Investigating synchrony in biomass trends across fishes

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Warming and other environmental changes affect individual-level ecological processes (growth, size, movement)

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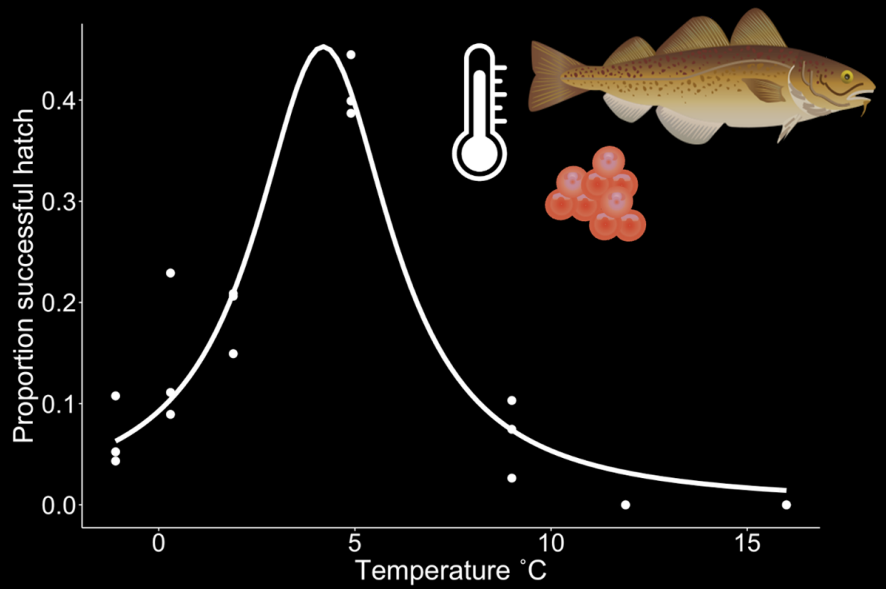
Hatch success varies with temperature (under laboratory conditions)



Modified from Laurel & Rogers 2020

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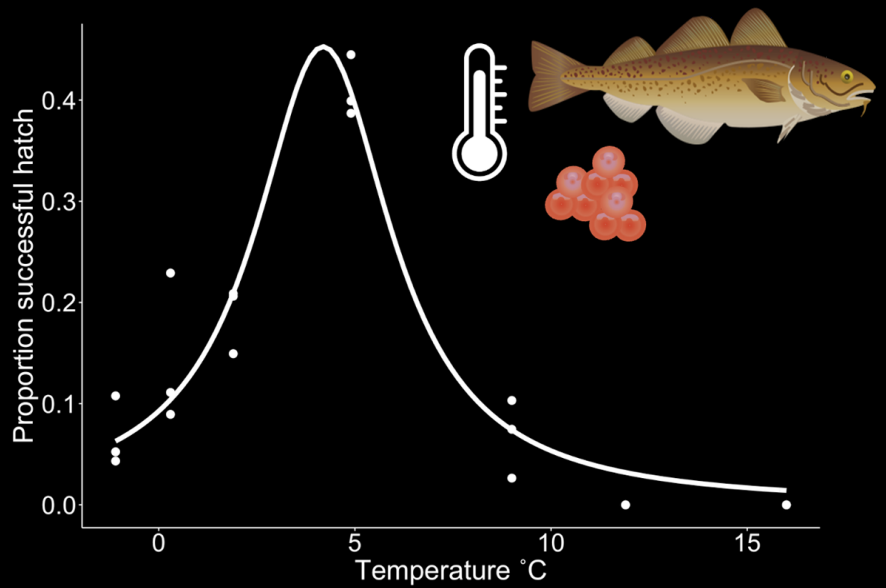


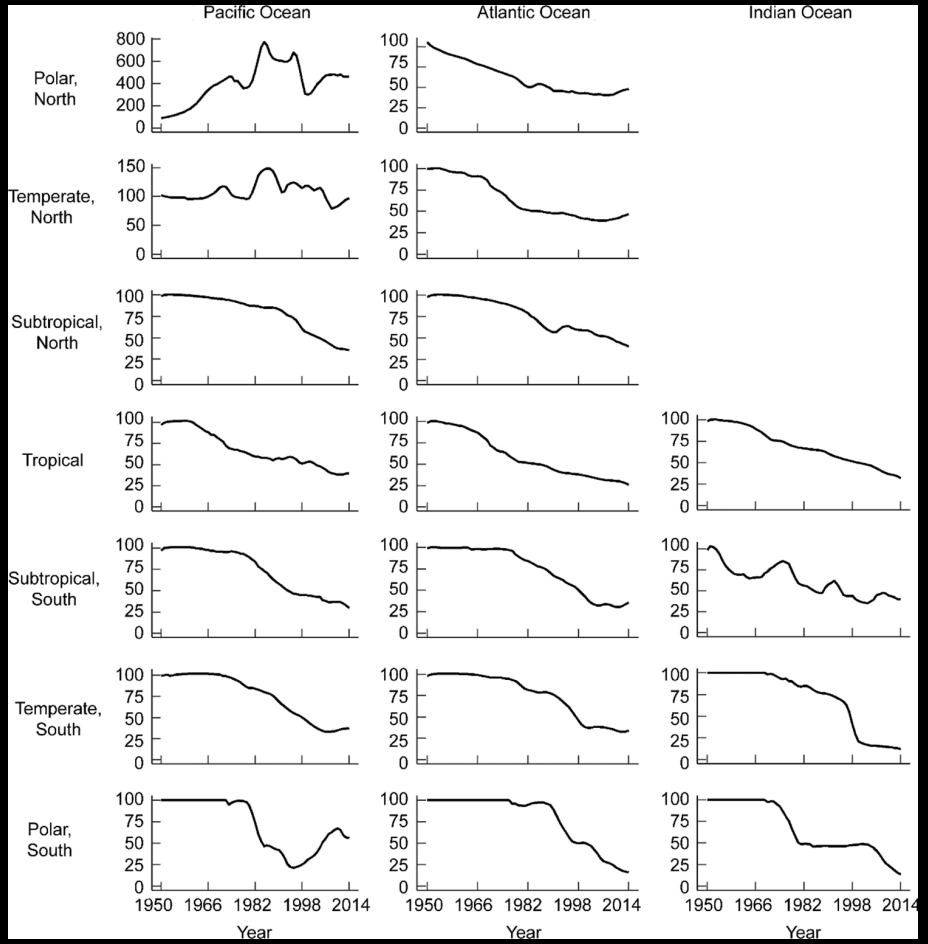
…how do these changes scale up to affect populations and species?

Modified from Laurel & Rogers 2020

A way to characterize these changes within and across populations is through synchrony

- That is, similarities in trends across broad species groups

Palomares et al. (2020) found large, wide-spread biomass loss across species and regions



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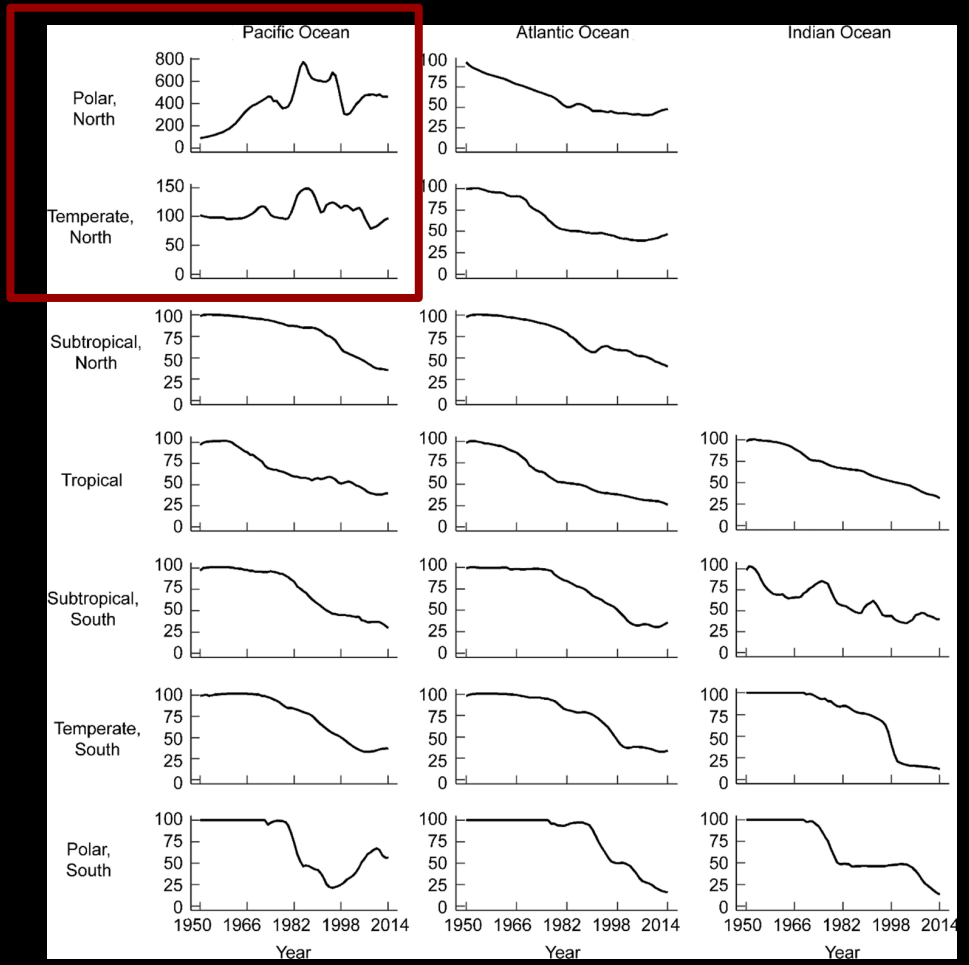
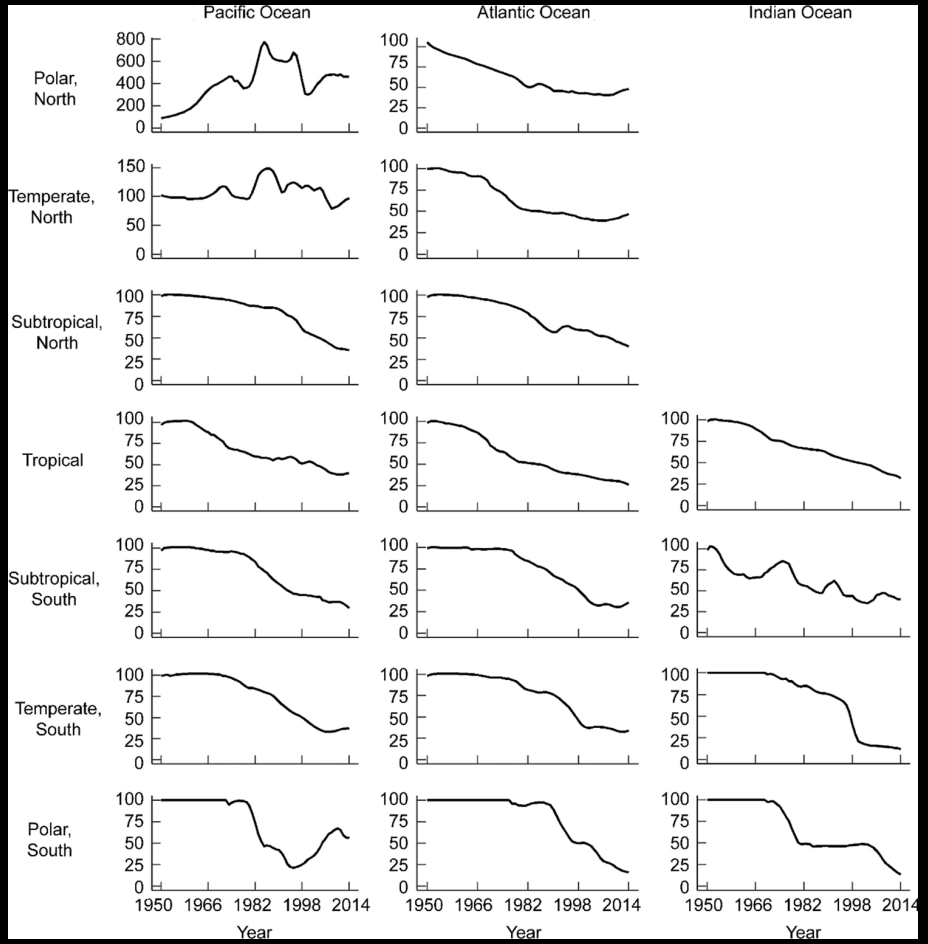


Biomass can be affected by:

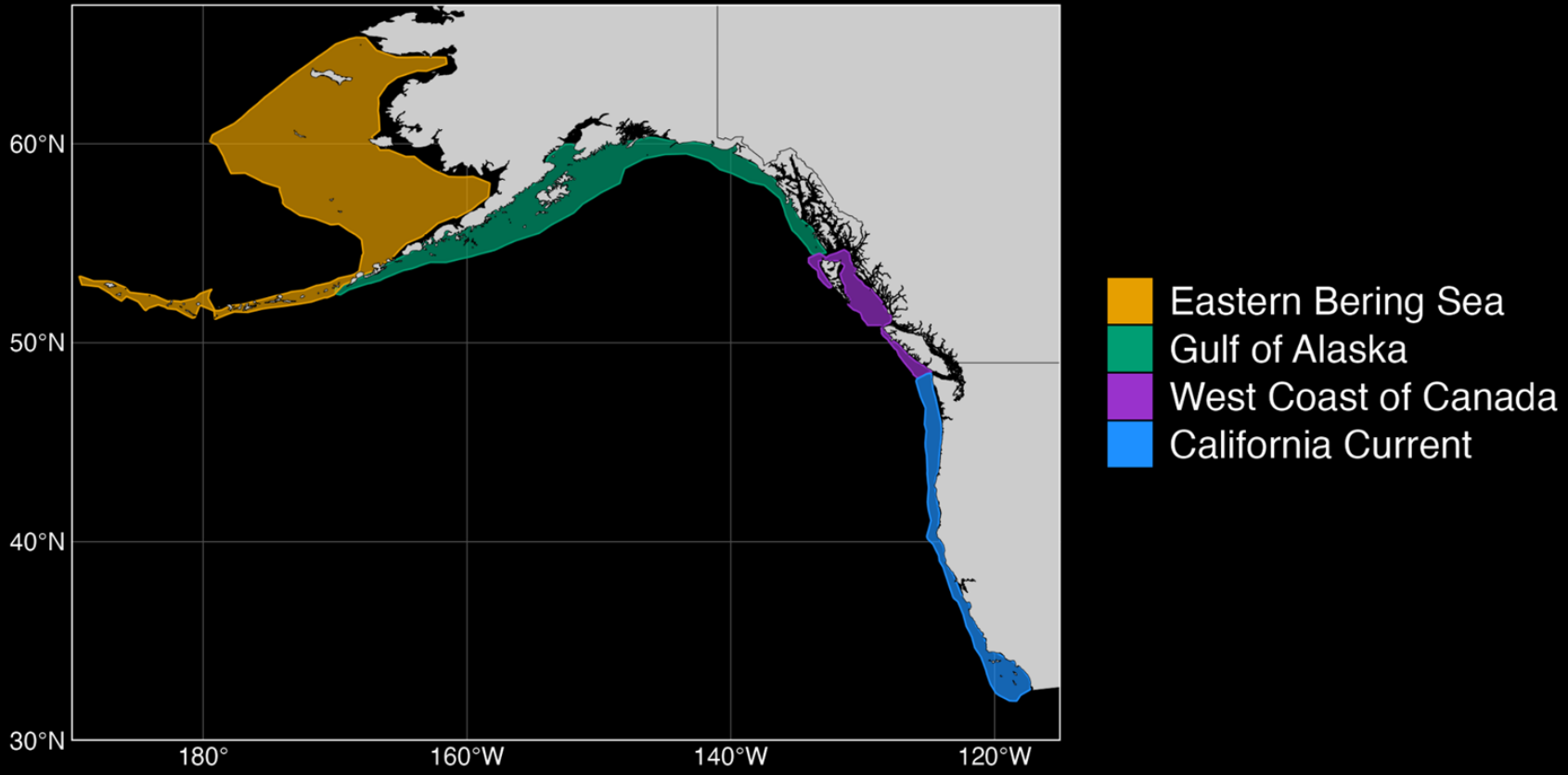
- growth and temperature
-survival (fishing and natural mortality)
-recruitment
-management practices



Is there synchrony in fish biomass trends along the West Coast of North America?

What's driving synchrony within and across regions?

Regions of Interest



Stock Data

Stock SMART is NOAA Fisheries' Stock Status, Management, Assessment, and Resource Trends tool

- Collects individual stock models
- Allows for extensive biomass and abundance downloads
- We collated biomass for 78 stocks (53 species) across 80 years, with most having 50 years of information

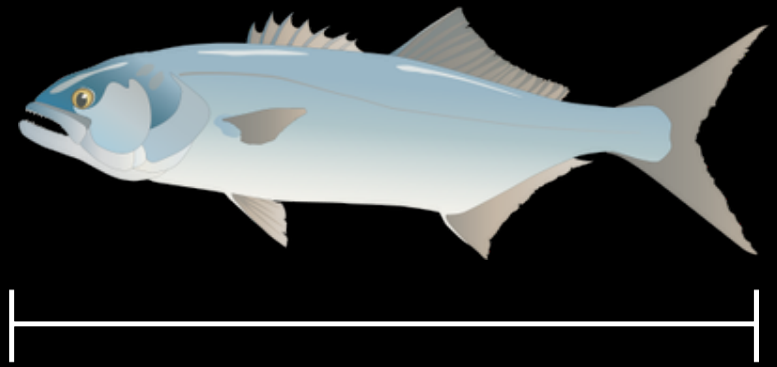
Biomass for West Coast of Canada from DFO



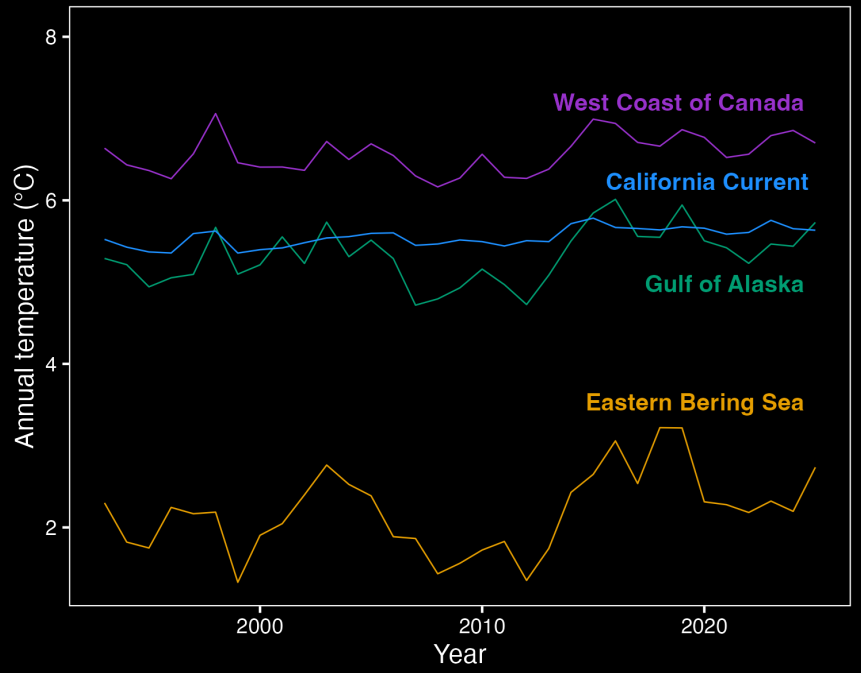
Region	Number of Stocks
Bering Sea	18
Gulf of Alaska	12
Canada	31
California Current	17

Potential drivers

Asymptotic size (Fishbase)



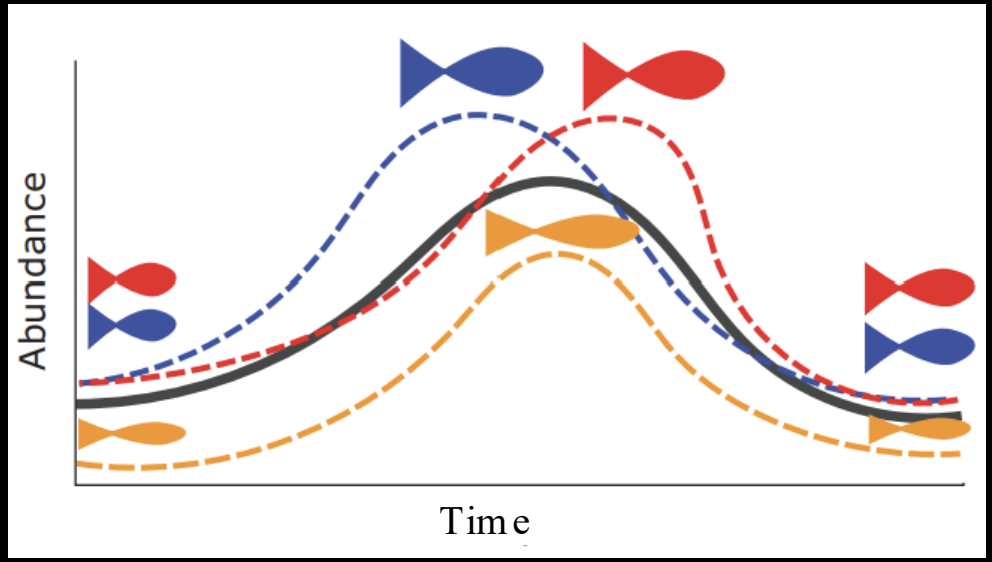
Bottom temperature (MOM6 ocean model)



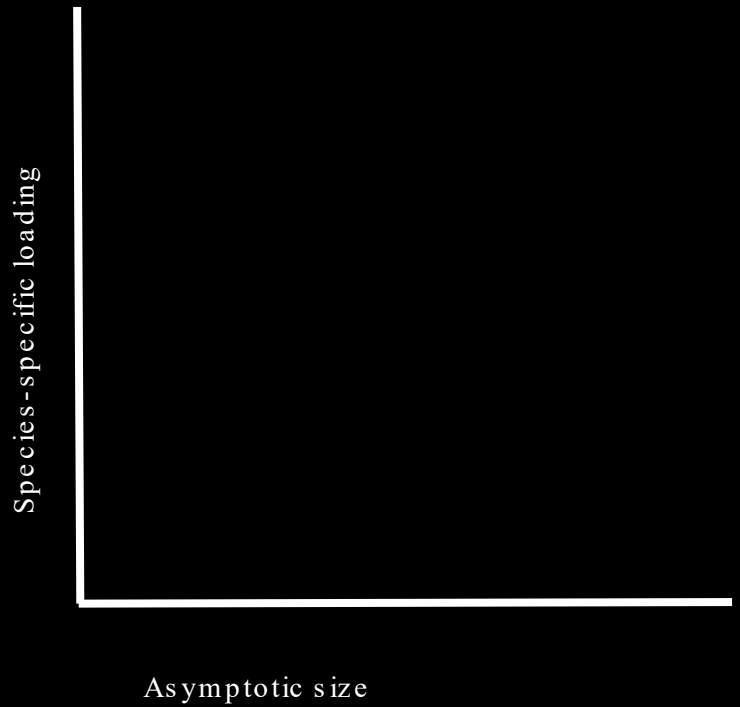
Statistical Models

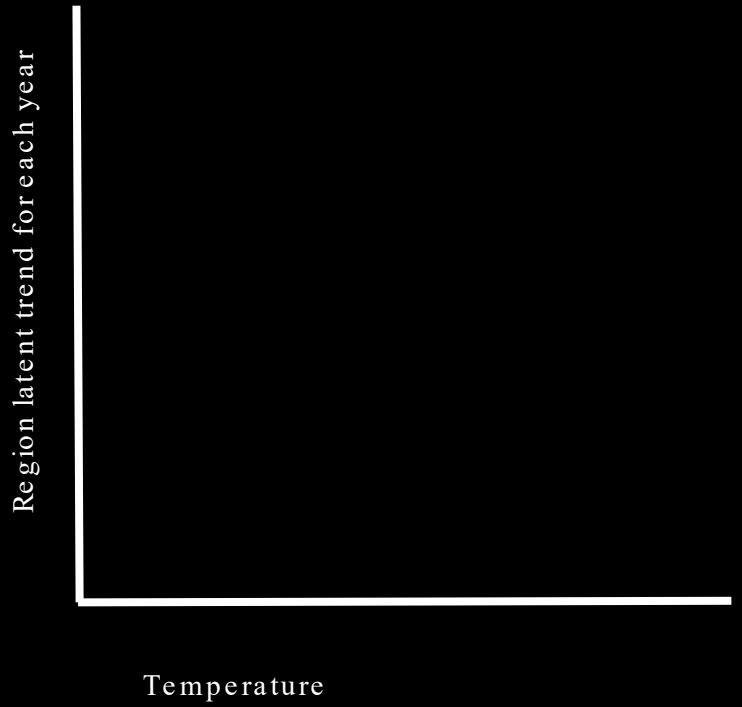
Bayesian Dynamic Factor Analysis (DFA)

- Time series analysis
- Estimates a shared (latent) trend across all groups
- Quantifies the strength and direction that each species loads (fit) onto the trend



Potential driver exploration





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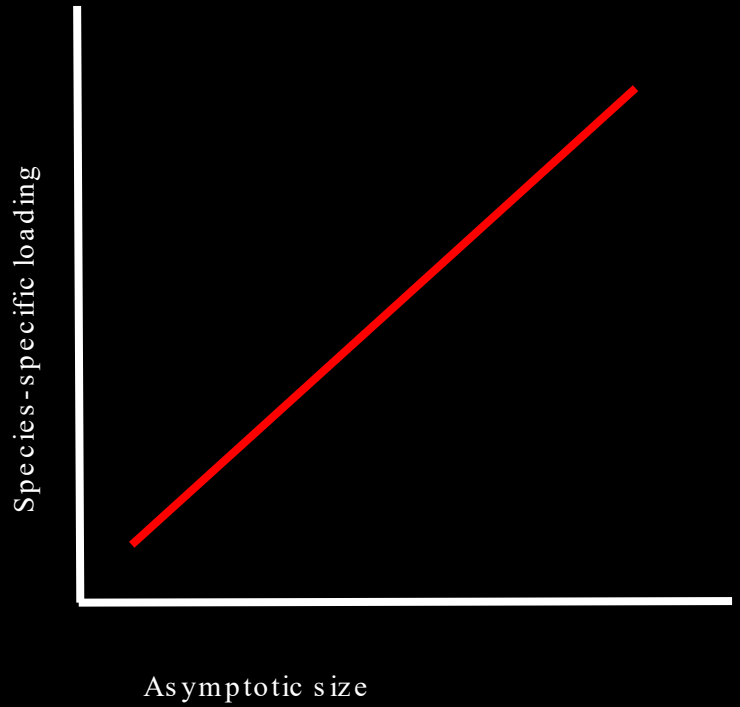
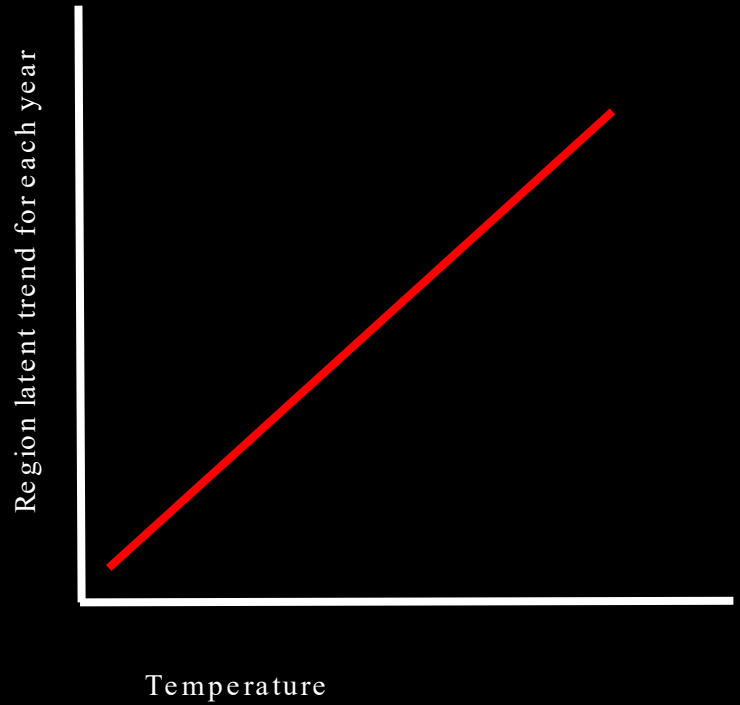
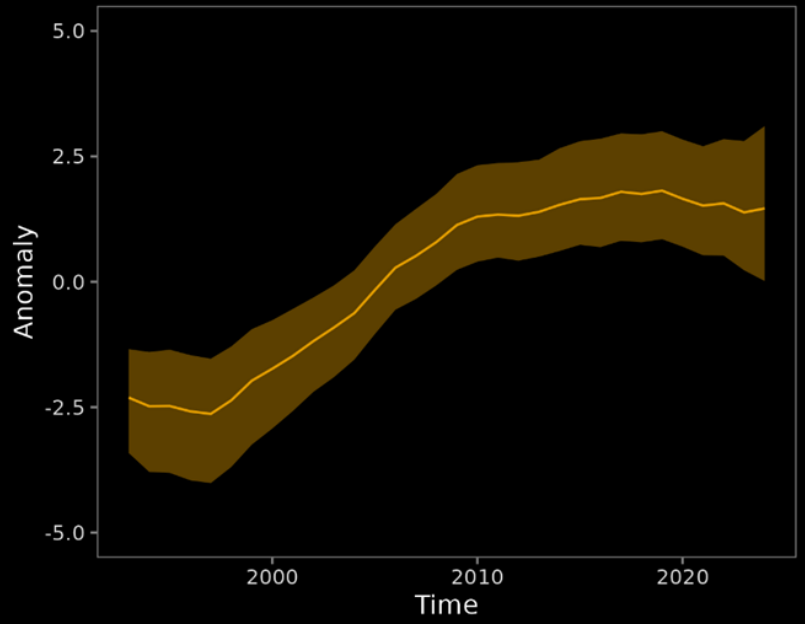
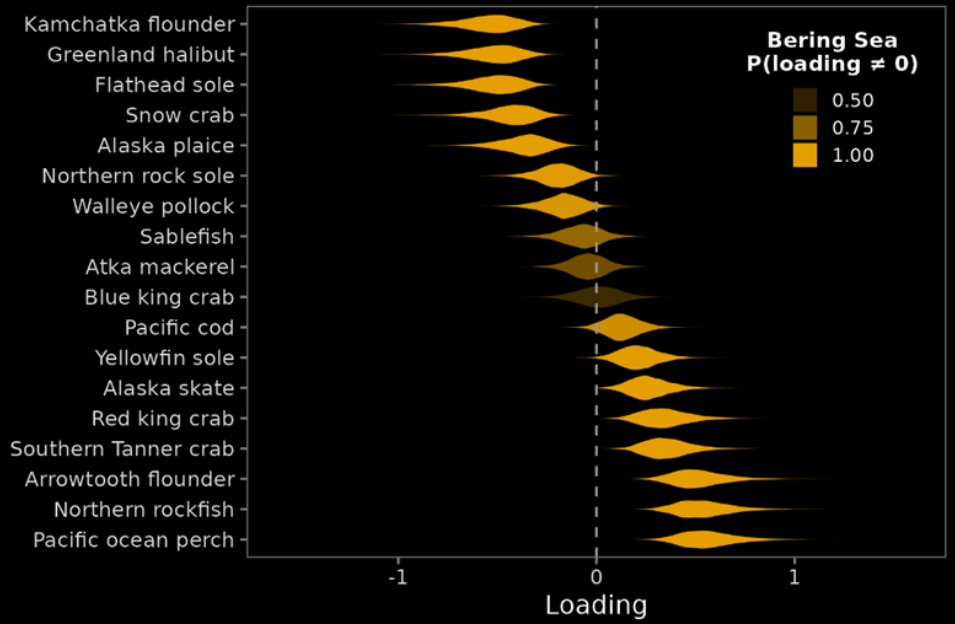


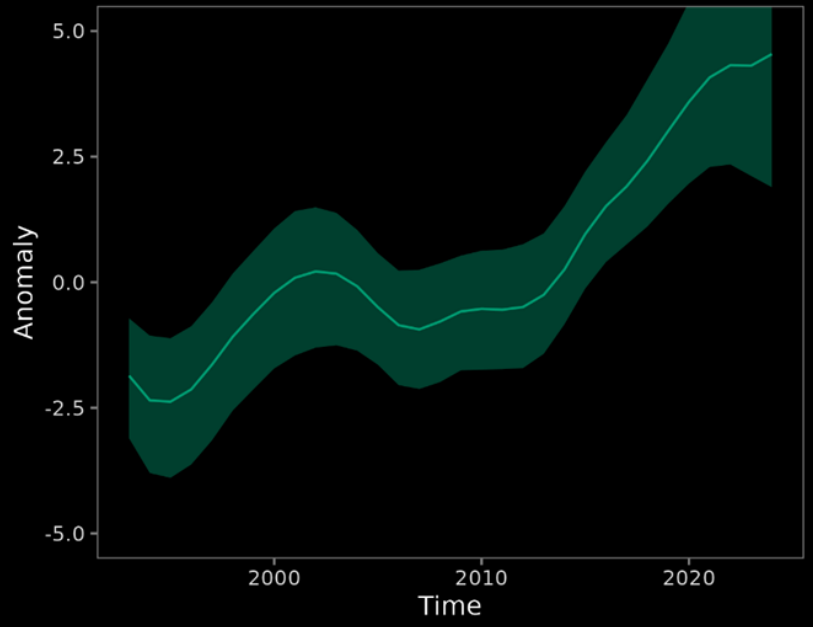


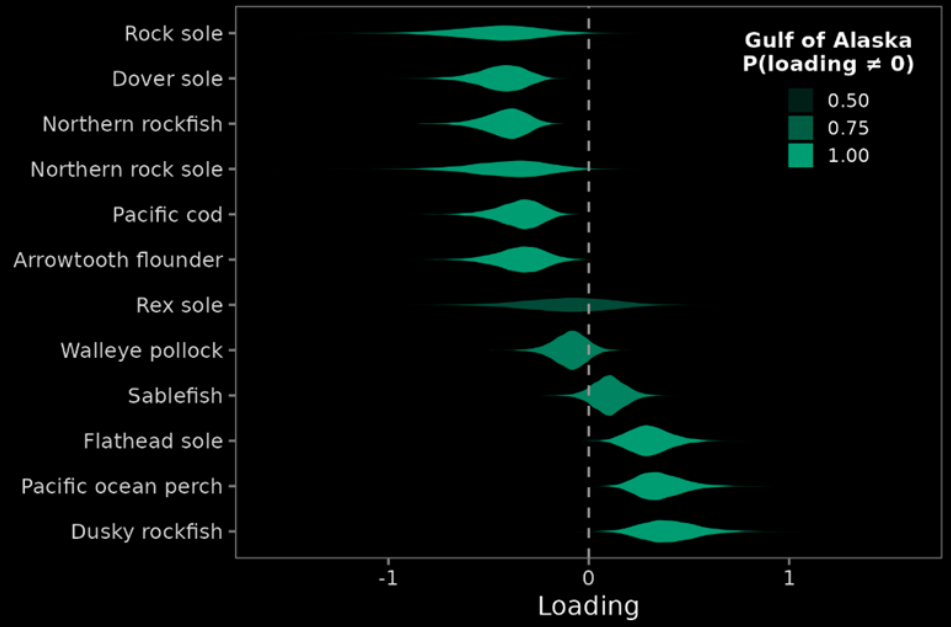
DFA Model - Bering Sea



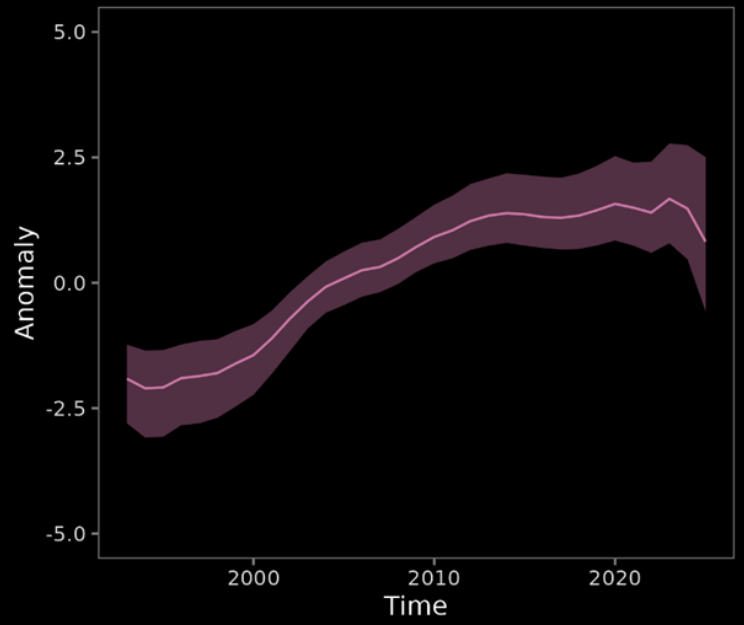


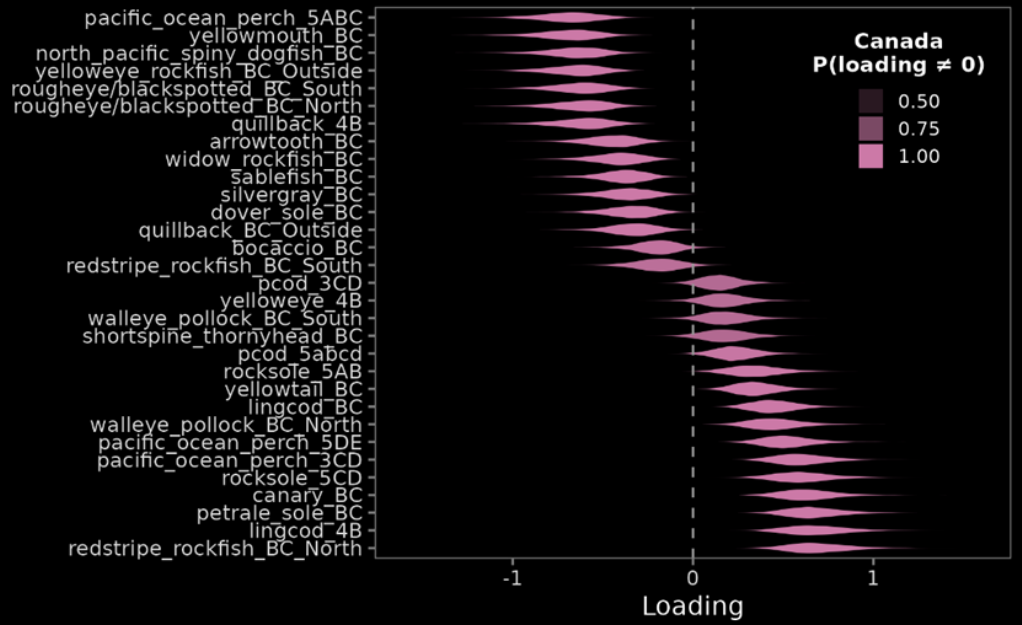
DFA Model - Gulf of Alaska



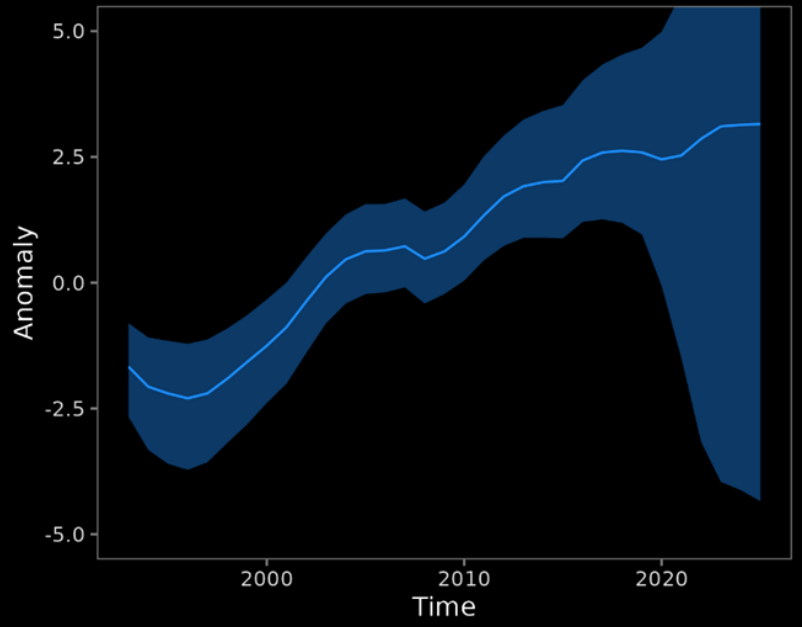


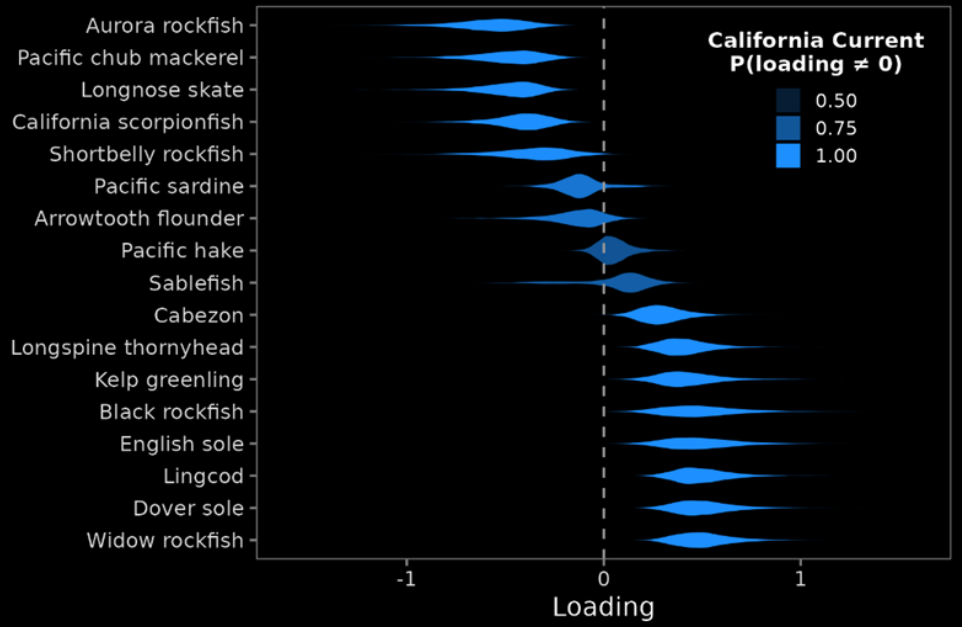
DFA Model - West Coast of Canada



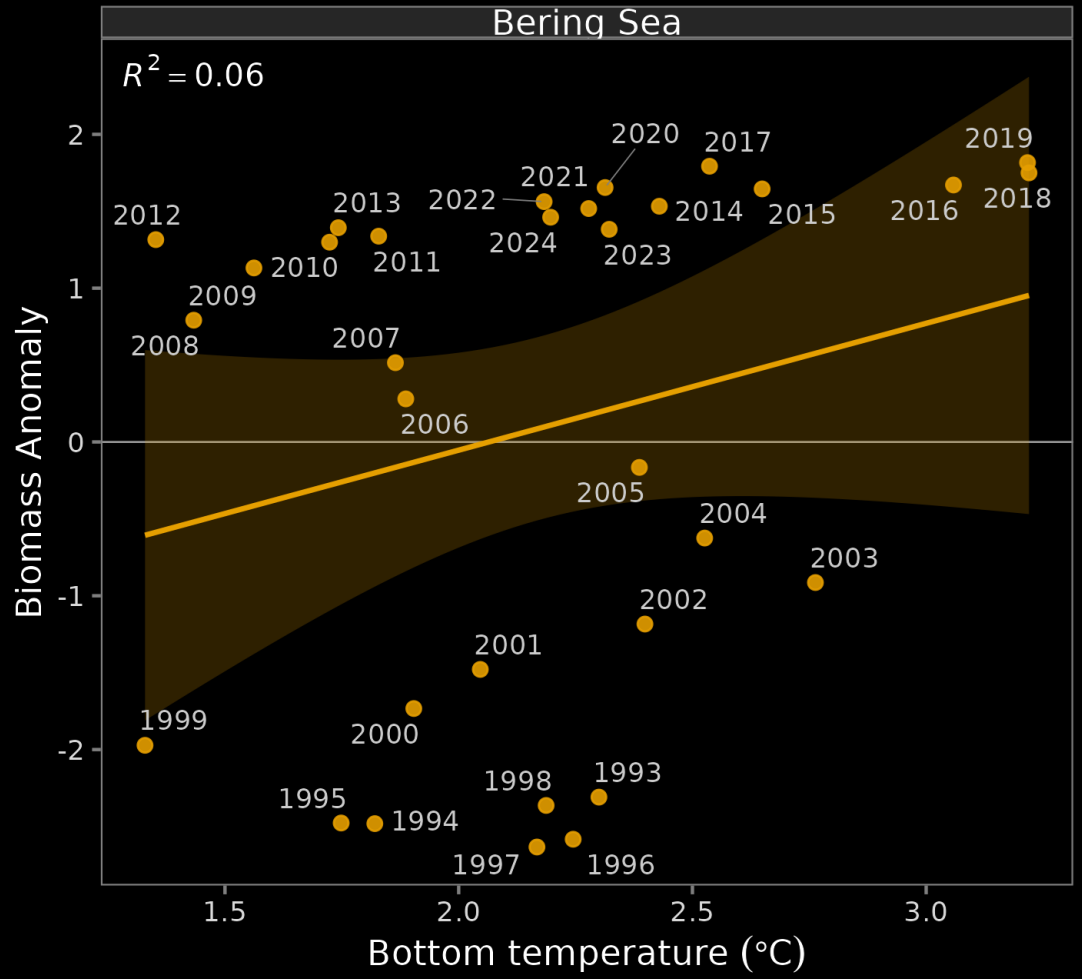


DFA Model - California Current

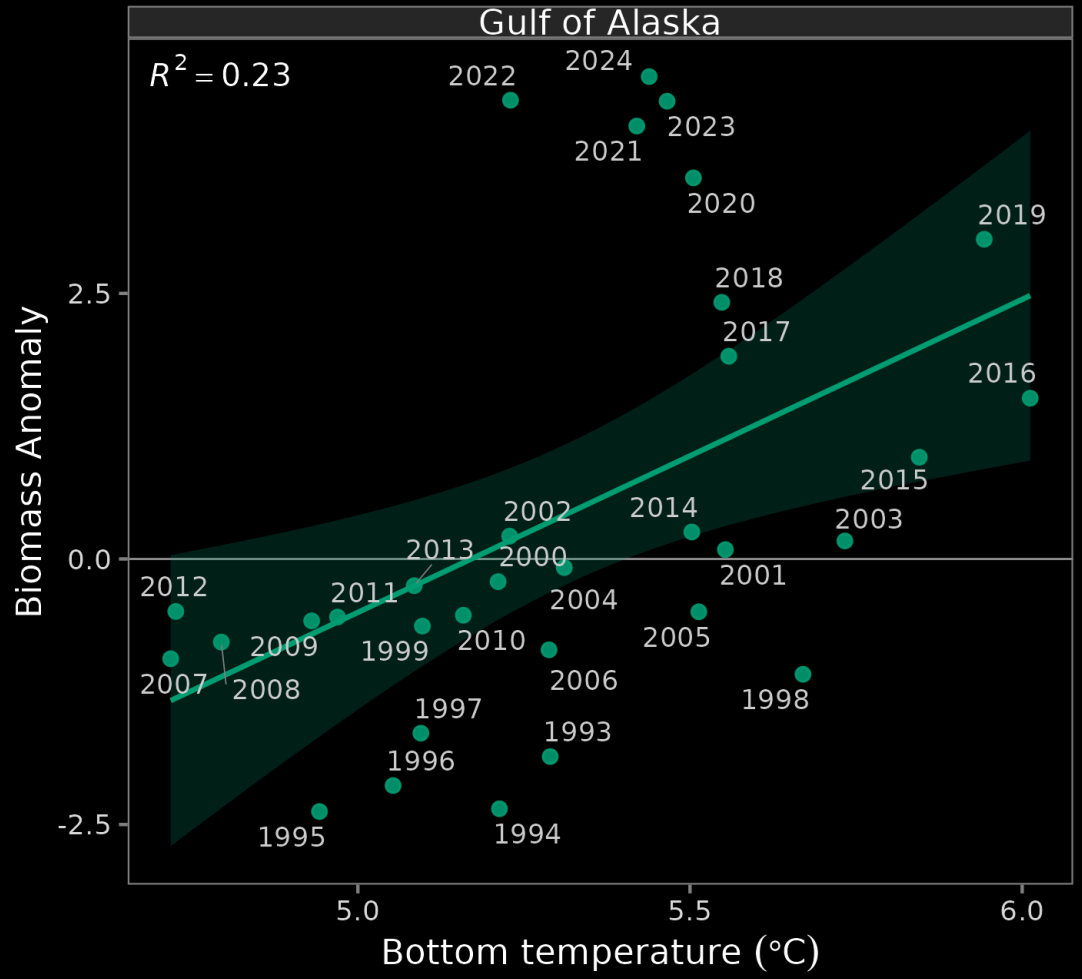




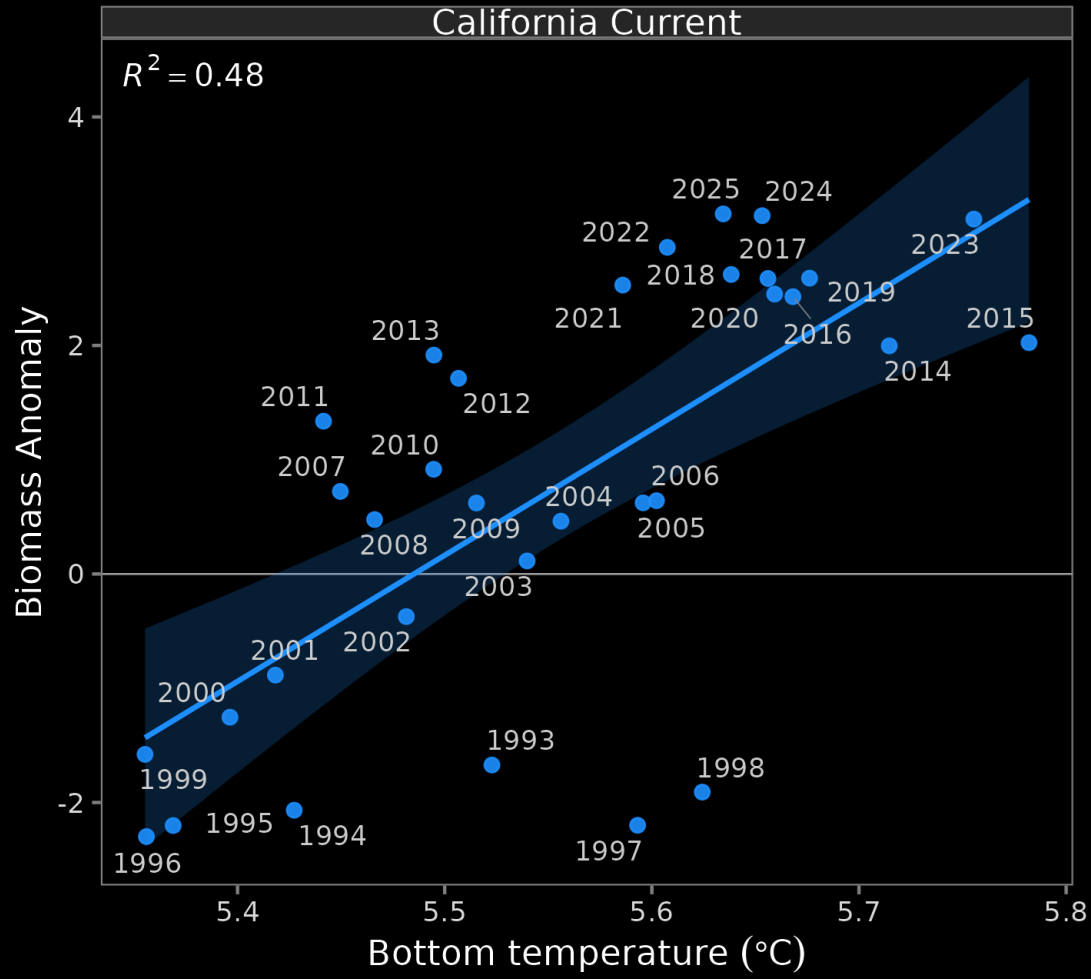
Temperature Analysis - Bering Sea



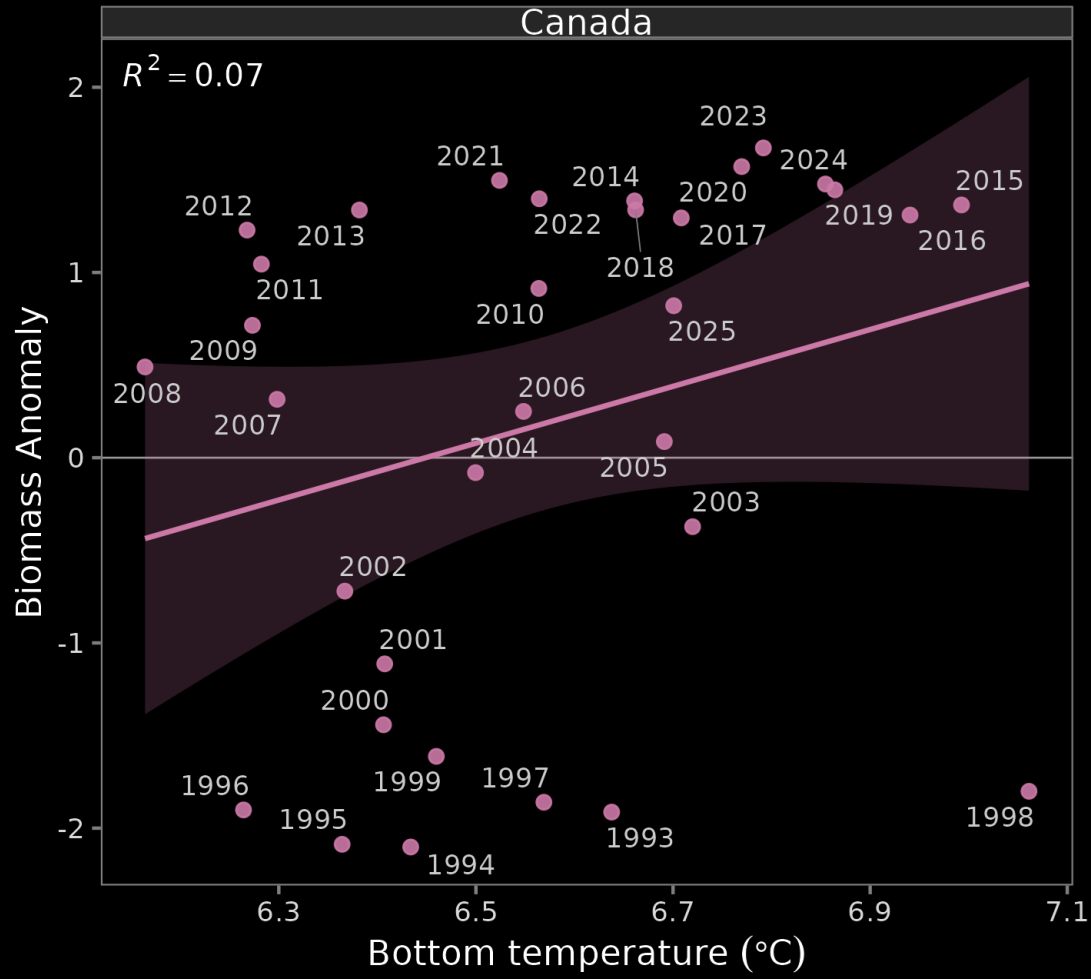
Temperature Analysis - Gulf of Alaska



Temperature Analysis - California Current



Temperature Analysis - West Coast of Canada



Key conclusions:

Temperature may be related to biomass trend in some regions (Gulf of Alaska, CA Current), not in others

No relationships with asymptotic size

Main Takeaways

Few stocks did not load onto trend suggesting high synchrony

Contrasting patterns in biomass over time for all regions - close to 50/50 split between stocks that increased or decreased

Drivers of trends still uncertain, cannot distinguish among different forces

Main Takeaways

Patterns across regions for species with multiple stocks:

1. Same pattern (3 Species)
    - Increasing: Pacific ocean perch, Lingcod
    - Decreasing: Northern rock sole
2. Contrasting patterns (9 Species); across many different fish types

These patterns can help us start to tease apart what forces may be underlying biomass trends

Limitations

- Differences across stock assessments (inputs, considerations, model types, years modeled)
- Spawning stock biomass aggregated across ages, changes could mean specific age classes are increasing or decreasing in abundance or size
- Biomass likely affected by drivers at different temporal lags (i.e., change in biomass not immediate after environmental or management change)

Future Research

- Explore other drivers of biomass: factors other than temperature, population dynamics (population growth), fishing pressure
- Examine lagged effects (e.g., biomass affected by temperature after a number of years)
- DFA with covariates and other statistical approaches (e.g., hierarchical generalized additive models)

Acknowledgments

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Questions?

Thanks for the time!!

Looking for graduate position in Fall of 2027