Research update: BBRKC bycatch distribution models

January 20, 2023

Emily Ryznar and Mike Litzow
NOAA Fisheries, Kodiak Lab

NOAA FISHERIES

Motivation

- BBRKC distribution is poorly understood outside the NMFS summer survey season
    - Environmental and biological drivers

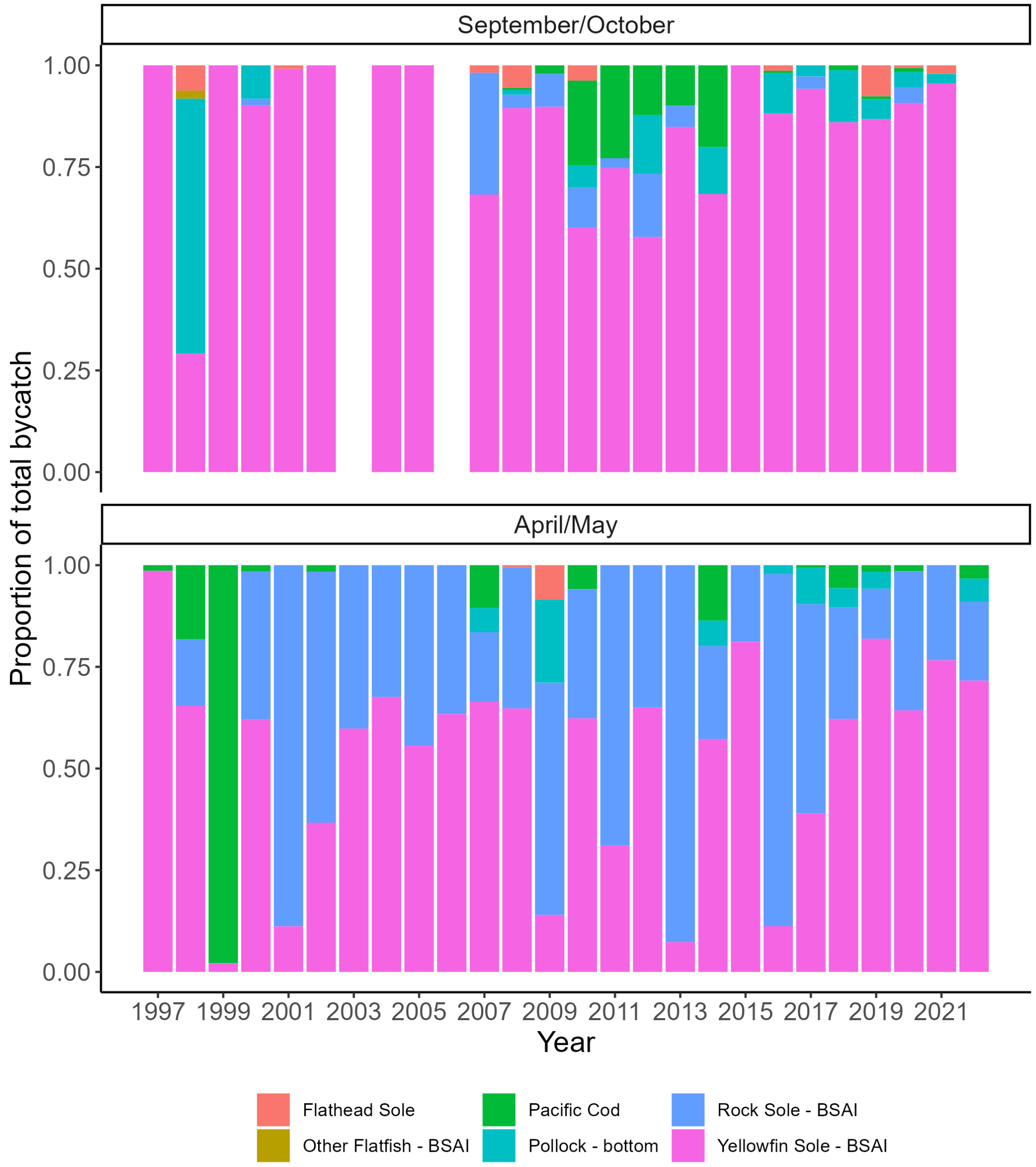
    → Better understanding is needed to support management and conservation

Objectives

1. Create models to predict the distribution of BBRKC bycatch in fall/spring bottom trawl fisheries
2. Identify covariates that drive changes in bycatch distribution from year to year

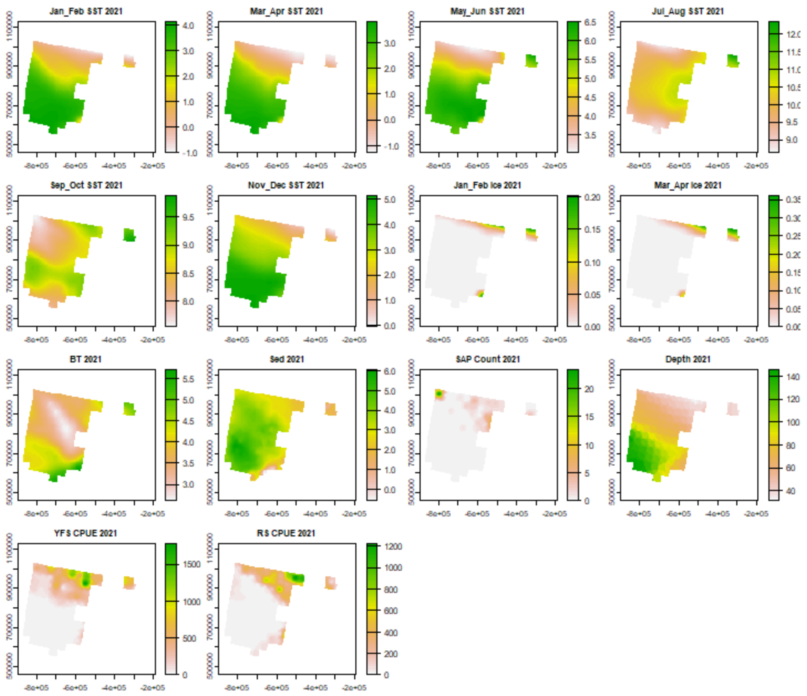
Data

- <u>Response</u>: legal male BBRKC bycatch in two trawl fisheries:
    1. Yellowfin sole (September/October and April/May)
    2. Northern rock sole (April/May)
- <u>Prediction years</u>: 1997-present



Data

- <u>Covariates</u>:
  - Surface temperature (˚C; two-month increments)[1]
  - Ice area fraction (% cover; Jan/Feb, Mar/Apr)[1]
  - Bottom temperature (˚C; summer months)[2]
  - Depth (m; constant)[2]
  - BBRKC survey abundance (summer months)[2]
  - Target fish survey abundance (summer months)[2]
  - Sediment grain size (phi; constant)[3]
  - Target fishery quota, TAC (by year)[4]



[1]ERA5 [2]NMFS-AFSC bottom trawl survey [3]Smith & McConnaughey 1999 [4]NPFMC SAFEs

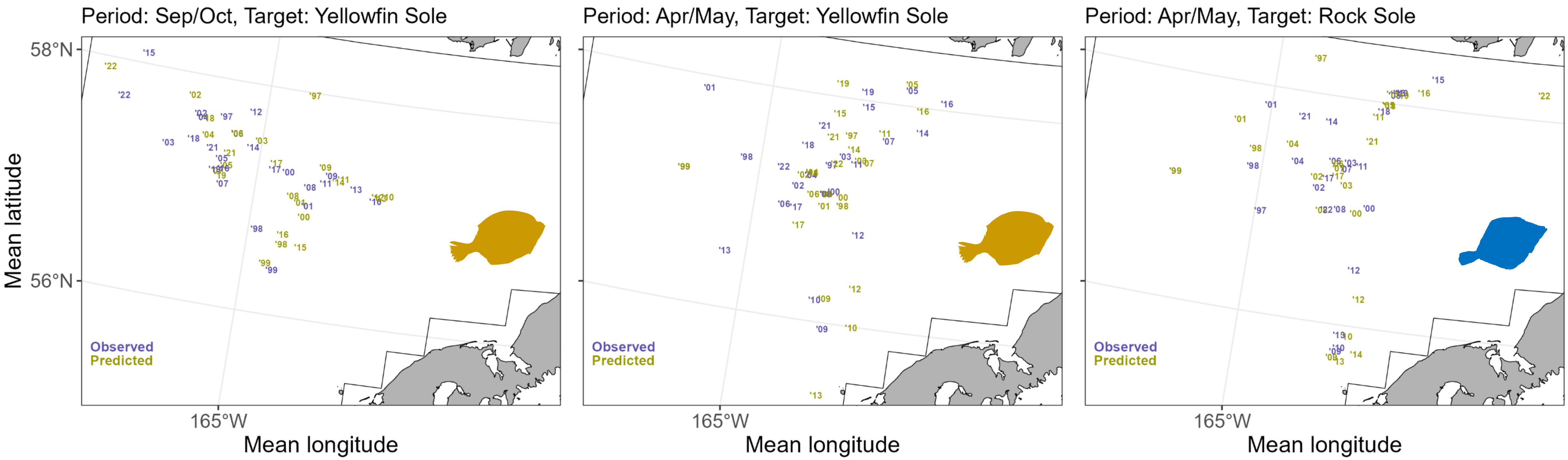
Species distribution models (SDMs)

- Algorithm: Boosted Regression Trees
  - Machine learning
  - Estimate non-linear responses through binary splits (“regression trees”)
  - A top-performing SDM algorithm
- Framework: Delta models
  - Two components:
    1. Occurrence (binomial presence/absence, all data)
    2. Abundance (Poisson, only positive catch data)
  - Suitable for zero-inflated data (e.g., survey data)
  - Components evaluated separately

General approach

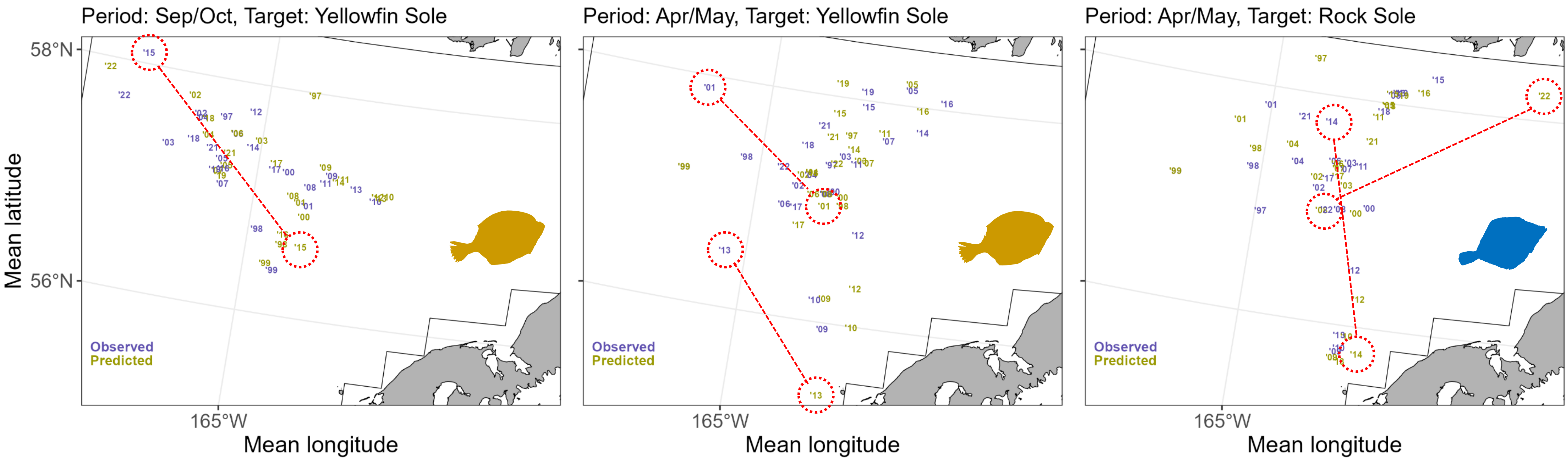
1. Evaluate covariate collinearity
2. Randomly split data into training (80%) and testing (20%)
3. Fit models with training data
4. Evaluate model performance with testing data
    - Occurrence component: AUC-ROC, values ≥ 0.8 indicate excellent predictive ability
    - Abundance component: Spearman's ρ, higher values indicate better predictive ability

Centers of distribution (CODs)



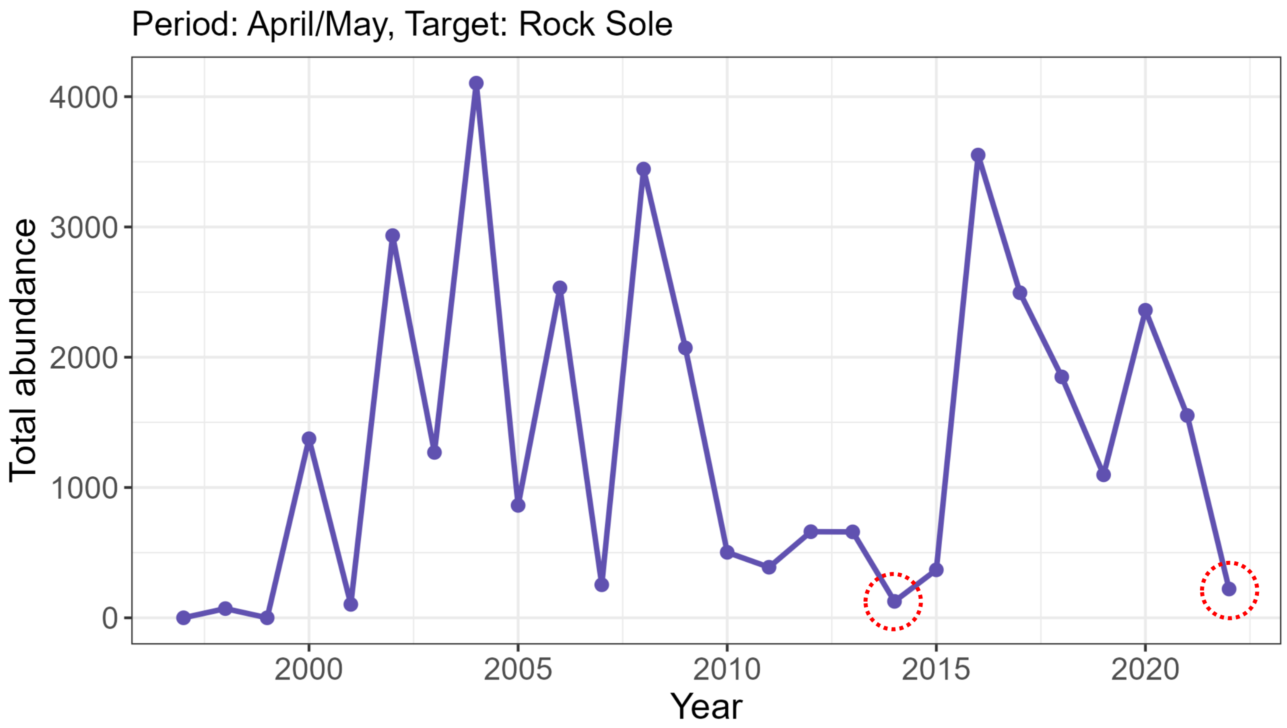
- Large degree of spatial overlap in observed vs. predicted values for each model
- Observed vs. predicted CODs more dispersed for the April/May yellowfin sole model
- Bycatch distributed more in the northwest for September/October yellowfin sole

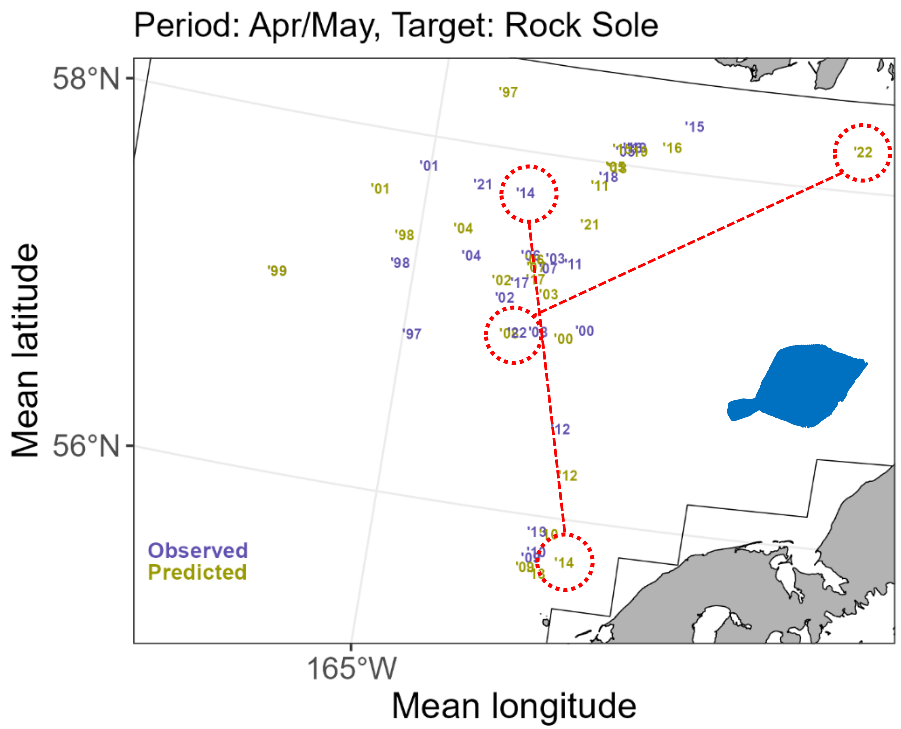
Centers of distribution (CODs)



- Large degree of spatial overlap in observed vs. predicted values for each model
- Observed vs. predicted CODs more dispersed for the April/May yellowfin sole model
- Bycatch distributed more in the northwest for September/October yellowfin sole
- CODs most dispersed when observed bycatch is low, closer together with higher observed bycatch

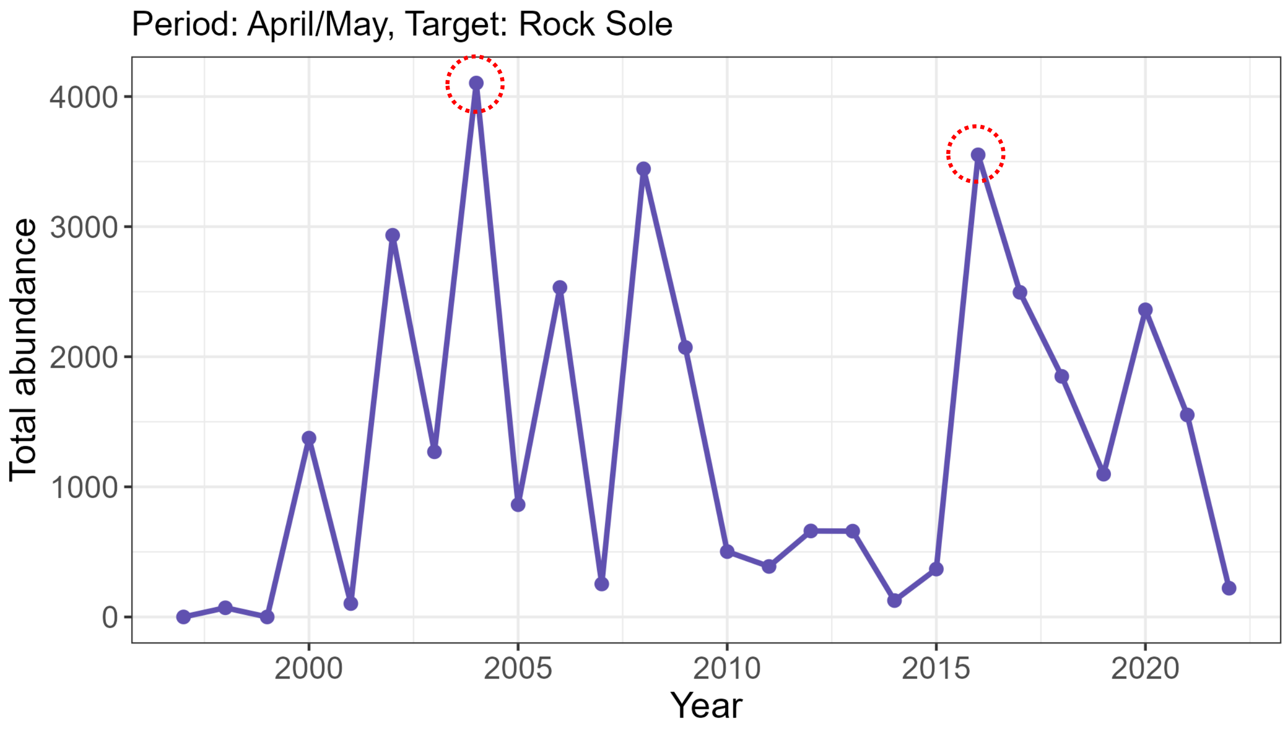
Centers of distribution (CODs)

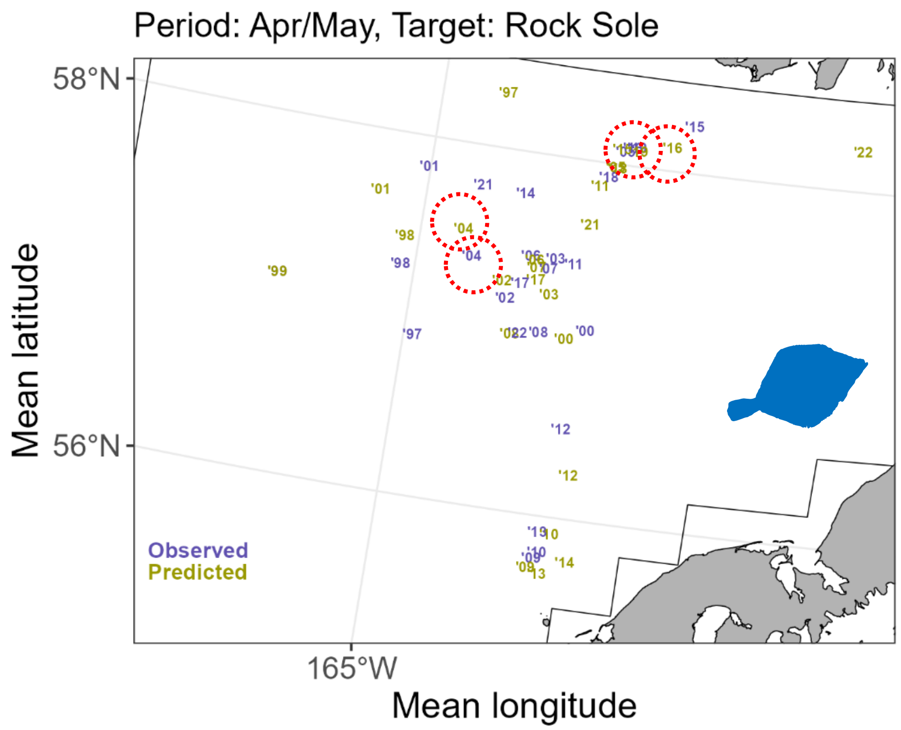




- Large degree of spatial overlap in observed vs. predicted values for each model
- Observed vs. predicted CODs more dispersed for the April/May yellowfin sole model
- Bycatch distributed more in the northwest for September/October yellowfin sole
- CODs most dispersed when observed bycatch is low, closer together with higher observed bycatch

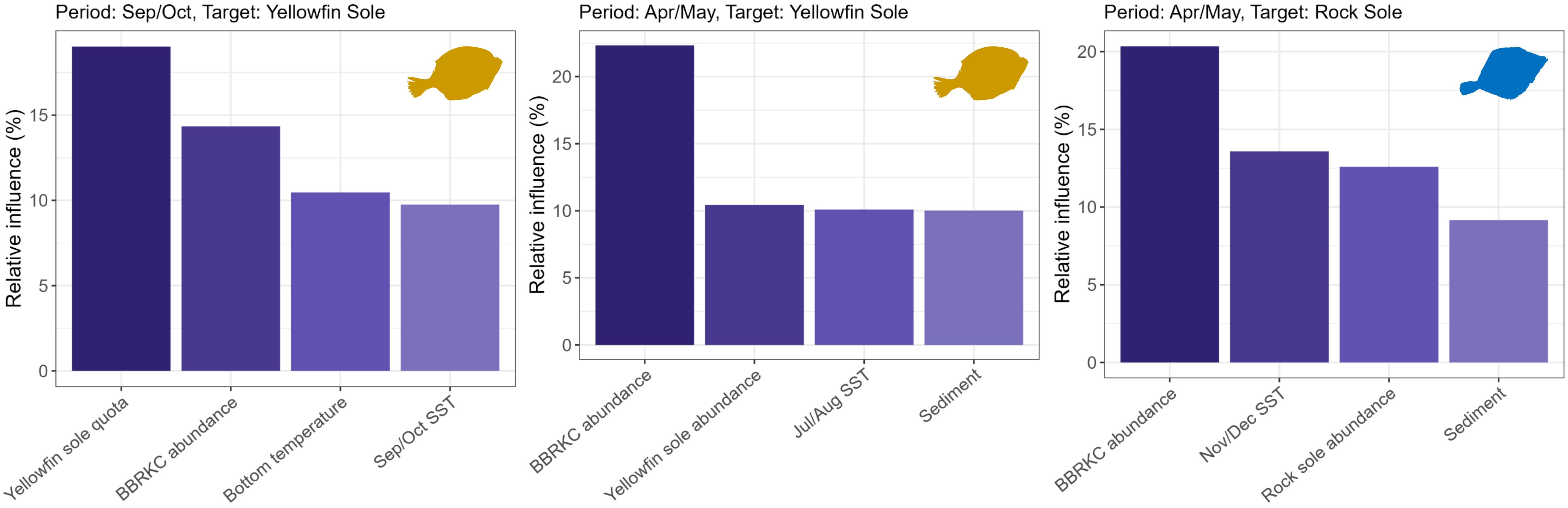
Centers of distribution (CODs)





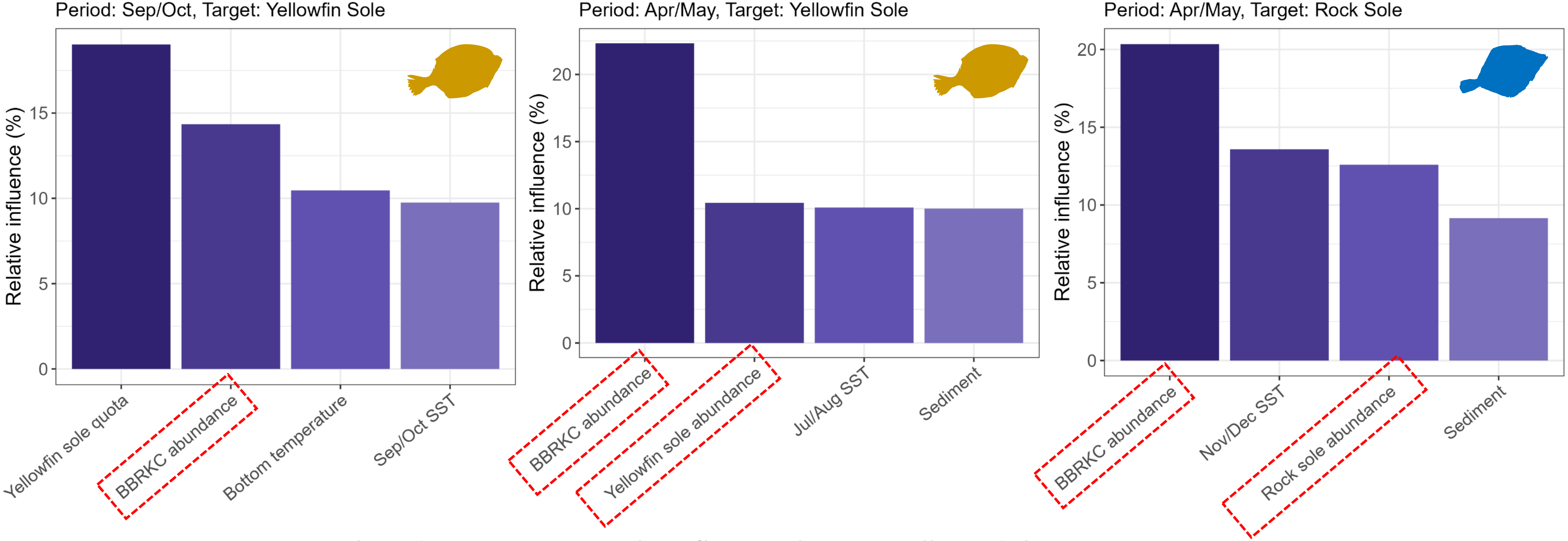
- Large degree of spatial overlap in observed vs. predicted values for each model
- Observed vs. predicted CODs more dispersed for the April/May yellowfin sole model
- Bycatch distributed more in the northwest for September/October yellowfin sole
- CODs most dispersed when observed bycatch is low, closer together with higher observed bycatch

Leading covariates



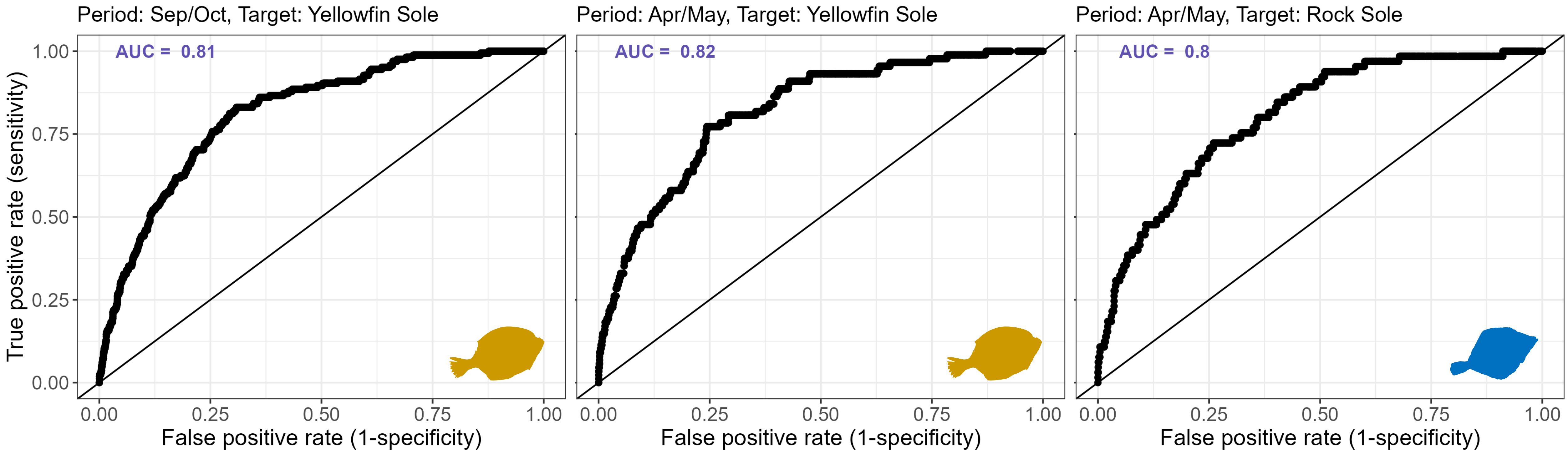
- BBRKC survey abundance consistently influential across all models
- Target fish survey abundance and sediment also highly influential for April/May models
- Dissimilarities in variable importance across models are interesting

Leading covariates



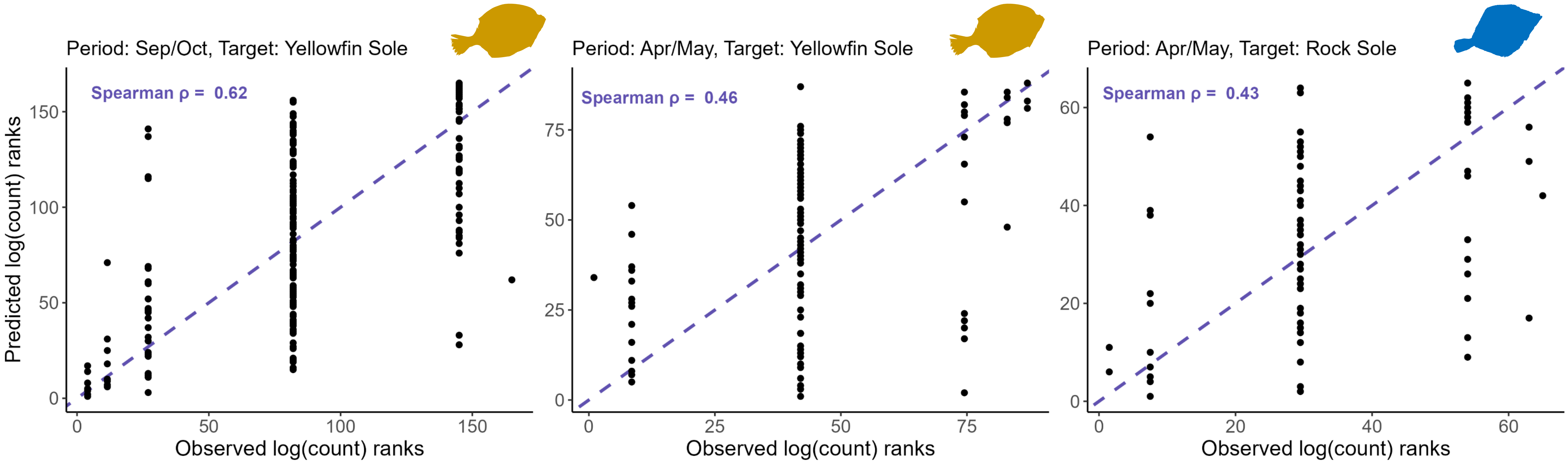
- BBRKC survey abundance consistently influential across all models
- Target fish survey abundance and sediment also highly influential for April/May models
- Dissimilarities in variable importance across models are interesting

Occurrence model evaluation



- Models exhibit excellent ability to correctly predict species occurrence (AUCs ≥0.8)
- Yellowfin sole models slightly better than the rock sole model

Abundance model evaluation



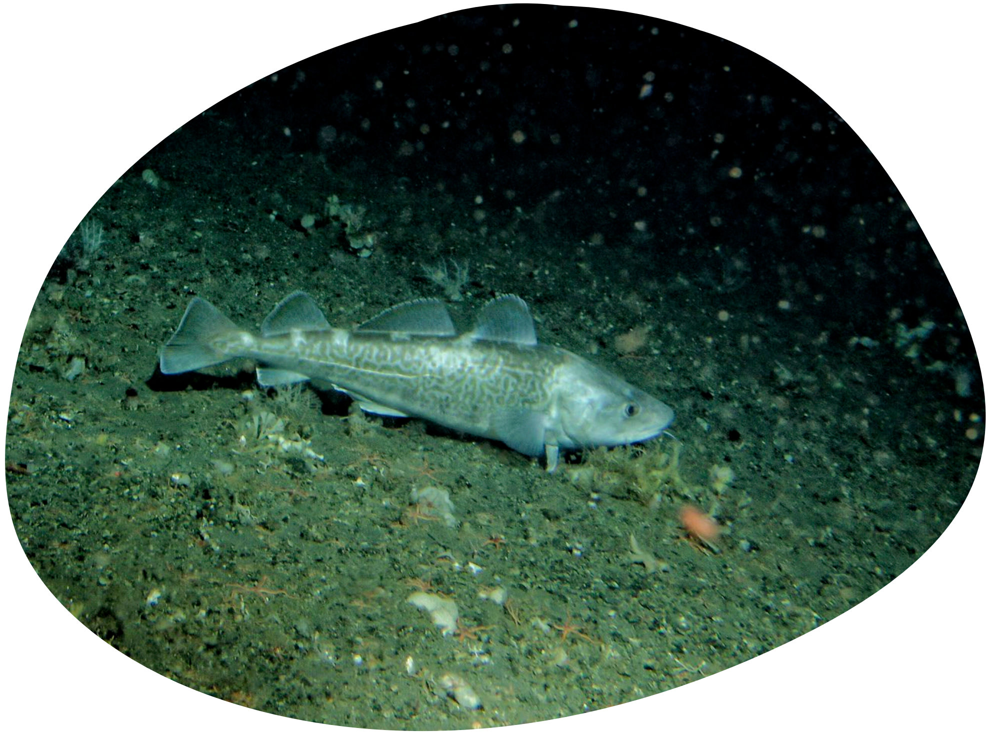
- The Sept/Oct yellowfin sole performed better at predicting abundance, though all models performed relatively well

Conclusions

- SDMs may be useful tools for predicting BBRKC bycatch
  - → Models performed well in predicting observed bycatch magnitude and spatial distribution
- Survey data is important
  - → Survey-estimated BBRKC and target fish abundance highly influential covariates
- Differences in covariate importance for bycatch in different seasons/fisheries should be explored

Next steps

- Develop bycatch prediction models for BBRKC mature females and the pot cod fishery
- Develop SDMs to predict BBRKC distribution in data-poor fall/winter seasons



Thank you!

emily.ryznar@noaa.gov