

HICast: Dynamic Fishing and Bycatch Avoidance Tool

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Bycatch in the Hawai‘i longline fishery poses a challenge for its fishers with the potential of fleetwide consequences if bycatch allowances are exceeded. The goal of this project is to develop a near real-time tool to aid deep-set fishers in choosing locations that reduce bycatch without sacrificing bigeye tuna catch rates.

Creating Species Interaction Models

We first created species interaction and catch rate models, or models that predict when and where a species is catchable, for bigeye tuna and nine bycatch species. We focused on the following bycatch species: oceanic whitetip shark, silky shark, leatherback sea turtle, olive ridley sea turtle, loggerhead sea turtle, false killer whales, Laysan albatross, blackfooted albatross, and manta rays. We paired observer data from 2005-2023 from the deep-set fishery with oceanographic data (*e.g.*, temperature, salinity, chlorophyll, etc) to identify relationships between catch of these species and their environment. We then used these relationships to generate predictions of bigeye tuna catch rate and probability of occurrence of bycatch species in 2024 and 2025. We normalized all predictions, assigned bycatch predictions a negative value, and multiplied the bigeye tuna predictions by the total number of bycatch species ($N=9$) (see Figure 1). We then overlaid the predictions to create an integrated prediction map. Values can range from -9 to 9, where -9 indicates very high probability of bycatch and 9 indicates very high catch rate of bigeye tuna with minimal bycatch risk (Figure 1).

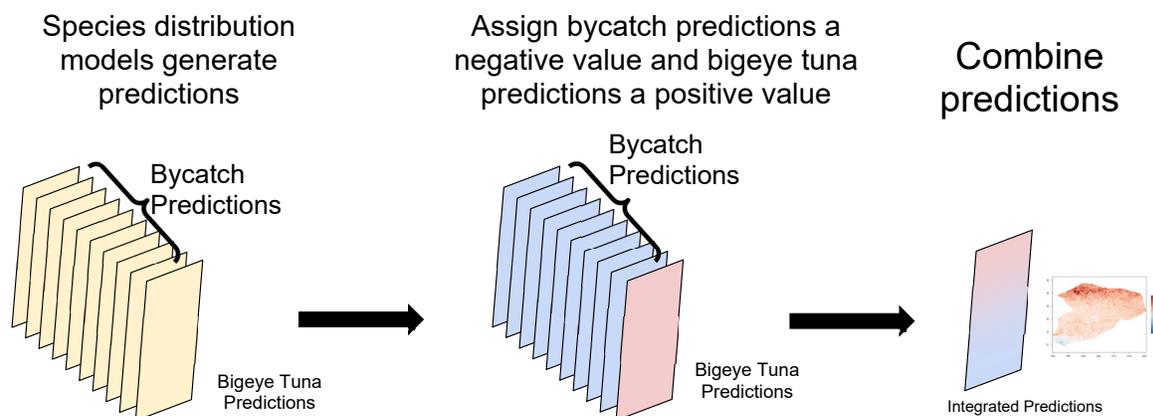


Figure 1. Diagram showing workflow of individual predictions, normalized, integrated predictions.

Species Interaction Model Performances

Generally, model estimates of withheld data in the training window (*i.e.*, 2005-2023) for bigeye tuna and bycatch performed well, with more variability in the prediction window (*i.e.*, 2024 and

2025 observer data; Table 1). Bigeye tuna, Laysan albatross, and blackfooted albatross performed above average and silky shark, oceanic whitetip shark, olive ridley sea turtle, and false killer whales had average performance for the prediction window. Leatherback sea turtles and manta rays had below average performance. Loggerhead sea turtle performance could not be assessed because they were not caught in 2024 or 2025. See Figure 2 for examples of weekly recommended fishing locations using the fully integrated tool, and the tool when only applying oceanic whitetip sharks, false killer whales, and leatherback sea turtles as examples.

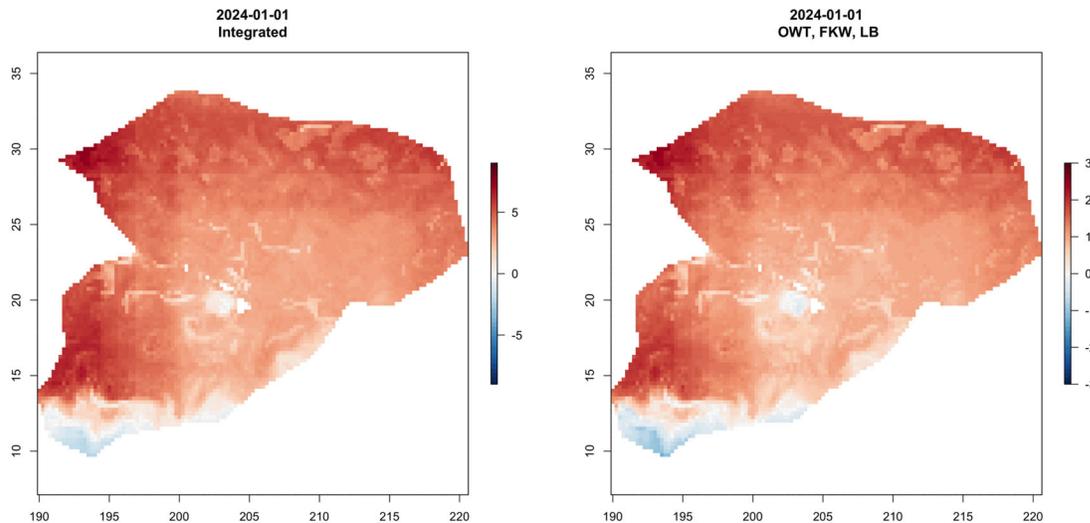


Figure 2. GIF of integrated tool with all 9 bycatch species (left) and of tool using only oceanic whitetip shark, false killer whales, and leatherback sea turtles (right). GIFs are at a weekly scale over 2024. Spatial domain reflects the 90% effort polygon.

Simulating Impacts on Bycatch

We conducted a species sensitivity analysis to identify which bycatch species catch rates are sensitive to the number and combination of bycatch species used in the tool. We implemented the tool to identify the best fishing locations each day from January 1, 2024 to July 17, 2025 for different combinations of bycatch species. We then randomly assigned N fishing sets on a given day to the best N fishing locations for each combination. The number of fishing sets (N) was determined from observer data. We then predicted the probability of interacting with a bycatch species for each set and classified the probability as a presence/absence (interaction or no interaction). We compared the number of interactions to the true number of interactions. We found that both shark species and manta rays would benefit from the tool usage, while both albatross species and false killer whales may be at a disadvantage.

Proposed Tool Implementation

Once a week, 7 maps for each day of the upcoming week will be produced showing a heatmap of the best and worst fishing locations at 1° resolution scale (Similar to the third panel of Figure 1 and Figure 2).

Table 1. Model performance of the training and forecasted dataset data for bigeye tuna and protected species. R2 was used for bigeye tuna models and AUC for bycatch species. Training data came from 2005 to 2023. Forecasted data came from 2024 and 2025, which new data the model had never seen. For the R2 and AUC, we provide a “grade” to assist in interpretability.

Species	AUC/R2 for Training Dataset (Grade)	AUC/R2 for Forecasted Dataset (Grade)
Bigeye tuna	0.21 (C)	0.17 (C)
Silky shark	0.84 (B)	0.79 (C)
Oceanic whitetip shark	0.81 (B)	0.76 (C)
Loggerhead sea turtle	0.71 (C)	NA
Leatherback sea turtle	0.73 (C)	0.6 (D)
Olive Ridley sea turtle	0.74 (C)	0.7 (C)
Manta rays	0.82 (B)	0.63 (D)
Laysan albatross	0.95 (A)	0.99 (A)
Black-footed albatross	0.89 (B)	0.94 (A)
False killer whales	0.63 (D)	0.7 (C)