Life history spatial constraints and species adaptability to climate change

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PICES, November 10, 2016

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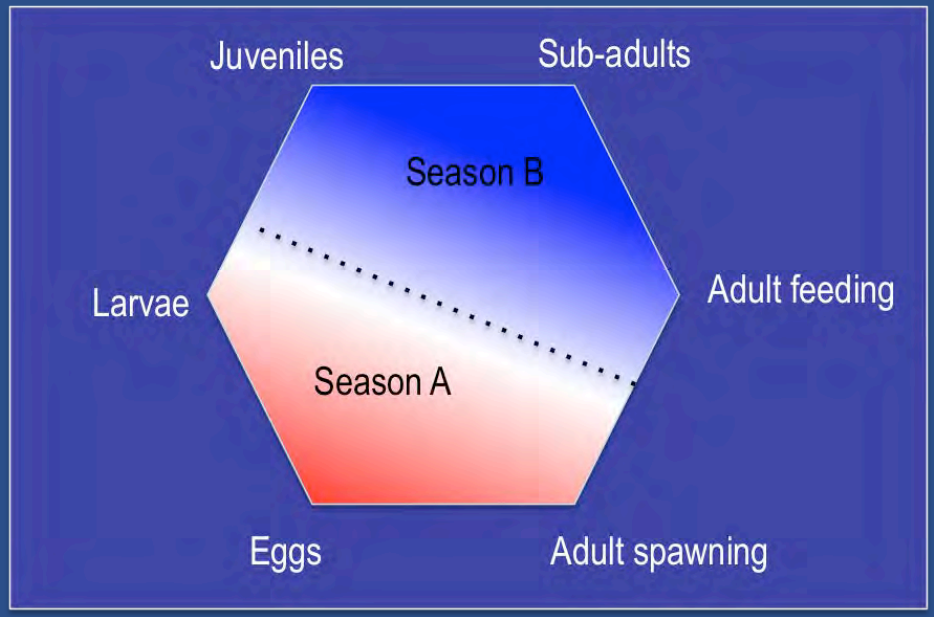
Outline

1. Are there habitat constraints in a species life cycle? If so,
2. Can we identify them?
3. When do they occur?
4. What are the implications for species adaptability to climate change?

Quantifying habitat constraints



Least constrained: environmentally fixed habitats

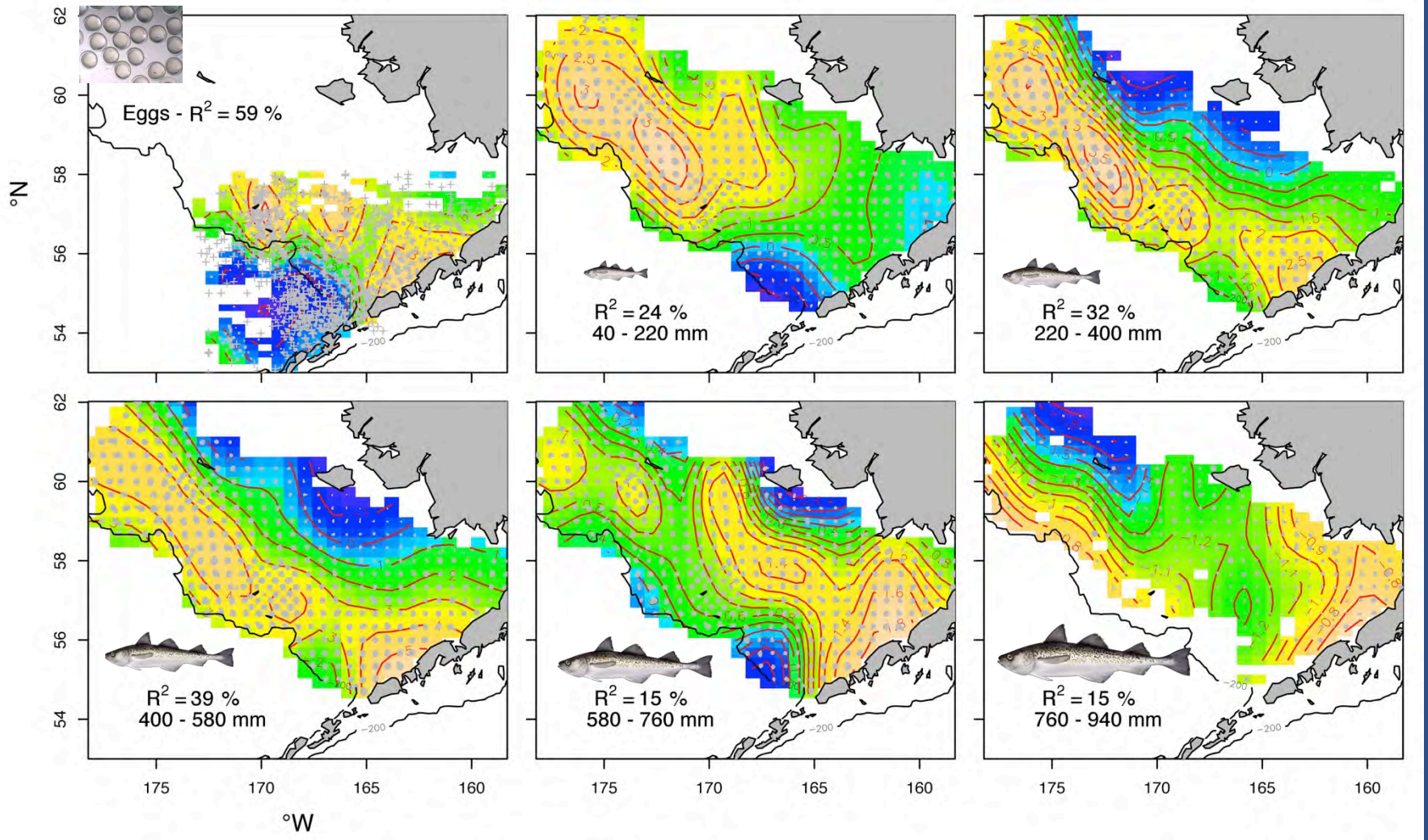
Most constrained: spatially fixed habitats

R^2

$$X_{s,lat,lon,y} = a_{s,y} + s(lat,lon) + e_{s,lat,lon,y}$$

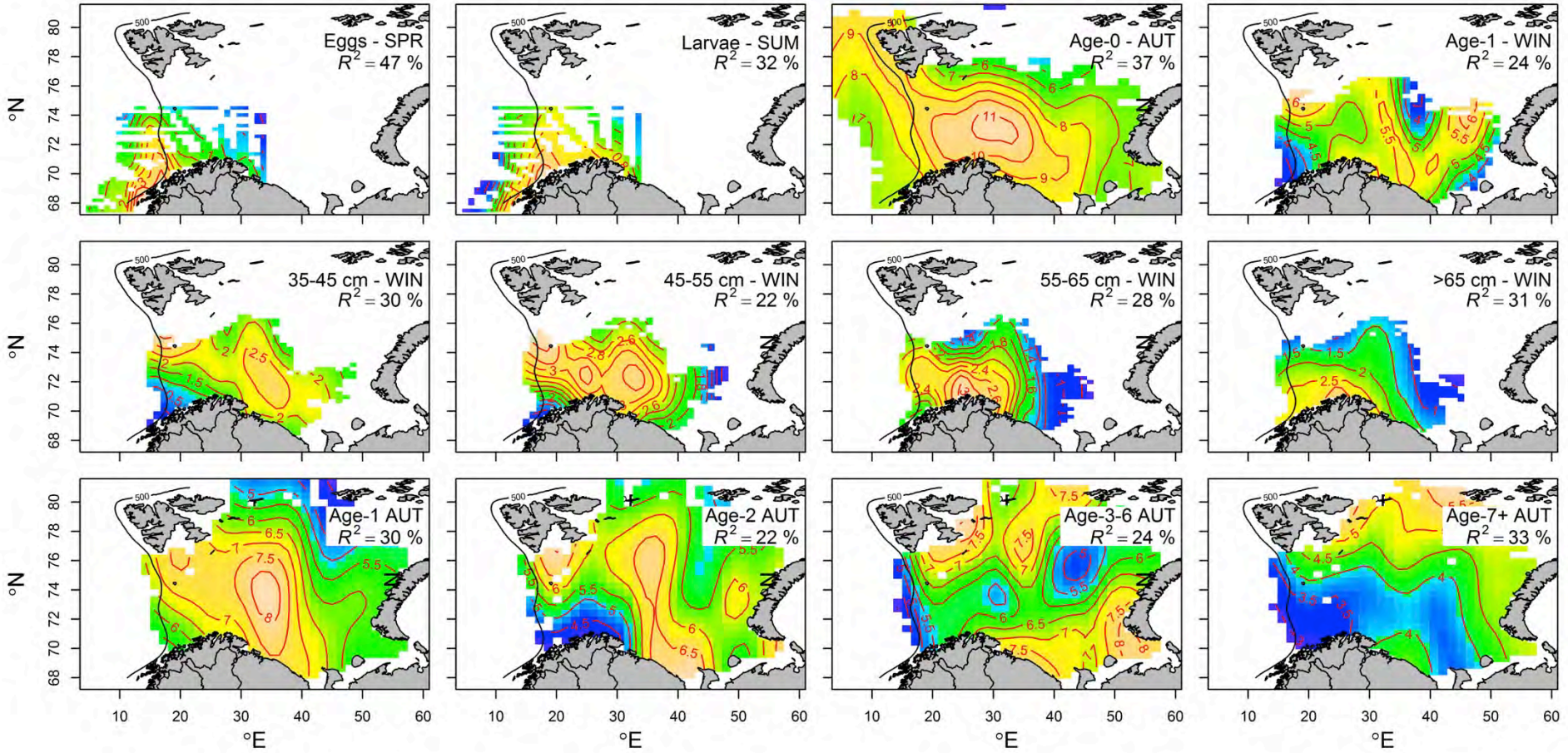
Habitat constraint across life stages

Walleye pollock (*Gadus chalcogrammus*) in the Bering Sea



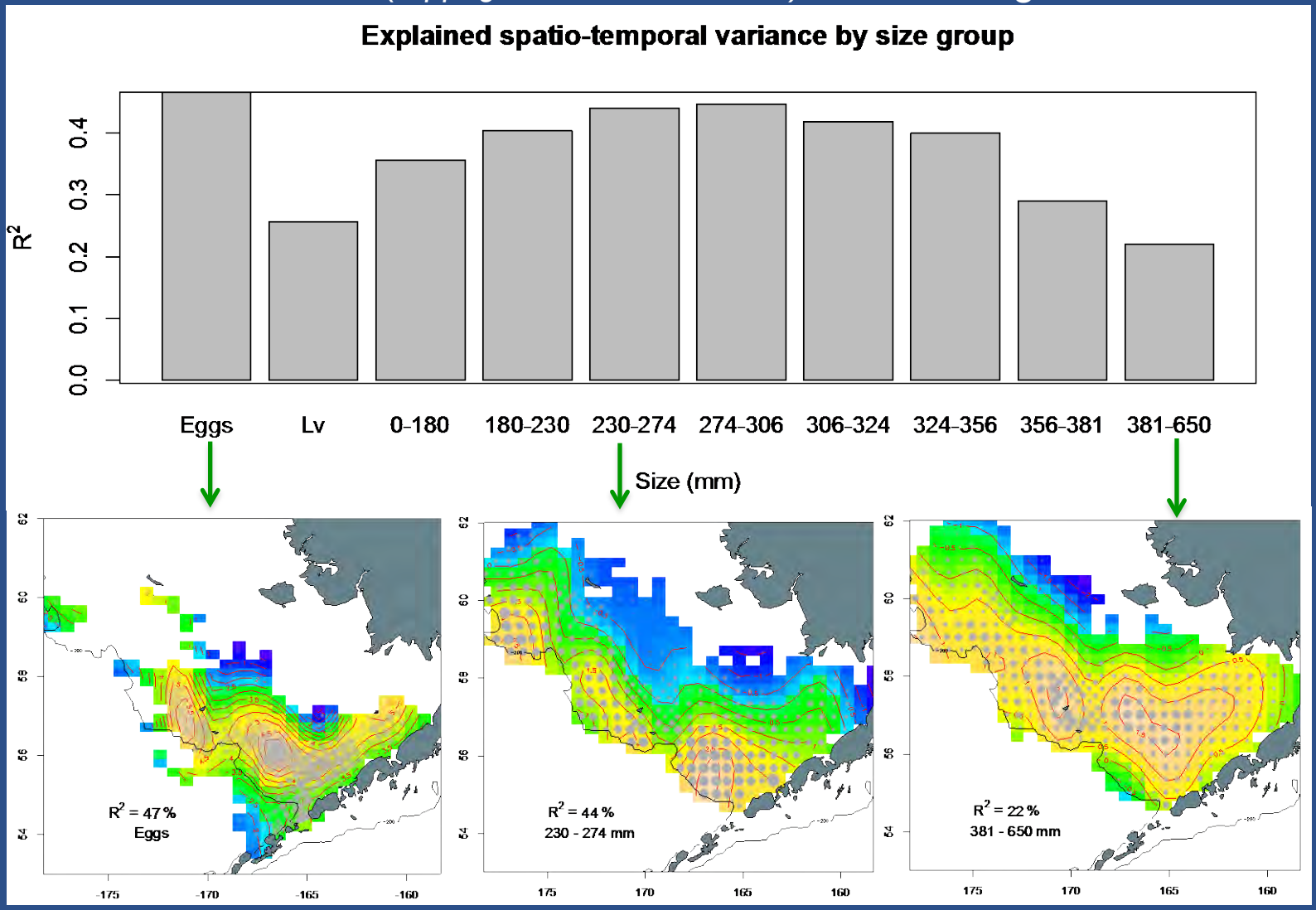
Habitat constraint across life stages

Atlantic Cod (*Gadus morhua)* in the Barents Sea



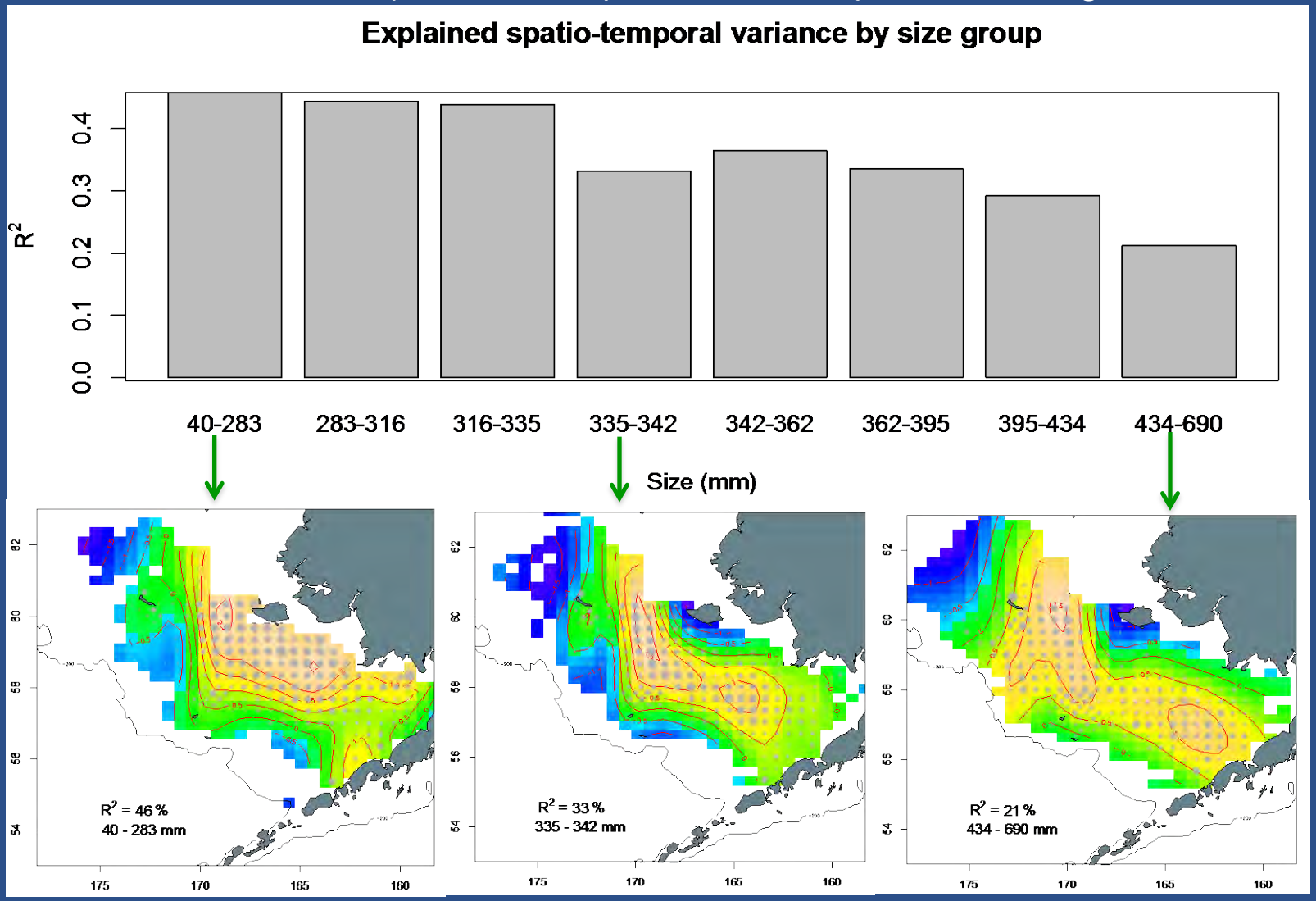
Habitat constraint across life stages

Flathead sole (*Hippoglossoides elassodon)* in the Bering Sea



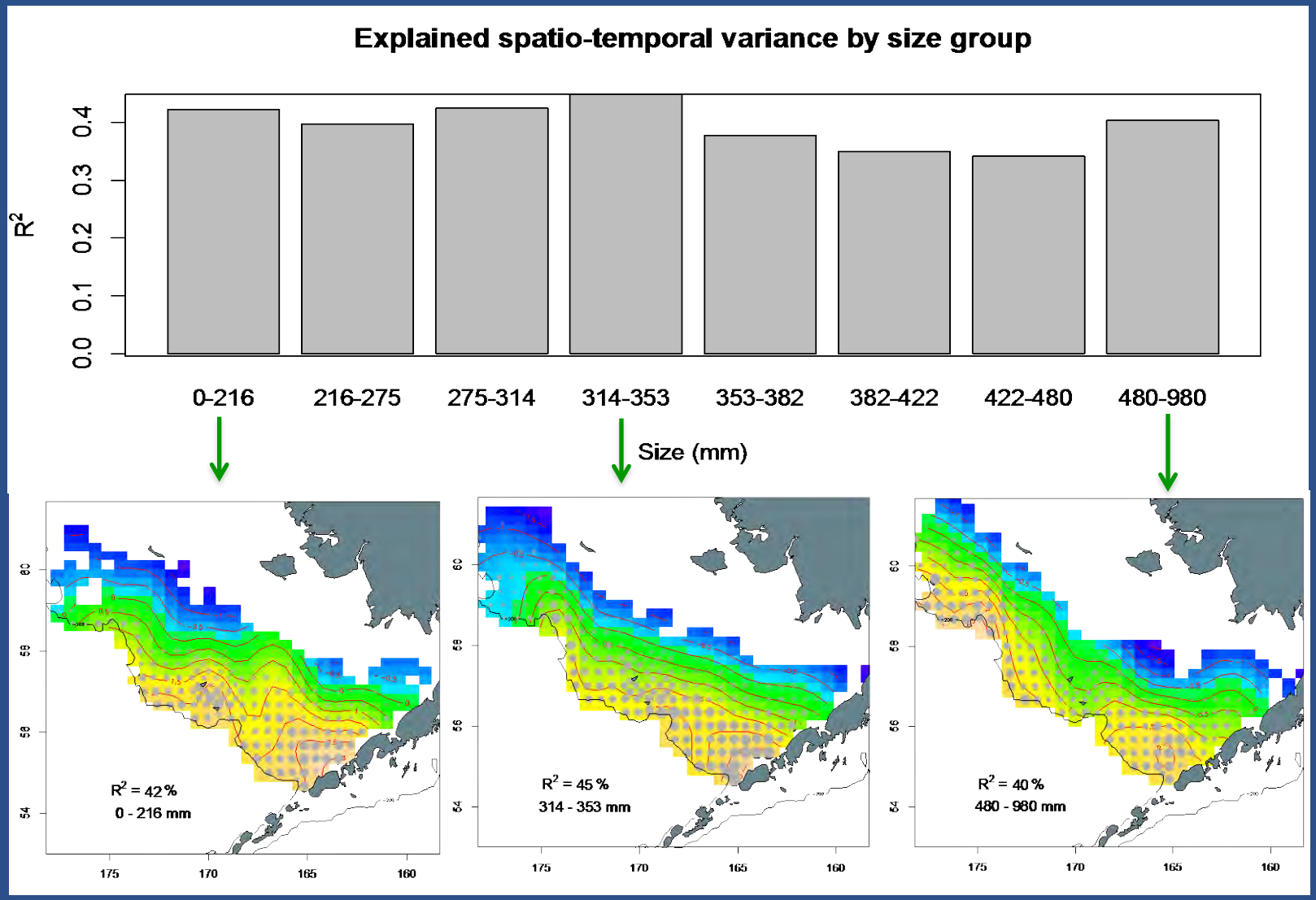
Habitat constraint across life stages

Alaska Plaice (*Pleuronectes quadrituberculatus*) in the Bering Sea



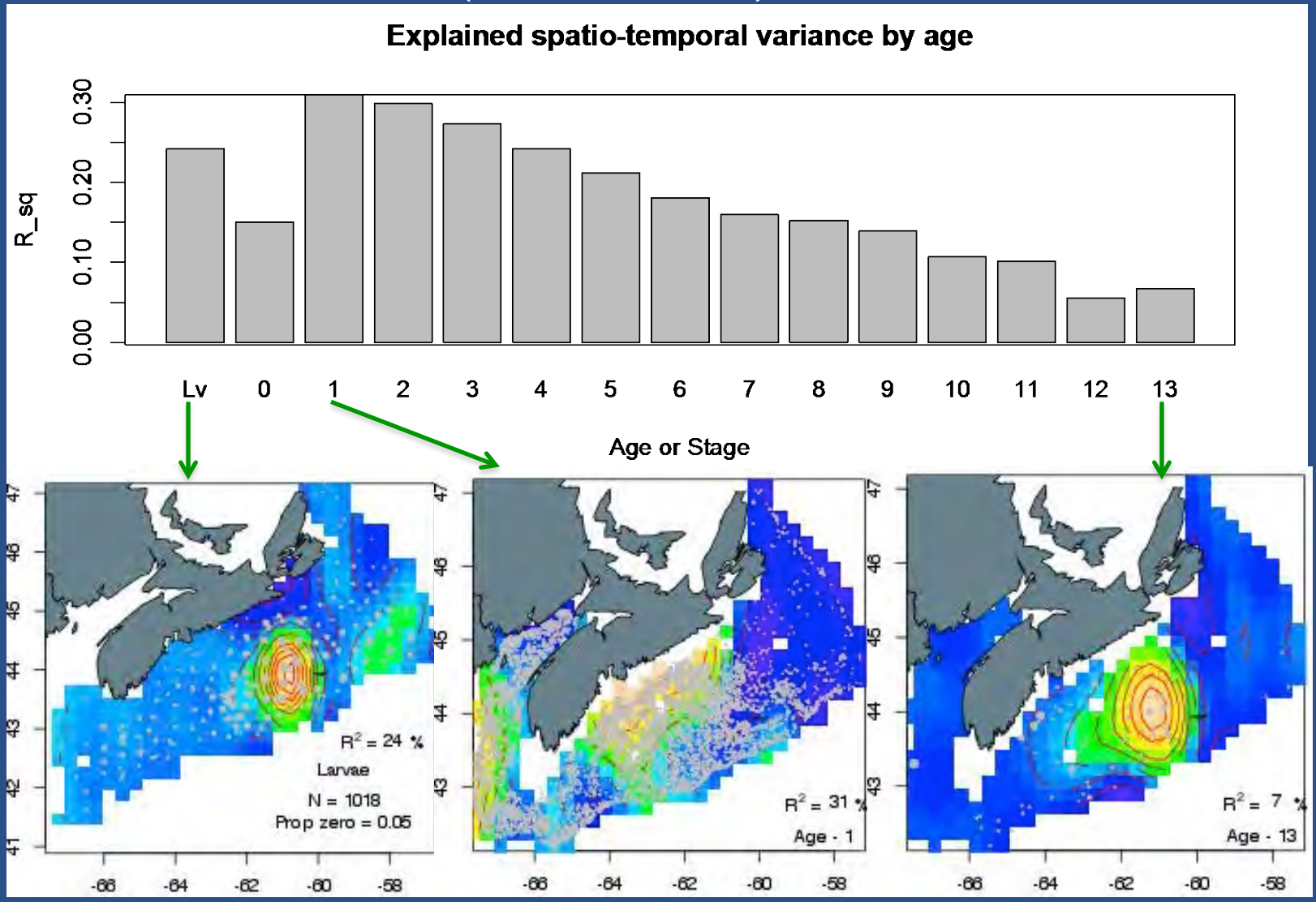
Habitat constraint across life stages

Arrowtooth flounder (*Atheresthes stomias)* in the Bering Sea



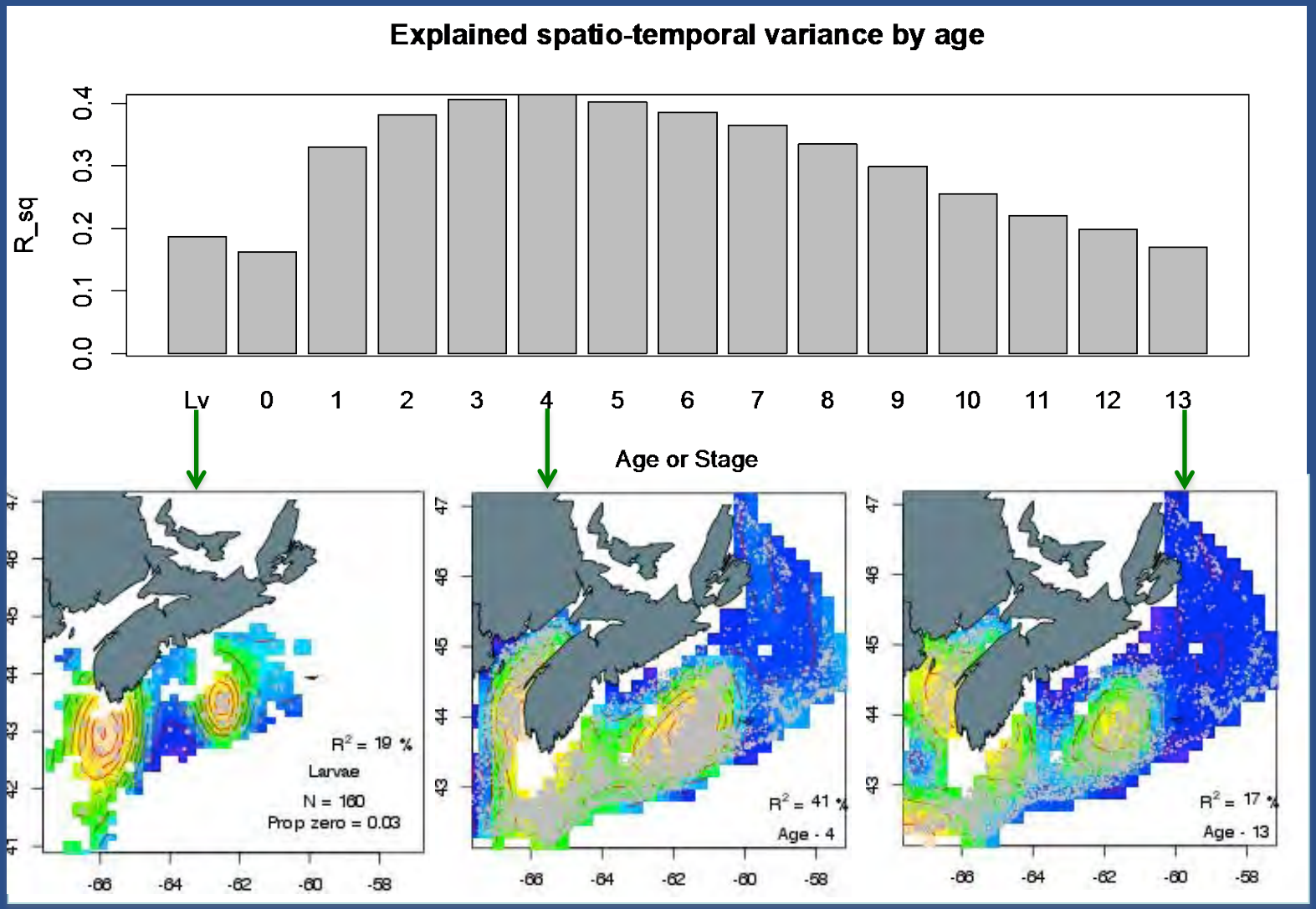
Habitat constraint across life stages

Silver hake (*Merluccius bilinearis*) in the Scotian shelf

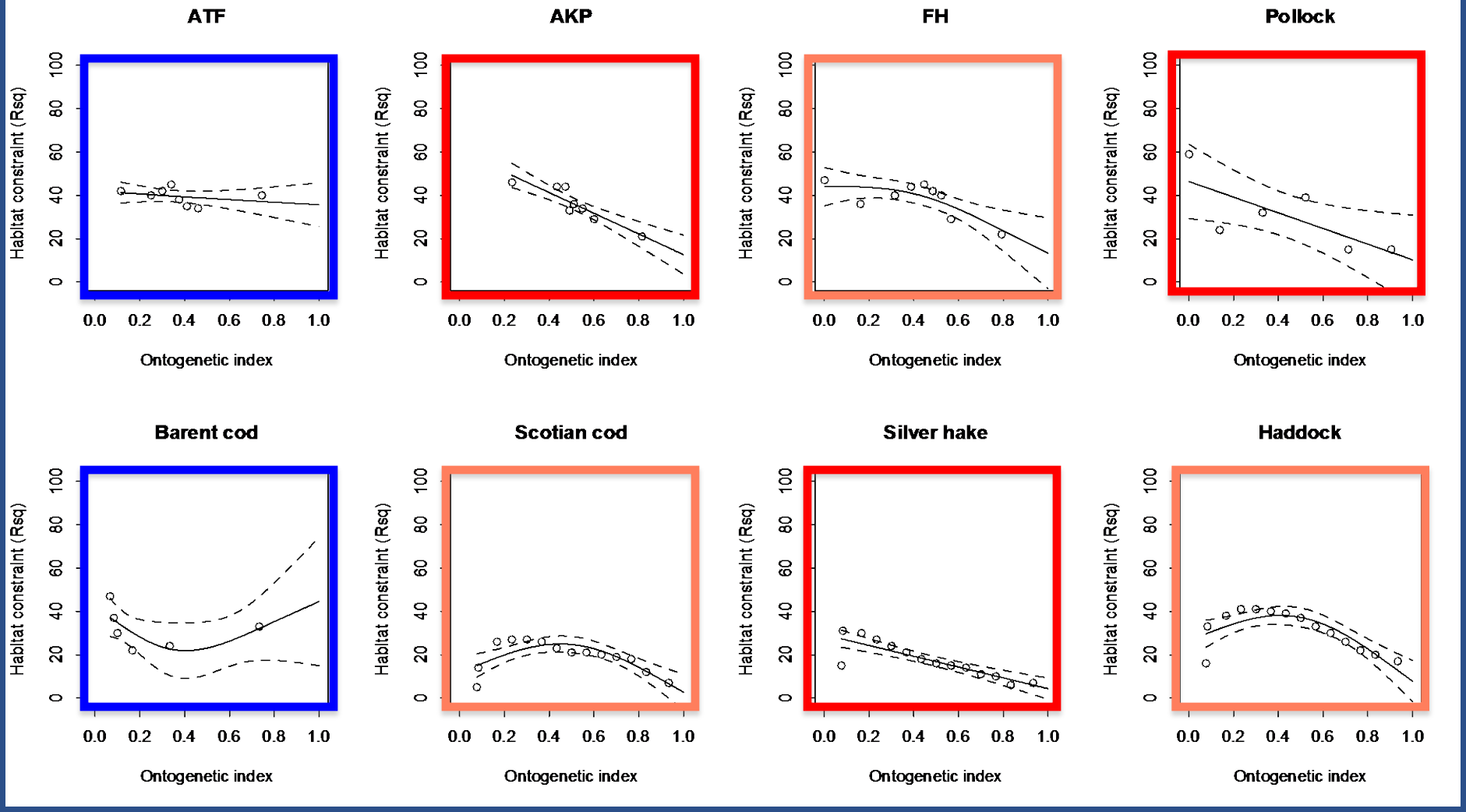


Habitat constraint across life stages

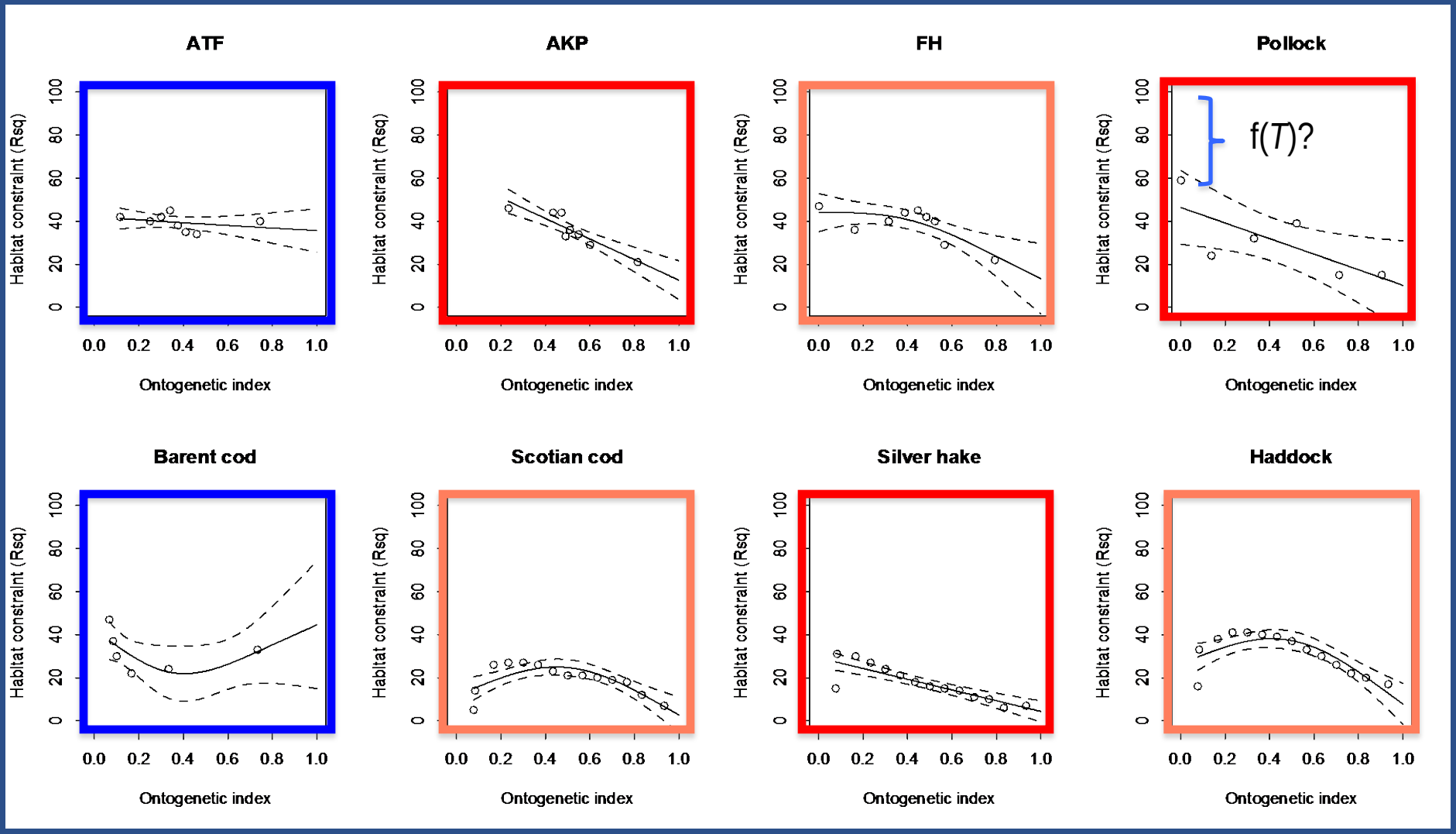
Haddock (*Melanogrammus aeglefinus)* in the Scotian shelf



Habitat constraint across life histories

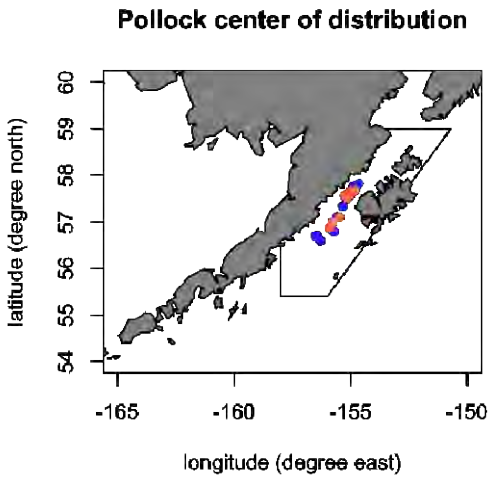


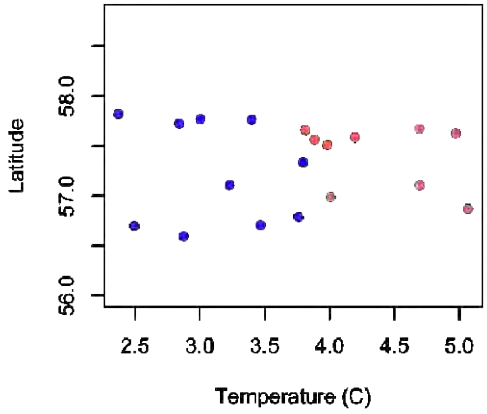
Habitat constraint across life histories

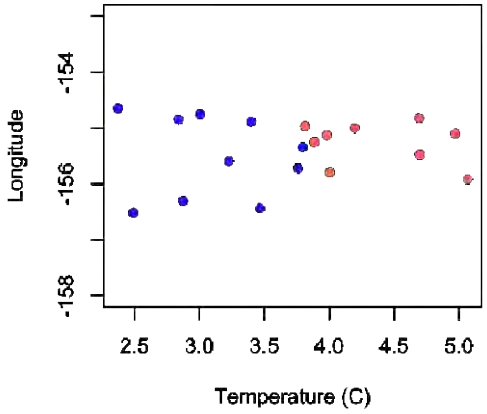


Alaska pollock

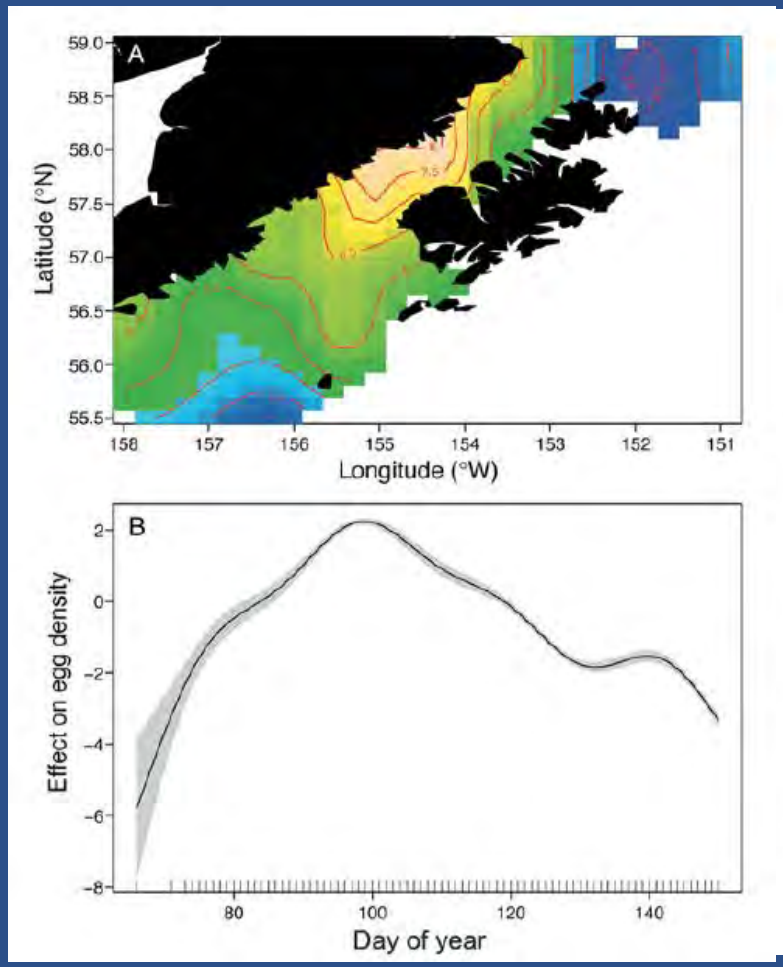
Gadus chalcogrammus

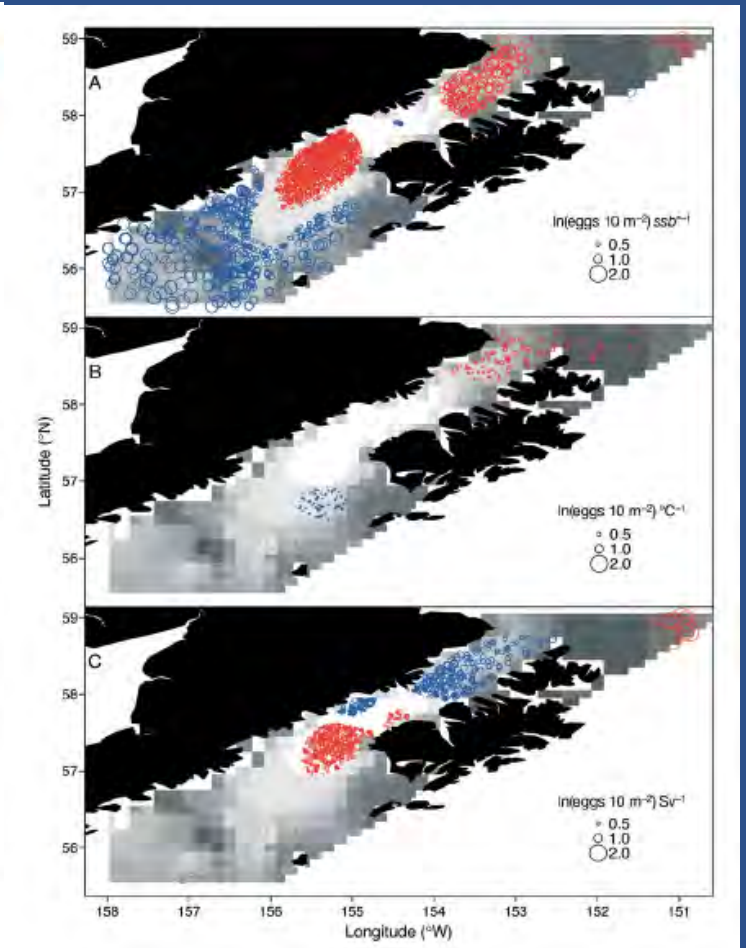






Gulf of Alaska pollock





Biomass (*B*)

SST (*T*)

Transport (*Sv*)

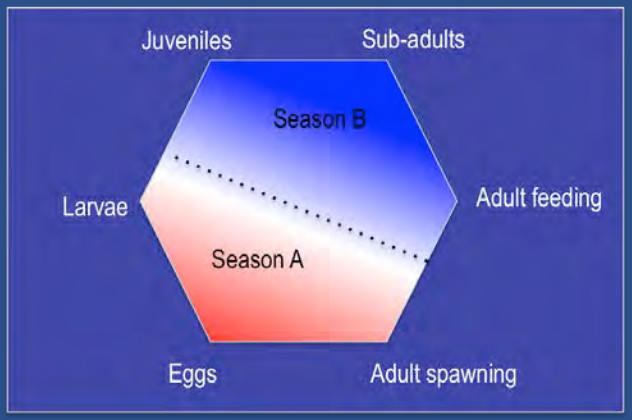
Bacheler et al. (2009) MEPS

Summary

1. Temperature does not always matter
2. Different life history stages have different responses to temperature: more sensitivity for older stages
3. There is a tendency for early life stages to be more constrained in space

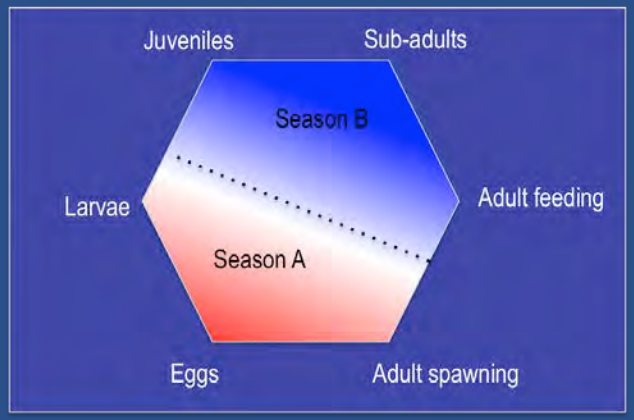
Implications for SDM

1. Check data: coverage, stock structure, stages, season



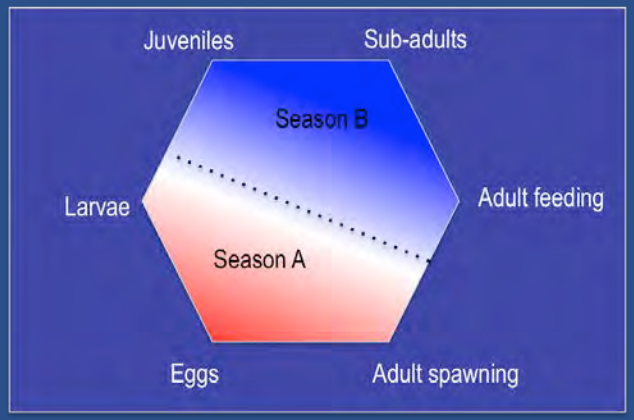
Implications for SDM

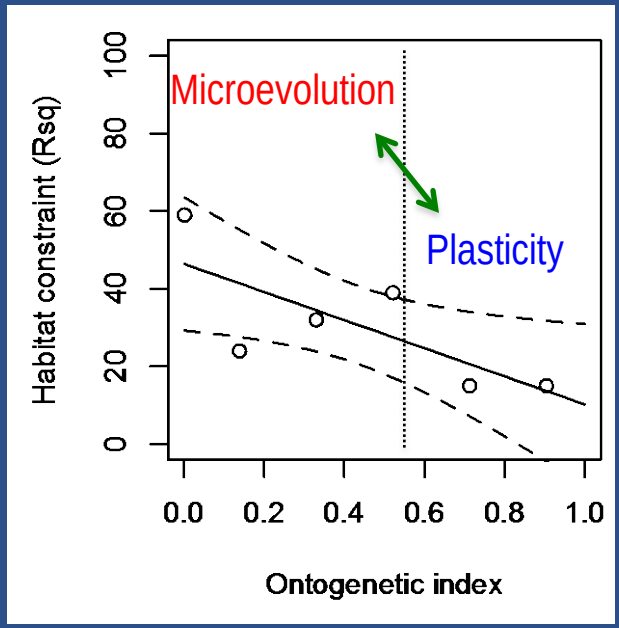
1. Check data: coverage, stock structure, stages, season
2. Obtain data for different life stages and seasons, and quantify habitat constraint
3. To expand approach to species poor data examine link with life history strategies



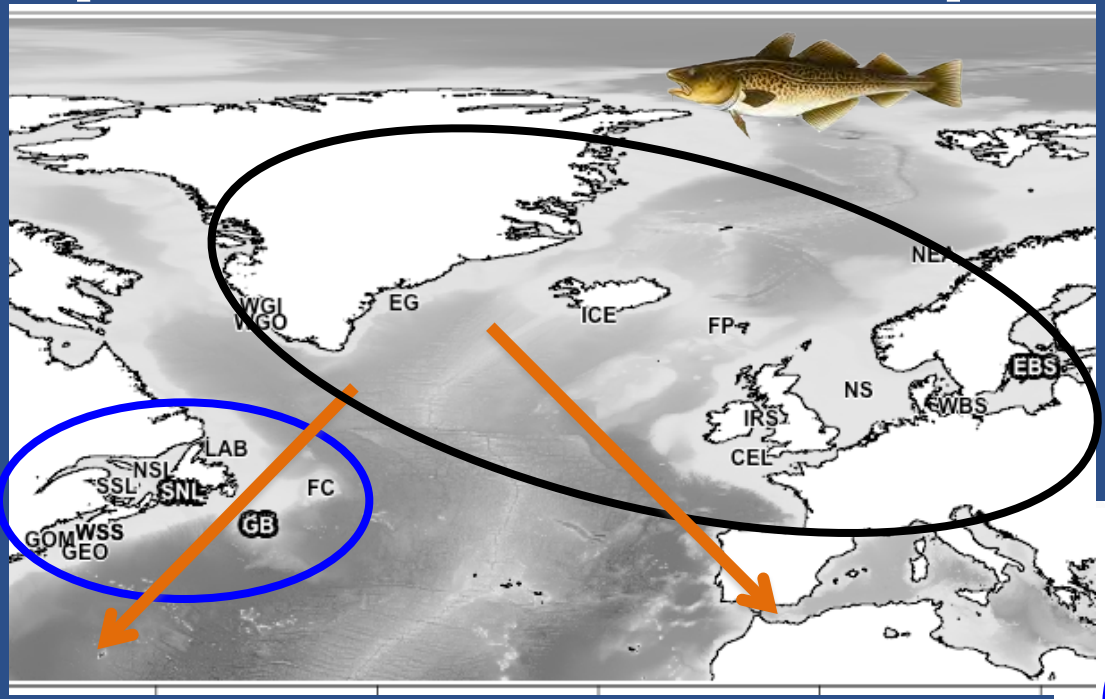
Implications for SDM

1. Check data: coverage, stock structure, stages, season
2. Obtain data for different life stages and seasons, and quantify habitat constraint
3. To expand approach to species poor data examine link with life history strategies
4. There is a need for combining ecology and evolution approaches to predict species distribution
5. ASLO Meeting 2017, Hawaii, S44: 'Bridging the eco-evolutionary gap'





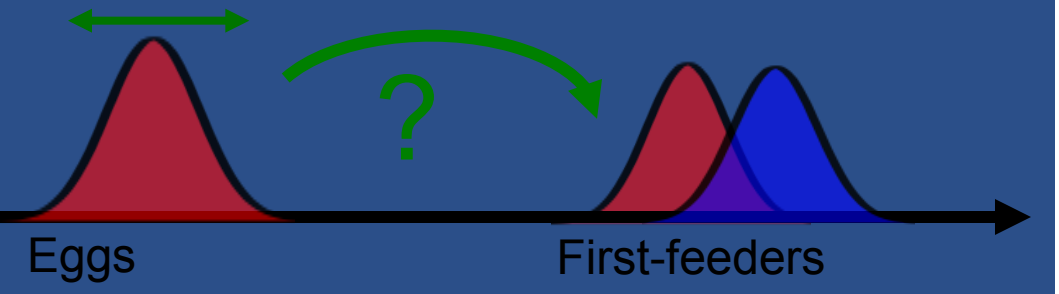
Spatial variation in spawning

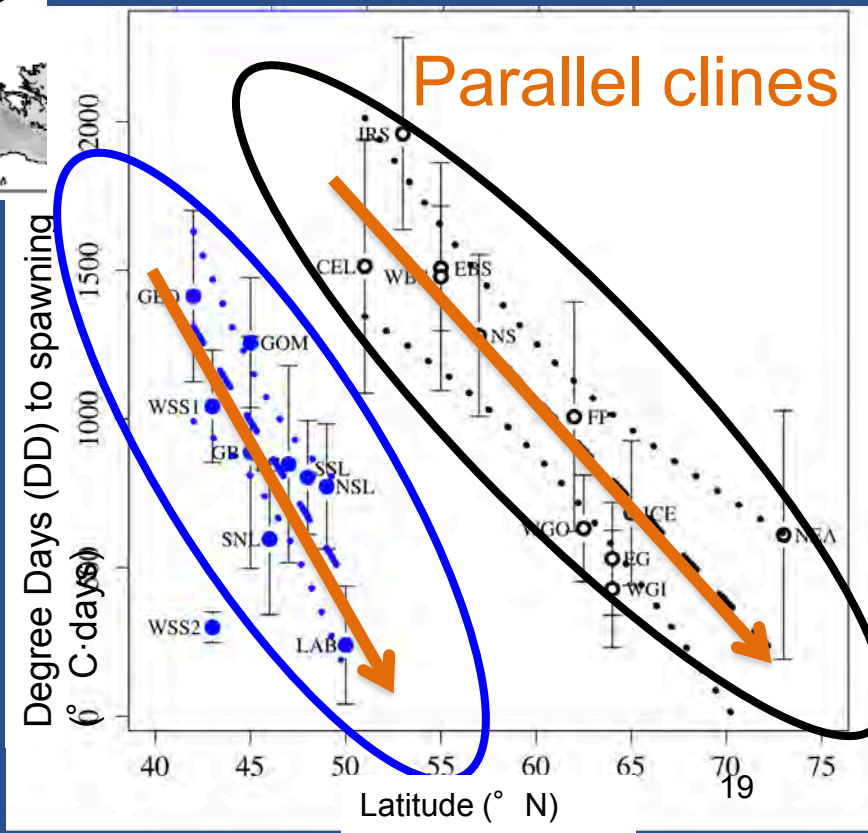


Evolutionary history of the species

(Bigg et al. 2008)

Adaptation to prey timing?





Neuheimer & MacKenzie 2014 Ecology 95:3364-3375

Thank you!

Nathan Bacheler, Cathleen Vestfals, Dongwha Sohn, Janet Duffy-Anderson, Stan Kotwicki, Robert Lauth, Mark R. Payne, Brian R. MacKenzie