Applying Resource Selection Models to Predict Occurrence of Juvenile Flatfish

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Objectives

Flatfish populations are constrained by nursery area. If resource selection models can be shown to accurately predict the location and geographic extent of flatfish nursery areas, they will become important tools in the management and study of flatfish population dynamics. We demonstrate that some resource selection (RS) models derived previously to predict the presence and absence of juvenile flatfishes nearshore are also applicable over the continental shelf (Norcross, 1999); for other flatfishes, derivation of new models for the continental shelf was necessary. Our study was conducted in the western Gulf of Alaska during September 2011 on 4 species of age-0 juvenile flatfishes: Pacific halibut (*Hippoglossus stenolepis*), arrowtooth flounder (*Atheresthes stomias*), northern rock sole (*Lepidopsetta polyxystra*), and flathead sole (*Hippoglossoides elassodon*); and 2 species of age-1 juvenile flatfishes: northern rock sole and flathead sole.

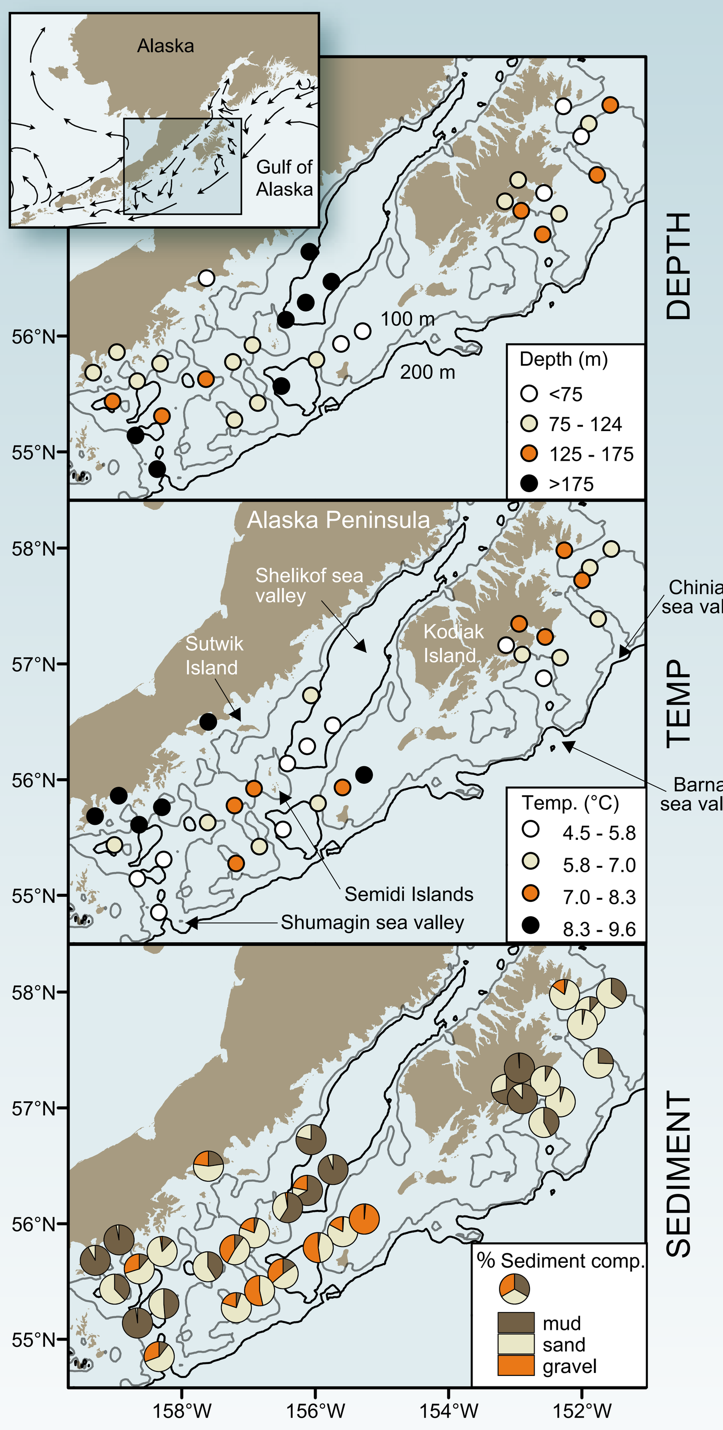

Fig 1. Physical variables used in logistic resource selection models, water depth (m), near-bottom temperature (°C), and sediment composition (%), were measured at 33 sites during September 2011 in the Gulf of Alaska. The inset map shows ocean currents (Reed & Schumacher 1986).

Methods

Sampling occurred at 33 sites across the continental shelf. Fish were collected using a 3-m beam trawl, and a small-mesh midwater trawl. Environmental data were collected on sediment composition using a van Veen benthic grab and water temperature and depth were measured using a Sea-Bird Electronics (SBE) 39 temperature profiler. Both reliability (agreement between predicted and observed) and discrimination (ability to correctly distinguish between presence and absence) are important in evaluating the predictive performance of logistic RS models (Pierce and Ferrier, 2000). First, the reliability of the previously derived Norcross logistic RS models (termed NC model here) was evaluated using the Hosmer-Lemeshow goodness-of-fit test (Hosmer et al, 1997). For those groups that failed to have a good fit, we derived our own logistic RS models (termed best-fit or BF model here) using a stepwise regression method to determine significant predictors. Next, discrimination between presence and absence was evaluated using both a 0.5 threshold (≥0.5 is presence and <0.5 is absent) and a threshold-adjusting method based on maximizing the sum of proportions of correctly classified presences and absences (Freeman and Moisen, 2008).

Van Veen Benthic Grab
Photo by Morgan Busby

Results

Environmental conditions varied among the 33 sites from shallow, sandy, warm-water sites along the Alaska Peninsula to deep, muddy, cold-water sites in the Shelikof sea valley (Fig. 1). Goodness of fit tests showed that the NC models for age-0 Pacific halibut and age-0 northern rock sole are reliable models for predicting presence-absence on the shelf. Both groups were largely confined to shallow, sandy, warm-water sites on the shelf, as illustrated by these predictors (Figs. 2a and 2b, *left*). In our new, BF models, age-0 arrowtooth flounder best predictors were also temperature and percent sand (Fig. 2c, *left*). The best-fit predictor for age-0 flathead sole was the absence of gravel (Fig. 2d, *left*). Age-1 flathead sole preferred muddy sediment while age-1 northern rock sole avoided it (Figs. 2e and 2f, *left*). The threshold-adjusting discrimination method resulted in better performance than the 0.5 threshold, unless the number of presences and absences are equal, such as for age-0 flathead sole.

Flathead Sole

Conclusions

The previously published NC models are adequate to predict the presence and absence of age-0 Pacific halibut and northern rock sole on the continental shelf. For age-0 arrowtooth flounder, age-0 flathead sole, age-1 flathead sole, and age-1 northern rock sole, our own BF logistic RS models improved reliability but will require further testing with independent data. Except for age-0 flathead sole, the threshold-adjusting method improved discrimination compared with the 0.5 threshold method used by Norcross (1999), therefore improving overall prediction ability. Sea valleys were centers of occurrence for several species and the expansive habitat of age-0 arrowtooth flounder was consistent with their ranking as the most abundant flatfish in the GOA.

3-m Beam Trawl with SBE 39
Photo by Morgan Busby

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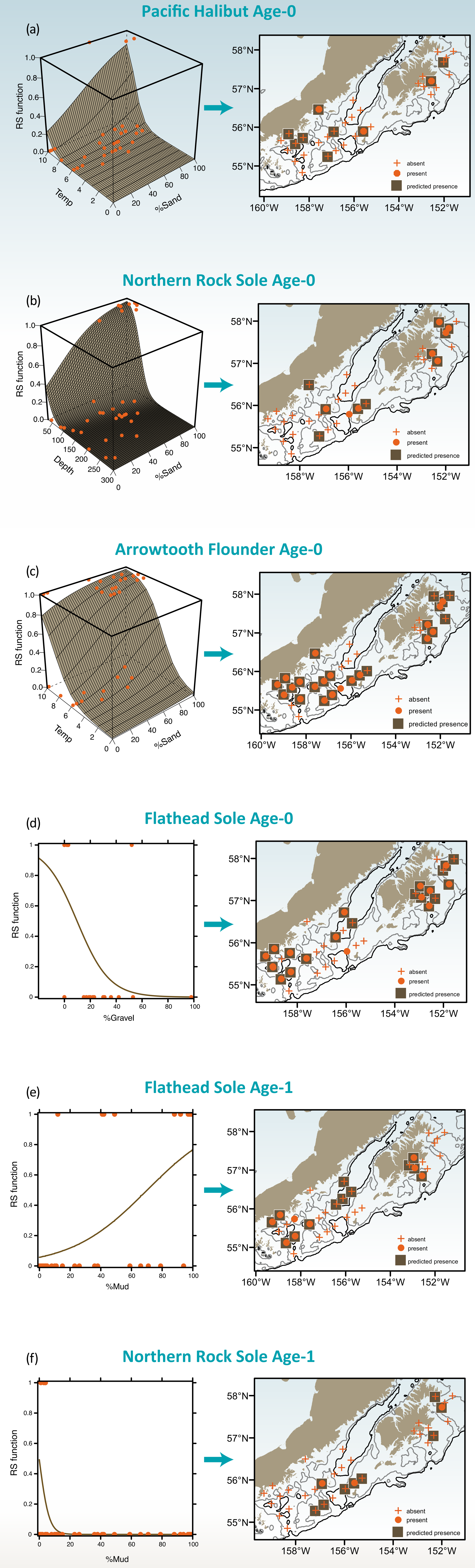

Figure 2 *(left)*. Plots of acceptable NC models (a,b) and our BF models (c-f) shown as either a line (single physical variable) or shaded surface (two physical variables) relating observed presence/absence to water depth (Depth), near-bottom temperature (Temp), and sediment composition (%Sand, %Mud, %Gravel). Orange dots on top of graphs show observed presences (RS function = 1) while orange dots on bottom show observed absences (RS function = 0).

Figure 2 *(right)*. Model predicted presence (dark gray squares) underlie observed presences (orange dots) and absences (orange pluses) of juvenile flatfishes at collection sites in the western Gulf of Alaska during September 2011.

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