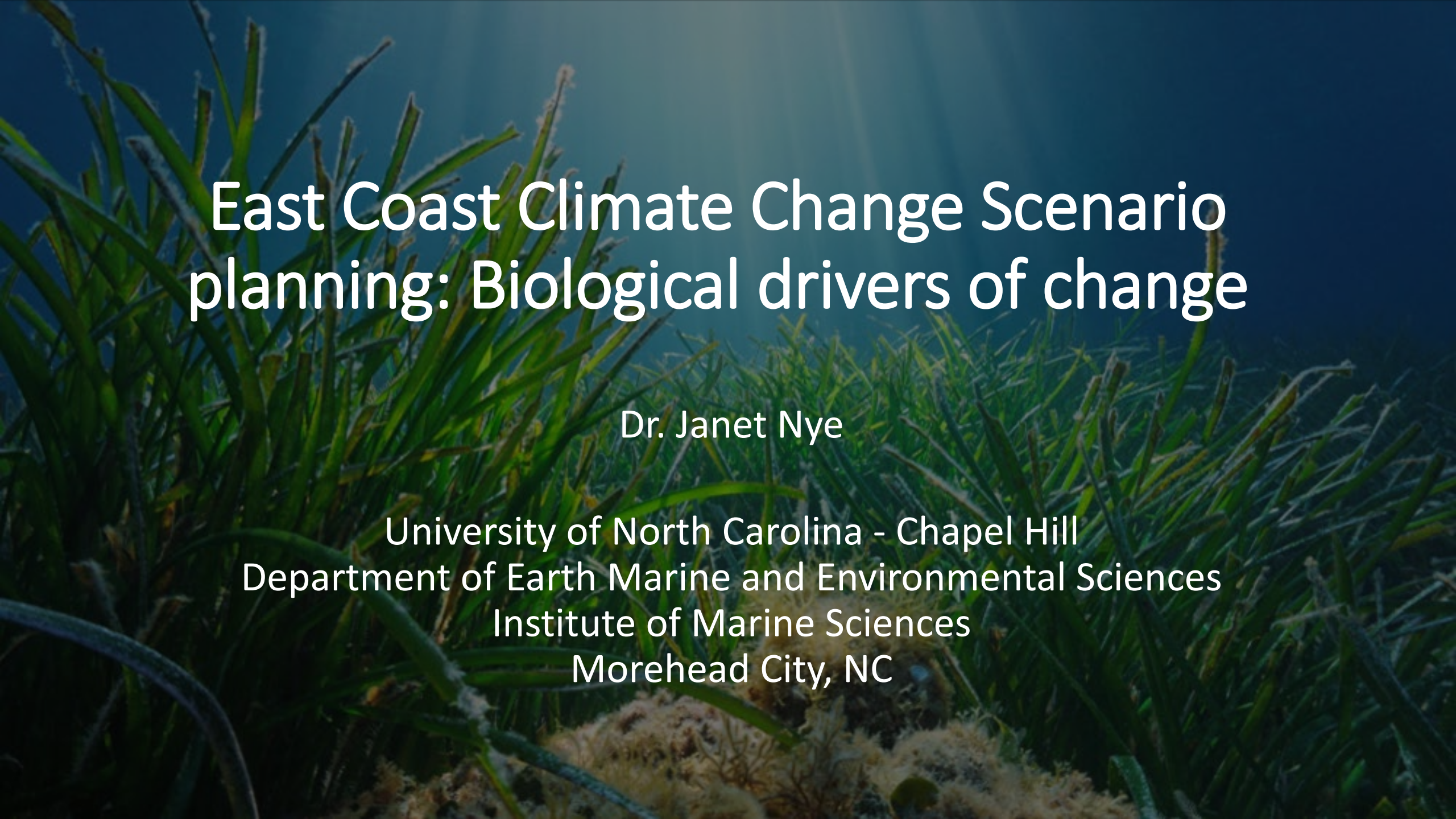


East Coast Climate Change Scenario planning: Biological drivers of change

Dr. Janet Nye

University of North Carolina - Chapel Hill
Department of Earth Marine and Environmental Sciences
Institute of Marine Sciences
Morehead City, NC

Response of organisms to climate change

Direct effects

- Shift is spatial distribution
- Population productivity
- Phenology
- Changes in community assemblages

Indirect effects

- Changes in food availability
- Changes in habitat availability
- Change in trophic, competitive or mutualistic relationships
- Increase in disease incidence and susceptibility
- Changes in emergent properties of food webs and ecosystems

Response of organisms to climate change

Direct effects

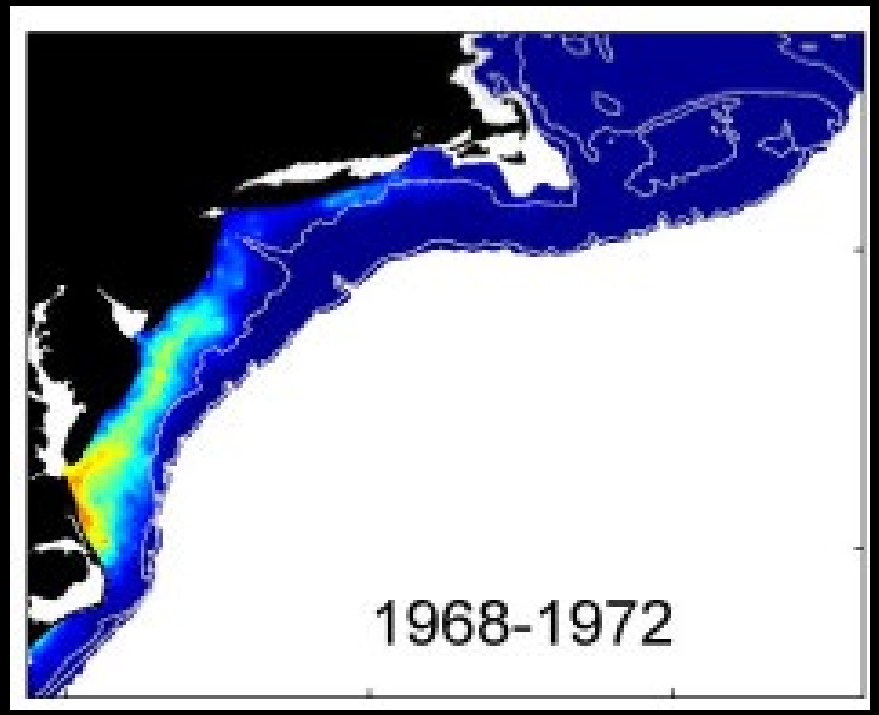
- Shift is spatial distribution
- Population productivity

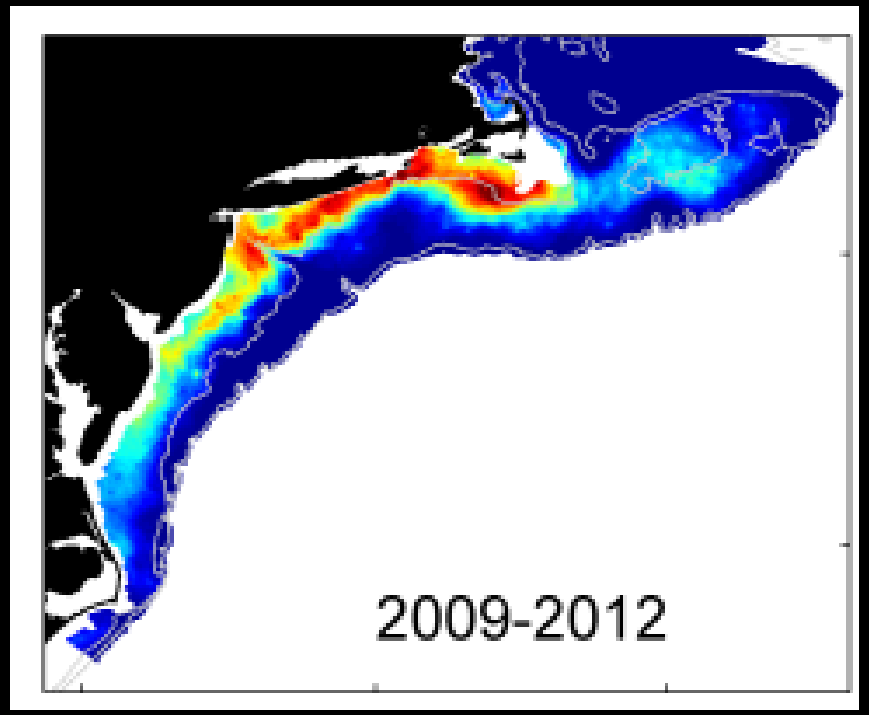
Two mechanisms of species distribution shifts

Movement/migration

Population productivity

Most species have shifted their distribution

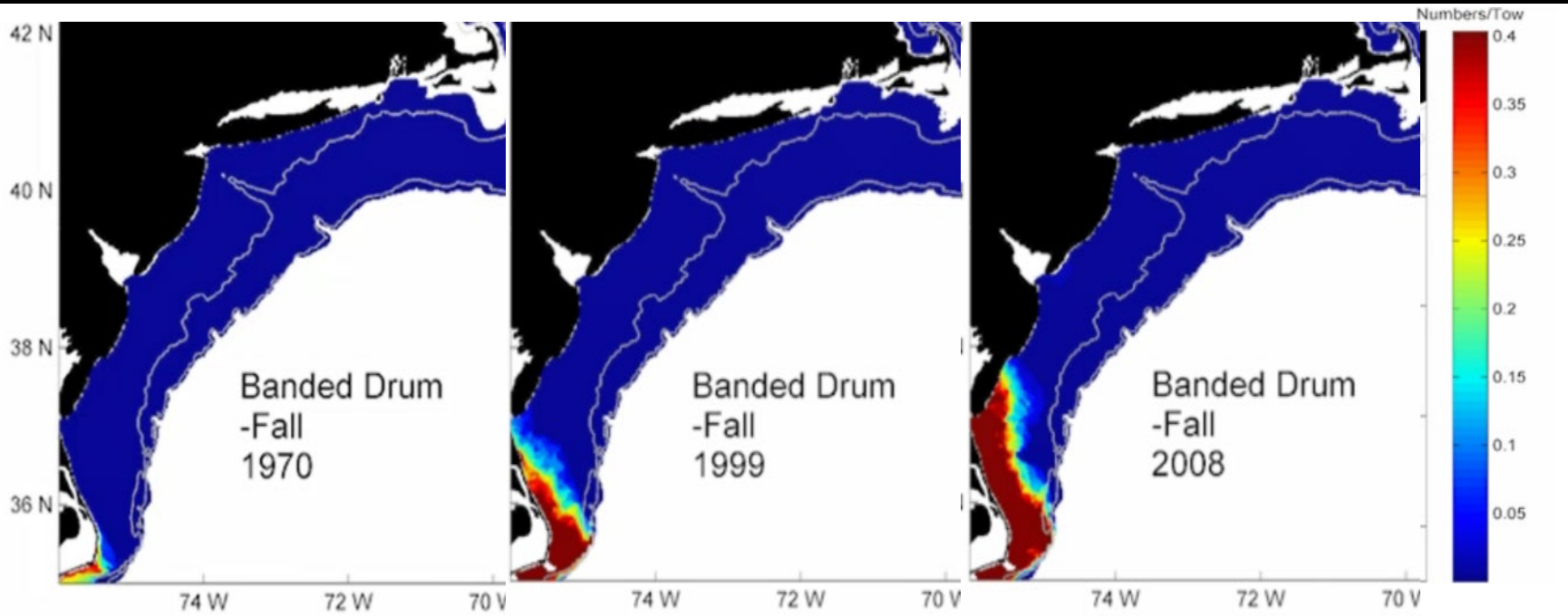




NOAA NEFSC

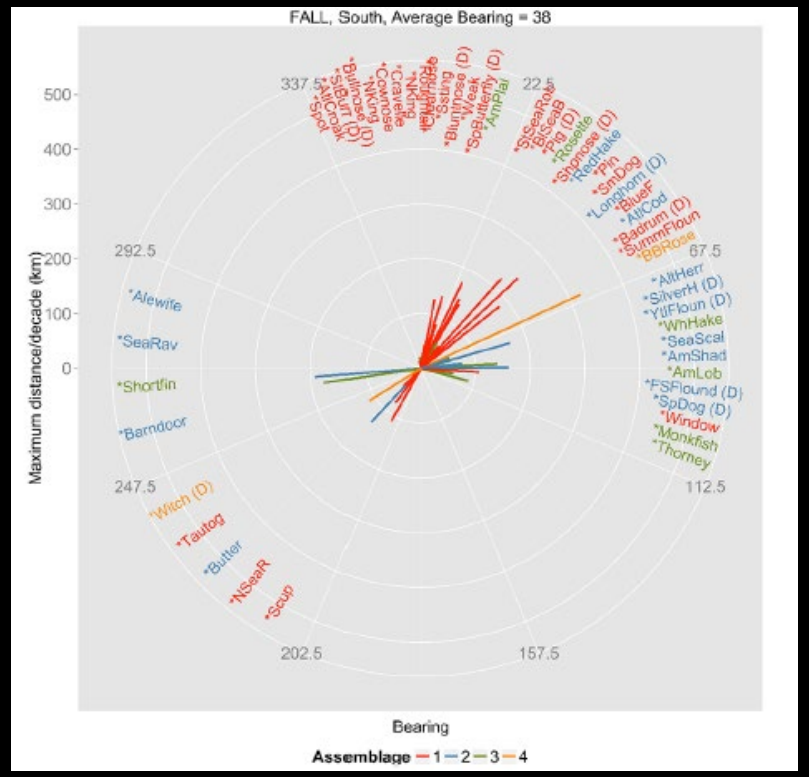
Nye et al. 2009 MEPS, Pinsky et al. 2013, many others

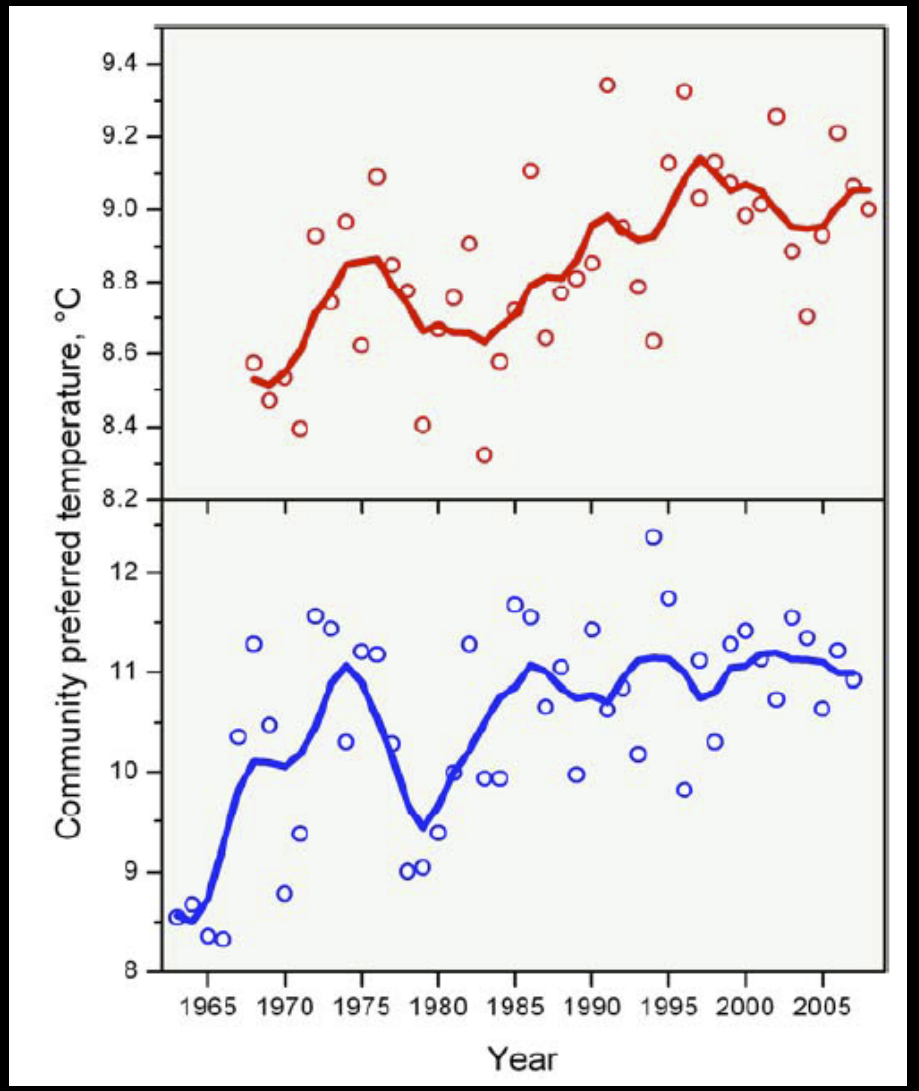
Most species have shifted their distribution



https://www.nefsc.noaa.gov/ecosys/spatial-analyses/other.html

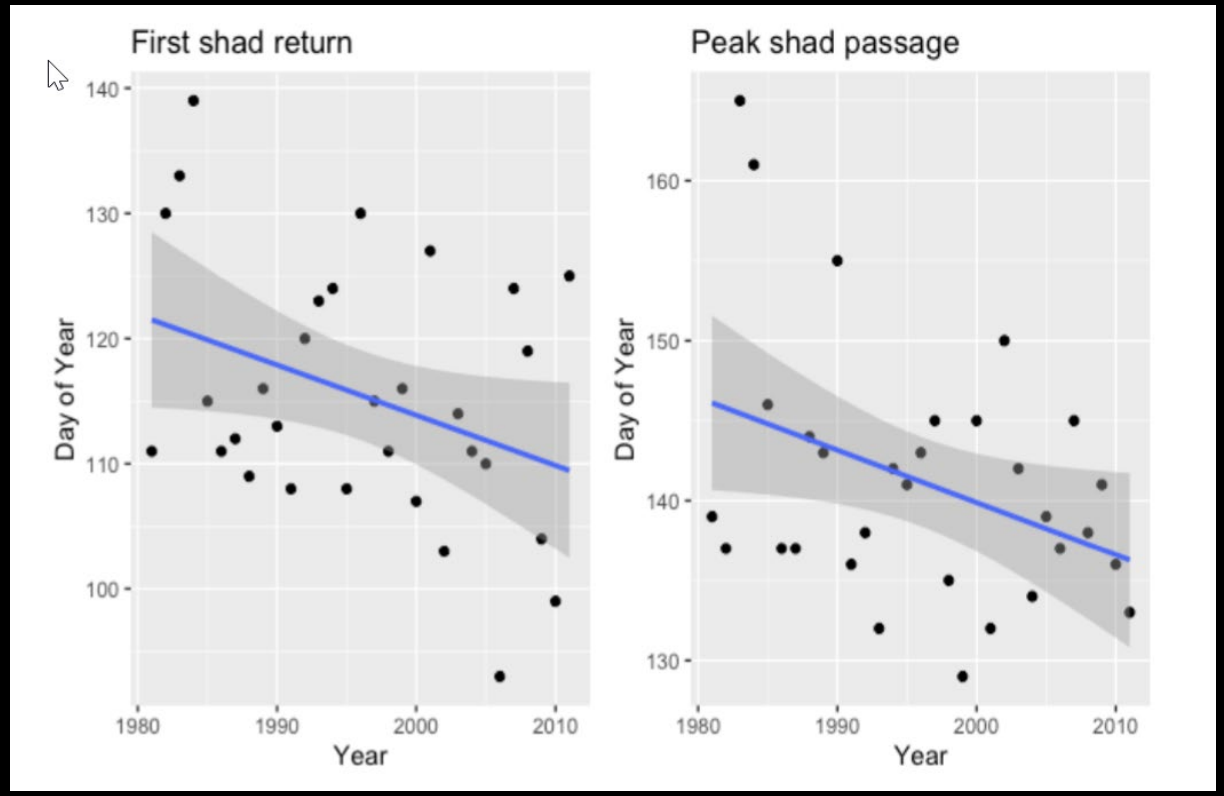
Tropicalization of marine communities

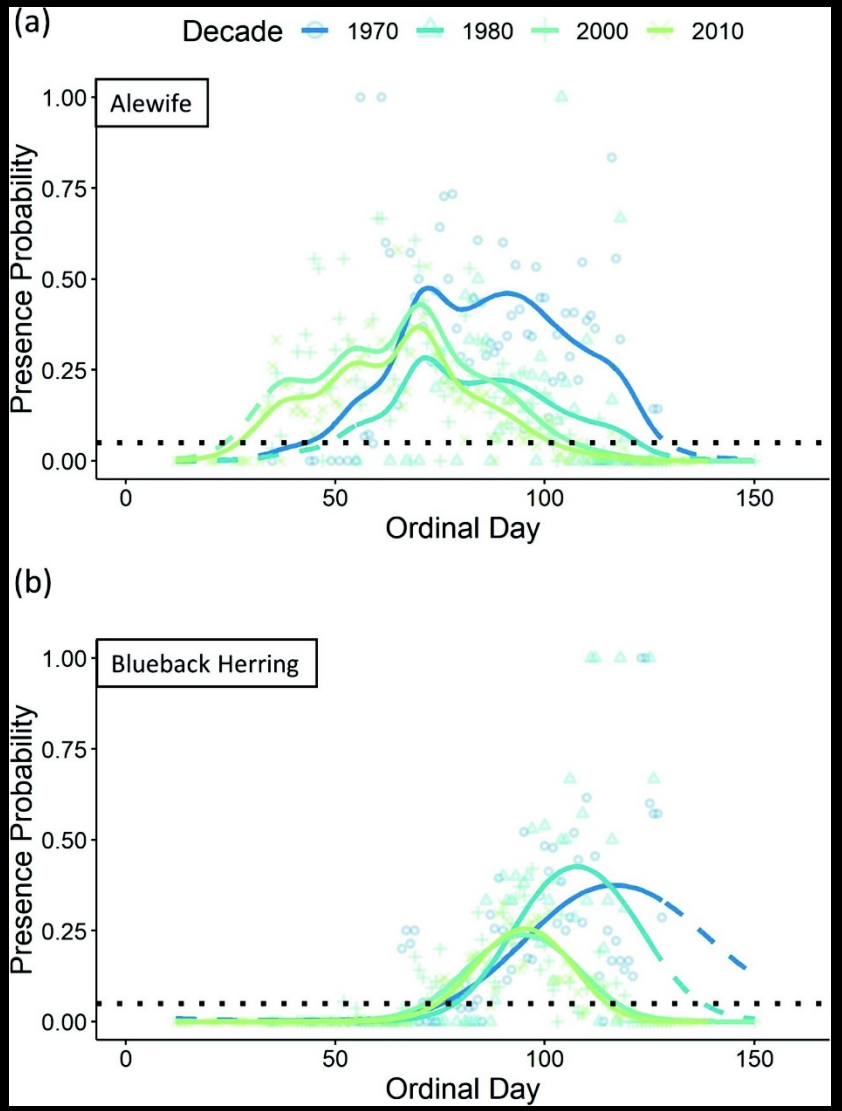




Lucey and Nye 2010, Kleisner et al 2016, NEUS ESR 2009

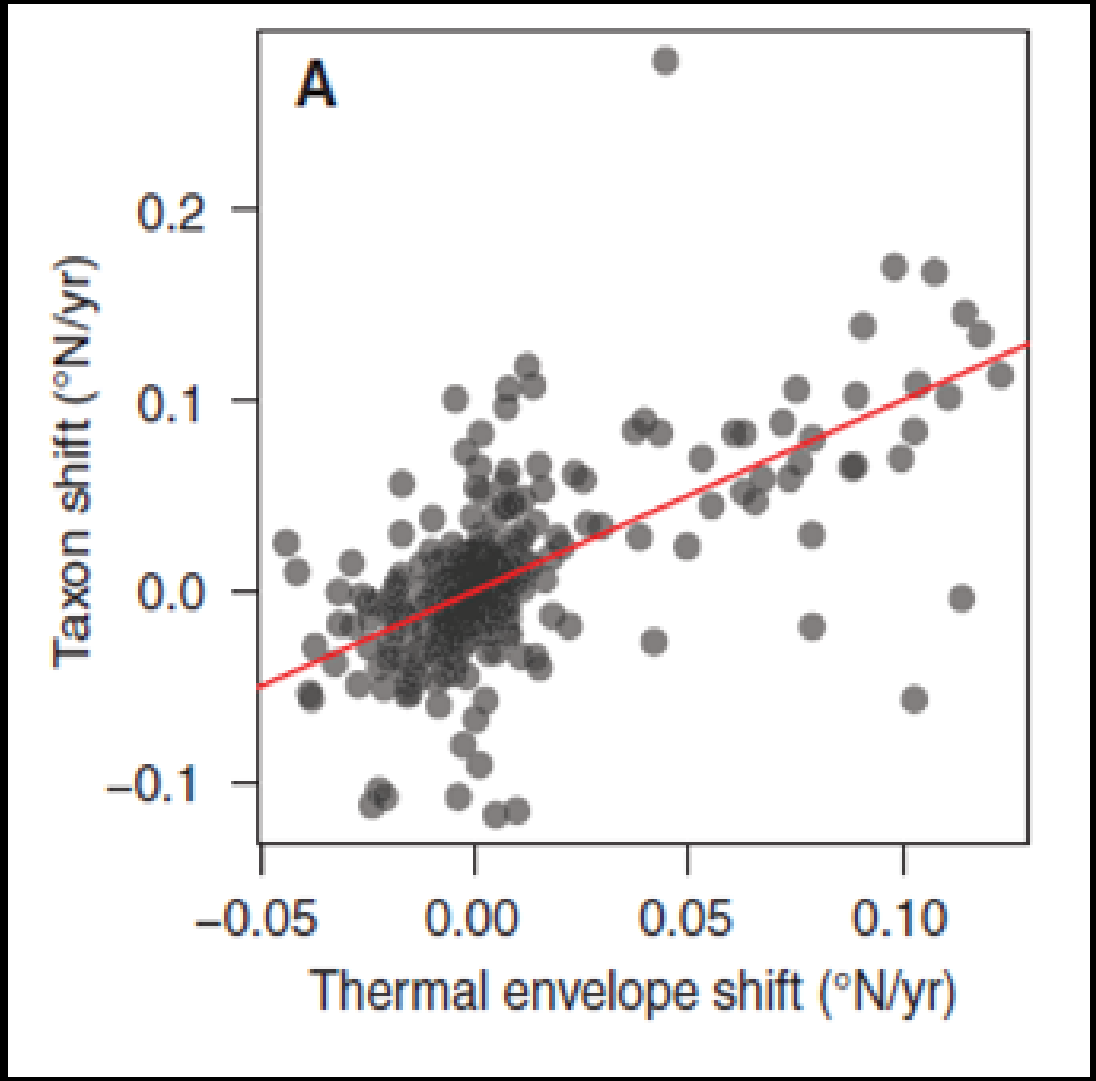
Changes in migration timing





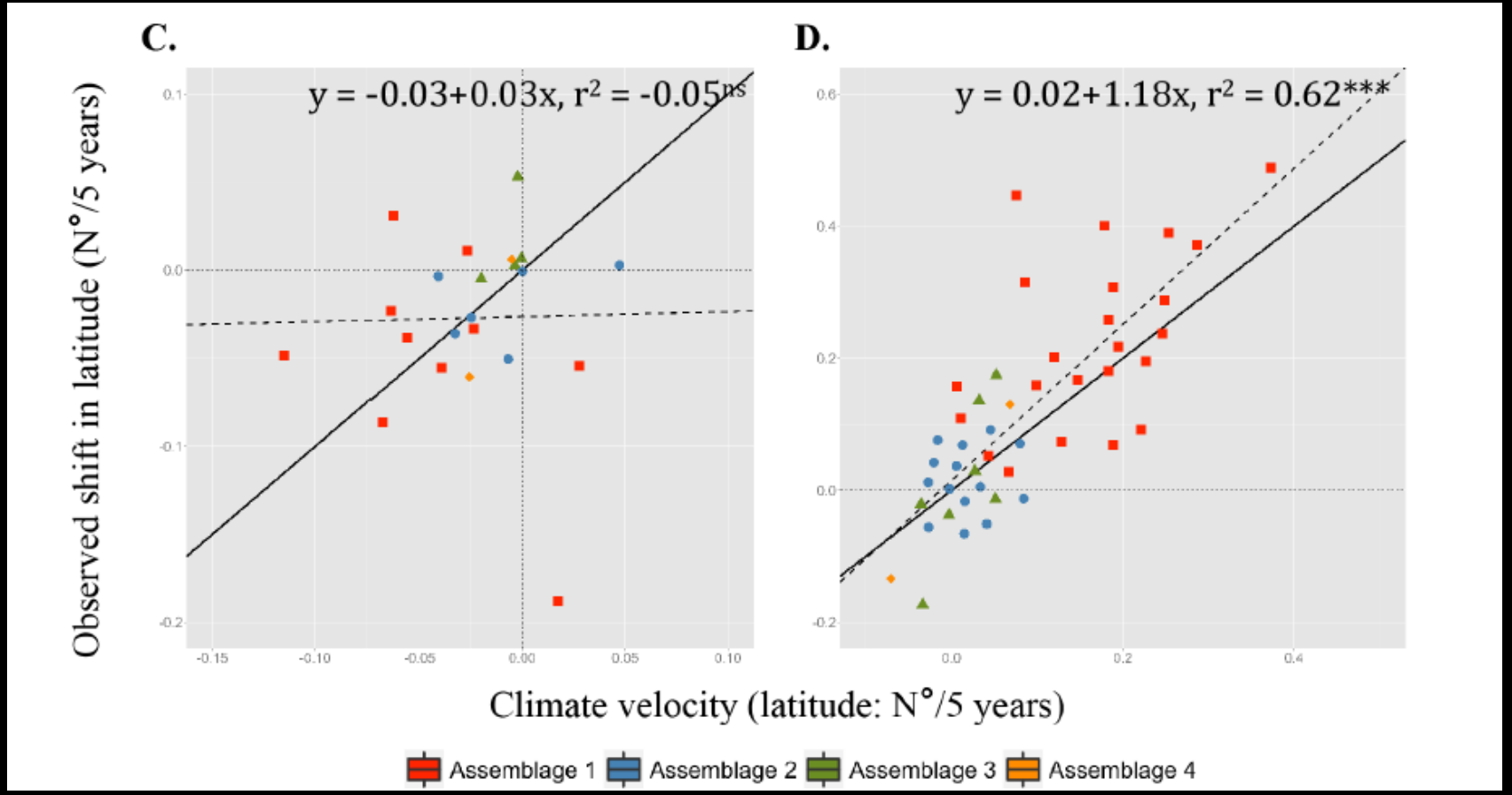
Peer and Miller 2014, Lombardo et al. 2019, Cobb 2020

Temperature drives species shifts



Pinsky et al. 2013 Science

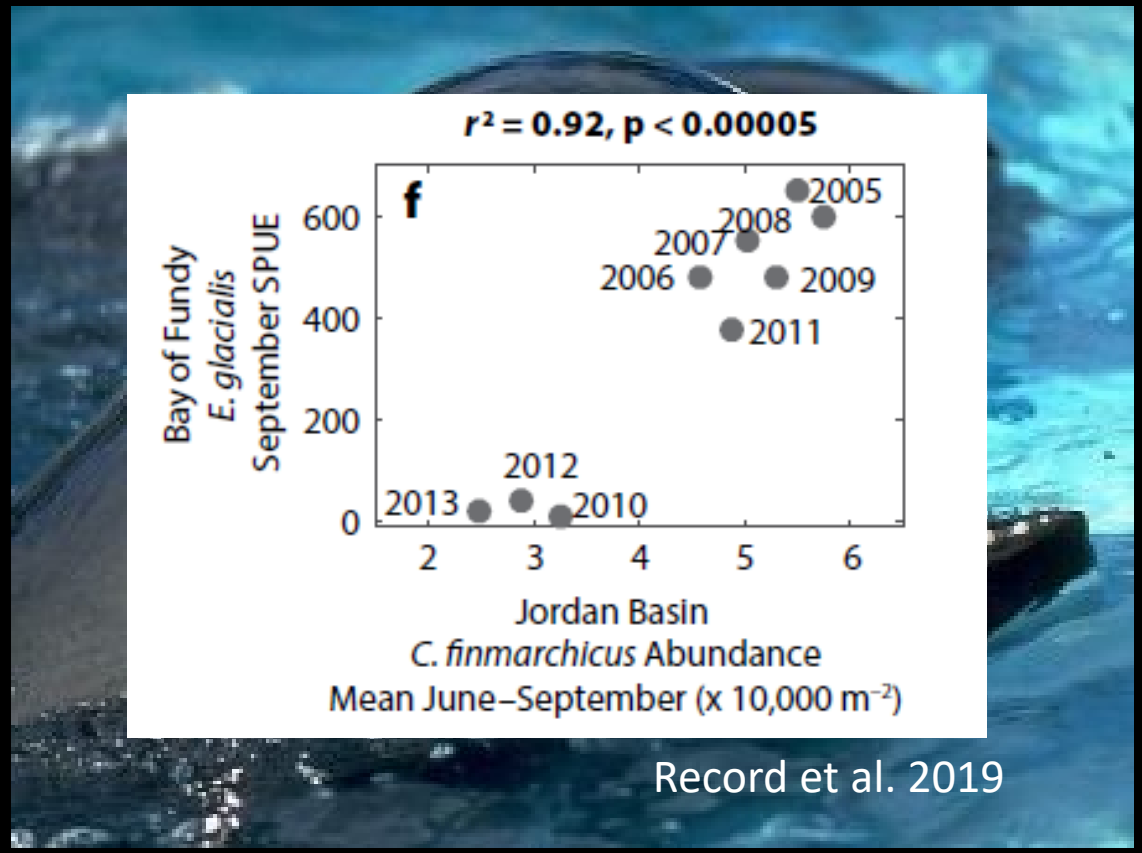
Temperature drives assemblage shifts



Kleisner et al. 2016

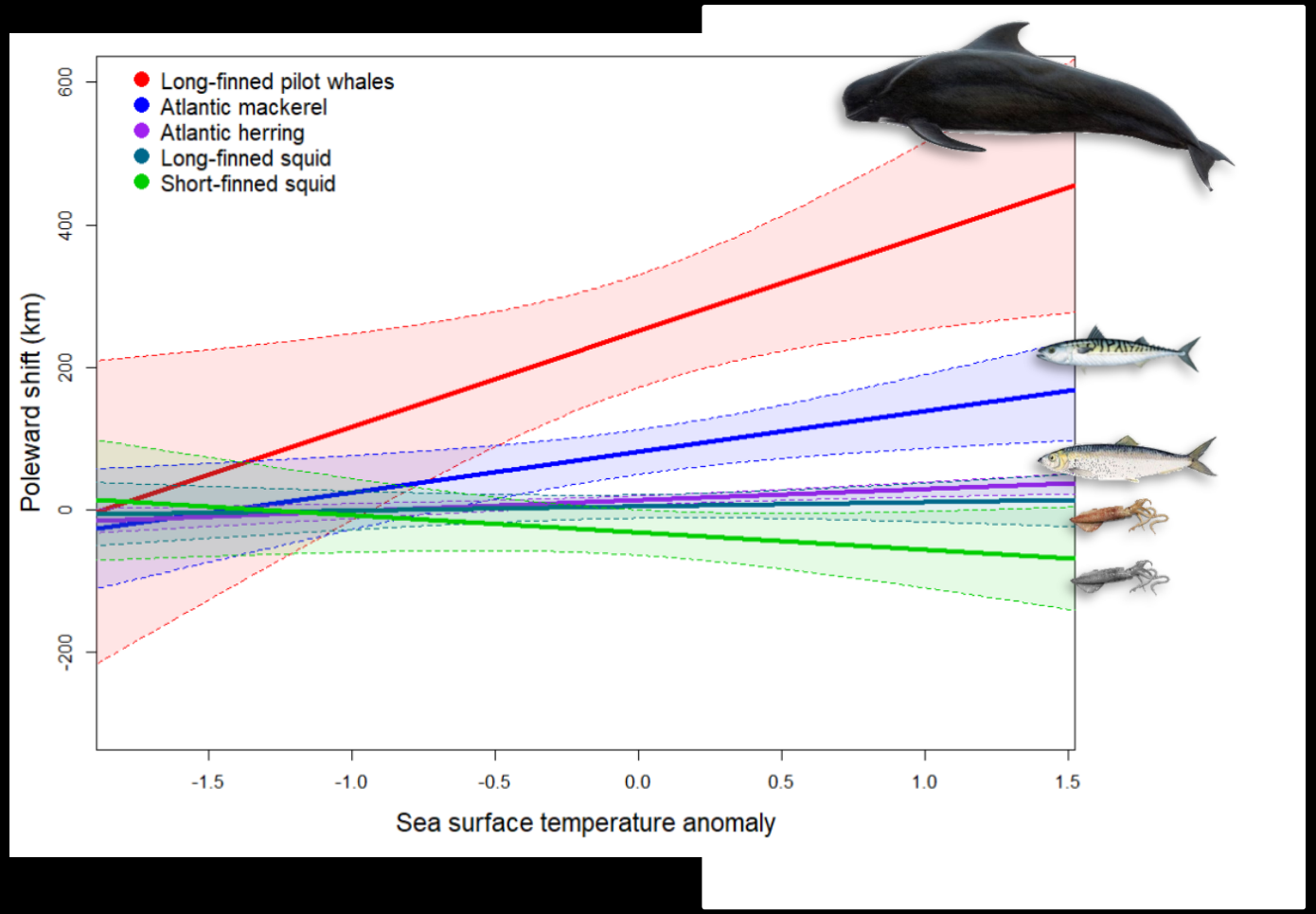
Will predators follow their prey?

North Atlantic right whale



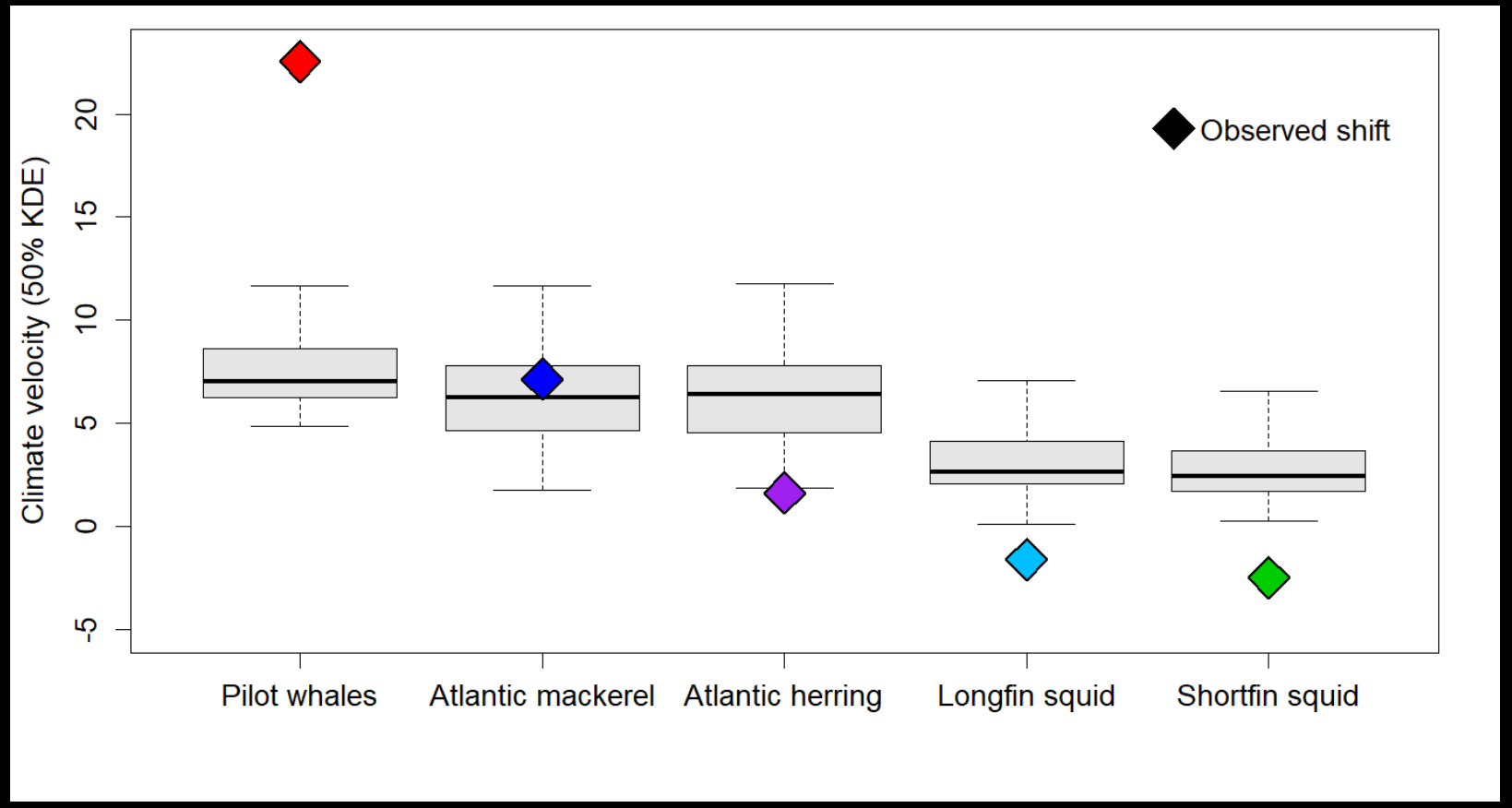
Long finned pilot whale

Will predators follow their prey?



Thorne and Nye 2021 Scientific Reports

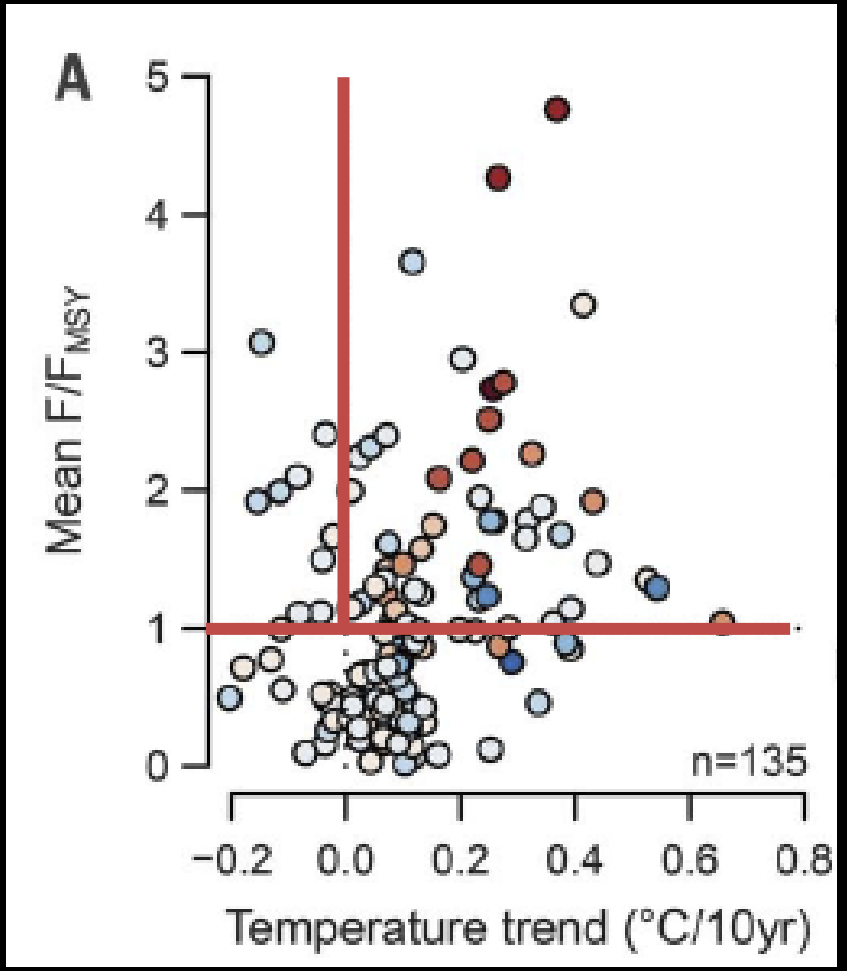
Mismatches between climate velocity and shifts



Thorne and Nye 2021 Scientific Reports

Changes in stock productivity

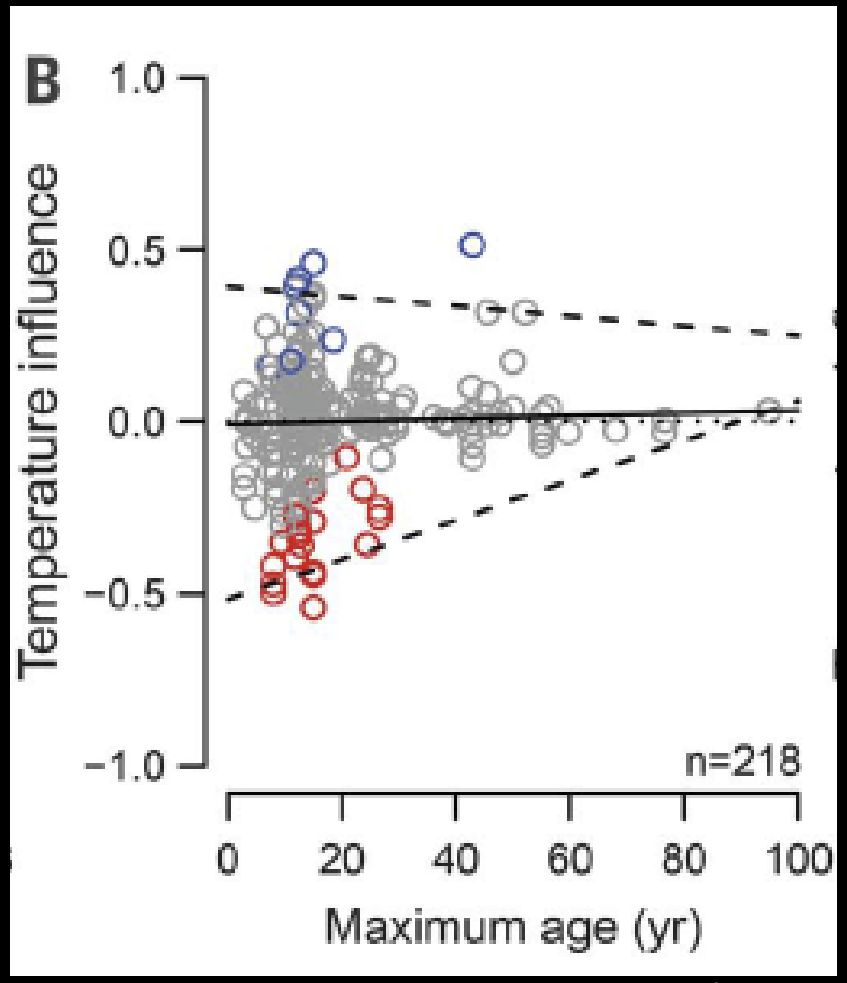
More and larger negative influences of warming for overfished populations and rapid temperature increase



Free et al. 2019

Changes in stock productivity

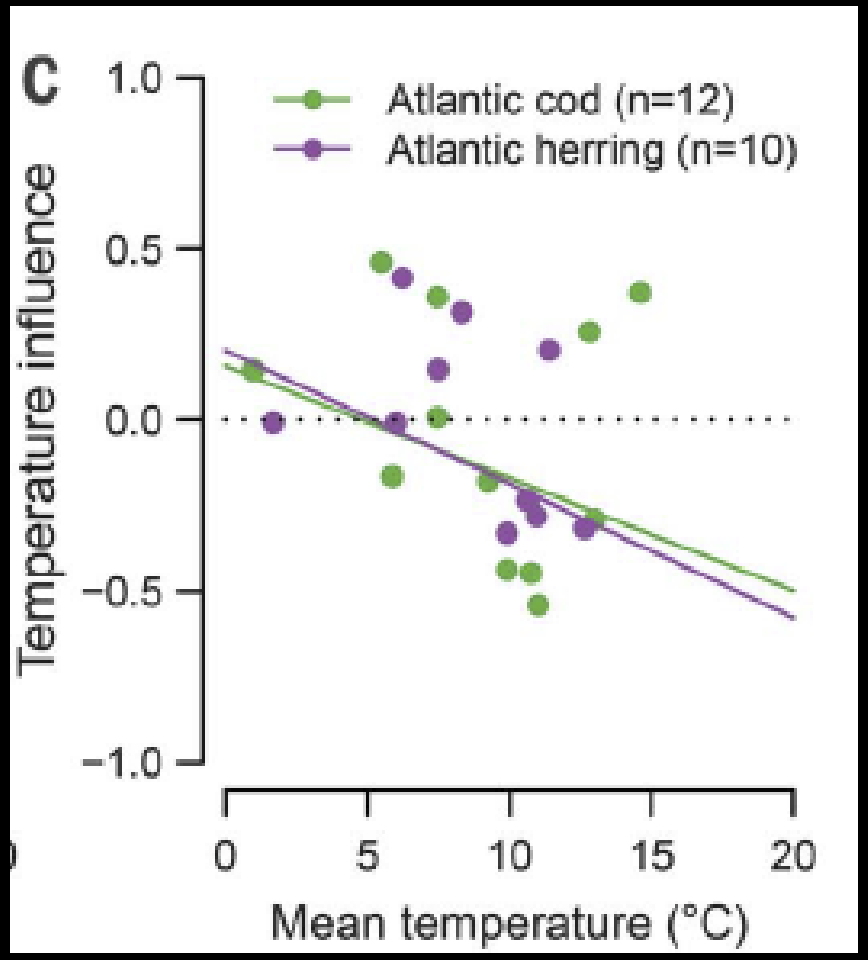
Larger and more significant responses of populations with fast life histories



Free et al. 2019

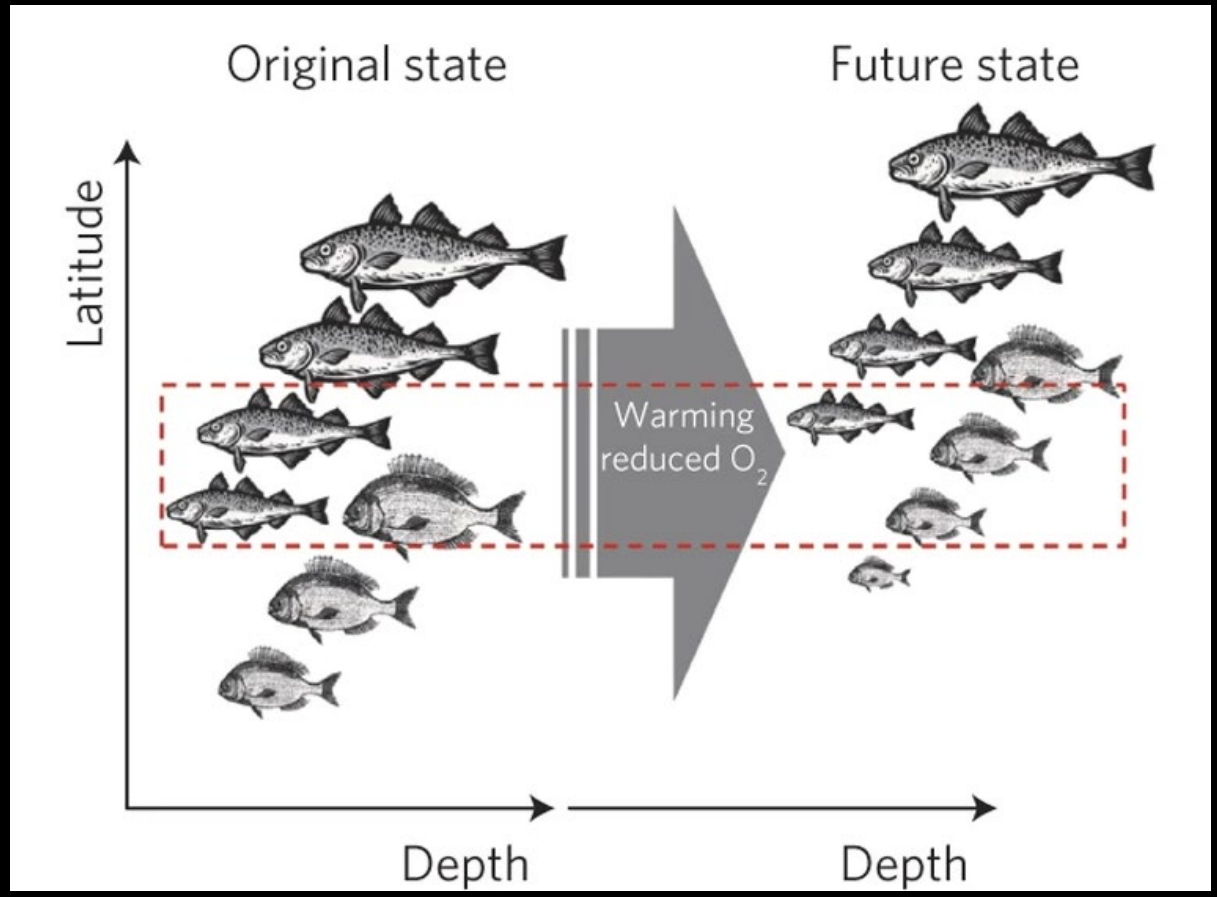
Changes in stock productivity

Negative influences of species at the southern extent of their range



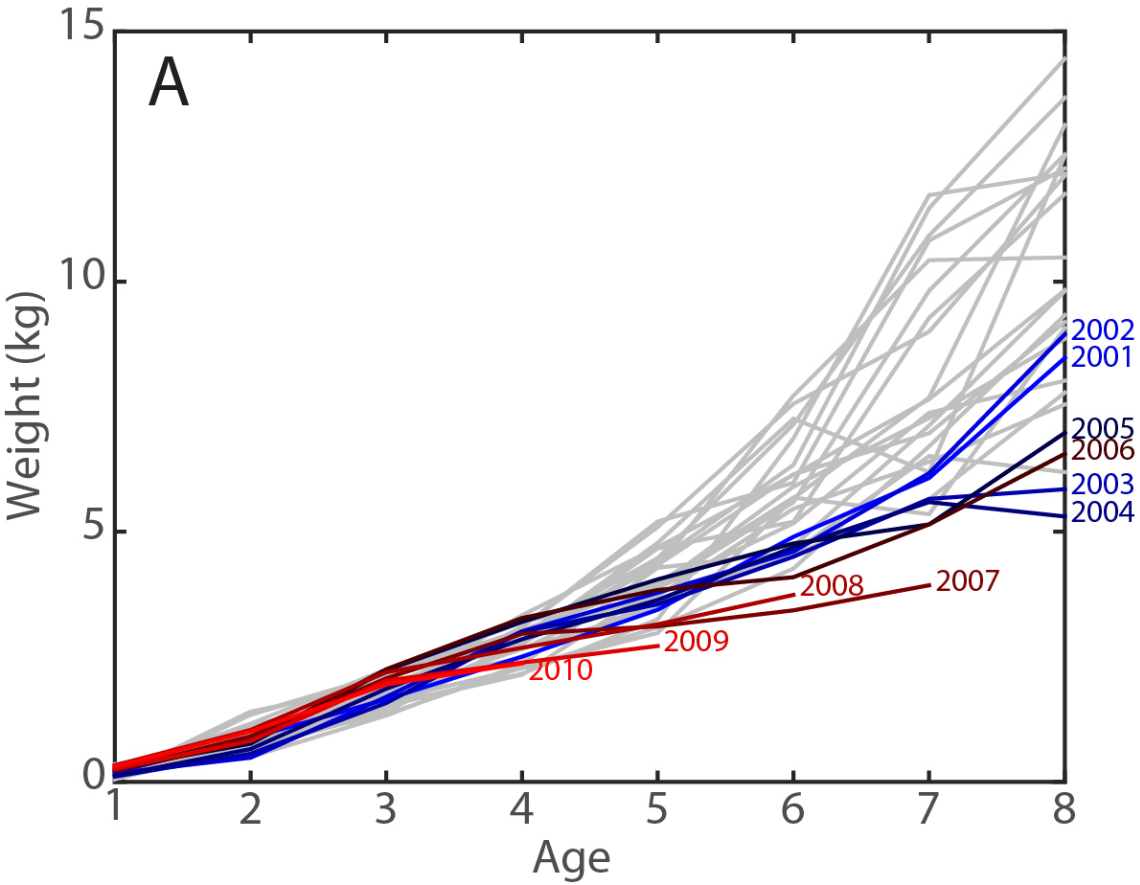
Free et al. 2019

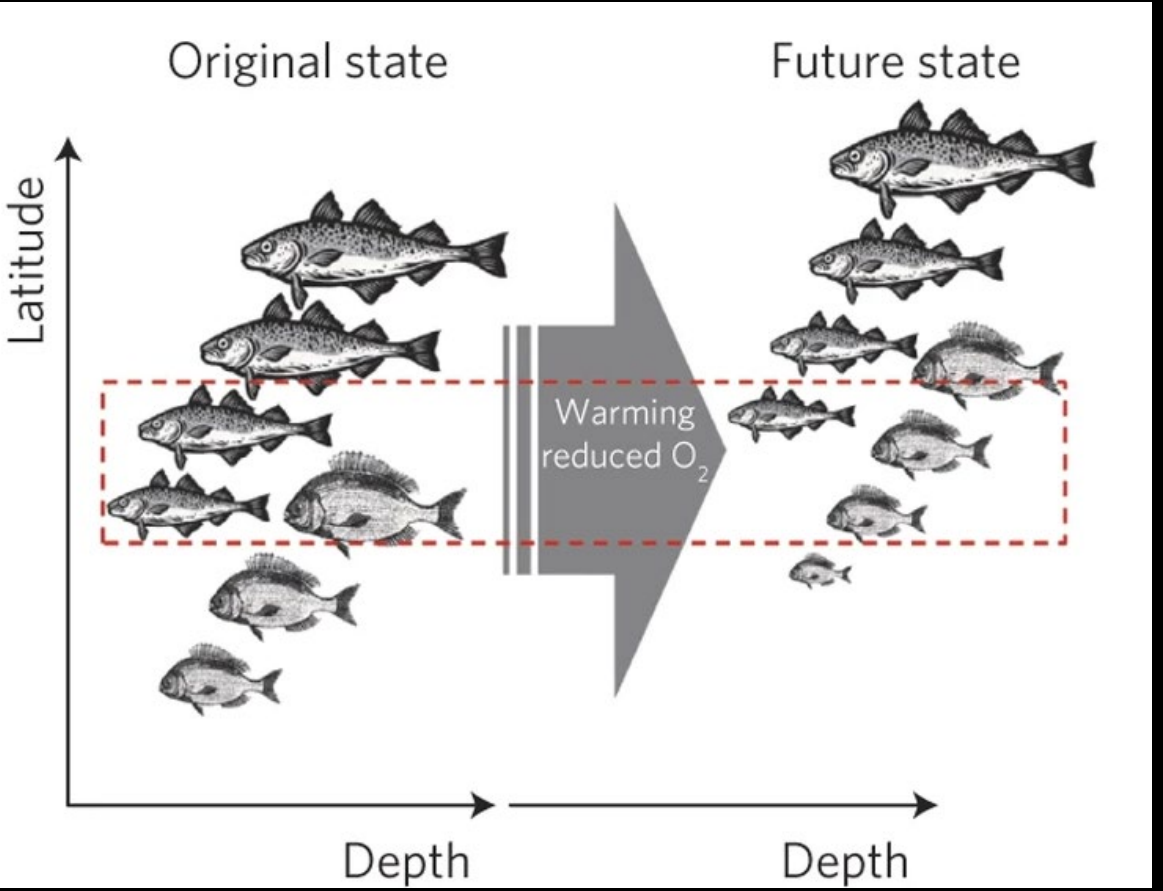
Smaller body size



Cheung et al. 2012 – Shrinking of fishes…, Natural climate change

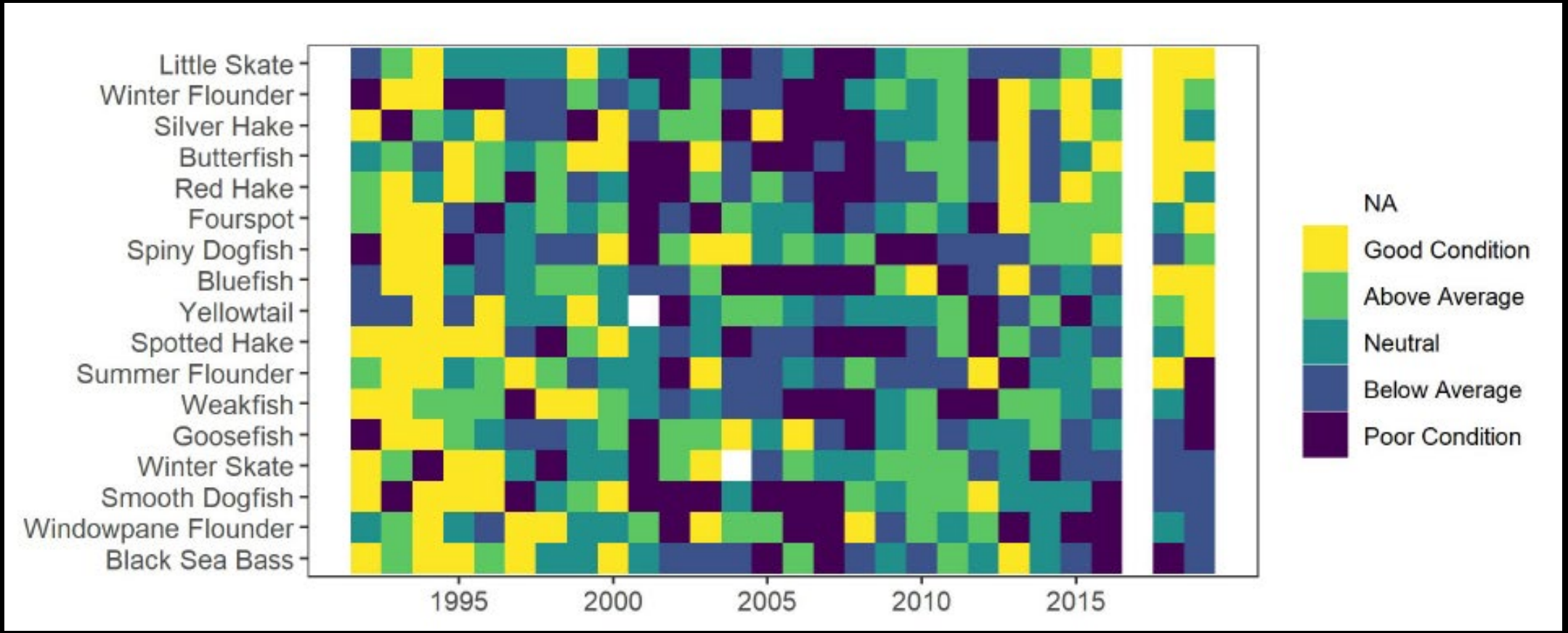
Smaller body size



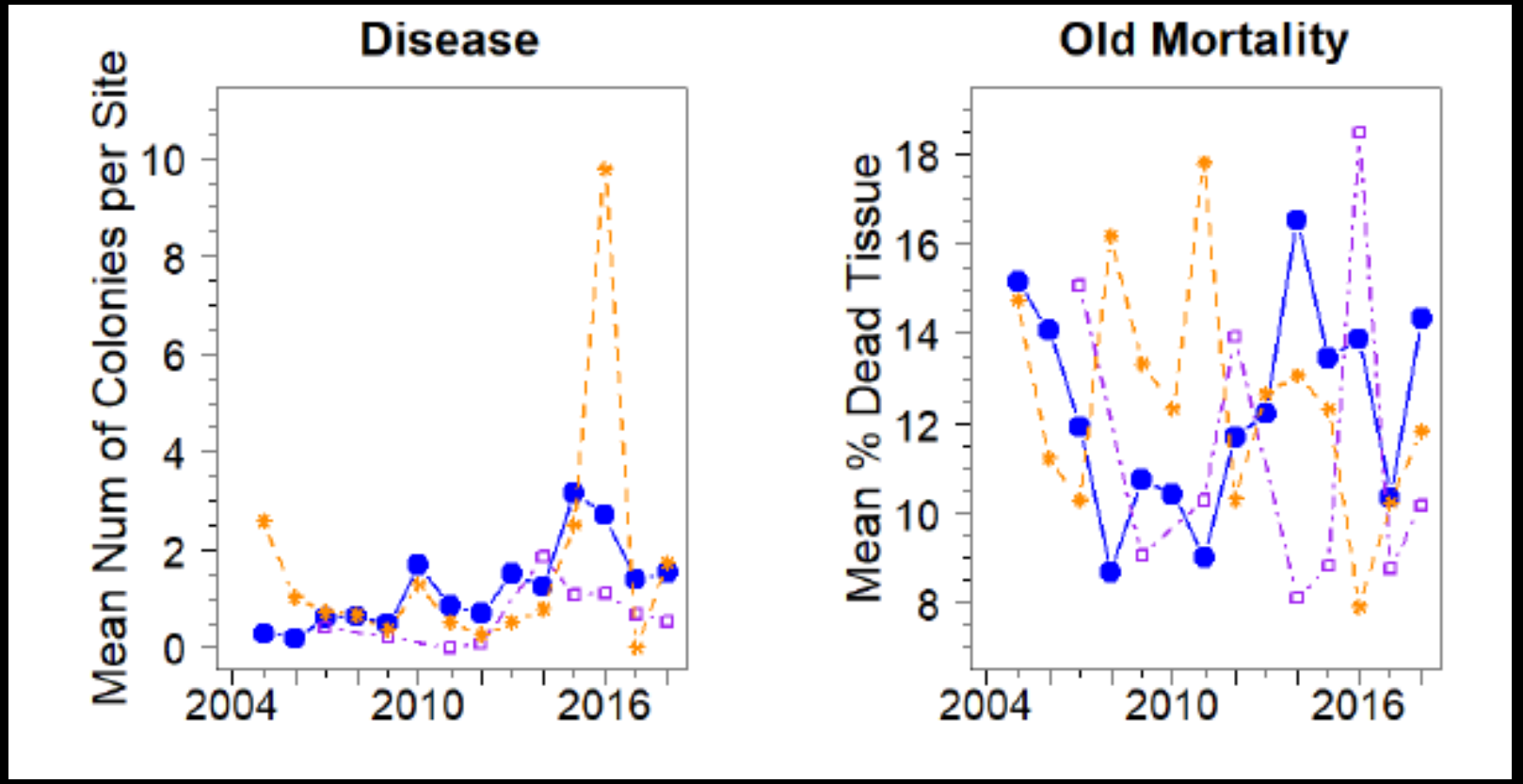


Cheung et al. 2012 – Shrinking of fishes…, Natural climate change

Changes in body size and condition

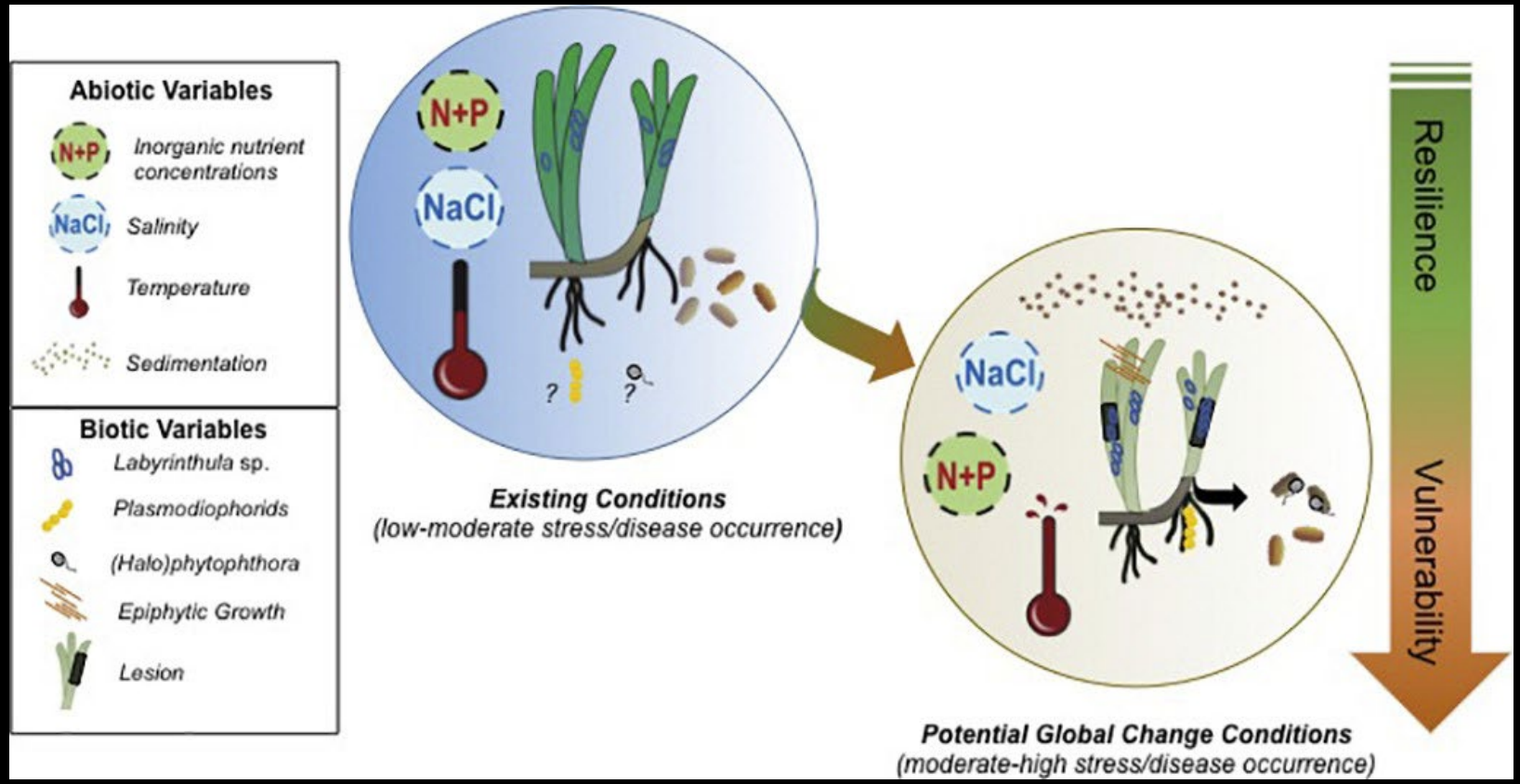


Disease



US South Atlantic Ecosystem Status Report 2021

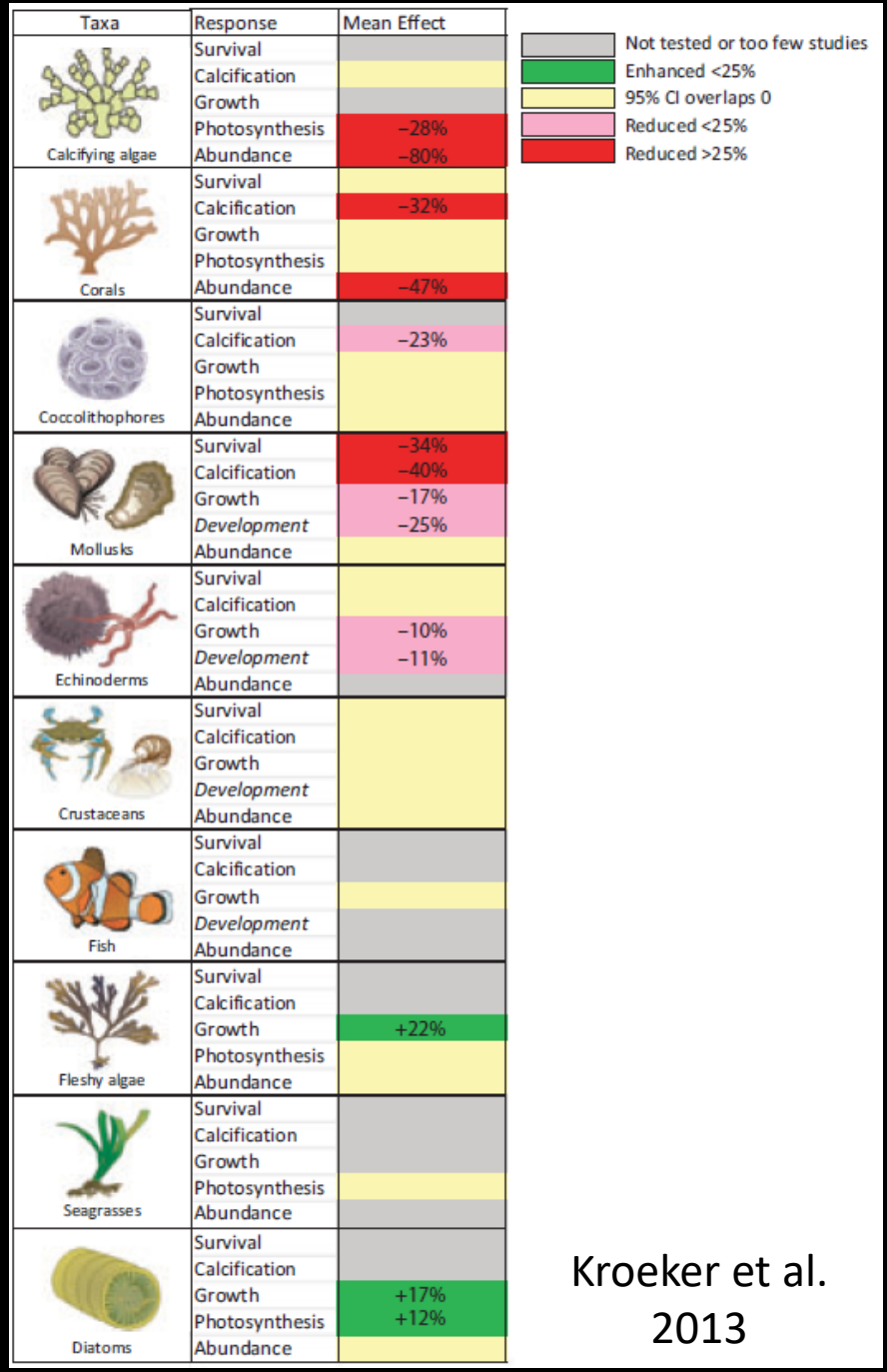
Disease



Sullivan et al. 2018

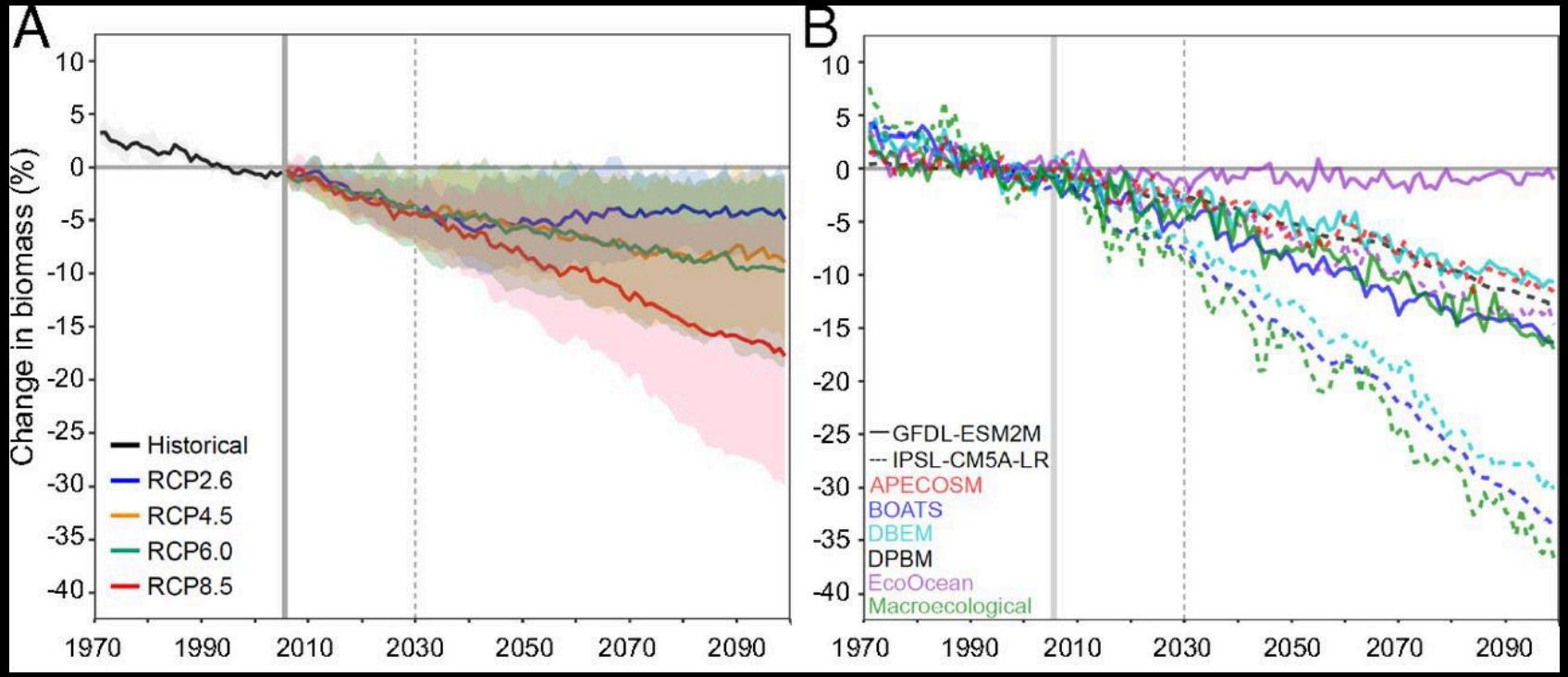
Ocean acidification

- Temperature seems to have a stronger effect than acidification
- The combined effect of temperature, hypoxia and ocean acidification can be synergistic
- Multistressor studies are needed



Kroeker et al. 2013

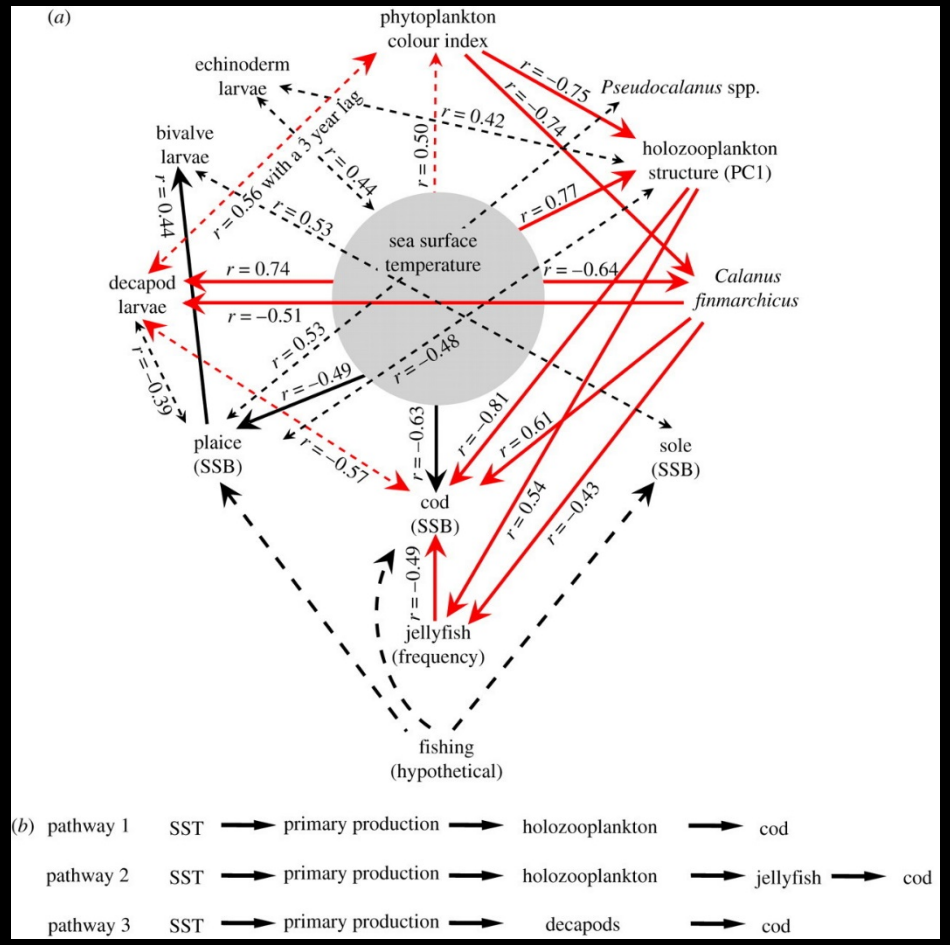
Declines in primary productivity



Lotze et al .2019

Trophic amplification

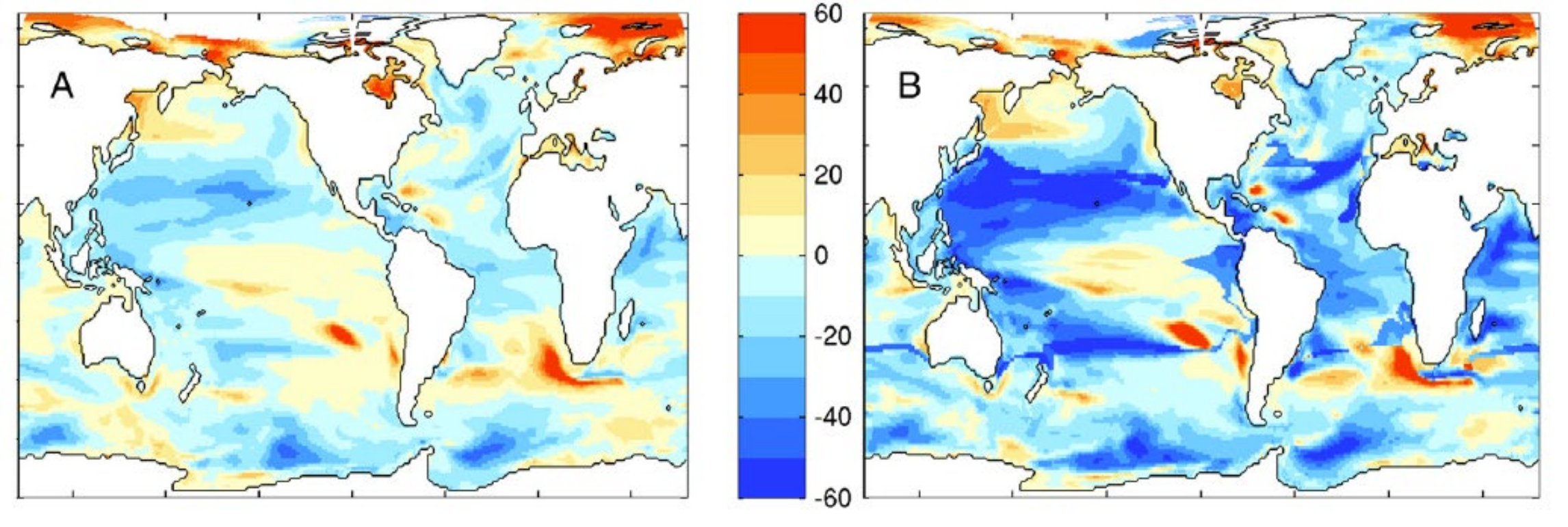
Intensification of stressor through indirect trophic pathways in the food web



Kirby and Beaugrand 2009

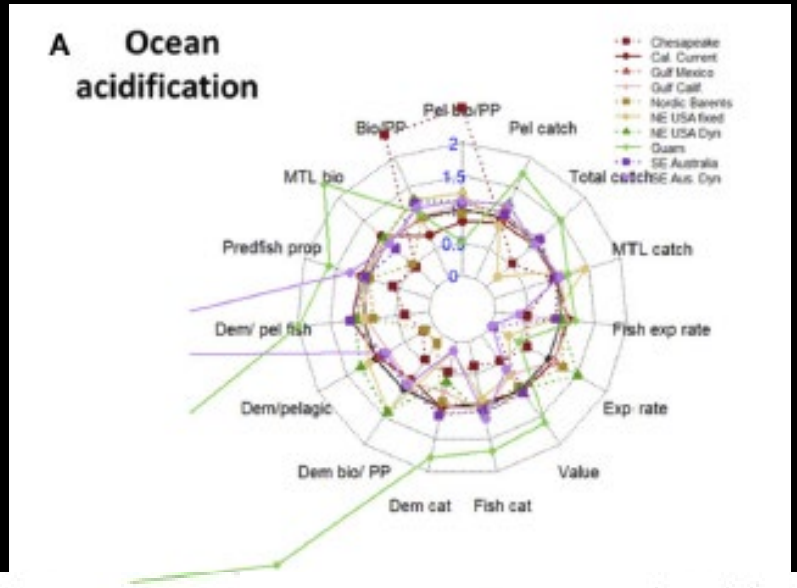
Trophodynamic factors amplify the effects of declines in primary productivity

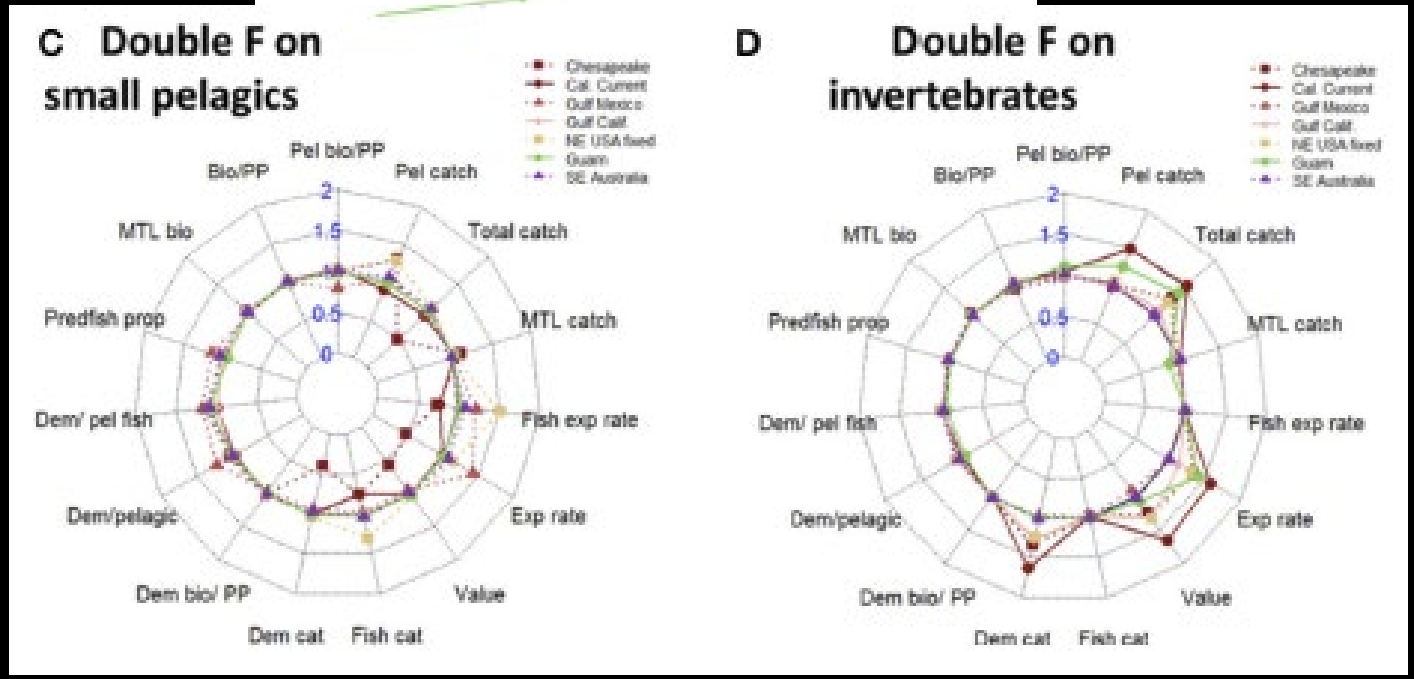
Net Primary Productivity **Fish Catch**



Stock et al. 2017

Trophic amplification



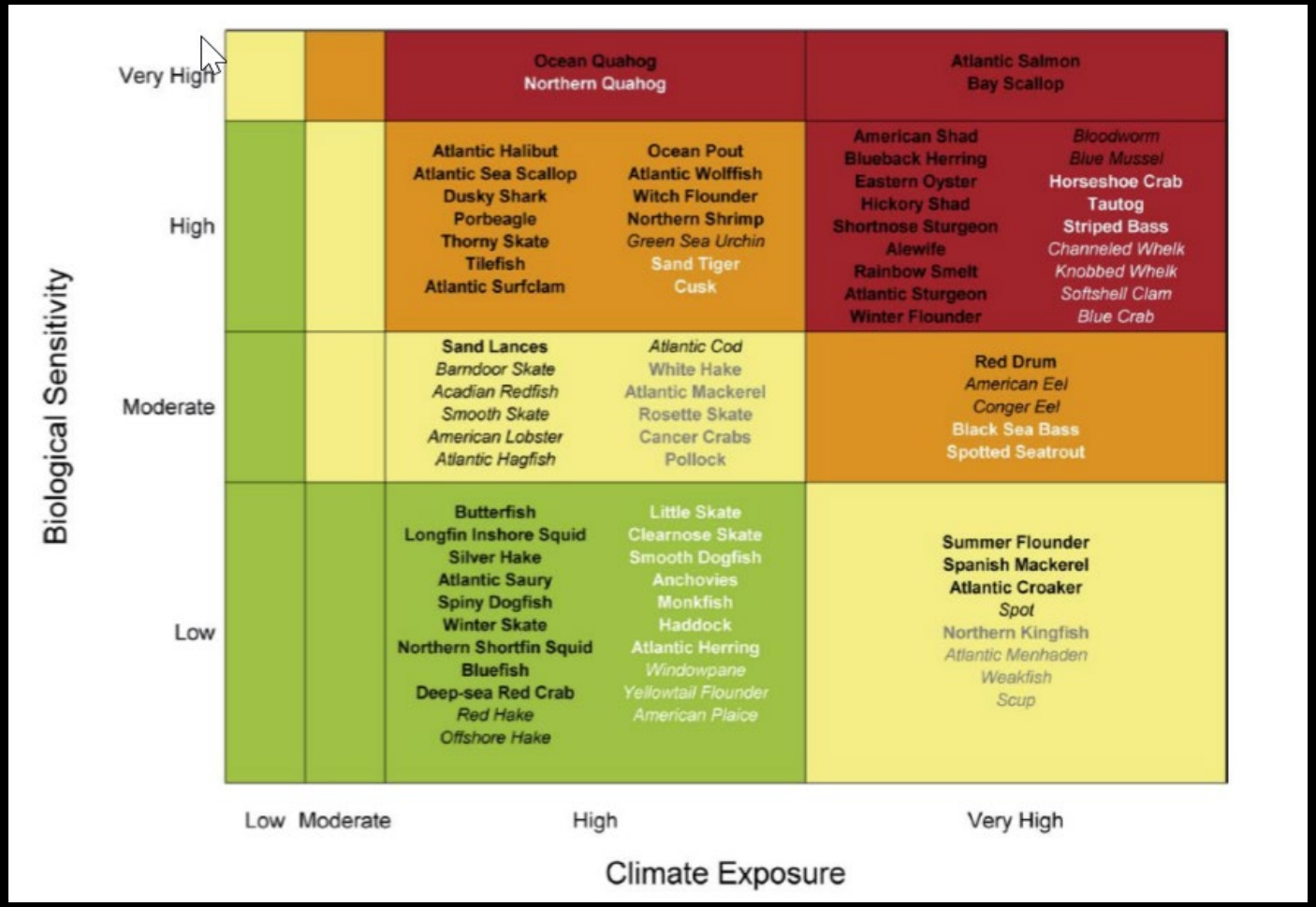


Olsen et al. 2018

Thanks for listening

Now let’s discuss!

Vulnerability assessments and trait-mediated responses



Hare et al. 2016