

A statistical approach to estimate optimal habitat suitability of Pacific cod off the northeastern coast of Japan

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An accurate estimate of a potential habitat of fish species enables us not only to understand the response of species to environmental changes but also to utilize it for an efficient use of fish resources. Habitat suitability index (HSI) model is widely used as a tool in ecological impact assessments, ecological restoration studies, and practical exploration of potential fishing zone. Pacific cod (*Gadus macrocephalus*) is widely distributed in the North Pacific and adjacent waters, and important as a commercial resource and higher-trophic key species in the subarctic ecosystems. We developed the HSI models for the population of Pacific cod off the northeastern coast of Honshu island, Japan (Tohoku area). For developing the model, we applied Generalized Additive Model (GAM) and Random Forest (RF) algorithm, and used three kinds of dataset; Japanese commercial fishery dataset compiled by Tohoku National Fisheries Research Institute (TNFRI), Japan Fisheries Research and Education Agency, that includes trawling catch data of more than 30 species of demersal fishes, an ocean reanalysis dataset FORA (4-dimensional variational Ocean Re-Analysis)-WNP30 produced by JAMSTEC/CEIST and MRI-JMA, which has 0.1*0.1 degree horizontal resolution with 54 vertical levels and can provide realistic fields of 3-dimensional ocean circulation and environmental structures including ocean bottom layers up to 1500m depth, and the estimated stock biomass of this species off Tohoku area derived from trawl surveys by TNFRI. We investigated the HSI response of this species to ocean environmental changes occurring in this area. The results indicated that the Oyashio intrusion from the northern part of the North Pacific characterized by a low-salinity is related to higher HSI in winter. And GAM and RF were improved by adding a term fluctuating with the stock amount of this species. In addition, a significant improvement also can be seen in the case that the term which fluctuates with the bottom water temperature in Sendai Bay in the previous June was added to HSI model. This result shows a good agreement with the fact that the Pacific cod habiting waters near northern Japan migrates to spawning grounds characterized by shallow bay waters and silty or sandy bottoms, and suggests that the bottom water temperature in Sendai Bay in the previous June could be a potential indicator for predicting the habitats of Pacific cod in this area.

Keywords: habitat suitability index model, Pacific cod, FORA