Linking recruitment synchrony to environmental variability

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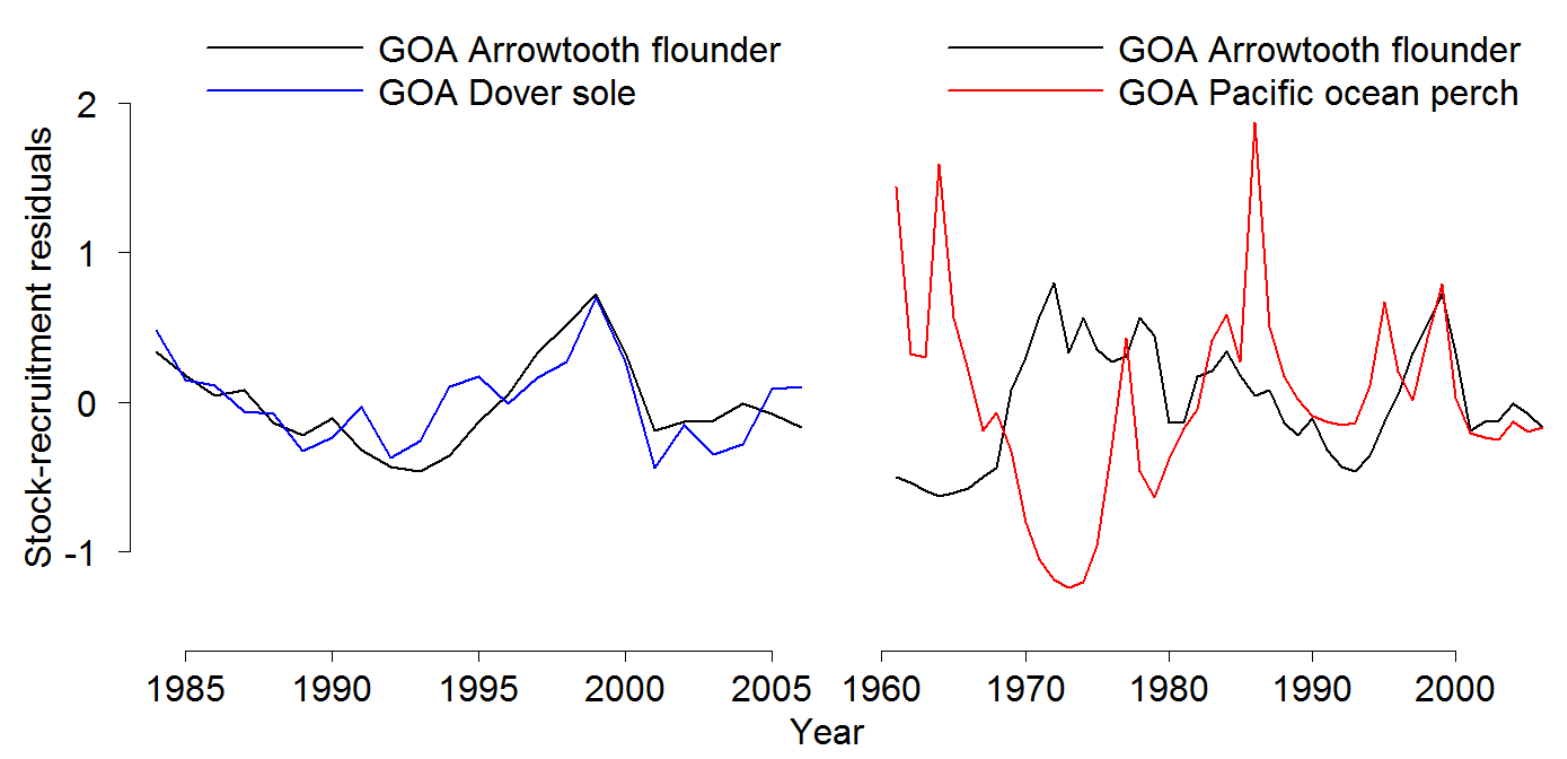
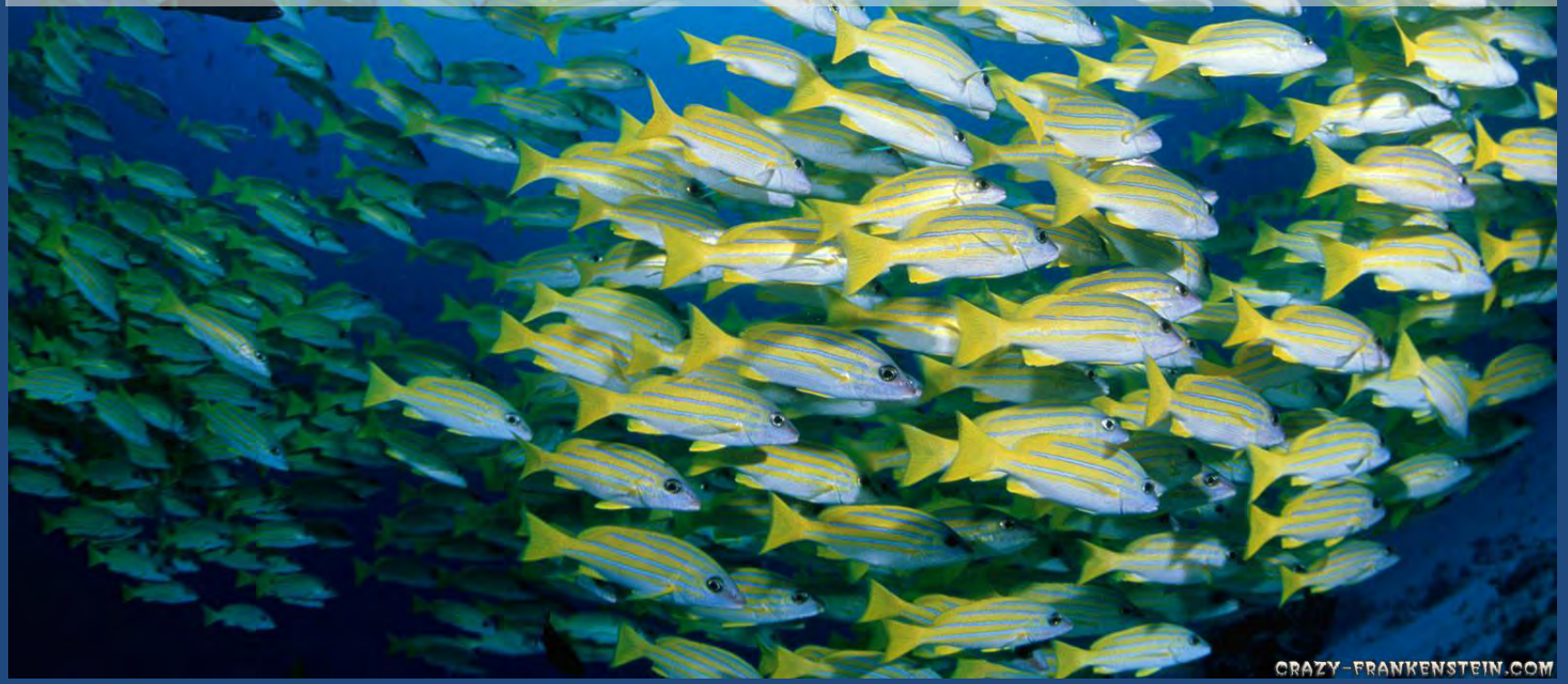
Recruitment Synchrony

- Synchrony in Northeast Pacific marine fish recruitment (Hollowed et al., 1987; Mueter et al., 2007)
- Ecosystem-wide associations between environmental and biological variability (Hare and Mantua, 2000)



Hypothesis

Synchronous production dynamics of stocks within and across ecosystems are due to ***shared sensitivity to common environmental drivers***



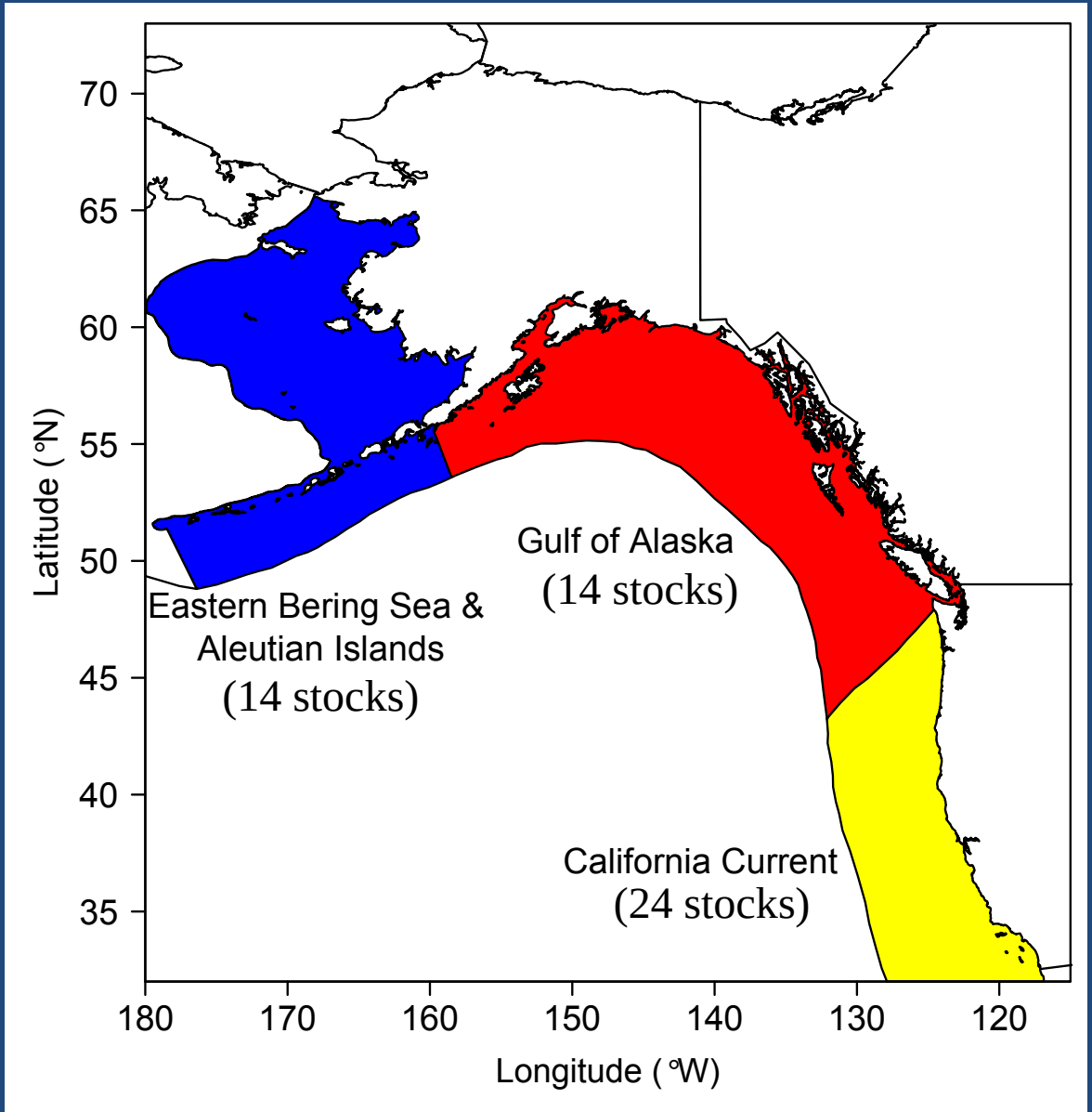
Approach

Growth

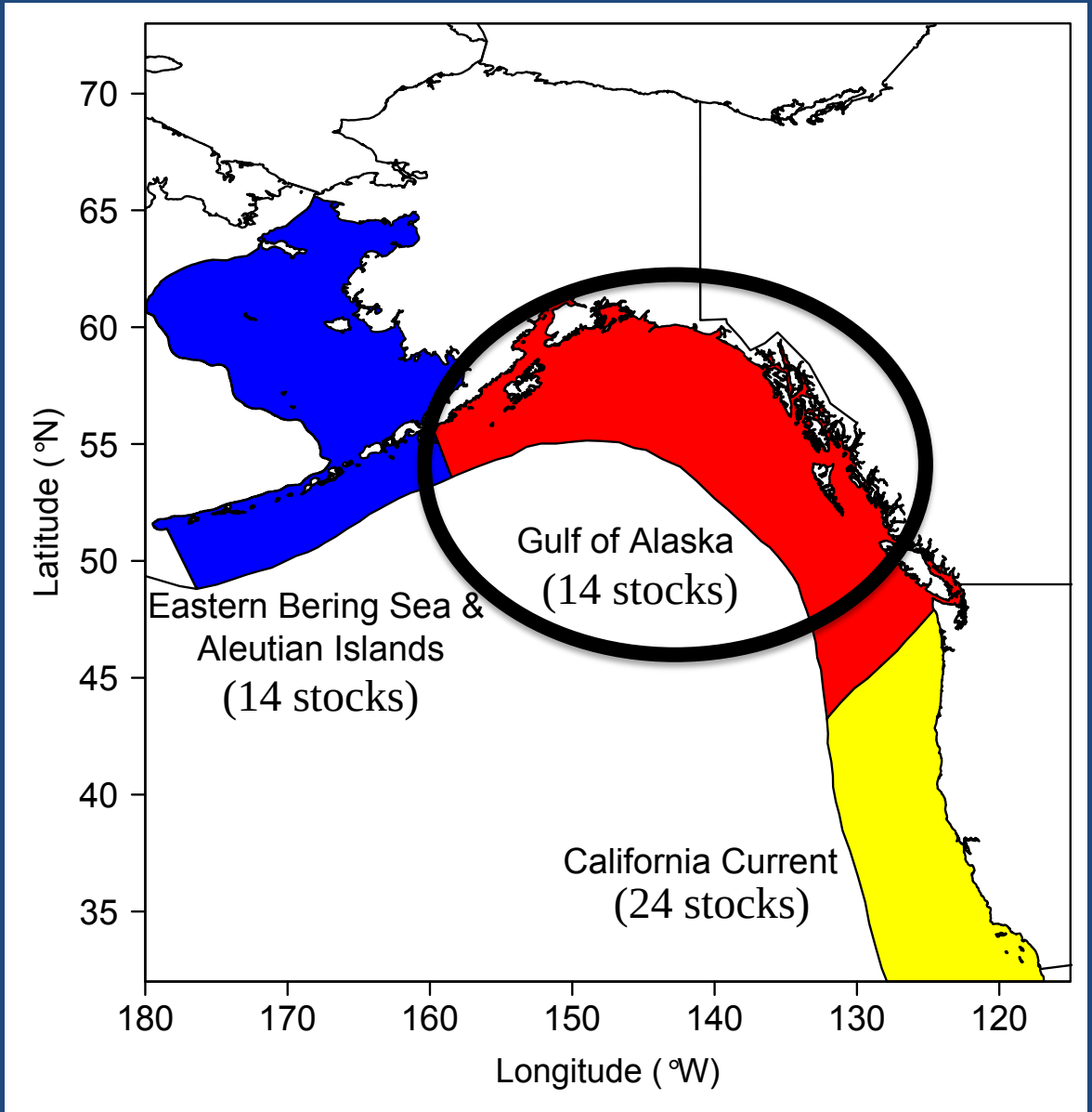
Recruitment

1. Evaluate synchrony within ecosystems
2. Identify stocks with similar susceptibility to environmental processes
3. Identify important environmental processes
4. Modeling

Recruitment Data

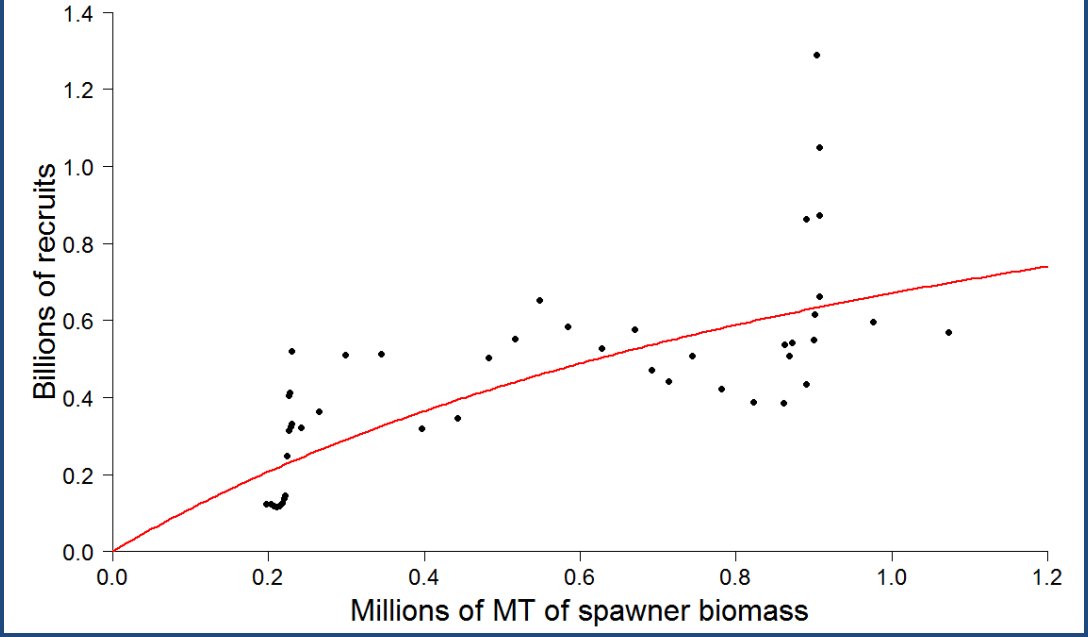


Recruitment Data



Recruitment Data

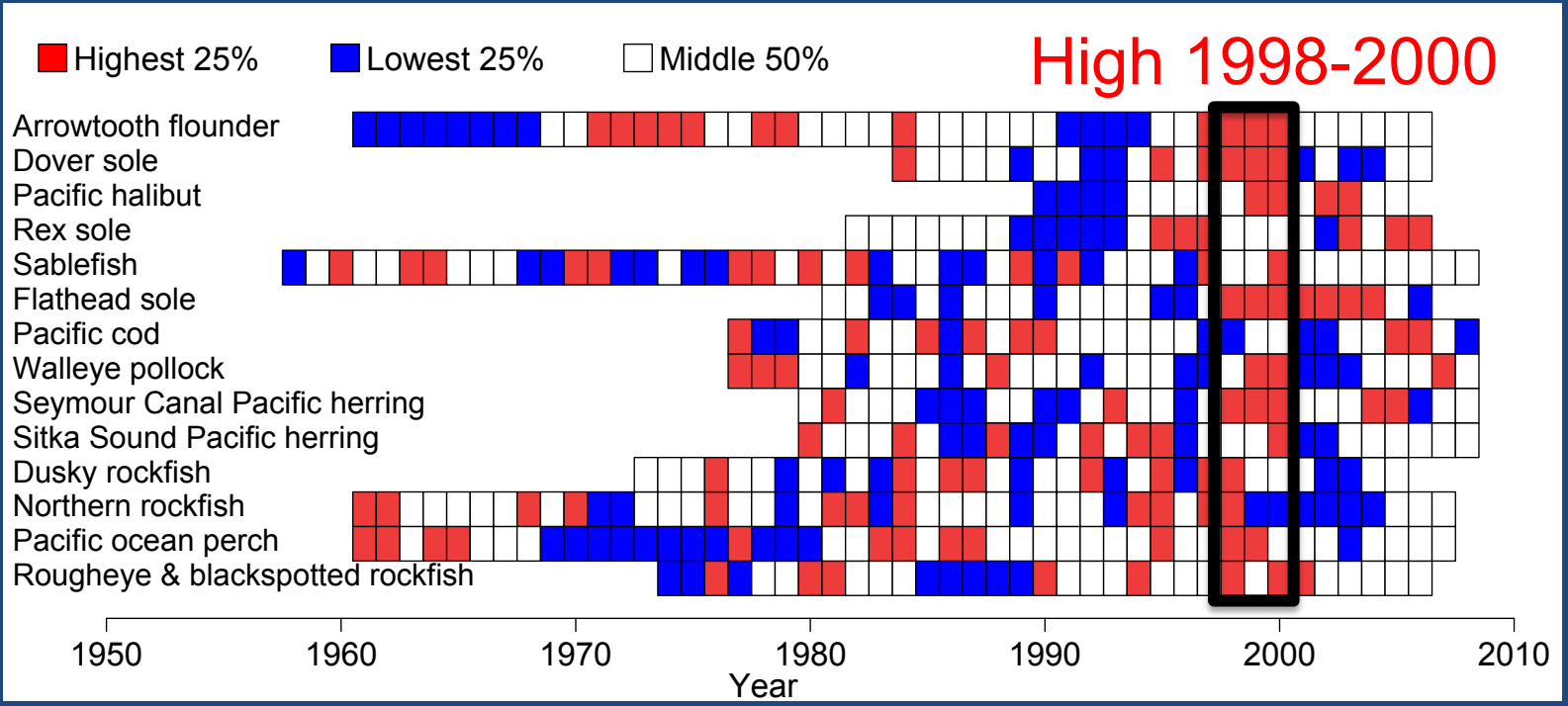
- Removed effects of spawner biomass
- Used stock-recruitment residuals for all analyses



GOA arrowtooth flounder Beverton-Holt model fit

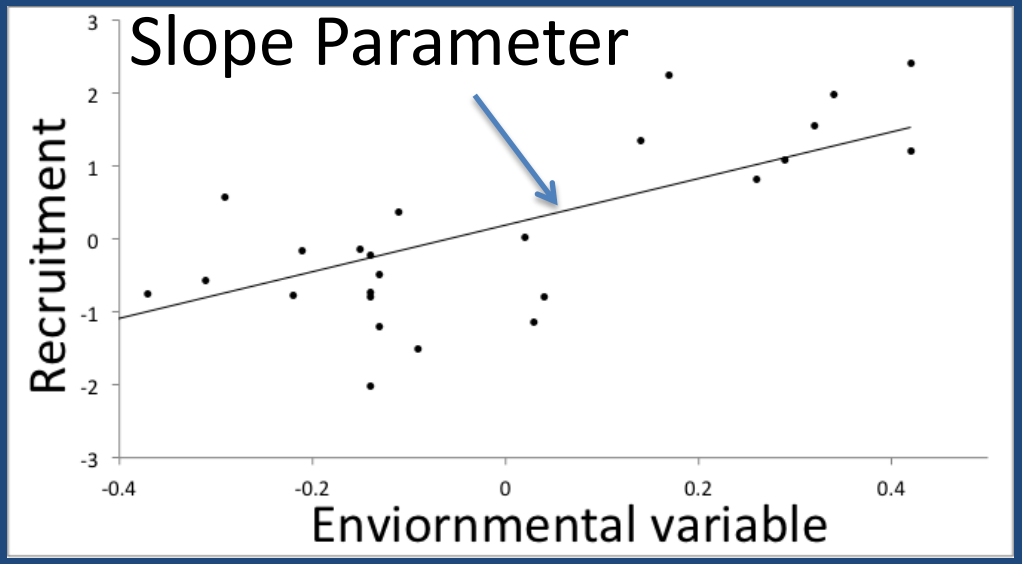
Recruitment Synchrony

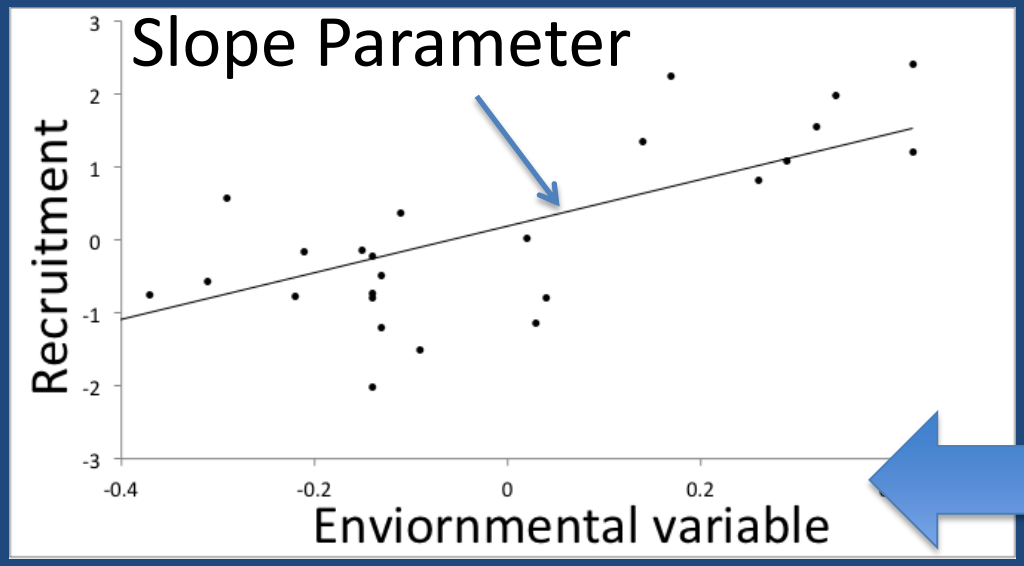
- Synchrony in extreme recruitment events
- Correlation in recruitment between stocks



Bayesian Hierarchical Modeling

- Data rich stocks inform data poor stock
- Modeled recruitment as a linear function of environmental variables


Slope Parameter
Recruitment
Enviornmental variable
3
2
1
0
-1
-2
-3
-0.4
-0.2
0
0.2
0.4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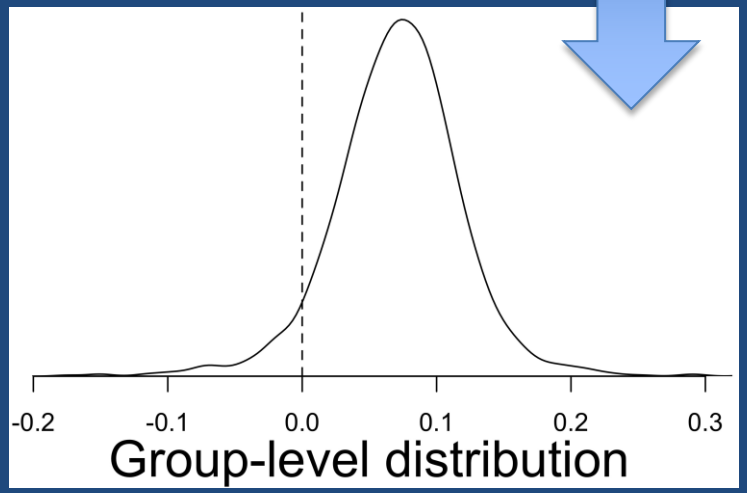
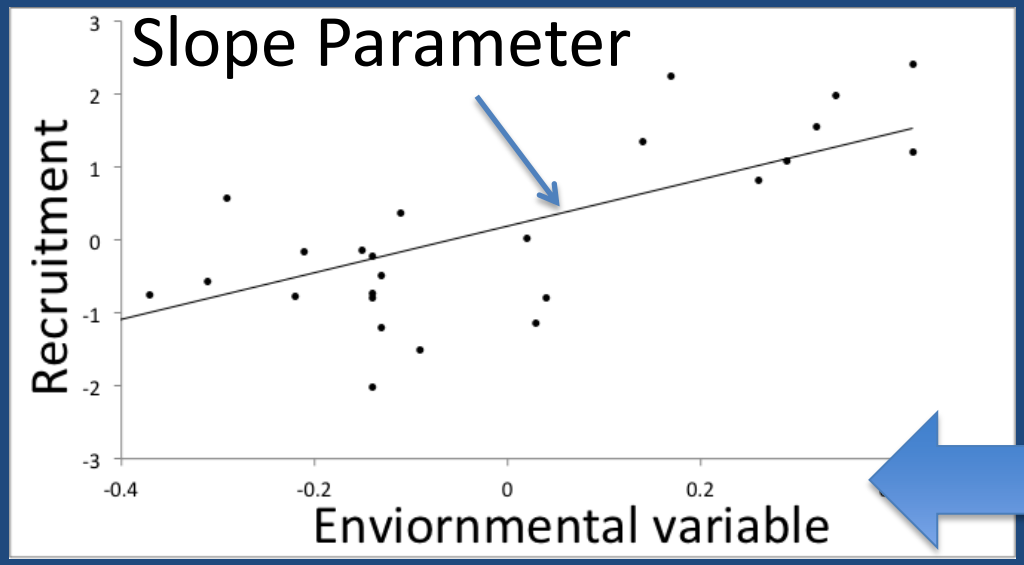
Enviornmental variable


-0.2
-0.1
0.0
0.1
0.2
0.3
Group-level distribution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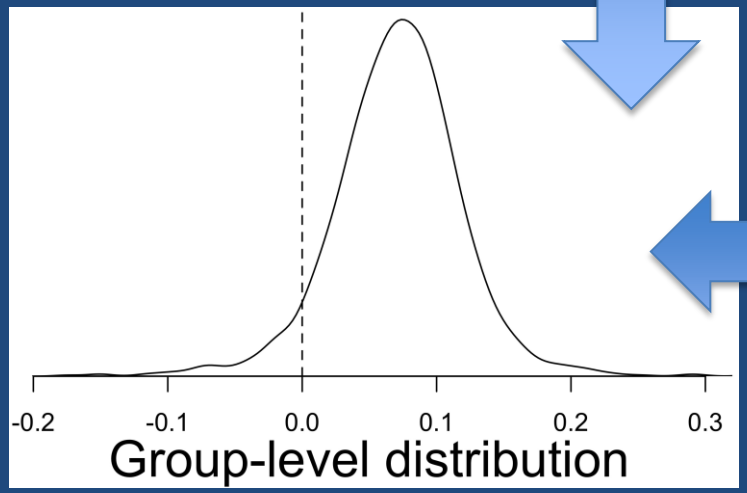
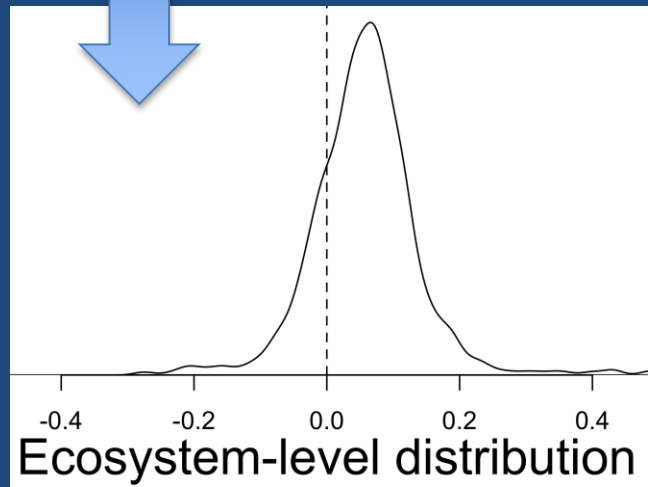
Enviornmental variable


-0.2
-0.1
0.0
0.1
0.2
0.3
Group-level distribution

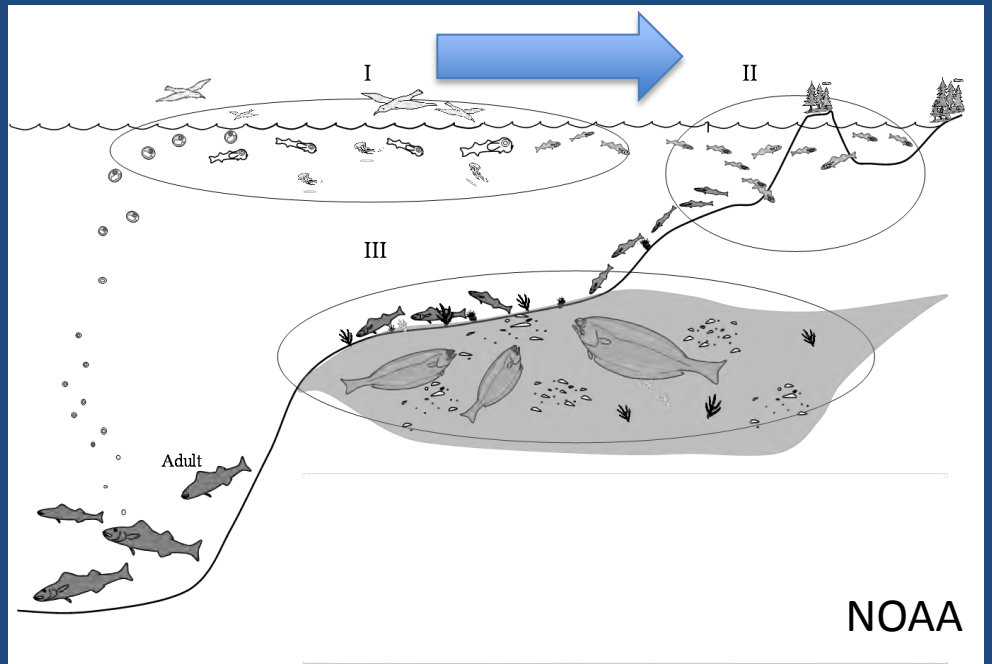

-0.4
-0.2
0.0
0.2
0.4
Ecosystem-level distribution

Stock Grouping

- Early life history information
- GOA: 4 groups

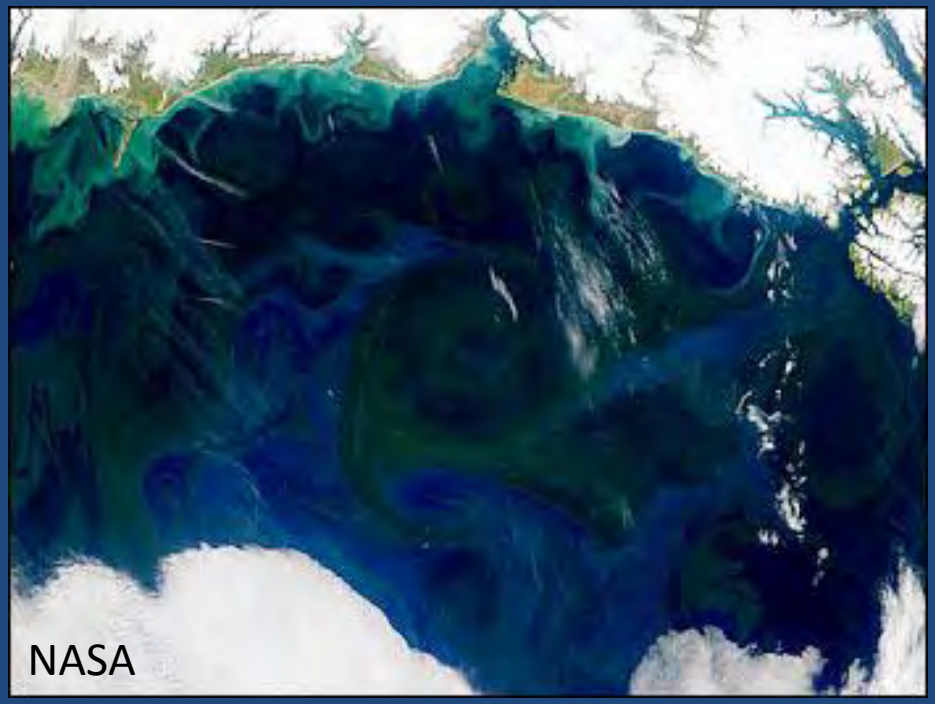
Cross-shelf transport group

- Arrowtooth flounder
- Dover sole
- Pacific halibut
- Rex sole
- Sablefish



Retention group

- Walleye pollock
- Pacific cod
- Flathead sole



Coastal group

- Seymour Canal Pacific herring
- Sitka Sound Pacific herring

Parental investment group

- Dusky rockfish
- Northern rockfish
- Pacific ocean perch
- Rougheye & blackspotted rockfish

Environmental Variables

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- GOA
  - Sea surface temperature (SST)
  - Upwelling
  - Freshwater discharge
  - Sea surface height (SSH)

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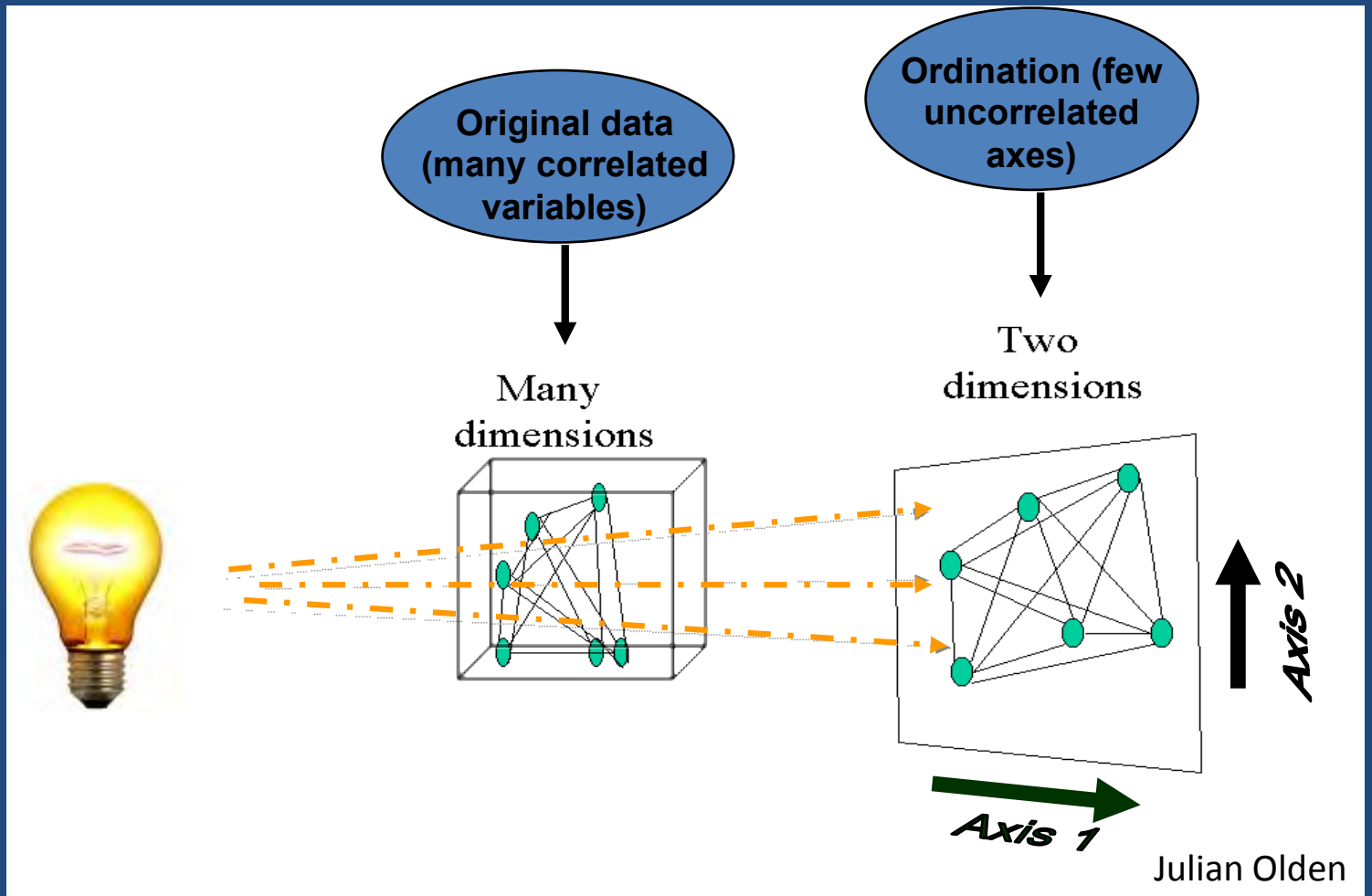
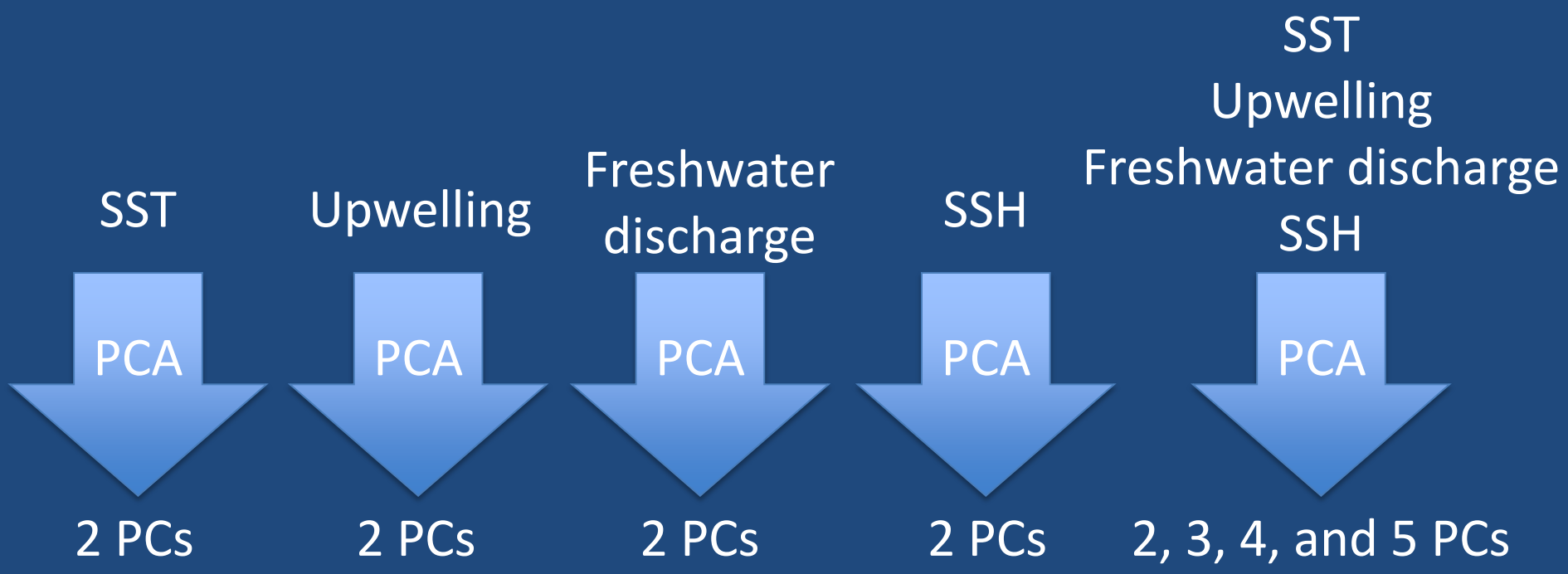
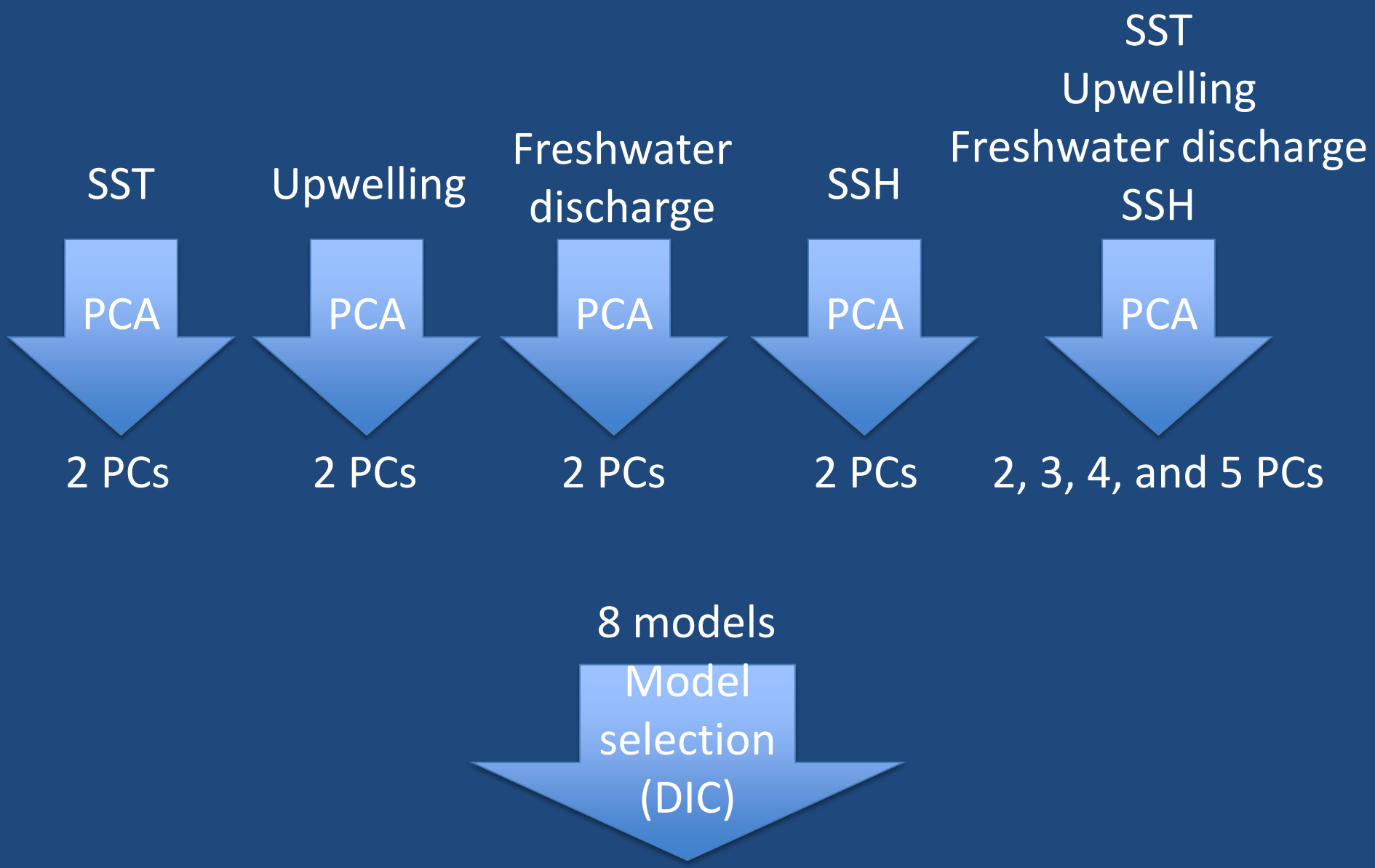
- GOA
  - Sea surface temperature (SST)
  - Upwelling
  - Freshwater discharge
  - Sea surface height (SSH)
- Data for each variable across many locations and times

Environmental Variables

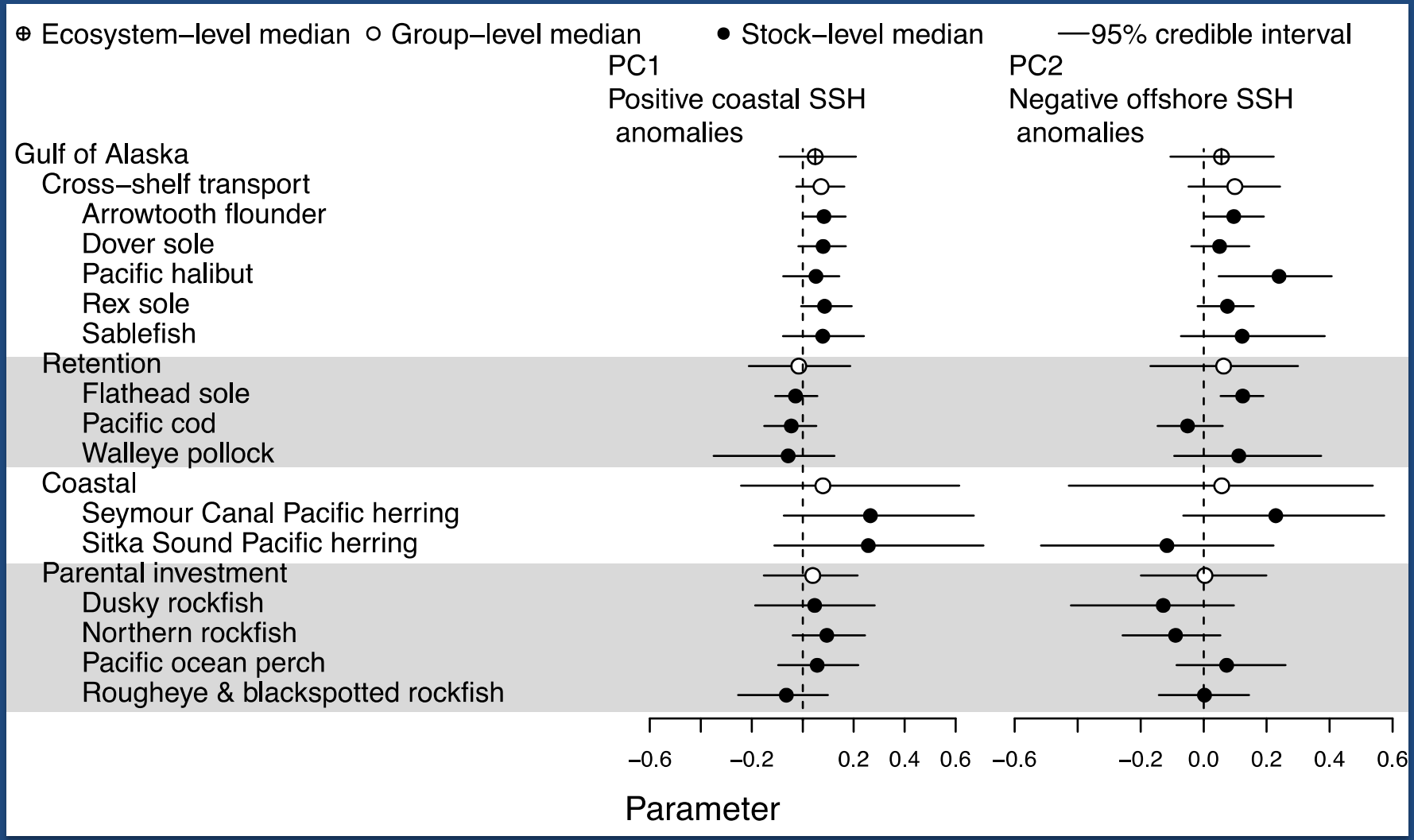
- Principal component analysis to explain a large portion of the variance as a smaller number of uncorrelated time series



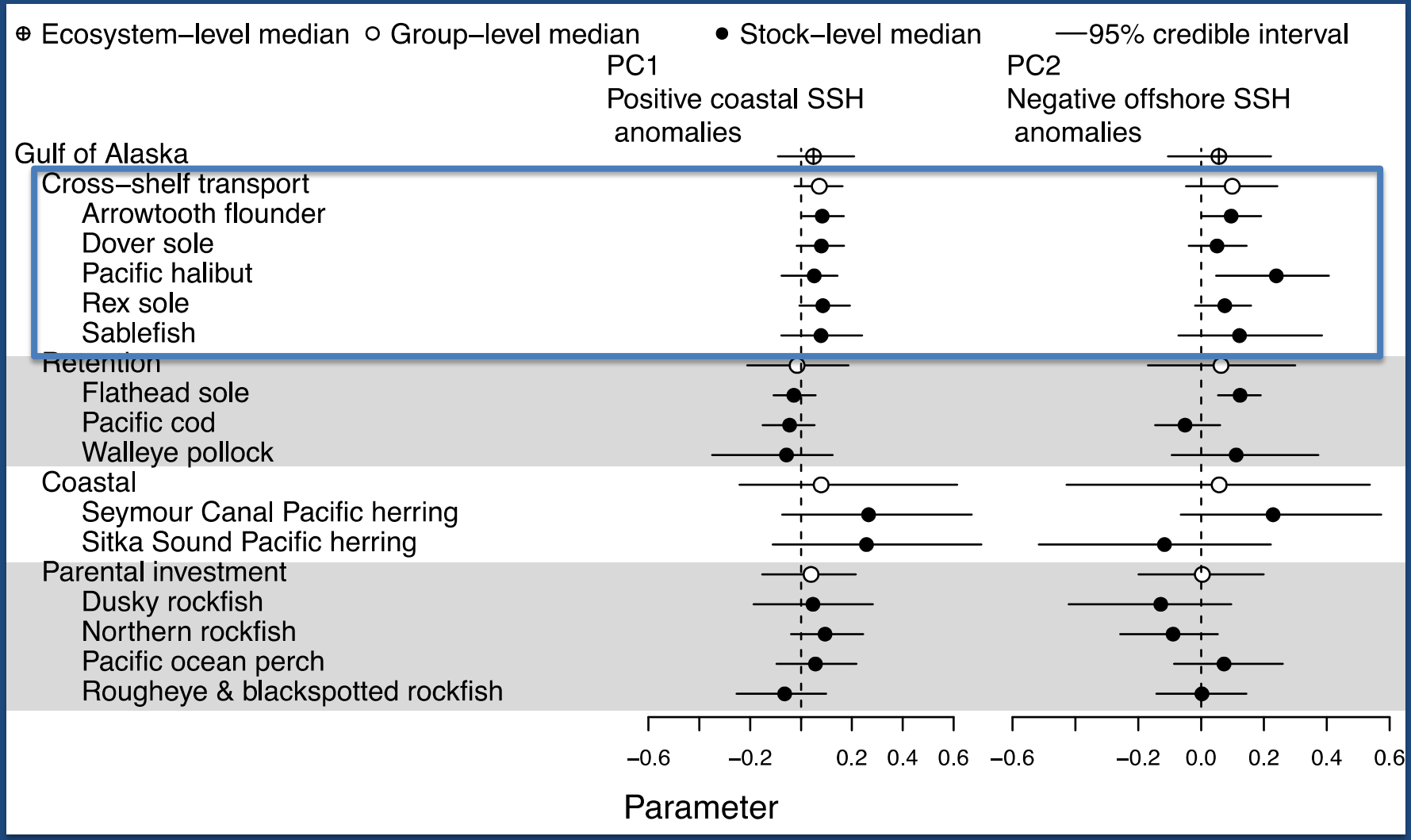

SST
PCA
2 PCs
Upwelling
PCA
2 PCs
Freshwater discharge
PCA
2 PCs
SSH
PCA
2 PCs
SST
Upwelling
Freshwater discharge
SSH
PCA
2, 3, 4, and 5 PCs


SST
Upwelling
Freshwater discharge
SSH
SST
Upwelling
Freshwater discharge
SSH
PCA
PCA
PCA
PCA
PCA
2 PCs
2 PCs
2 PCs
2 PCs
2, 3, 4, and 5 PCs
8 models
Model selection (DIC)
Best model

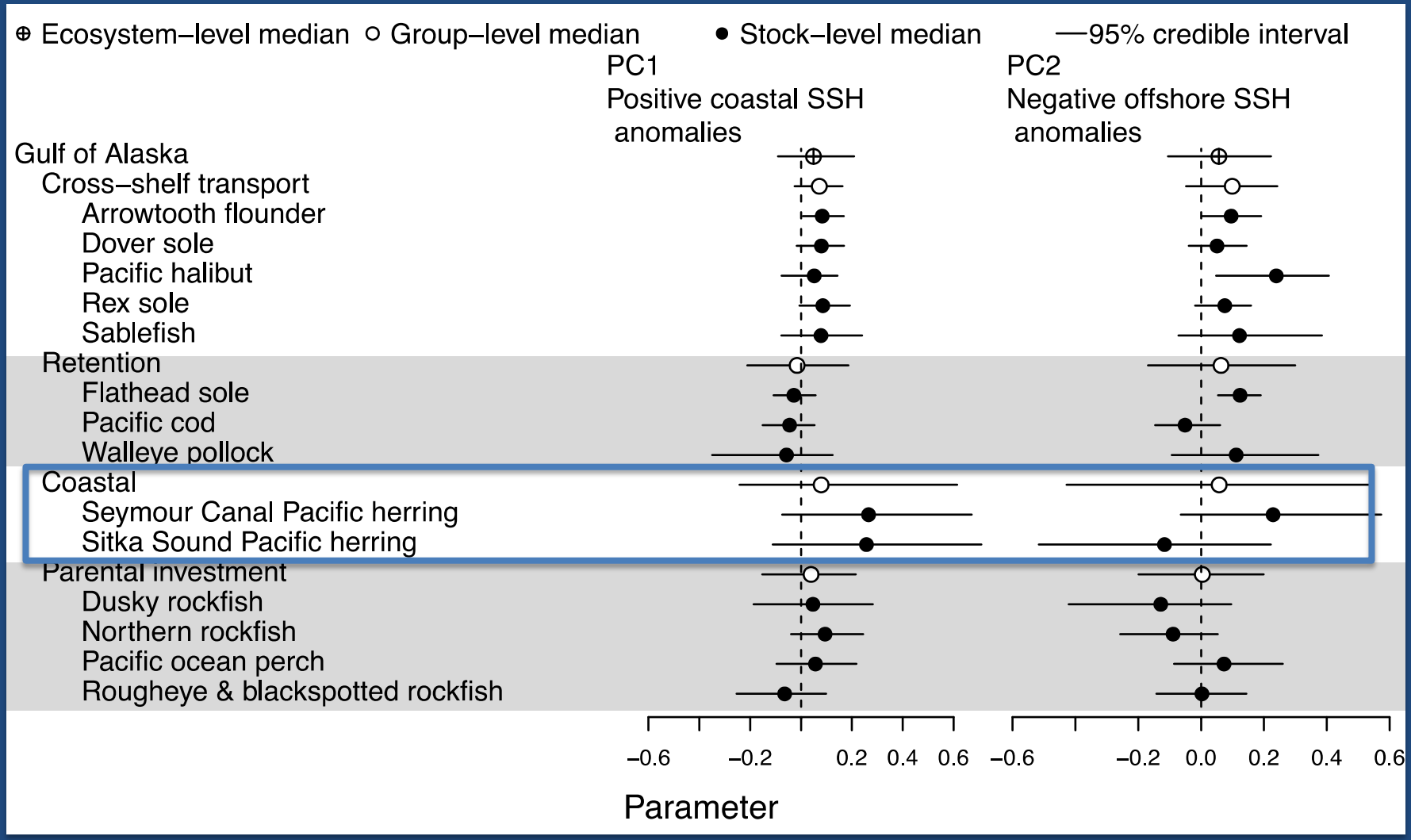
GOA Best Model: Sea Surface Height



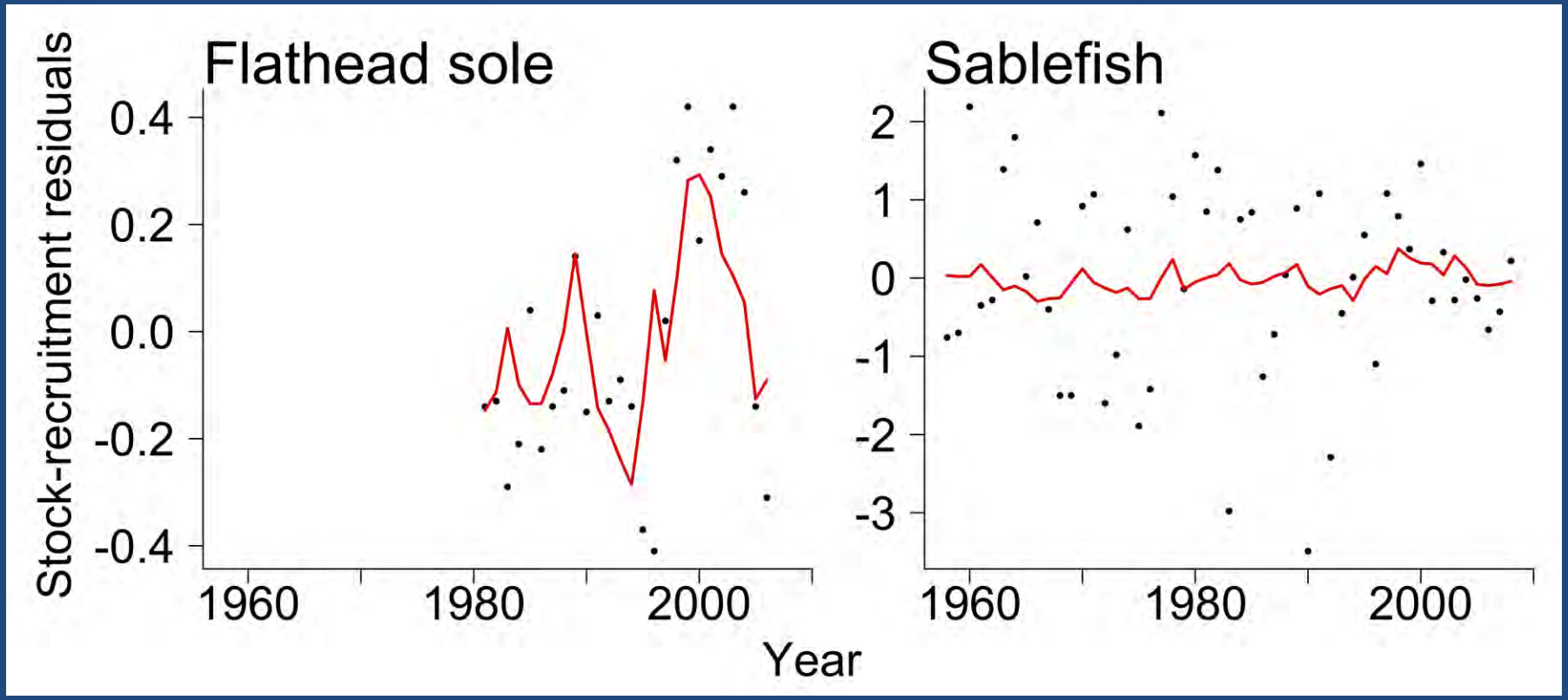
GOA Best Model: Sea Surface Height



GOA Best Model: Sea Surface Height

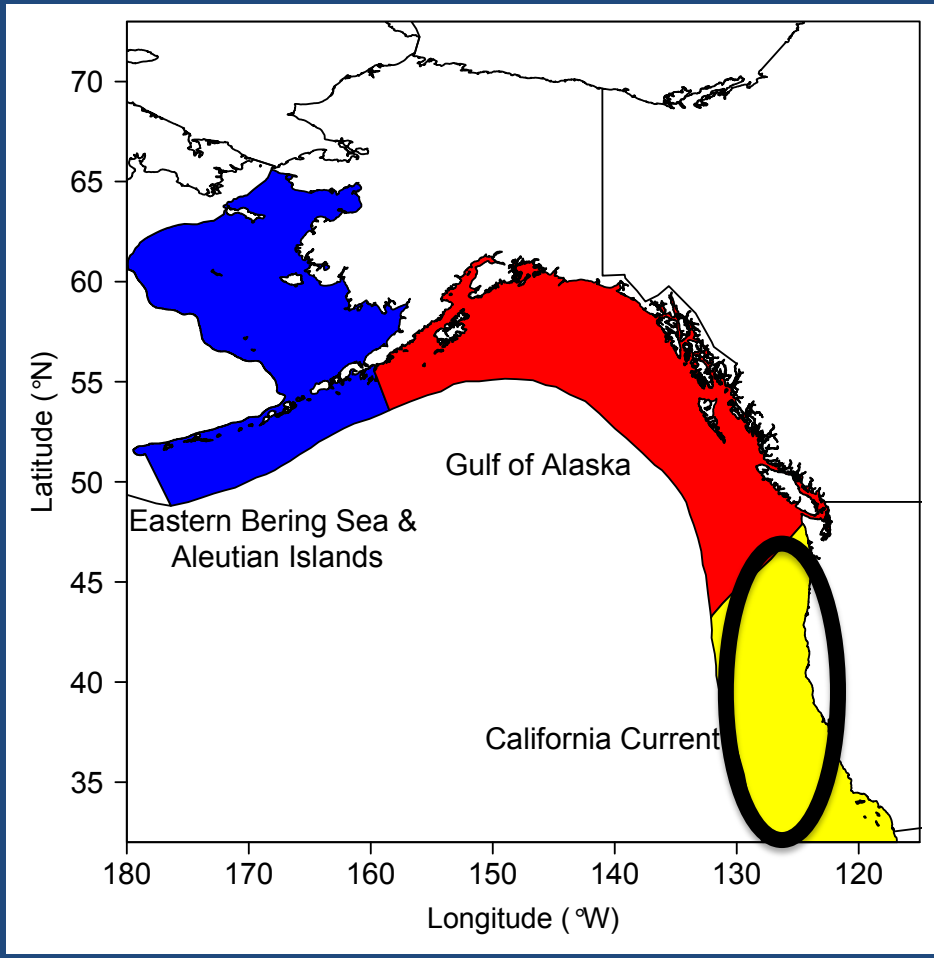


GOA Sea Surface Height Model Fits



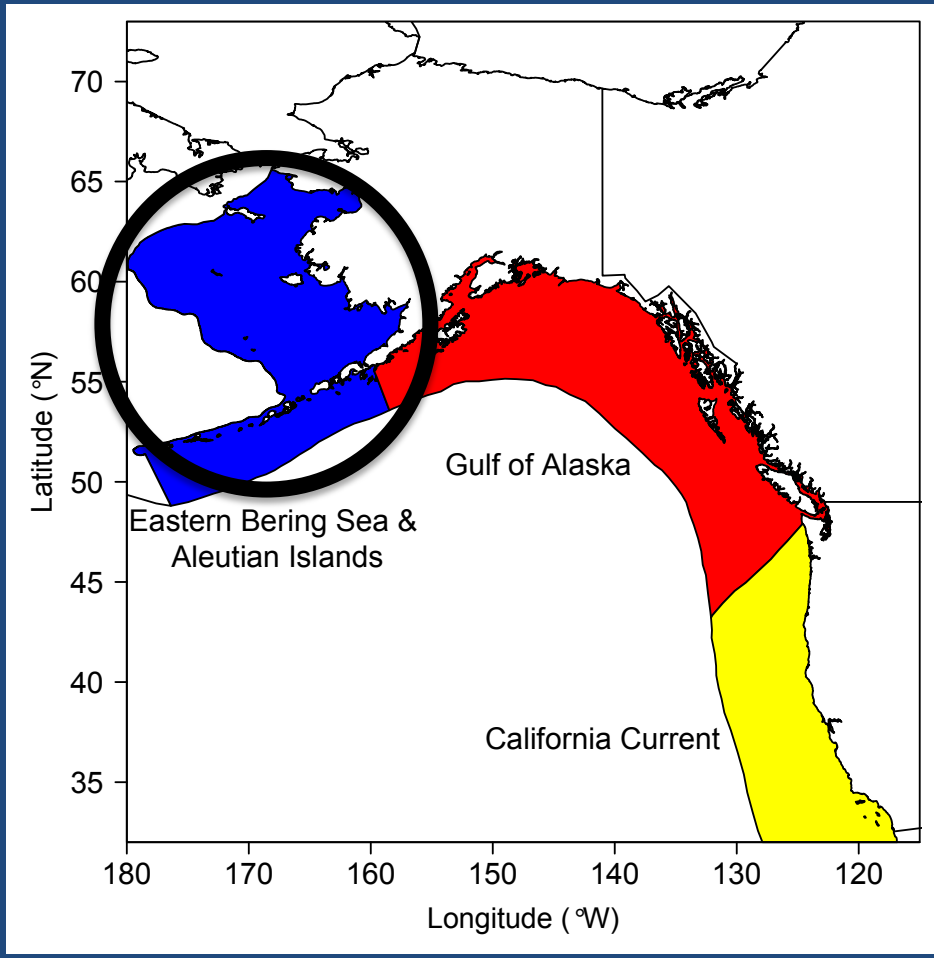
California Current

- Best model: sea level
- High recruitment associated with:
  - High upwelling the year of spawning
  - Low upwelling the year before spawning



Eastern Bering Sea and Aleutian Islands

- Best model: all environmental variables considered
- Not simple to separate out the driving processes



Evaluating Stock Grouping

- Tested best model without separate groups
  - Support for grouped model in the BSAI, support not as strong in the GOA and CC
- Other grouping structures may improve the fit
  - More early life history information

Conclusions

- Synchrony in Northeast Pacific recruitment
  - Use methods that draw strength from this synchrony
- Some evidence for similar environmental influences within defined groups
- Environmental variables showed common influence on recruitment for several stocks
  - GOA: sea surface height
  - CC: sea level

Thanks!

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