Habitat characteristics of skipjack tuna (*Katsuwonus pelamis*) in the western North Pacific: a remote sensing perspective

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Abstract
Skipjack tuna habitat in the western North Pacific was studied from satellite remotely sensed environment and catch data, using generalized additive models and geographic information systems. Weekly resolved remotely sensed sea surface temperature, surface chlorophyll, sea surface height anomalies and eddy kinetic energy data were used for the year 2004. Fifteen generalized additive models were constructed with skipjack catch per unit effort as a response variable, and sea surface temperature, sea surface height anomalies and eddy kinetic energy as model covariates to assess the effect of environment on catch per unit effort (skipjack tuna abundance). Model selection was based on significance of model terms, reduction in Akaike's Information Criterion, and increase in cumulative deviance explained. The model selected was used to predict skipjack tuna catch per unit effort using monthly resolved environmental data for assessing model performance and to visualize the basin scale distribution of skipjack tuna habitat. Predicted values were validated using a linear model. Based on the four-parameter model, skipjack tuna habitat selection was significantly ($P < 0.01$) influenced by sea surface temperatures ranging from 20.5 to 26°C, relatively oligotrophic waters (surface chlorophyll 0.08–0.18, 0.22–0.27 and 0.3–0.37 mg m^{-3}), zero to positive anomalies (surface height anomalies 0–50 cm), and low to moderate eddy kinetic energy (0–200 and 700–2500 cm^2 s^{-2}). Predicted catch per unit effort showed a trend consistent with the north–south migration of skipjack tuna. Validation of predicted catch per unit effort with that observed, pooled monthly, was significant ($P < 0.01$, $r^2 = 0.64$). Sea surface temperature explained the highest deviance in generalized additive models and was therefore considered the best habitat predictor.