Modeling ocean acidification in the Bering Sea to support long-term planning and management of the largest U.S. fishery

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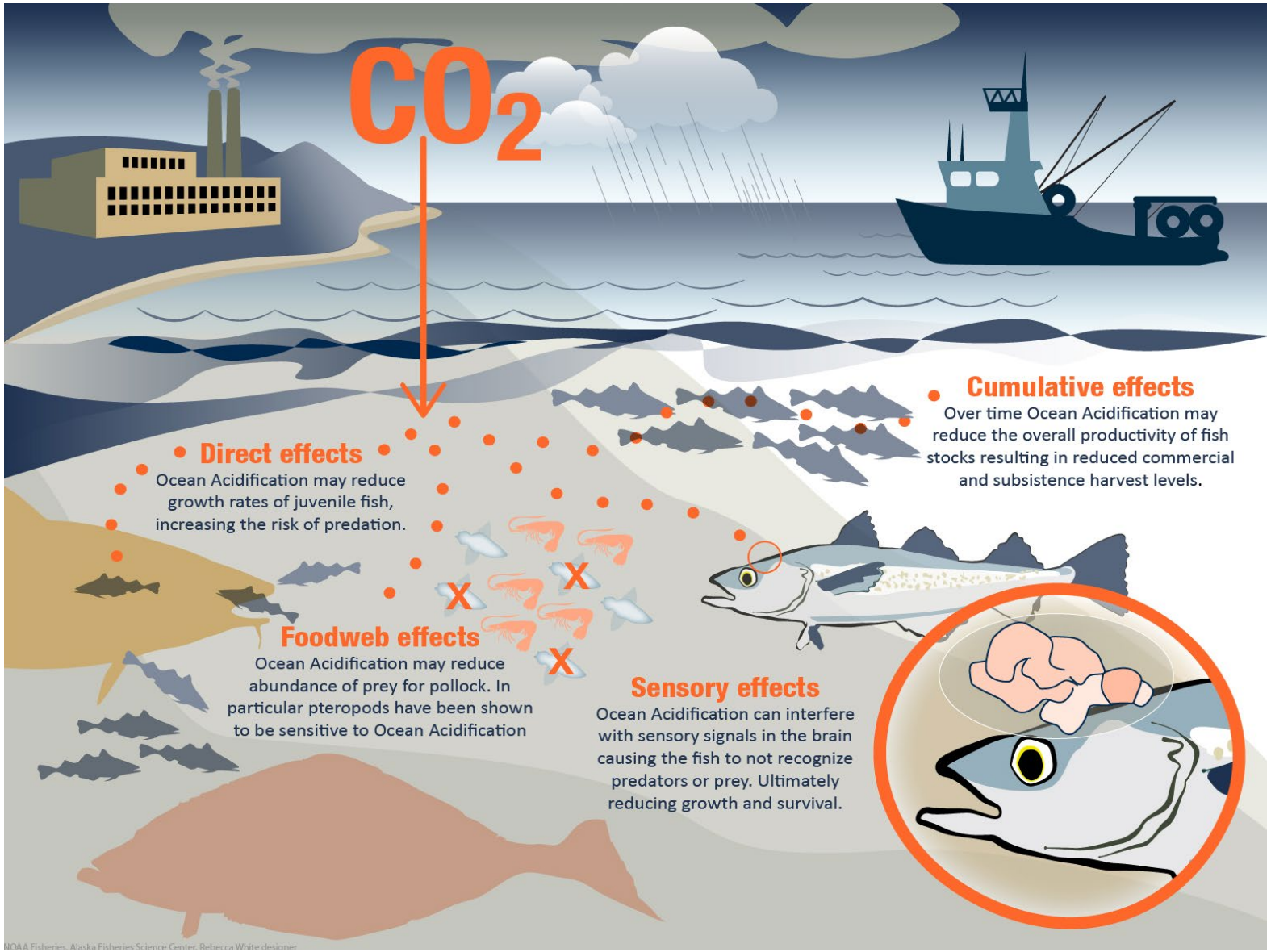
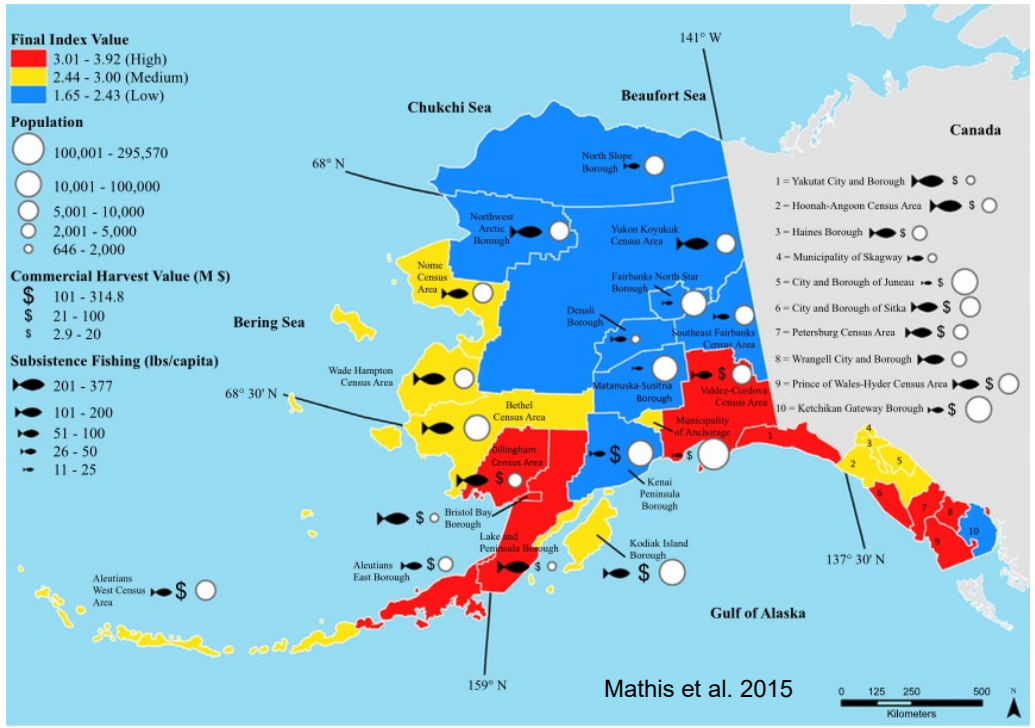
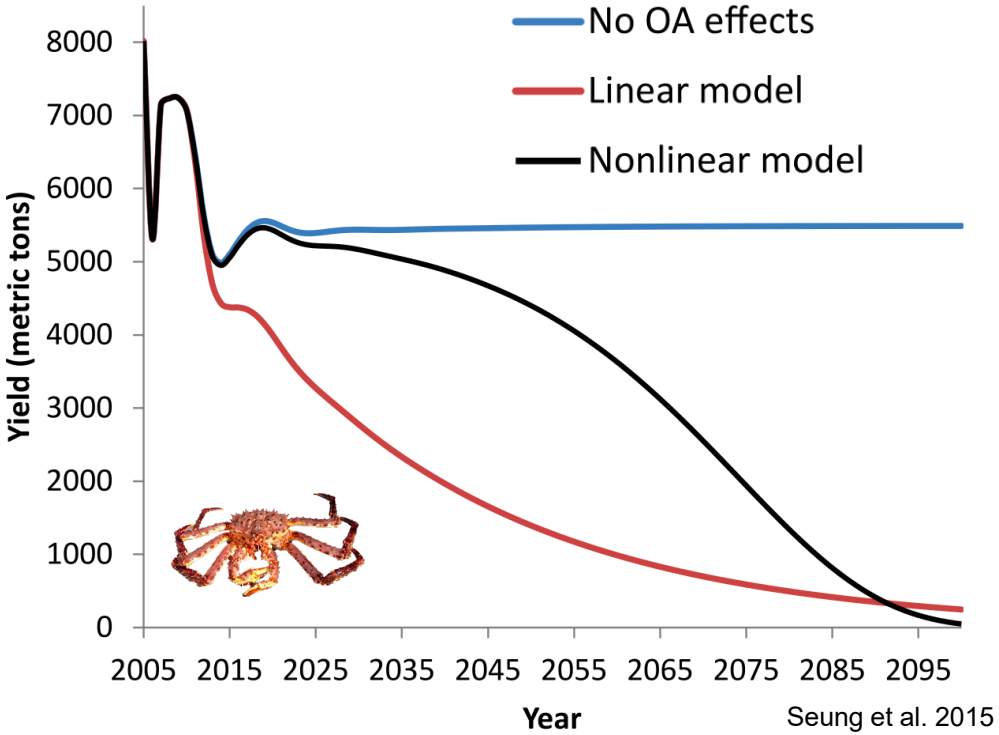
OA Impacts Fish



Ocean Acidification poses a risk to Alaska's fisheries



Mathis et al. 2015



Seung et al. 2015

Alaska lands more fish by weight than every other US state **combined**

Crab fishery accounts for 15% of total fishery

How do we bring OA into fisheries management?

Strategic

- Produce accurate projections of where the system is going
- Supports biological experiments, socioeconomic models, vulnerability assessments

Tactical

- Develop an ecological indicator for the Ecosystem Status Report
- Supports fisheries management council and catch-limit setting process

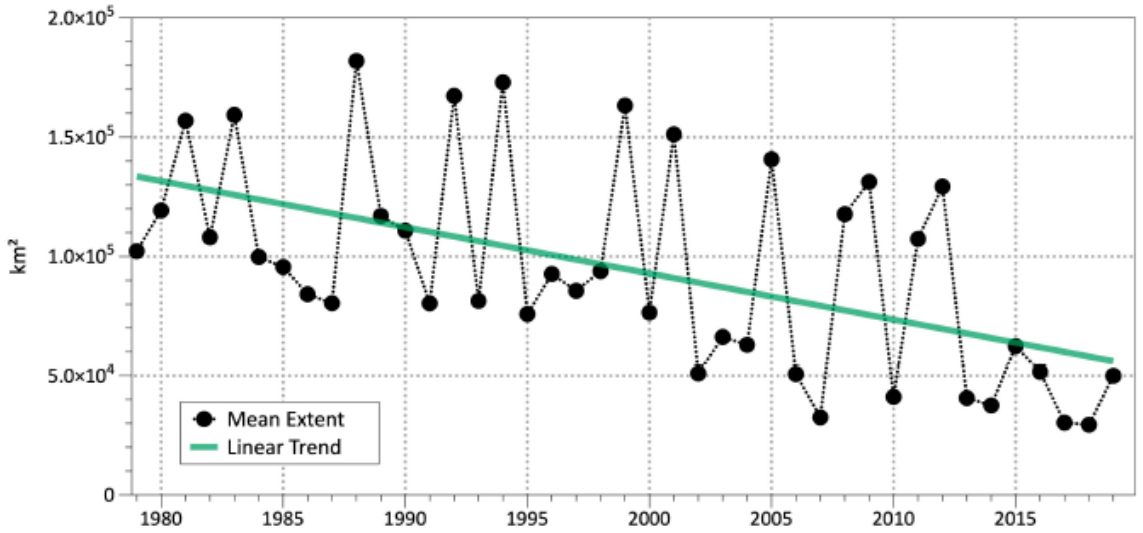
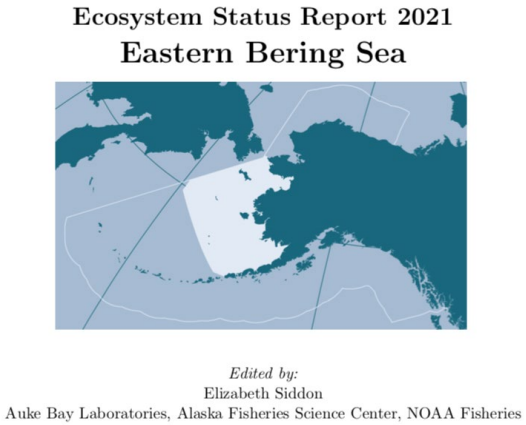
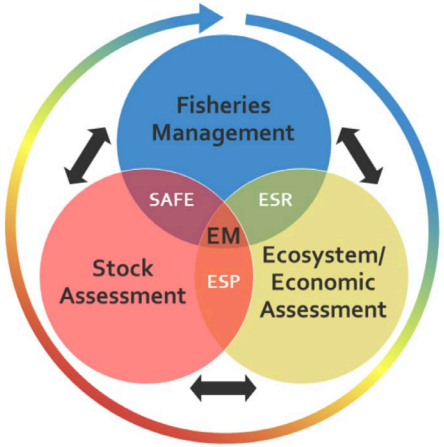


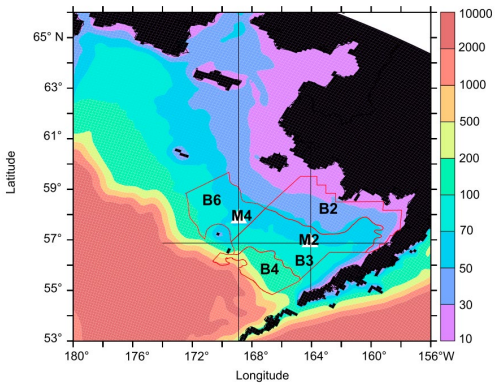
Figure 20: Early (15 Oct–15 Dec) mean sea-ice extent in the Bering Sea, 1979–2019.



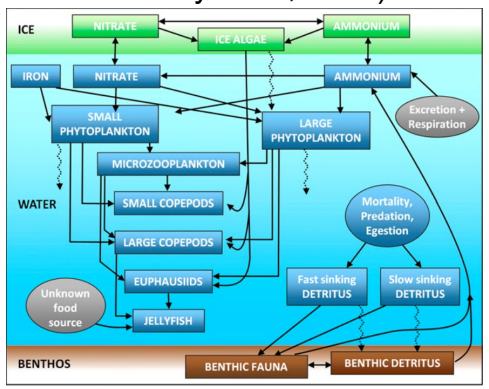


ROMS Bering10K

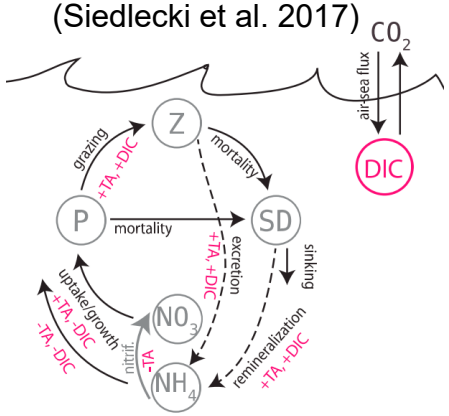
Physics
(Hermann et al., 2015)



Biology
(Gibson and Spitz 2011
Kearney et al., 2020)

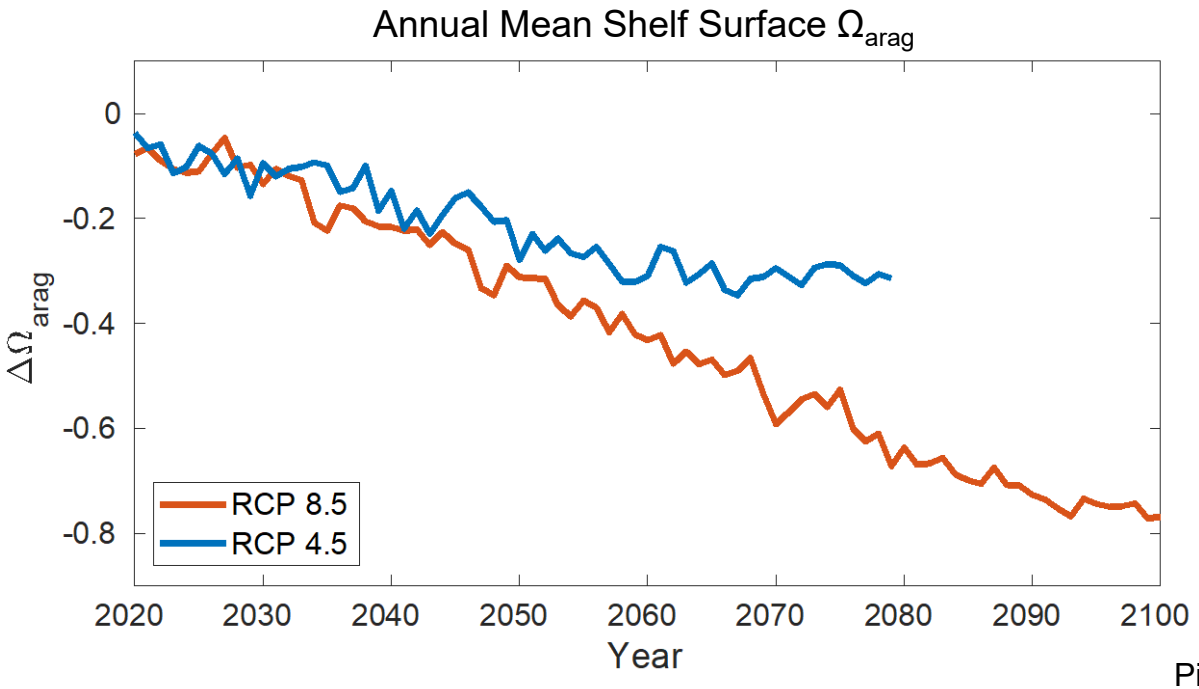


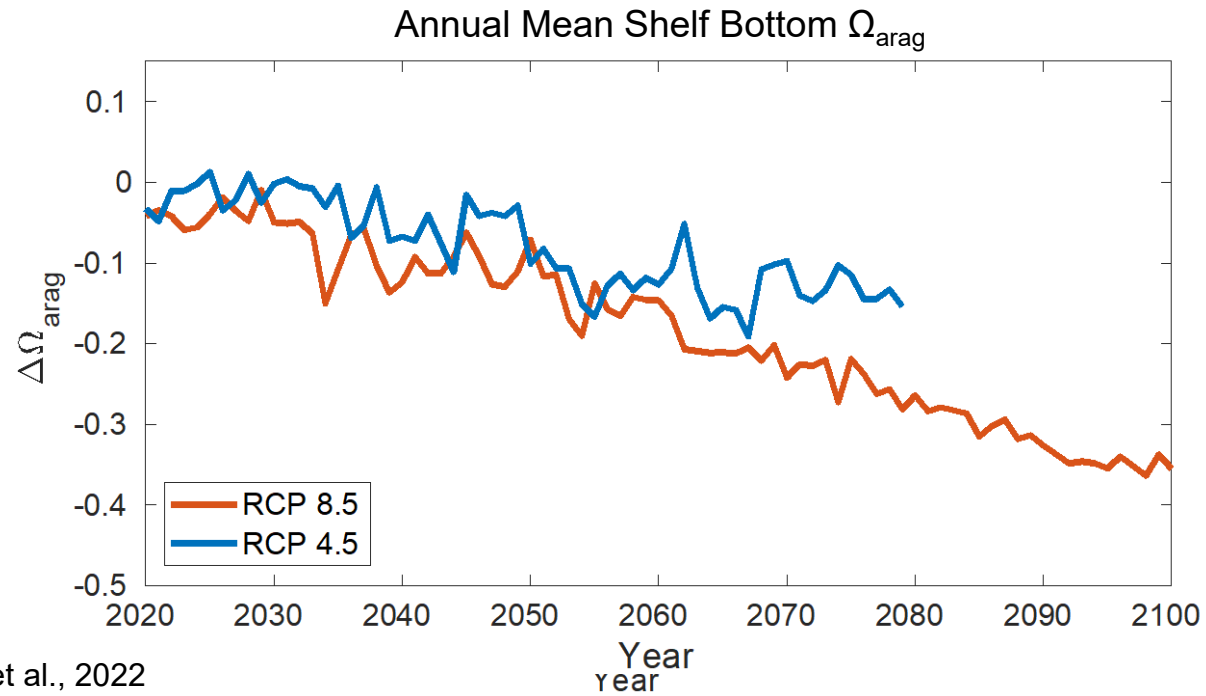
Chemistry
(Siedlecki et al. 2017)



al. 2019

Longterm OA Projections



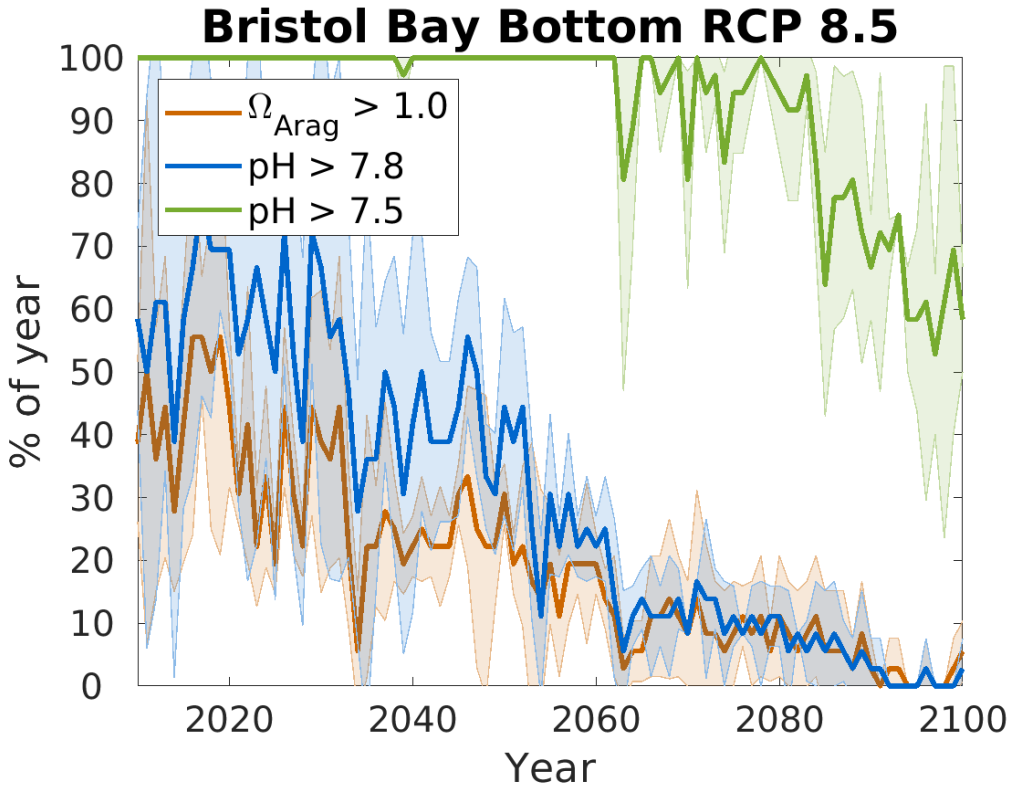


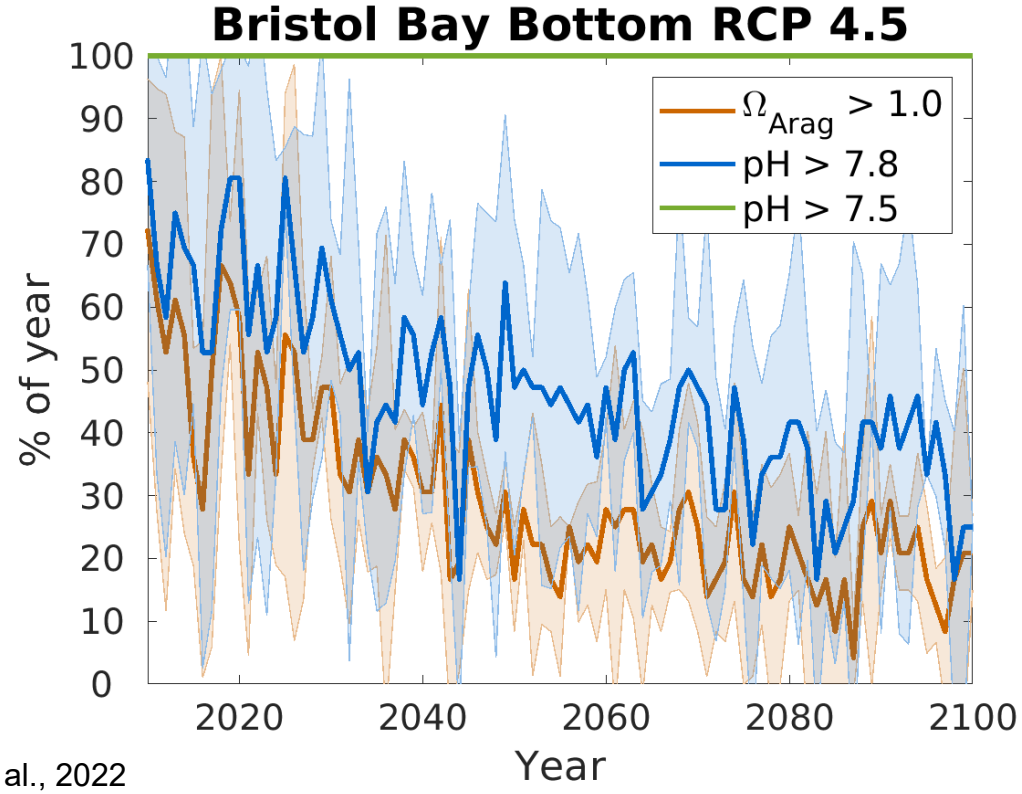
Pilcher et al., 2022

Rate of Ω_{arag} decrease is greater at the surface and under RCP 8.5

However, current bottom water values lower overall, pass thresholds (e.g. Ω_{arag} = 1) earlier than at the surface

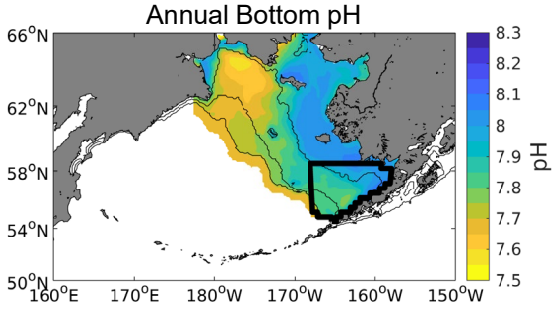
Projected habitat suitability



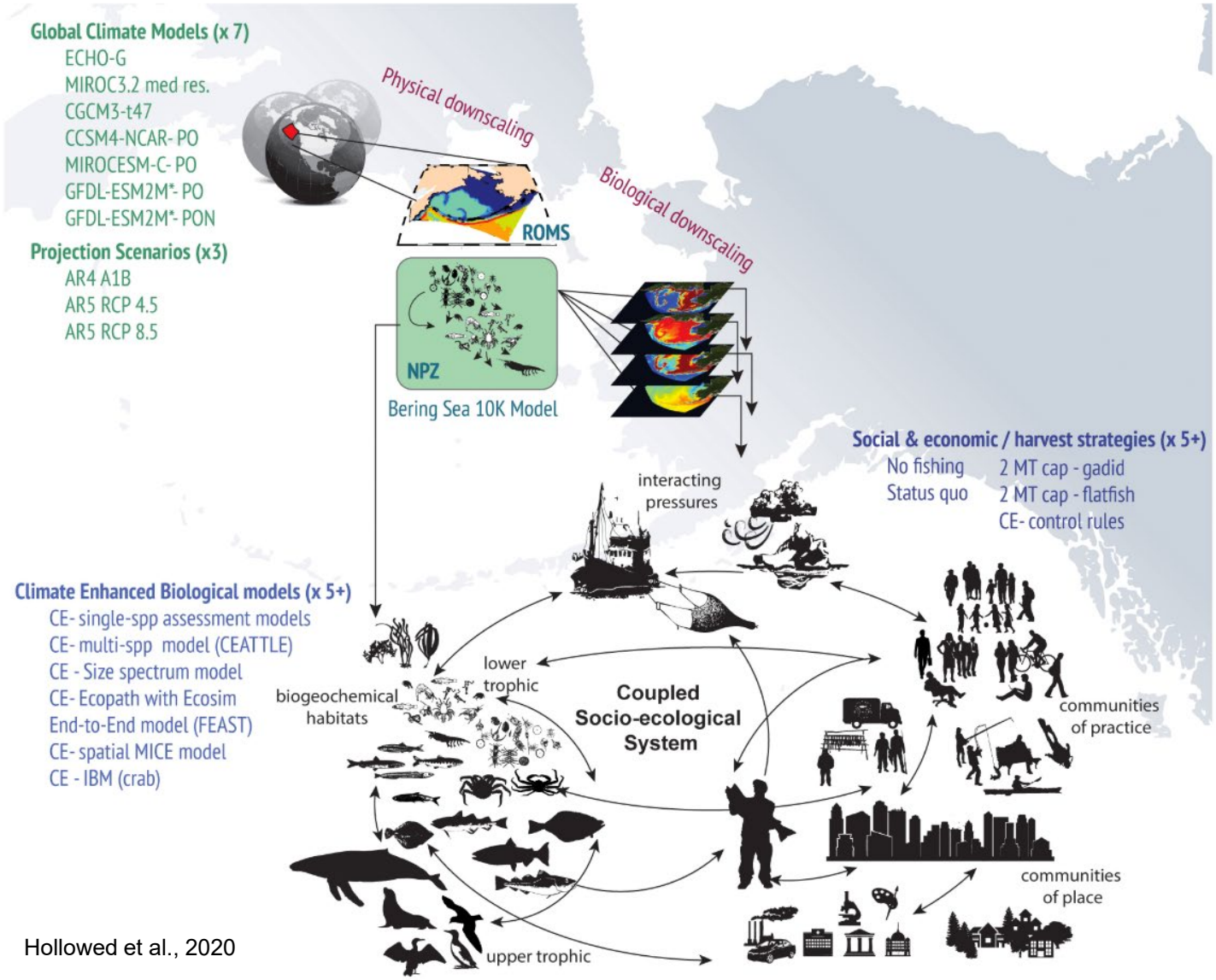


Pilcher et al., 2022

Apply experimentally derived thresholds to specific regions and stocks



Alaska Climate Integrated Modeling Project (ACLIM)



Hollowed et al., 2020

Results integrated into ACLIM and ACLIM 2.0 framework

Evaluating the impact of climate and demographic variation on future prospects for fish stocks: An application for northern rock sole in Alaska

André E. Punt [a,*], Michael G. Dalton [b], Wei Cheng [c,d], Albert J. Hermann [c,d], Kirstin K. Holsman [b], Thomas P. Hurst [e], James N. Ianelli [b], Kelly A. Kearney [c,b], Carey R. McGilliard [b], Darren J. Pilcher [c,d], Matthieu Véron [a]

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[b] Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Way Point Way, NE, Seattle, WA, United States
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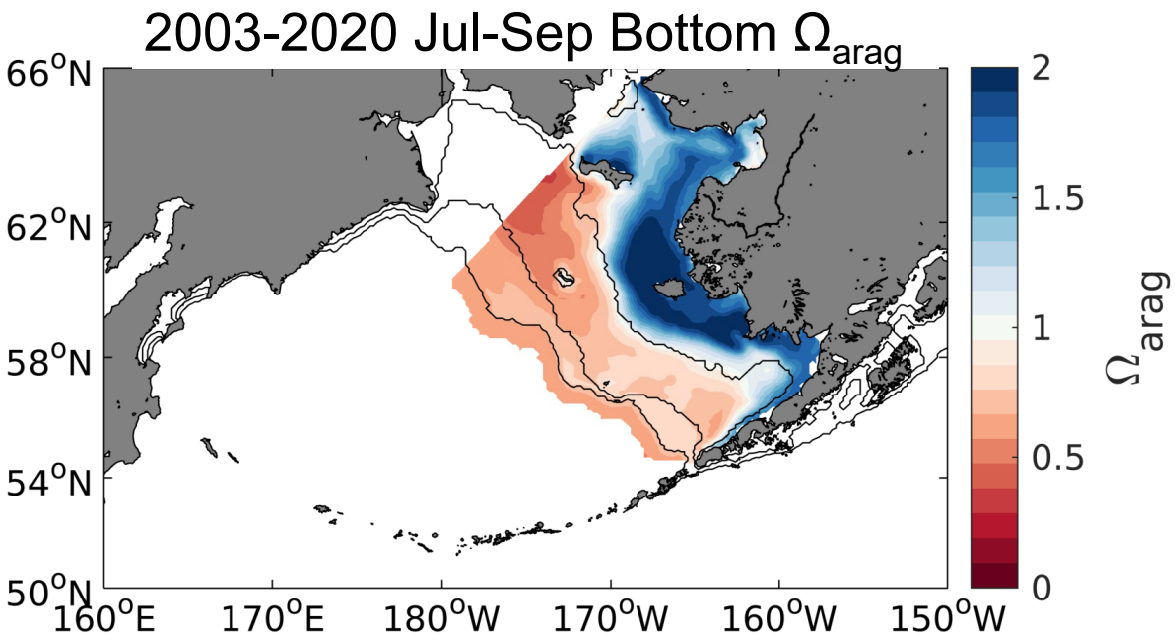
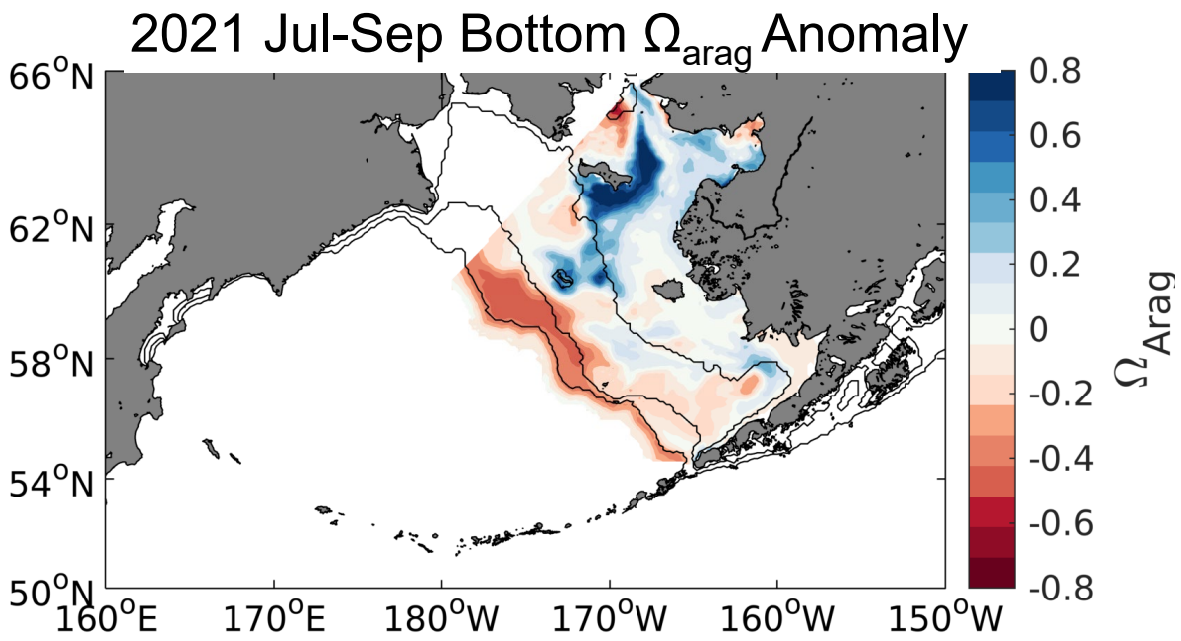
[d] Pacific Marine Environmental Laboratory, Oceans and Atmospheric Research, National Oceanic and Atmospheric Administration, Seattle, WA, United States
[e] Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, Hatfield Marine Science Center, Newport, OR, USA

What about shorter timeframes?

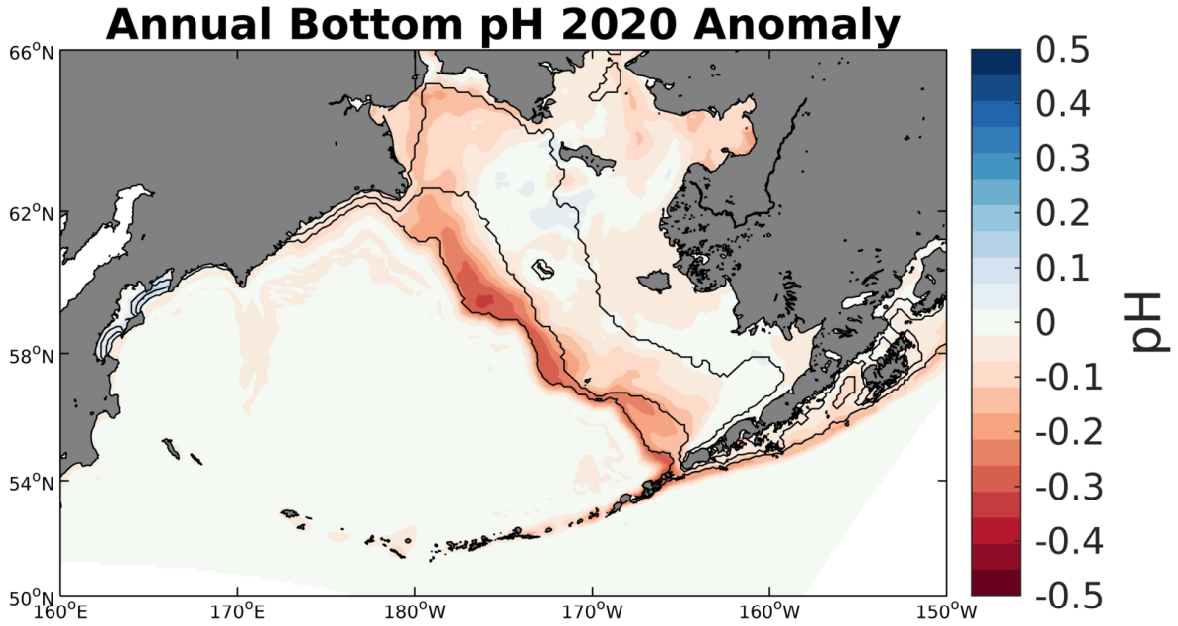
2021 in review

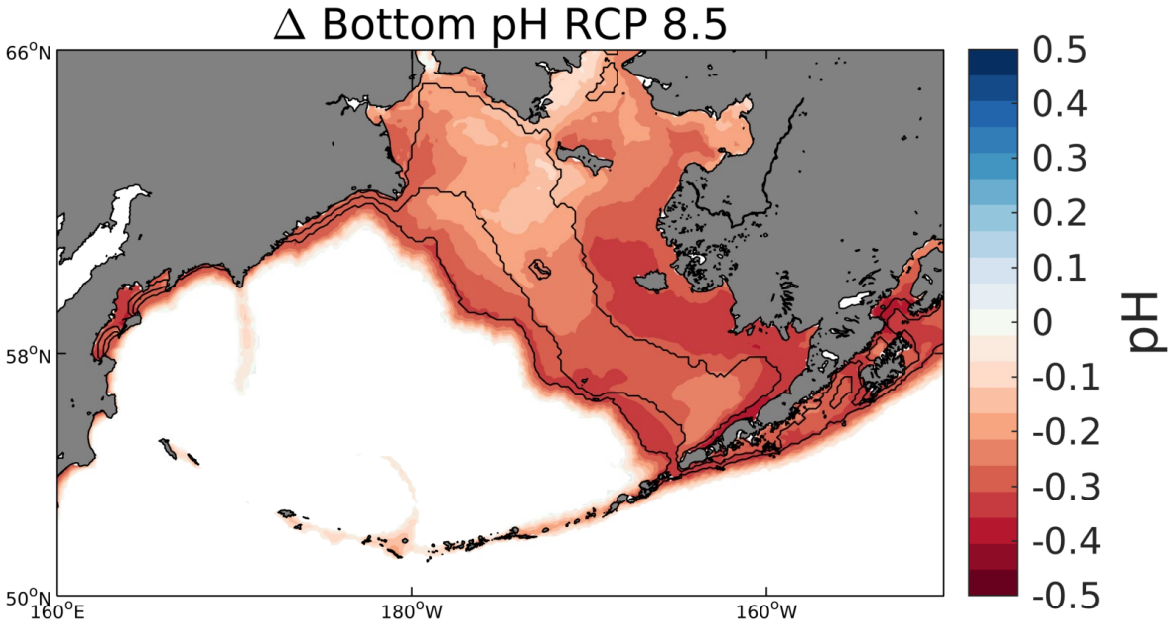




- Bottom water conditions near St. Lawrence Island greater than normal
- Outer shelf conditions more corrosive than normal, part of a pattern since 2018 tied to off shelf upwelling

A natural OA analogue?

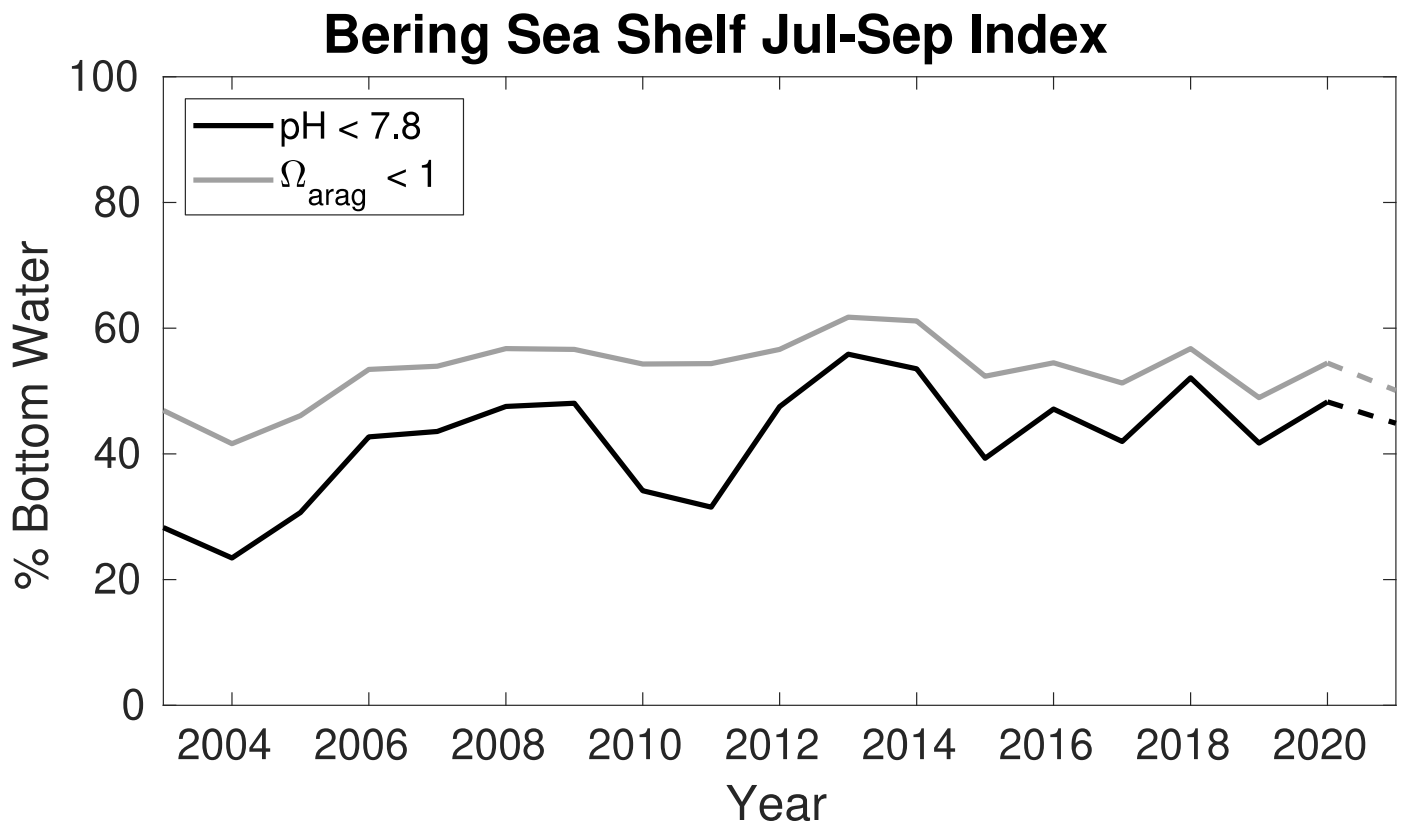




Outer shelf anomaly is comparable to the total projected change in pH under RCP 8.5

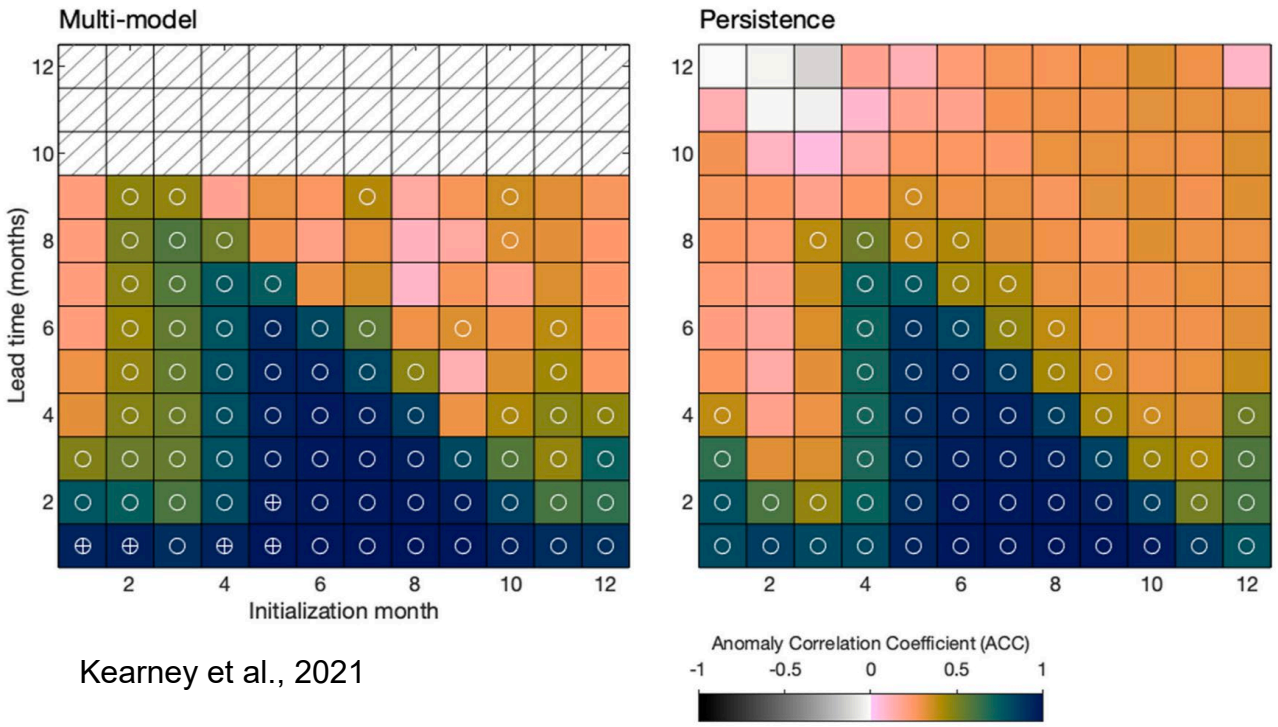
Unable to verify with current observational assets (last bottom data for SE shelf from 2010!)

2021 in review

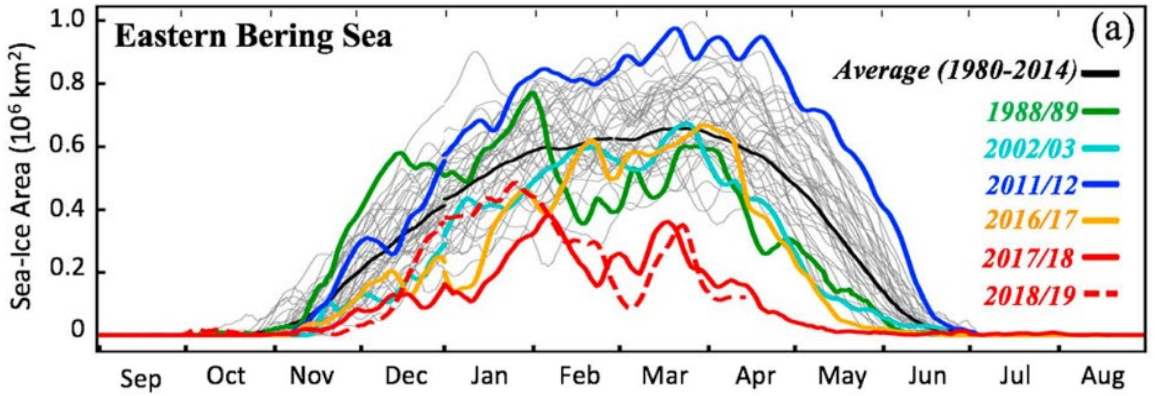


- Develop indices based on biologically relevant threshold values
- pH 7.8 based on red king crab experiments
- Both indices are slightly improved compared to 2020 and are near the 2003-2020 average

Seasonal Predictability



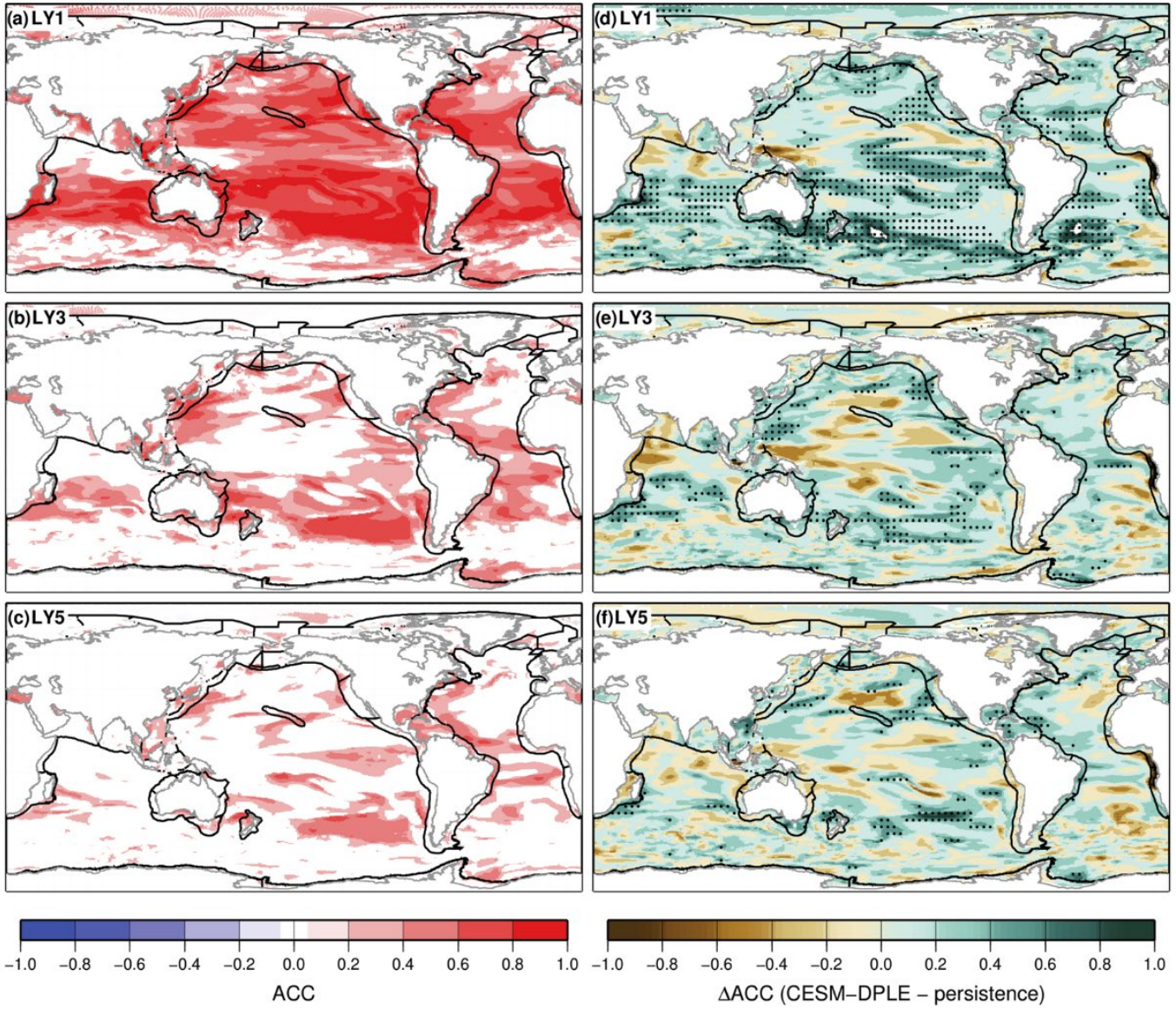
Kearney et al., 2021



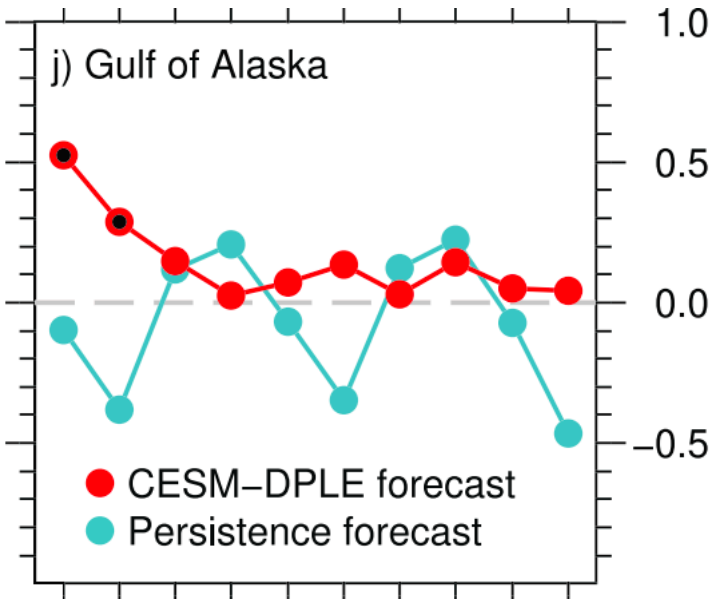
Stabeno and Bell 2019

Dynamic forecasts of bottom temperature are only slight better than persistence, with both limited by a spring predictability barrier tied to sea ice retreat

Interannual Predictability



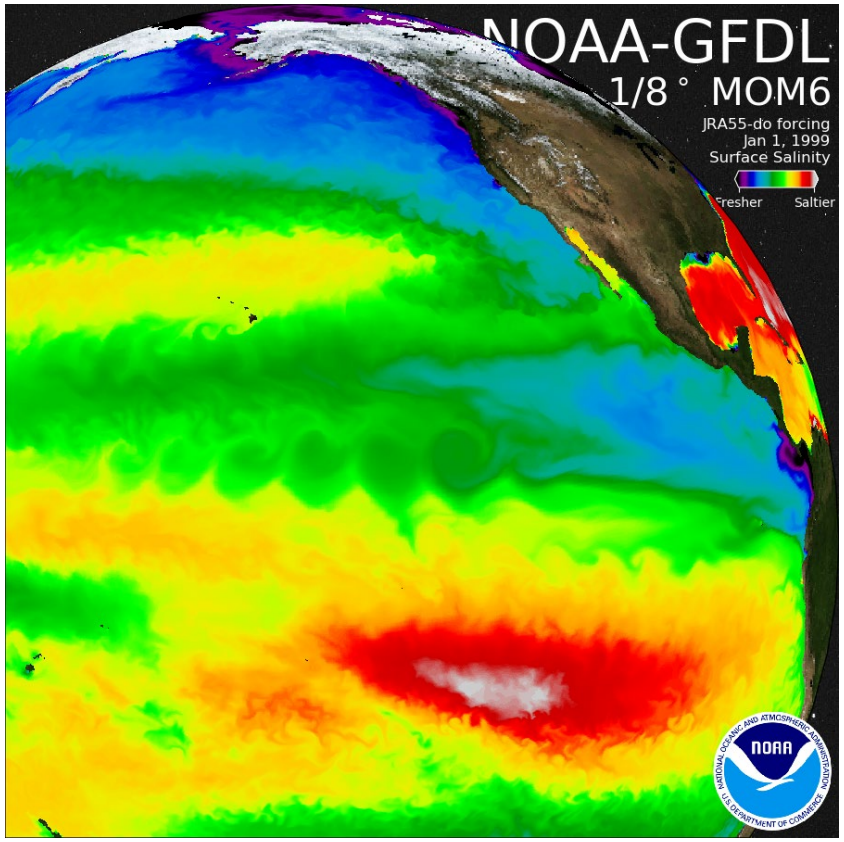
Potential predictability of ocean NPP on interannual timeframes



Krumhardt et al., 2020

Emerging tools and efforts to address these topics

UFS
UNIFIED FORECAST SYSTEM



NOAA Climate, Ecosystems, and Fisheries Initiative

The NOAA Climate, Ecosystems, and Fisheries Initiative (CEFI) will build the end-to-end, operational ocean modeling and decision support system needed to safeguard the nation's marine resources and resource-dependent communities in a changing climate.

The Challenge

Climate change is significantly impacting the nation's valuable marine and Great Lakes ecosystems, fisheries and the many people, communities, and economies that depend upon them. Warming oceans, rising seas, melting sea ice and increasing acidification are affecting ecosystem structure and the distribution and abundance of marine species in many regions.

These changes affect many parts of NOAA's mission, from fisheries management and aquaculture to conservation of protected resources and habitats. The impacts are expected to increase and there is much at risk. In the U.S., for example, marine ecosystems annually contribute over $210 billion and 1.7 million jobs from fisheries and provide a range of other vital services including recreation and protection from coastal storms and erosion.

To safeguard fisheries and other resources in the face of rapidly changing oceans, resource managers and stakeholders urgently need better information on what's changing, who's at risk and how to increase resilience. NOAA currently must develop the ocean mod-eling and decision-support system needed to produce, deliver and use information to sus-tain marine resources and resource-dependent communities in a changing climate.

Thanks to our funding sources and the team!

NOAA OCEAN ACIDIFICATION PROGRAM

ARCTIC PROGRAM

NOAA

Cooperative Institute for CLIMATE, OCEAN & ECOSYSTEM STUDIES

THE UNIVERSITY OF CALIFORNIA DAVIS