Drivers of recruitment dynamics in northeast Atlantic pelagic fish stocks

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Small pelagics symposium

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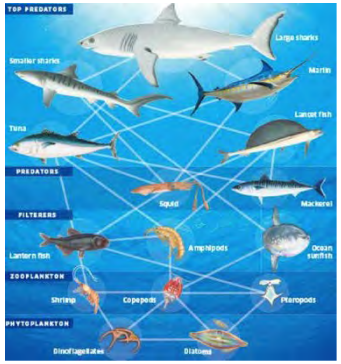
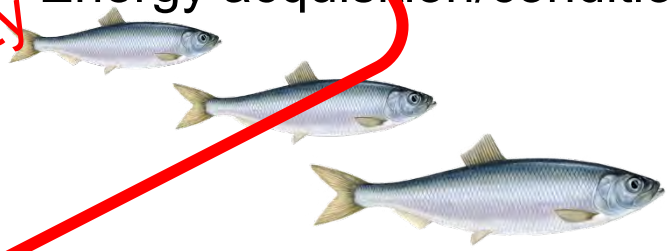
Recruitment dynamics

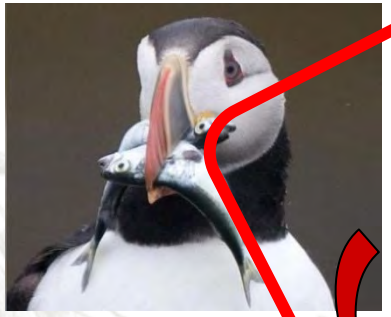


Food web interactions

Stock composition
Life history
Energy acquisition/condition



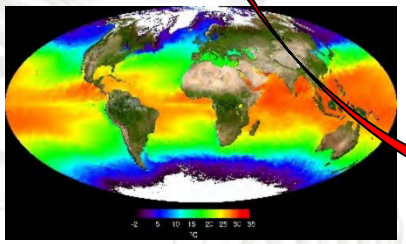
Spatio-temporal variability on varying scales

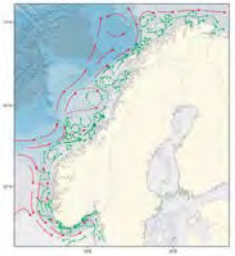


Environmental change

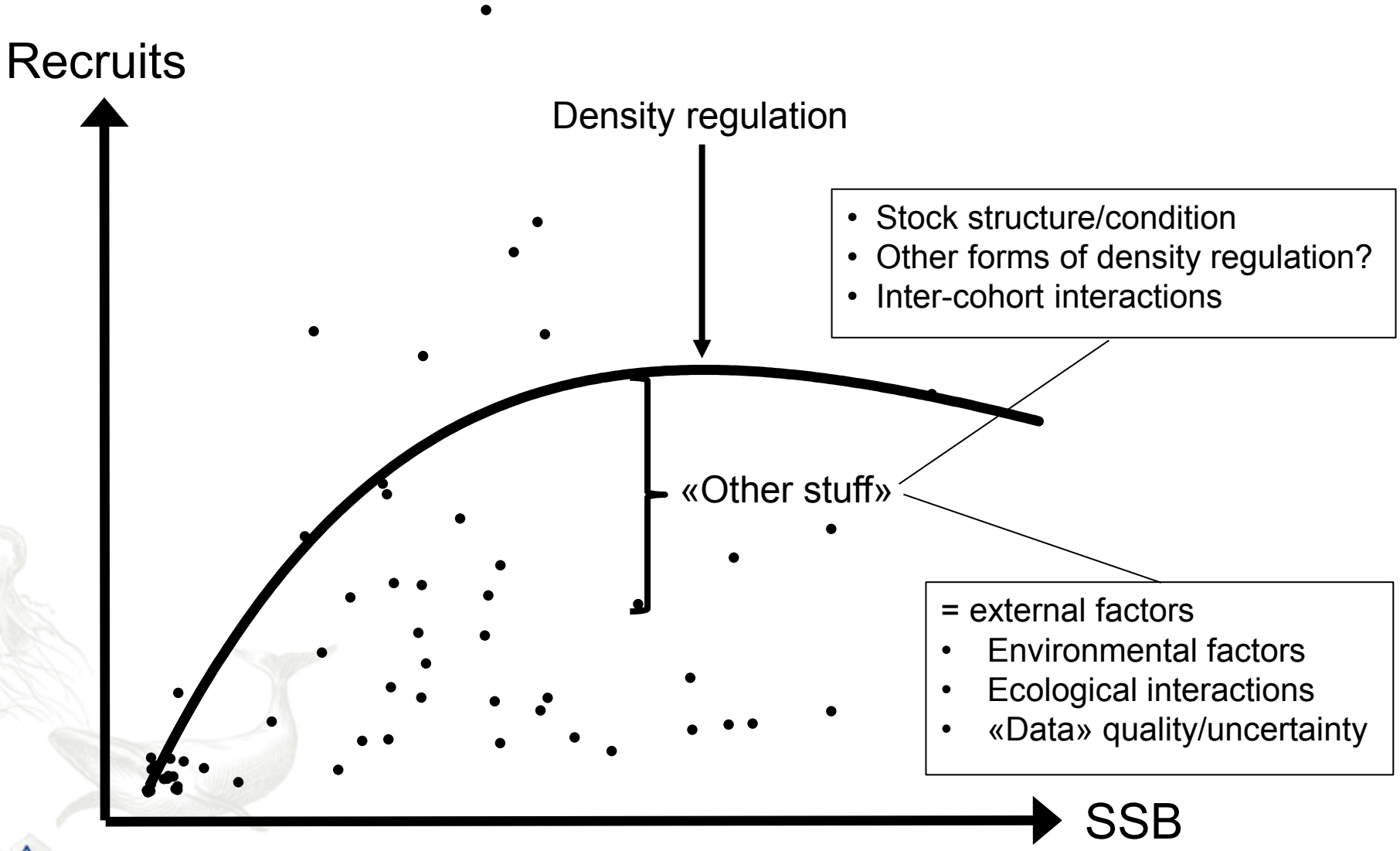
Food availability
Predation
Turbidity
Salinity
Oxygen
Temperature
Transport

Ocean circulation and climate





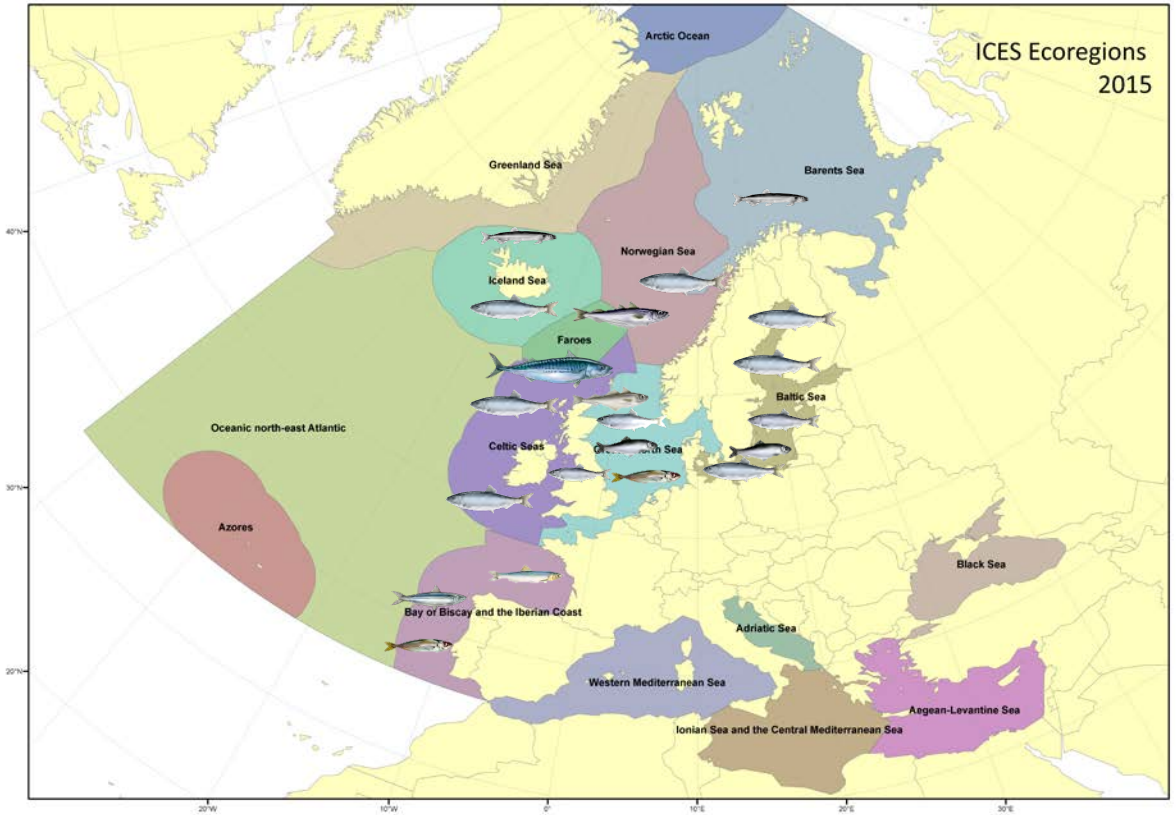
Stock-recruitment relationship



Approach

Approximating a solution to recruitment dynamics from different angles:

1. Comparative analysis of density-dependent growth/ recruitment
2. Autocorrelation analysis of recruitment residuals
3. Correlation analysis with abiotic and biotic factors
   - Based on literature review of suggested drivers



Data: 22 stocks from NE Atlantic

Anchovy (Bay of Biscay)
Atlantic herring:

- Celtic Sea/South of Ireland
- West of Scotland
- Irish Sea
- Iceland
- North Sea
- Norwegian spring spawners
- Western Baltic spring spawners
- Eastern Baltic
- Gulf of Riga
- Bothnian Sea
- Bothnian Bay

Atlantic mackerel
Blue whiting
Capelin

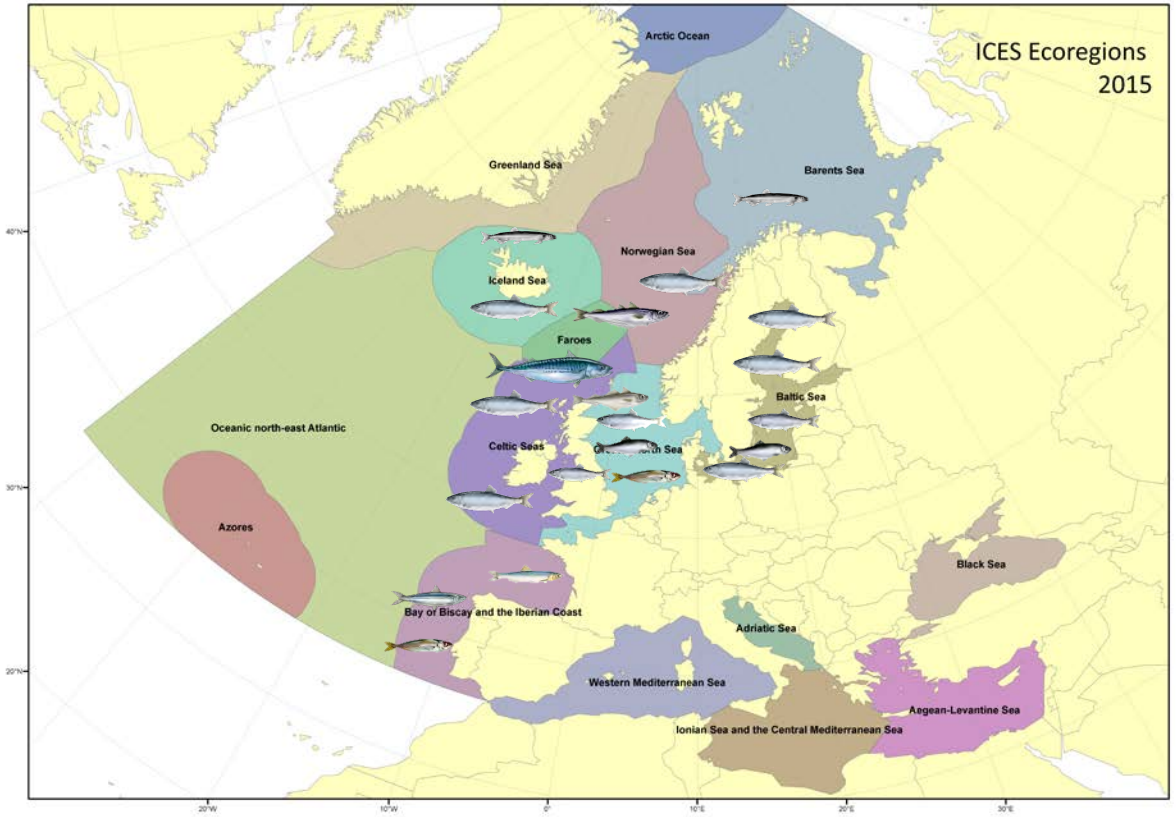
- Barents Sea
- Iceland

Horse mackerel:

- Western stock
- Southern stock

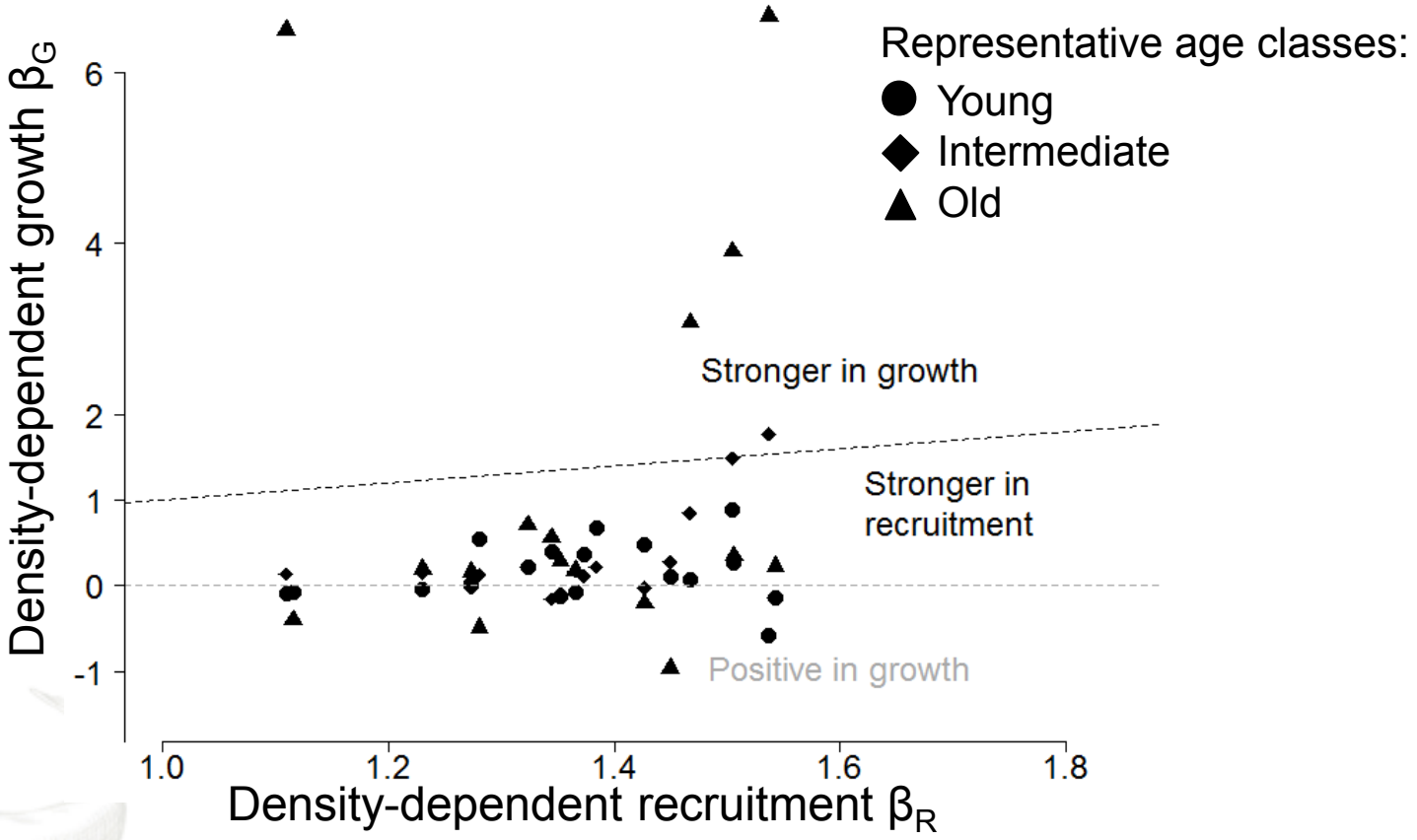
Norway pout
Sardine
Sprat

- Baltic Sea
- North Sea



Density-dependent growth vs. recruitment

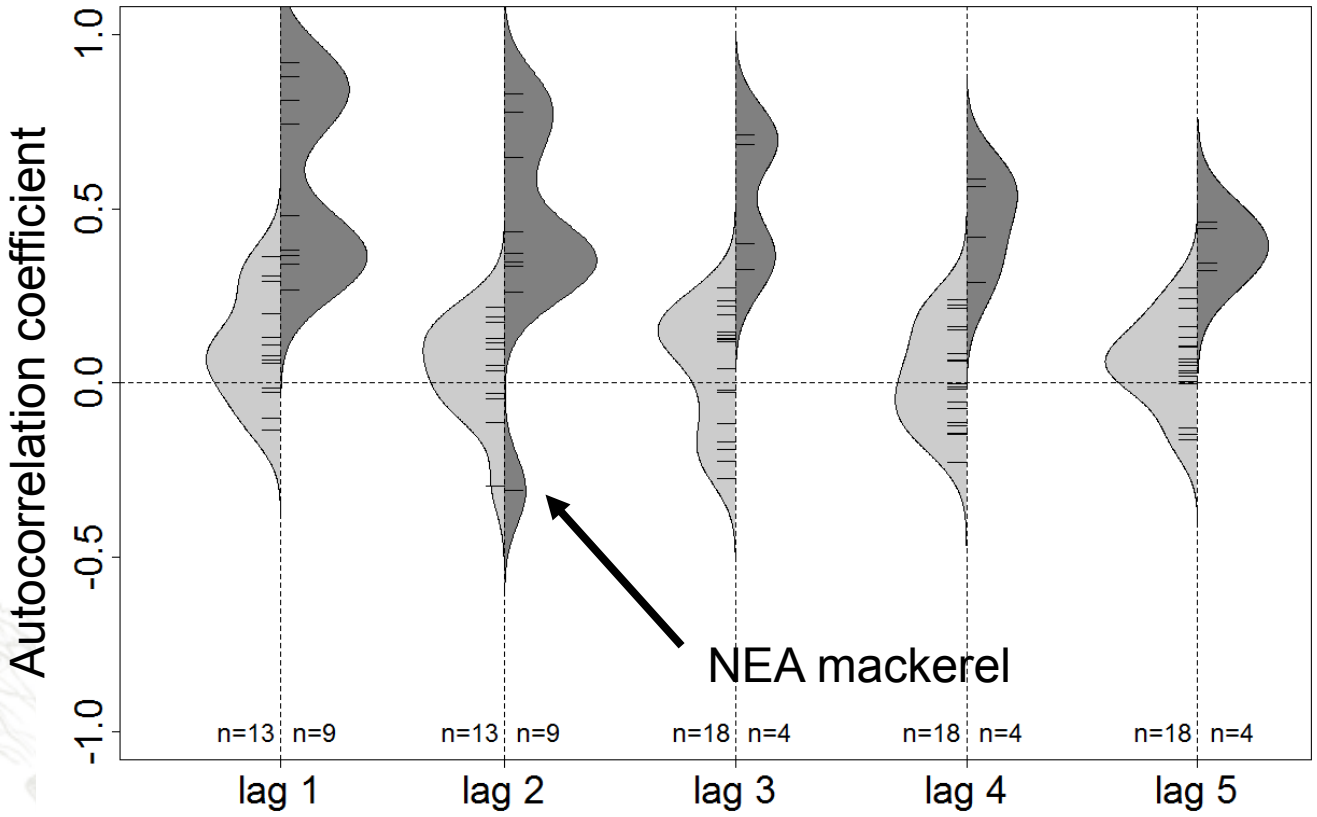
Estimating comparable parameters for growth increments/recruitment

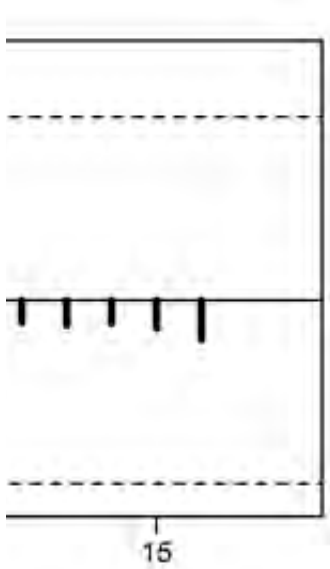


- Both forms of density regulation present in most stocks
- Density-dependent recruitment > growth
- Implications? Interactions? Common drivers?

Inter-cohort interactions

Autocorrelation in recruitment residuals at different time lags





Ricard, Zimmermann & Heino. 2016

- Few and weak negative autocorrelation
- Positive autocorrelation: Ageing issues vs. external drivers?
- Common patterns among stocks?

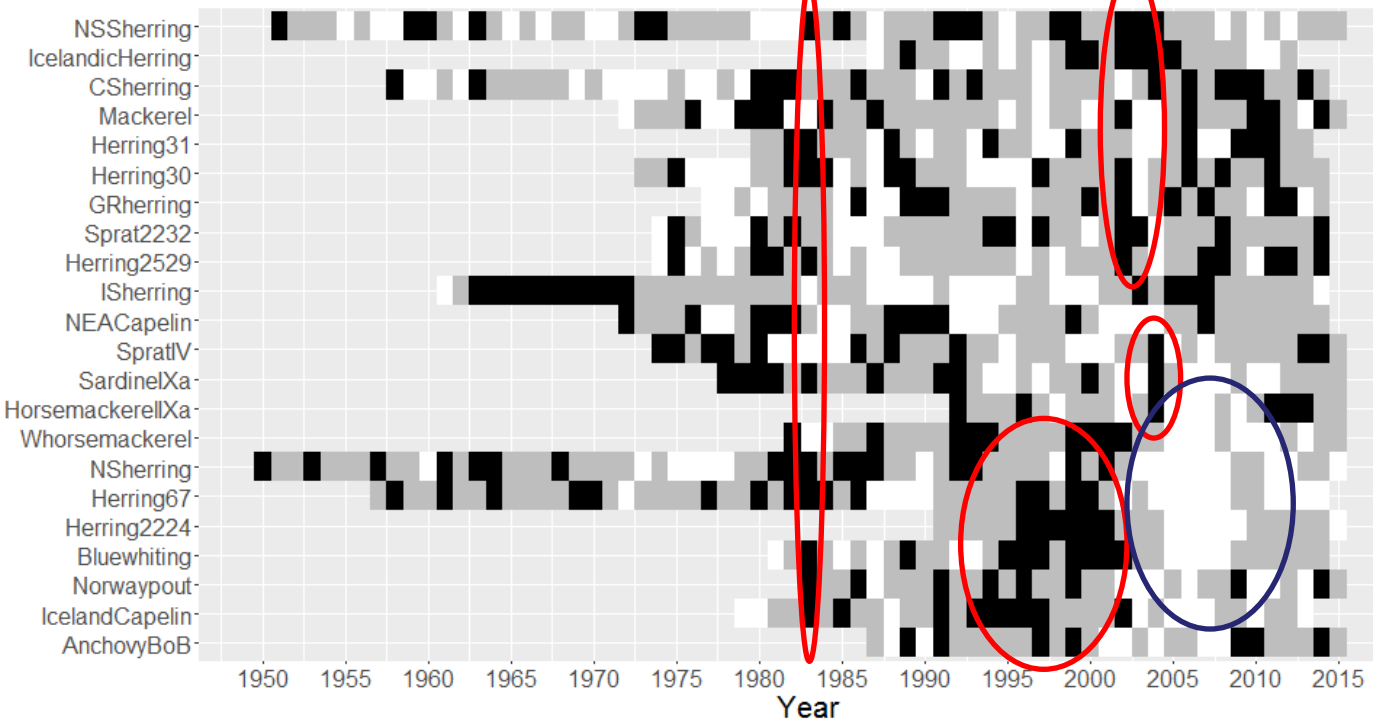
Synchrony in recruitment variability?

Strong (>75% quantile of residuals)

Average (25-75% quantile of residuals) year classes

Weak (<25% quantile of residuals)

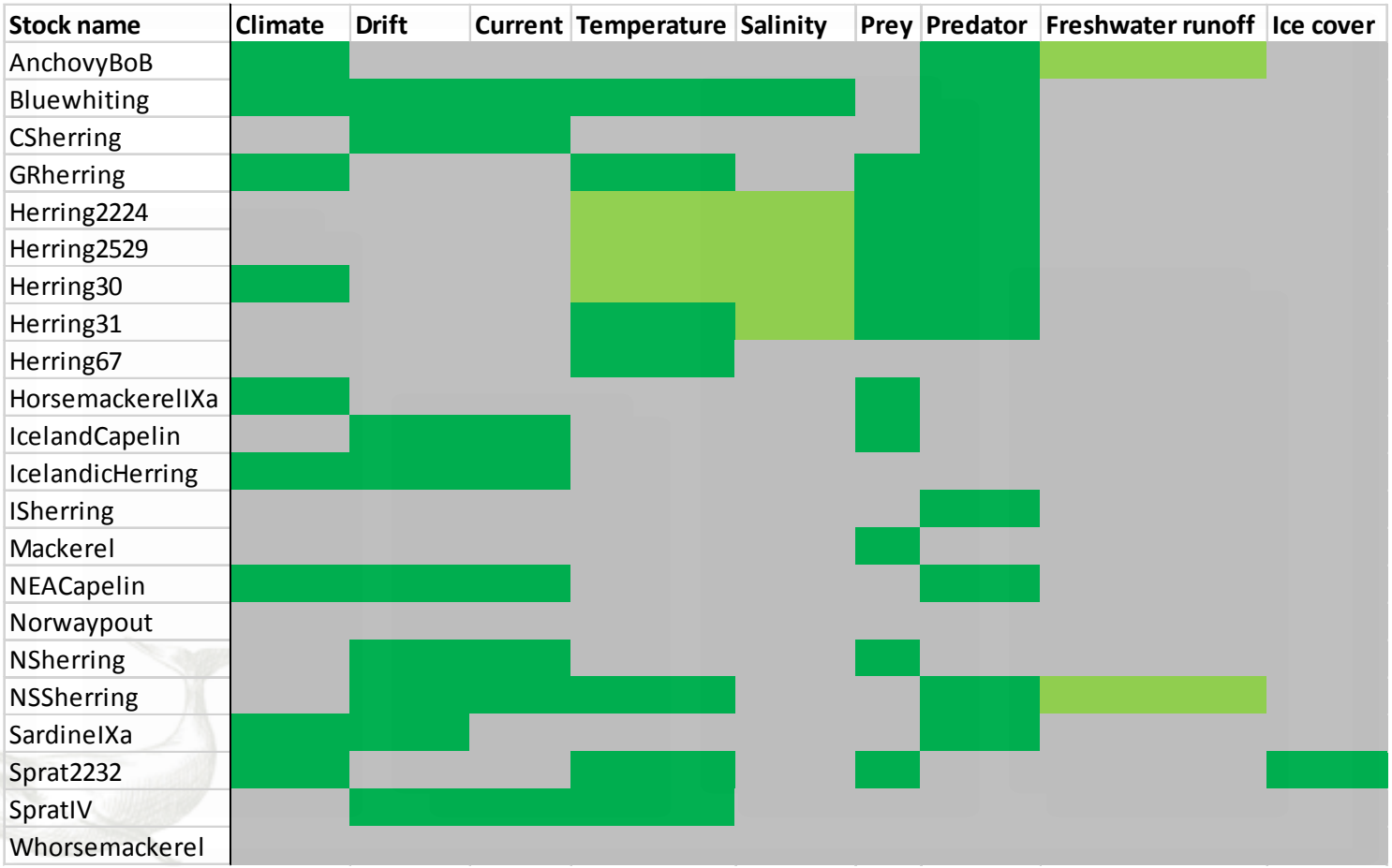
Ordered by clustering



- Qualitative patterns: common years of strong/weak year classes
- However: no real synchrony, few and spurious correlations
- Does not refute common underlying patterns

Back to the roots

Influence known/suggested, possible, not known in literature



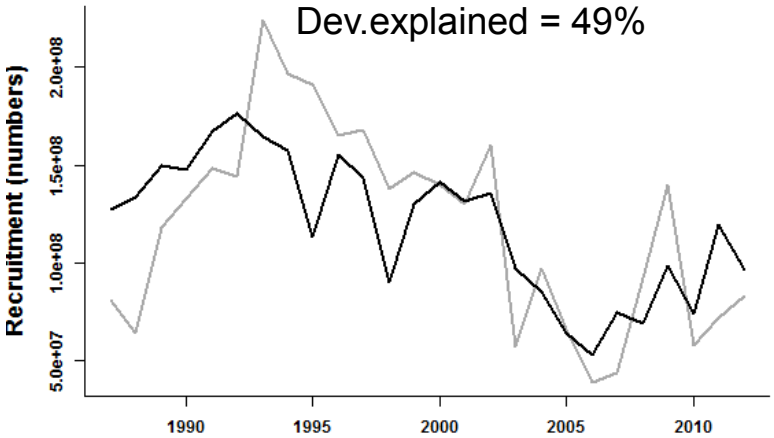
Correlation analysis

Total recruitment

Recruitment residuals

Icelandic Capelin

AMO + Icelandic Herring SSB
Dev.explained = 49%



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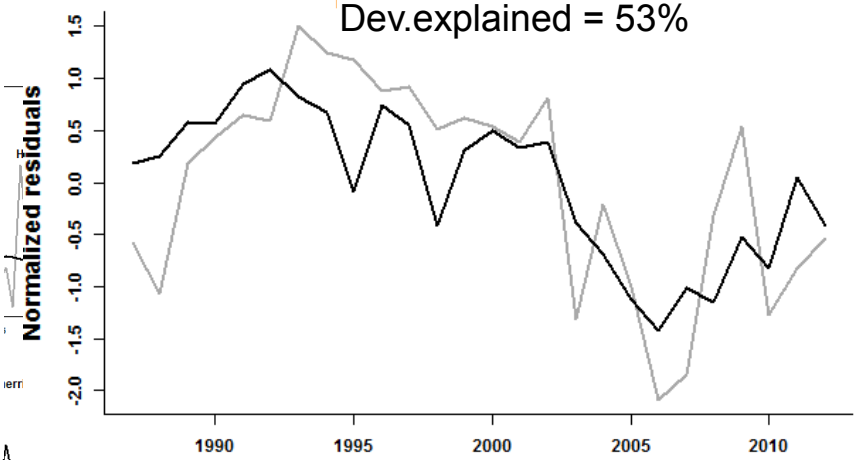
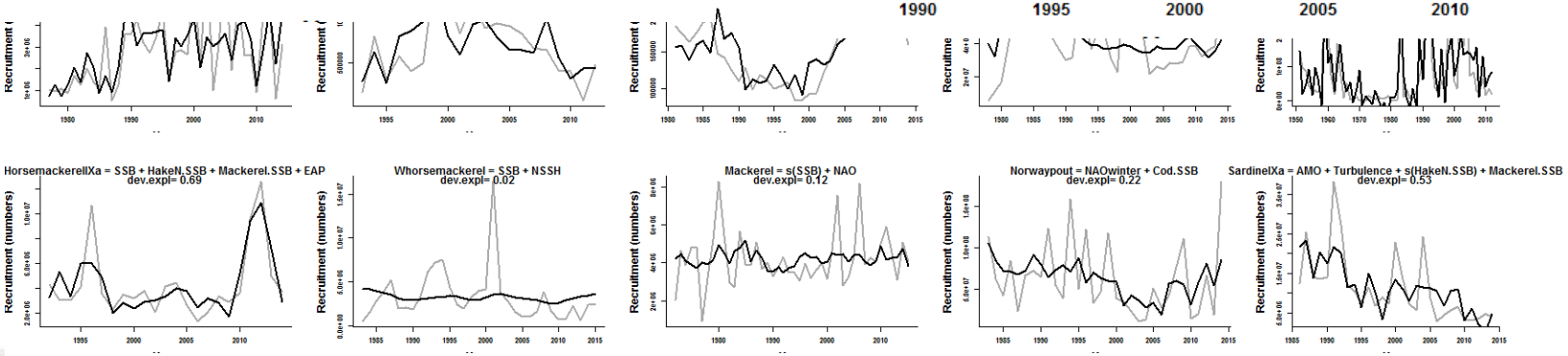
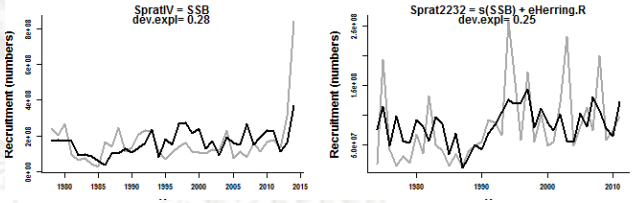
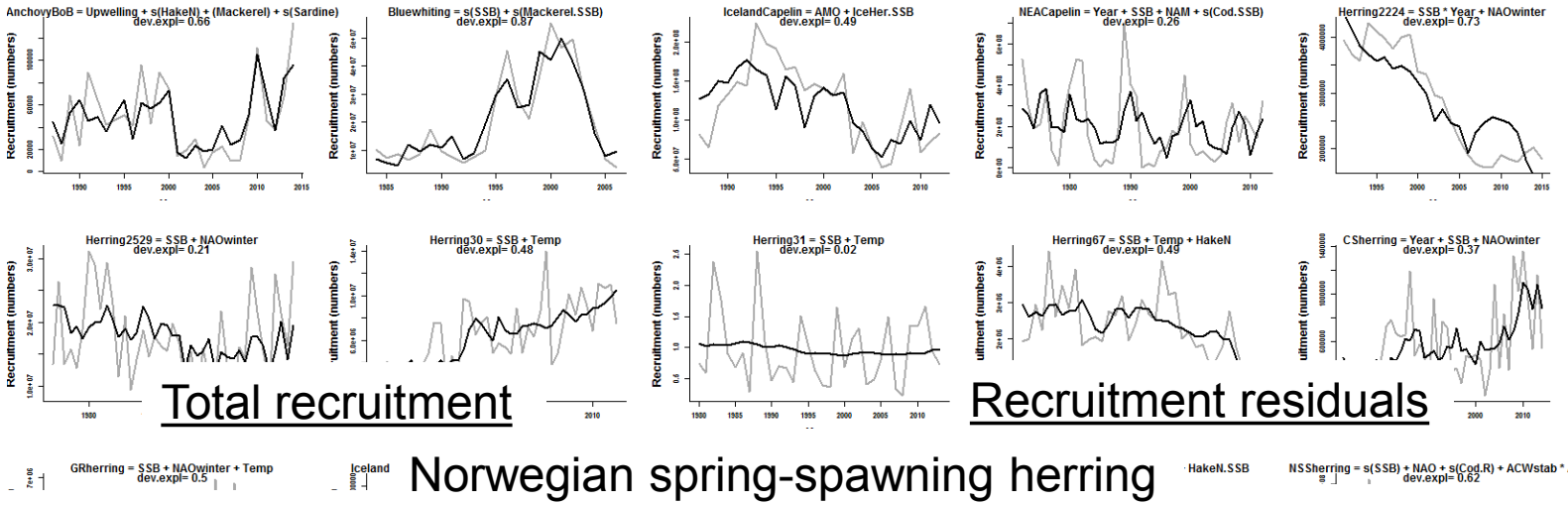






Correlation with environmental factors



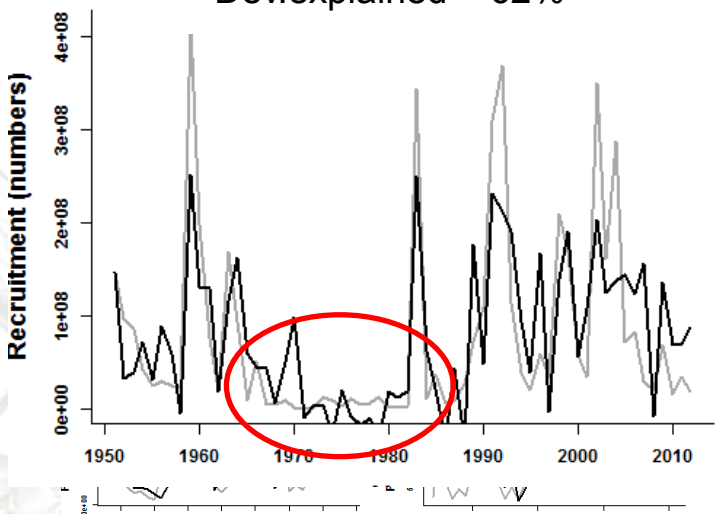
Total recruitment

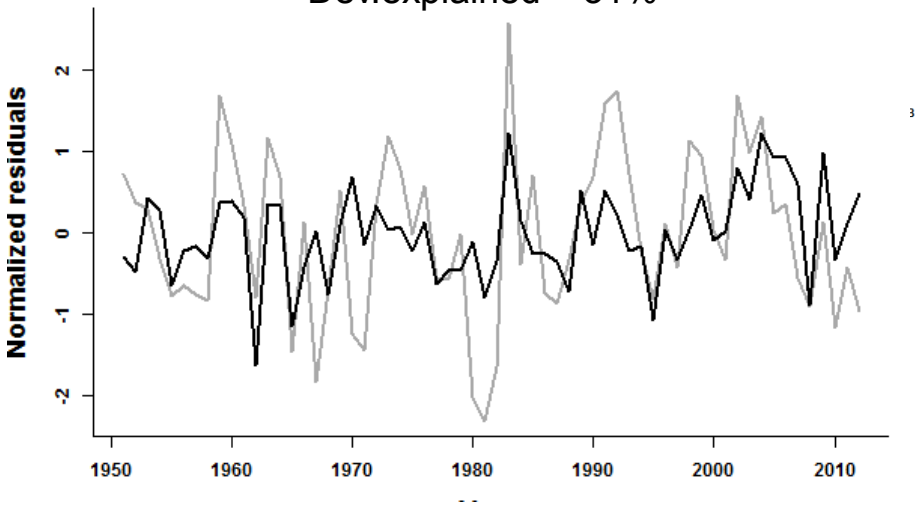
Recruitment residuals

Norwegian spring-spawning herring

s(SSB)+s(Cod recruitment) + T + ACW strength*stability
Dev.explained = 62%

Cod recruitment + T + ACW strength*stability
Dev.explained = 31%



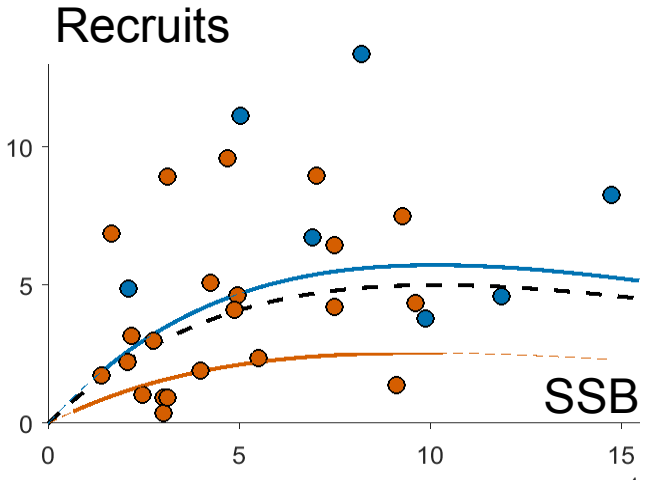


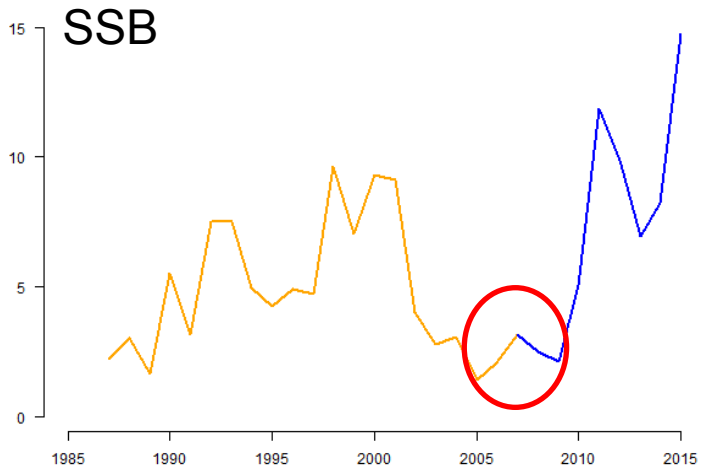
Collapses and regime shifts: temporal changes in recruitment drivers?

Temporal patterns and regime shifts

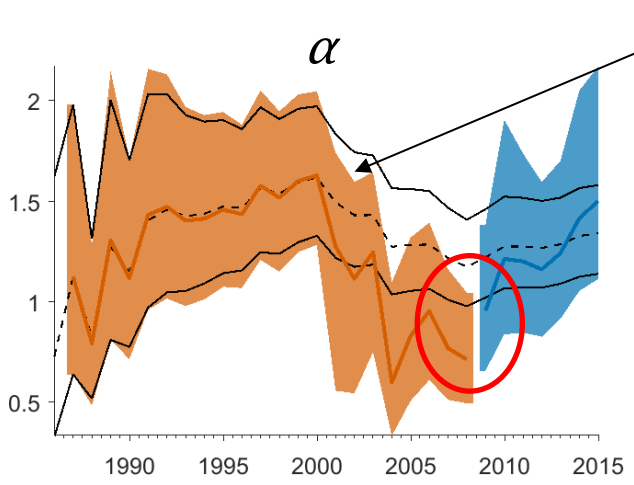
Bayesian switch-point models used to estimate temporal variability in stock-recruitment parameter and sudden changes («regime shifts»)

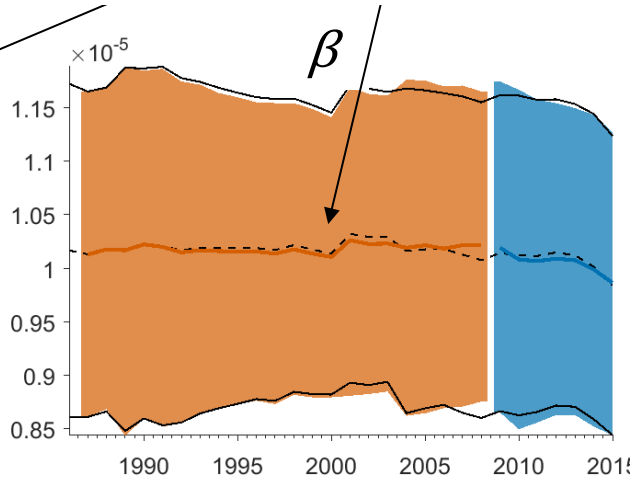
Example: Anchovy in Bay of Biscay





Ricker model parameters: $R = \alpha \cdot SSB \cdot e^{-\beta \cdot SSB}$





Collapse → changes in stock productivity → regime shift?

based on Perälä & Kuparinen 2016

Conclusion and outlook

- Density-dependent recruitment present in most pelagic stocks
  - Stronger than density-dependent growth
- Few and weak year class interactions
  - Indication for external forcing?
- Environmental/ecological drivers confirm (some) known relationships but also challenges
  - Relevance may vary over time and space

- Large scale vs. fine scale
  - Exploring further general variability and common events
  - Underlying variability patterns: linked to large-scale modes?
  - Increase spatio-temporal resolution (stock-recruitment and external drivers)
- Mechanisms? (correlation ≠ causality)
- Data issues and uncertainty?

Thank you!

Collaborators:

- Katja Enberg (Institute of Marine Research)
- Daniel Ricard (Fisheries & Oceans Canada)
- Mikko Heino (University of Bergen)
- Tommi Perälä (University of Helsinki)
- Marion Claireaux (Institute of Marine Research)