Spatial scales and magnitudes of covariation among fish populations in the Northeast Pacific

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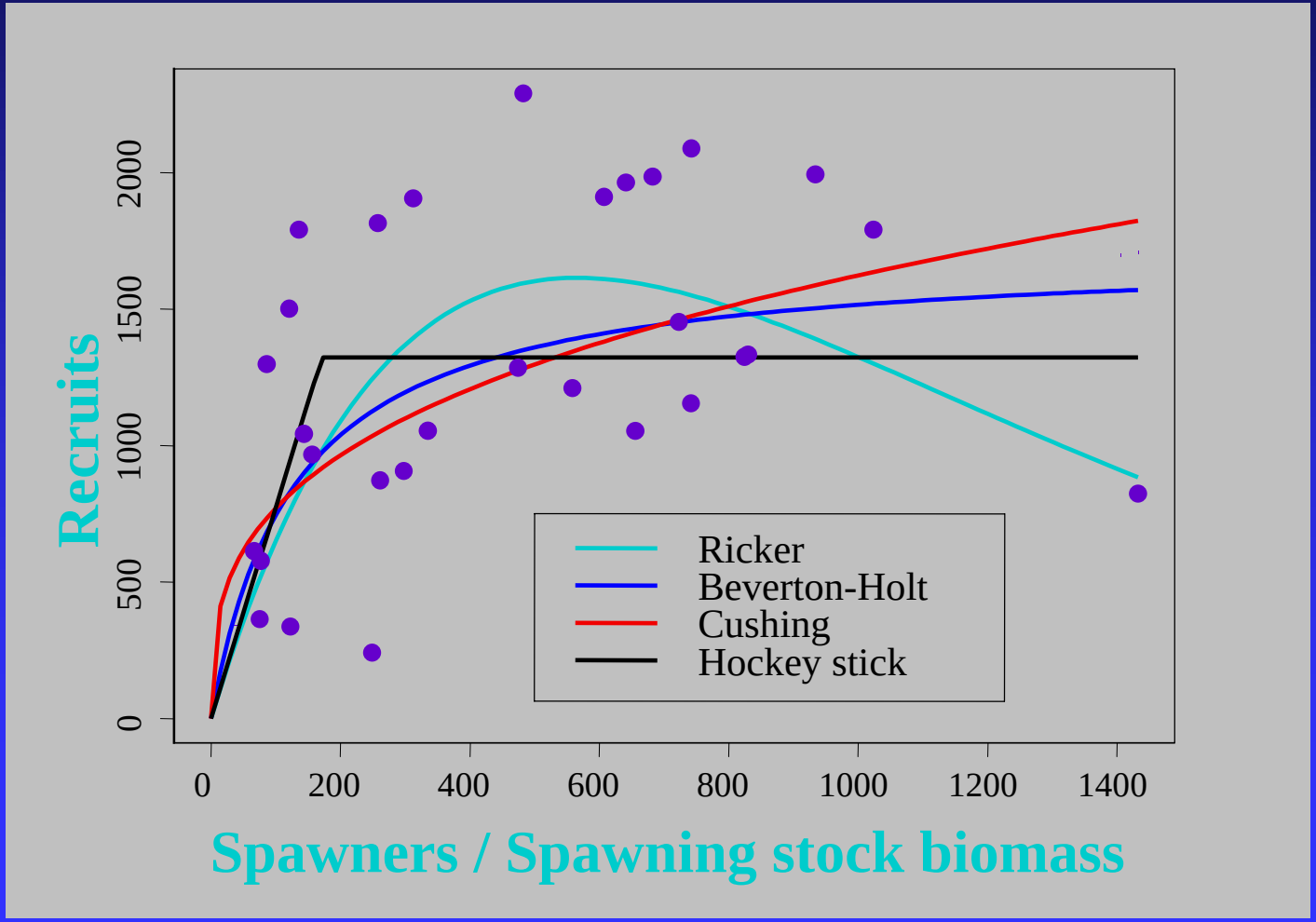
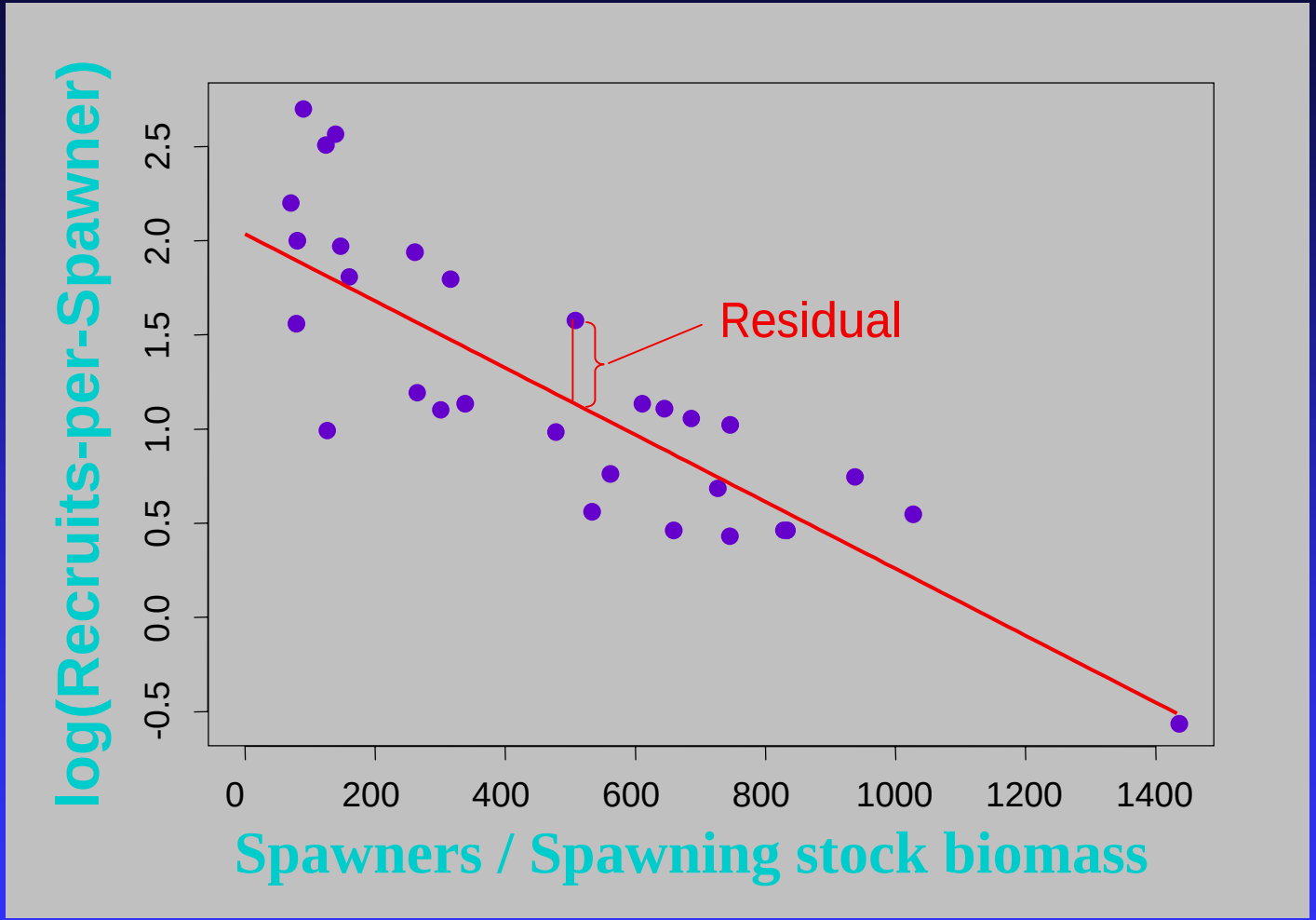
Outline

- Covariation in what?
- Review: Spatial scales of covariation among salmon populations
- Spatial scales of covariation among
  - herring populations
  - groundfish populations
- Covariation patterns among fish populations within and among the Eastern Bering Sea, Gulf of Alaska, and U.S. West Coast
- Conclusions

Stock-recruit relationships



Linearized Ricker model



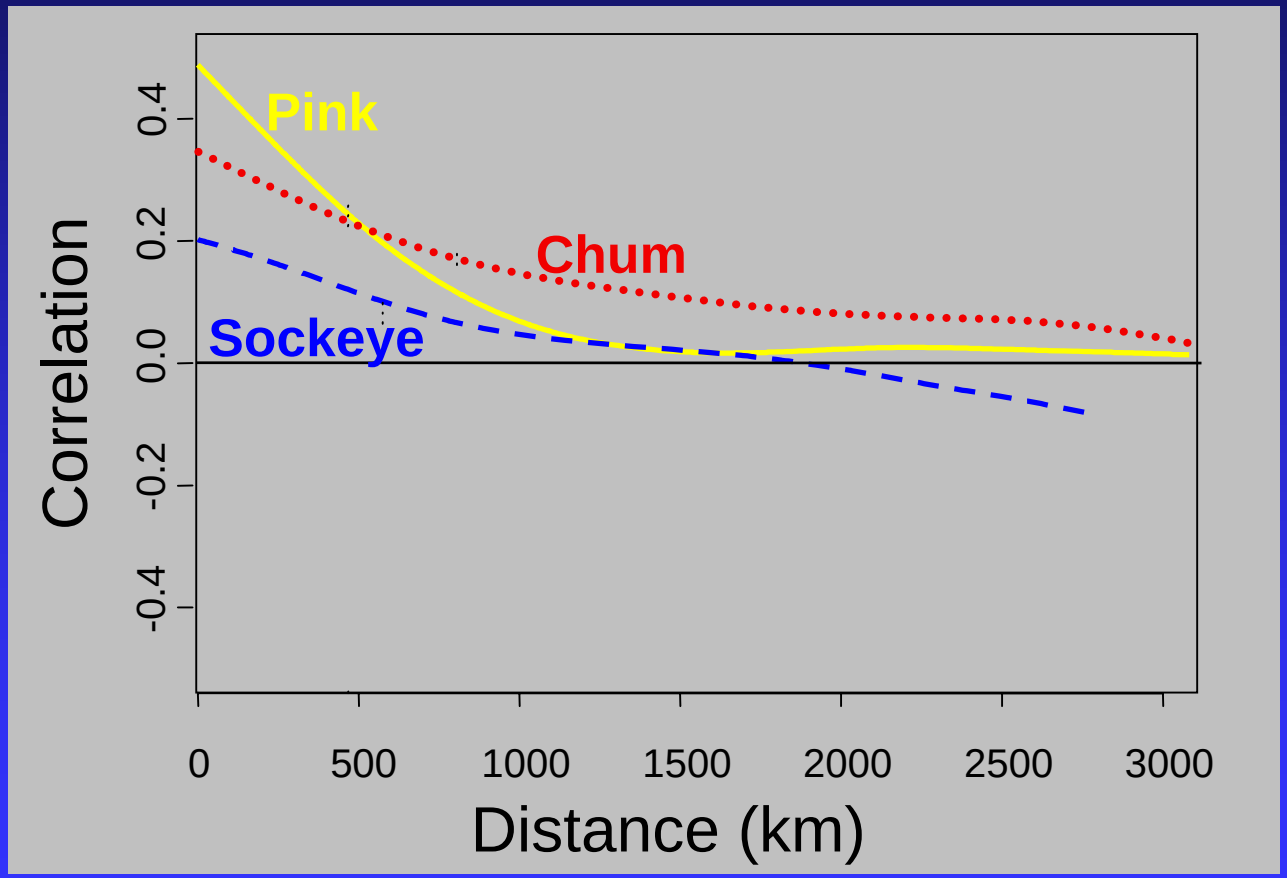
Stock-recruit residuals as proxies for variations in survival rate caused by density-independent effects

Spatial scales of covariation: Salmon

- Regional covariation in salmon survival rates, uncorrelated > 1000 km

  (Mueter et al. 2002)

Spatial scales of covariation: Salmon



(from Mueter et al. 2002)

Spatial scales of covariation: Salmon

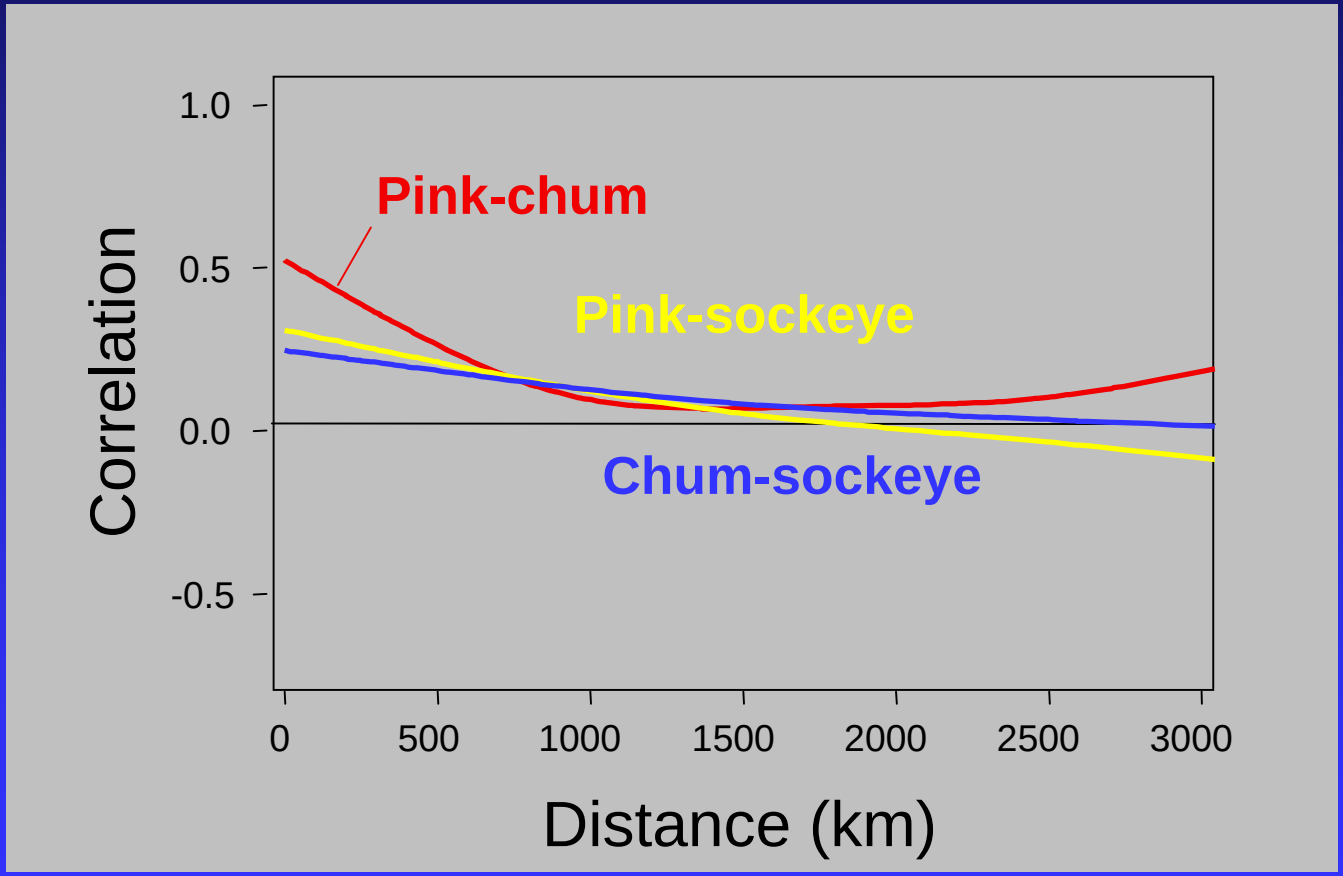
- Regional covariation in salmon survival rates, uncorrelated > 1000 km

  (Mueter et al. 2002)

- Regional covariation between species
  - Strong covariation: pink vs. chum salmon
  - Weak covariation: sockeye vs. pink
    sockeye vs. chum

  (Pyper et al., in press)

Spatial scales of covariation: Salmon



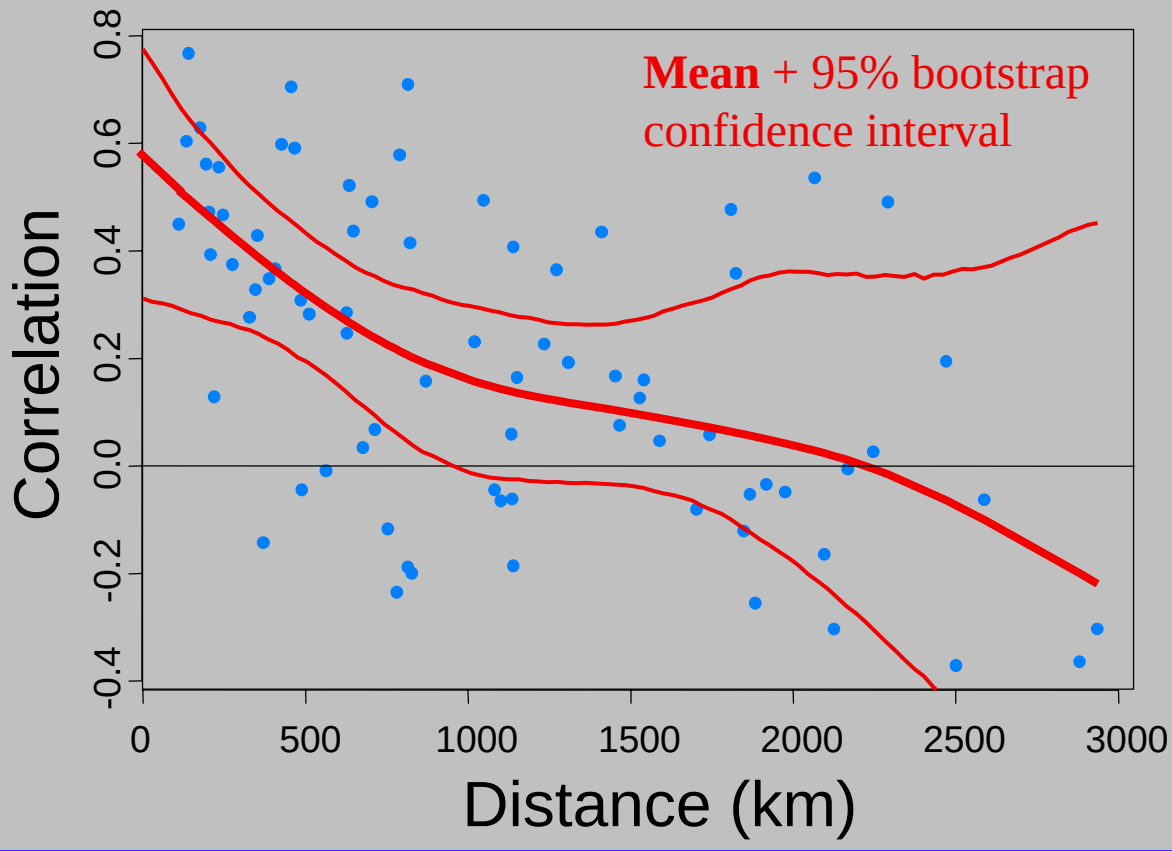
(from Pyper et al., in press)

Spatial scales of covariation: Herring

- Regional covariation in herring recruitment (Williams & Quinn 2000)

Spatial scales of covariation: Herring

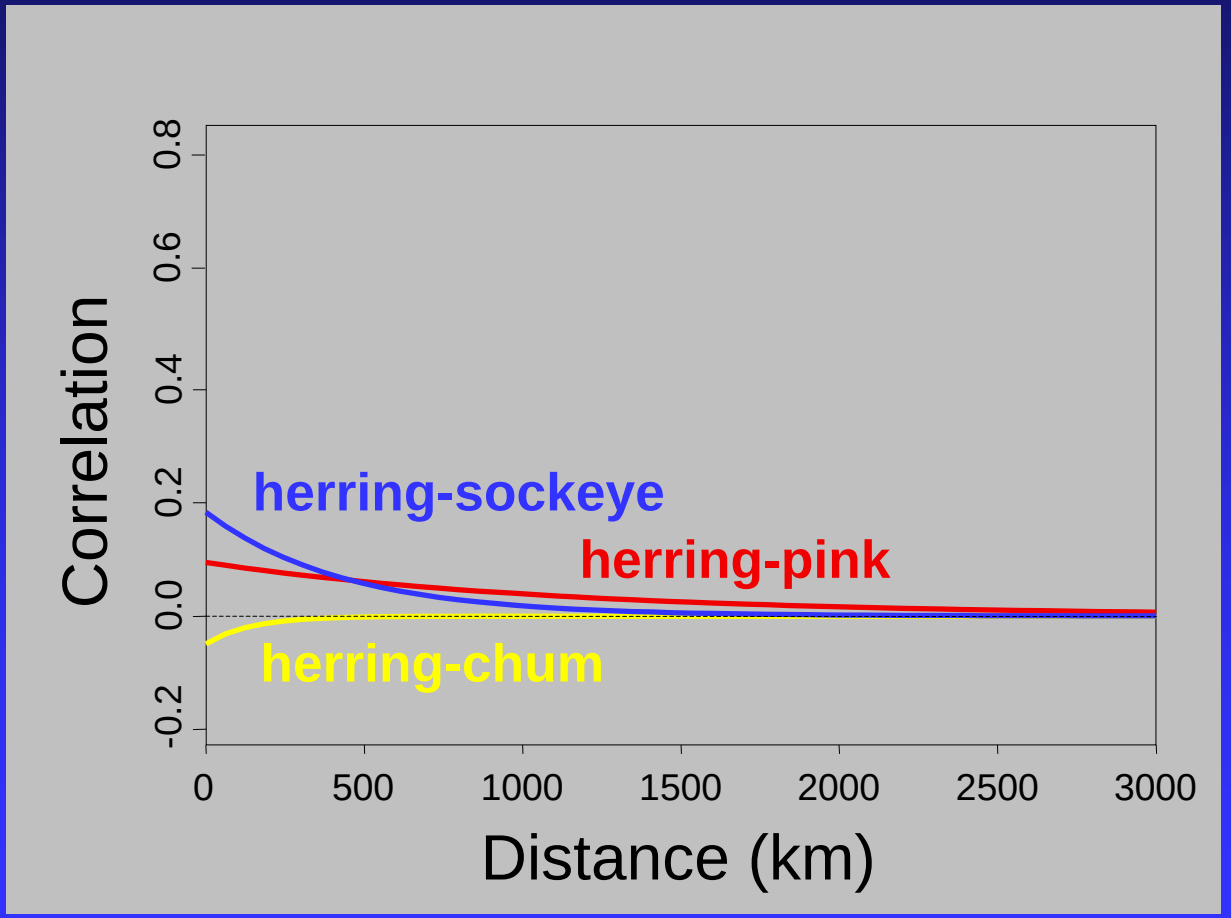
Pairwise correlations among 13 herring stocks



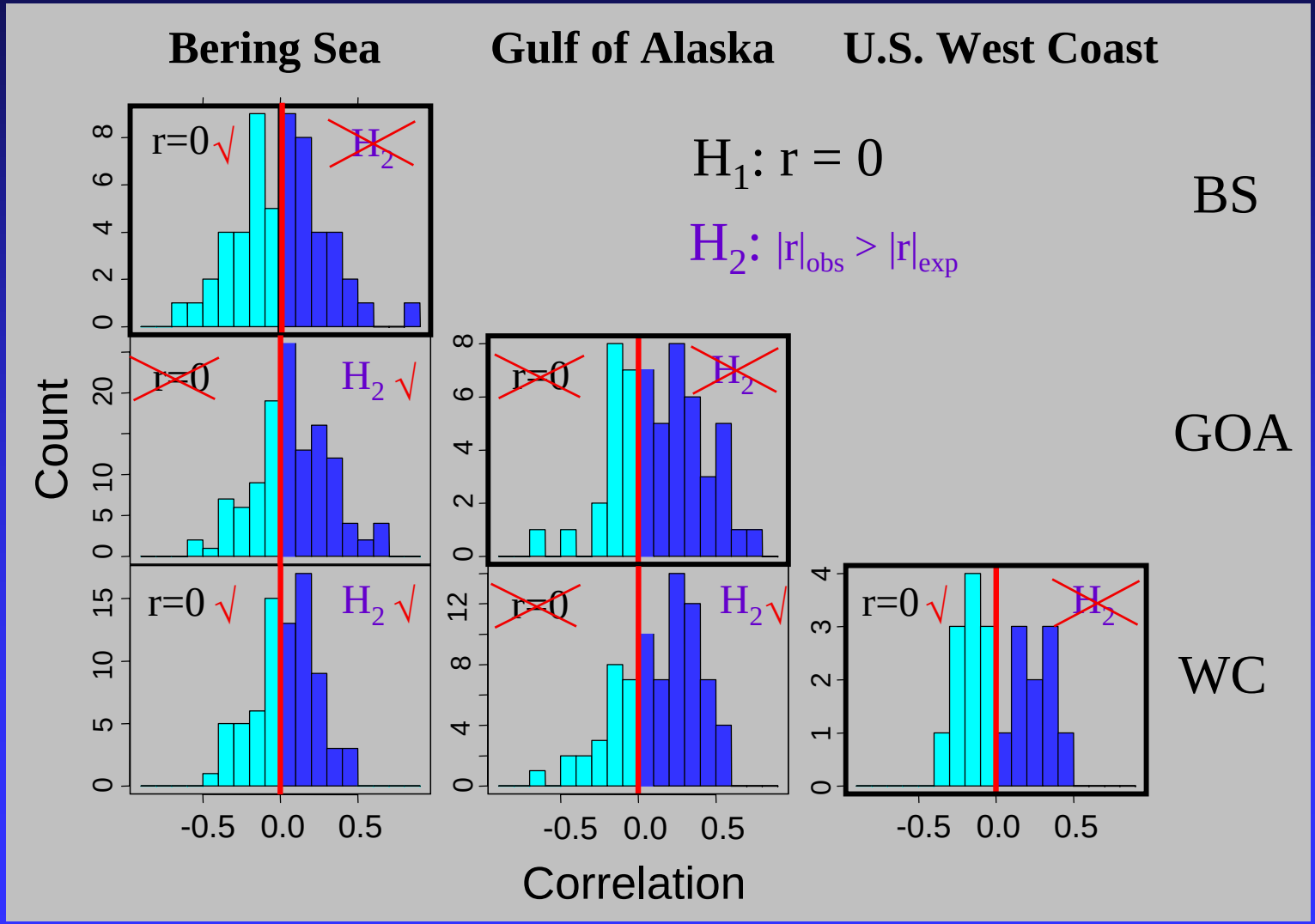
Spatial scales of covariation: Herring

- Regional covariation in herring recruitment (Williams & Quinn 2000)
- No significant covariation between herring and salmon

Spatial scales of covariation: Herring vs. salmon



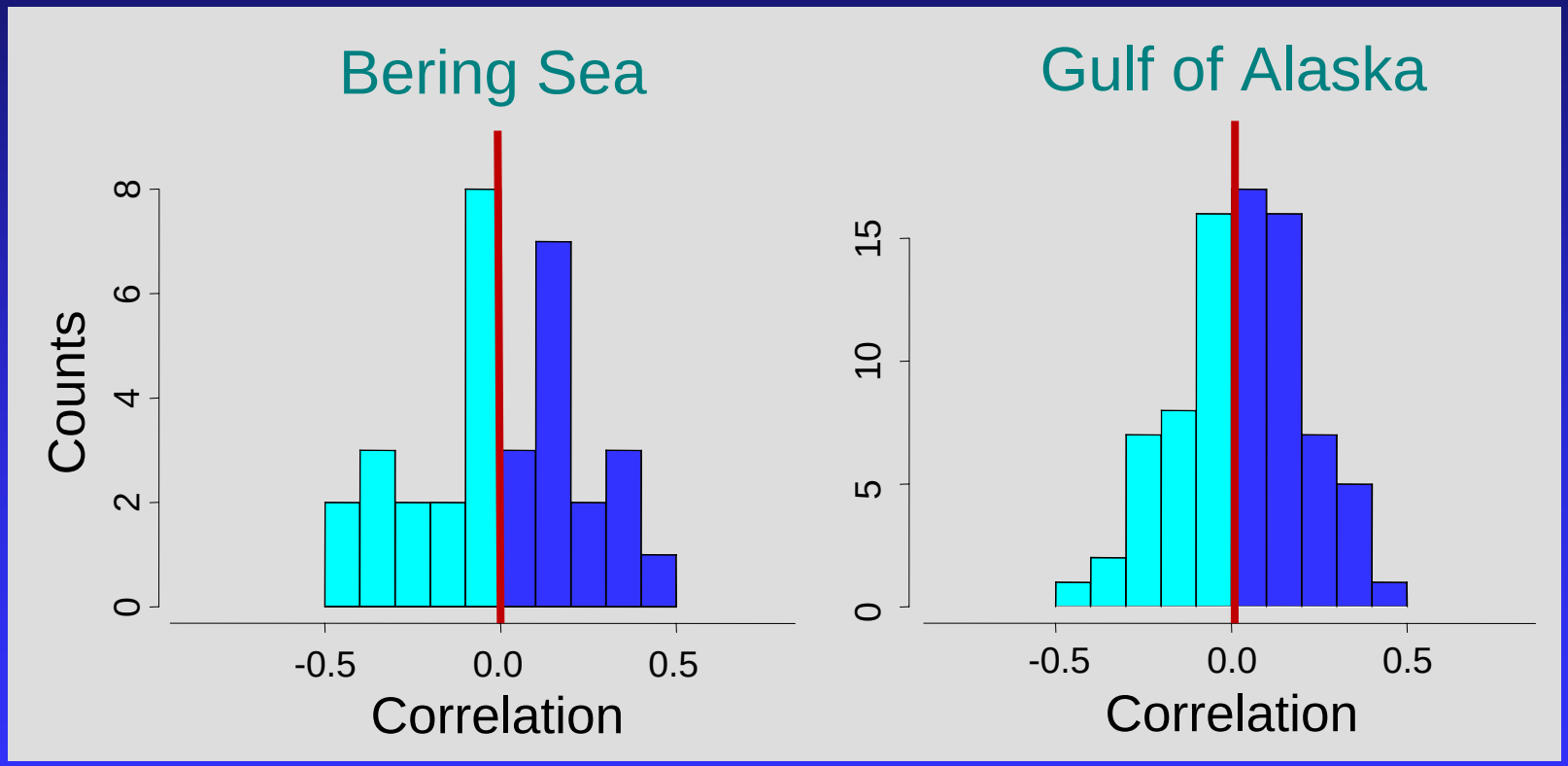
Correlations among SR residuals within and between regions



Correlations by species

- Bering Sea vs. Gulf of Alaska
  - Walleye pollock: - 0.021
  - Pacific cod 0.026
  - Arrowtooth flounder - 0.249
  - Flathead sole - 0.003
  - Pacific Ocean Perch **0.464 (p = 0.061)**
- Gulf of Alaska vs. West Coast
  - Pacific Ocean Perch - 0.030

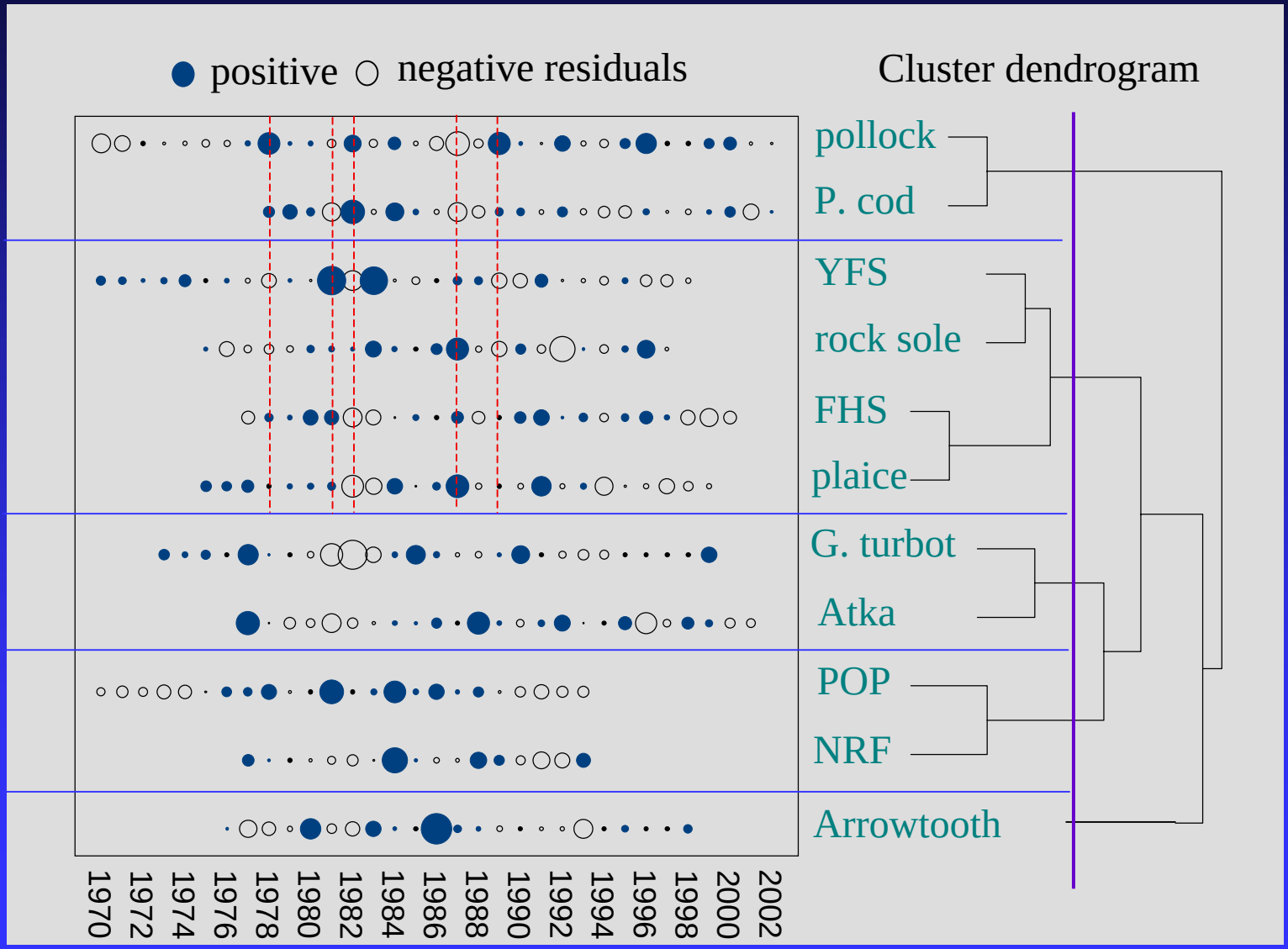
Covariation: demersal vs. pelagic



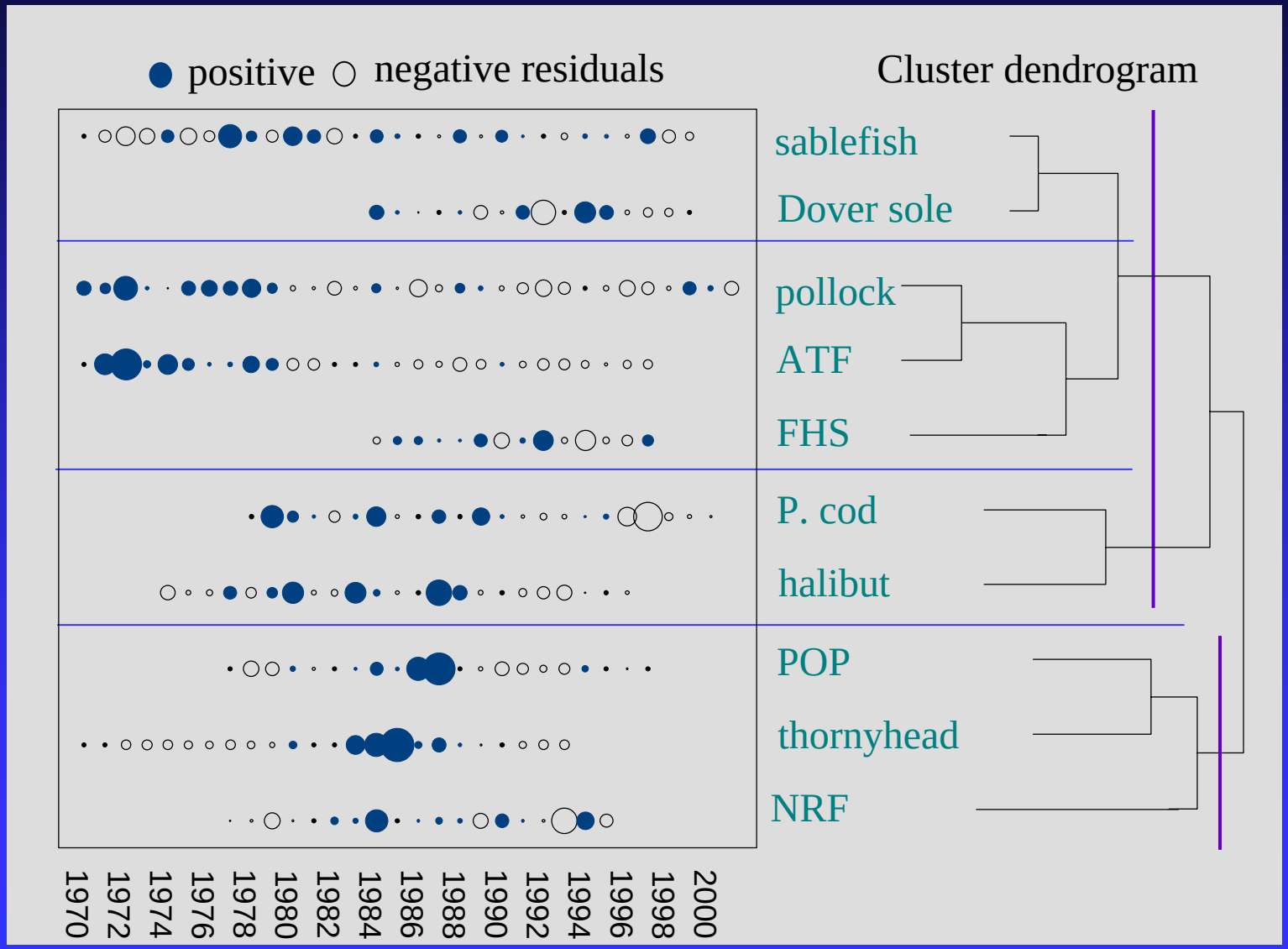
Covariation patterns among survival rates of groundfish populations

- Cluster analysis to identify groups of covarying populations within each region
- Patterns of variation in key groups

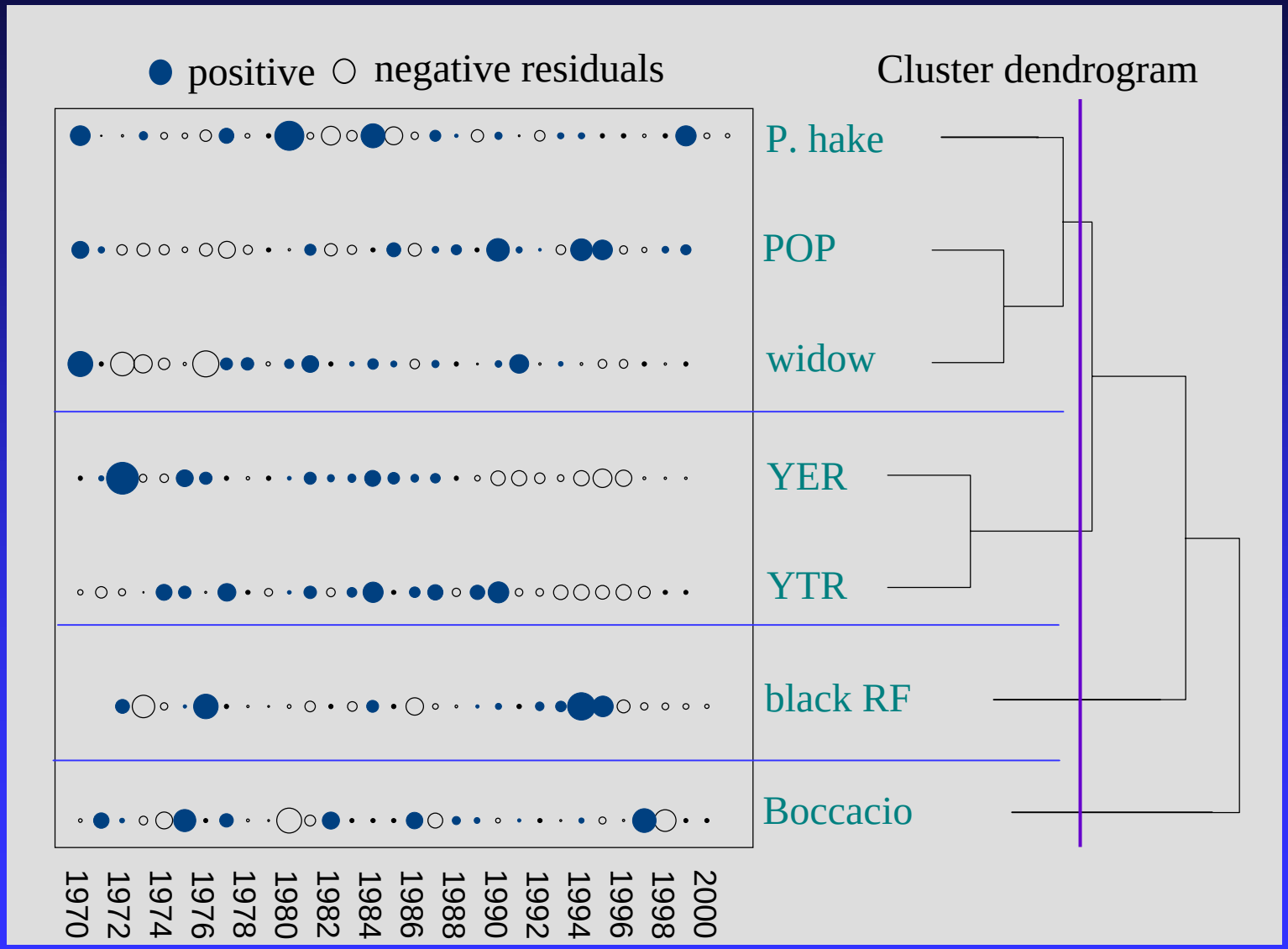
Cluster dendrogram based on stock-recruit residuals: Bering Sea



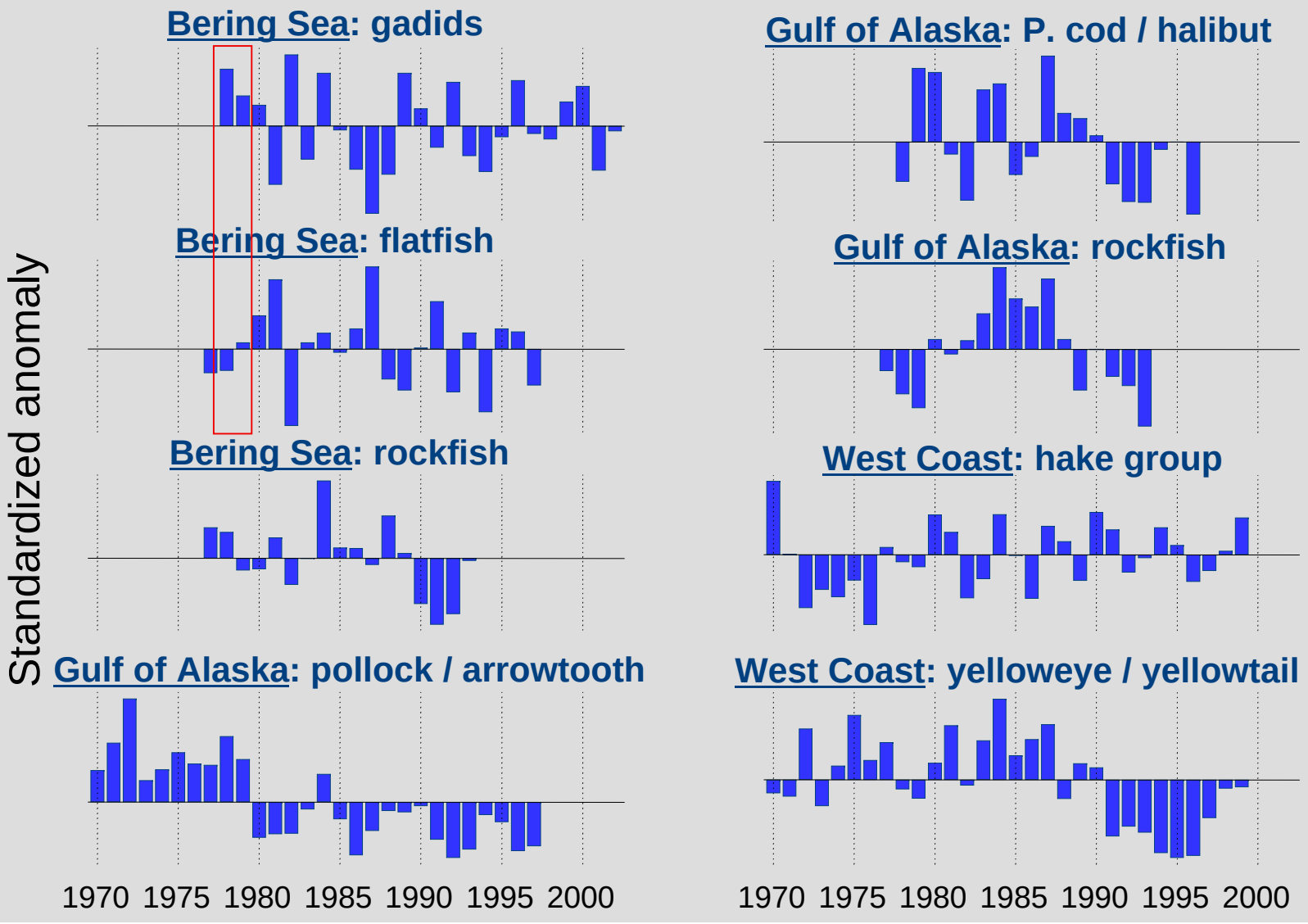
Cluster dendrogram based on stock-recruit residuals: Gulf of AK



Cluster dendrogram based on stock-recruit residuals: West Coast



Standardized stock-recruit residuals aggregated by major species groups



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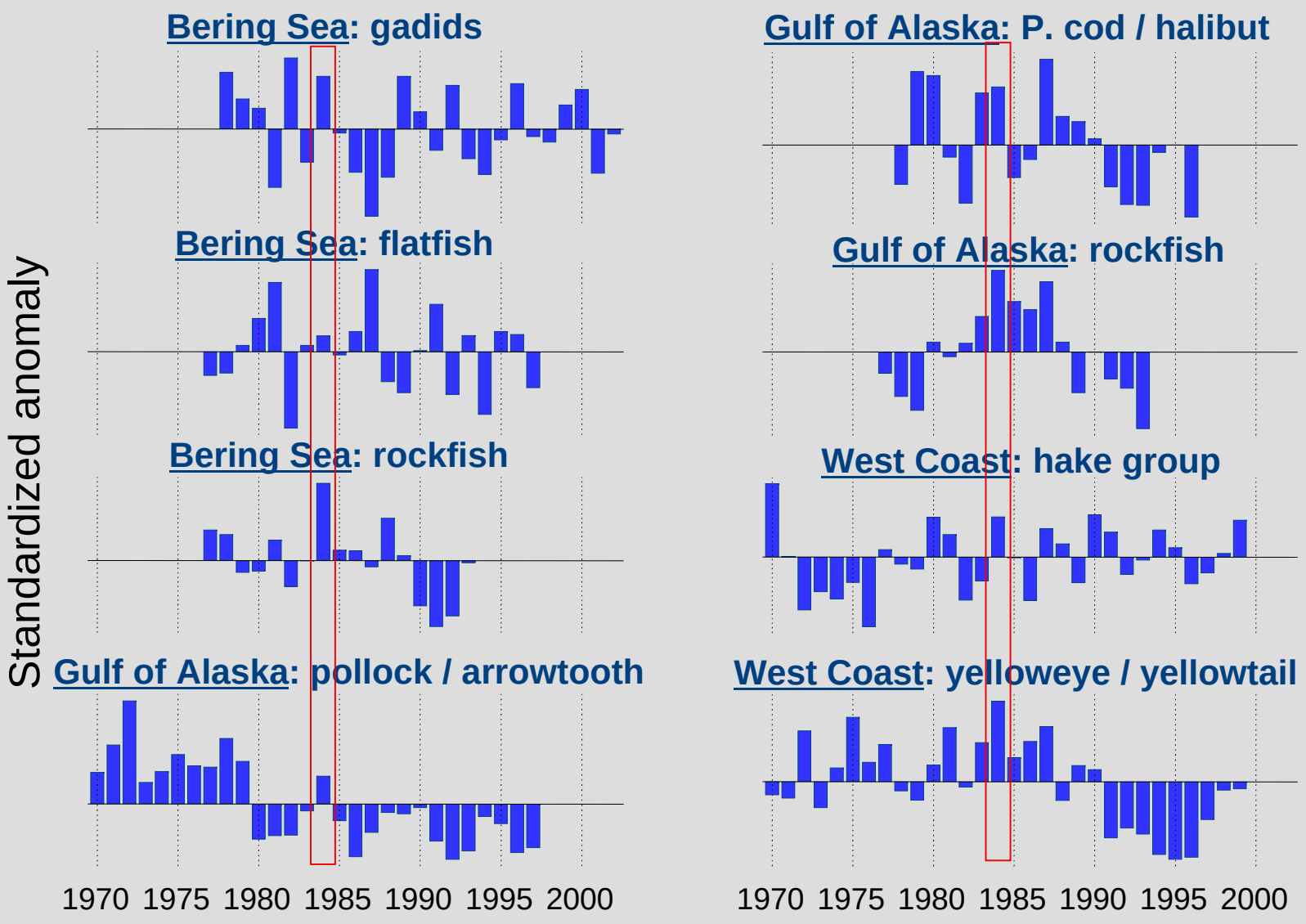

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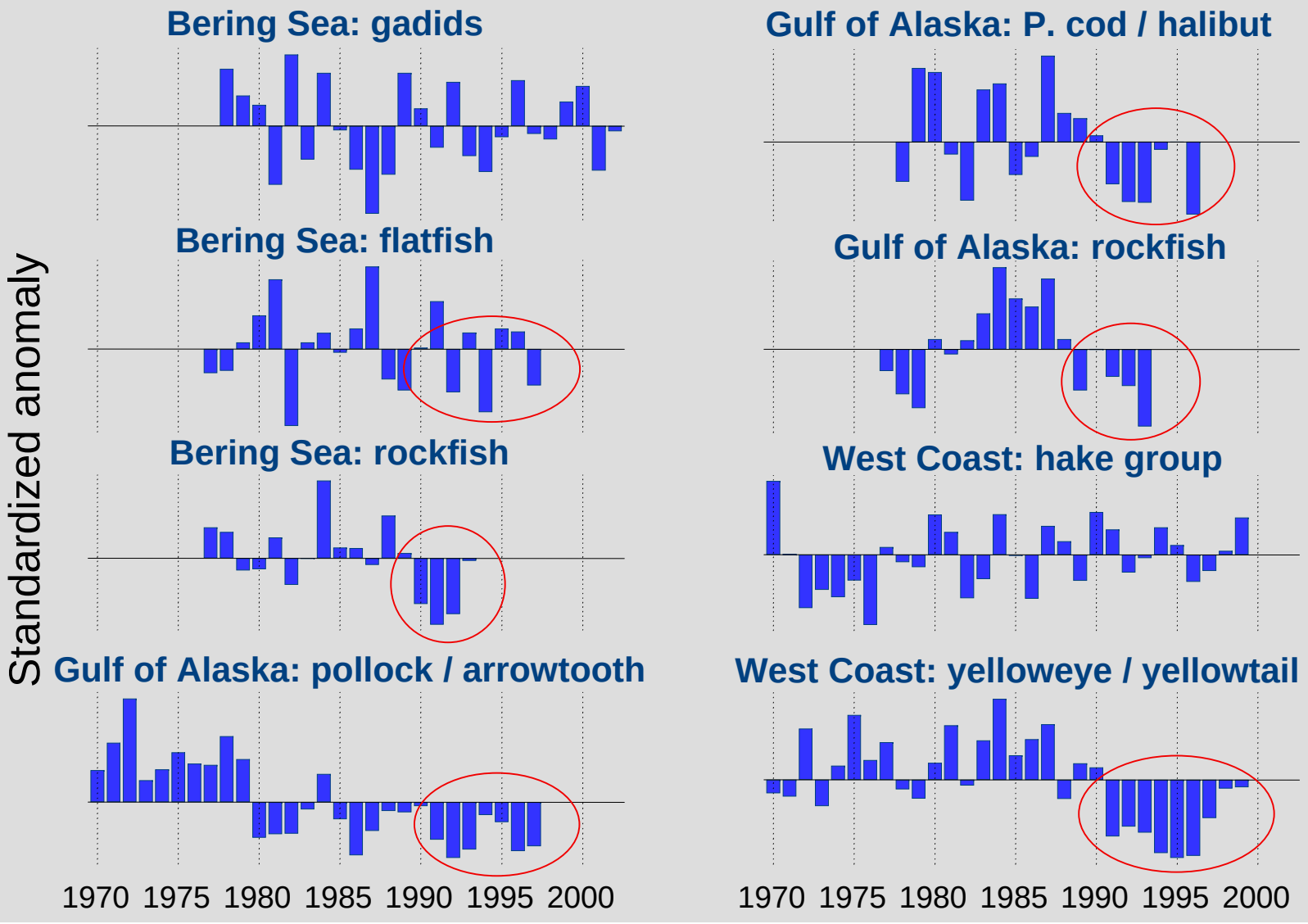
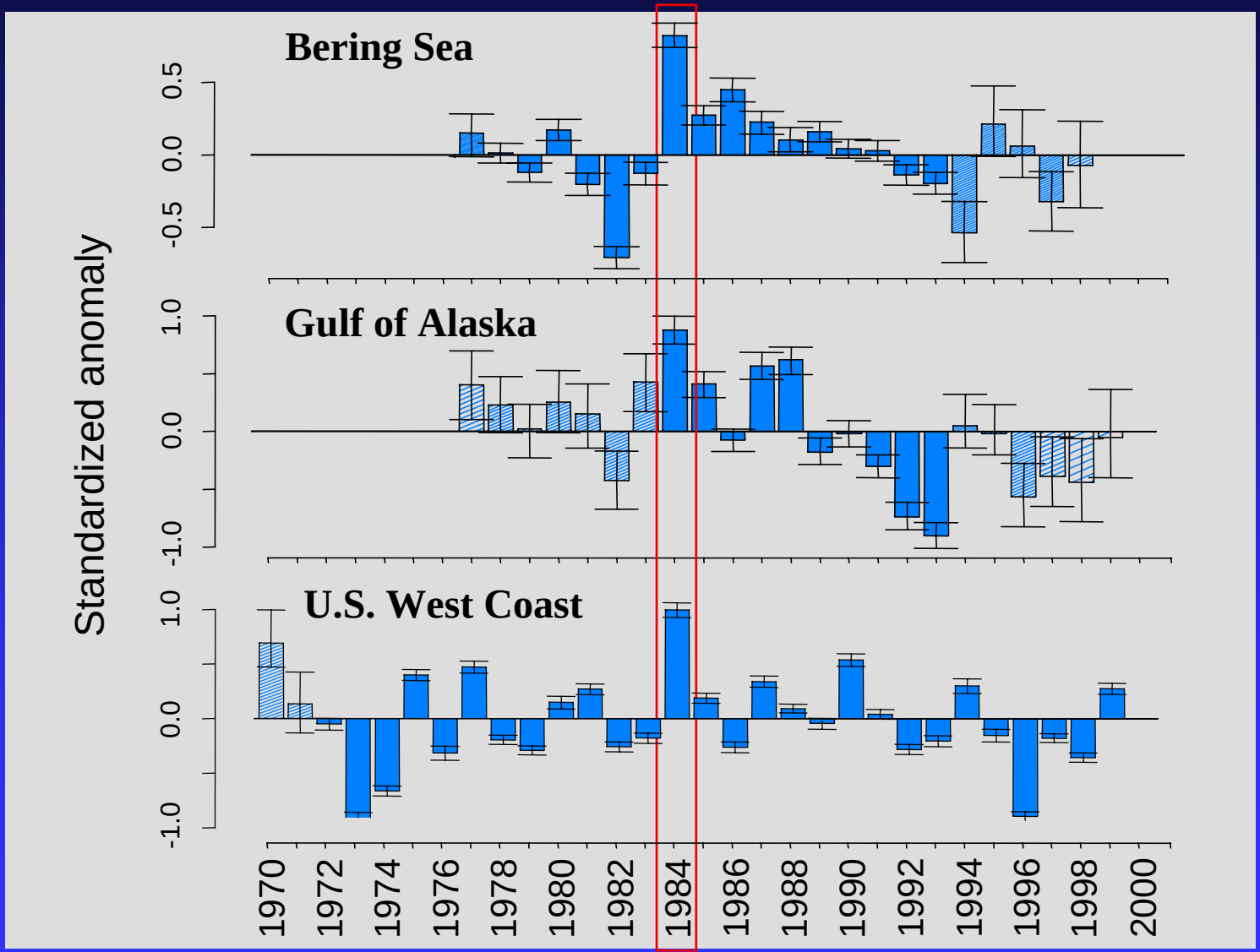
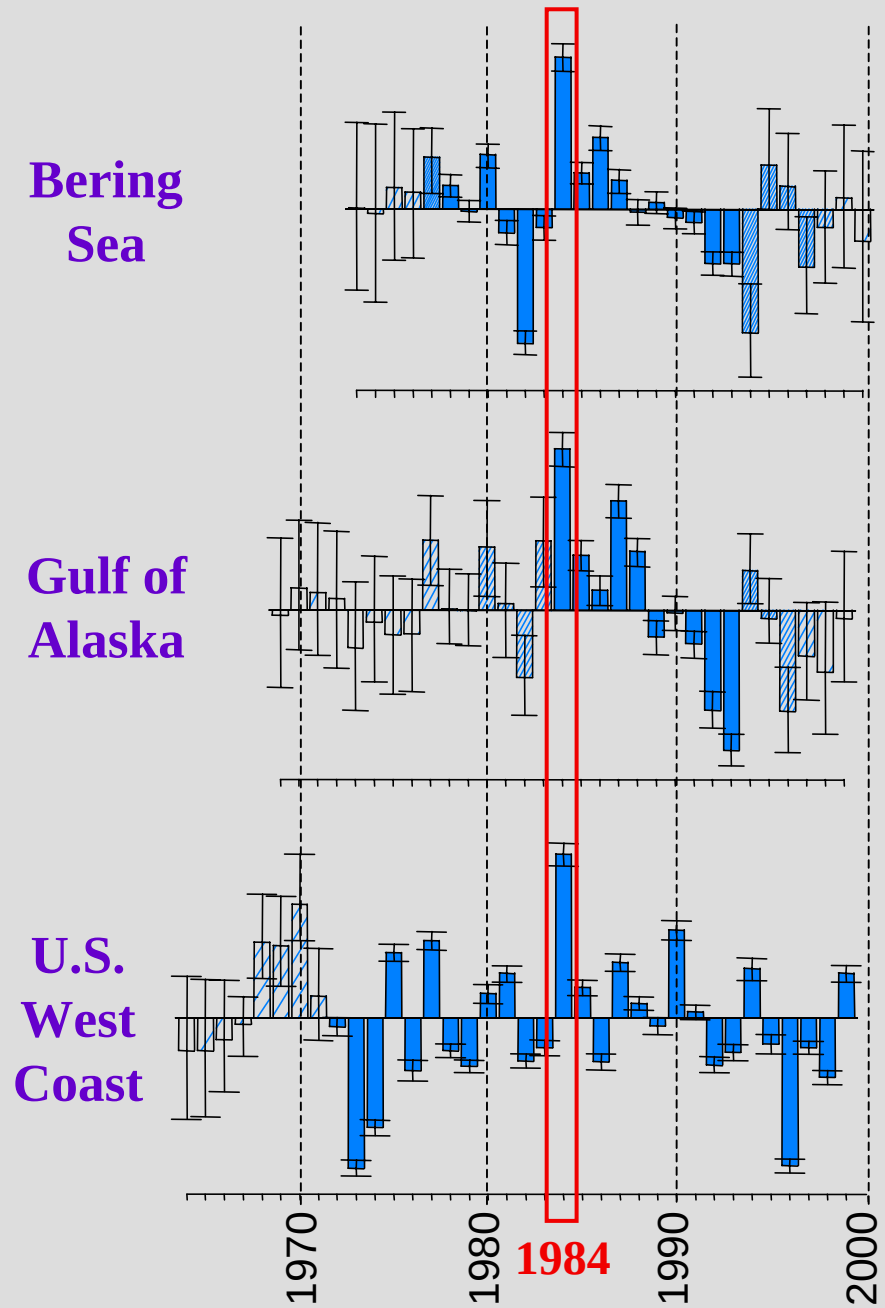


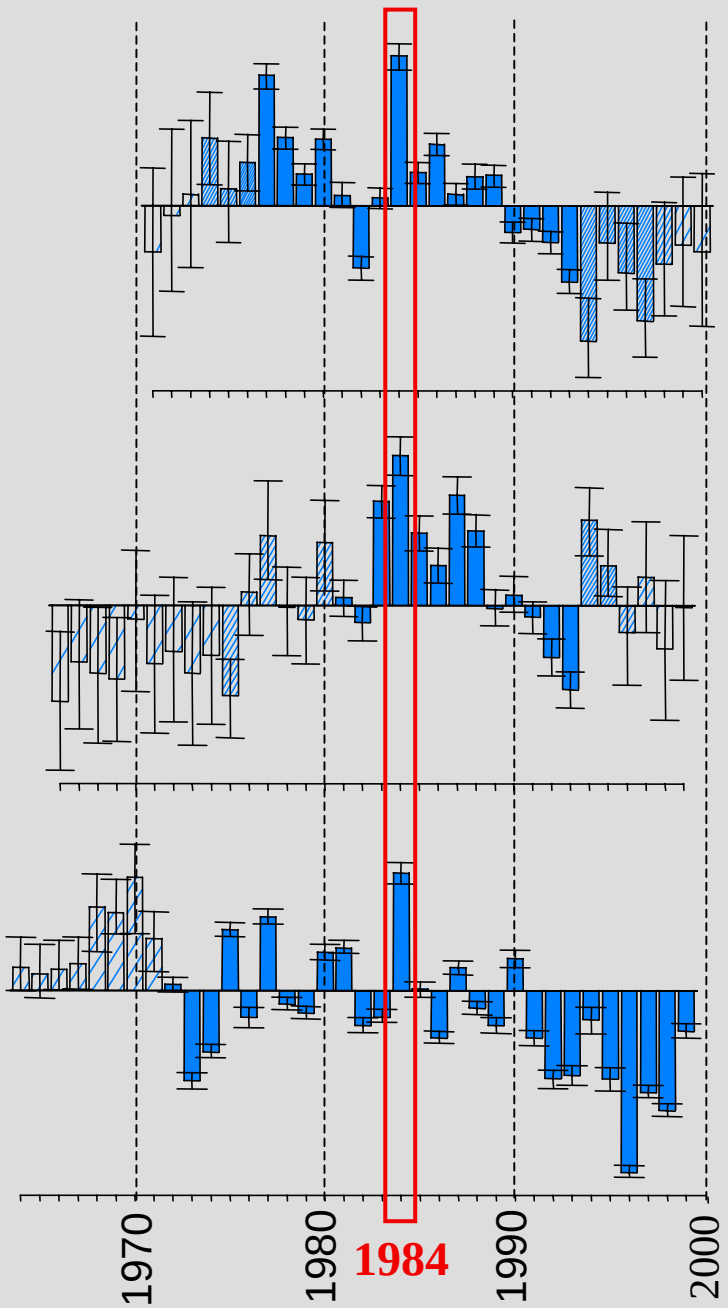
Combined standardized indices across all groundfish stocks by region



Combined Survival Rate Index



Combined Recruitment Index



Conclusions

- Studies of effects of climate on (long-lived) fish populations should focus on variability in survival rates
  - Some variability in recruitment and most variability in abundance / biomass results from internal dynamics and species interactions
    - Stock assessment can capture internal dynamics
    - Multi-species / ecosystem models required to account for interactions
    - Internal dynamics and interactions tend to reinforce and enhance “regime-like” patterns (regardless of environment)
  - Interannual variability in survival rates provides link to climate

Conclusions

- Covariation in survival rates primarily linked to regional-scale effects (not basin-wide patterns)
  - Stronger positive or negative covariation within regions
  - Groups of related species (similar life history / habitat) respond similarly to regional-scale climate variability. Examples include:
    - Opposite effects of ice conditions on gadids and shallow-water flatfish in Bering Sea
    - Effects of freshwater discharge on GoA stocks
    - Effects of spring transition / upwelling on west coast stocks

Conclusions

- Apparent large-scale climate effects on fish stocks act through their impacts on regional-scale oceanographic variability
  - Correlations with large-scale indices may be useful in predictions, but account for small percentage of overall variability in survival
  - Predictive power increases when region-specific indices are used