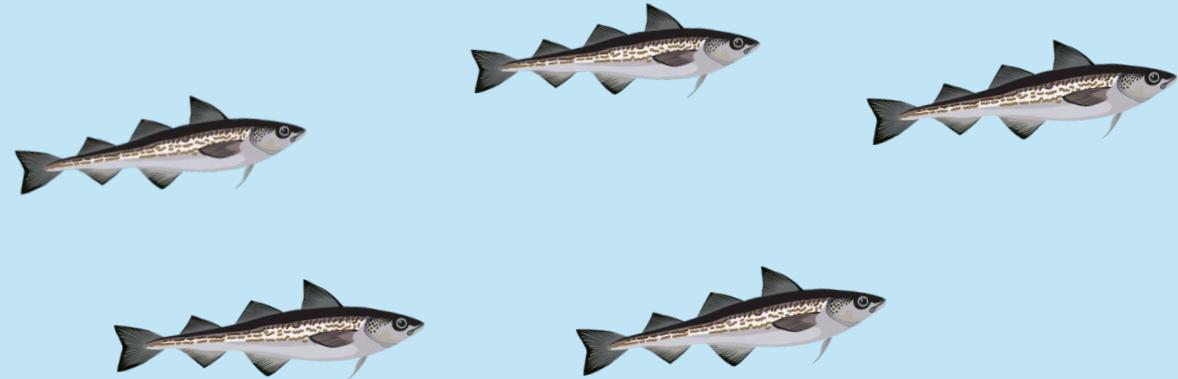
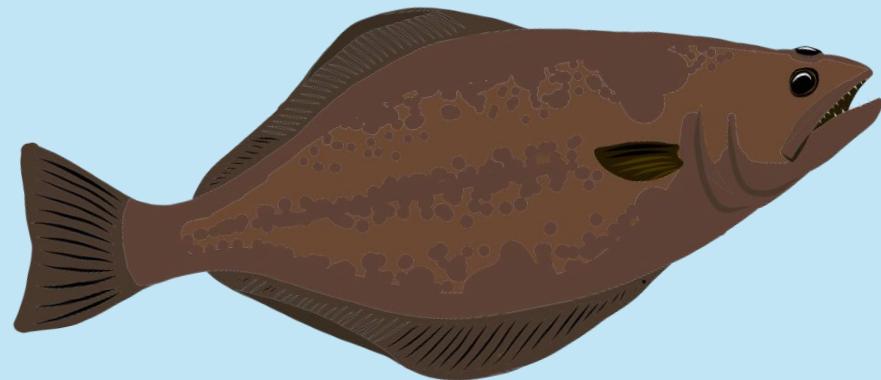


Using predators as samplers to quantify foraging landscapes throughout the Gulf of Alaska



Oregon State University
Coastal Oregon Marine
Experiment Station

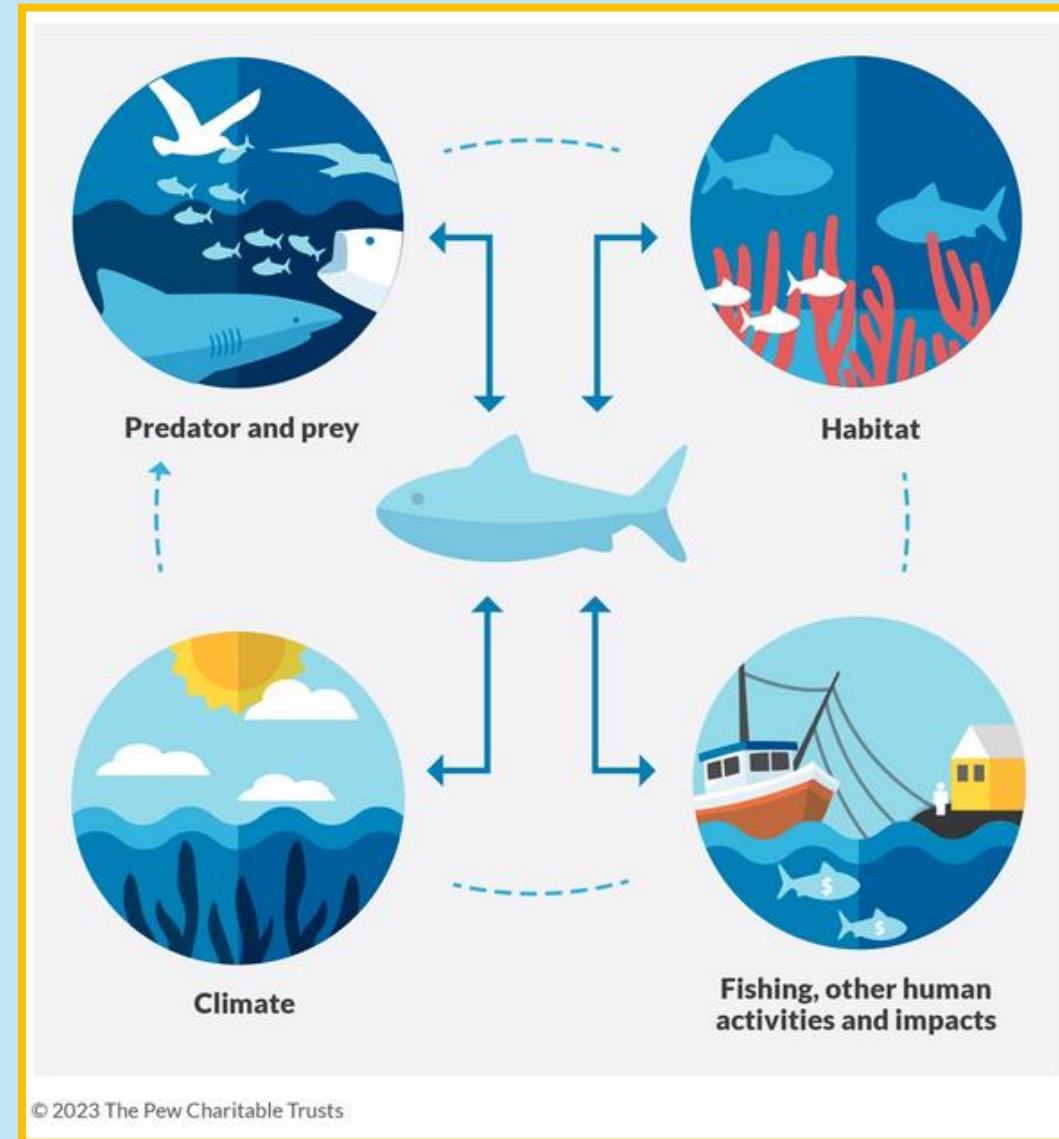
Peri Gerson* (OSU), Cheryl Barnes (OSU),
Jodi Pirtle (ARO, NOAA), Jessica Miller (OSU),
Jonathan Reum (AFSC, NOAA), James Thorson (AFSC, NOAA)



Funding support from:
Alaska Essential Fish Habitat Research Plan
National Marine Fisheries Service
NOAA's Alaska Regional Office



Holistic thinking for ecosystem-based management



Prey: foundations of our ecosystems



Predator and prey

Prey: foundations of our ecosystems



Predator and prey

- Support our prominent predators, such as cetaceans, seabirds, and commercially important fishes

Prey: foundations of our ecosystems



- Support our prominent predators, such as cetaceans, seabirds, and commercially important fishes
- Mediate bottom-up effects from environmental changes

Prey: foundations of our ecosystems



Predator and prey

Prey: foundations of our ecosystems



Predator and prey

- Food web models

Prey: foundations of our ecosystems



Predator and prey

- Food web models
- Climate vulnerability assessments

Prey: foundations of our ecosystems



- Food web models
- Climate vulnerability assessments
- Species distribution models

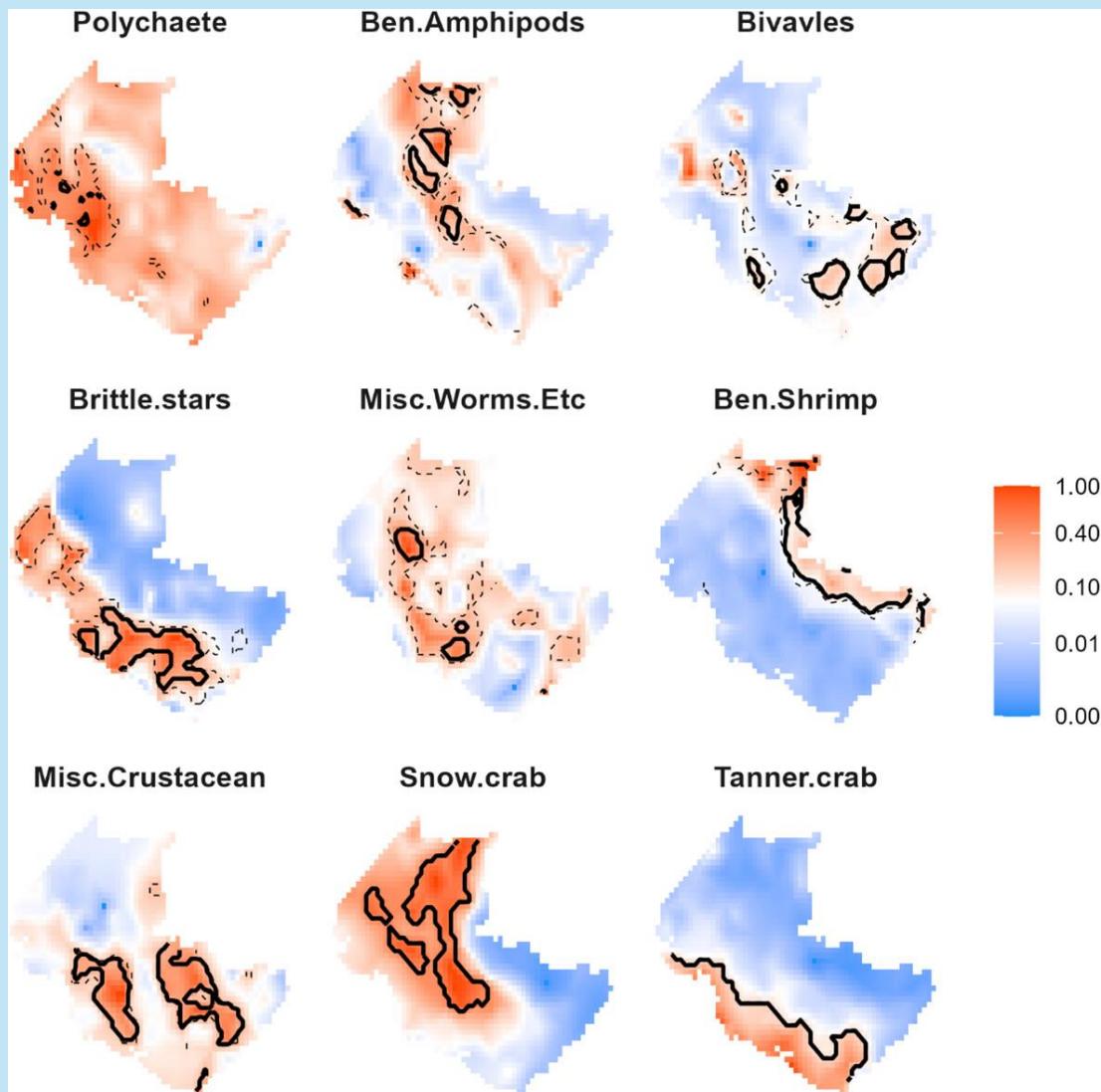
Prey: foundations of our ecosystems



- Food web models
- Climate vulnerability assessments
- Species distribution models
- Competition and predation studies

But, we often lack region-wide data for lower- and mid-trophic level species

Diet data can be used to map prey



- Density maps of benthic prey in the Bering Sea (Reum et al., 2025)
- Densities for crab correlated well with survey data

Species distribution models

Species distribution models

- SDMs estimate relationships between species and environmental characteristics

Species distribution models

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- Great effort to advance SDMs

Species distribution models

- SDMs estimate relationships between species and environmental characteristics
- Great effort to advance SDMs
- Questions remain about modeling configurations for SDMs when using diet data

Project goals

Project goals

- Explore different modeling frameworks for diet data

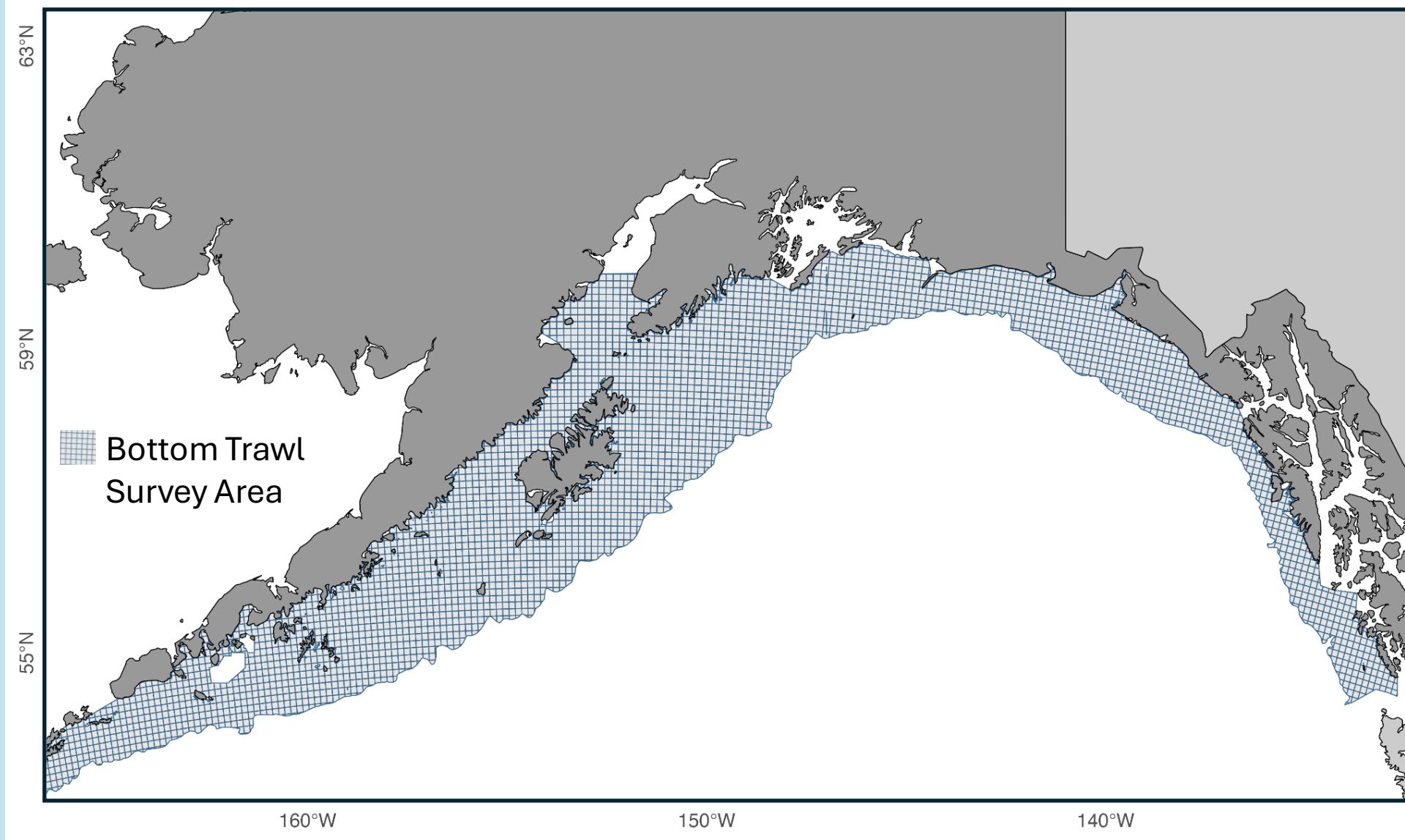
Project goals

- Explore different modeling frameworks for diet data
 - Model predators and/or prey simultaneously

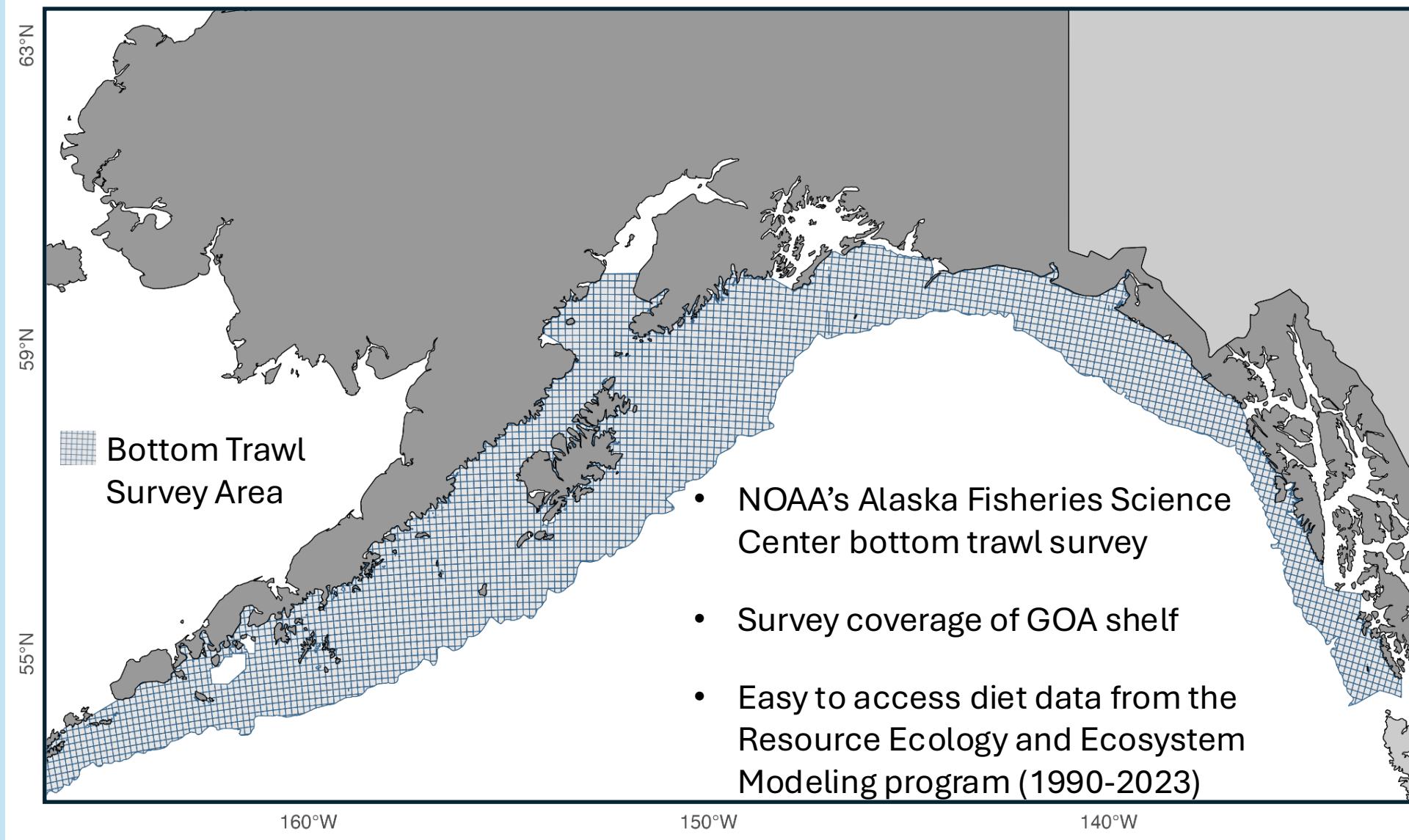
Project goals

- Explore different modeling frameworks for diet data
 - Model predators and/or prey simultaneously
 - Make density maps for prey the GOA using diet data

The Gulf of Alaska



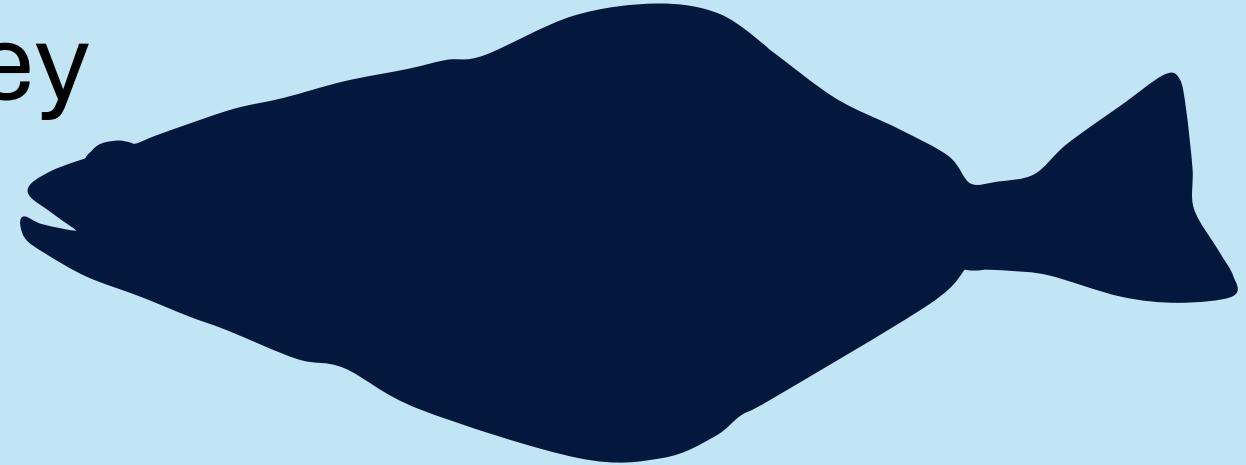
The Gulf of Alaska



Focal predators from the GOA bottom trawl survey

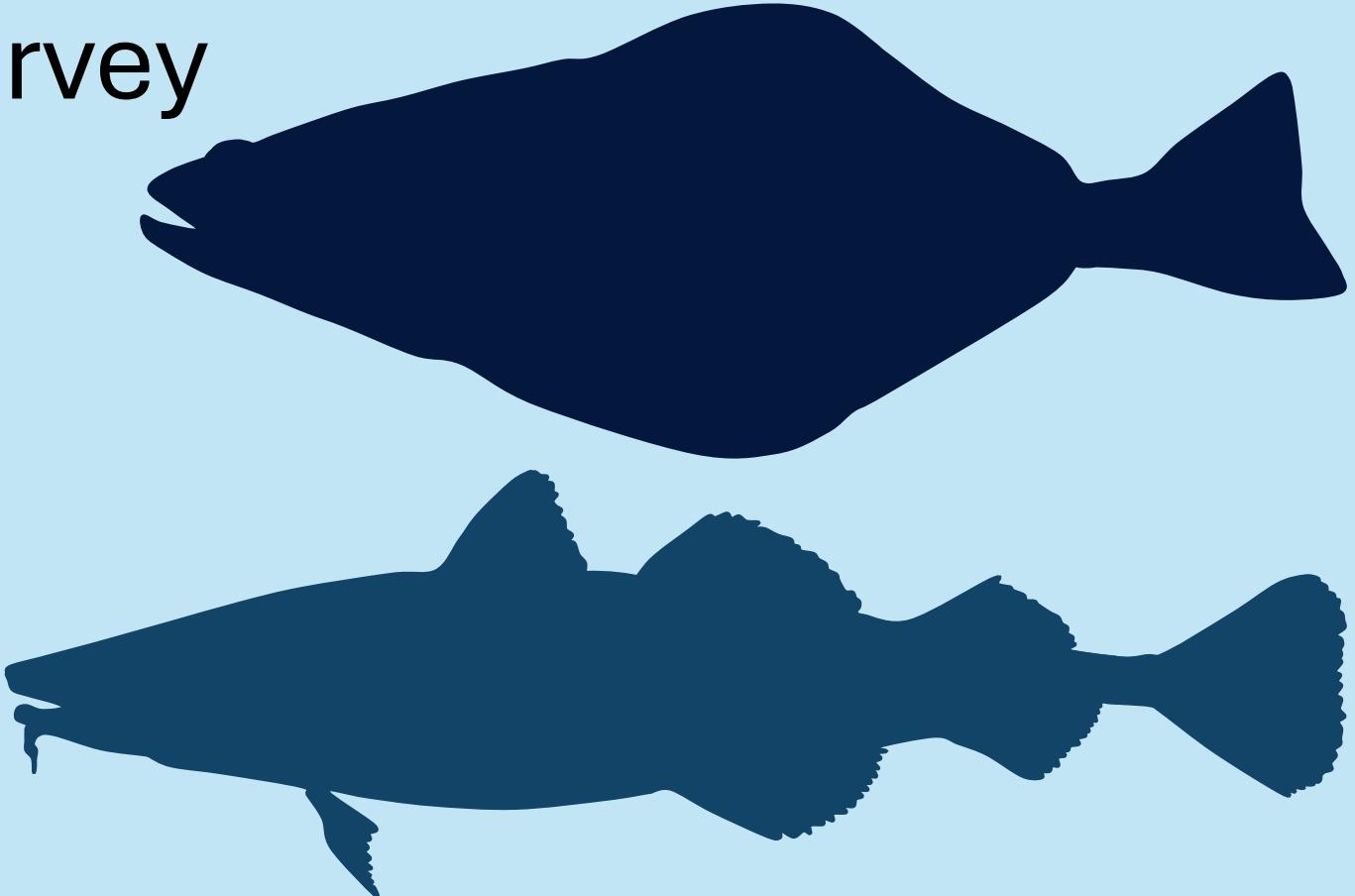
Focal predators from the GOA bottom trawl survey

Arrowtooth flounder



Focal predators from the GOA bottom trawl survey

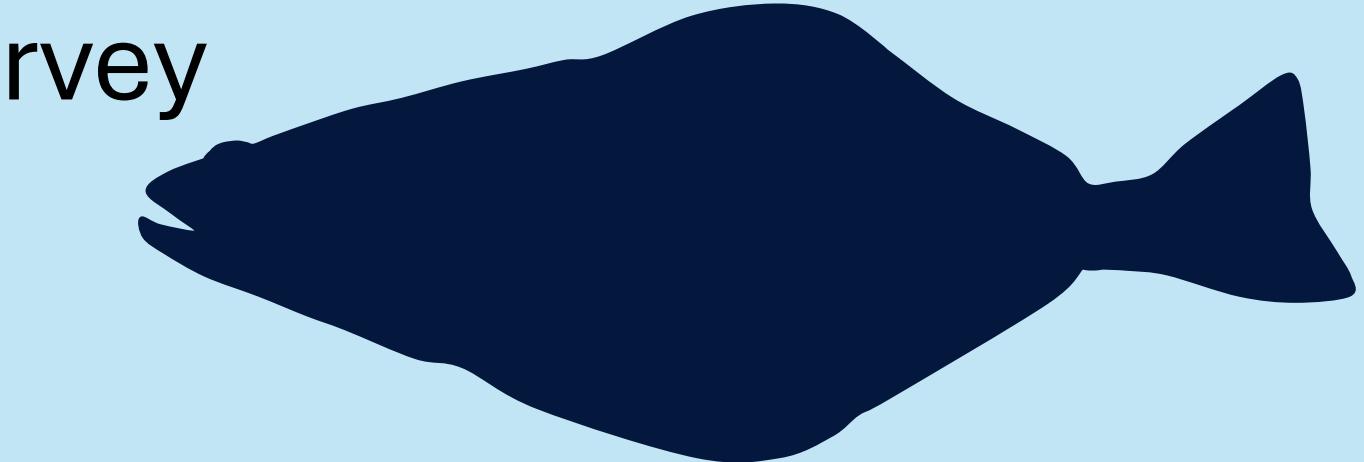
Arrowtooth flounder



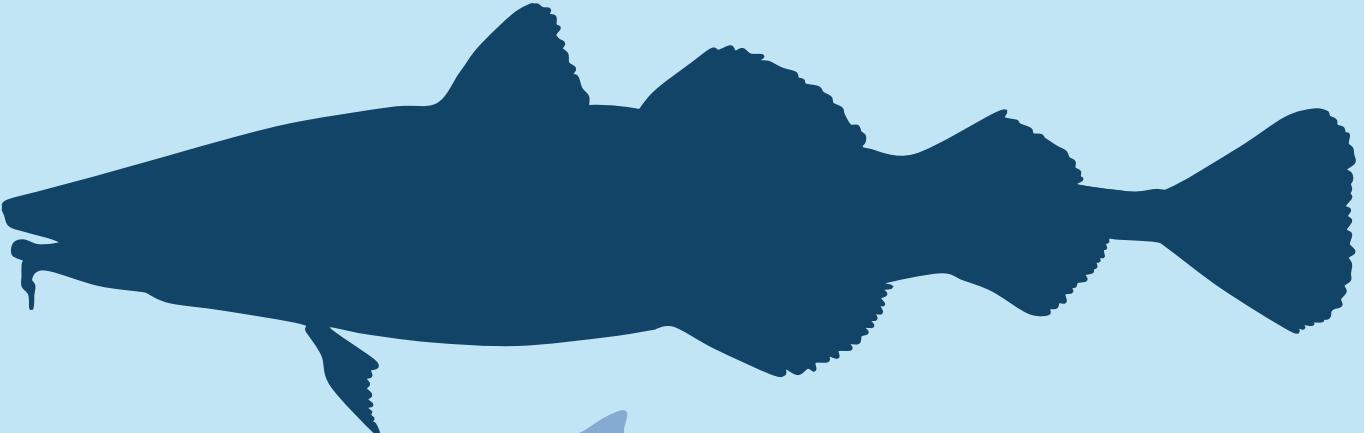
Pacific cod

Focal predators from the GOA bottom trawl survey

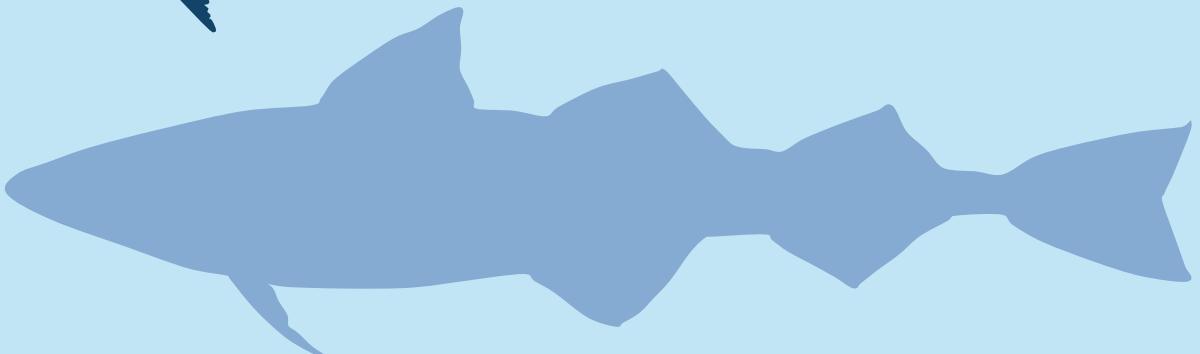
Arrowtooth flounder



Pacific cod

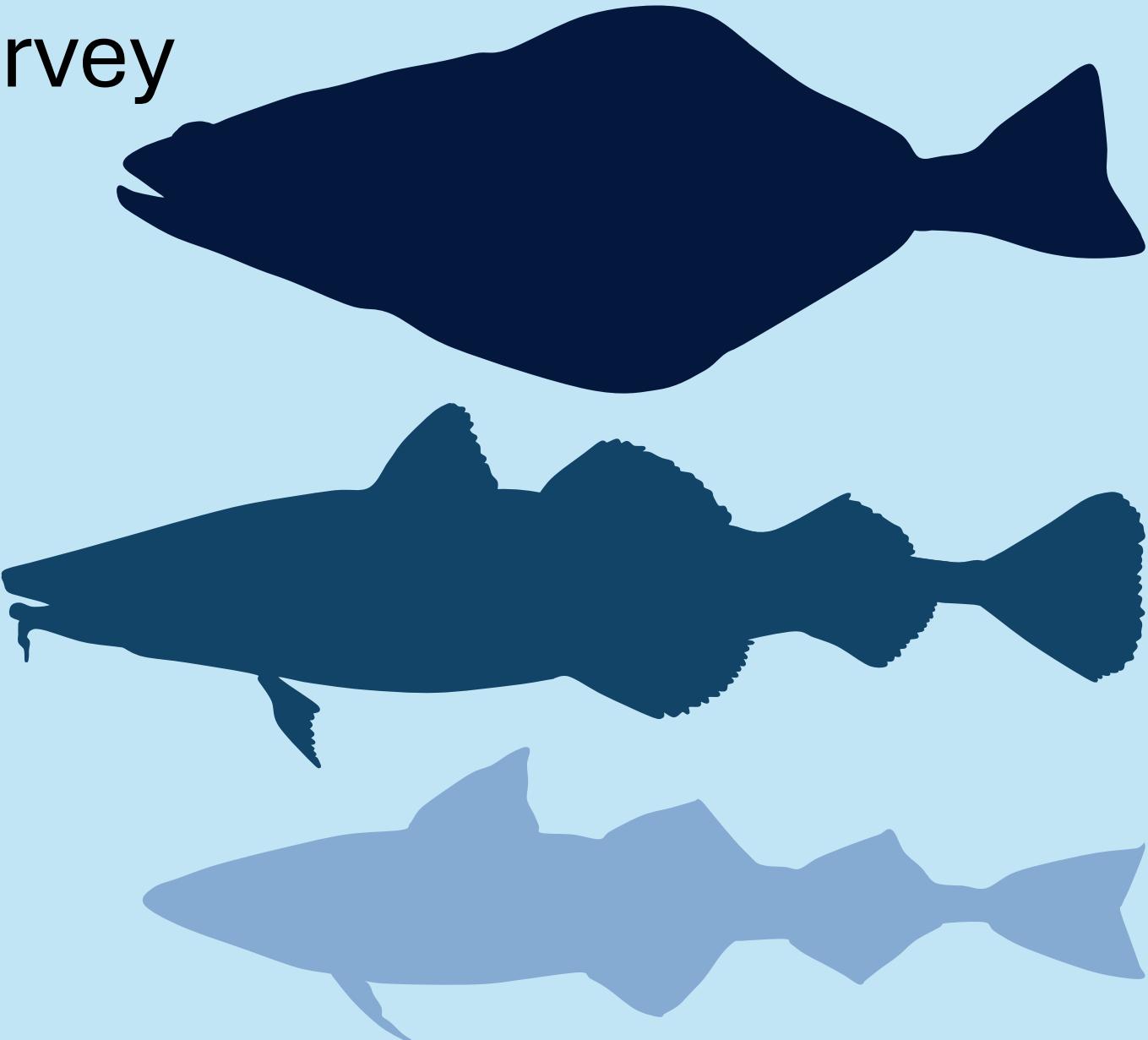
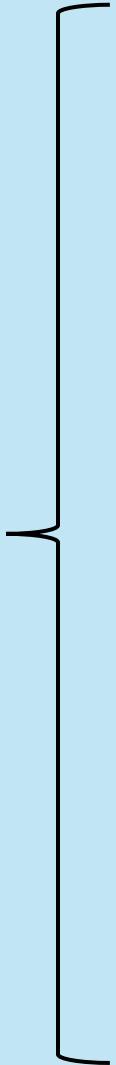


Walleye pollock



Focal predators from the GOA bottom trawl survey

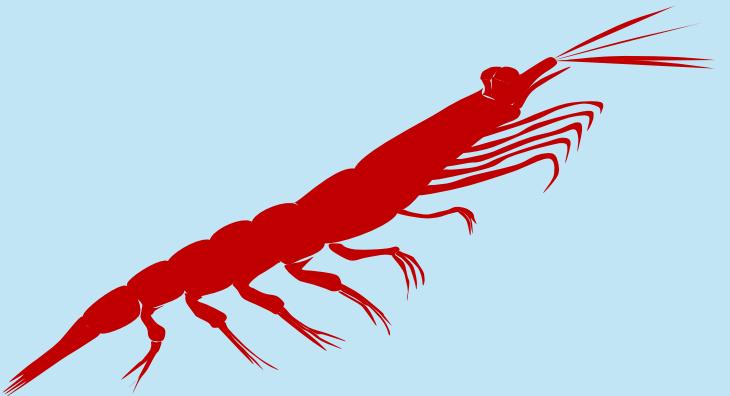
64% of stomach
samples



Focal prey

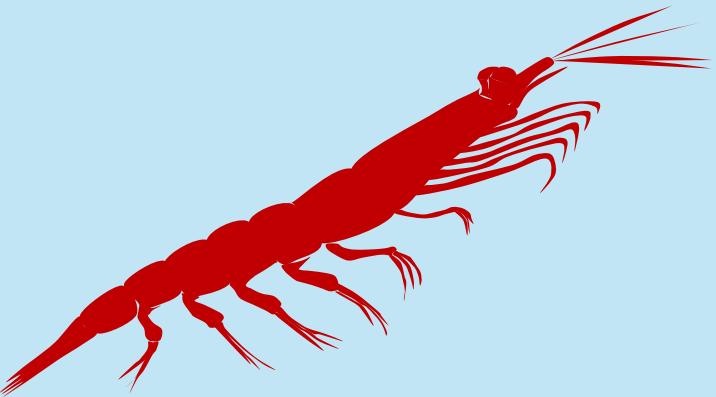
Focal prey

Krill



Focal prey

Krill

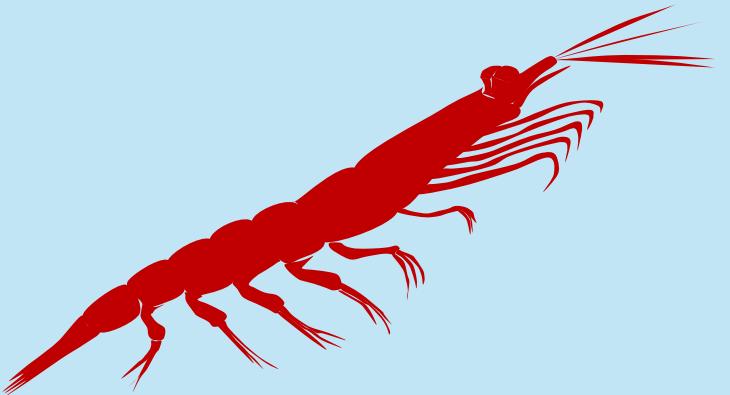


Shrimps



Focal prey

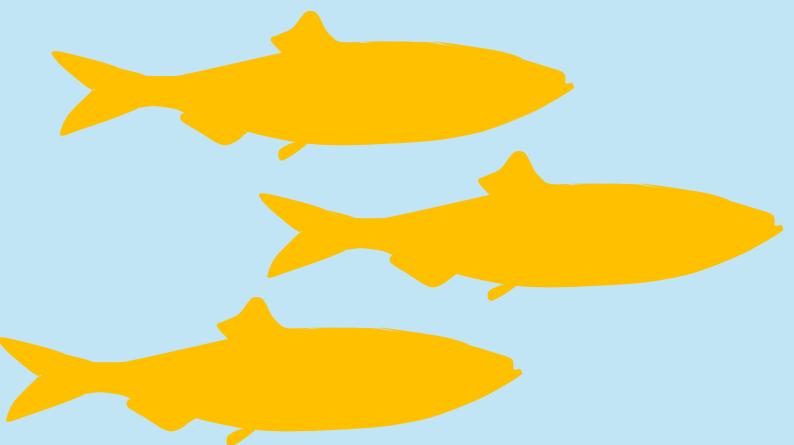
Krill



Shrimps

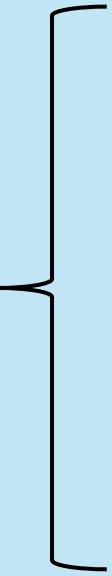


Forage Fishes

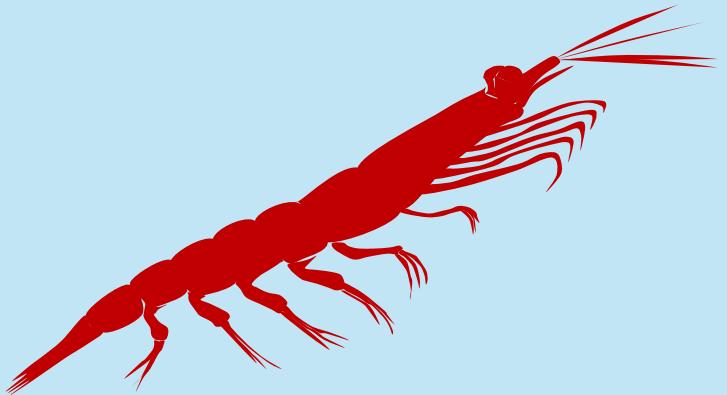


Focal prey

Commonly occurring



Krill



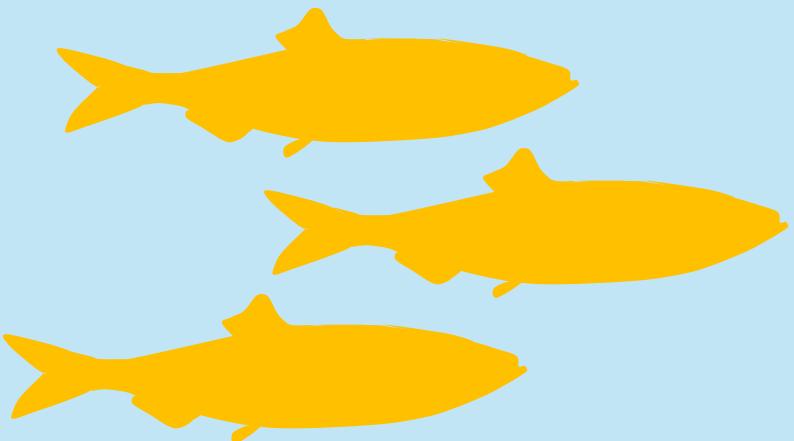
Shrimps



Large proportion of
diet biomass



Forage Fishes



Candidate Model Structures

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- Does modeling multiple predators and/or prey improve model performance?

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- Compare joint species distribution models (JSDMs) to SDMs

Candidate Model Structures

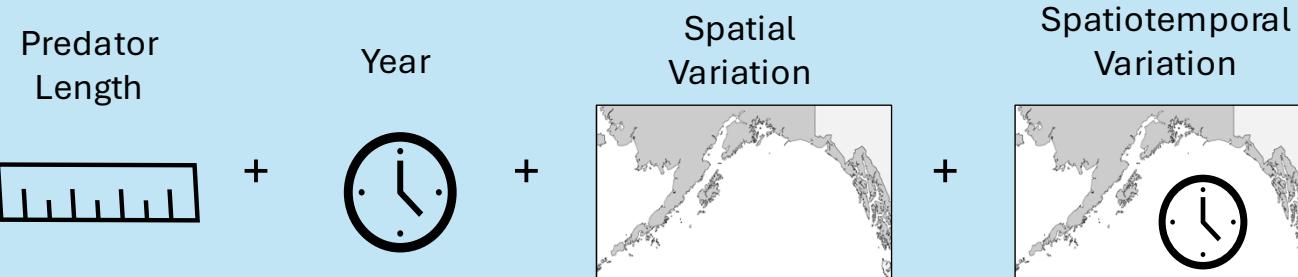
- Does modeling multiple predators and/or prey improve model performance?
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Candidate Model Structures

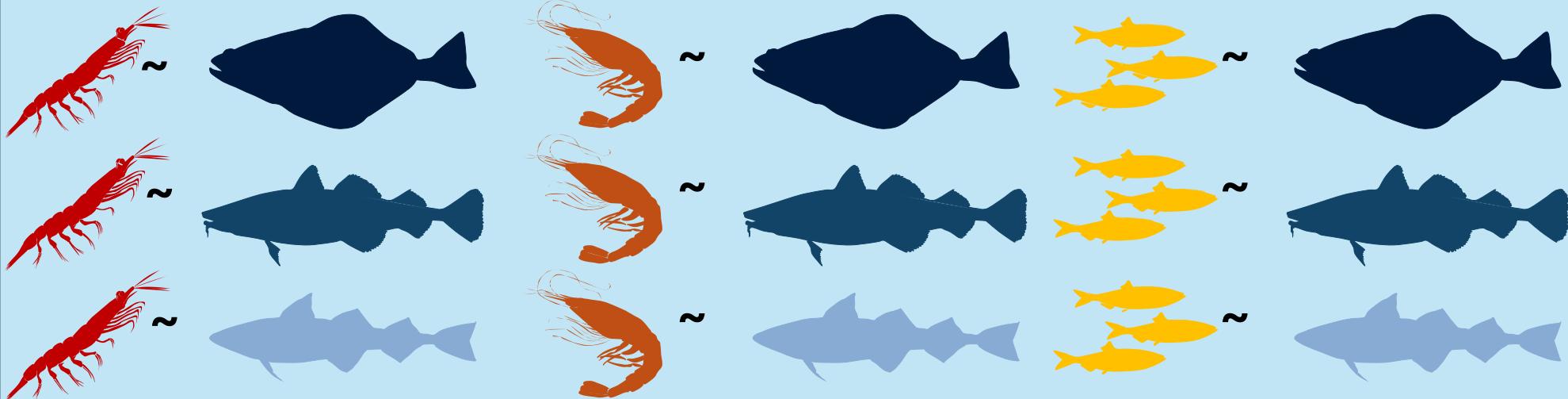
- Does modeling multiple predators and/or prey improve model performance?
- Compare joint species distribution models (JSDMs) to SDMs
- JSDMs estimate species correlations and can improve model performance
- 4 candidate model structures

Candidate Model Structures

Model Structure 1 – Single prey, single predator

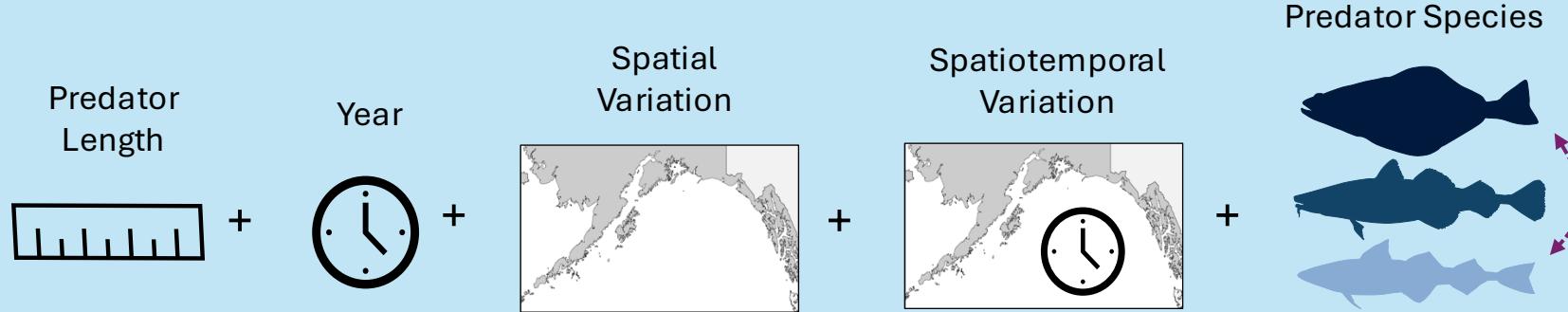


Predator-prey combinations (N = 9)

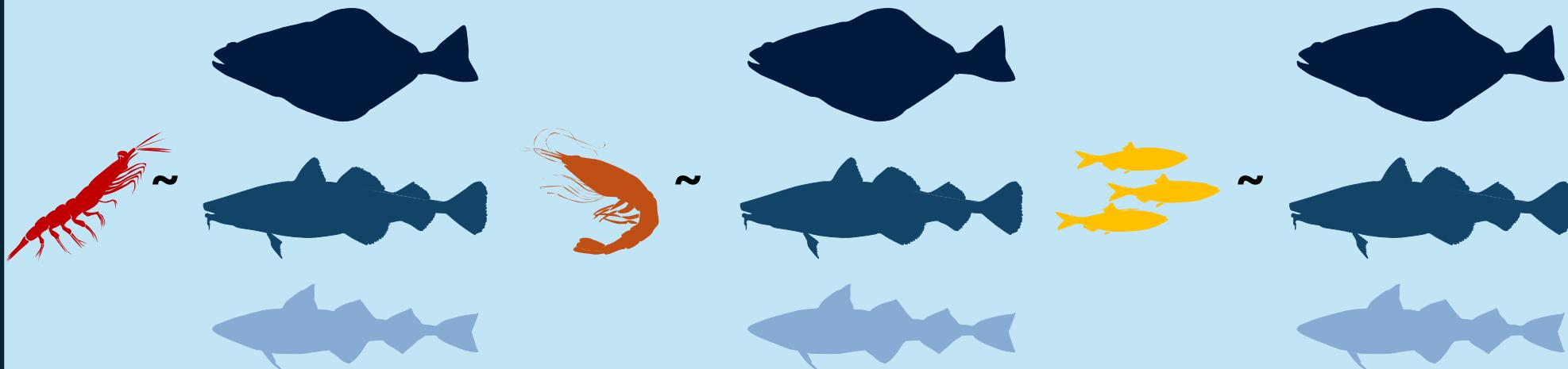


Candidate Model Structures

Model Structure 2 – Single prey, multiple predator

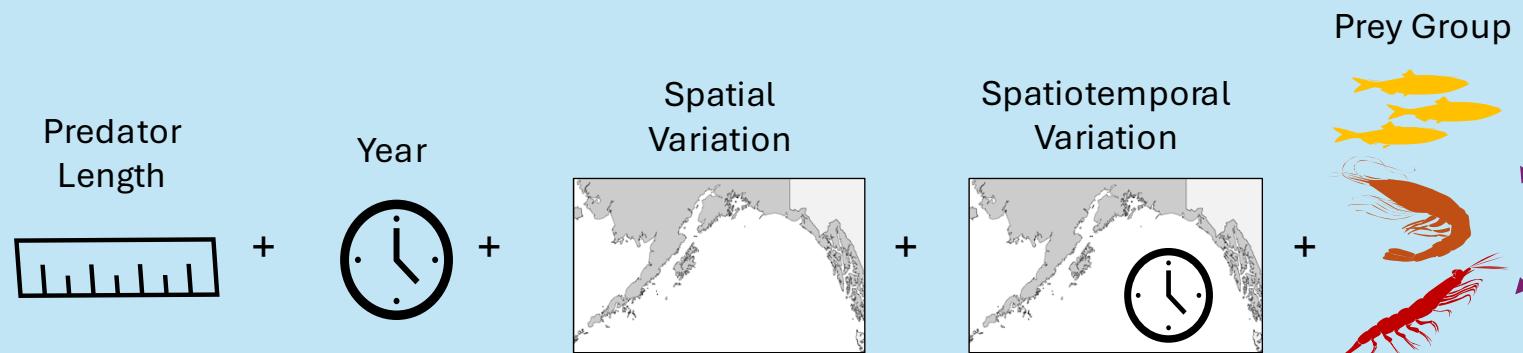


Predator-prey combinations (N = 3)

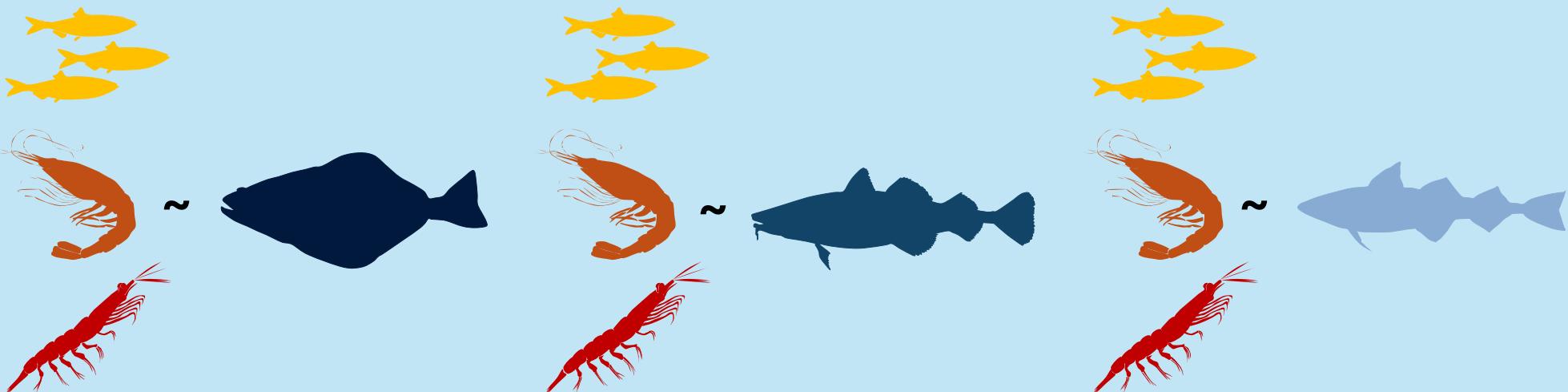


Candidate Model Structures

Model Structure 3 – Multiple prey, single predator

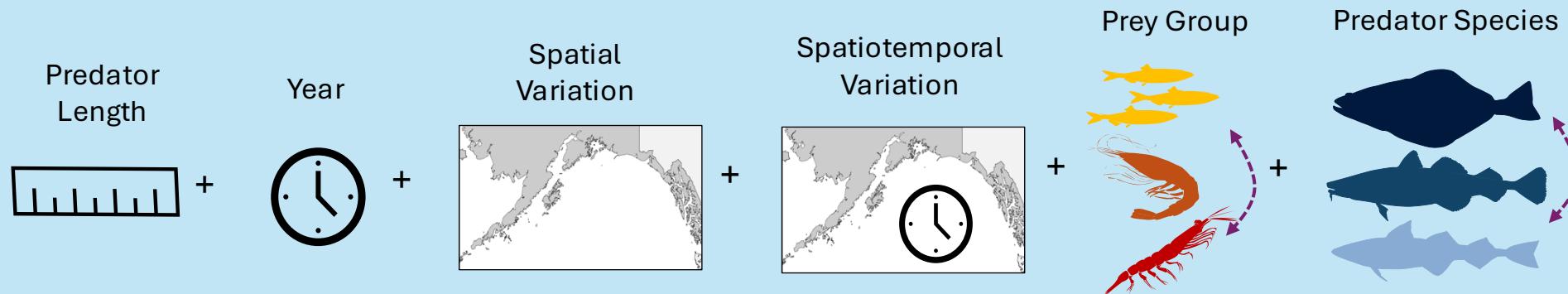


Predator-prey combinations ($N = 3$)

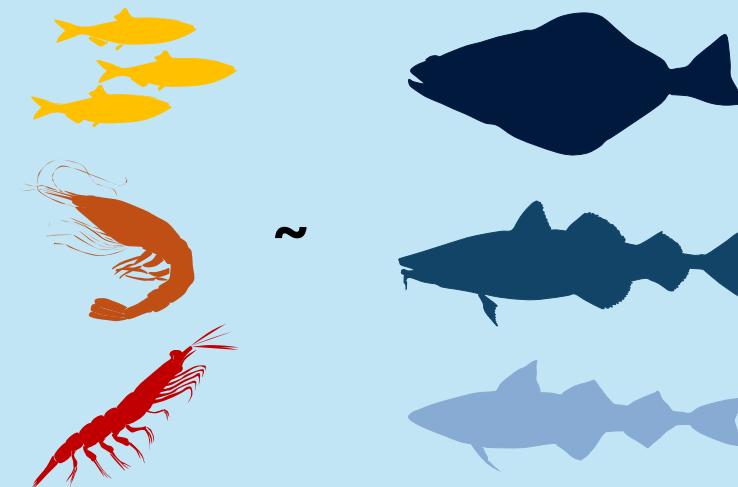


Candidate Model Structures

Model Structure 4 – Multiple prey, multiple predator

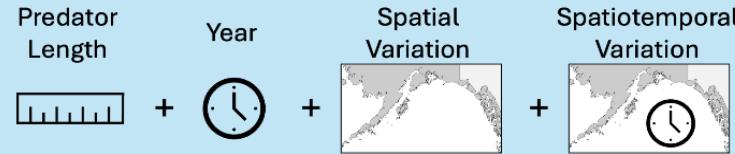


Predator-prey combinations ($N = 1$)

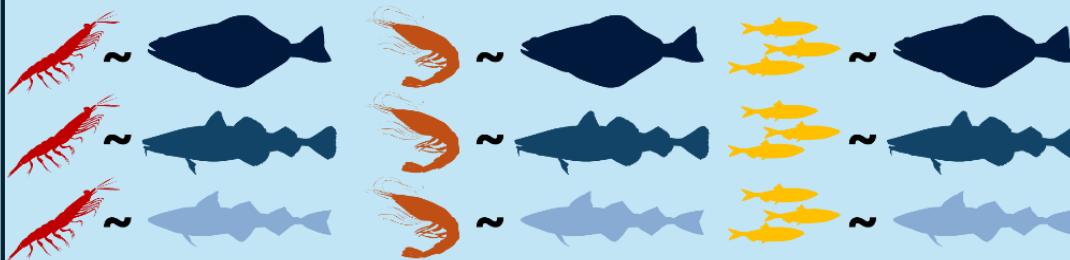


Compared models using cross validation

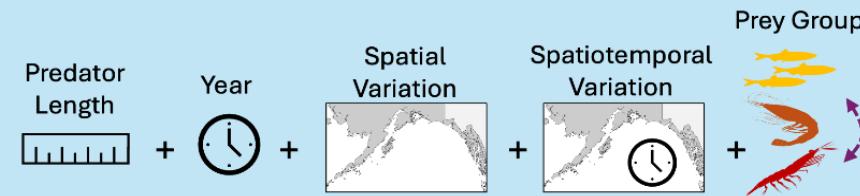
Model Structure 1 – Single prey, single predator



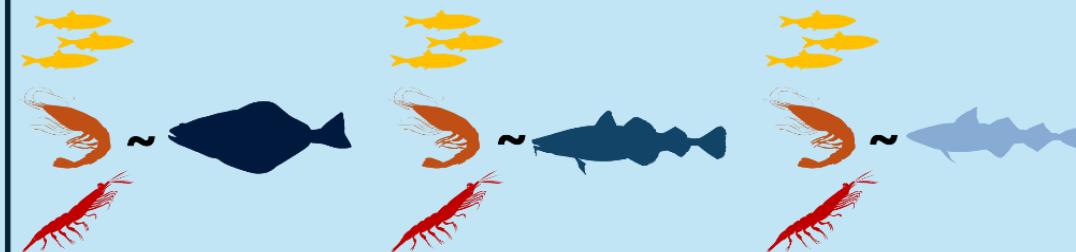
Predator-prey combinations (N = 9)



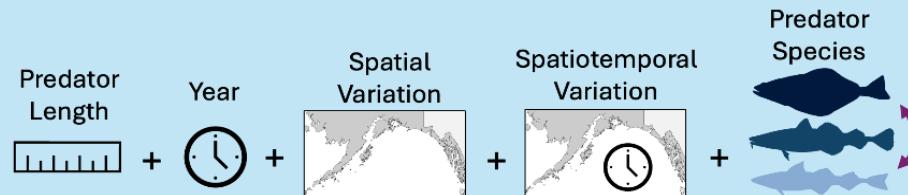
Model Structure 3 – Multiple prey, single predator



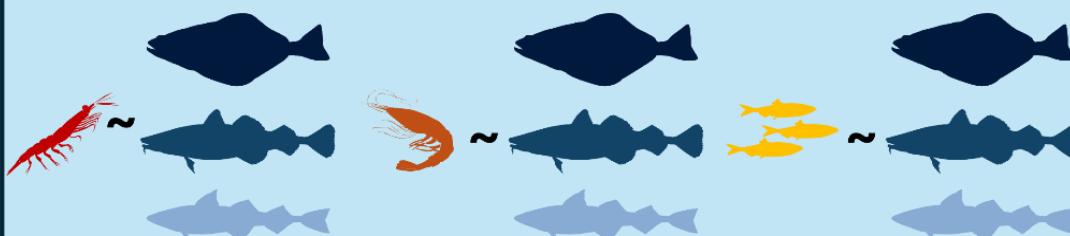
Predator-prey combinations (N = 3)



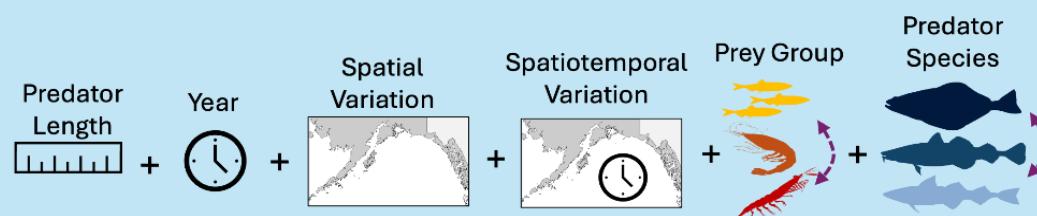
Model Structure 2 – Single prey, multiple predators



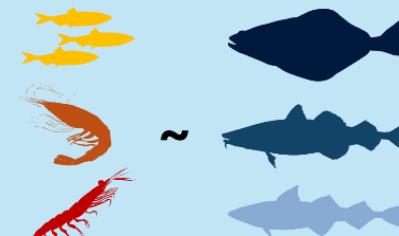
Predator-prey combinations (N = 3)



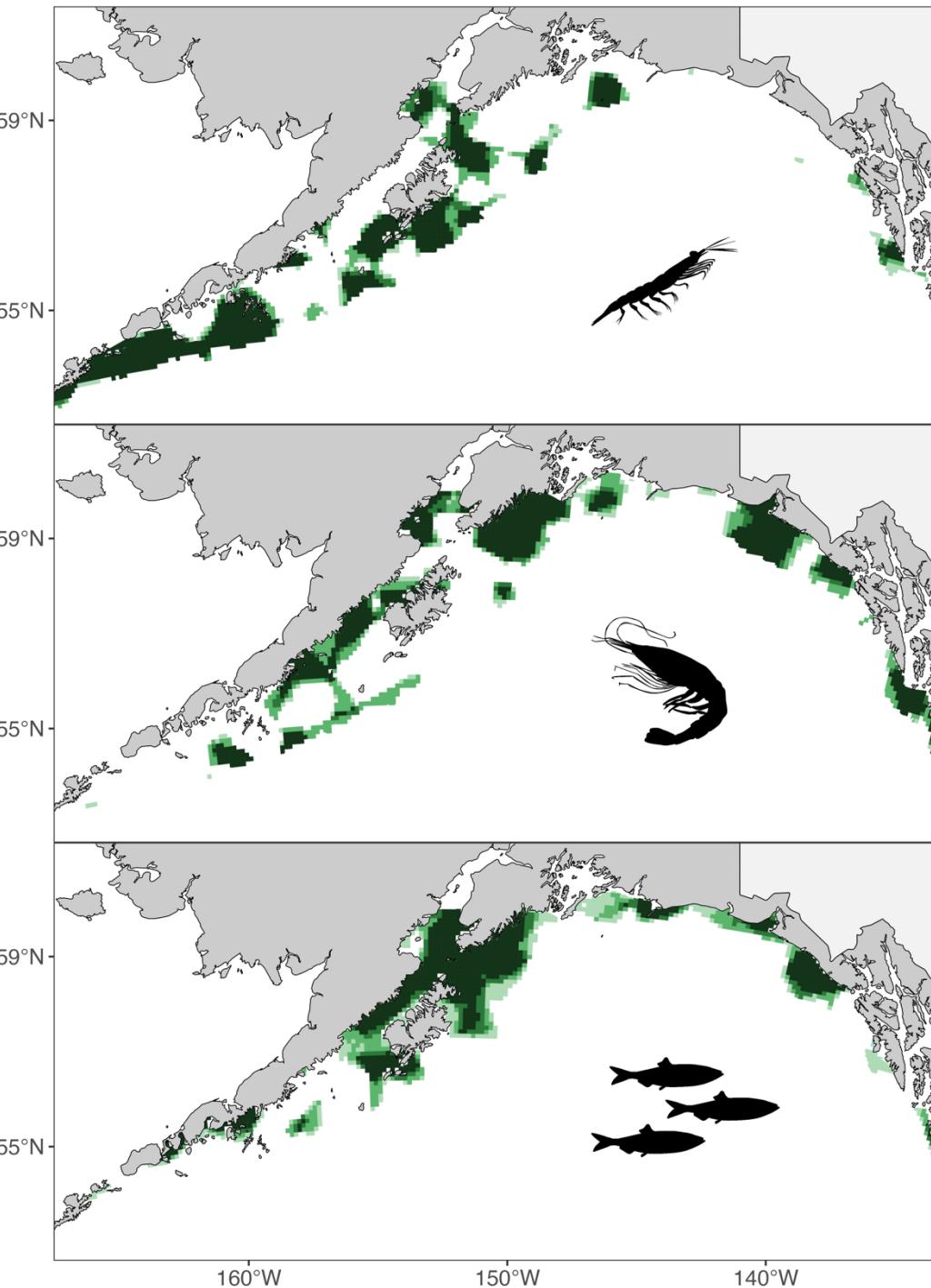
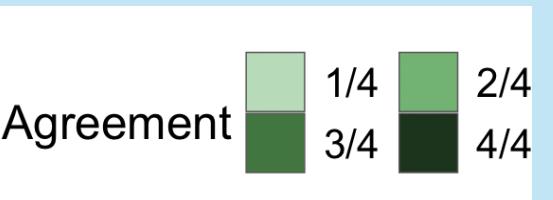
Model Structure 4 – Multiple prey, multiple predators



Predator-prey combinations (N = 1)



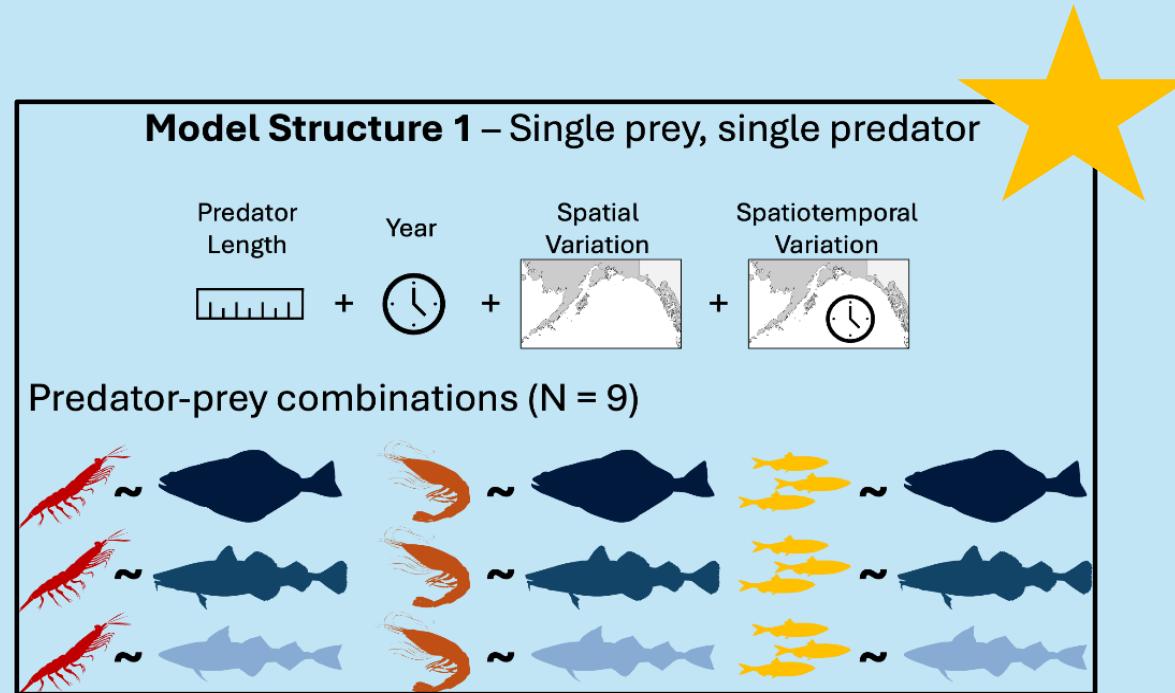
Model agreement



Model comparison results

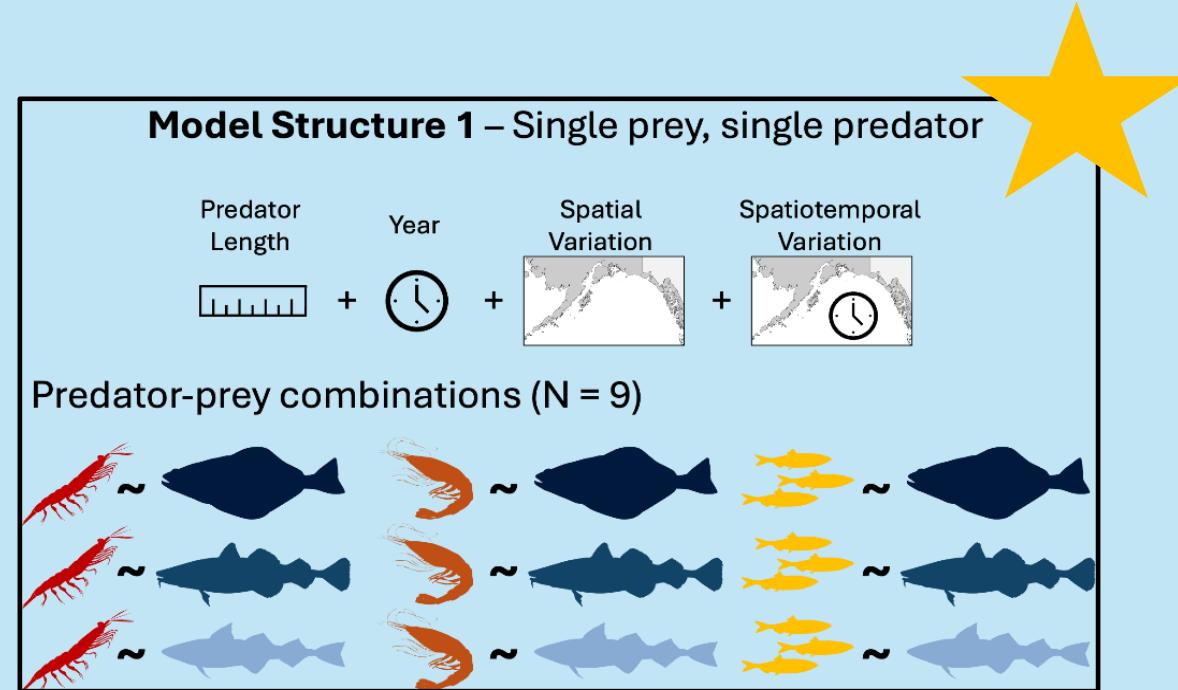
Model comparison results

- Model Structure 1 performed the best for out-of-sample predictions



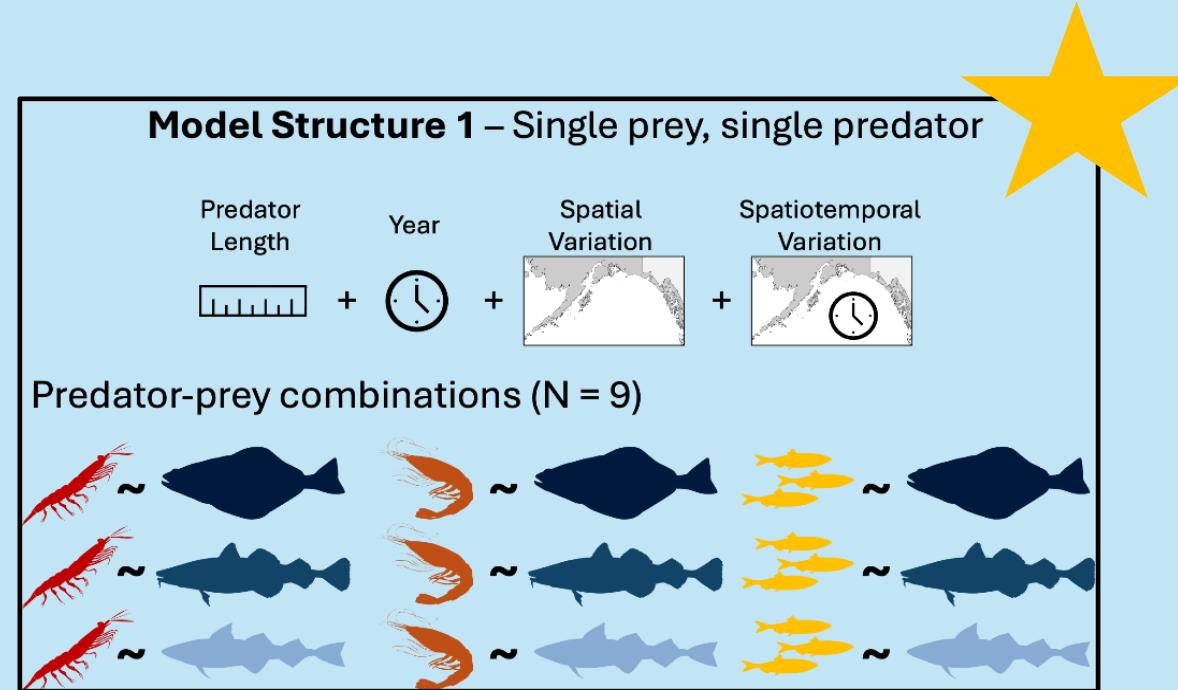
Model comparison results

- Model Structure 1 performed the best for out-of-sample predictions
- No discernable difference when comparing correlations between model predictions and observations



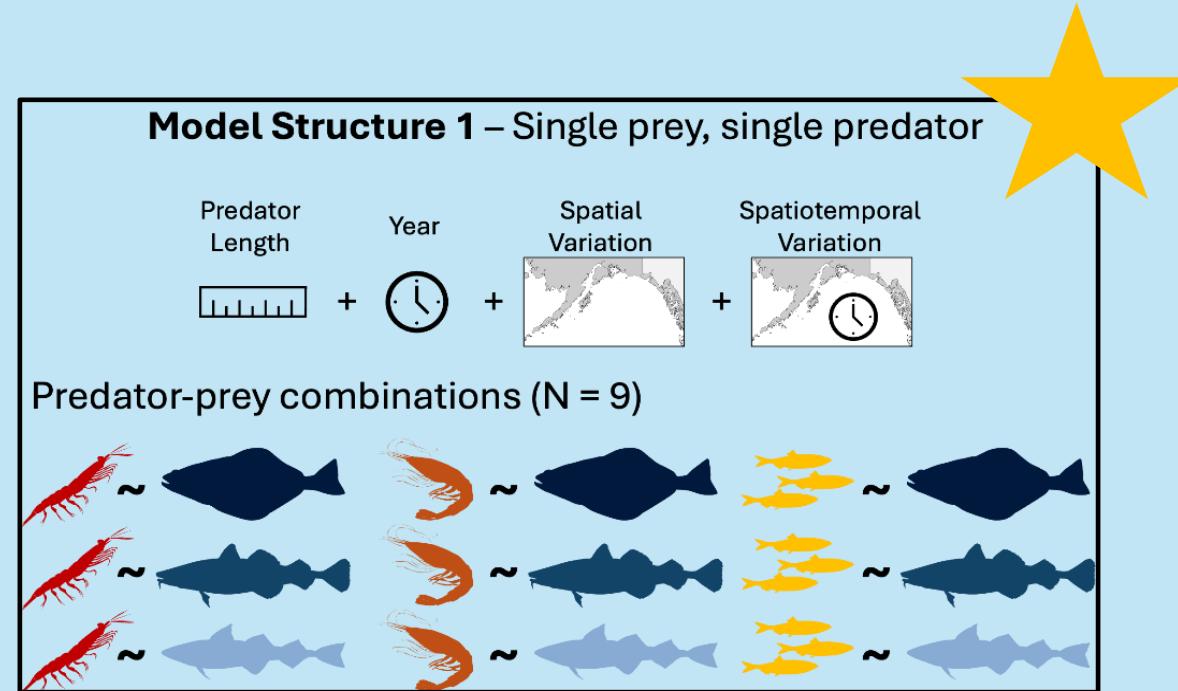
Model comparison results

- Model Structure 1 performed the best for out-of-sample predictions
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- Yield similar prediction results

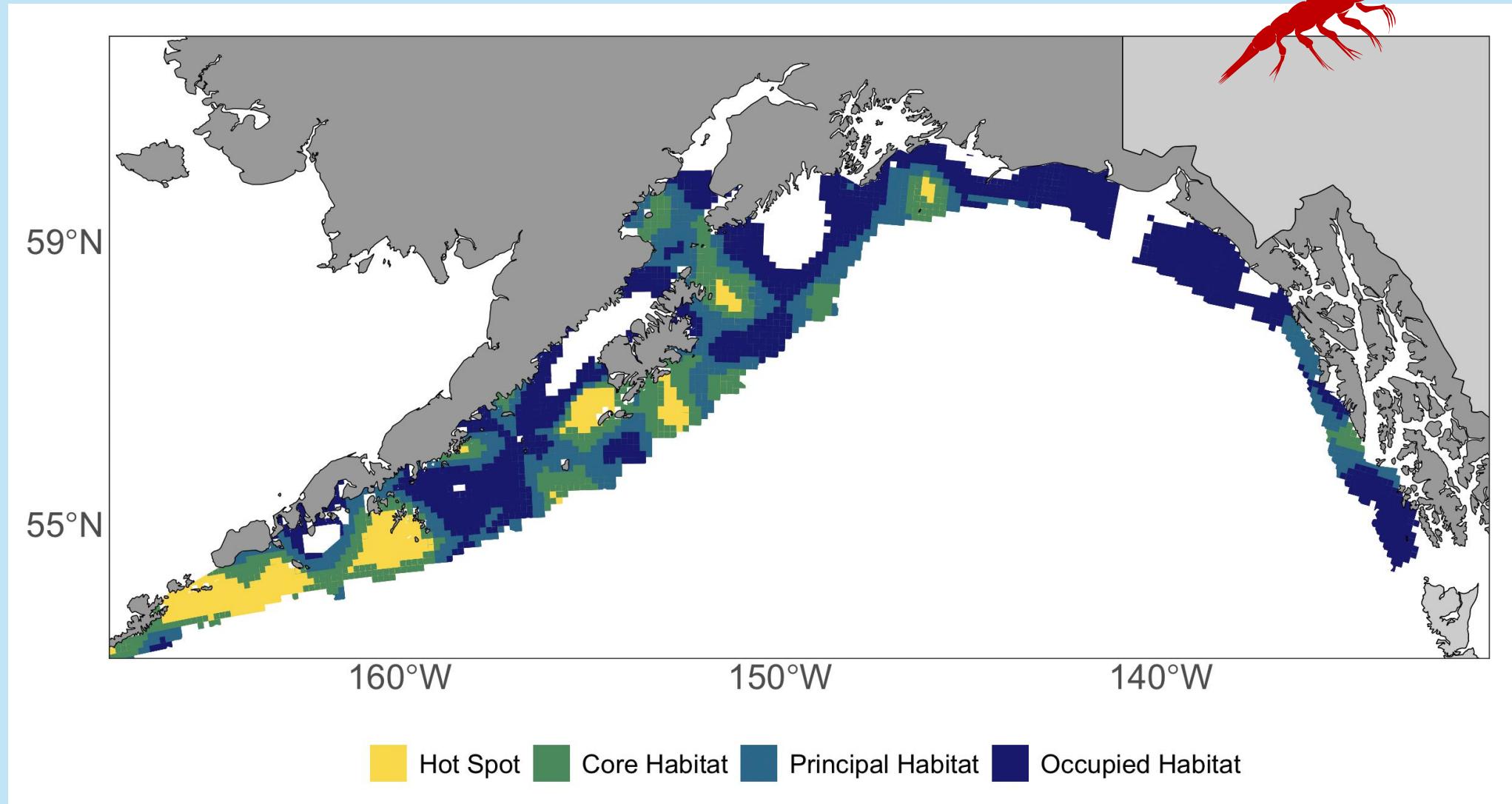
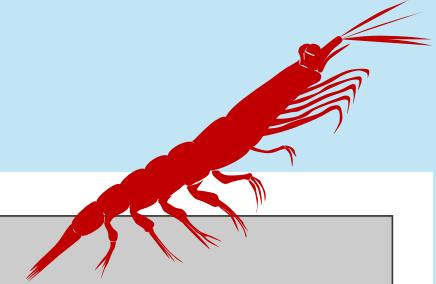


Model comparison results

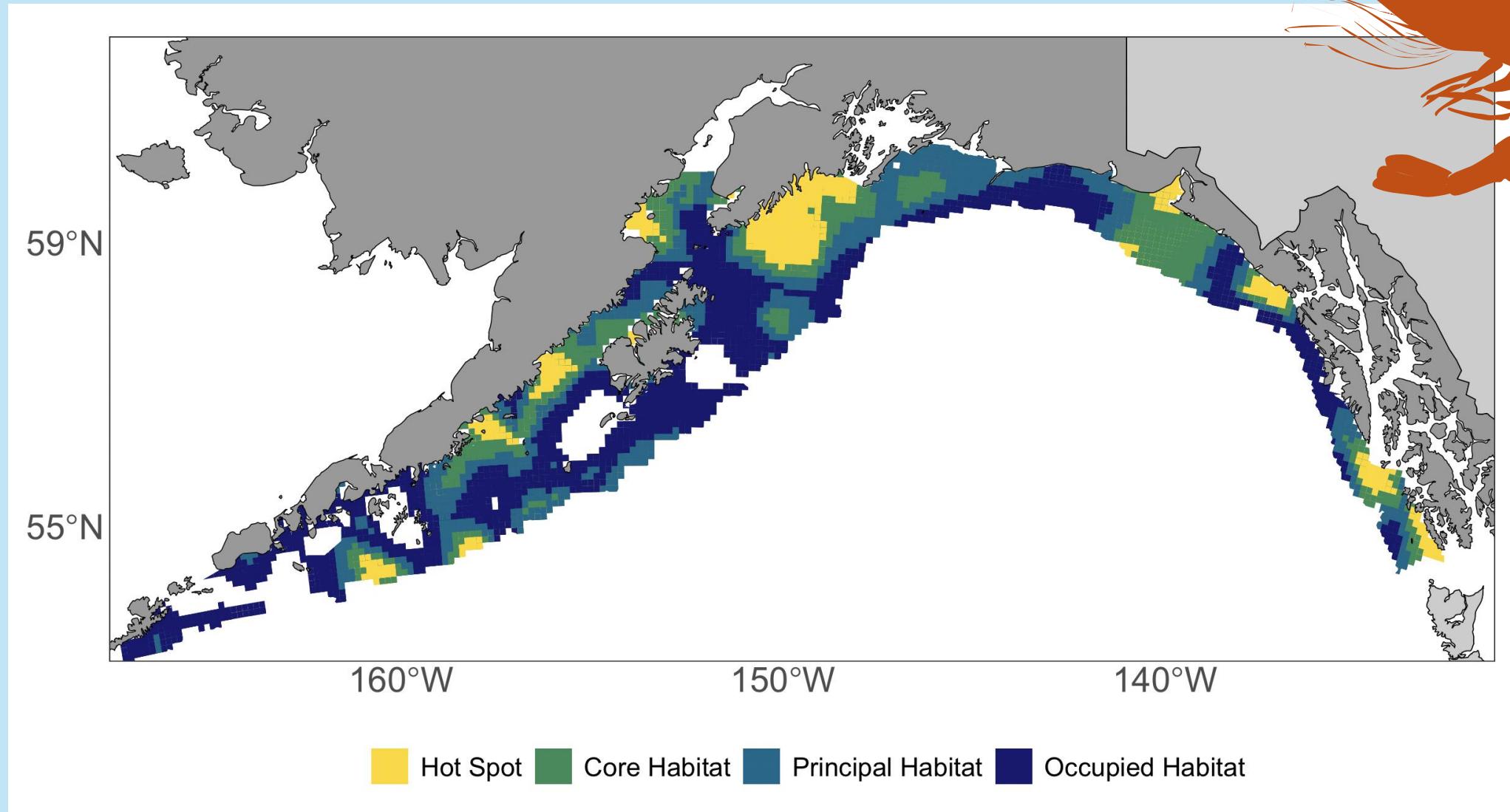
- Model Structure 1 performed the best for out-of-sample predictions
- No discernable difference when comparing correlations between model predictions and observations
- Yield similar prediction results
- Prioritize parsimony



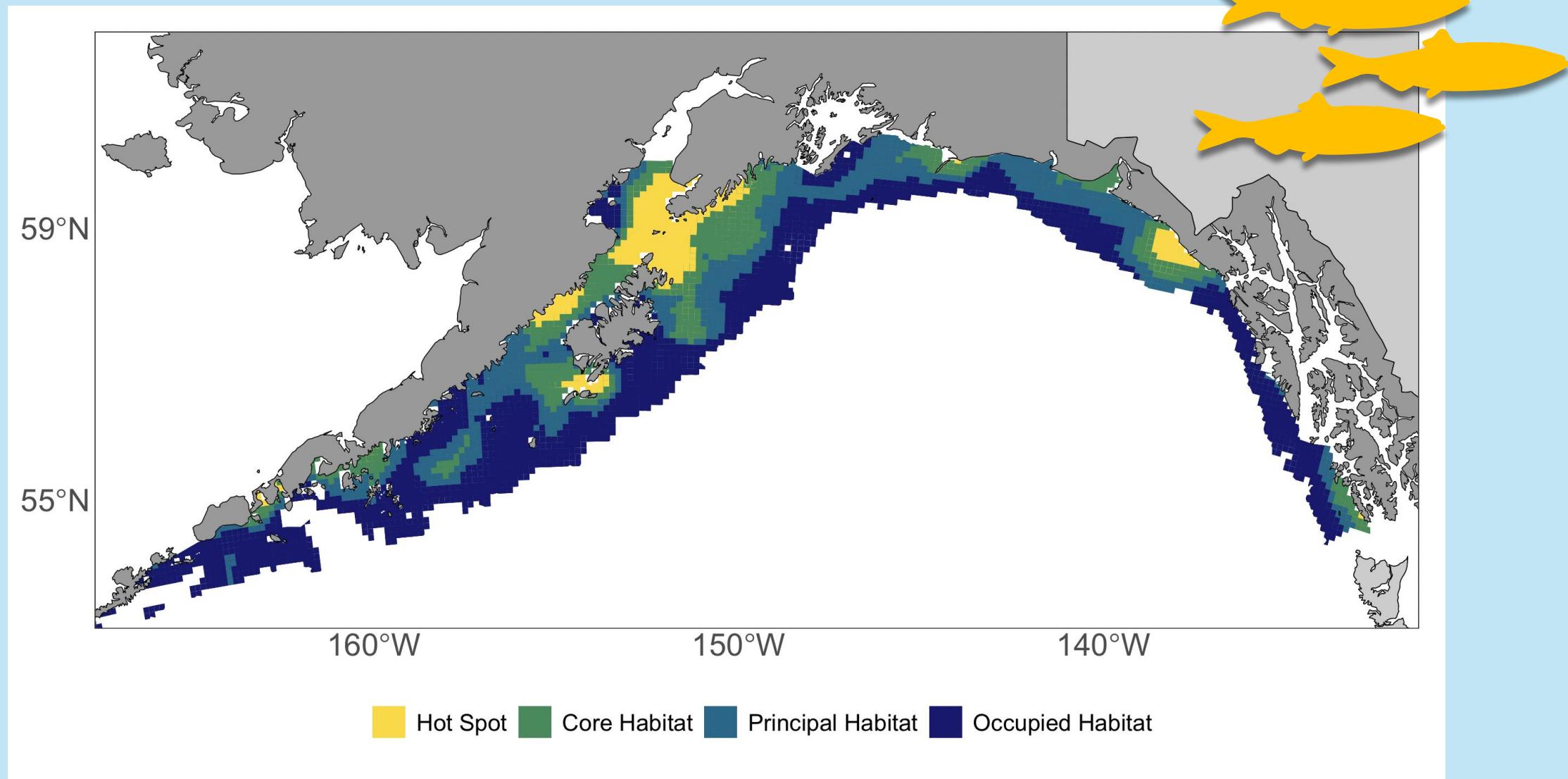
Habitat use for krill



Habitat use for shrimps



Habitat use for forage fishes



Management Applications

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- Our prey maps help advance EFH work in the GOA

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- EFH encompass waters and substrates integral for supporting healthy fisheries and includes habitat for feeding, growing, and breeding

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Management Applications

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- EFH encompass waters and substrates integral for supporting healthy fisheries and includes habitat for feeding, growing, and breeding
- Identification of EFH is required for all species in the Fishery Management Plan (FMP) under the Magnuson-Stevens Fishery Conservation and Management Act
- Advancing EFH Component 7: identifying habitat of important prey

Management Applications

- First time using SDMs to map prey for EFH!

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- Prey densities can also be used as ecological covariates for groundfish SDMs

Management Applications

- First time using SDMs to map prey for EFH!
- Prey densities can also be used as ecological covariates for groundfish SDMs
- Create indicators for the Ecosystem Status Report (ESR) and Ecosystem and Socioeconomic Profiles (ESP) for the GOA

Take home messages

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- Diet data can be used to map data limited lower- and mid trophic level species

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Take home messages

- Diet data can be used to map data limited lower- and mid trophic level species
- The simplest modeling approach performed the best
- It is critical to continue survey efforts to maintain our long-term datasets

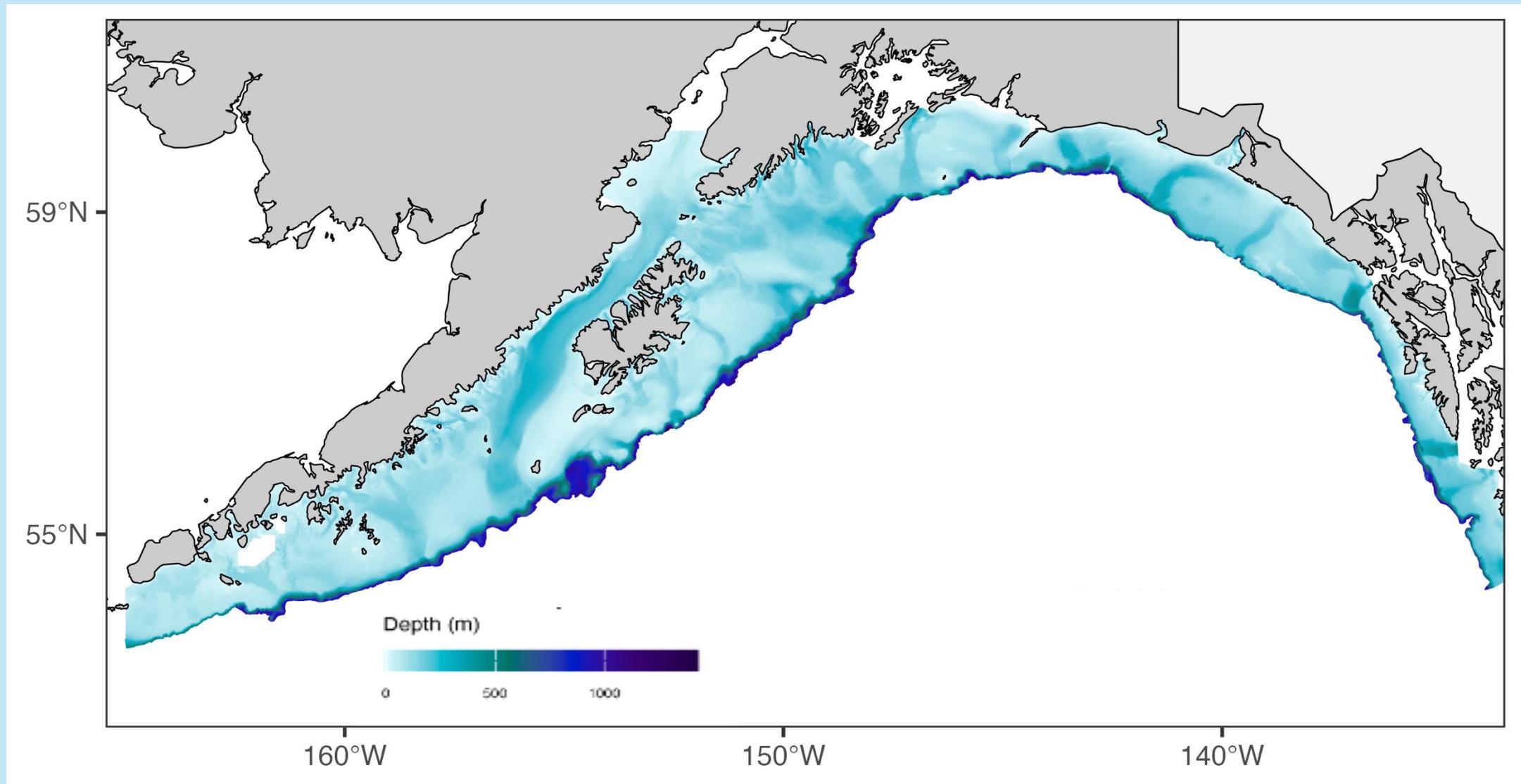
Thank you!

Special thanks to the
Integrated Marine Fisheries
Lab for their endless support:
Vaughn Robison, Madison
Bargas, Isabelle Galko, and
Chelsey Beese!

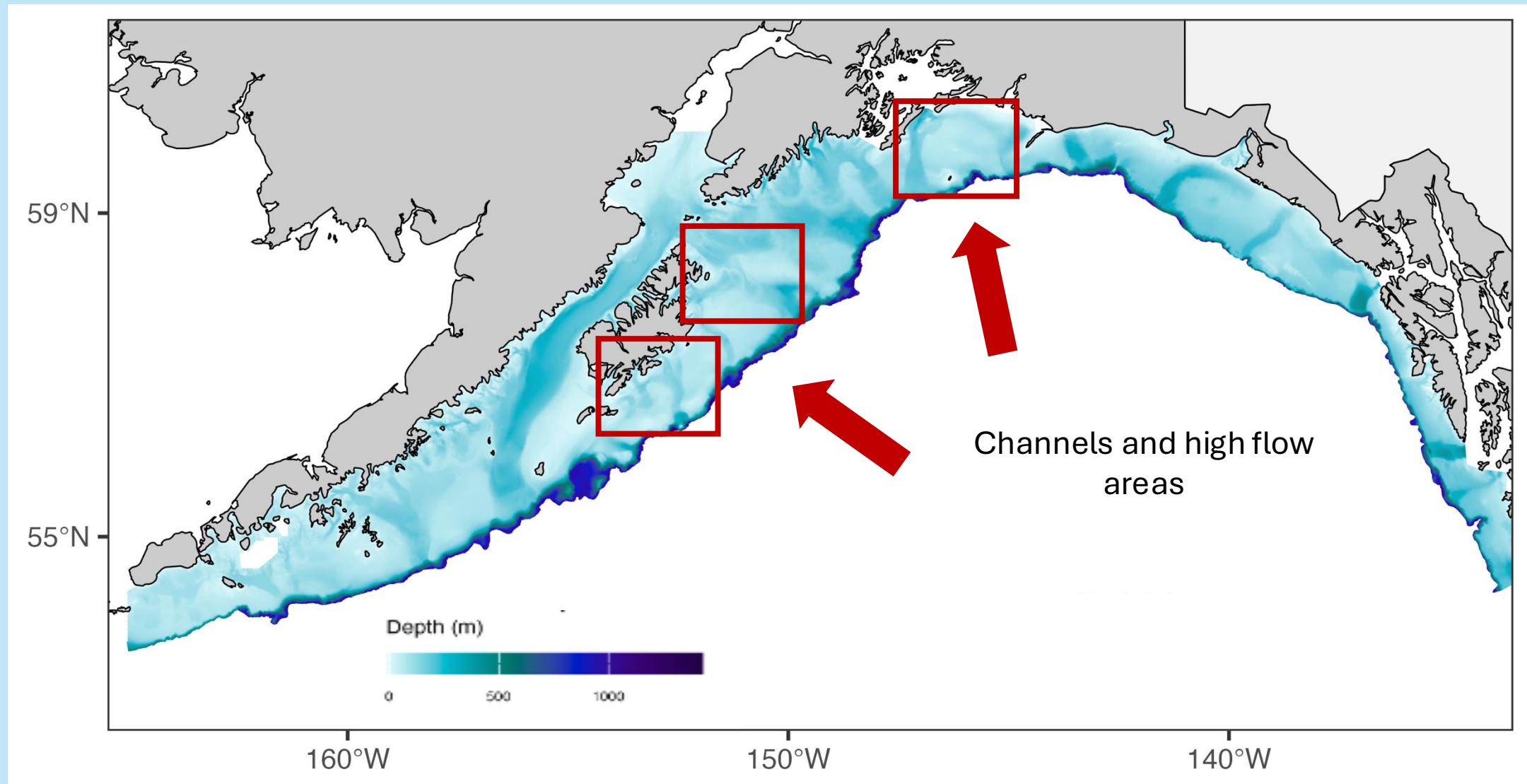


Oregon State University
Coastal Oregon Marine
Experiment Station

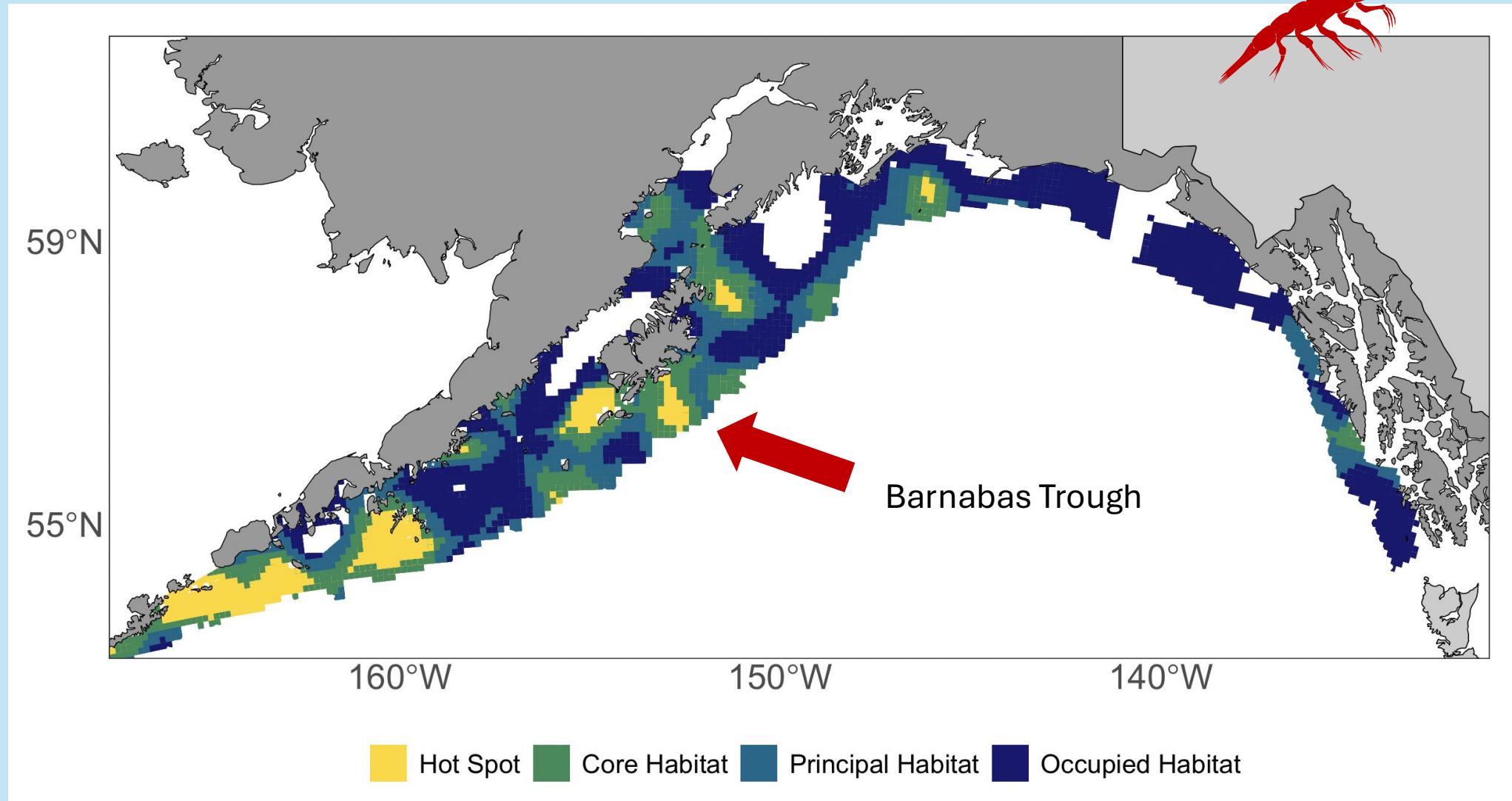
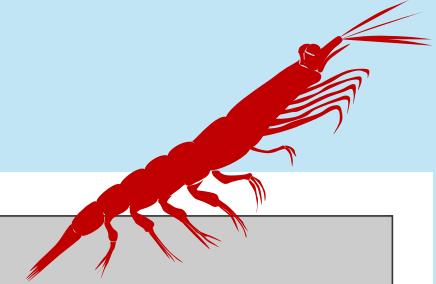
The Gulf of Alaska



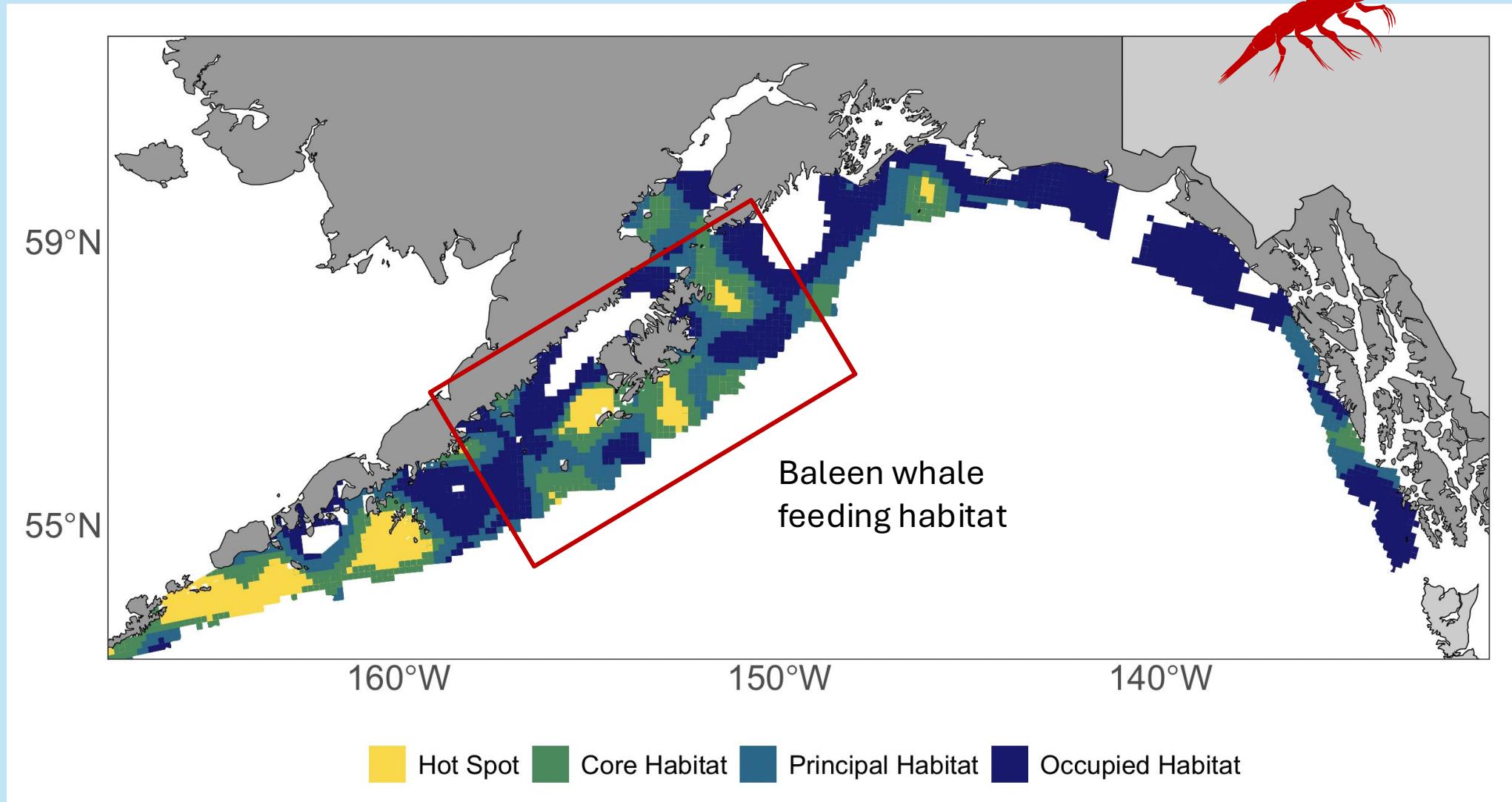
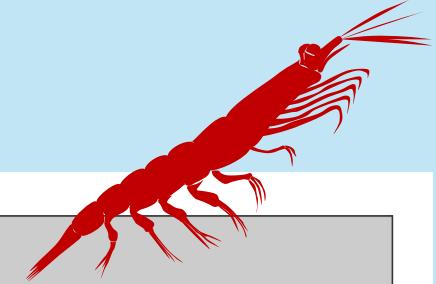
The Gulf of Alaska



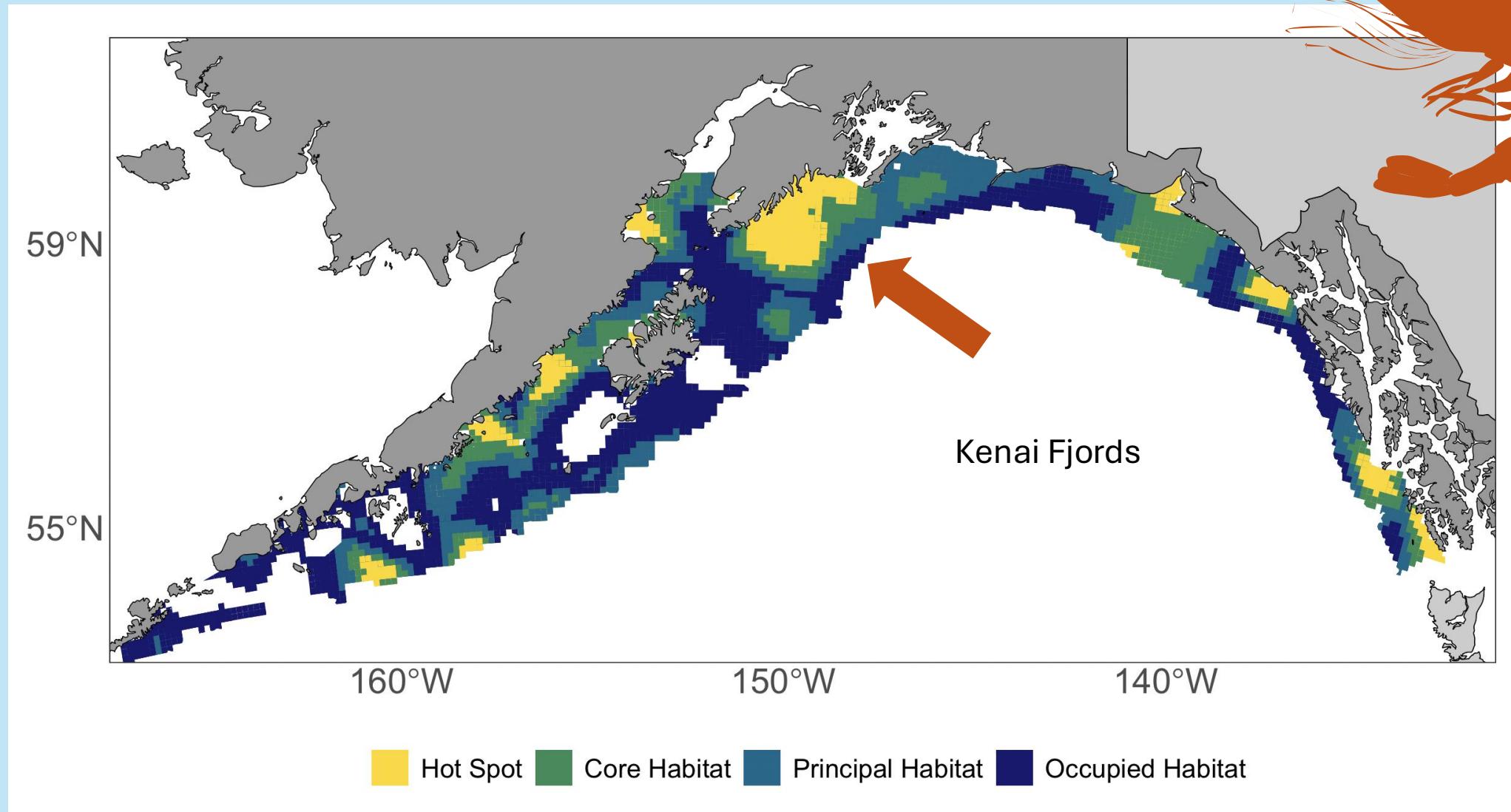
Habitat use for krill



Habitat use for krill

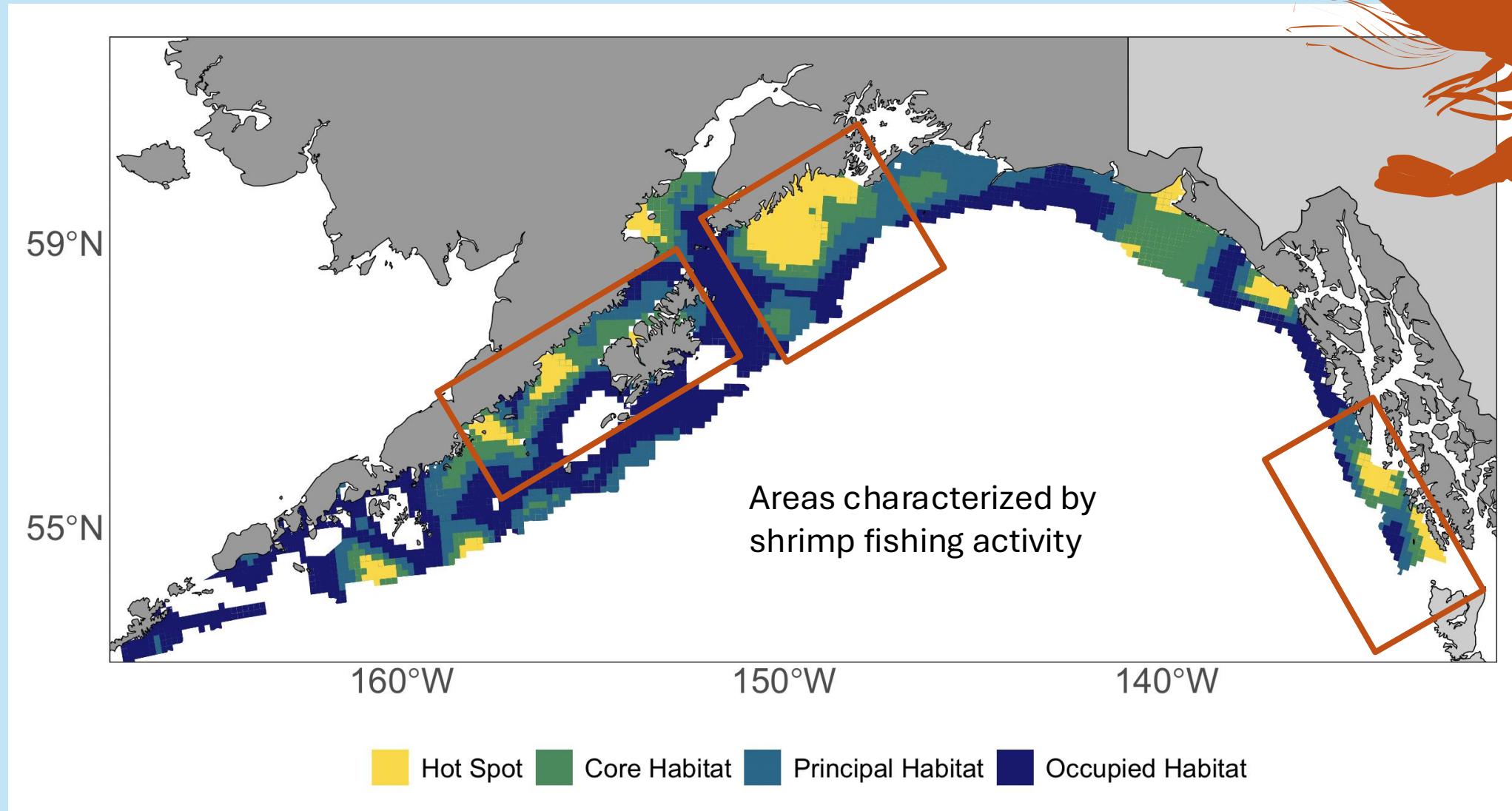


Habitat use for shrimps

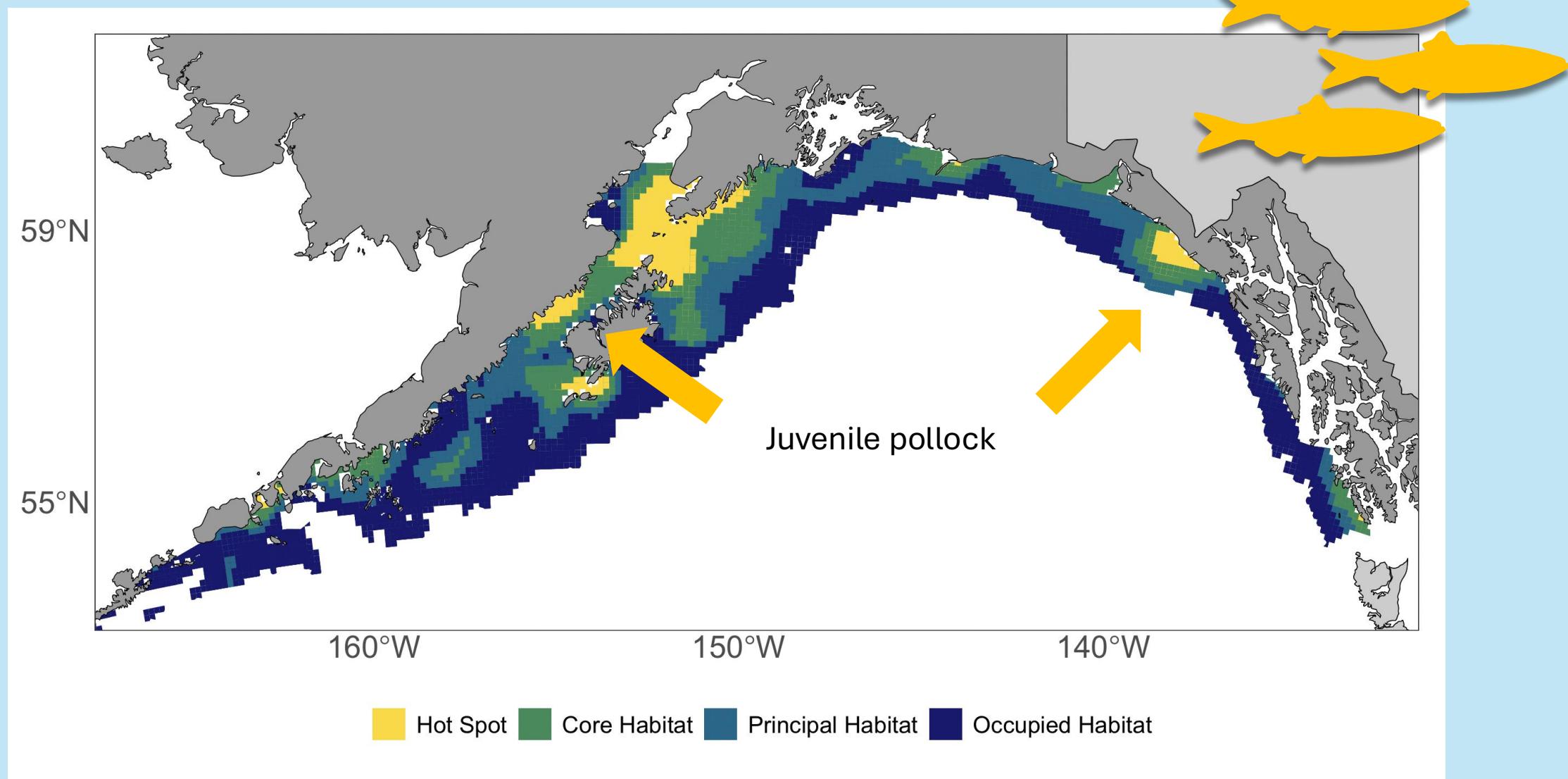


Butler, 1964; Lowry et al., 2007

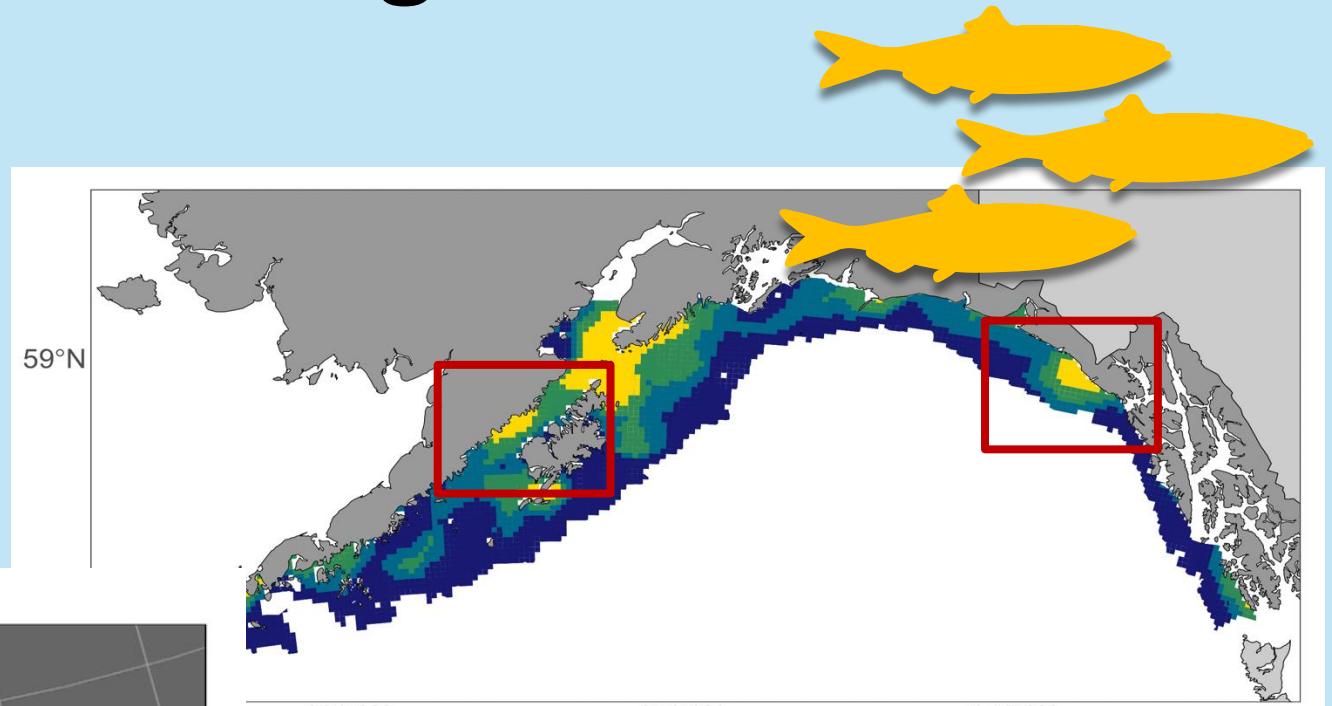
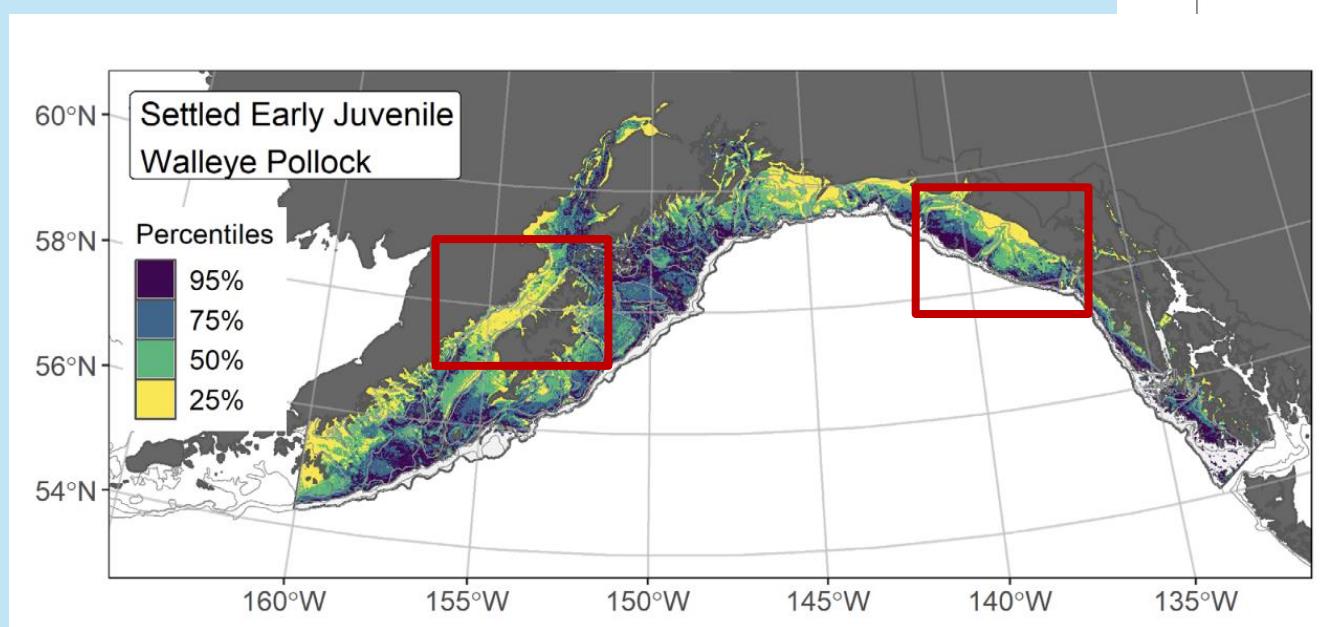
Habitat use for shrimps



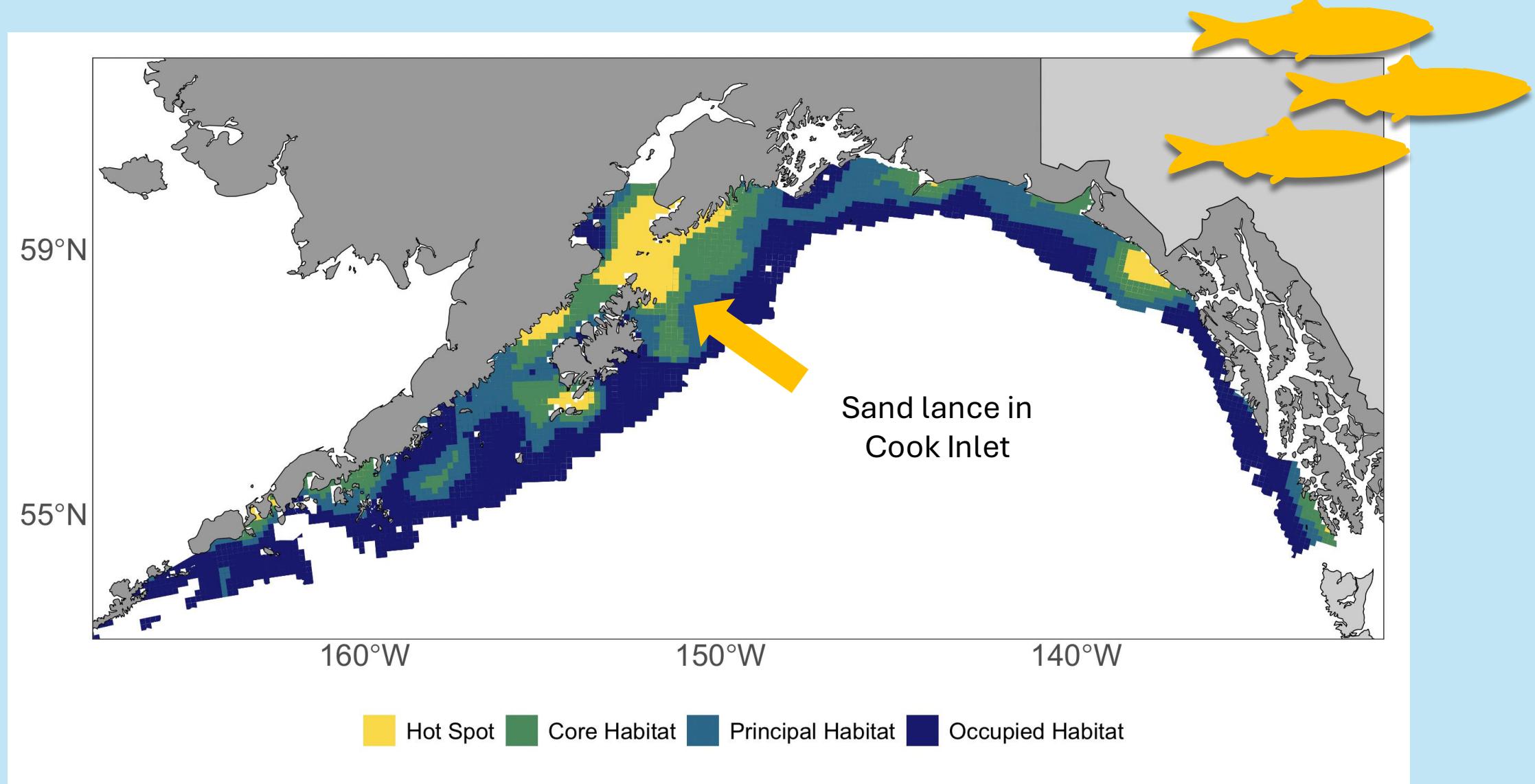
Habitat use for forage fishes



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