Larval Sablefish Exhibit Stable Geographic Distributions and Varying Phenology across National Boundaries



Janie Sanborn



Katherine Dale

ICES Journal of Marine Science, 2026, Vol. 83, Issue 9, fsag171
https://doi.org/10.1093/icesjms/fsag171
Original article

ICES CIEM International Council for the Exploration of the Sea / Conseil International pour l'Exploration de la Mer

OXFORD

Larval sablefish exhibit stable geographic distributions and variable phenology in response to interannually variable environmental conditions

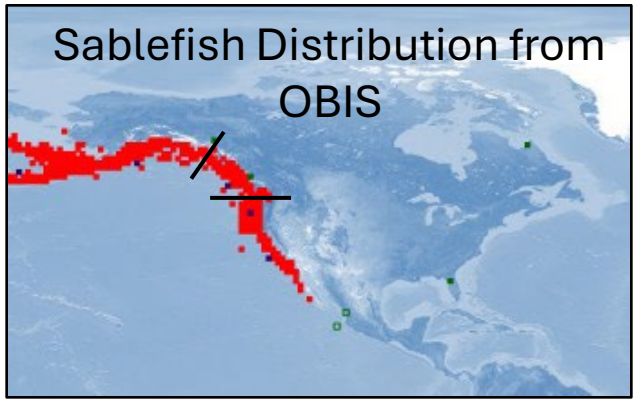
Janie Sanborn[1,*], Katherine E. Dale[2], Martina Van Etten[3], Toby D. Auth[4], R. Ian Perry[5], Mercedes Pozo Buil[6], Lauren A. Rogers[7], Andrew R. Thompson[8], Rebecca G. Asch[2]

Janie Sanborn, Katherine E. Dale, Martina Van Etten, Toby D. Auth, R. Ian Perry, Mercedes Pozo Buil, Lauren A. Rogers, Andrew R. Thompson, and **Rebecca G. Asch**

Picture credit: Golden Eagle Sablefish

Sablefish (Anoplopoma fimbria) – "The Cheesecake of the Ocean"

- Long-lived, highly migratory, deep-water species with a a long larval duration and a single panmictic population in the Northeast Pacific



- Relevant environmental variables: Depth, temperature, salinity, hydrographic conditions (approximated by sea surface height), water mass properties (approximated by spiciness)

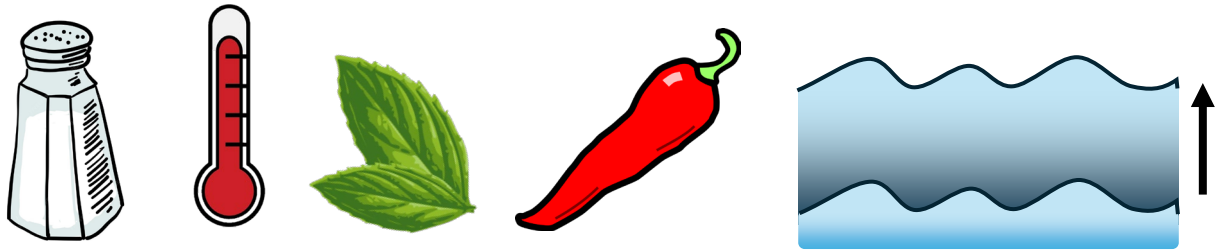


- Climate variability (ENSO, PDO) affect recruitment, but with different impacts in the California Current & Gulf of Alaska (Kimura et al., 1997; Shotwell et al., 2014; Stachura et al., 2014)

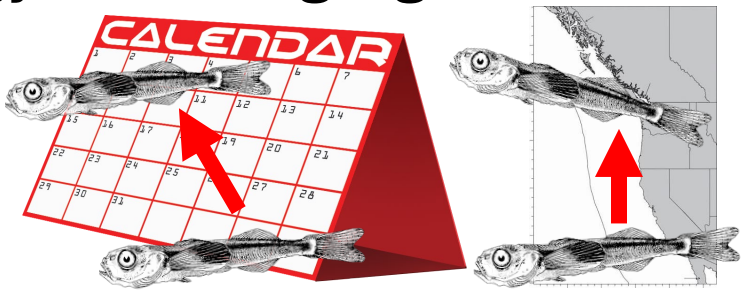
- Research gaps: (1) Most work focuses on adults & juveniles; (2) Most work focuses on one large marine ecosystem

Research Questions

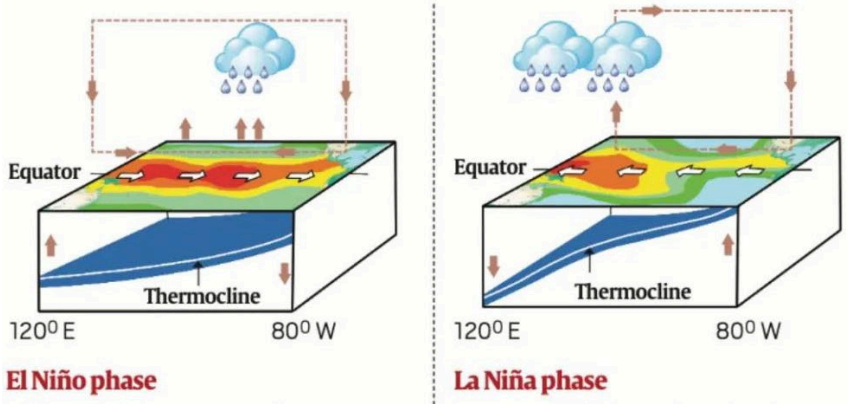
1. Which ***environmental covariates*** are most predictive of larval sablefish distribution?



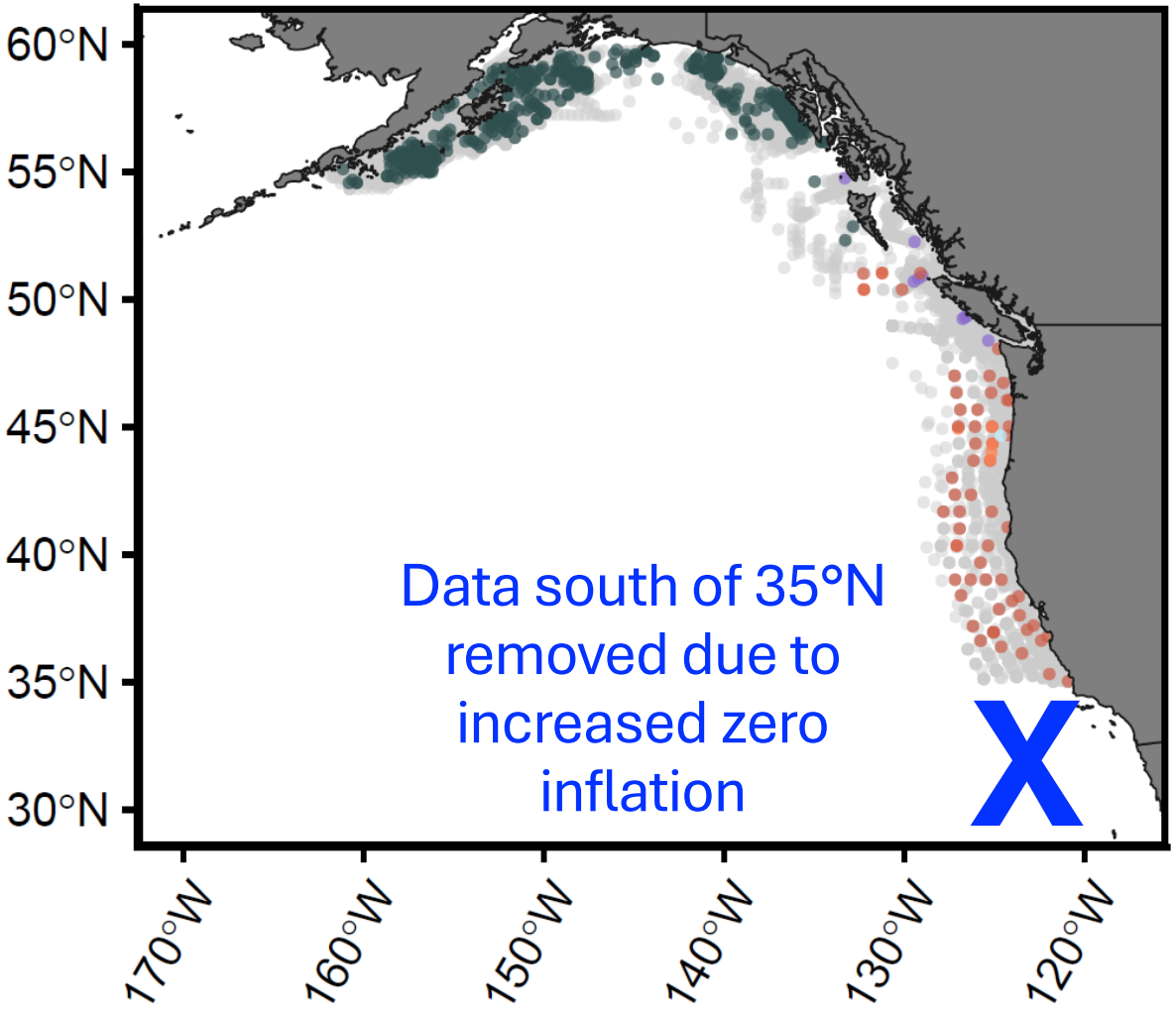
2. Are larval sablefish best described by a strategy of changing phenology, geography, or both? Are shifts in larval ***phenology and geography*** correlated?



3. Do larval sablefish exhibit varying relationships with environmental covariates under different ***modes of climate regimes?***



We combined data from 5 long-term larval fish sampling programs (across 3 management jurisdictions)!



← **12,308** individual tows analyzed from 1995-2018

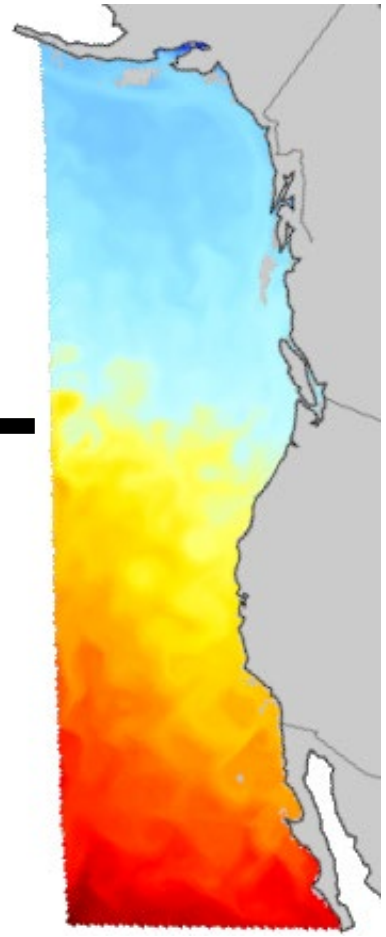
- EcoFOCI
- Dept. of Fisheries & Oceans Canada
- NOAA Newport Hydrographic Line
- NOAA Prerecruit Larval Survey
- California Cooperative Oceanic Fisheries Investigations

We constructed species distribution models to test the importance of environmental covariates & how sablefish navigate the geography-phenology tradeoff



Larval density data

+



10-km resolution ROMS data (1995-2018)



Jerome Fiechter

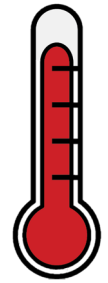


Mercedes Pozo Buil



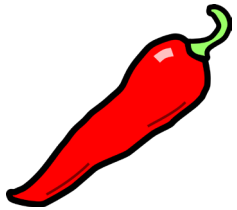


Sea surface salinity

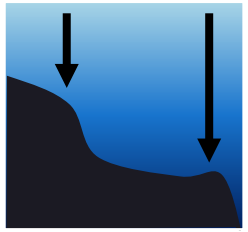


Sea surface temperature

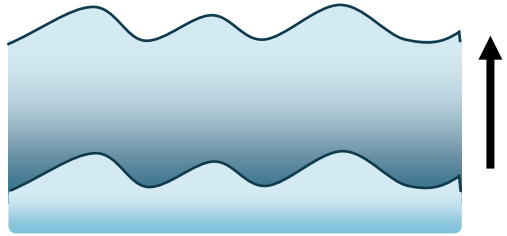




Spiciness



Bottom depth

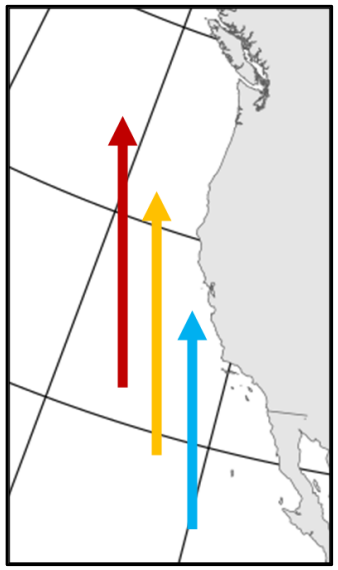


Sea surface height

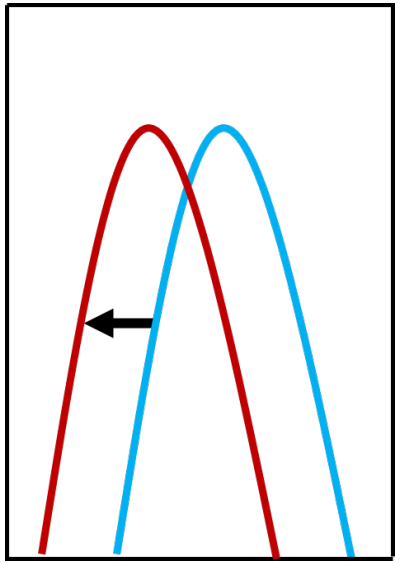
Model Details

- Tweedie distribution with log-link
- k = 3 splines
- Other factors: gear type, spatial autocorrelation, month as cyclic spline

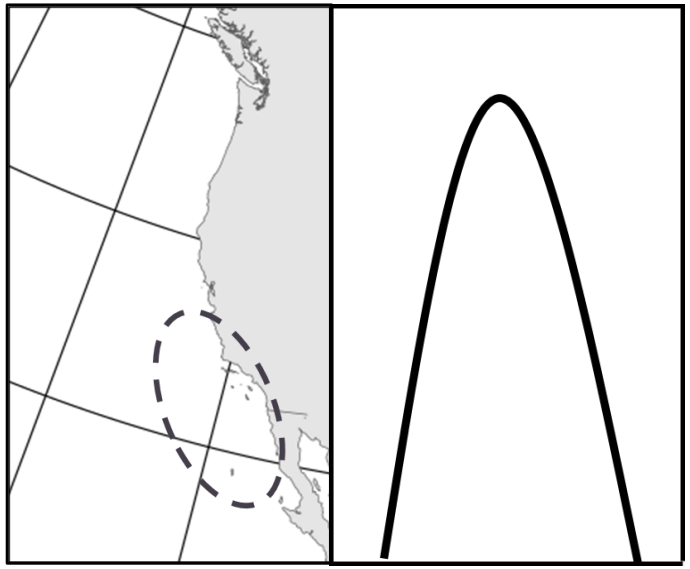
We compared four types of species distribution models, allowing shifts across 5-year periods



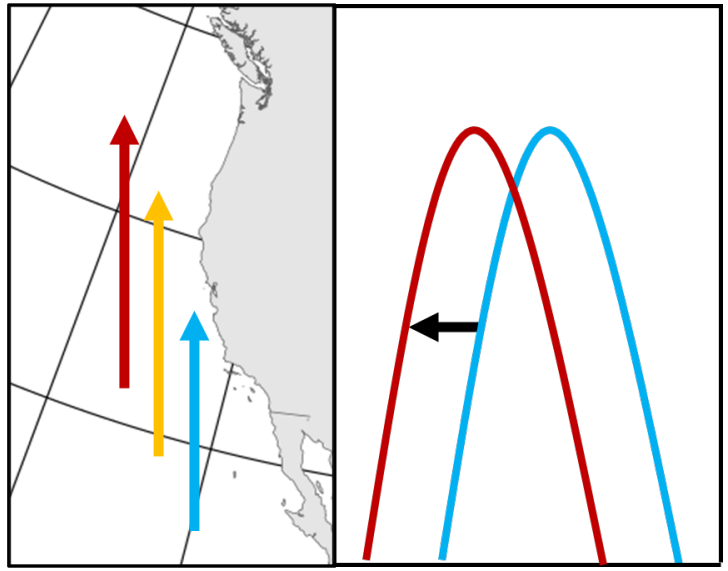
Shift **geography**



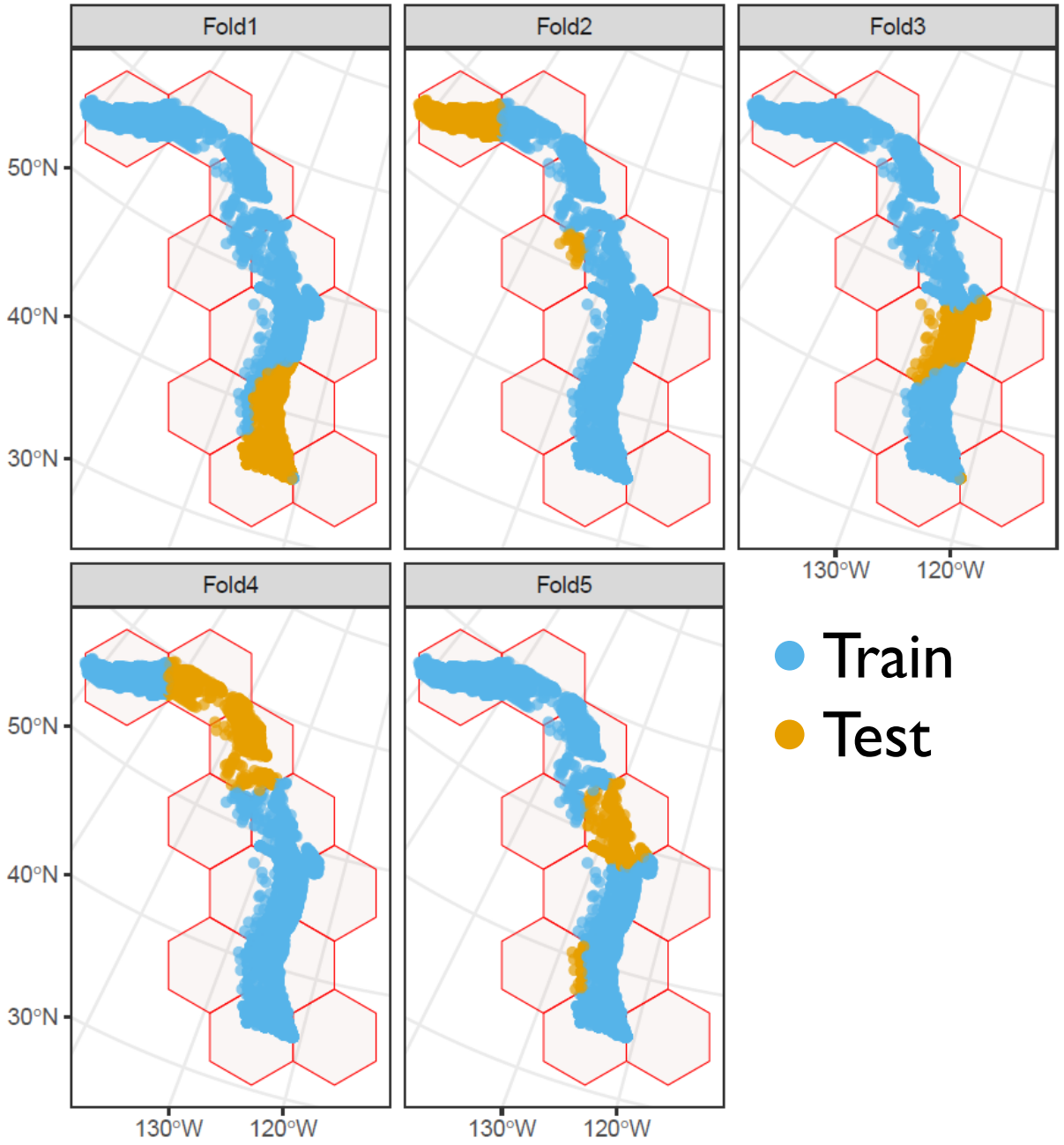
Shift **seasonality**



Shift **neither**



Shift **both**

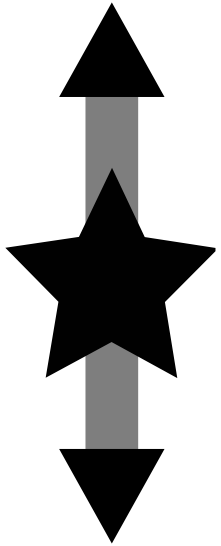


We compared models using 5-fold leave-one-out cross validation, and calculated performance weights for each model

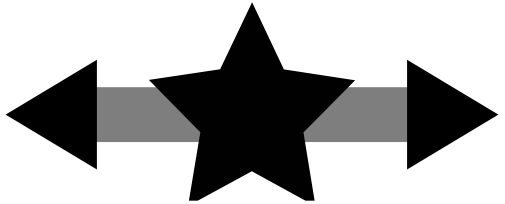
We then calculated four spatiotemporal metrics to further analyze tradeoffs and determine if they were correlated with environmental and climatic variability



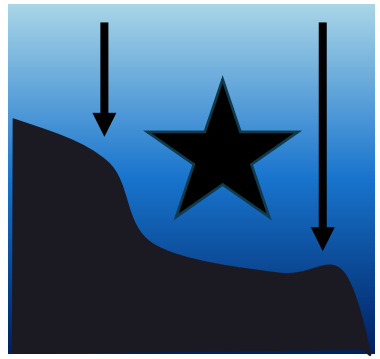
Seasonal center of gravity



Latitudinal center of gravity



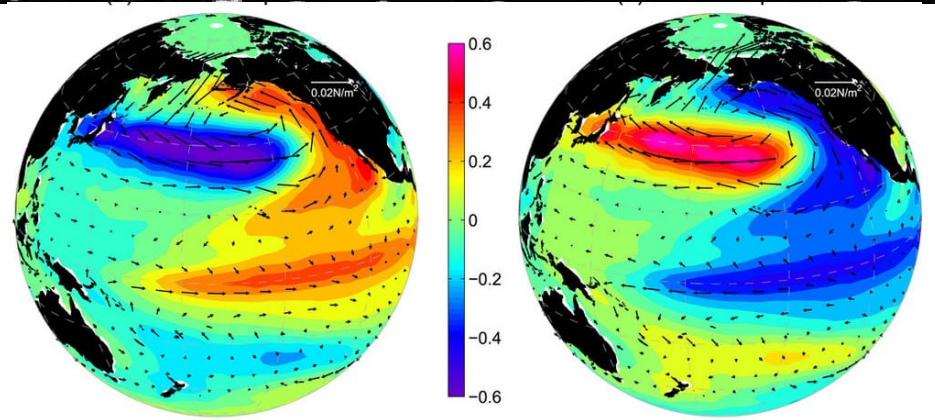
Longitudinal center of gravity



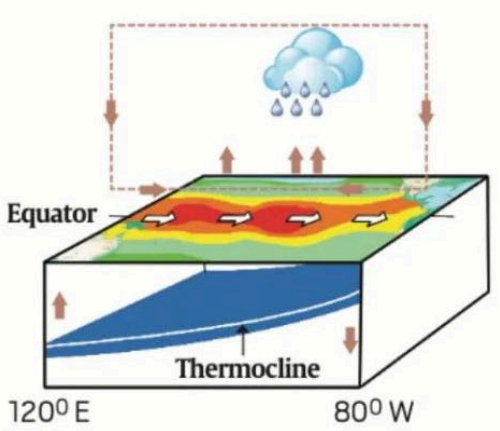
Bottom depth center of gravity

Q3: Do Larval Sablefish Exhibit Varying Relationships with Environmental Covariates Under Different Modes of Climate Variability?

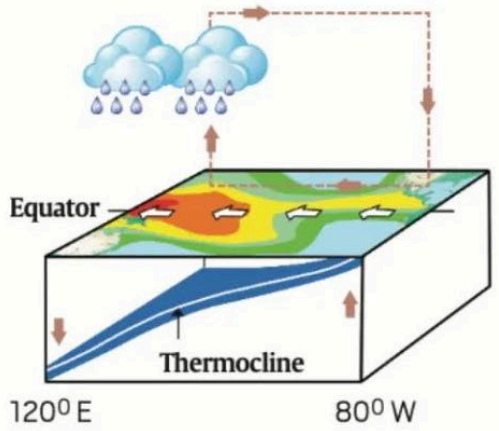
- Used top-performing model
- Added interactions between environmental covariates, the Pacific Decadal Oscillation (PDO), and the Oceanic Niño Index (ONI)
- Quotient curves (Drapeau, 2004) used to look at changes in relationships across modes of climate variability



Positive PDO phase Negative PDO phase

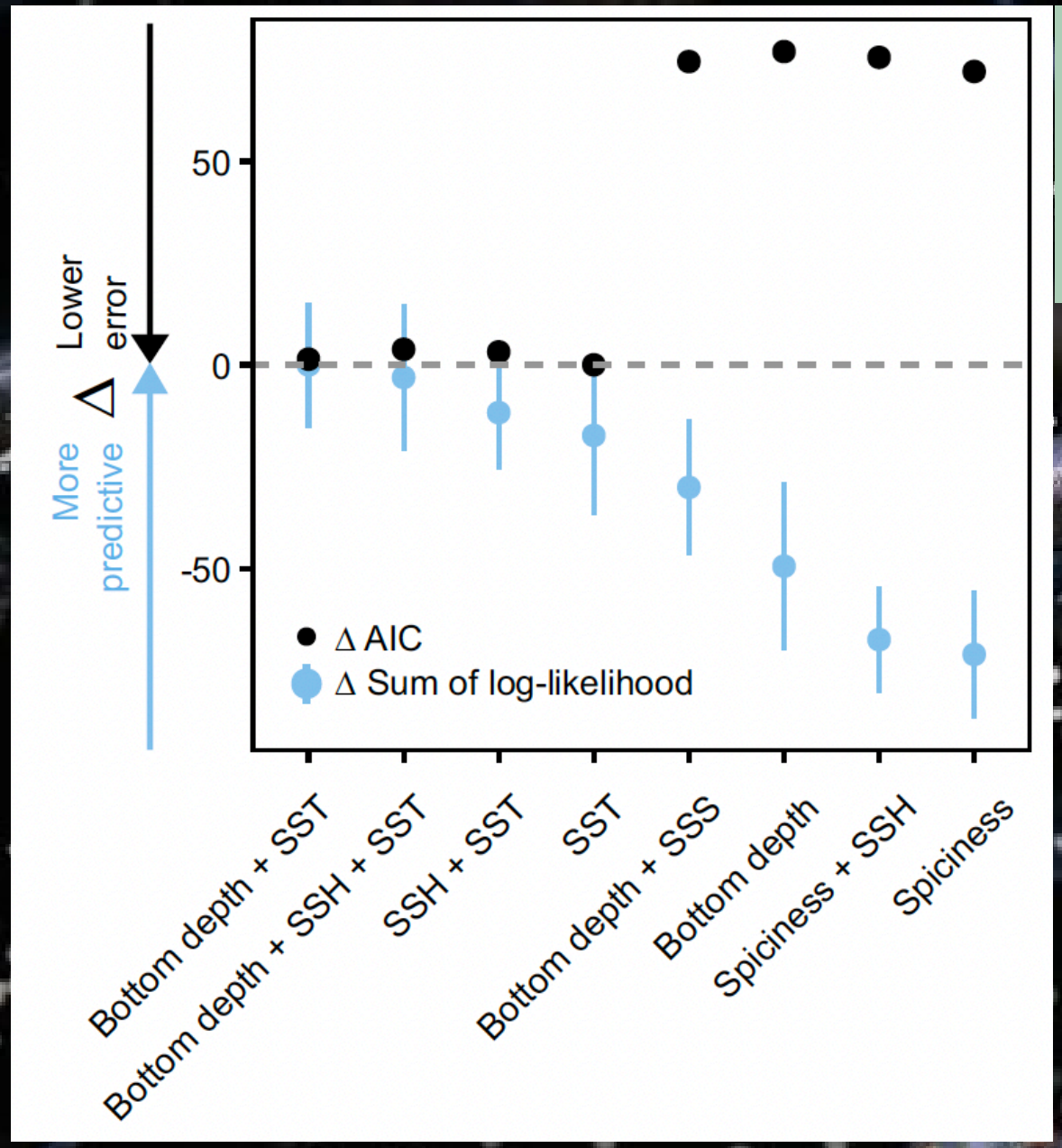


El Niño phase

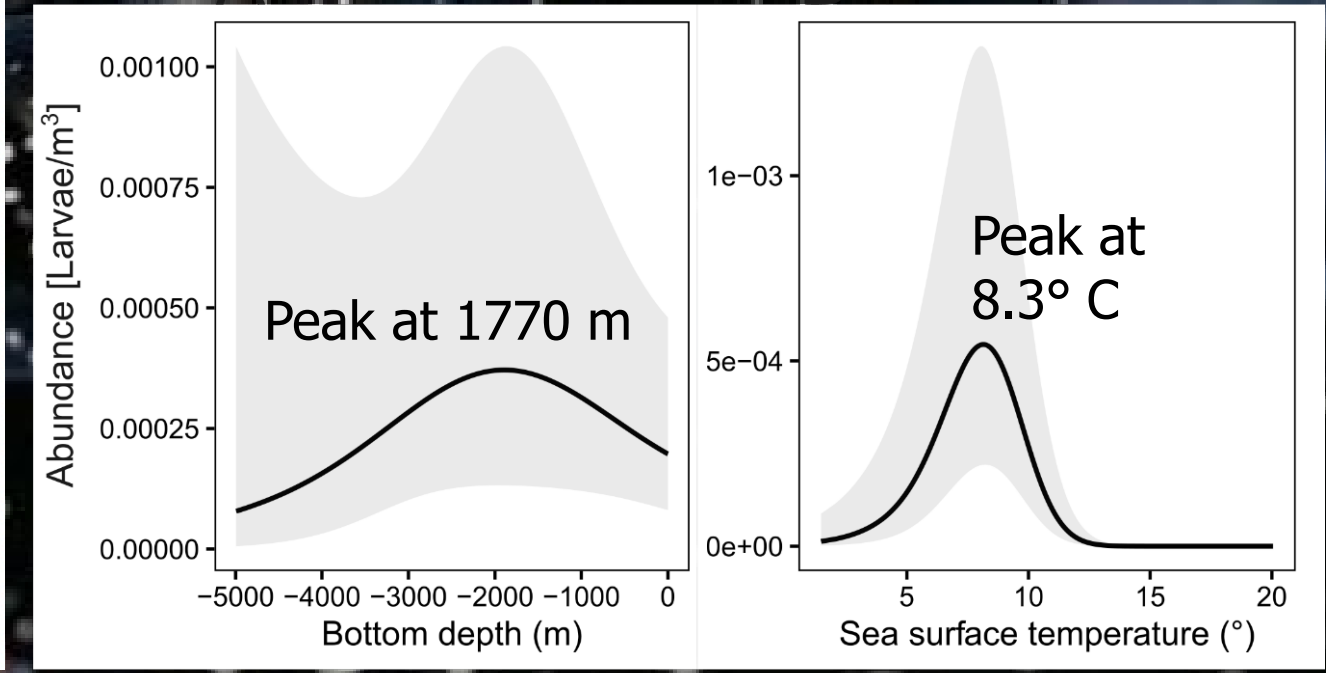


La Niña phase

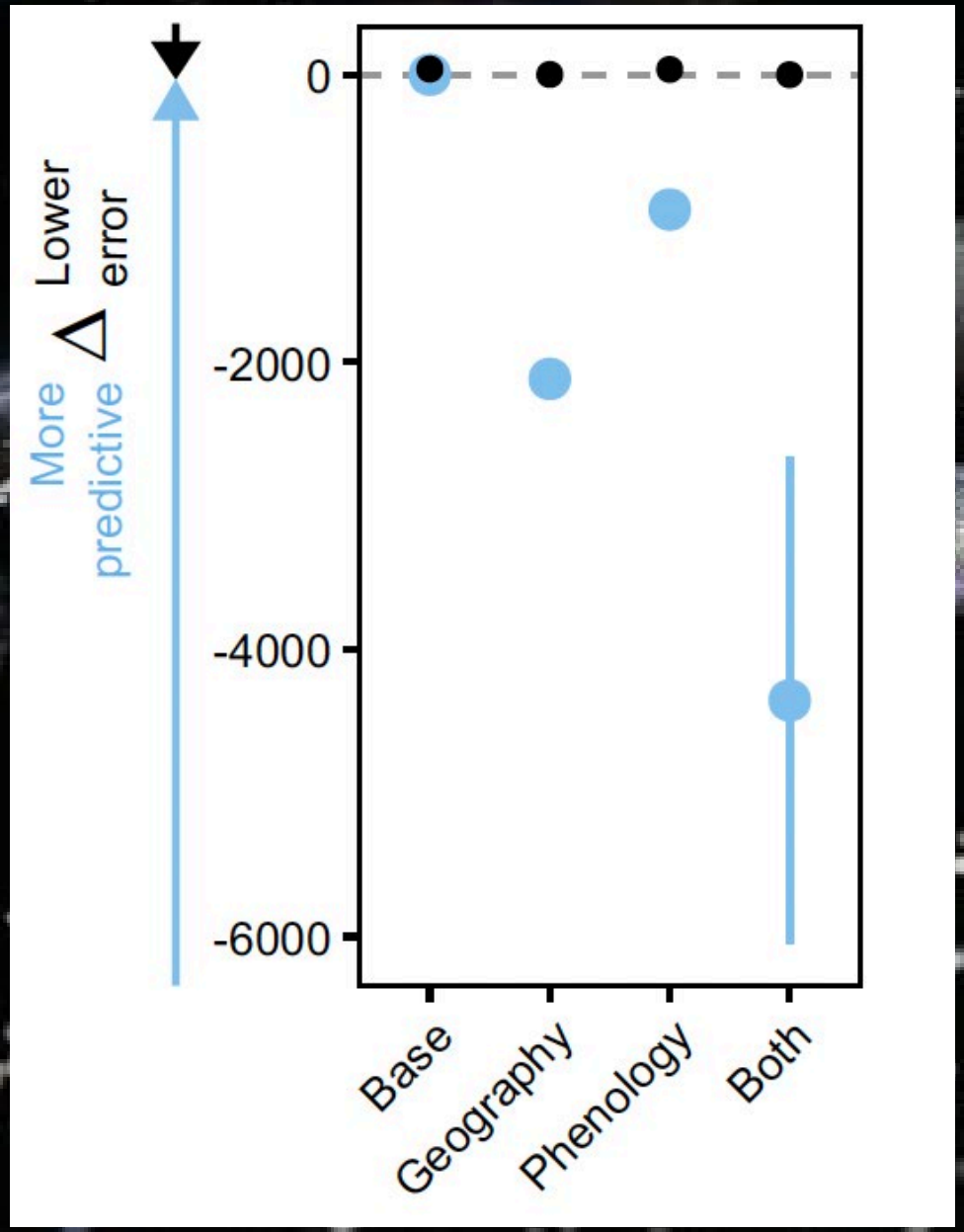
Results



Q1: Which environmental covariates are most predictive of larval sablefish distribution?

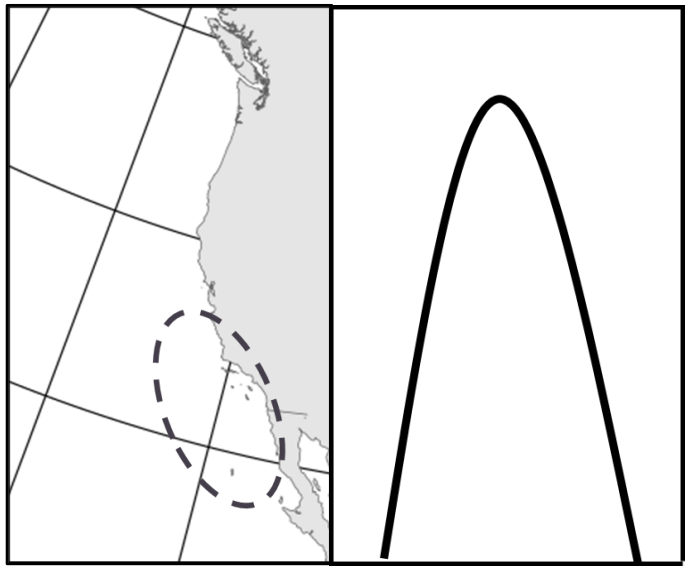


Results



Q2, Part 1: Are larval sablefish best described by a strategy of changing phenology, geography, or both?

- Δ AIC
- Δ Sum of log-likelihood

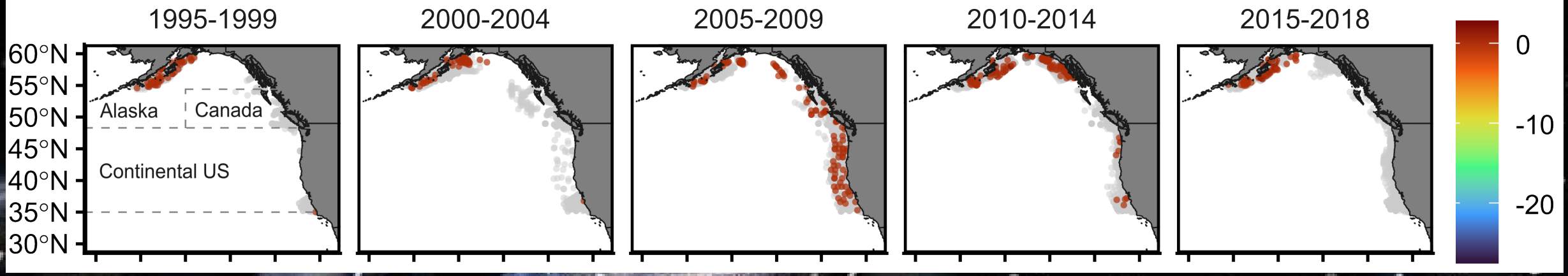


Shift in **neither**

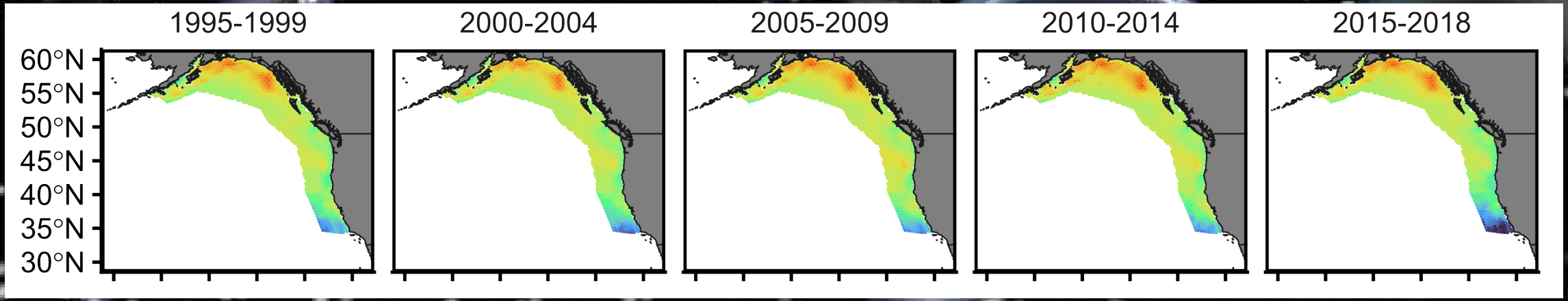
How Do Model Results Compare with Observations?

Empirical density

Log(larvae/m^3)

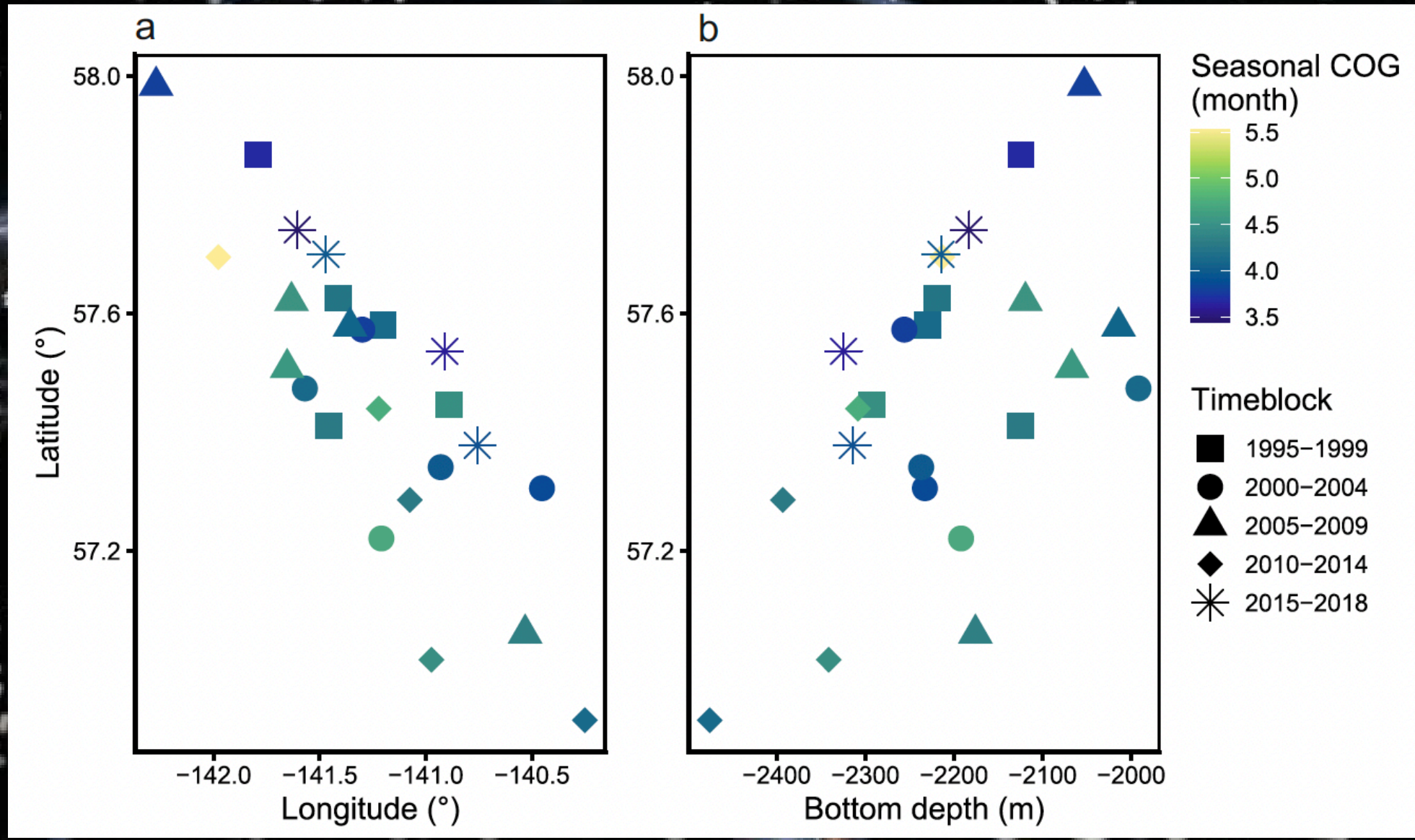


Modeled density



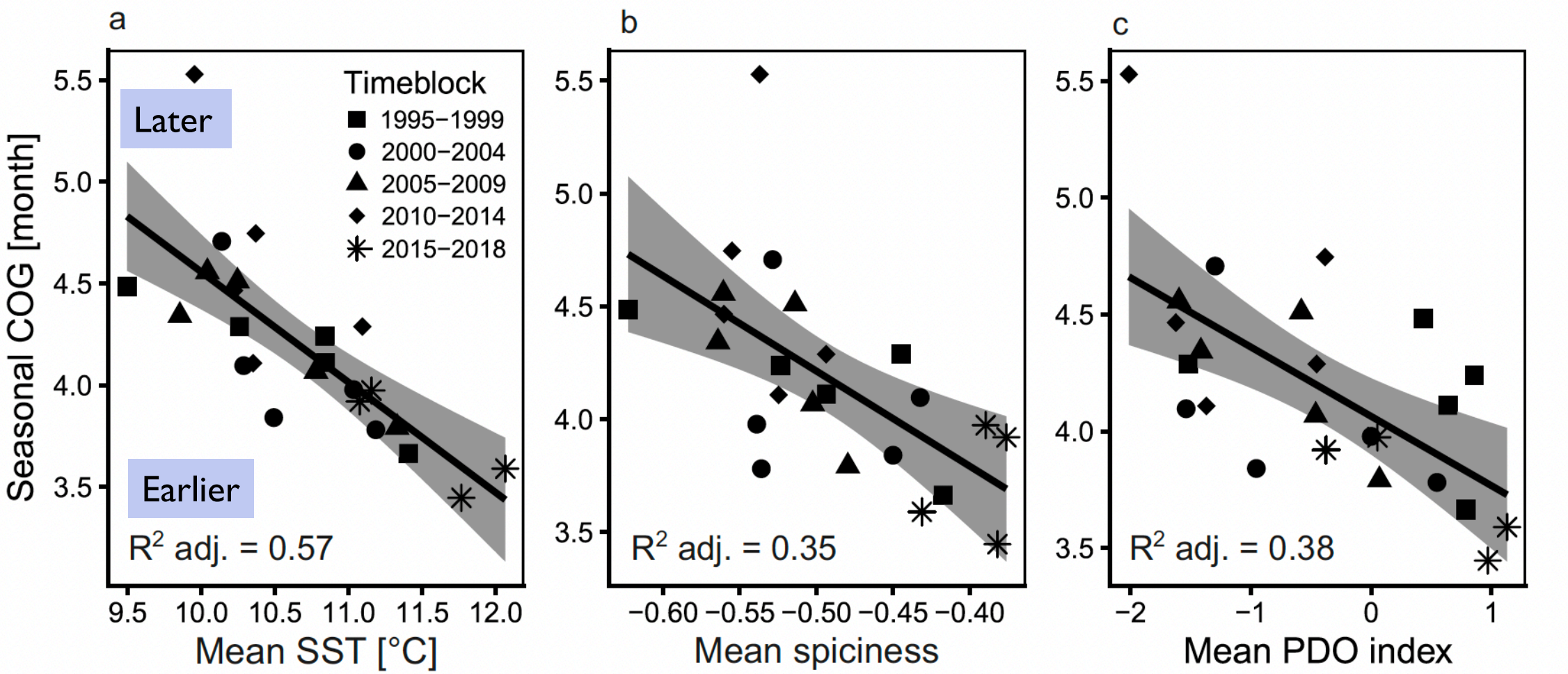
Correlation: r = 0.49

Q2, Part 2: Are shifts in larval phenology and geography correlated?



COG stands for Center of Gravity

Are variations in center of gravity related to oceanographic conditions?

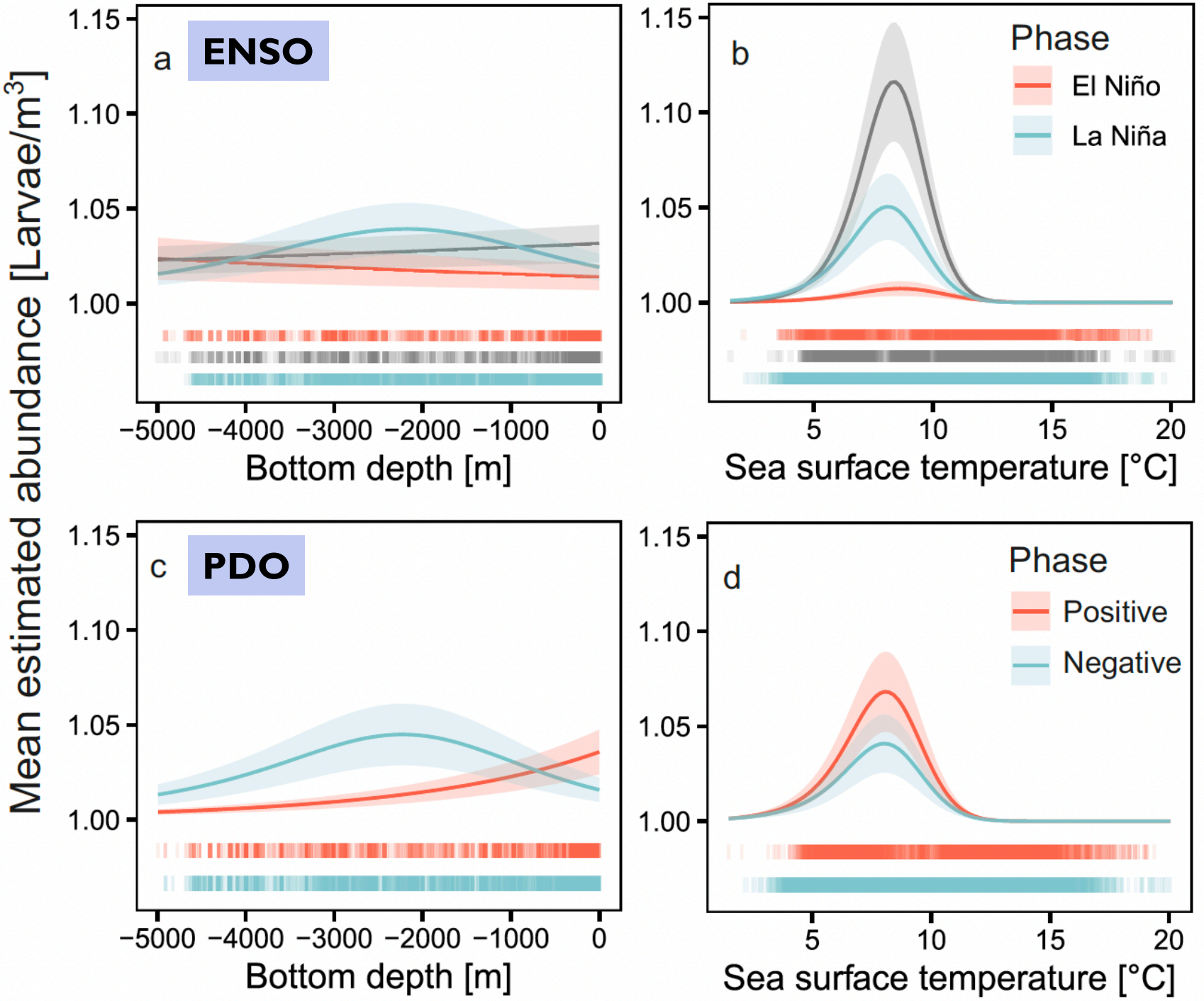


- Only 3 out of 24 relationships were significant
- Phenology gets earlier when it is hotter, spicier, and the PDO index is positive

Q3: Do larval sablefish exhibit varying relationships with environmental covariates under different modes of climate regimes?







Conclusions

- Depth and SST were the primary two environmental variables affecting sablefish larval spatiotemporal distribution
- No long-term trends in spatial distribution or phenology detected
- Changes in geographic center of gravity and phenology were interrelated
- Phenological variation was influenced by temperature, spiciness, and PDO phase
- Relationships with temperature were consistent across climate regimes, but relationships with depth varied
- Lack of major distributional changes may simplify transboundary management