

論文の内容の要旨

論文題目

Studies on effects of climate change on ocean environment and fisheries resources in the western coast of Kyushu

(気候変動が九州西岸域の海洋環境および水産資源に及ぼす影響に関する研究)

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【Objectives】

The aims of this study are to clarify the effects of climate change on the regional ocean environment and to investigate its influence on the Japanese anchovy as a proxy of important fisheries resources.

【Results of this study】

Chapter 2 Long-term trends in ocean-climate environment condition in Omura Bay

Long-term trends in SST in Omura Bay were investigated using heat balance estimates based on a daily data set obtained for 40 years (1955-1995). SST during the heating period (from March to August) tended to decrease, whereas that during most of the cooling period (from September to February) increased during these 40 years. The maximum rates of SST decrease and increase were found to be $0.020^{\circ}\text{C year}^{-1}$ in August and $0.028^{\circ}\text{C year}^{-1}$ in January, respectively. The sea surface heat balance analysis revealed that shortwave radiation flux decreased in the heating period due to decrease in solar radiation, resulting in a decrease in SST. In the cooling period, the increase in SST was attributed to the decrease in latent and sensible heat fluxes due to increased air temperature and decreased wind speed. These climatic changes affecting SST in Omura Bay showed a close linkage with global dimming and the East Asian monsoon circulation.

Chapter 3 Effect of wind-stress on the catch of Japanese anchovy

Effect of wind stress on the annual catch of Japanese anchovy off northwestern Kyushu for the period between 1963 and 2009 was investigated. Regime shift analysis detected several step changes in catch and environmental variables. Since the mid-1980s, the anchovy catch in the coastal fishery zones has declined, while the catch in the offshore zone has increased. The decline of catch in the coastal zones showed a significant correlation with the long-term variations in prevailing

north-northeastward wind stress over the Goto-Nada Sea during spring spawning season. The results indicated that weakened north-northeastward winds caused the recent low recruitment of anchovy through low levels of wind-induced eggs and larval transport from the offshore spawning ground to the coastal nursery areas, resulting in the potential shift of nursery area to the northwestern offshore region. Thus, as well as the growth-favorable ambient temperature, transport process would play a key role on long-term fluctuations in anchovy abundance in these coastal seas.

Chapter 4 Modeling eggs and larval transport process and its relation to catch fluctuations

To investigate the potential influence of change in the eggs and larval transport on the recruitment of Japanese anchovy off western coast of Kyushu, the numerical simulation using a coupled hydrodynamic and particle-tracking model were conducted from 1960 to 2007. In the study region, annual catch of anchovy in the offshore zone has increased since the mid-1980s, while those in the coastal zone has declined since the mid-1970s. Particle-tracking experiments revealed that increased and decreased transport success in the offshore and coastal zones, respectively. It was also suggested that the warming trend in the SST contributed to the increased transport success due to the northern shift of spawning ground. Weakening trend in the coastward current in the Goto-Nada Sea and shift of the spawning ground reduced the amount of transported eggs and larvae. The results implied that transport process have contributed to the recently flourished catch in the offshore zone and decreased catch in the coastal zone. This study showed that the changes in transport success induced by environmental condition change has potential to impact on the recruitment of anchovy off western coast of Kyushu.

Chapter 5 Estimation of the future change of anchovy in response to the global warming

Climate change possibly alters ocean state even in coastal waters, and could induce significant change in fish recruitment. Effect of global warming on the eggs and larval transport of Japanese anchovy in the western Kyushu was investigated using a coupled hydrodynamic and particle-tracking model. An atmosphere-ocean coupled model has predicted future environmental change under the IPCC A2 scenario. Using the predicted model result, this study revealed that the eggs and larval transport process would change and affect recruitment of anchovy more than the impact of an increased SST of 3°C. Particle-tracking experiment showed transport successes in the offshore zone would be lowered compared with those in the 1950–1990s. It was also revealed that intensified Tsushima Warm Current and shift of spawning ground would decrease retention rate in the offshore zone. Estimated increase in the SST also would change the biological condition such as the growth and survival of larval anchovy. The larval growth rate was estimated to be faster than the present state. Strengthened stratification seems to limit the nutrient supply, leading to a low primary production during spring bloom, and it may restrict the food availability.

On the whole, this study revealed the effect of climate change on the regional ocean environment and fisheries resources with a focus on the western coast of Kyushu located in continental margin of the East China Sea. Regional environmental changes due to global warming are not well studied and thus, the findings of this study would be useful for fisheries management and understanding of marine ecosystem.