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

Darren Pilcher [1,2], Jessica Cross [2], Elizabeth Siddon [3], Esther Kennedy [4], Natalie Monacci [5] Kelly Kearney [1,3], Albert Hermann [1,2], Wei Cheng [1,2]

[1] Cooperative Institute for Climate, Ocean, and Ecosystem Studies, University of Washington

[2] NOAA Pacific Marine Environmental Laboratory

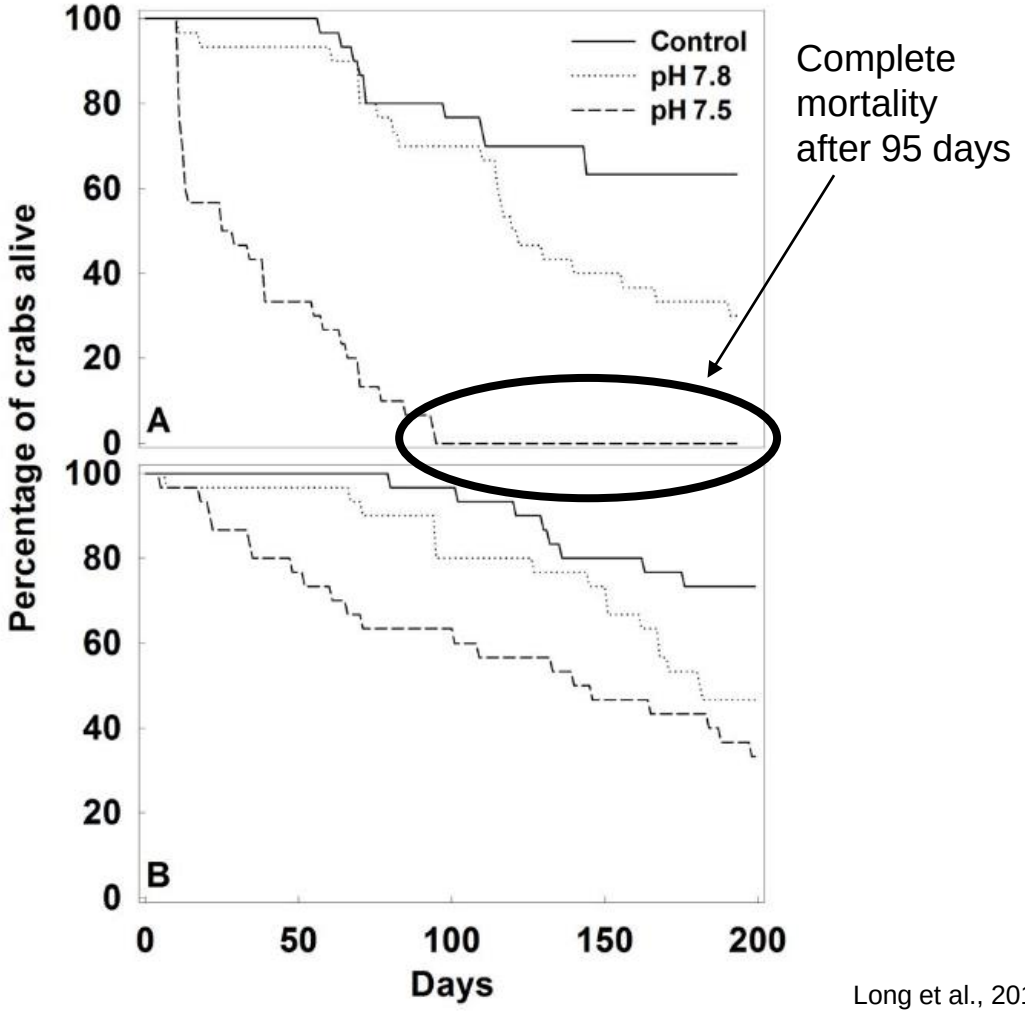
[3] NOAA Alaska Fisheries Science Center

[4] University of California Davis

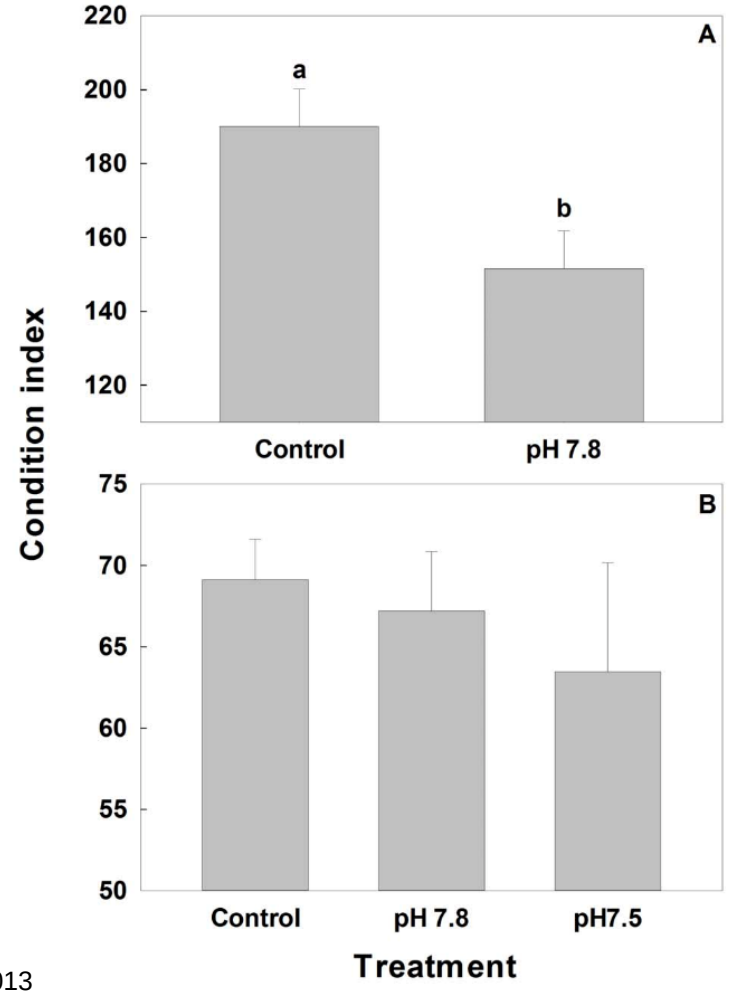
[5] University of Alaska Fairbanks

darren.pilcher@noaa.gov

OA Impacts Crab



Complete mortality after 95 days

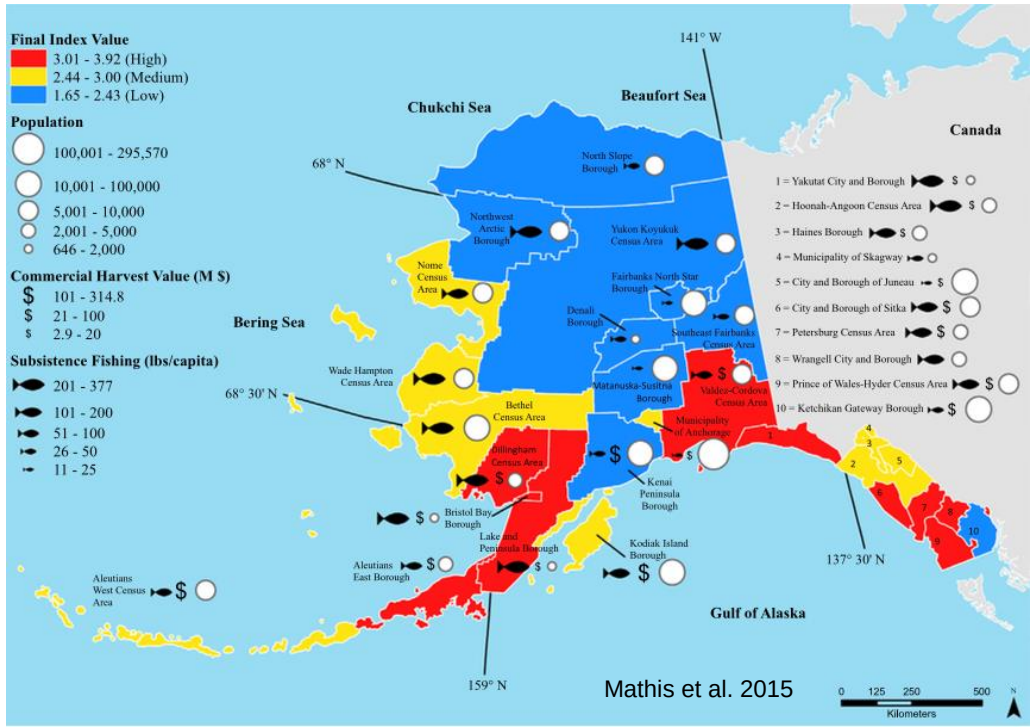


Red King crab

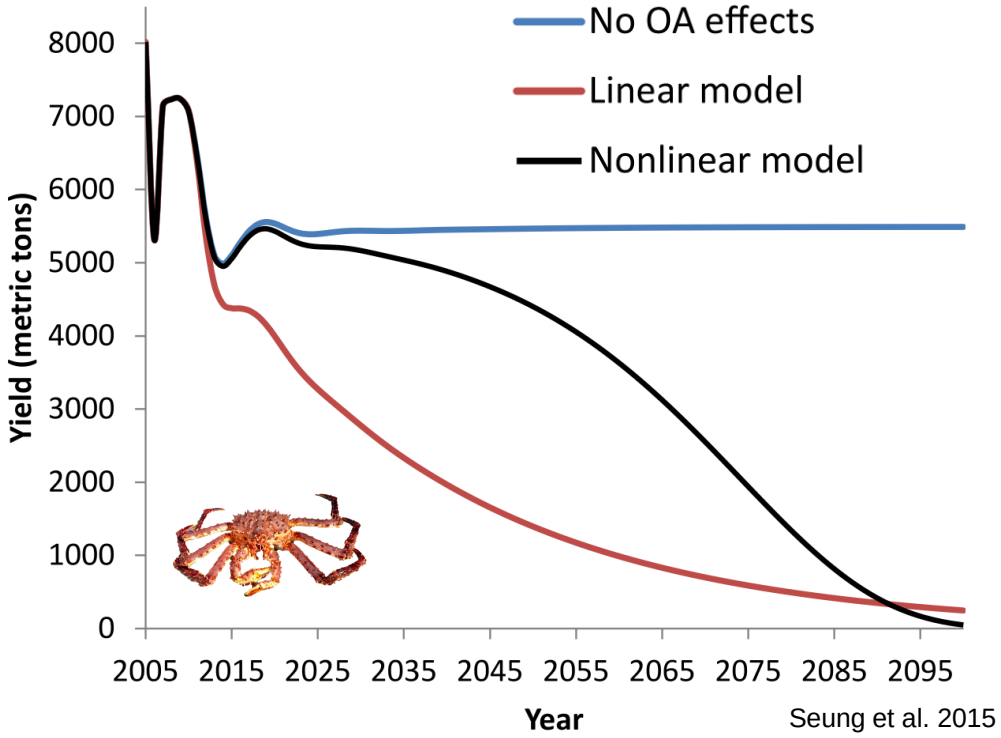
Tanner crab

Long et al., 2013

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

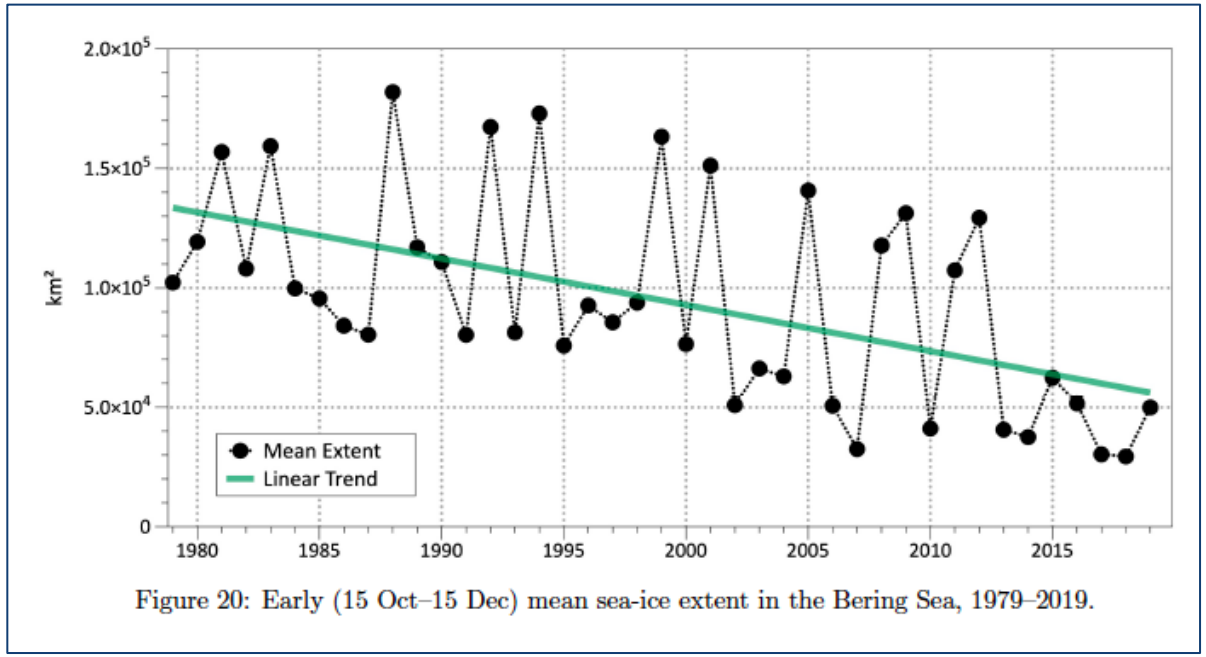
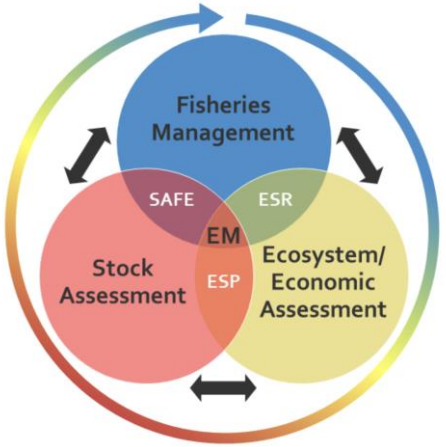
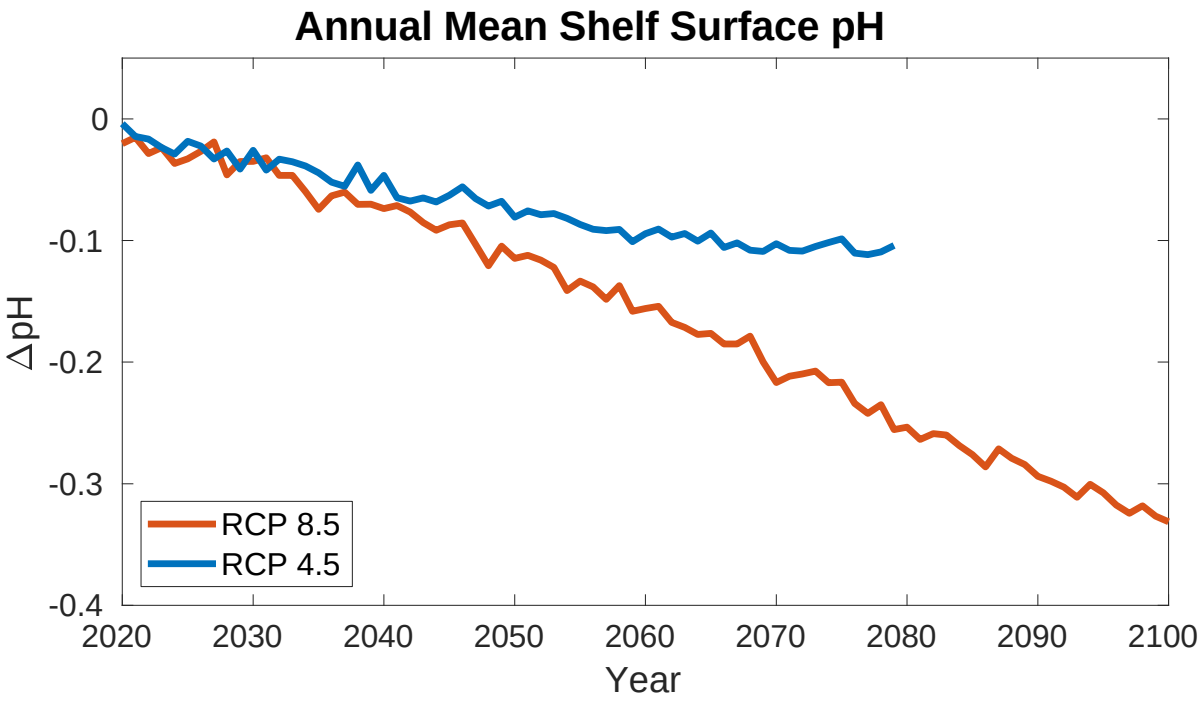
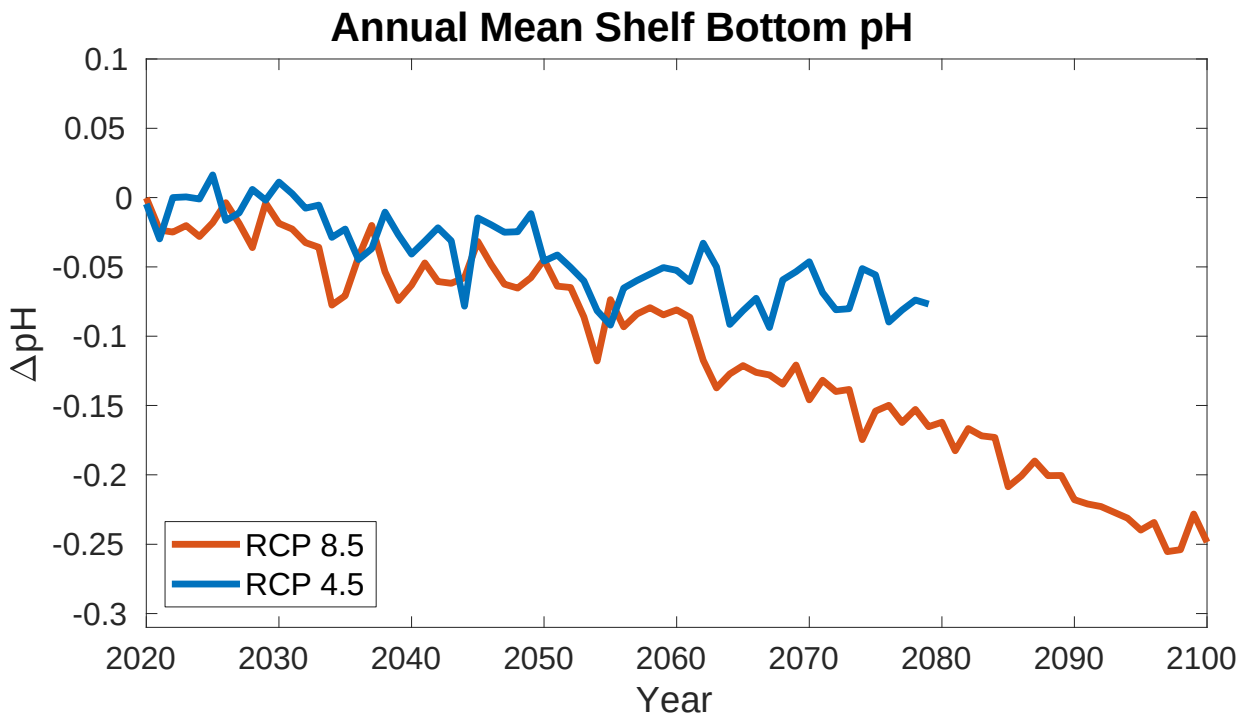


Figure 20: Early (15 Oct–15 Dec) mean sea-ice extent in the Bering Sea, 1979–2019.



Longterm OA Projections

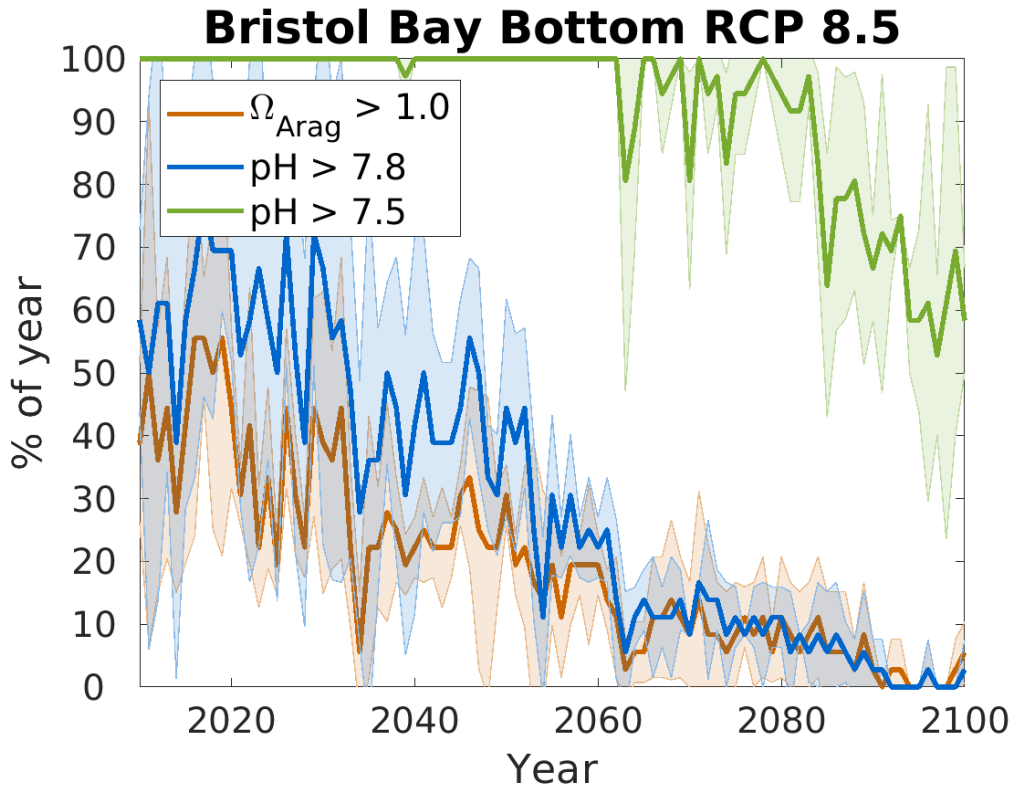


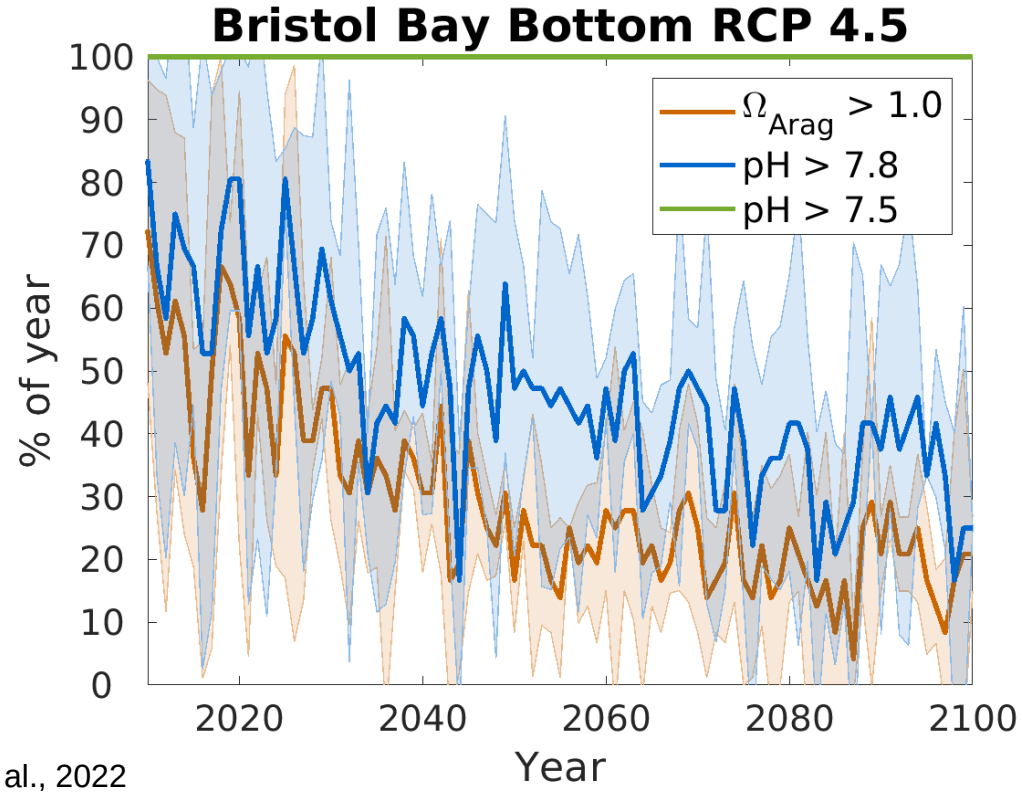


Rate of pH decrease is greater at the surface and under RCP 8.5

However, current bottom water values lower overall, pass thresholds (e.g. pH = 7.8) earlier than at the surface

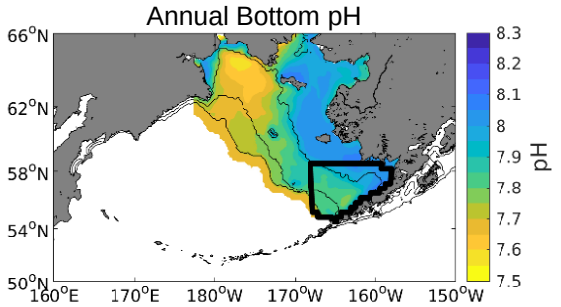
Projected habitat suitability



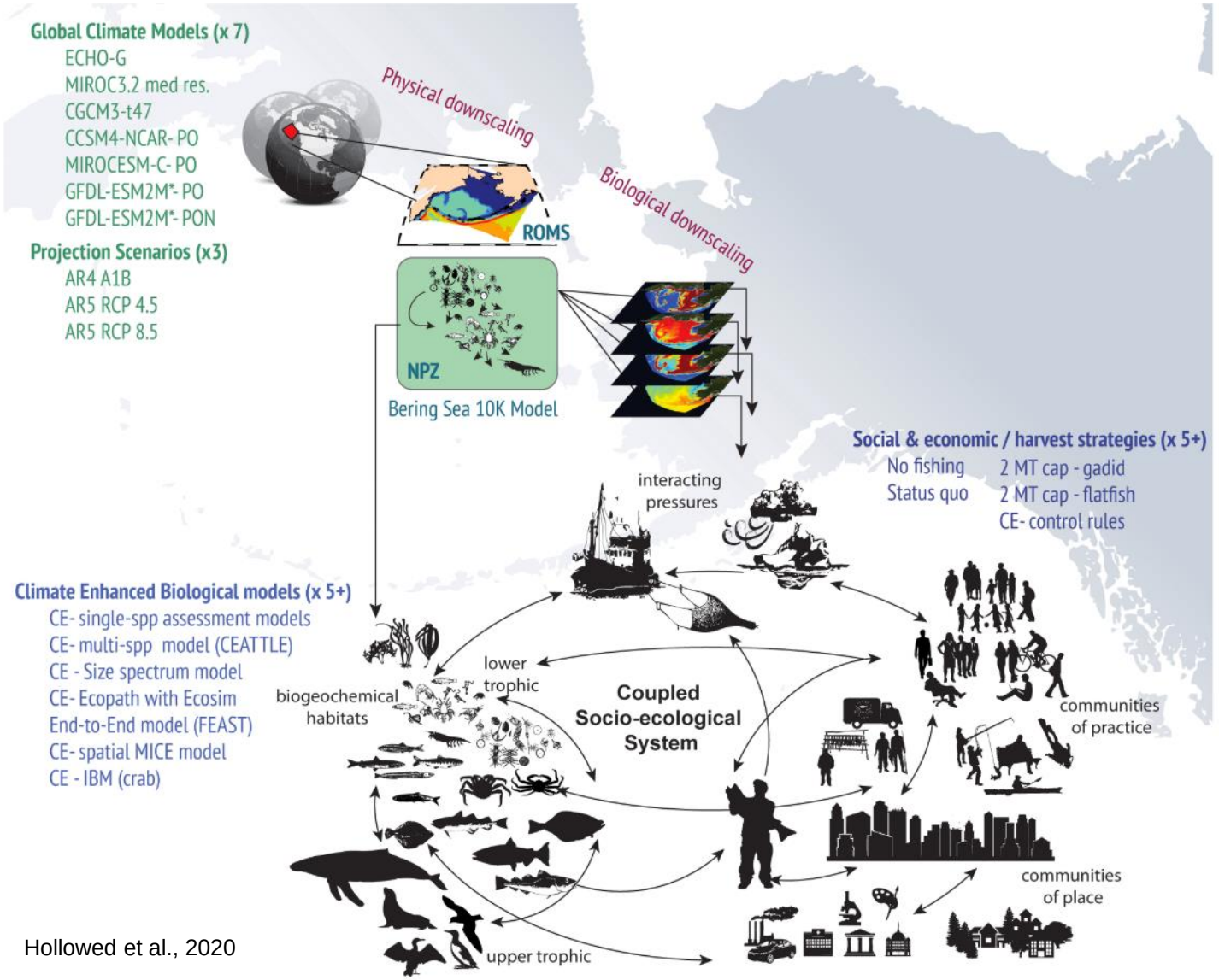


Pilcher et al., 2022

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

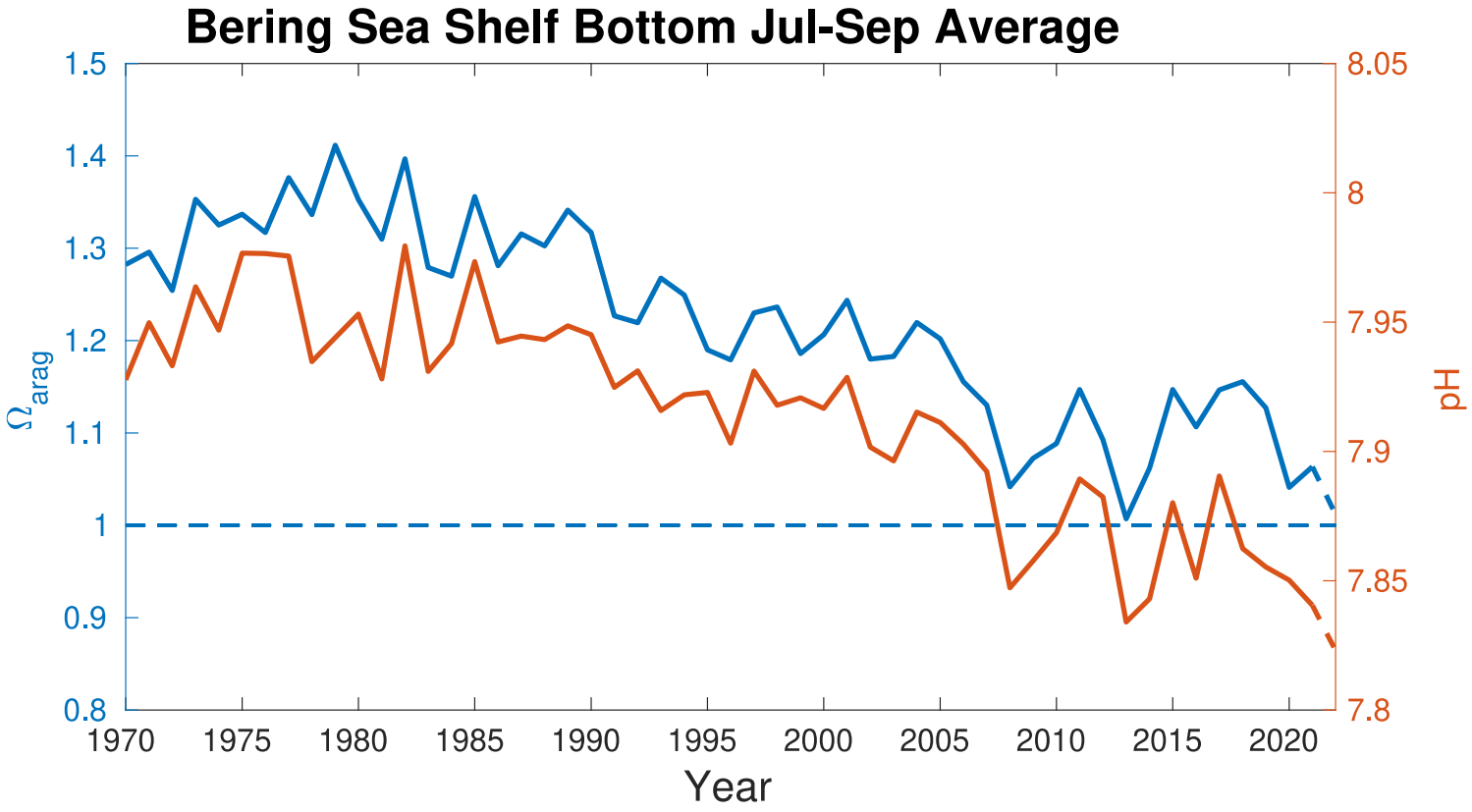
Evaluating the impact of climate and demographic variation on future prospects for fish stocks: An application for northern rock sole in Alaska

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]

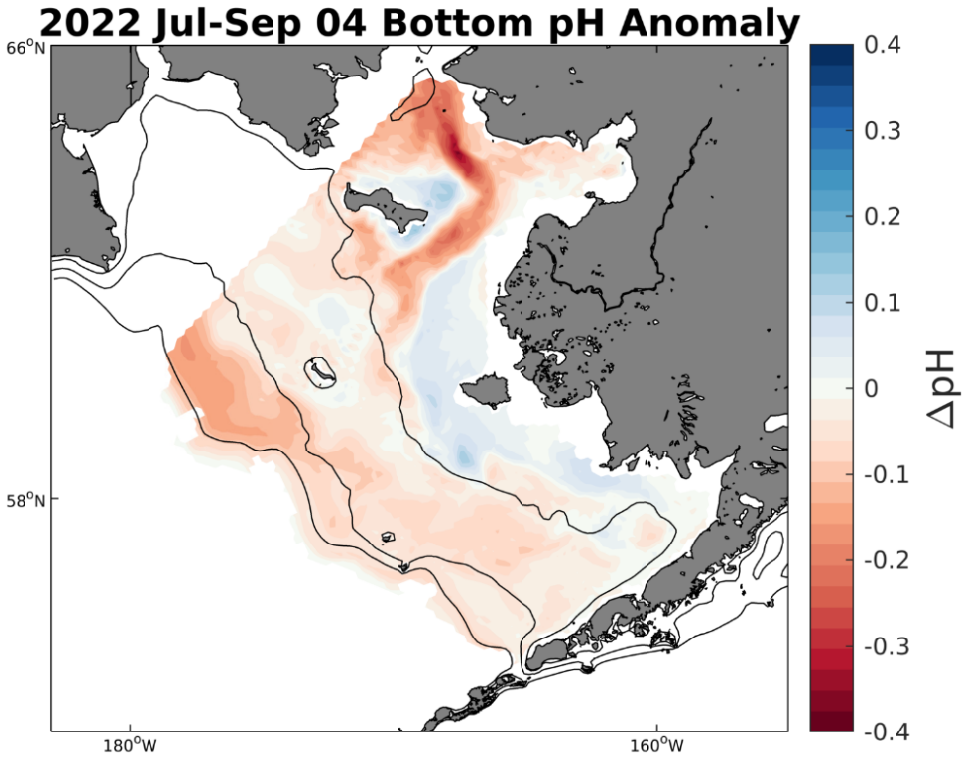
[a] School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA, United States
[b] Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 7600 Sand Way Point Way, NE, Seattle, WA, United States
[c] Cooperative Institute for Climate, Ocean, And Ecosystem Studies, University of Washington, Seattle, WA, United States
[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?

2022 In Review

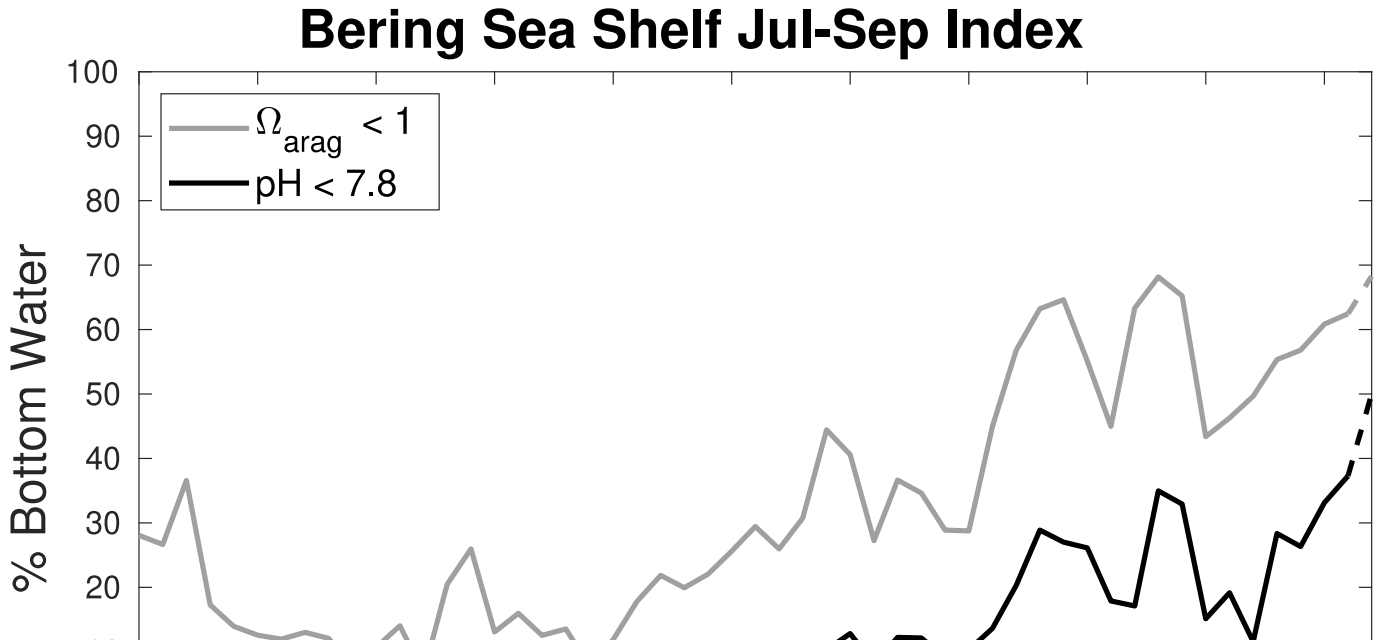


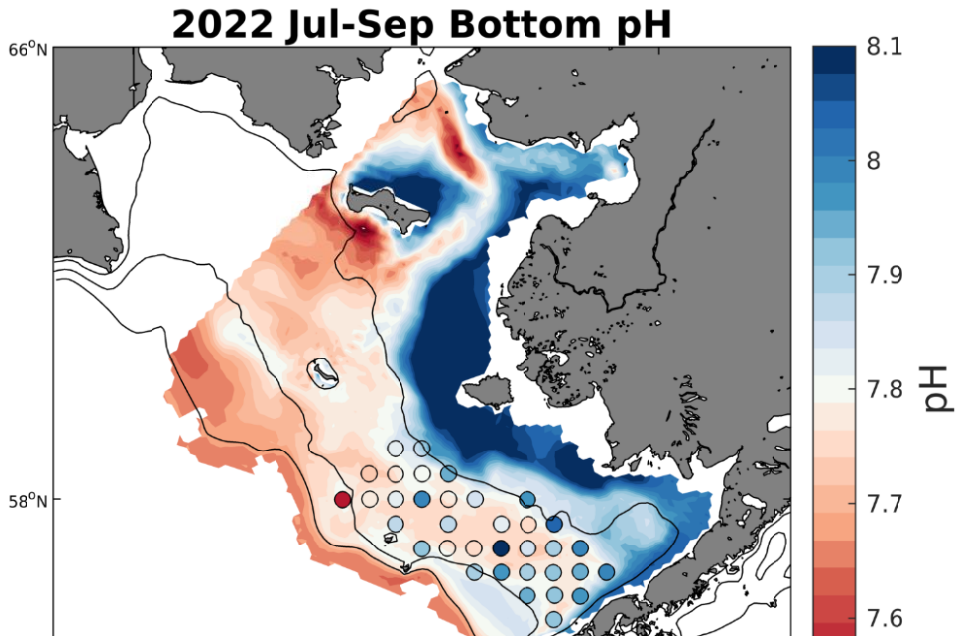
Steady, long-term decline in pH and Ω_{arag}, modified by periods of natural variability



Outer shelf low pH conditions part of multi-year pattern

2022 In Review

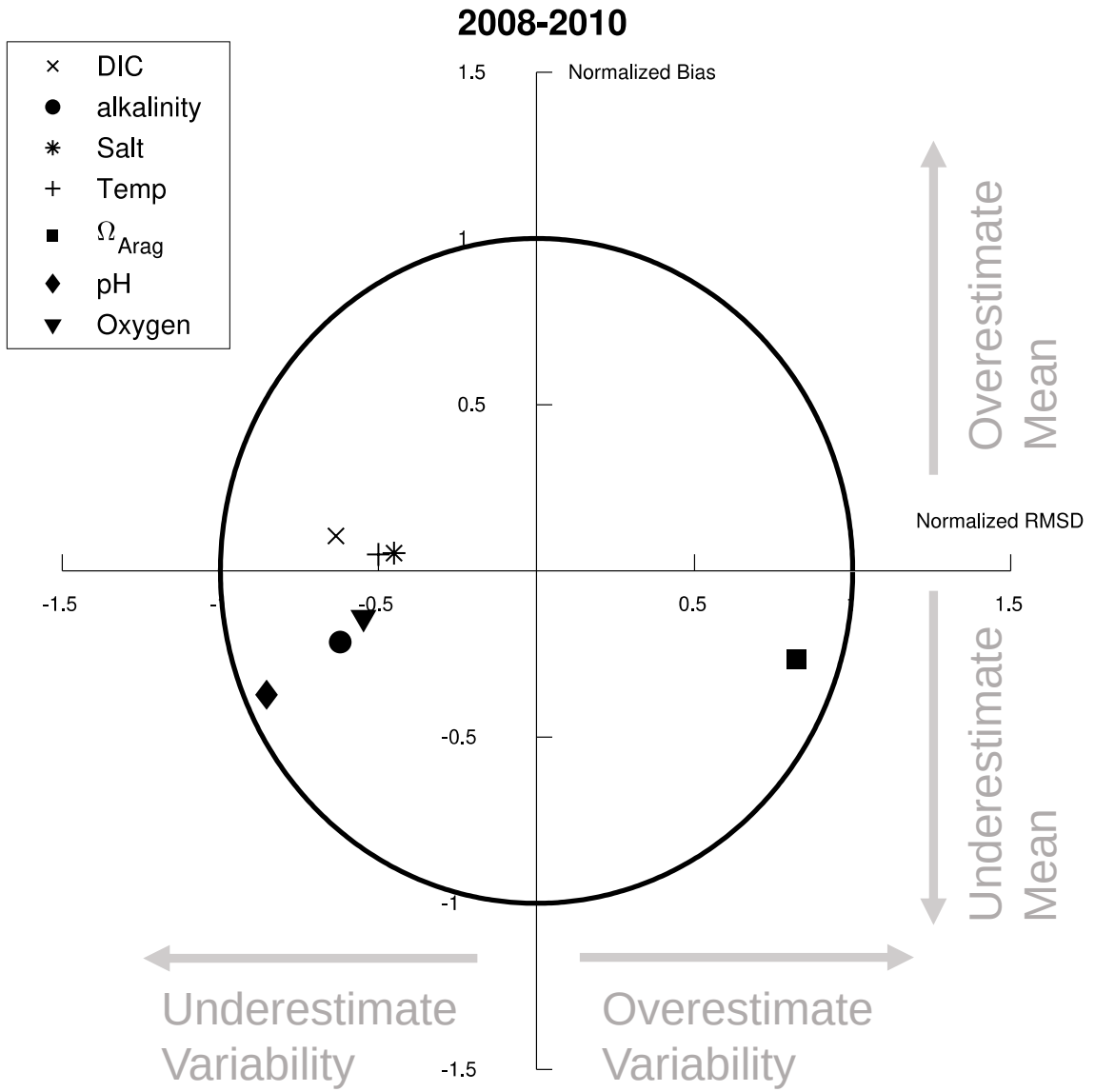


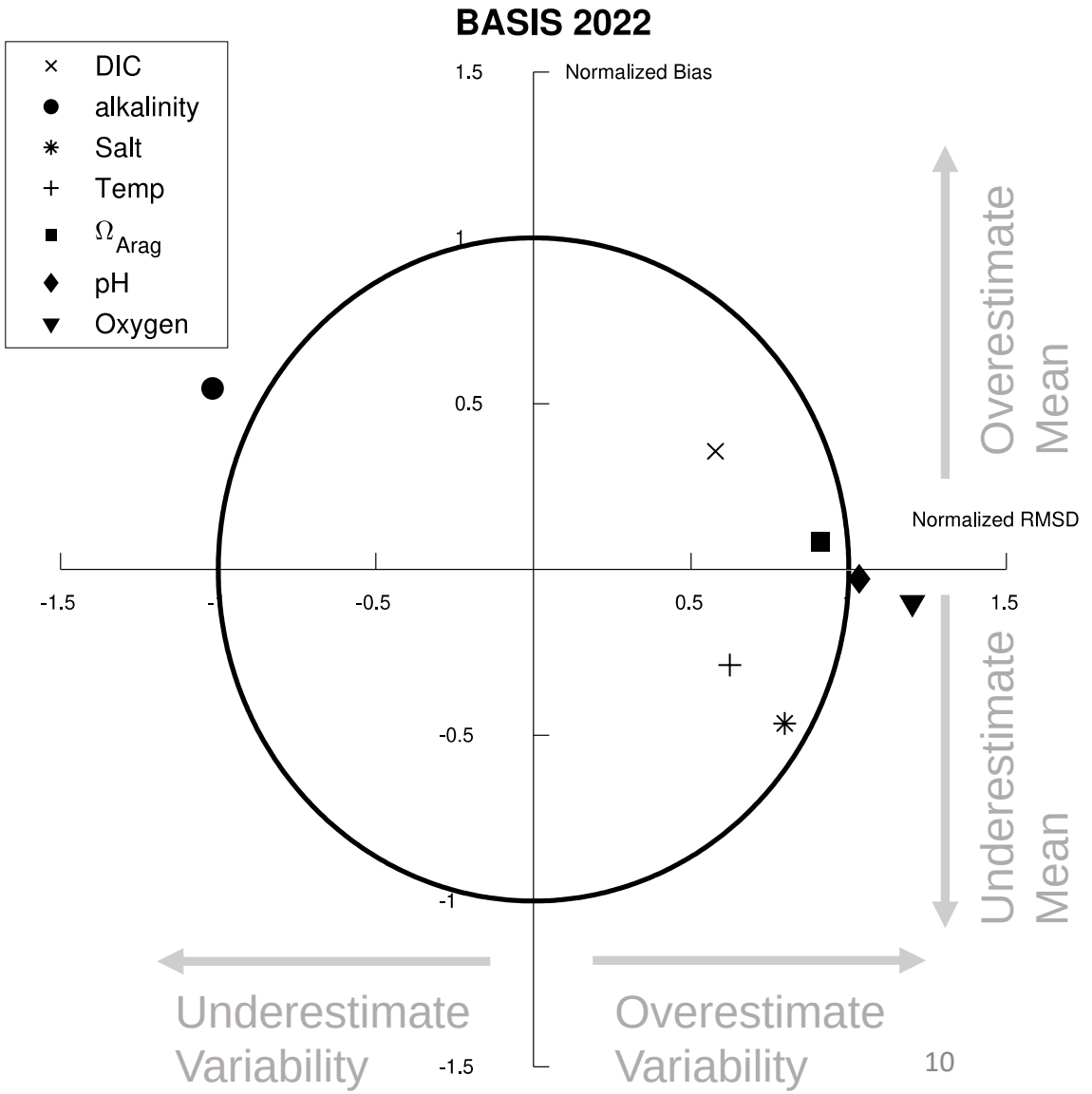


C4 BSAI Plan Team Minutes
December 2022

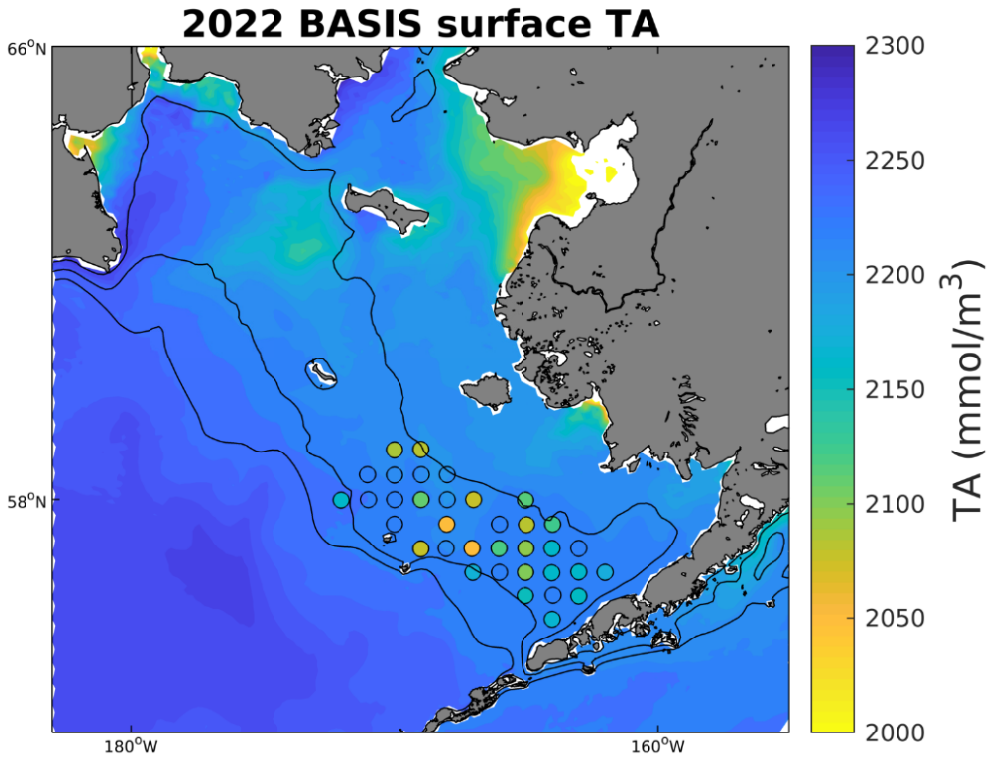
The Team recommended that pH data be aligned with "survey replicated" dates and locations in the model to further skill evaluations.

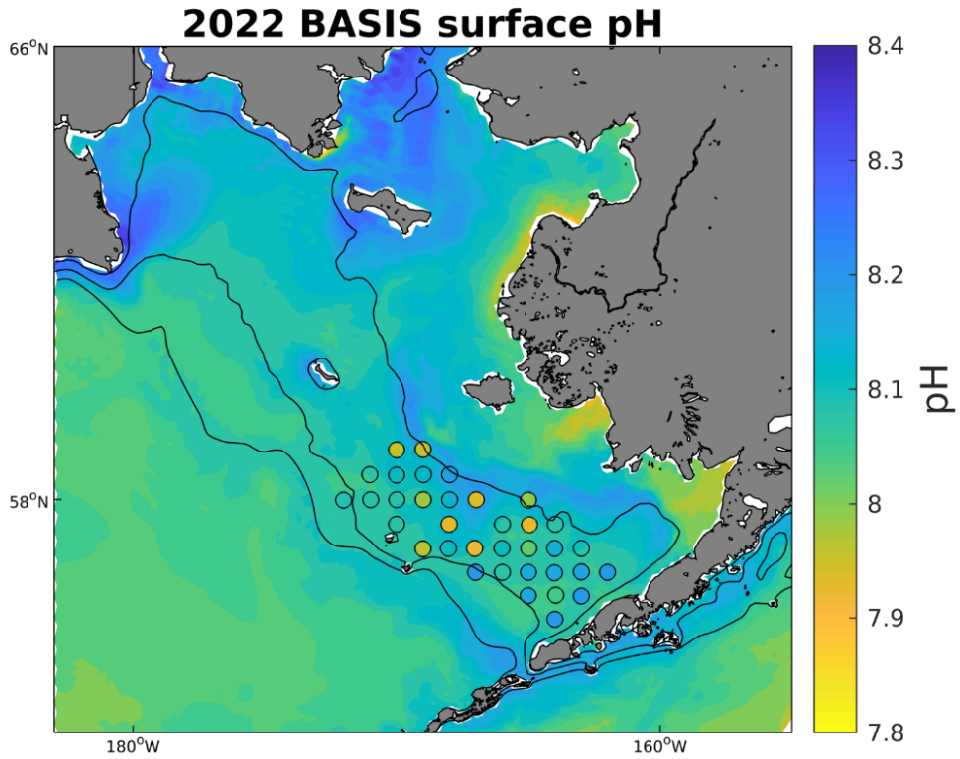
Model-Data Comparison





Coccolithophores?





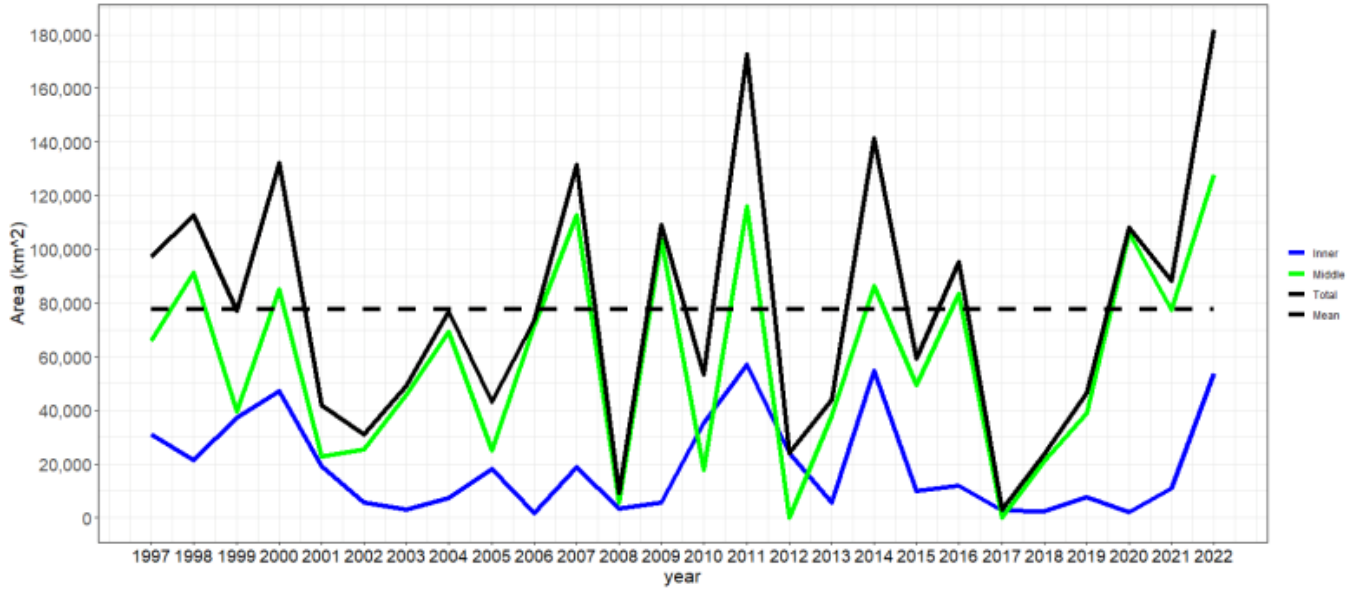
Coccolithophores consume total alkalinity and are not currently included in the model

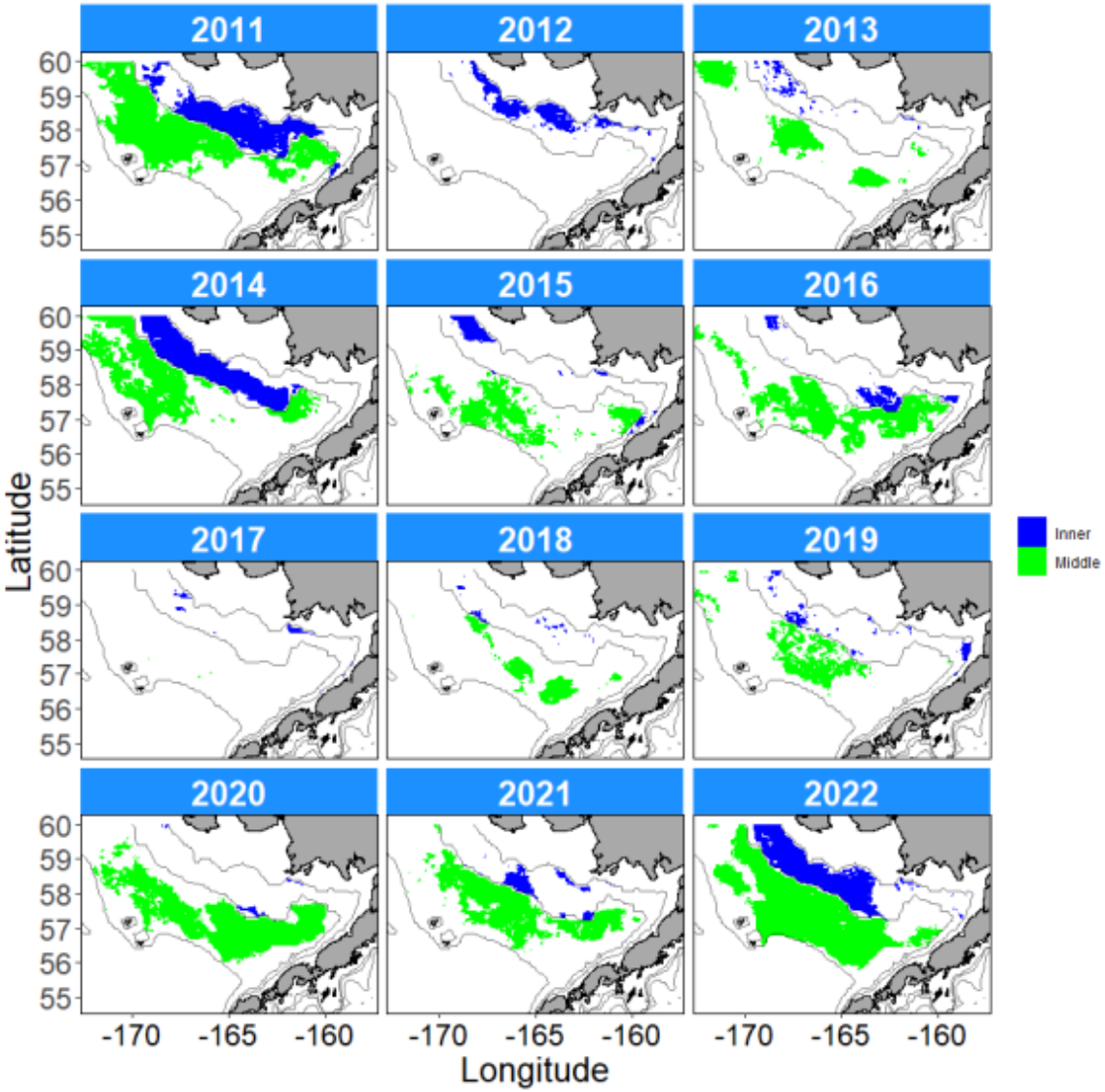
Positive model TA bias corresponds to positive pH bias

Largest Recorded Coccolithophore Bloom

Coccolithophores in the Bering Sea

Contributed by Jens Nielsen[1,2] and Lisa Eisner[3]
[1]Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, NOAA Fisheries
[2]Cooperative Institute for Climate, Ocean, and Ecosystem Studies (CICOES), University of Washington, Seattle, WA
[3]Auke Bay Laboratories, Alaska Fisheries Science Center, NOAA Fisheries
Contact: jens.nielsen@noaa.gov
Last updated: October 2022





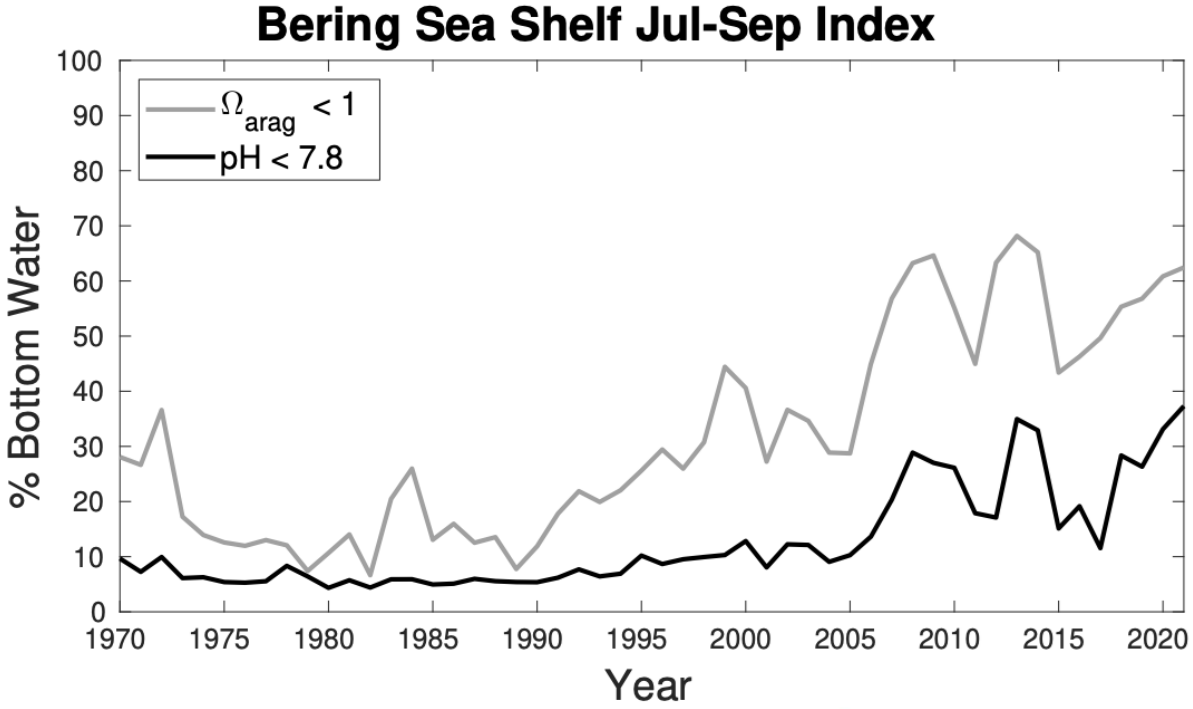
How are we bringing OA into fisheries management?

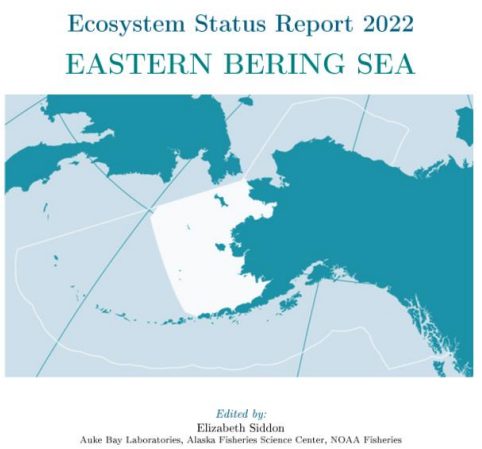
Strategic

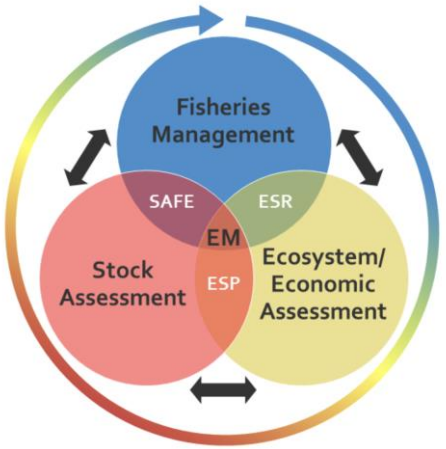
- Projections for longterm planning, incorporated into ACLIM framework, northern rock sole stock assessment (Punt et al., 2021), Pacific Cod sensitivity studies (Giancarlo et al., in prep)

Tactical

- Developed indicator for Ecosystem Status Report (ESR)
- Recently completed longterm (1970-2022) hindcast and developing 4-month seasonal forecasts







Key Stakeholders and Users

Connected with a wide range of federal, academic, commercial, and community partners!

ALASKA BERING SEA CRABBERS

Presentations from
Crab/Climate Mini Workshop for Crabbers

AOOS
Alaska Ocean Observing System

Alaska Ocean Acidification Network

NOAA 50 YEARS NOAA FISHERIES

BSFRF
Bering Sea Fisheries Research Foundation

UAF UNIVERSITY OF ALASKA FAIRBANKS

absi

Thanks to our funding sources and the team!