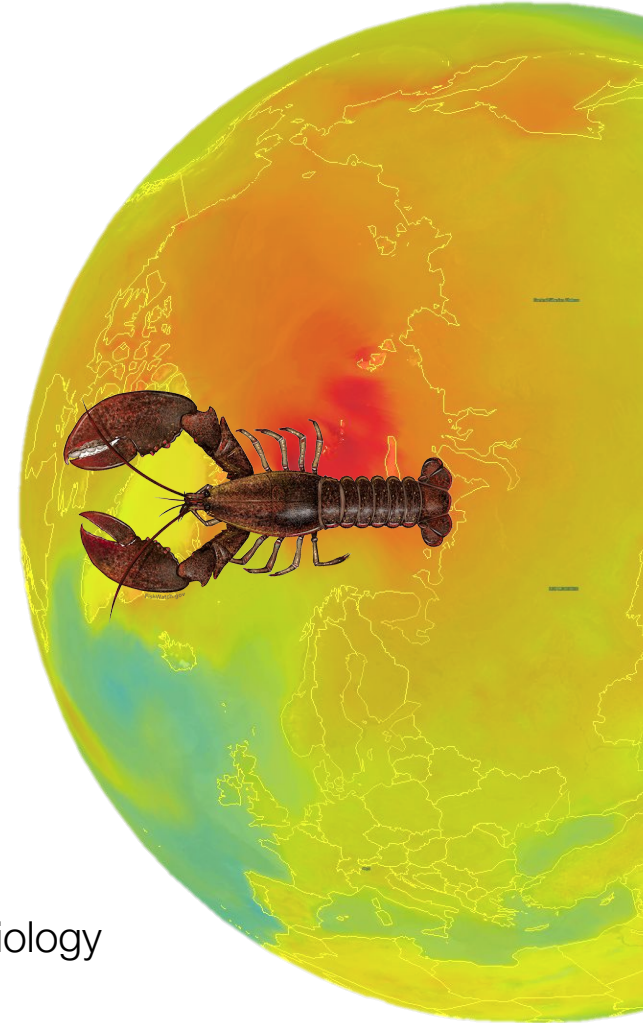
Species distributions and changes in climate



Malin Pinsky

mpinsky@ucsc.edu

UNIVERSITY OF CALIFORNIA SANTA CRUZ

Department of Ecology and Evolutionary Biology

1. Species move to new locations as climate changes, reshaping ecosystems & society

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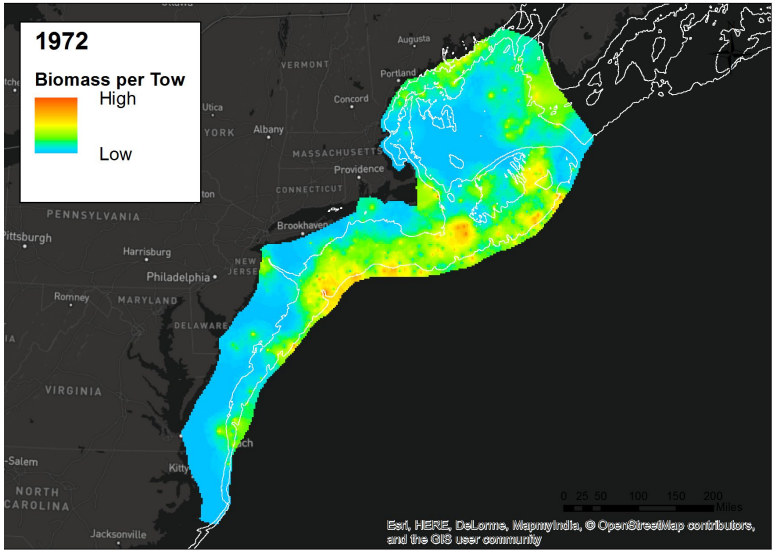
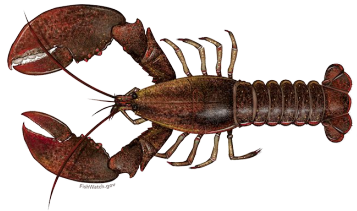
Marine species are shifting quickly

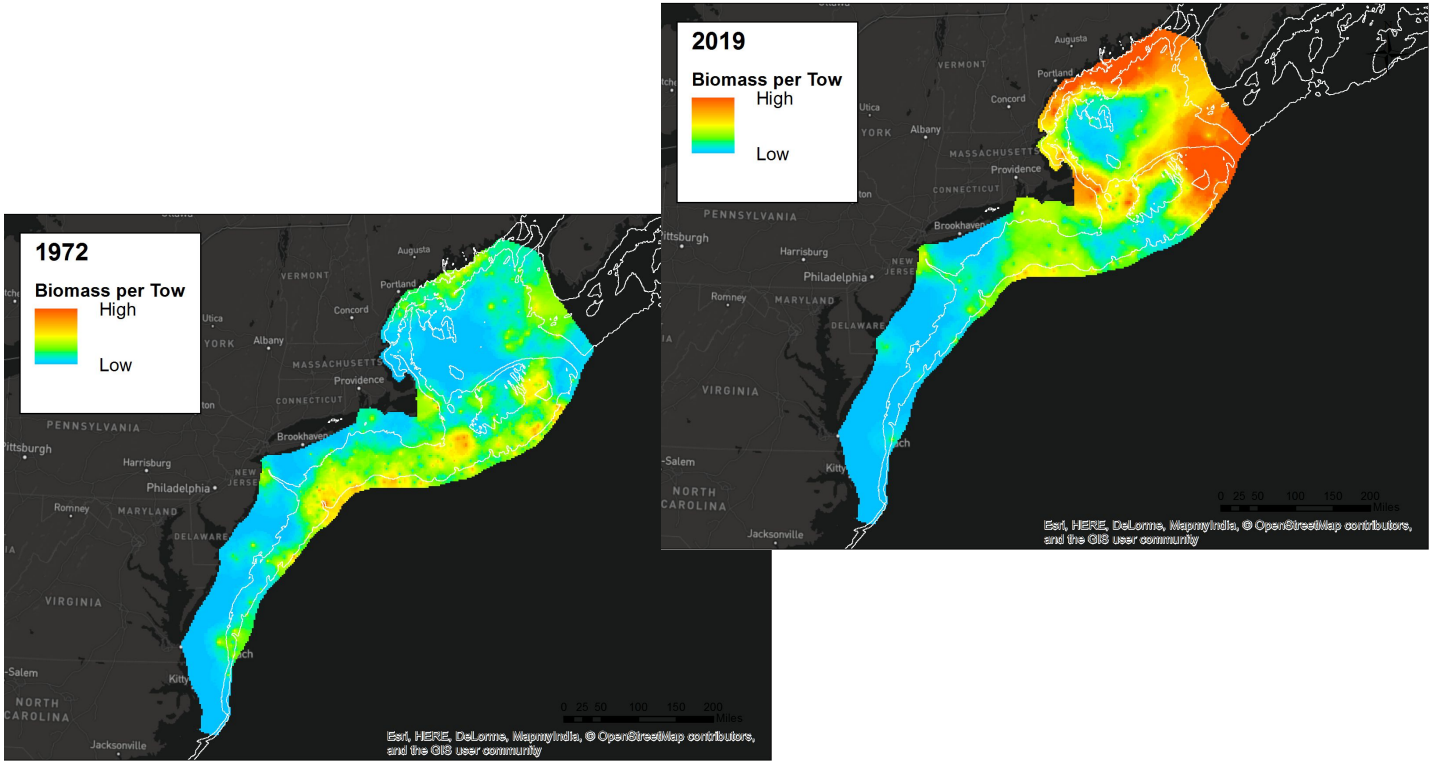


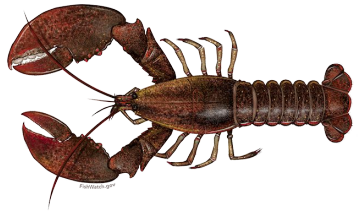


American lobster
Homarus americanus

http://oceanadapt.rutgers.edu from NEFSC Fall data

Marine species are shifting quickly





American lobster
Homarus americanus

http://oceanadapt.rutgers.edu from NEFSC Fall data

Marine species are shifting quickly

59

± 9
km/decade

11

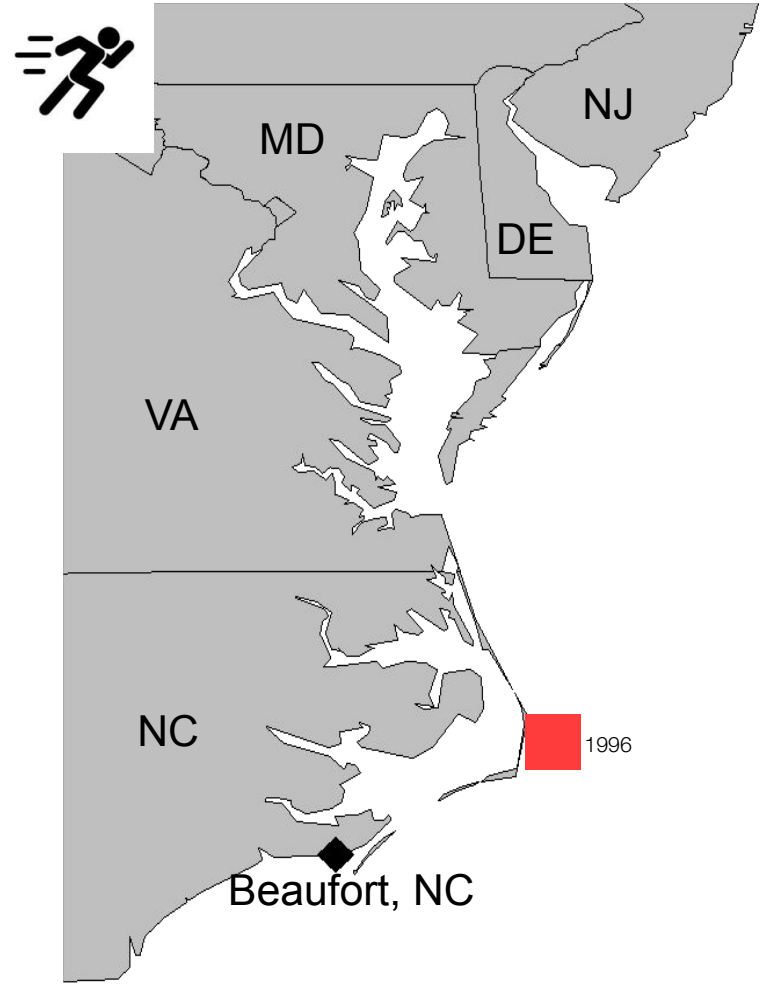
± 10
km/decade

Lenoir *et al.* 2020 *Nature Ecology & Evolution*

Reshaping ecosystems

Wernberg *et al.* 2016 *Science*

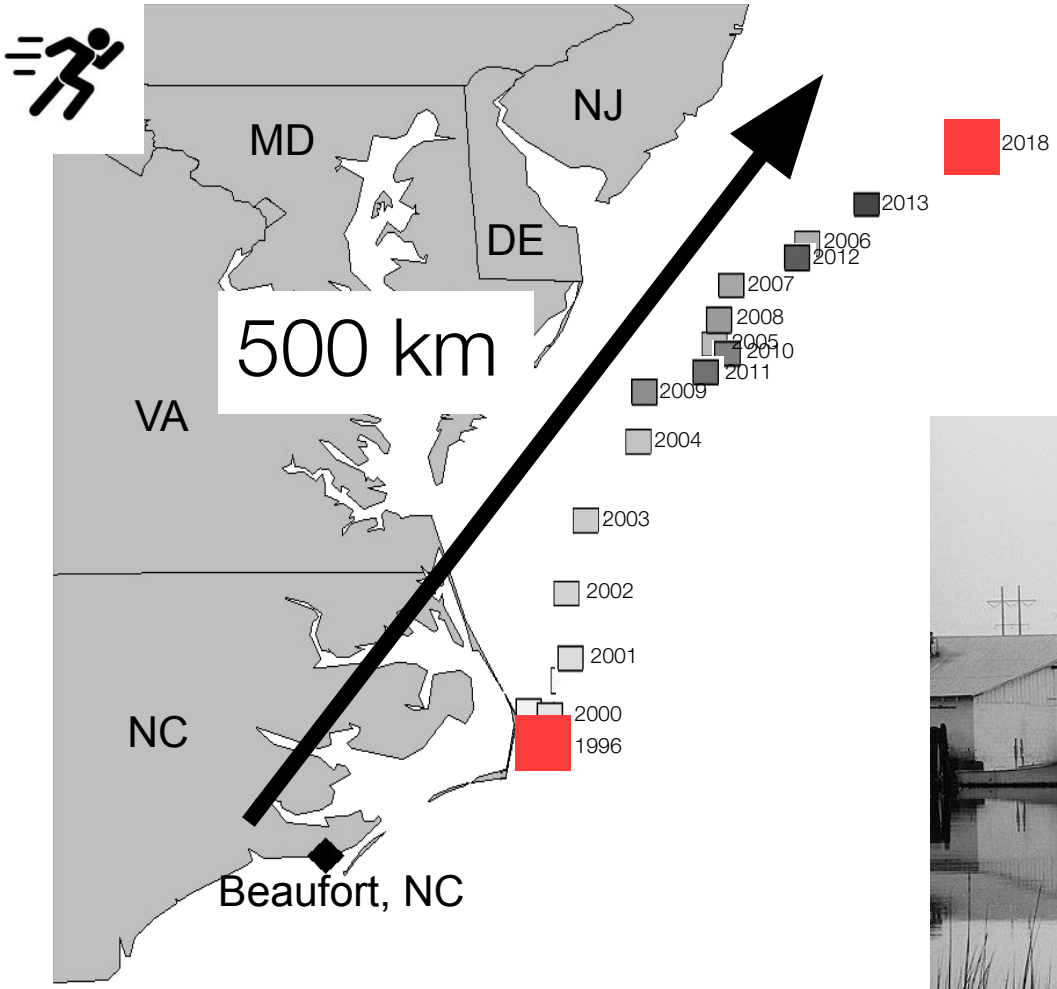
Reshaping society



1996

Young *et al.* 2019 *ICES J Marine Science*; Dubik *et al.* 2019 *Marine Policy*

Reshaping society



2014

Young *et al.* 2019 *ICES J Marine Science*; Dubik *et al.* 2019 *Marine Policy*

Reshaping society

$1+ Billion

national annual losses from fisheries
(high emissions scenario, no adaptation)

Moore *et al.* 2021 *Climate Change Economics*

Reshaping society

$1+ Billion

national annual losses from fisheries
(high emissions scenario, no adaptation)

Conflict

Moore *et al.* 2021 *Climate Change Economics*; Pinsky *et al.* 2018 *Science*

…and yet we don’t understand why they’re happening

Distribution shifts

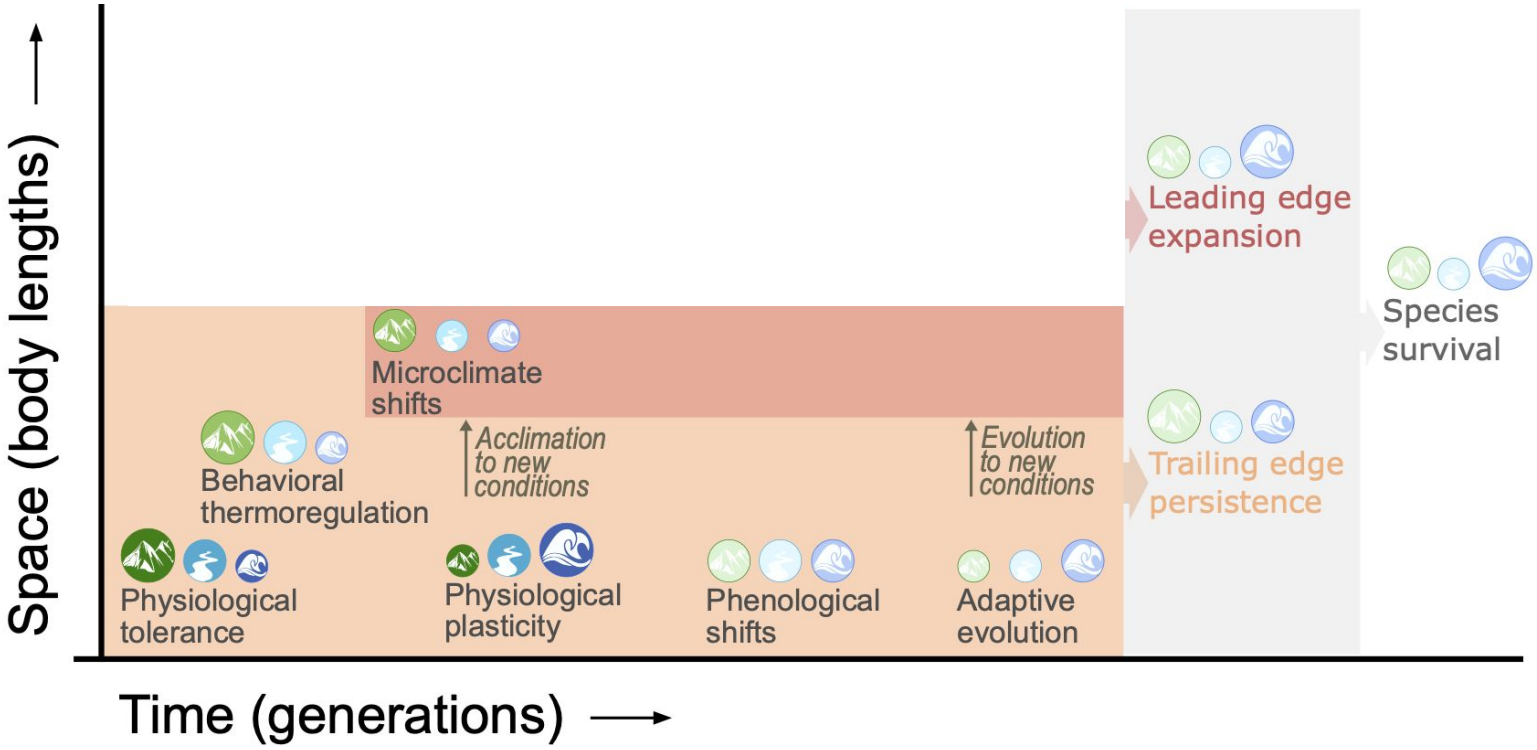
?

Climate &
oceanography

Processes driving distribution shifts

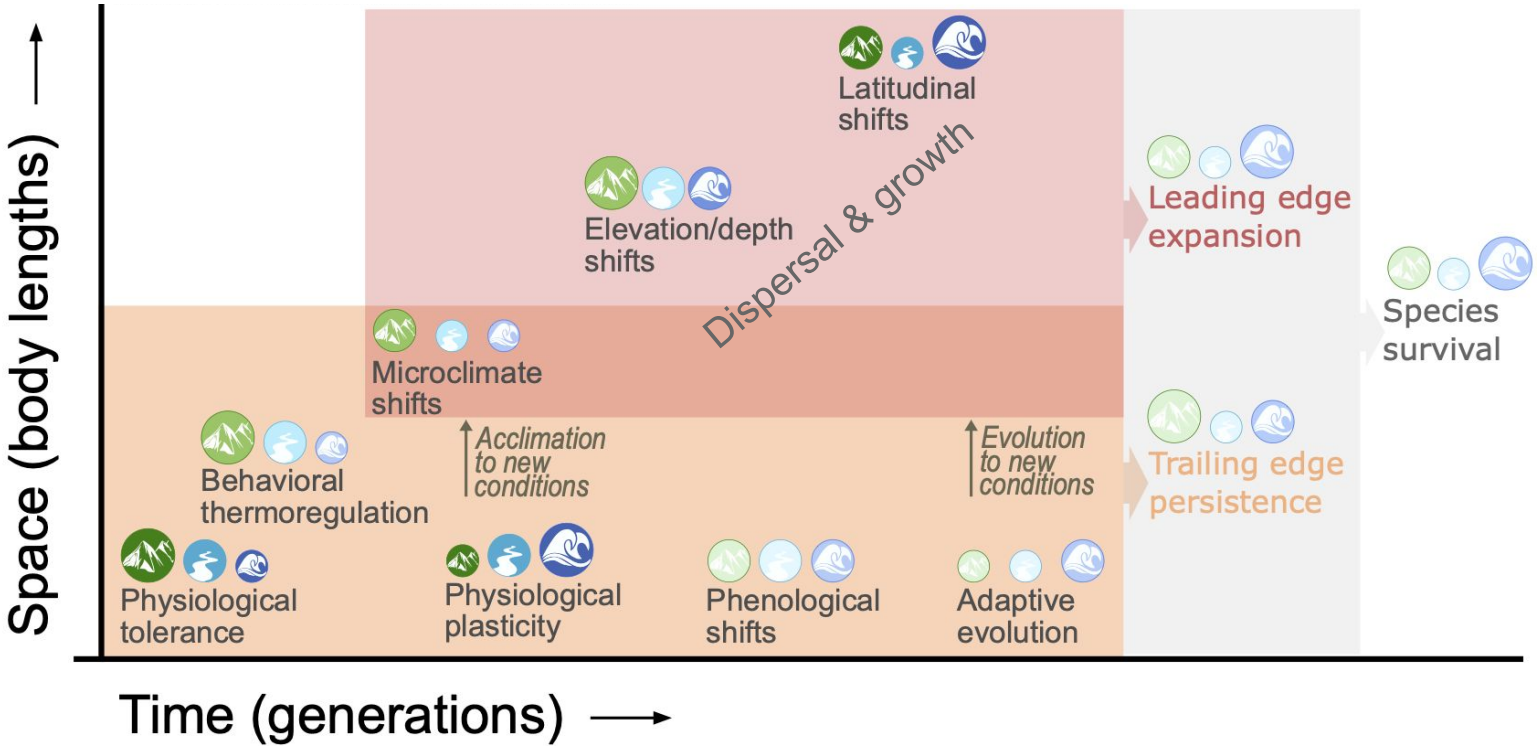
Pinsky *et al.* 2022 *Trends in Ecology & Evolution*

Why do species persist in place?



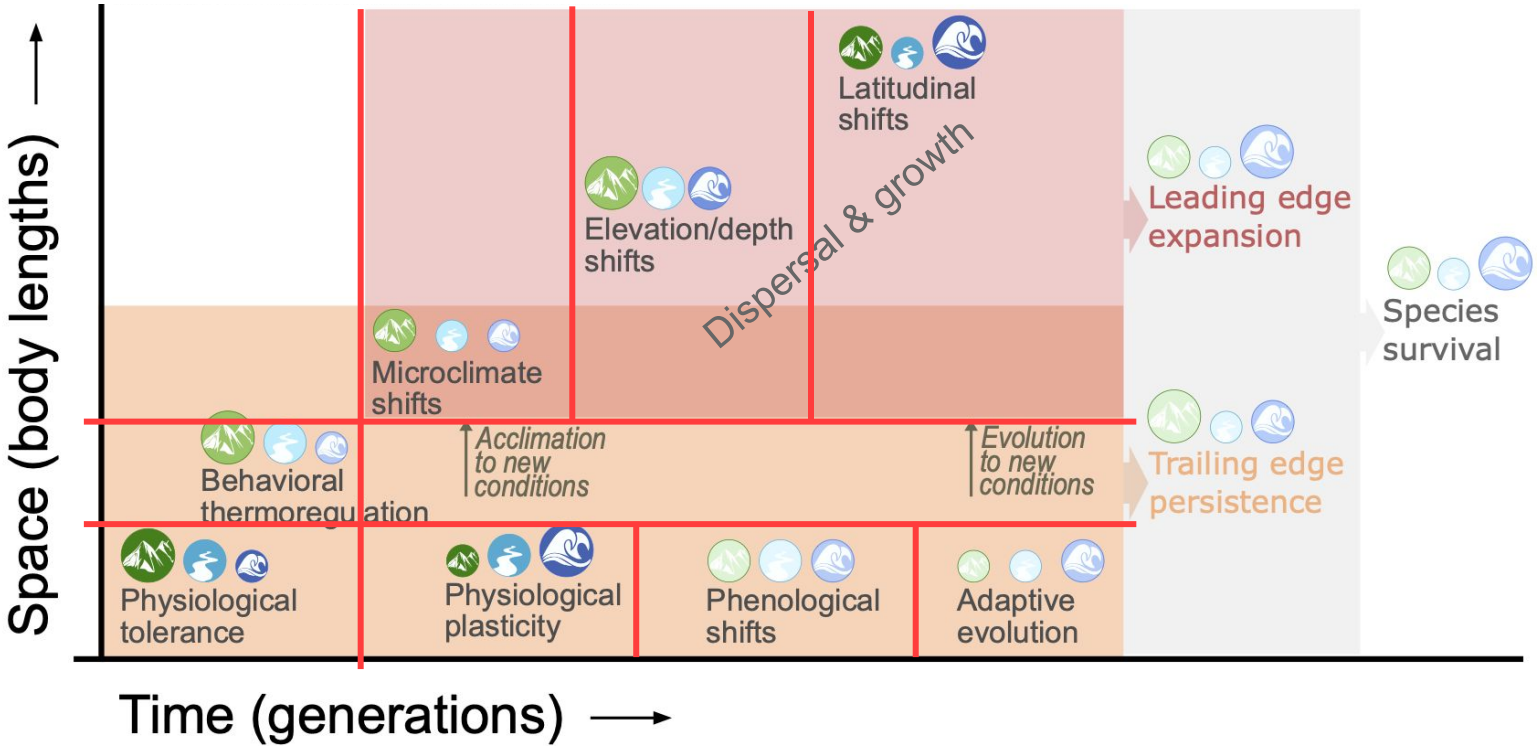
Pinsky *et al.* 2022 *Trends in Ecology & Evolution*

Why do species expand into new habitat?



Pinsky *et al.* 2022 *Trends in Ecology & Evolution*

Need integration across biological scales



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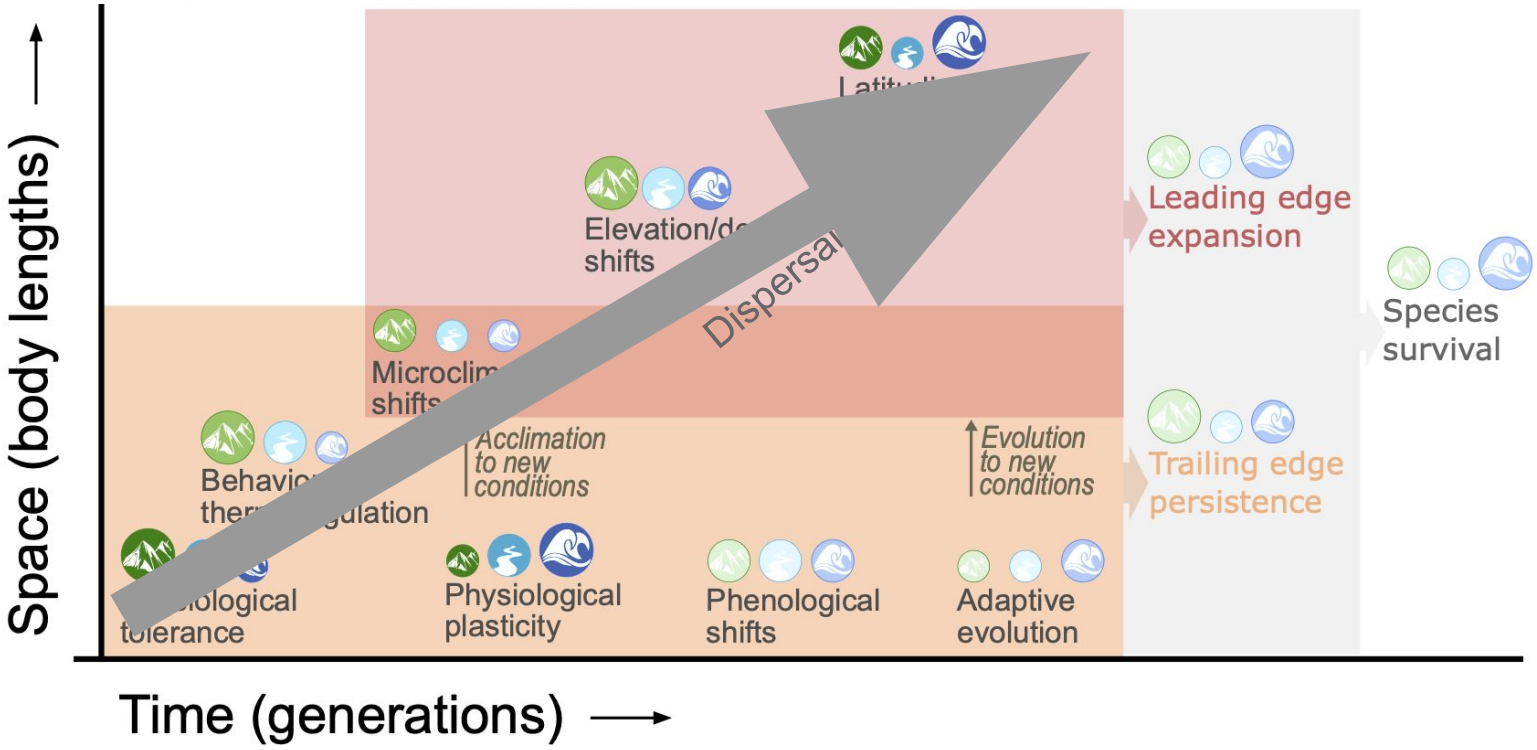
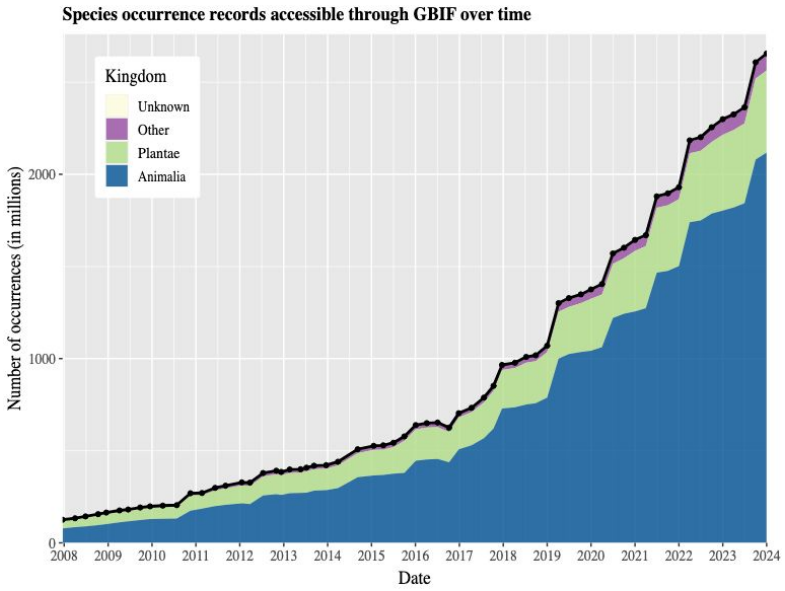
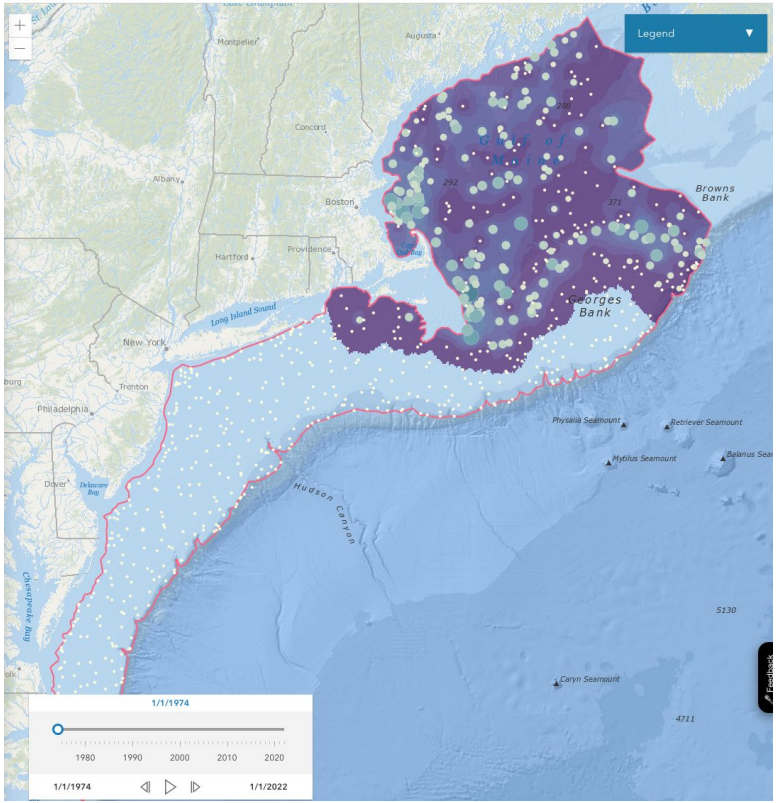


Pinsky *et al.* 2022 *Trends in Ecology & Evolution*

Indirect effects of species interactions

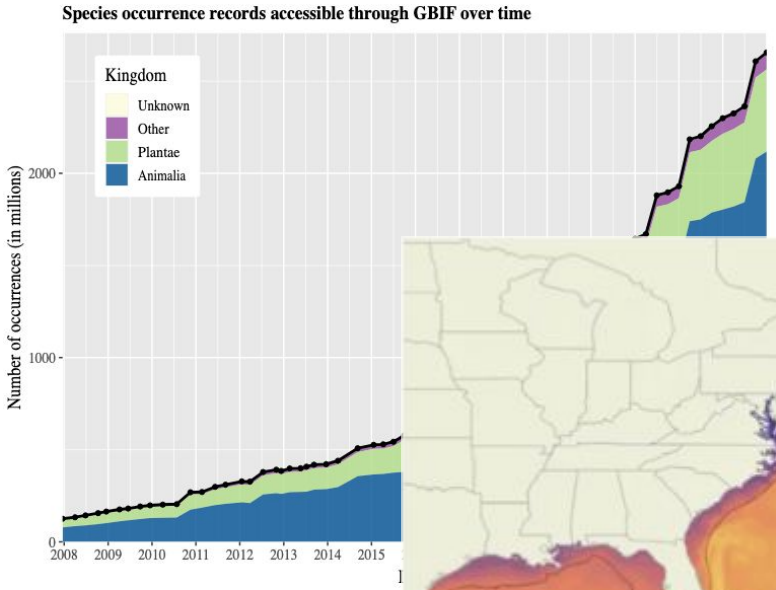
A wealth of observations

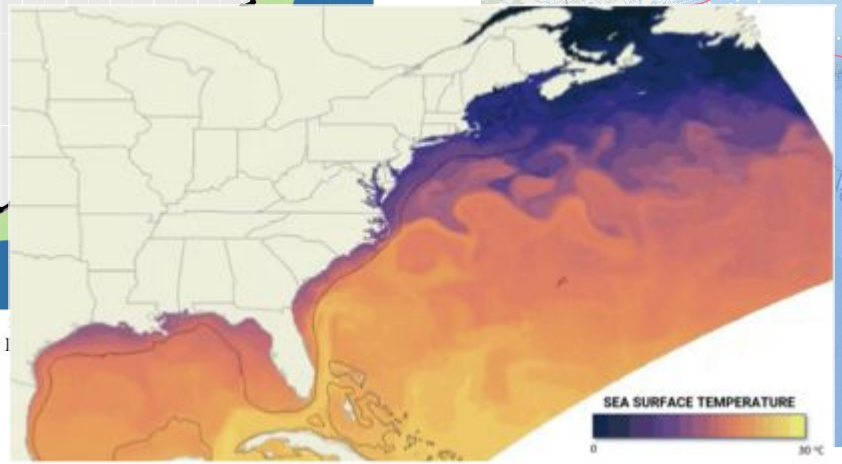


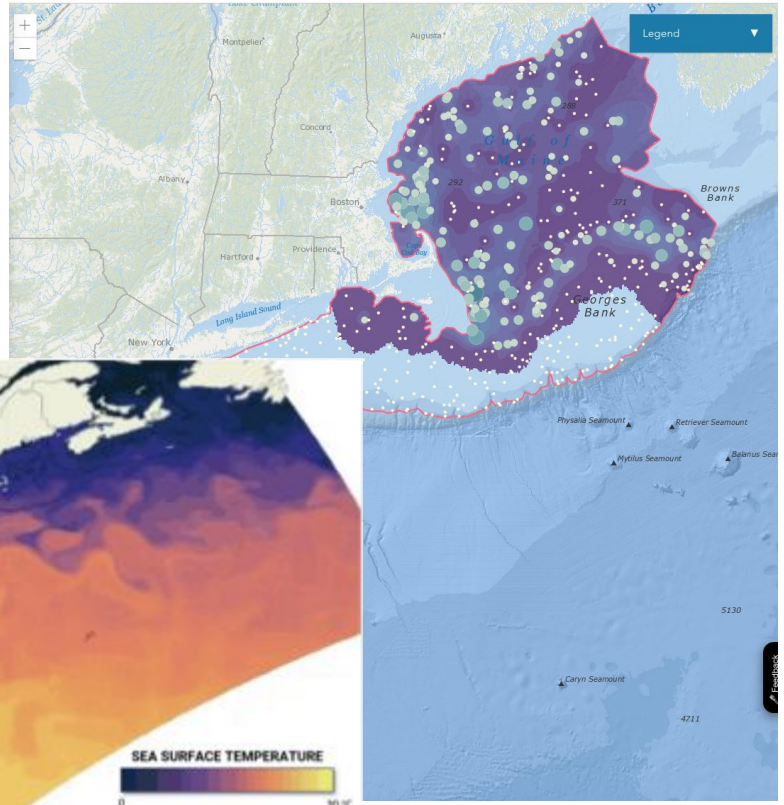


gbif.org, apps-st.fisheries.noaa.gov/dismap/

A wealth of observations







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Integrate data, theory & experiments

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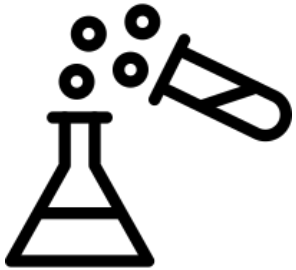
$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

Integrate data, theory & experiments

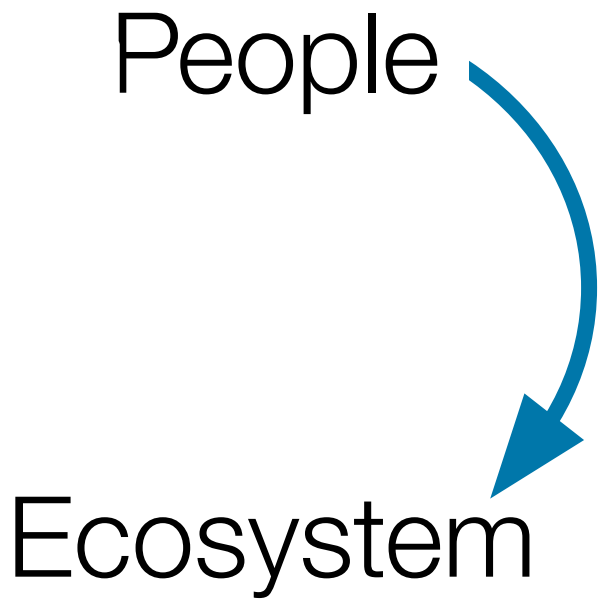


$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

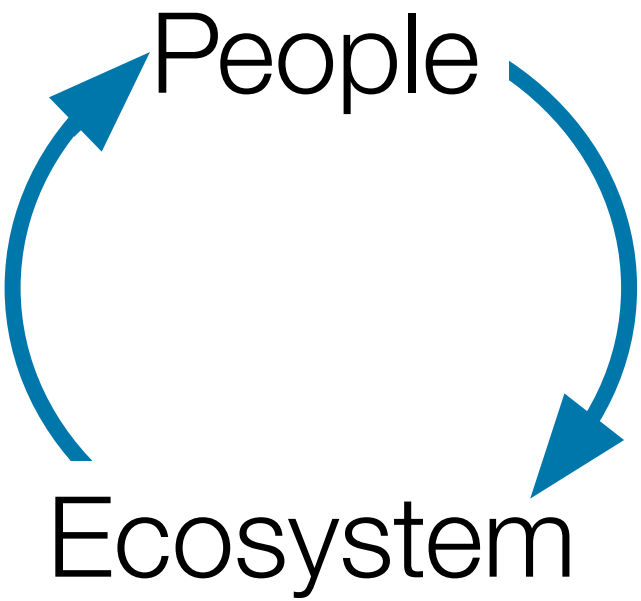
Proposal:

Program focused on integrating experiments, models, and observations to understand climate-driven shifts in species distributions

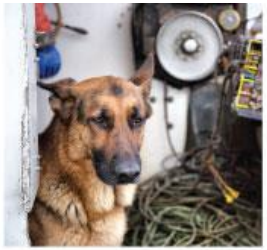
Social-ecological feedbacks



Social-ecological feedbacks



How does adaptation occur?

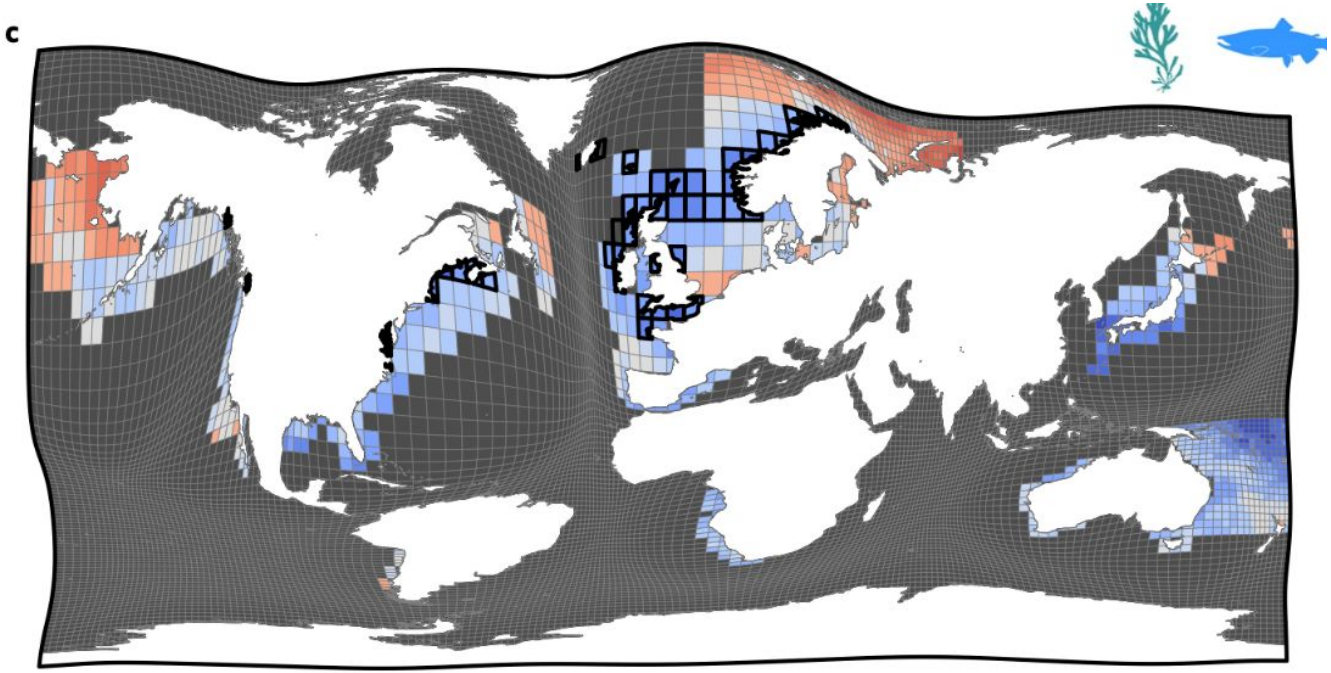


rimonthly.com

Proposal:

Cross-directorate program focused on understanding social-ecological feedbacks in response to species distribution shifts

Infrastructure to observe shifts

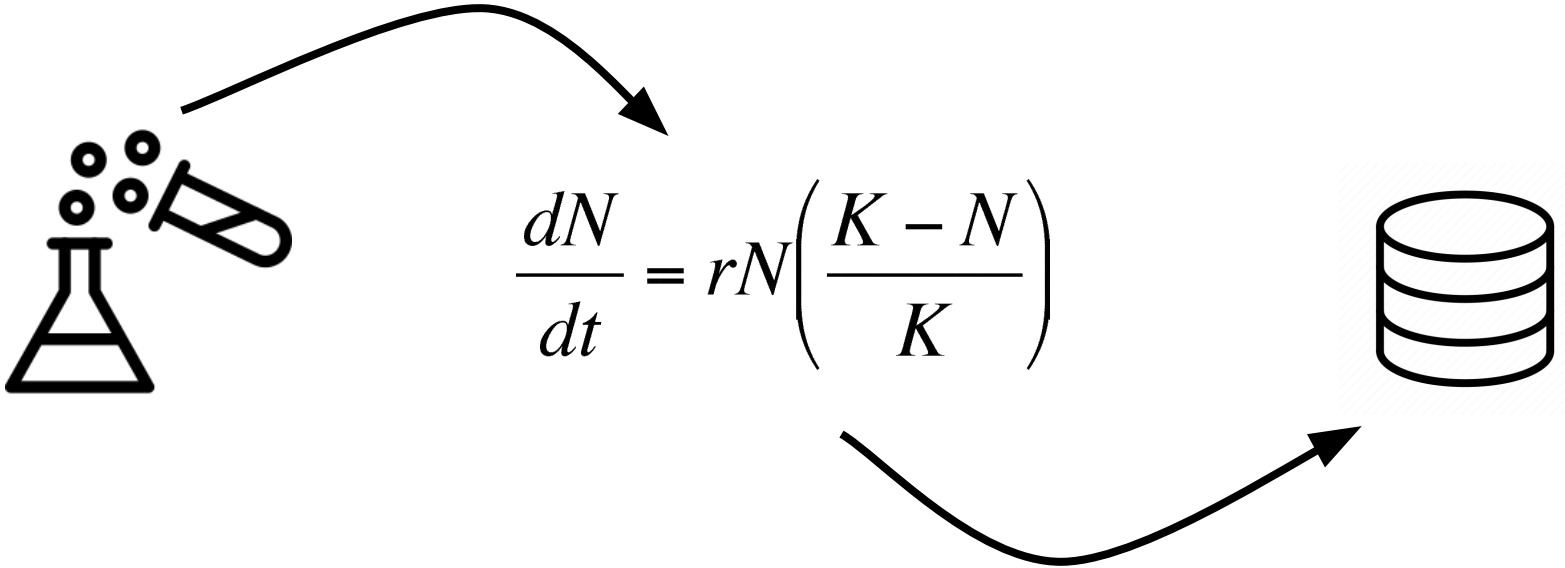


Lenoir *et al.* 2020 *Nature Ecology & Evolution*; Chapman *et al.* 2024 *Science*

Proposal:

“Regional global LTERs”: collaborations to share historical and develop new biodiversity observation programs across broad spatial extents and temporal spans.

Workforce development



Proposal:

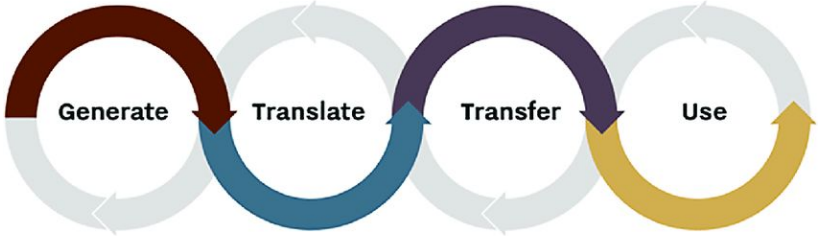
Workforce training for data science to interpret, forecast, and adapt to species distribution shifts

Opportunities beyond NSF

National Security

Living marine resource management

Public climate services



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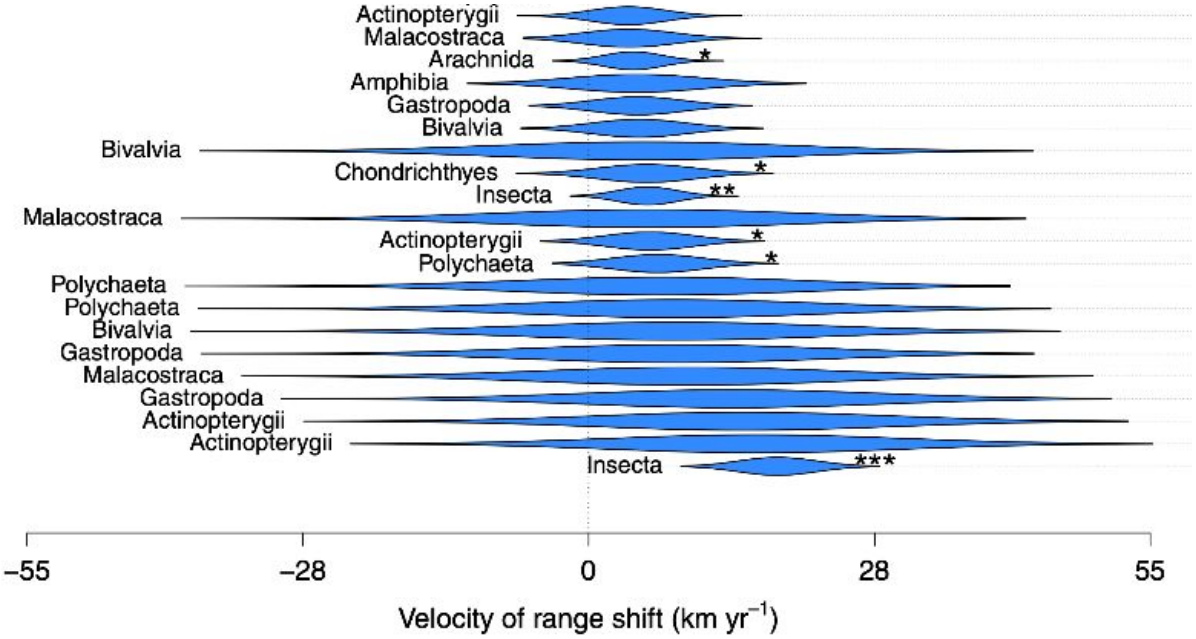
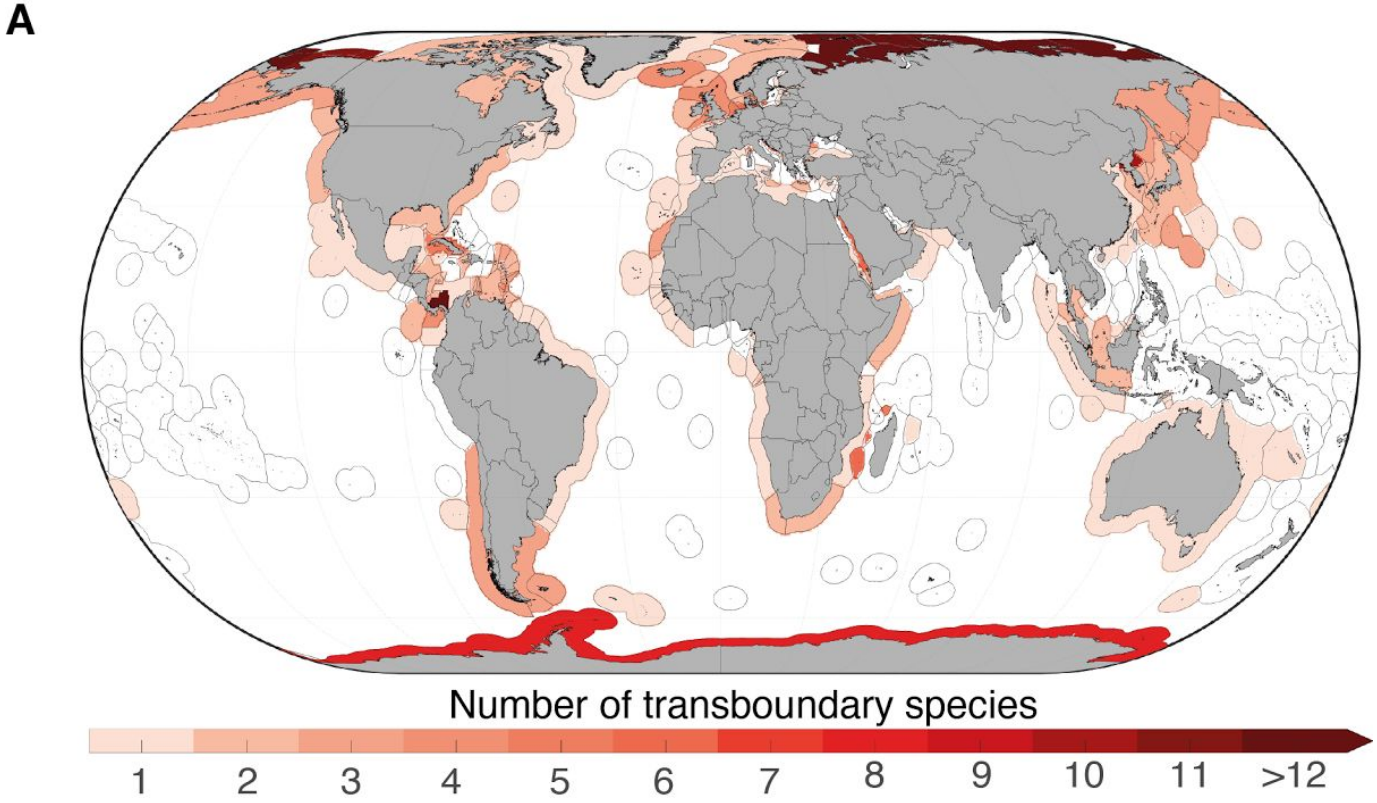
Explain the wide variation in rates of shift



Lenoir *et al.* 2020 *Nature Ecology & Evolution*

Underprepared for fisheries on the move

New transboundary fisheries by 2100



Pinsky *et al.* 2018 *Science*