes in stock structure and recruitment, resulting in the fluctuation of saury abundance. Hypothesized mechanism of the effects of climate changes on the stock structure and abundance is illustrated on the basis of changes in thermal regime and production cycle.

* Key words ; Pacific saury, sized group, catch, occurrence rate, abundance, oceanic climate, migration circuit

Introduction

Previous studies have shown that the timing and pattern of the distribution and migrations by sized groups of saury have varied widely in relation to the changes in oceanic conditions, resulting in changes of availability to the fishing fleets (Gong et al., 1983). It was suggested that the changes in environmental conditions affect the distribution and the structure of the stock manifested by

occurrence rates in the Tsushima Warm Current region (Gong and Suh, 2003). There is increasing evidence that variations in abundance of small pelagics are forced by changes in climate driven oceanic environments. The response of ocean ecosystems to oceanic regime shifts and long-term climate changes has caused great concern.

The objective of this study is to examine the interannual and decadal scale changes in occurrence (catch) rates of different sized groups and abundance of Pacific saury and to provide evidence that the decadal scale climate-driven oceanic changes lead the disturbance production system, resulting in changes of recruitment of main spawning cohort, and hence changes in abundance of the fish in the Tsushima Warm Current region.

Data and methods

Fluctuation indices of sea surface temperature(SST) anomalies were used to examine year-to-year and decadal oceanic-climate changes in the southern East/Japan Sea from 1957 to 2000. Zooplankton biomass in the East/Japan sea from 1965 to 1999 (Kang et al., 2000) and integrated mean temperature (0~150m) along PM line (Minami et al., 1999) were adopted to explore the trend of food environments. Year-to-year occurrence (catch) rates and mean body size of saury in the East/Japan Sea were obtained on the basis of monthly body length compositions by Korean commercial gillnet fishing (1957~2003), Japanese experimental gillnet fishing (1951~1977) and Russian trawl fishing (1960~1999) . Migration circuits of two cohorts of the saury stock in the Tsushima Warm Current region are hypothesized on the basis of spatio-temporal changes in sized groups in consideration for their short life-span.

Results and Discussion

Aleutian Low covaried with the Pacific North America pattern but also with the Arctic Oscillation and Asian Monsoon (Hare and Mantua, 2000; Overland et al, 2000).

① Intensification of Aleutian Low pressure system strengthened the wintertime East Asian Monsoon over the Siberia and the East/Japan Sea. The cooled surface water by strong westerlies over the northern East/Japan Sea subducted below the Tsushima Warm Current. ② SST and integrated (0-150m) mean temperature anomalies were far below normal in the region south of the subarctic (polar) front

in the East/Japan Sea in the late 1970s and 1980s.

③ Decadal scale low thermal regime, disturbed production cycle and decreased zooplankton biomass were responsible for the recruitment failure of important cohort of Pacific saury, resulting in the disappearance of major spawning cohort in the central East/Japan Sea in spring-summer during the period of the late 1970s to the 1980s.

④ The recruitment failure of the cohort led the changes in stock structure manifested by decadal scale disappearance of large sized group. The annual mean body size were extremely small in the entire stock area in the late 1970s and the 1980s, resulting in decreased abundance and catch. ⑤ The oceanic conditions such as thermal regime and production cycles must have returned to normal conditions in the early 1990s, resulting in the normal stock structure and high abundance of the fish.

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