Climate-informed models benefit hindcasting but present challenges when forecasting species-habitat associations

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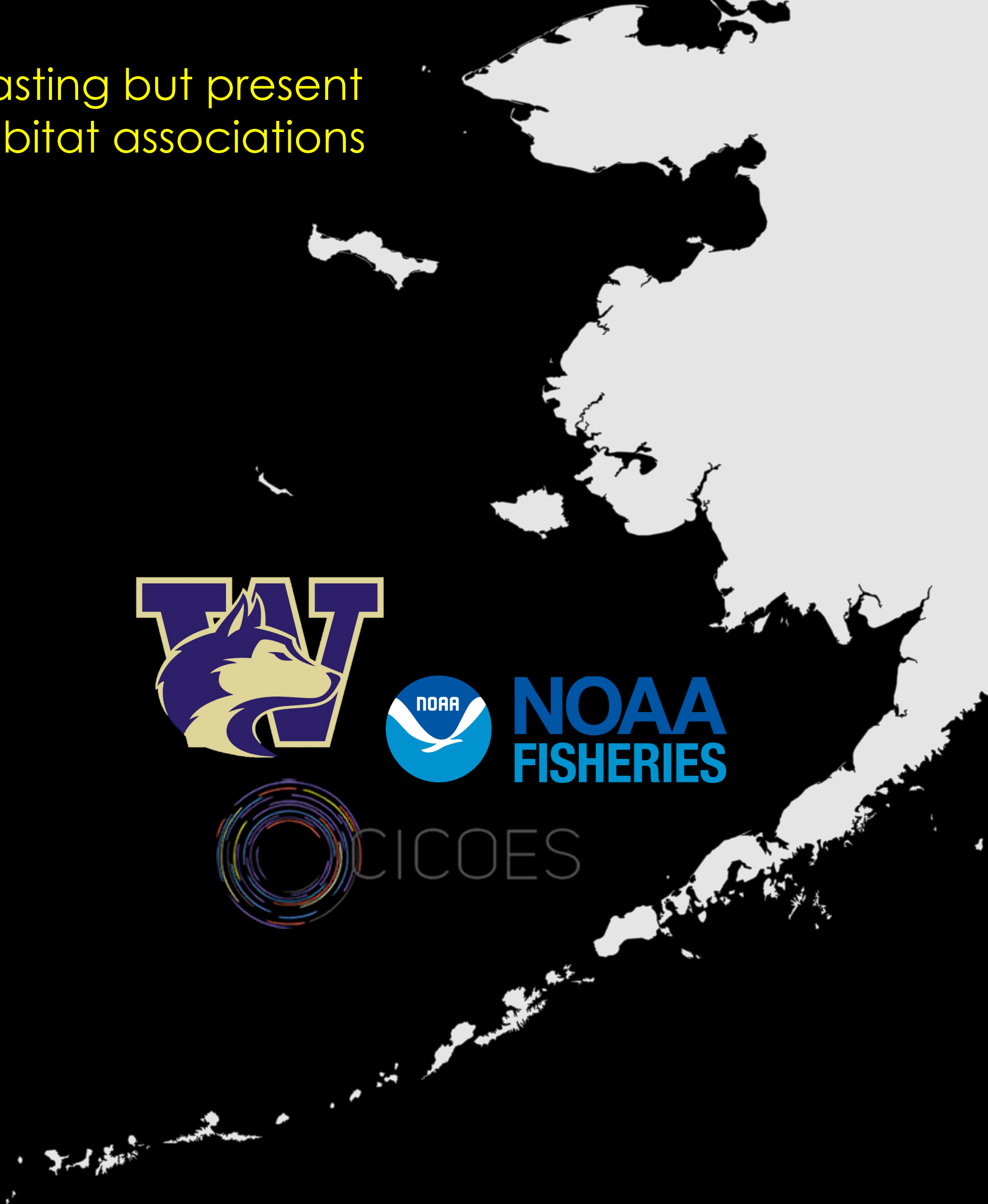


Species Distribution Models (SDMs)

Objective

– distributions and densities as function of the environment

Applications

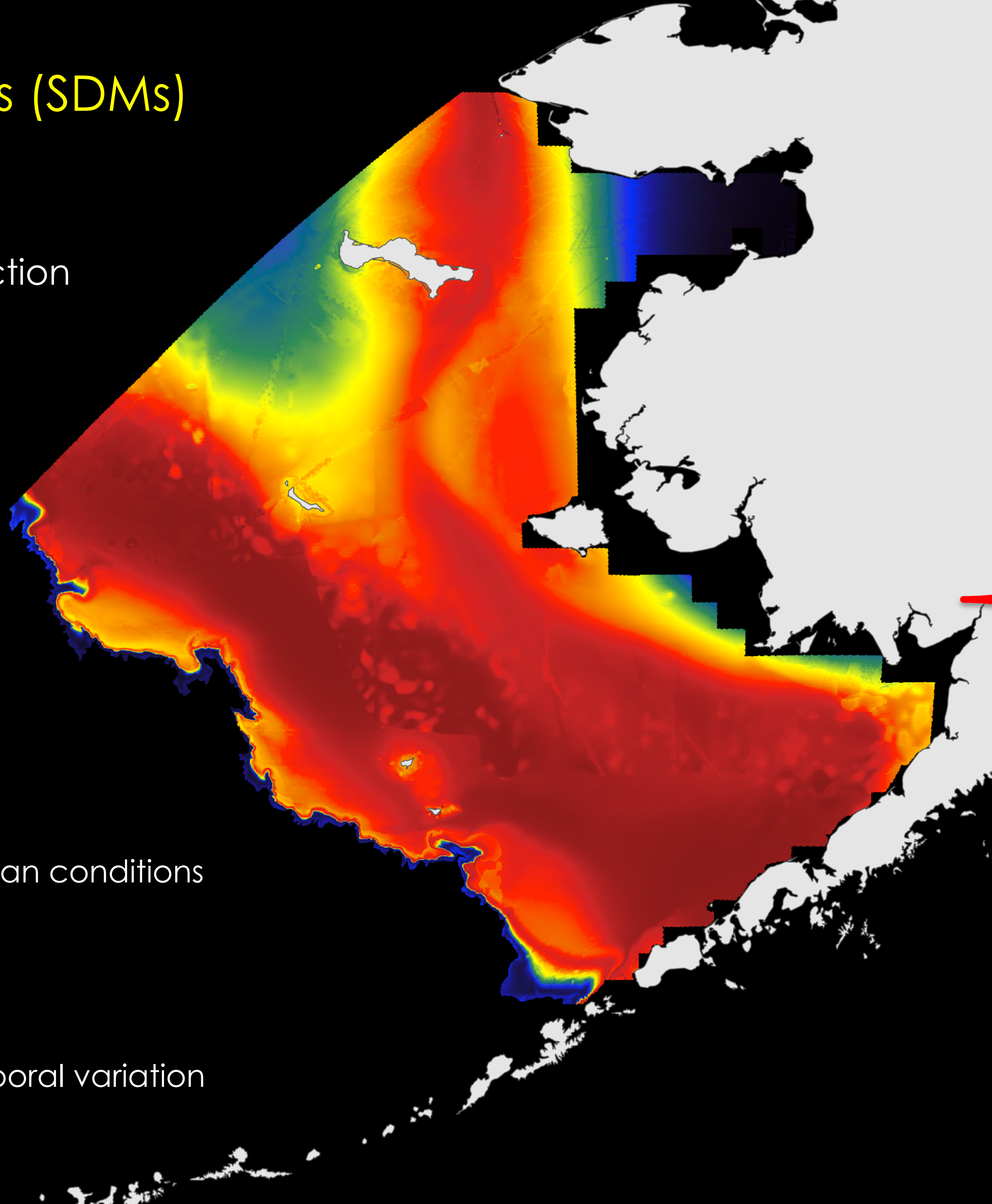
– species-habitat associations
– ecological inferences
  e.g., predation, competition
– fisheries management
  e.g., stock assessment, EFH

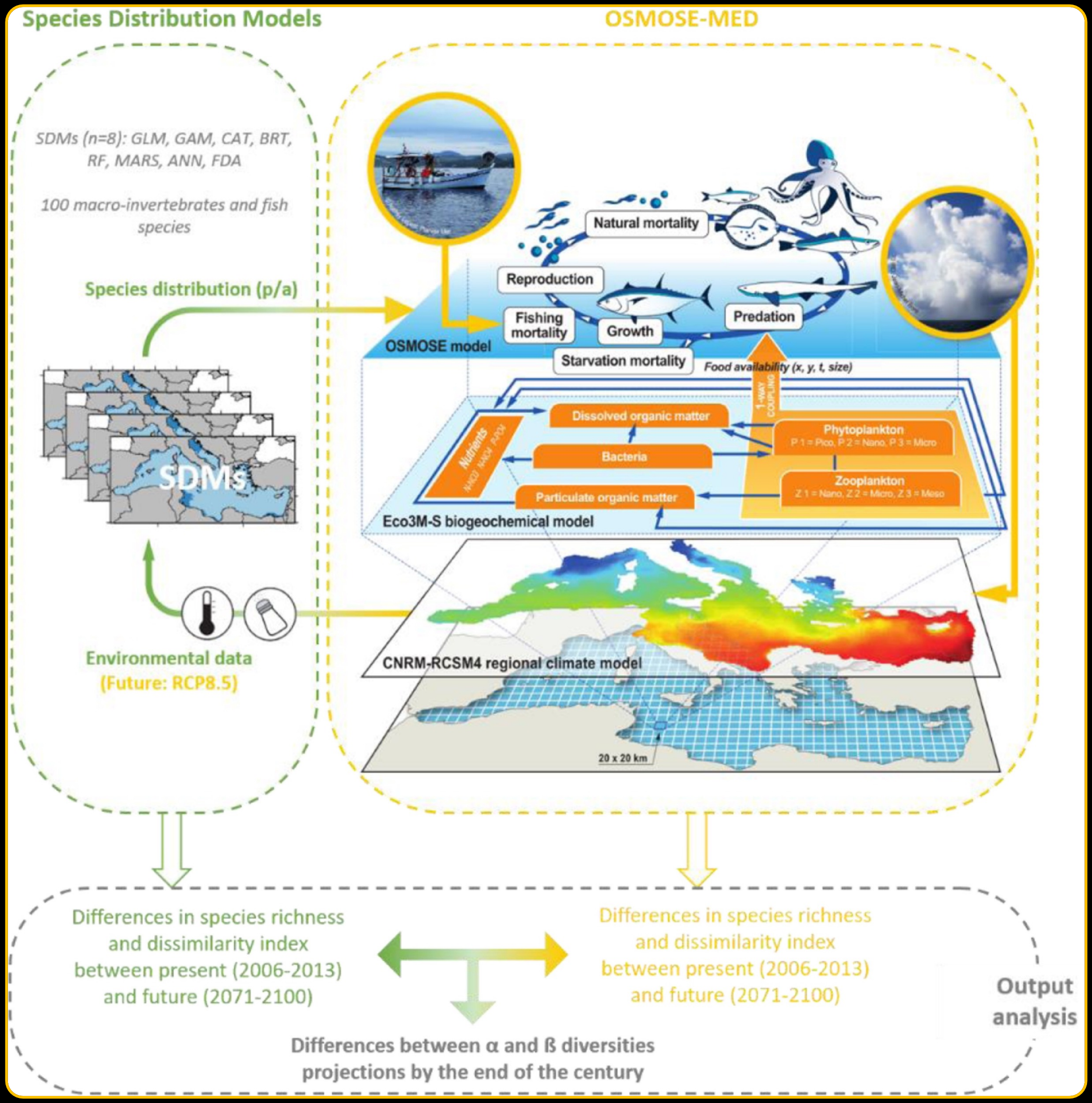
Conventional SDMs

- static approach
  i.e., spatial variation, long-term mean conditions

Climate-informed SDMs

- dynamic approach
  e.g., spatial, temporal, spatiotemporal variation
  year-specific conditions





Moullec *et al.* 2022

stakeholder interest:

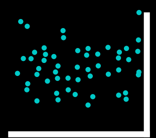
balance model complexity and interpretability

Research Questions

static vs. dynamic

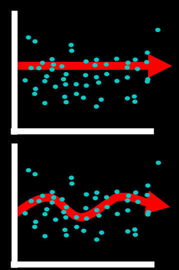
How does model complexity affect our ability to:

- bottom trawl survey data
- generalized additive models (GAMs)



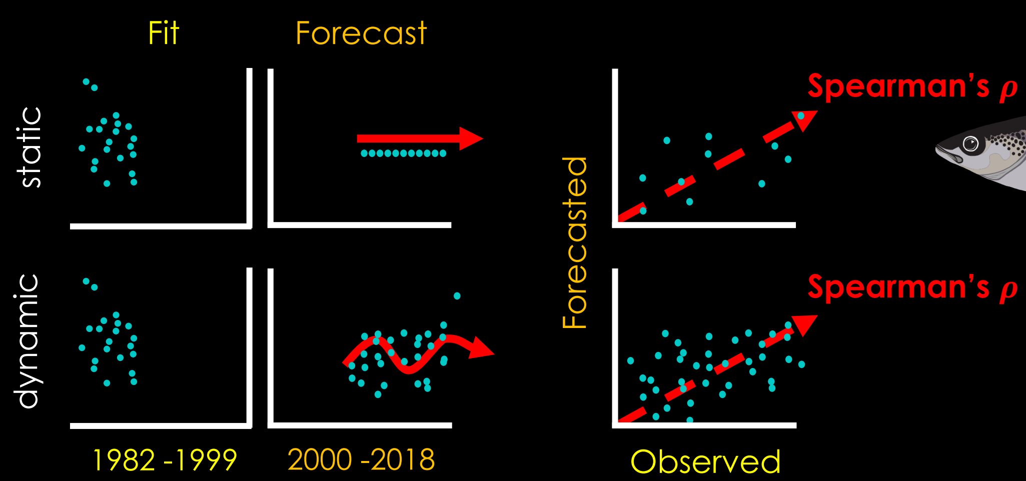
hindcast species-habitat associations?

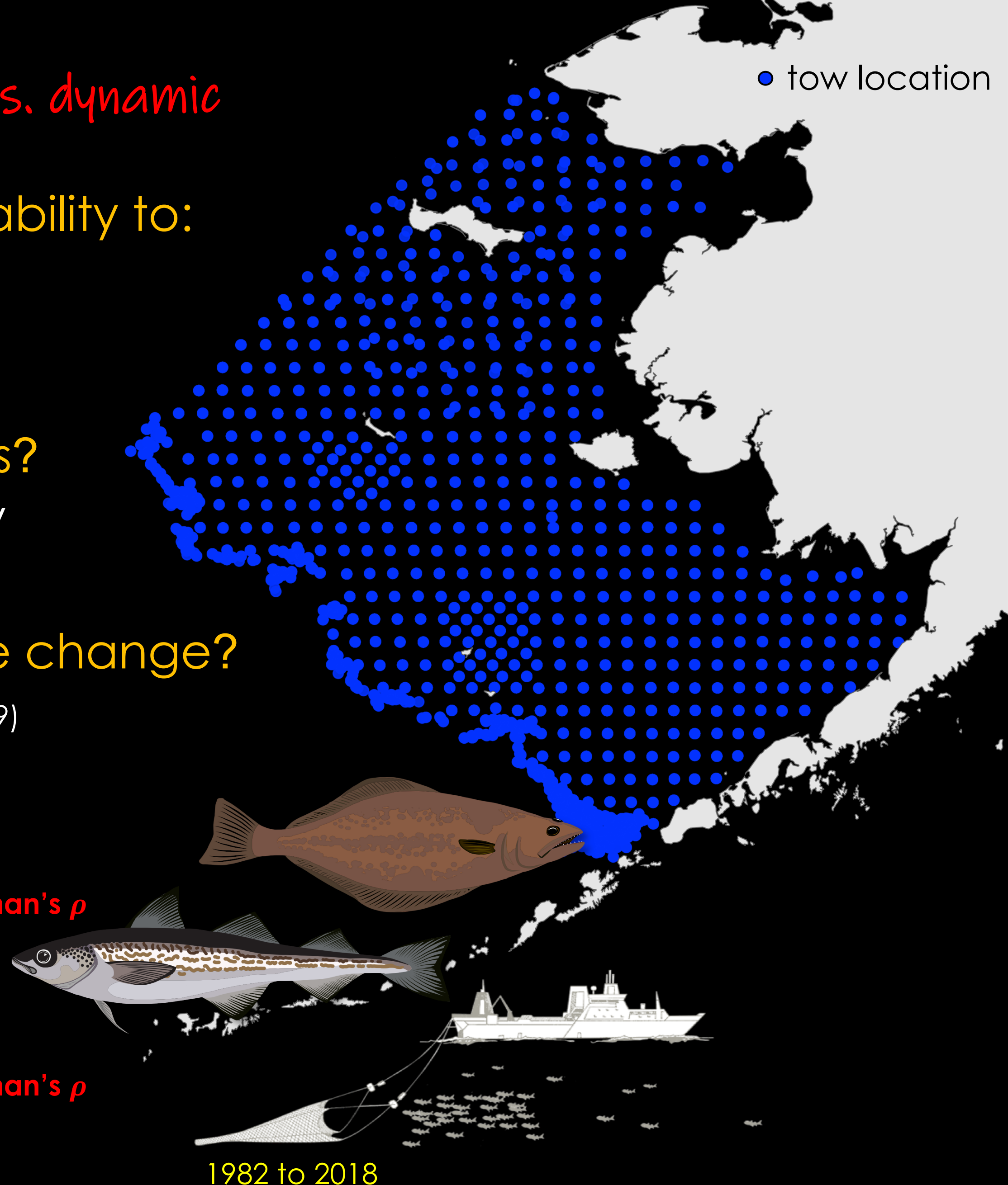
- R^2, % Deviance Explained, UBRE/GCV



forecast species responses to climate change?

- retrospective skill testing (*sensu* Thorson 2019)





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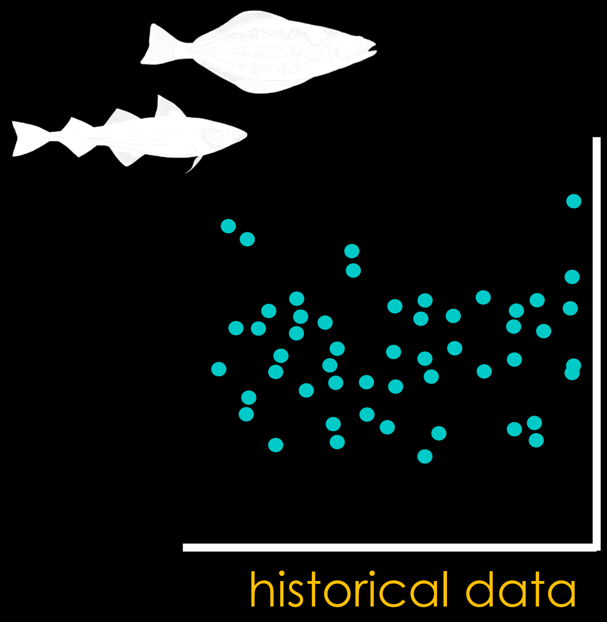
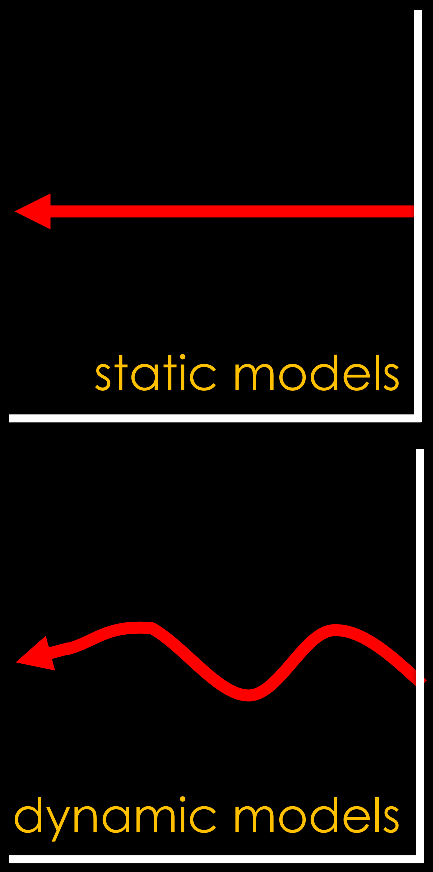
hindcasting species-habitat associations





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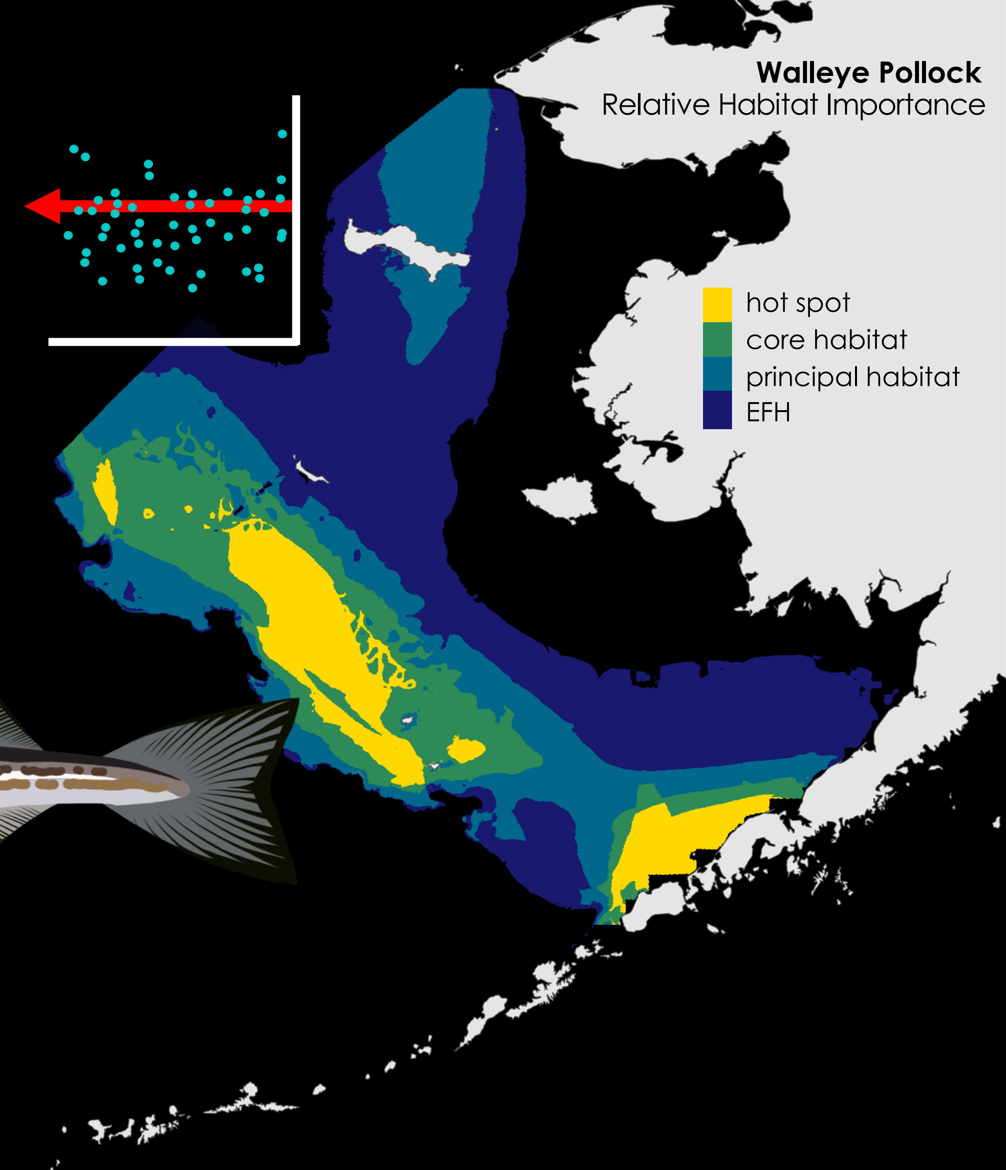

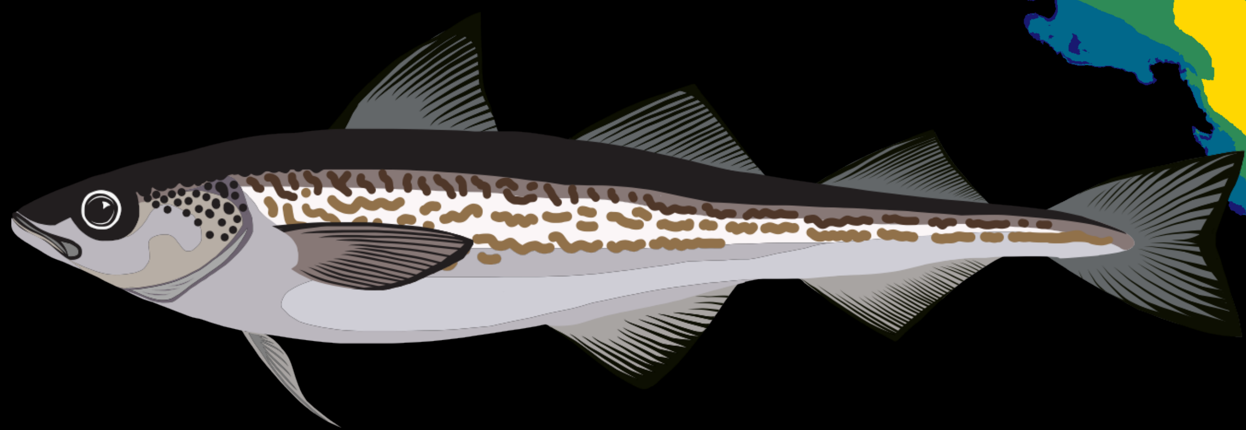

Essential Fish Habitat (EFH)

the physical, biological, and chemical characteristics
necessary for a particular species to survive, grow, and reproduce.

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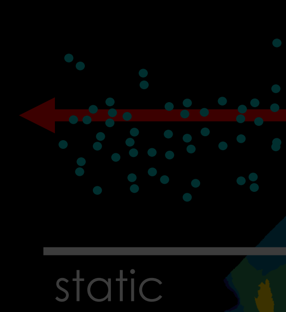
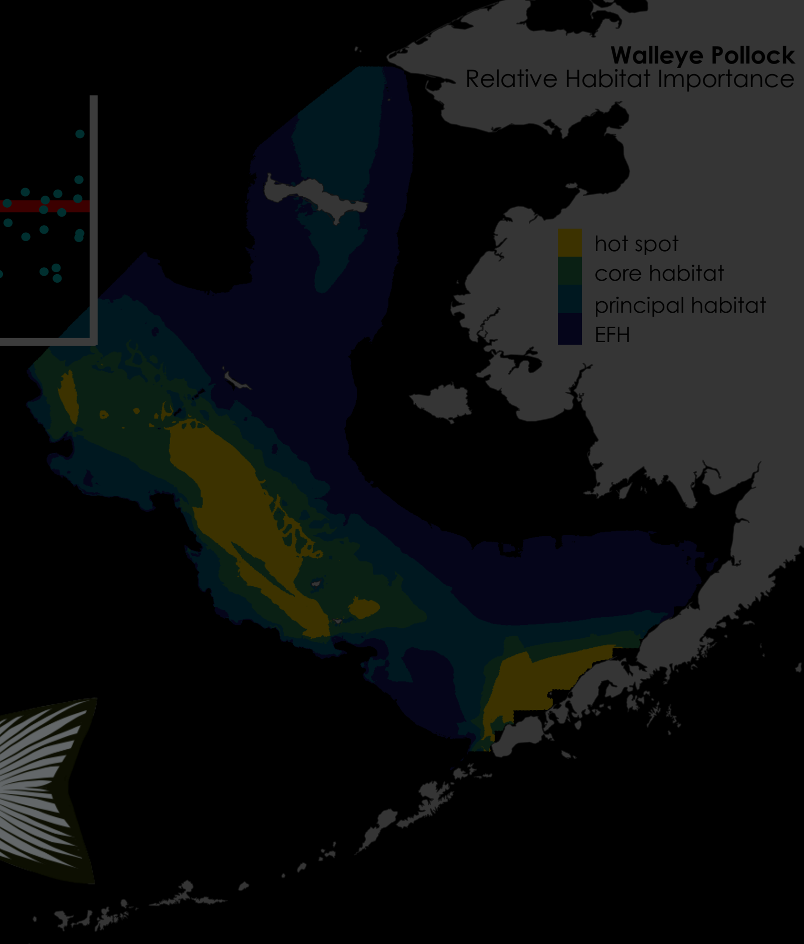
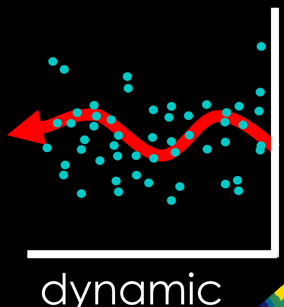
hindcasting species-habitat associations

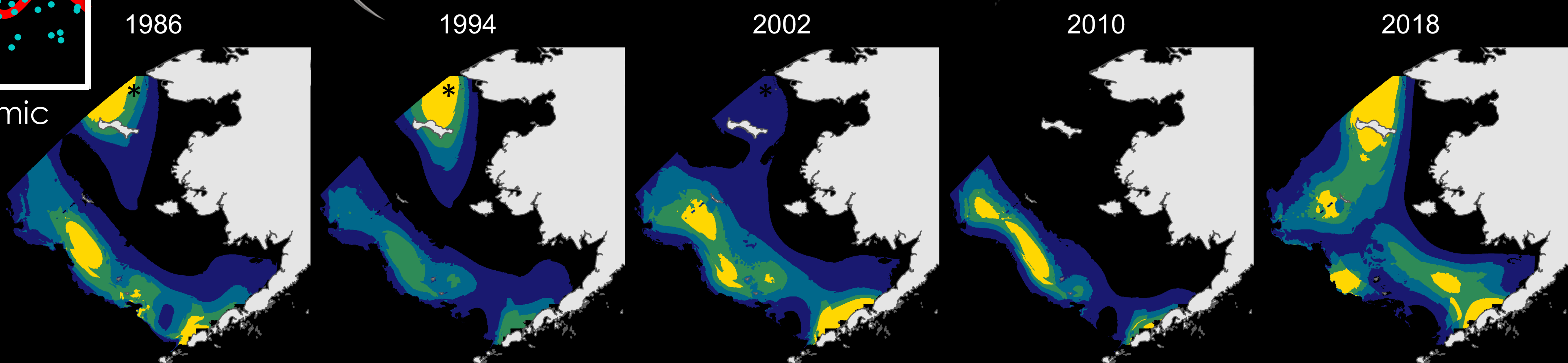




complex dynamic models = best-fit

↑ R^2, ↑ % Deviance Explained, ↓ UBRE/GCV





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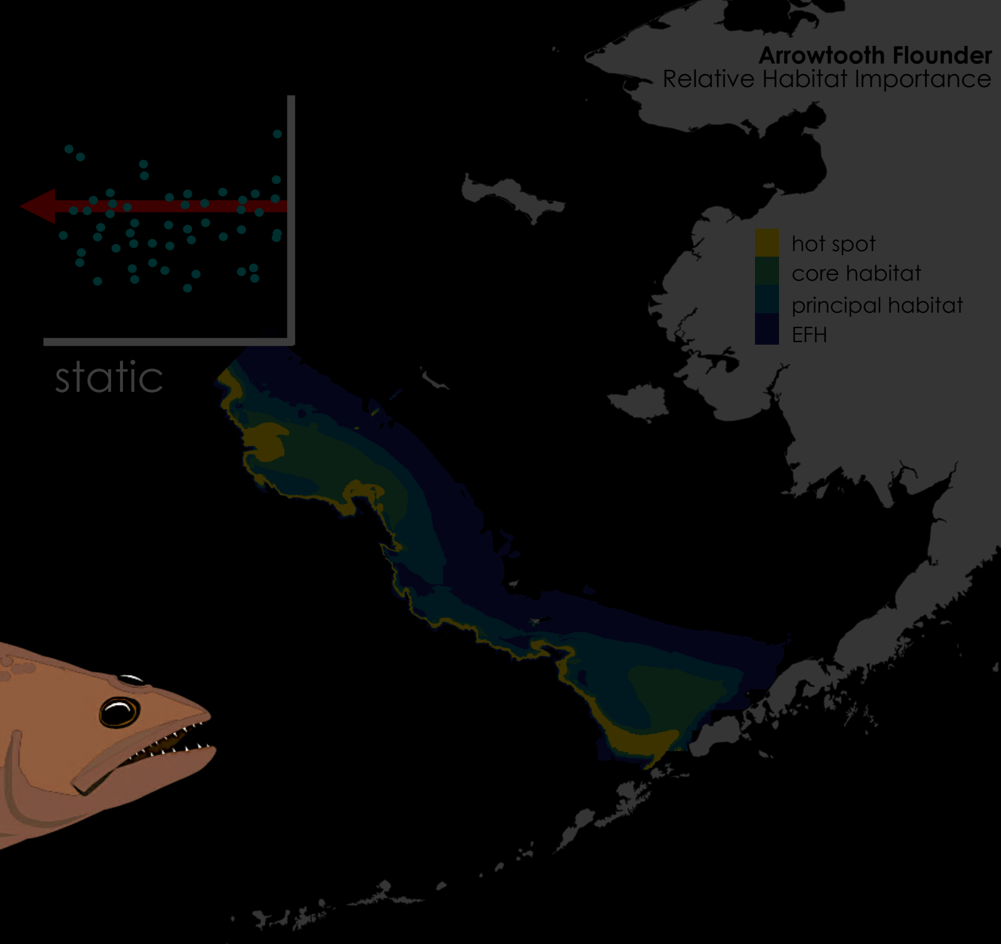
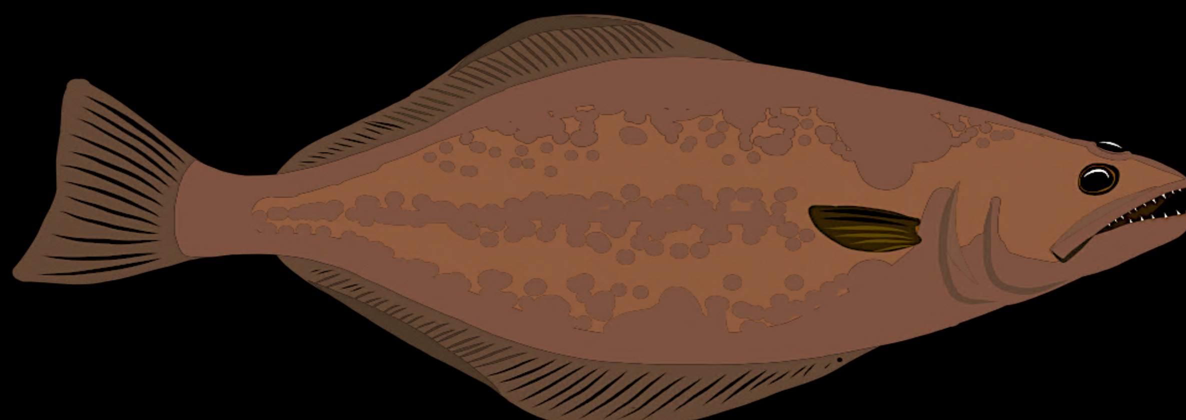
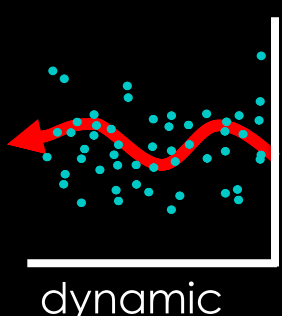
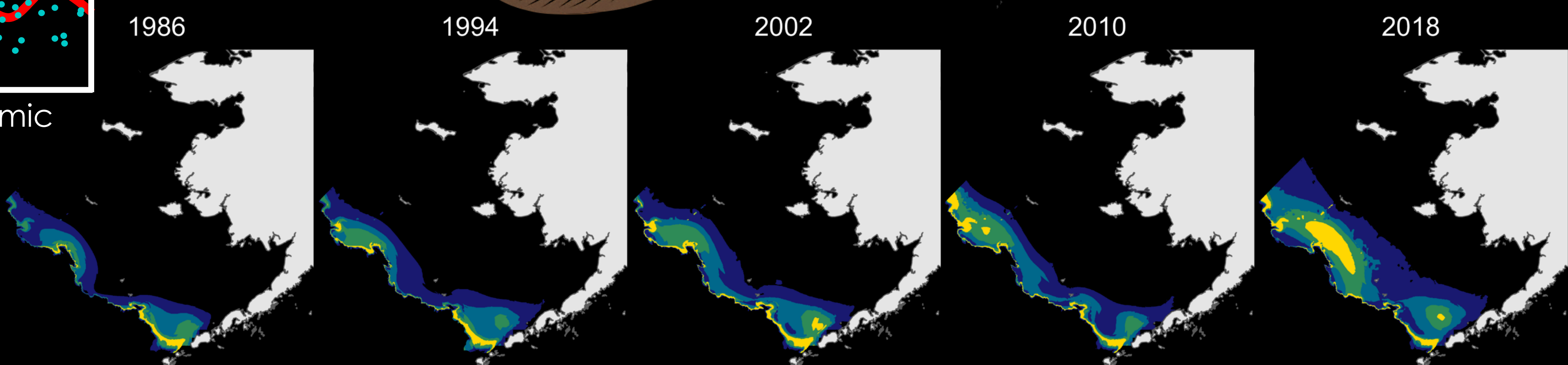
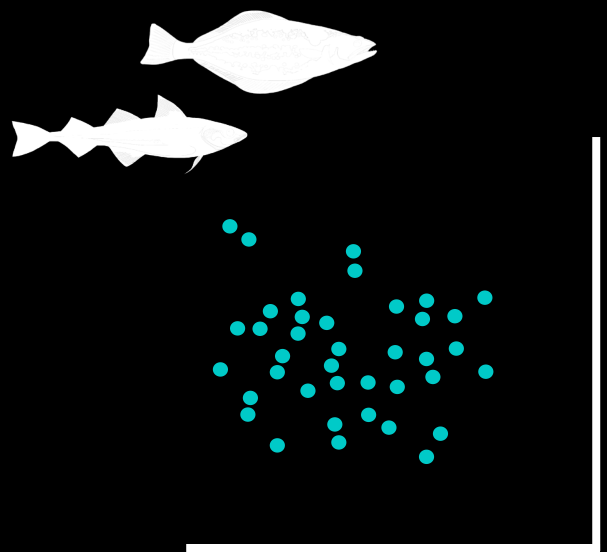




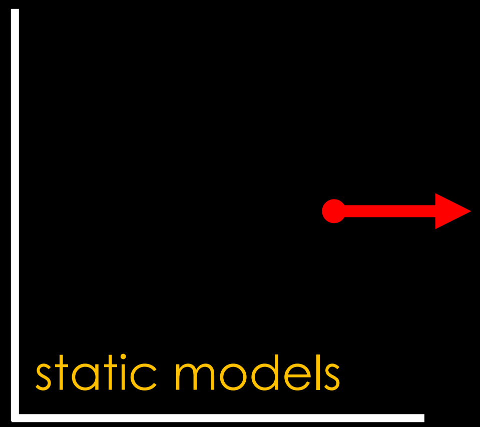


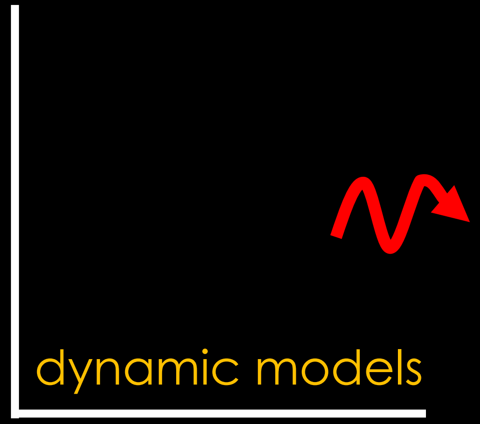


forecasting species responses to climate change



historical data





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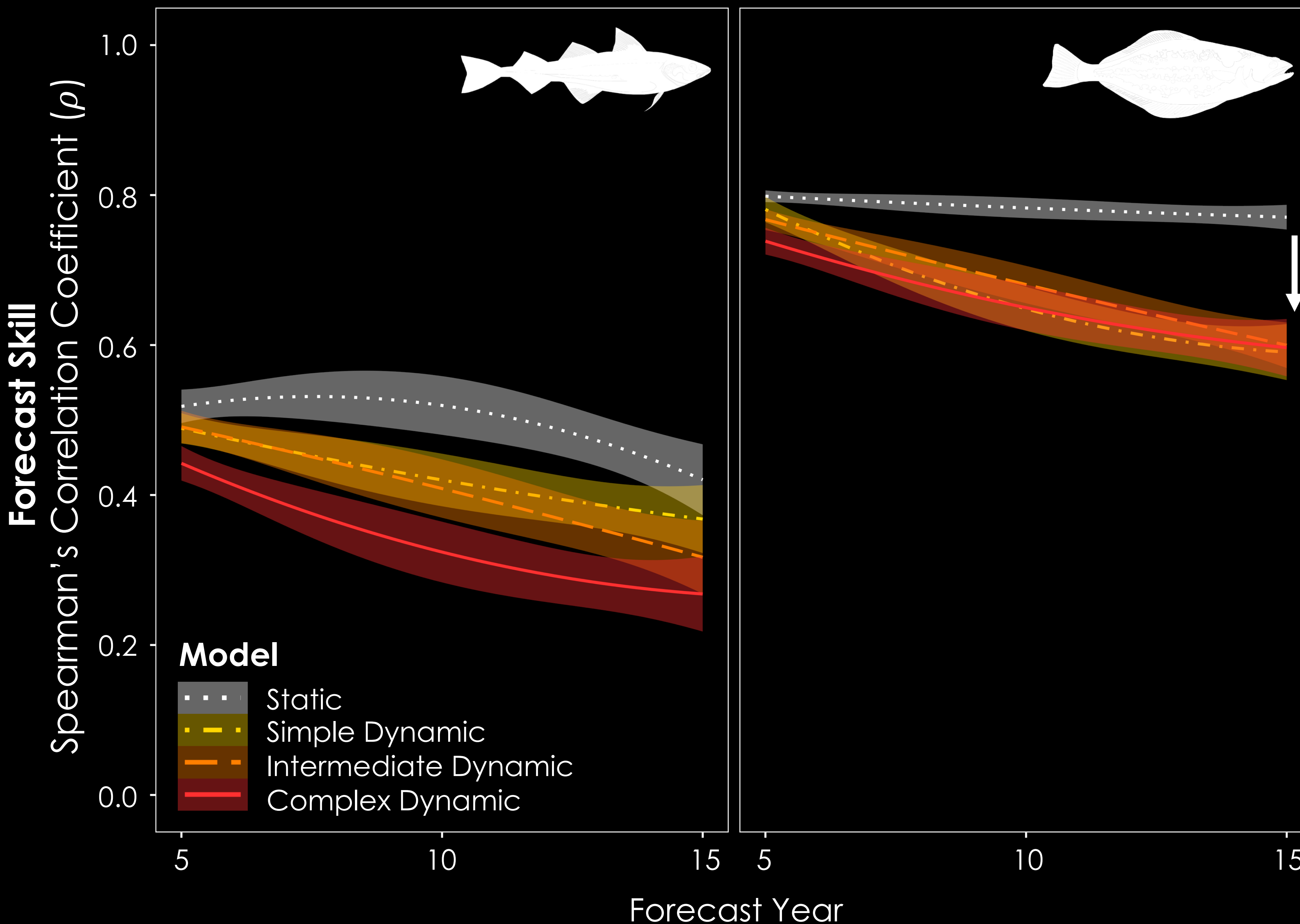

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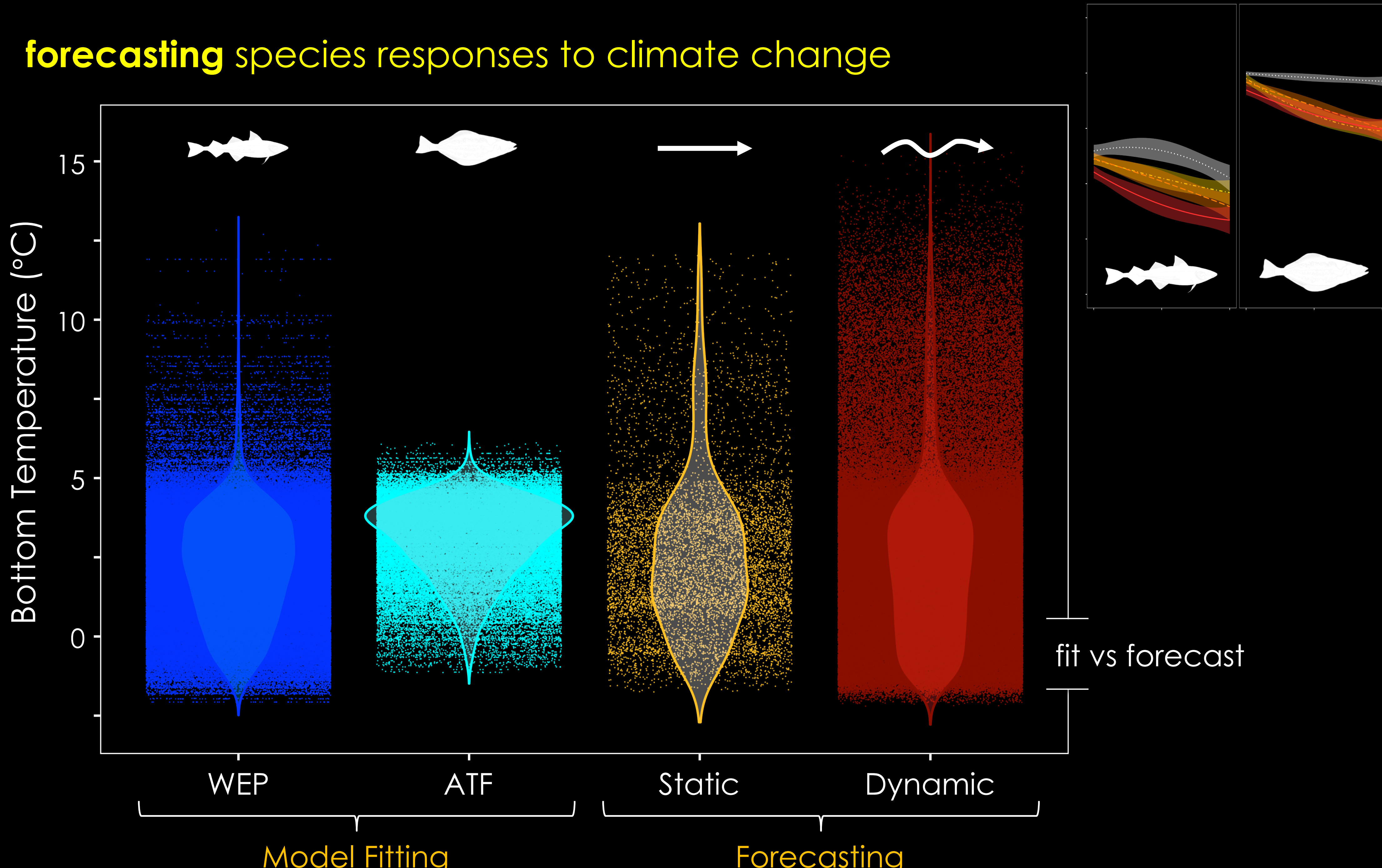

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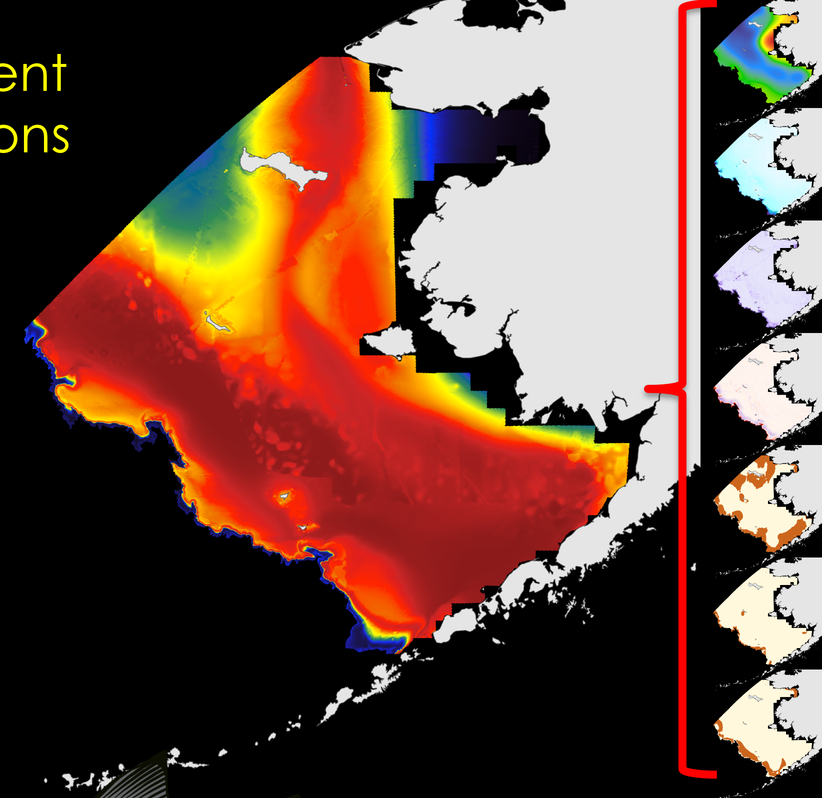


Take-home messages:

- dynamic SDMs best suited for hindcasting
  - no improvement or decrease in near-term forecast skill

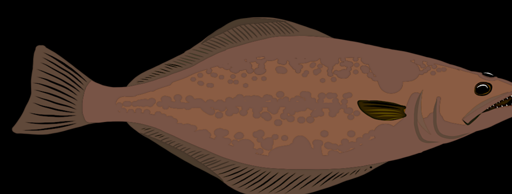
Recommendations for SDM users:

- analyses based on prediction task
  - hindcasting
    - complex dynamic models
      - spatial, temporal, and spatiotemporal variation
      - static and dynamic covariates
  - forecasting
    - retrospective skill testing for model selection
- exercise caution when forecasting based on temperature

fishing pressure
model performance

Where do we go from here?

- continue advancing development of dynamic SDMs
  e.g., incrementally adding non-environmental variables
- develop absolute measures of forecast skill



species interactions
dynamic forecast skill

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Funding:
MSA Implementation (NOAA)

Fish Art:
Nick Ingram

Data:
ACLIM
HCD, AKRO
RACE, AFSC