NMFS Climate Science Strategy

Southeastern Bering Sea

NOAA FISHERIES
Alaska Fisheries Science Center

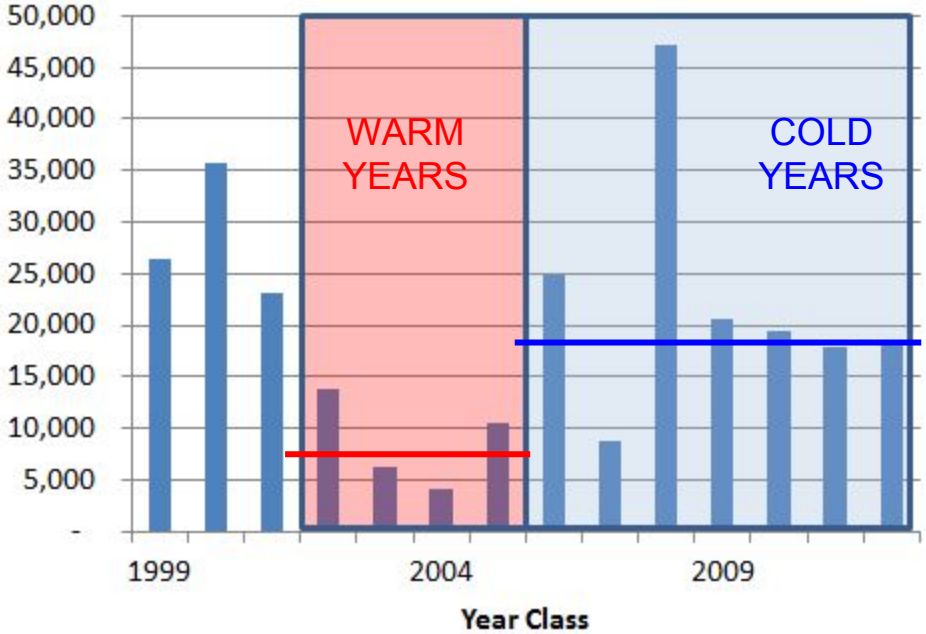
Mike Sigler, Alan Haynie, Amber Himes-Cornell, Anne Hollowed, Phil Mundy, Phyllis Stabeno, Stephani Zador, Steve Davis, Brandee Gerke

Climate and Fisheries

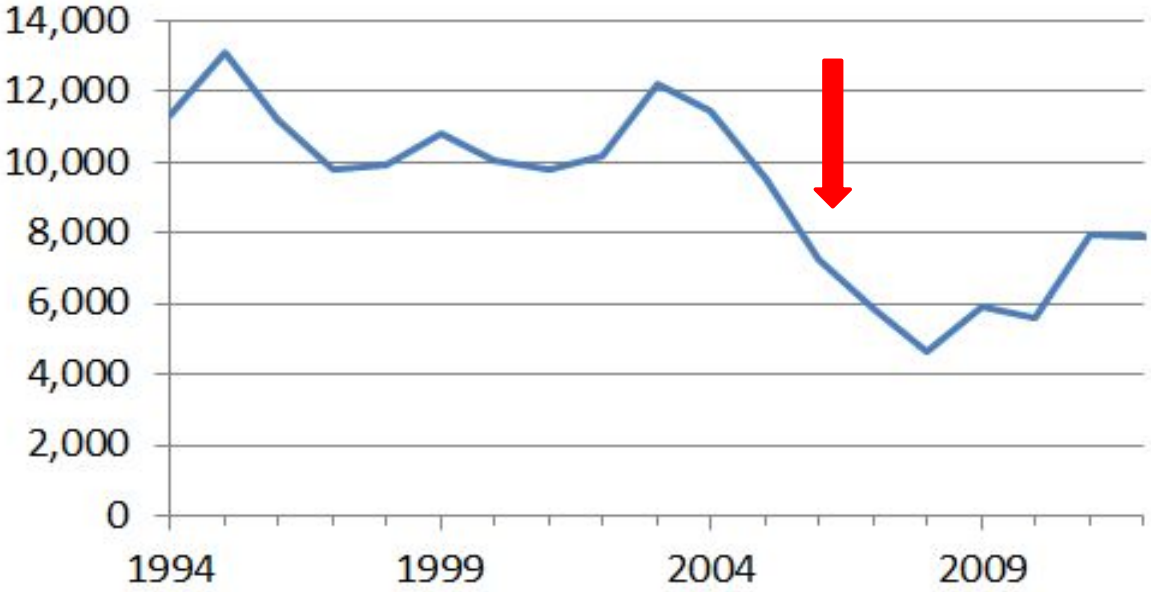
EXPLAIN THIS:

Walleye pollock abundance dramatically fell in the early 2000's, leading to a 40% drop in the quota for the largest single fishery in the US, and then rebounded.

Age-1 number (millions)



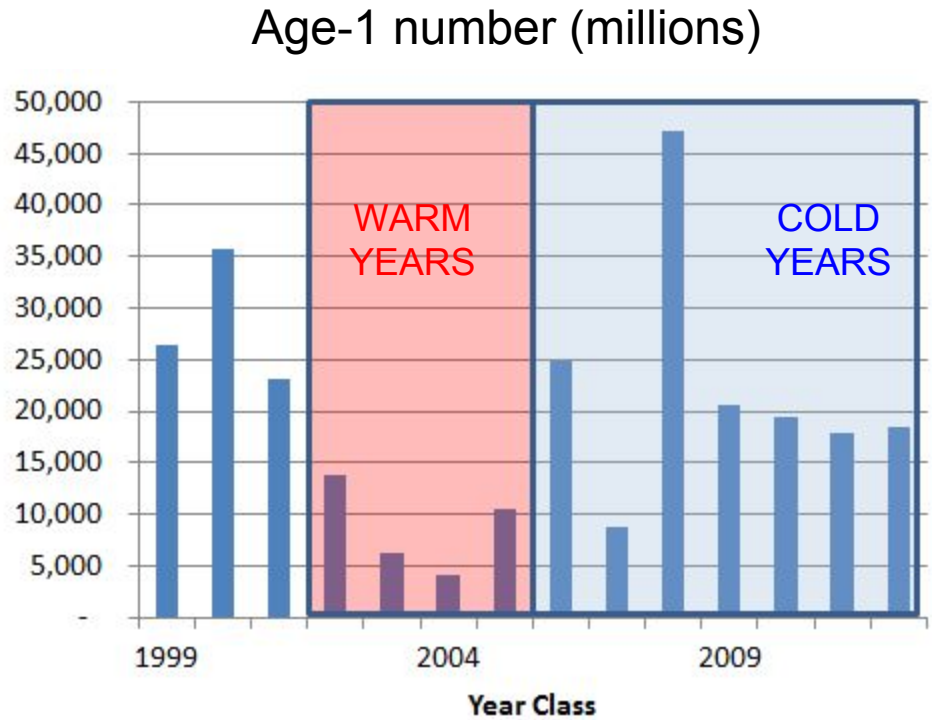
Age-3+ Biomass (thousands t)



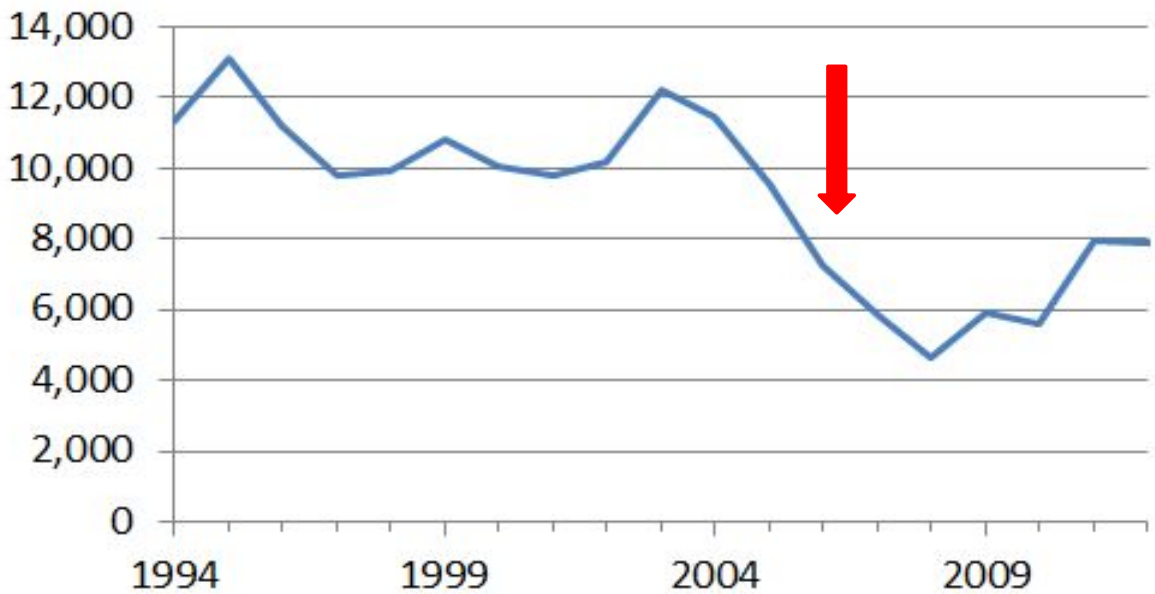
Ianelli, J.N., Barbeaux, S., Honkalehto, T., Kotwicki, S., Aydin, K. and Williamson, N., 2012. Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions. Anchorage, AK: North Pacific Fishery Management Council; 2009.*Assessment of the walleye pollock stock in the eastern Bering Sea for*, pp.49-148.

EXPLANATION:

Due to bloom timing, large crustacean zooplankton benefit from icy winters, providing prey for age-0 pollock to enter their first winter fat (and happy?)

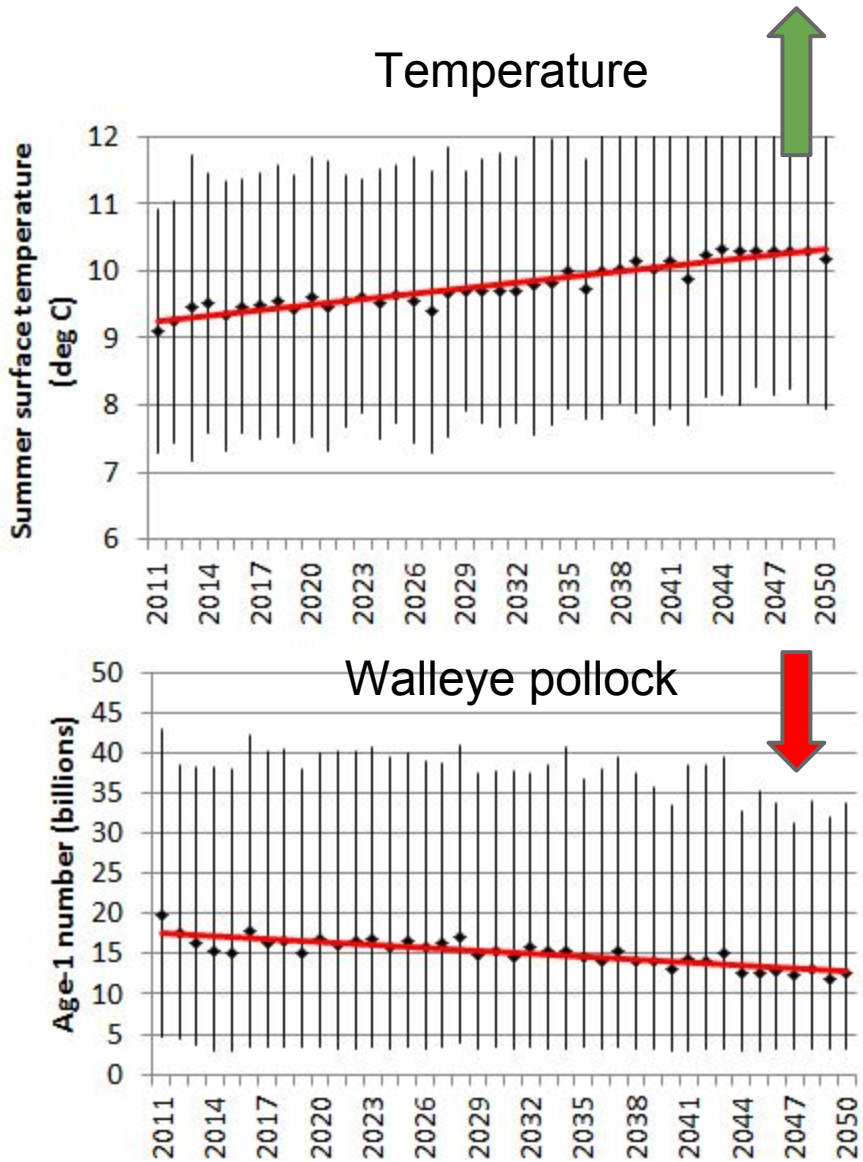


Age-3+ Biomass (thousands t)



Heintz, R.A., Siddon, E.C., Farley, E.V. and Napp, J.M., 2013. Correlation between recruitment and fall condition of age-0 pollock (Theragra chalcogramma) from the eastern Bering Sea under varying climate conditions. *Deep Sea Research Part II: Topical Studies in Oceanography*, *94*, pp. 150-156.

Forecast pollock abundance



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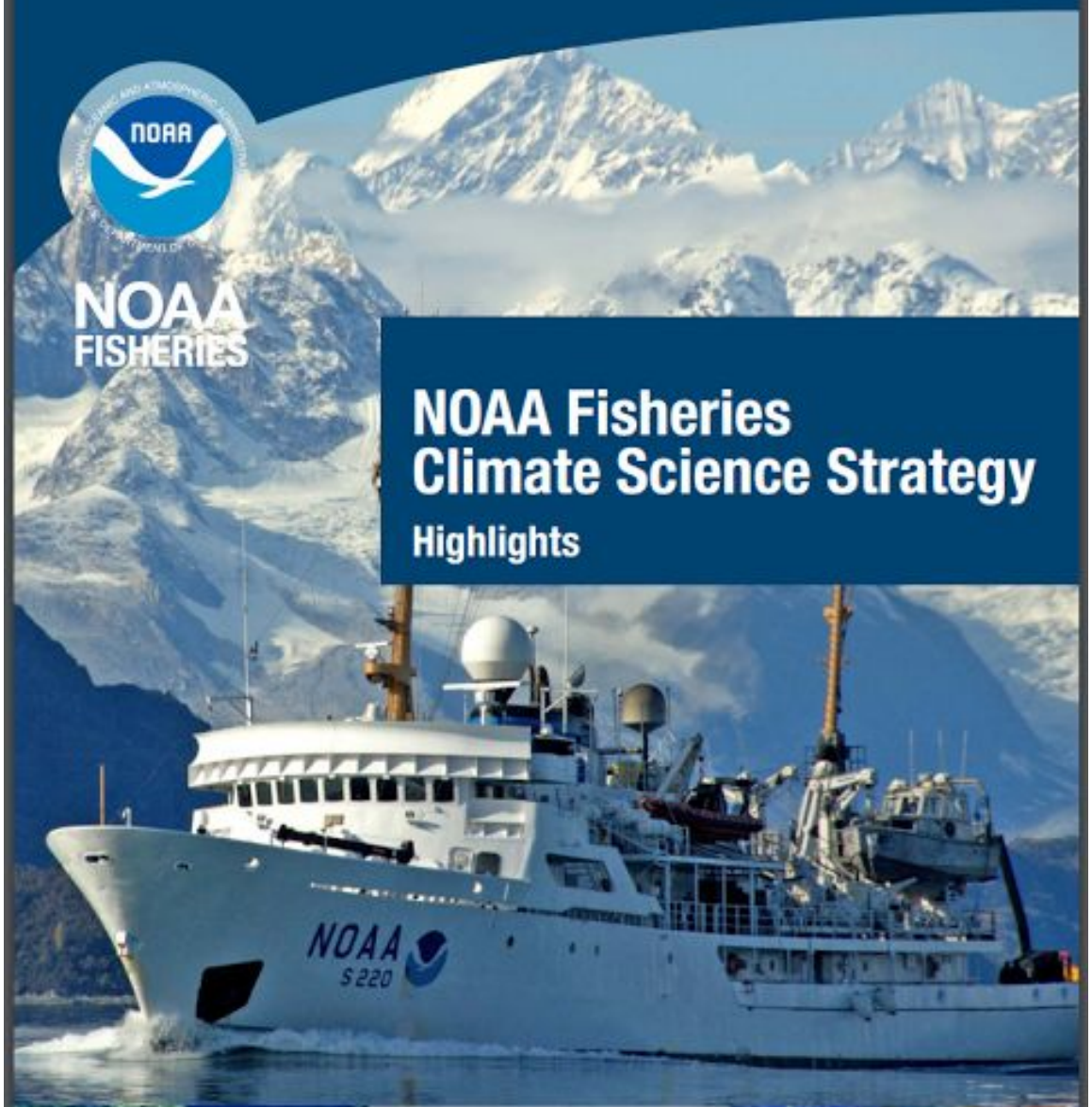
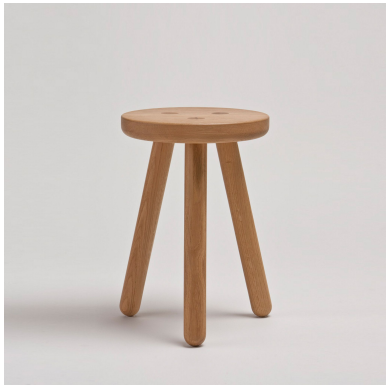
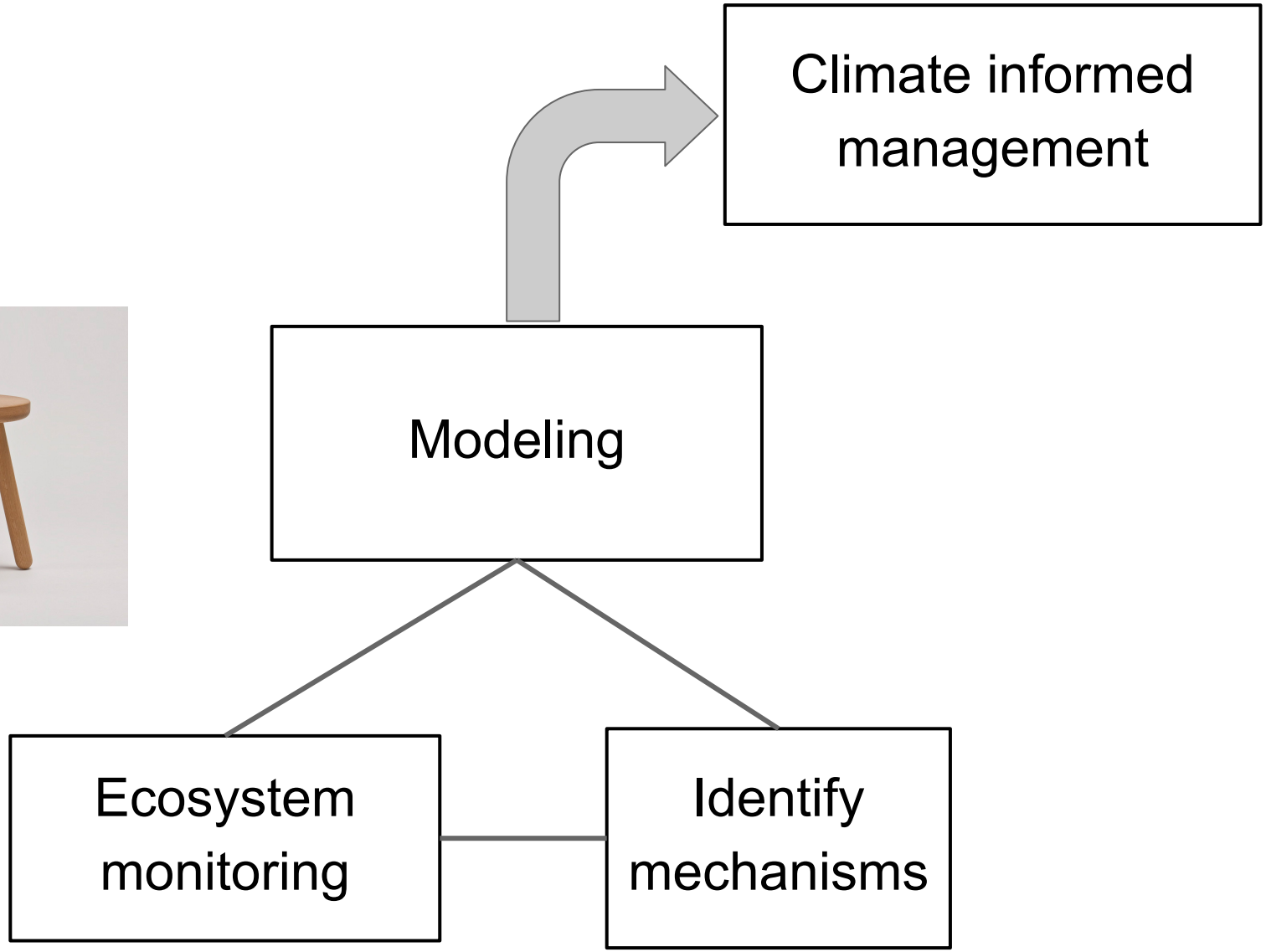
NOAA FISHERIES

NOAA Fisheries Climate Science Strategy

Highlights



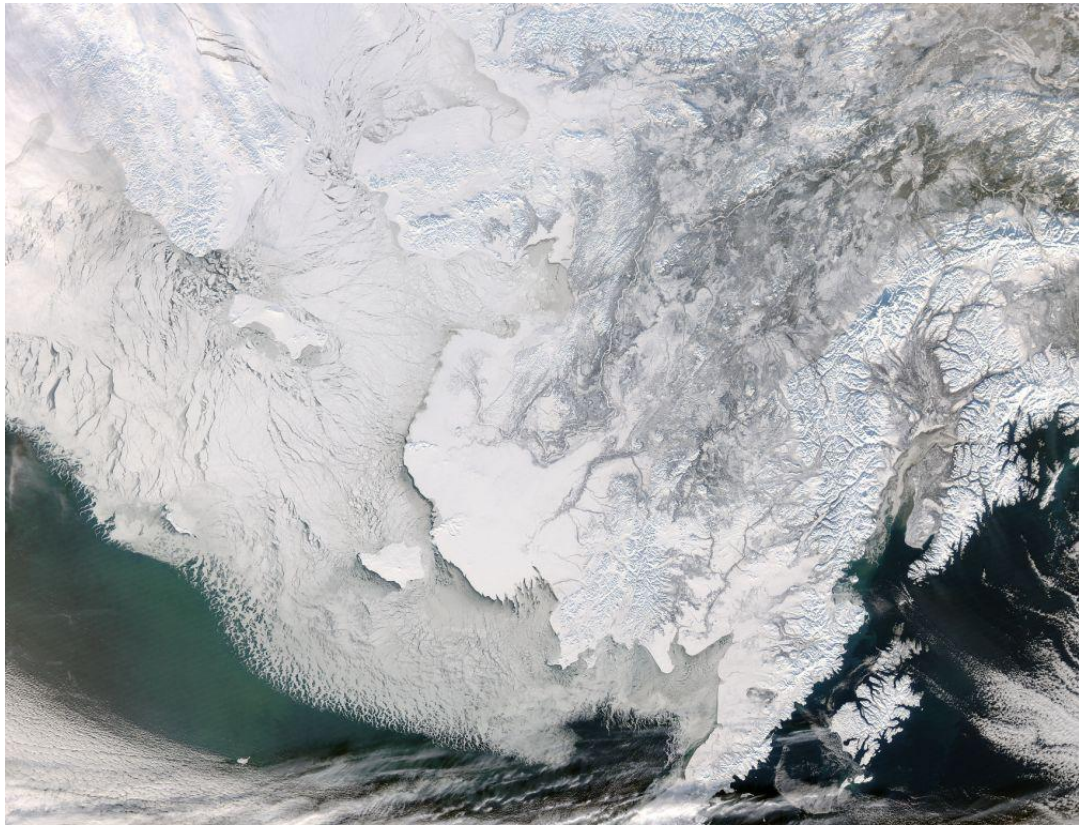



Climate informed management
Modeling
Ecosystem monitoring
Identify mechanisms

Regional Action Plan for Southeastern Bering Sea Climate Science

Assessment

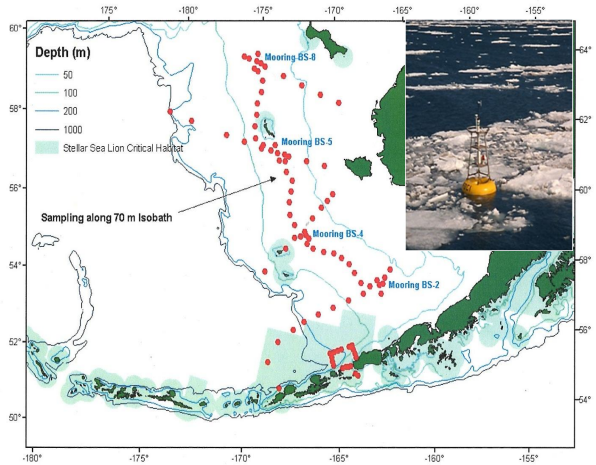
Action Plan



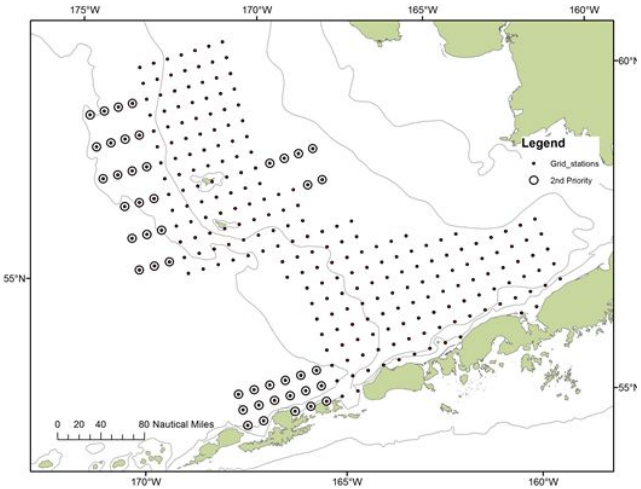
Monitor ecosystems

Seasonal surveys

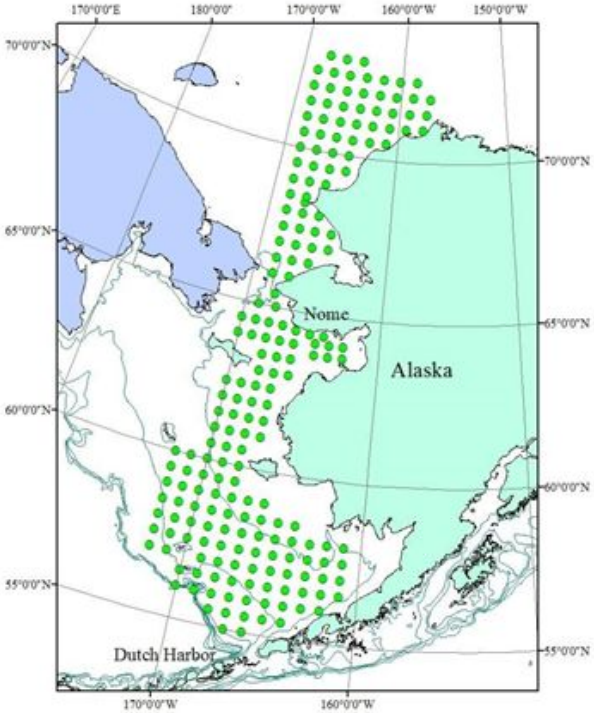
April-May & Sept-Oct physics



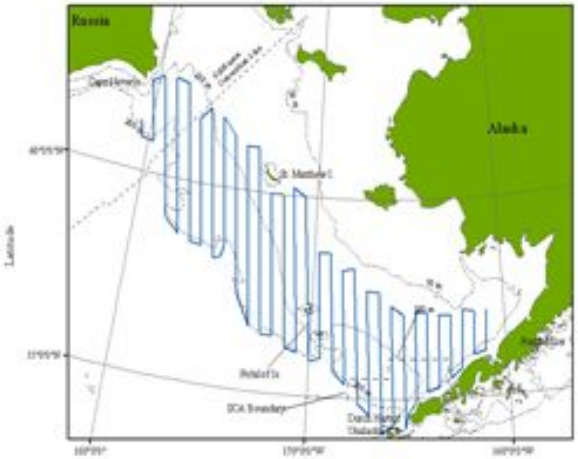
May, larval



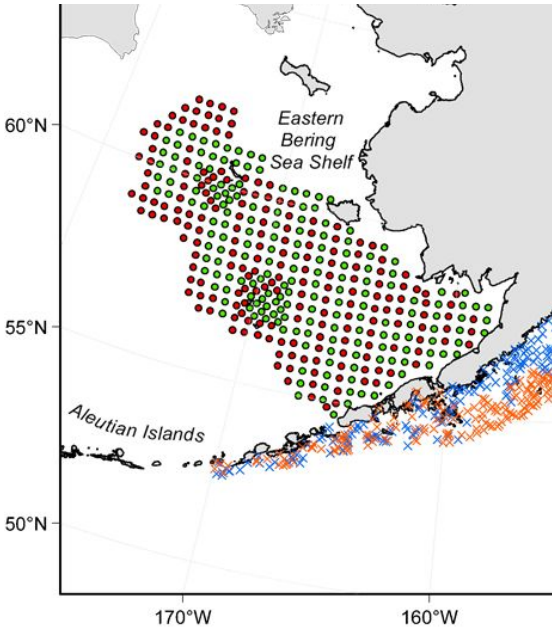
August-September, age-0



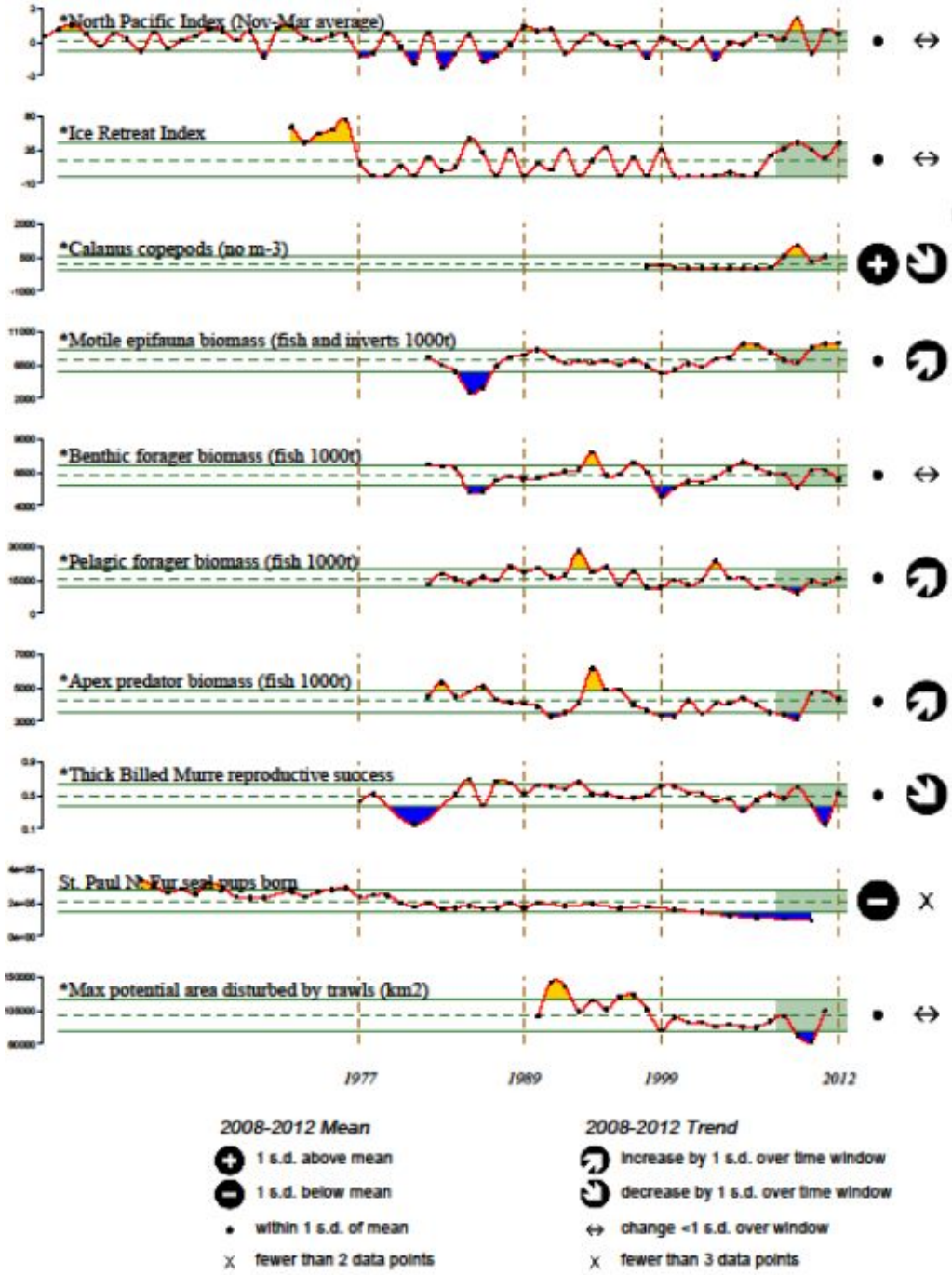
June-July, age-1



June-July, age-3+

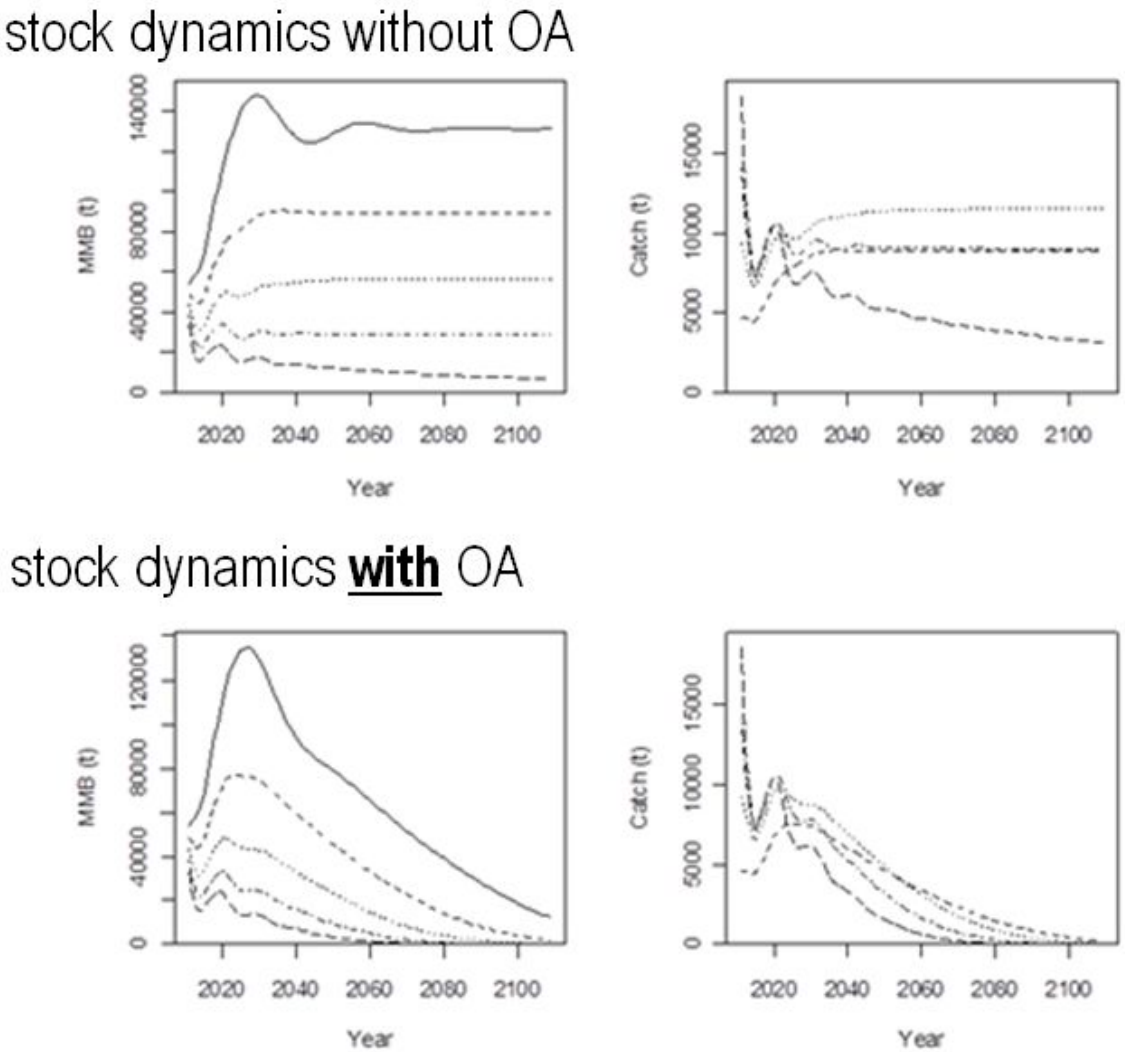


Alaska Marine Ecosystem Considerations



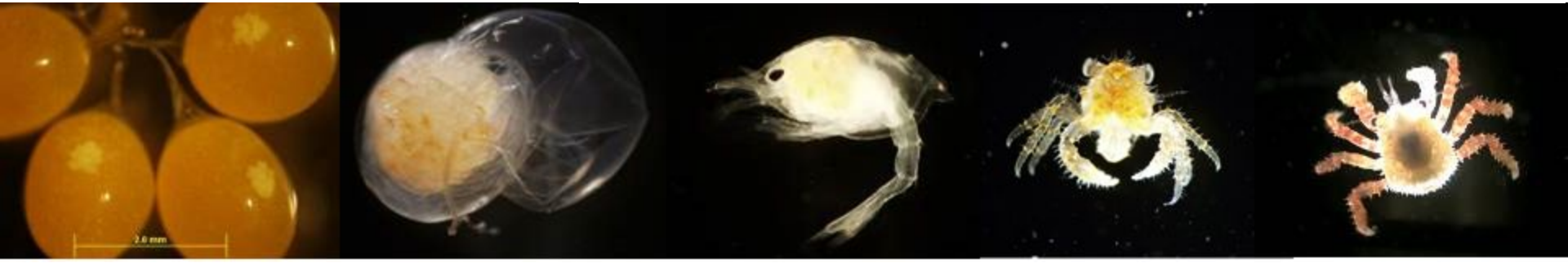
Identify mechanisms (process studies)

Ocean acidification research



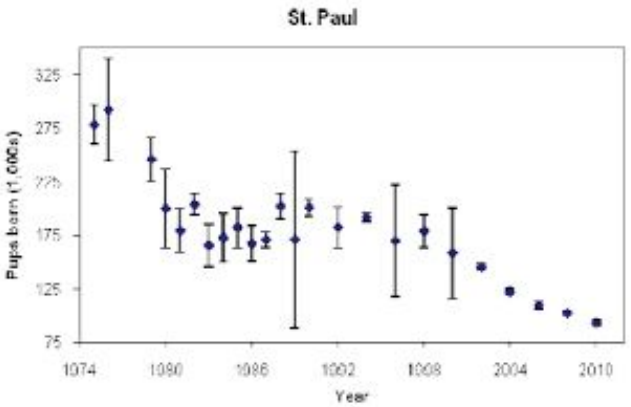
Long, W.C., Swiney, K.M. and Foy, R.J., 2013. Effects of ocean acidification on the embryos and larvae of red king crab, Paralithodes camtschaticus.*Marine pollution bulletin*, *69*(1), pp. 38-47.

Punt, Poljak, Dalton, Foy. 2014. Evaluating the impact of ocean acidification on fishery yields and profits: The example of red king crab in Bristol Bay. Ecol. Modeling. 285: 39-53.



Fur seal research

- Pup production on the Pribilof Islands decreased by approximately 45% since 1998. Cause unknown, but may include direct and indirect effects of fishery competition as well as climate.
- Satellite telemetry in 2015 and 2016 is being used to understand effects during the winter migration and summer foraging.
- This project will link fine-scale changes in fur seal foraging behavior with measures of pollock distribution and abundance in real time.

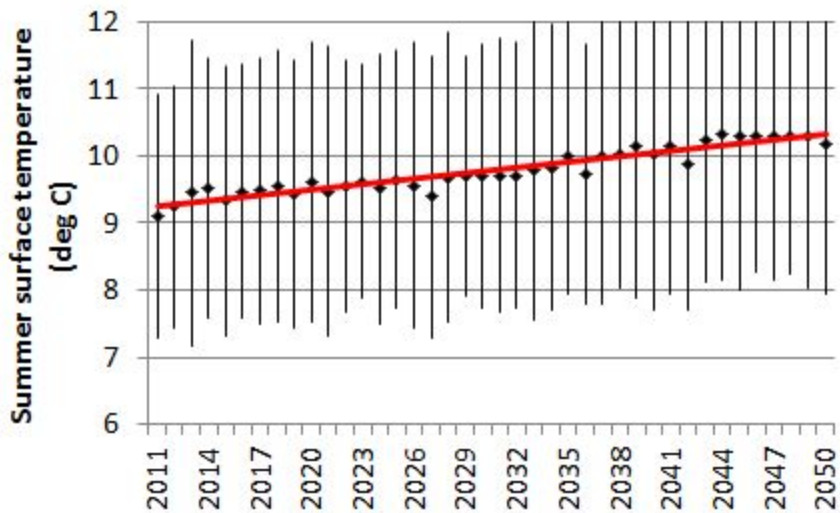


Allen, B.M., Angliss, R.P. and Wade, P. R., 2011. *Alaska marine mammal stock assessments, 2010*.

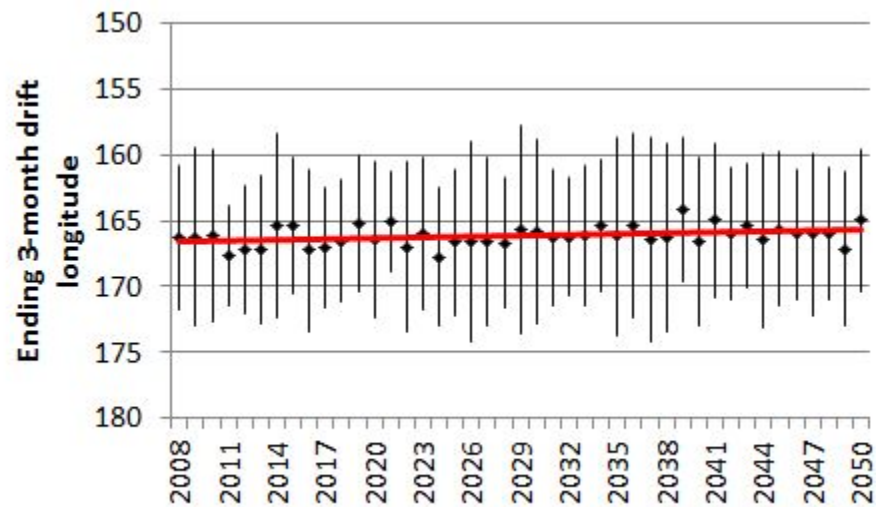
Modeling:
Forecast models and management strategy evaluations (MSE)

Ocean model projections

Temperature



Inshore transport



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NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Alaska CLIMate Project

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Trond Kristiansen (IMR, Norway)
Al Hermann (UW JISAO/PMEL)
Wei Cheng (UW JISAO/PMEL)
André Punt (UW SAFS)

FATE: Fisheries & the Environment
SAAM: Stock Assessment Analytical Methods
S&T: Climate Regimes & Ecosystem Productivity

IPCC Scenarios (x3)

AR4 A1B
AR5 RCP 4.5
AR5 RCP 8.5

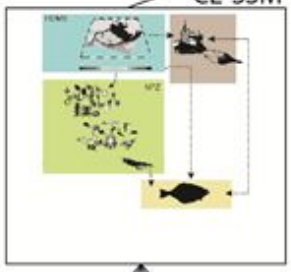
Global Climate Models (x 11)

ECHO-G (AR4 A1B)
MIROC3.2 med res. (AR4 A1B)
CGCM3-t47 (AR4 A1B)
CCSM4-NCAR- PO (AR5 RCP 4.5 & 8.5)
MIROCESM-C- PO (AR5 RCP 4.5 & 8.5)
GFDL-ESM2M*- PO (AR5 RCP 4.5 & 8.5)
GFDL-ESM2M*- PON (AR5 RCP 4.5 & 8.5)

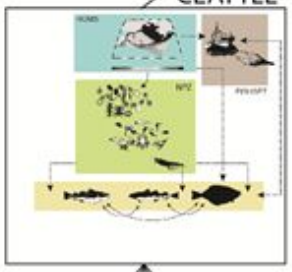
Future Climate Scenarios

Bering Sea Models

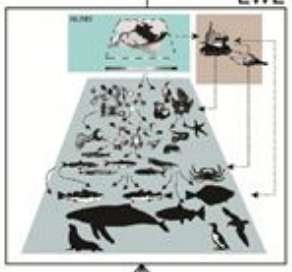
CE-SSM



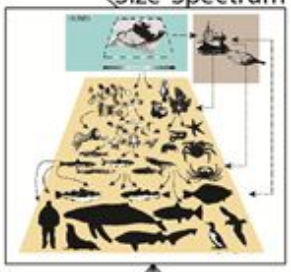
CEATTLE



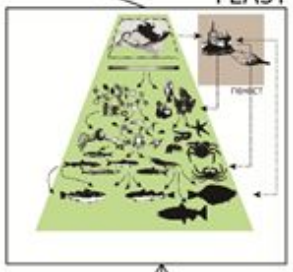
EwE



Size-Spectrum



FEAST



By-catch MSY
Status quo MEY No fishing
Harvest Control Rules (x5)

By-catch MSY
Status quo MEY No fishing
Harvest Control Rules (x5)

By-catch MSY
Status quo MEY No fishing
Harvest Control Rules (x5)

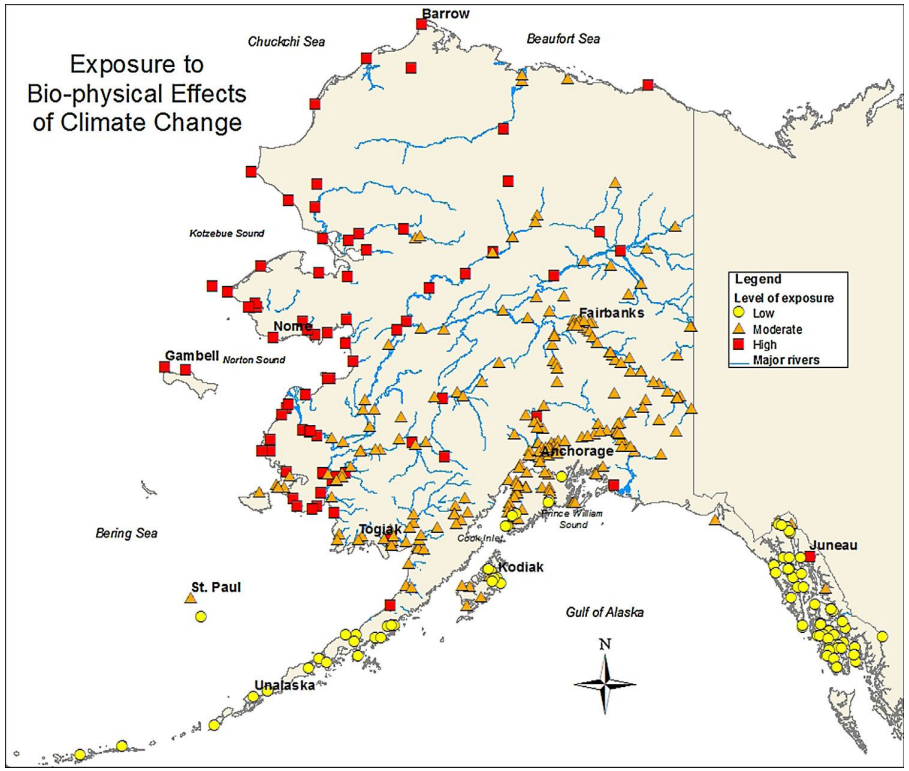
By-catch MSY
Status quo MEY No fishing
Harvest Control Rules (x5)

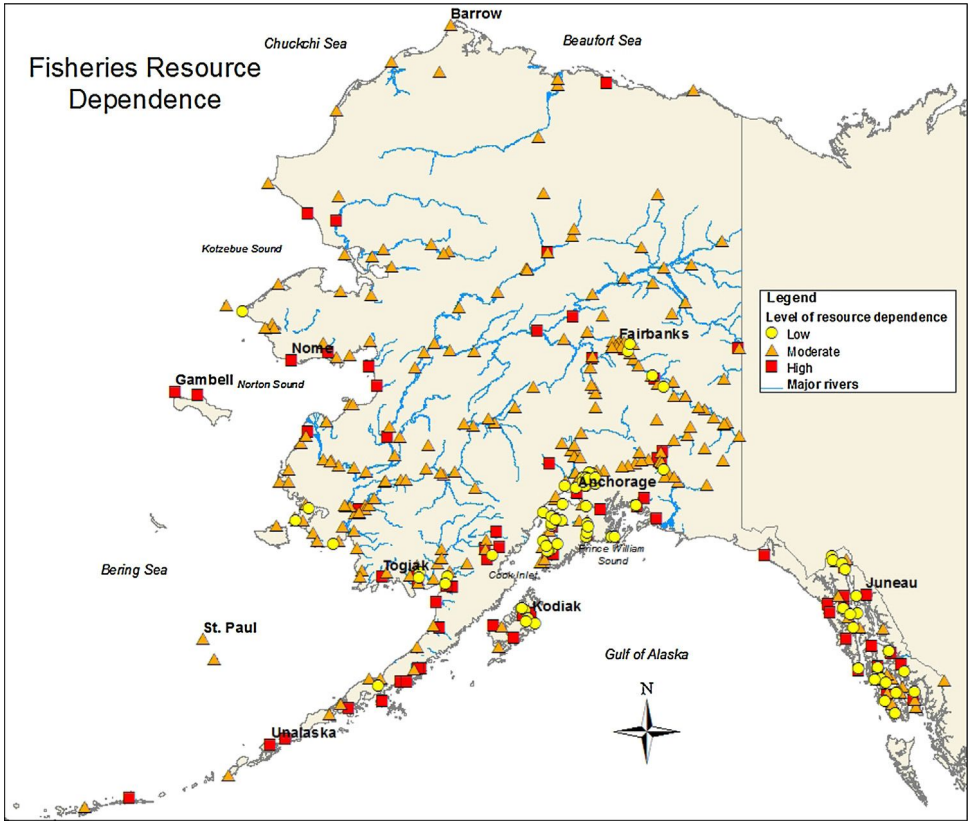
Fleet dynamics
Status quo No fishing
Harvest Control Rules (x3)

Climate-enhanced Biological Models

Fishing Scenarios

Identify human community dependence on LMRs and effects of climate change.





Himes-Cornell, A. and Kasperski, S., 2015. Assessing climate change vulnerability in Alaska's fishing communities. *Fisheries Research*, *162*, pp.1-11.

NPFMC Fisheries Ecosystem Plan. Approved by the Council in December 2015, the FEP includes a climate module that would:

1) synthesize current climate change project outcomes;
2) prioritize species for MSE evaluation; and
3) run MSEs on specific species and scenarios identified by the Council.

Challenge 1

Our ability to project future impacts is limited by our understanding of ecological processes. Understanding is sufficient for **only 3 of 21** comprehensively assessed stocks in the southeastern Bering Sea.

- Walleye pollock (through loss of sea ice)
- Red king crab (through increased CO2)
- Northern rock sole

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Climate vulnerability assessment

A climate vulnerability assessment for the southeastern Bering Sea, which will **qualitatively assess** species vulnerabilities to climate change and provide guidance on research prioritization, currently is underway. The vulnerability assessment uses expert elicitation methods to quantify a species' exposure and sensitivity to expected climate change.

Vulnerability Rank

Sensitivity \ Exposure	Low	Moderate	High	Very High
Very High	Moderate	High	Very High	Very High
High	Low	Moderate	High	Very High
Moderate	Low	Moderate	Moderate	High
Low	Low	Low	Low	Moderate

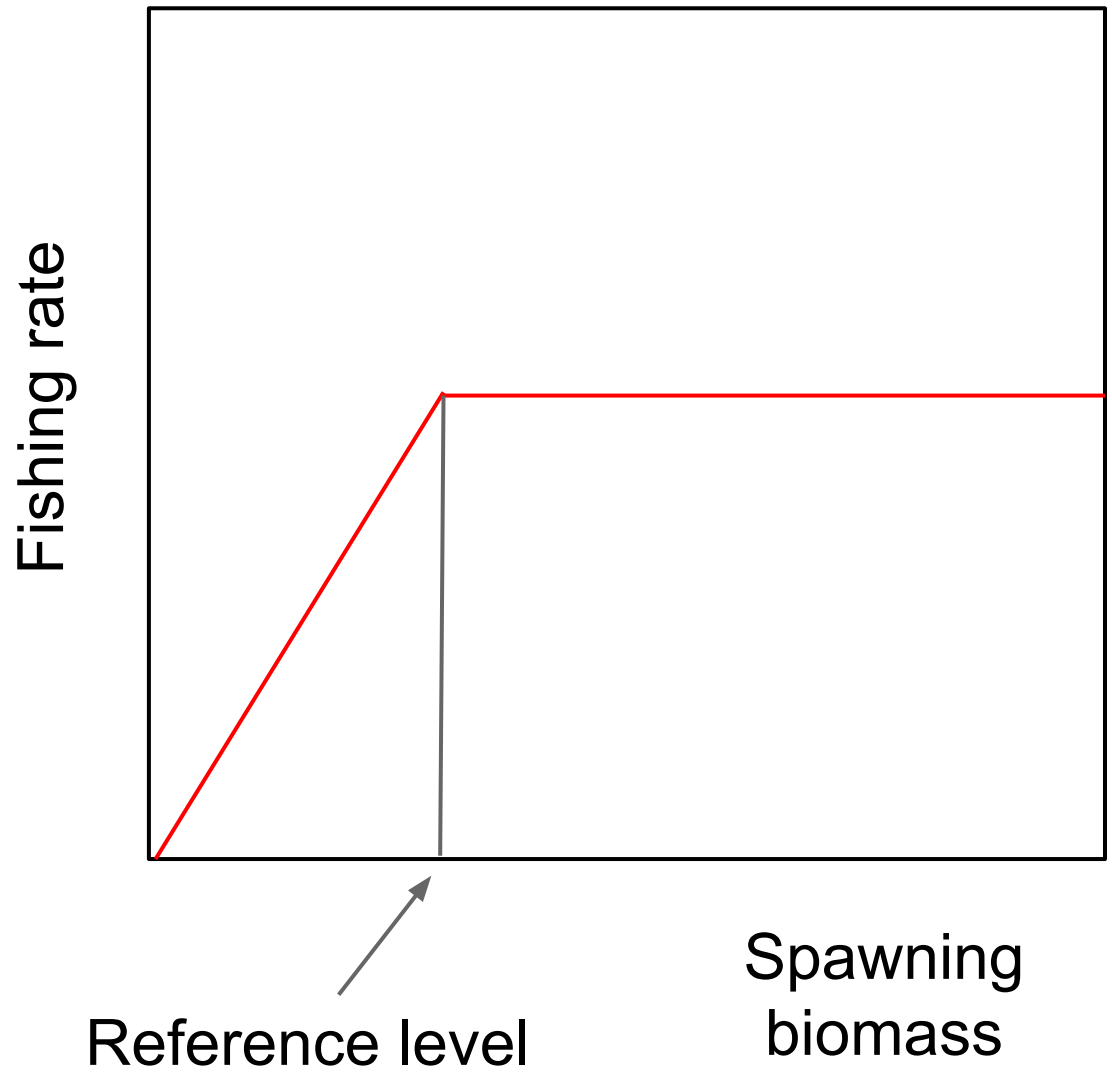
Spencer, Hollowed, Nelson, Sigler, In prep.. *Climate Vulnerability Assessment for the southeastern Bering Sea..*

Recruitment Processes Alliance

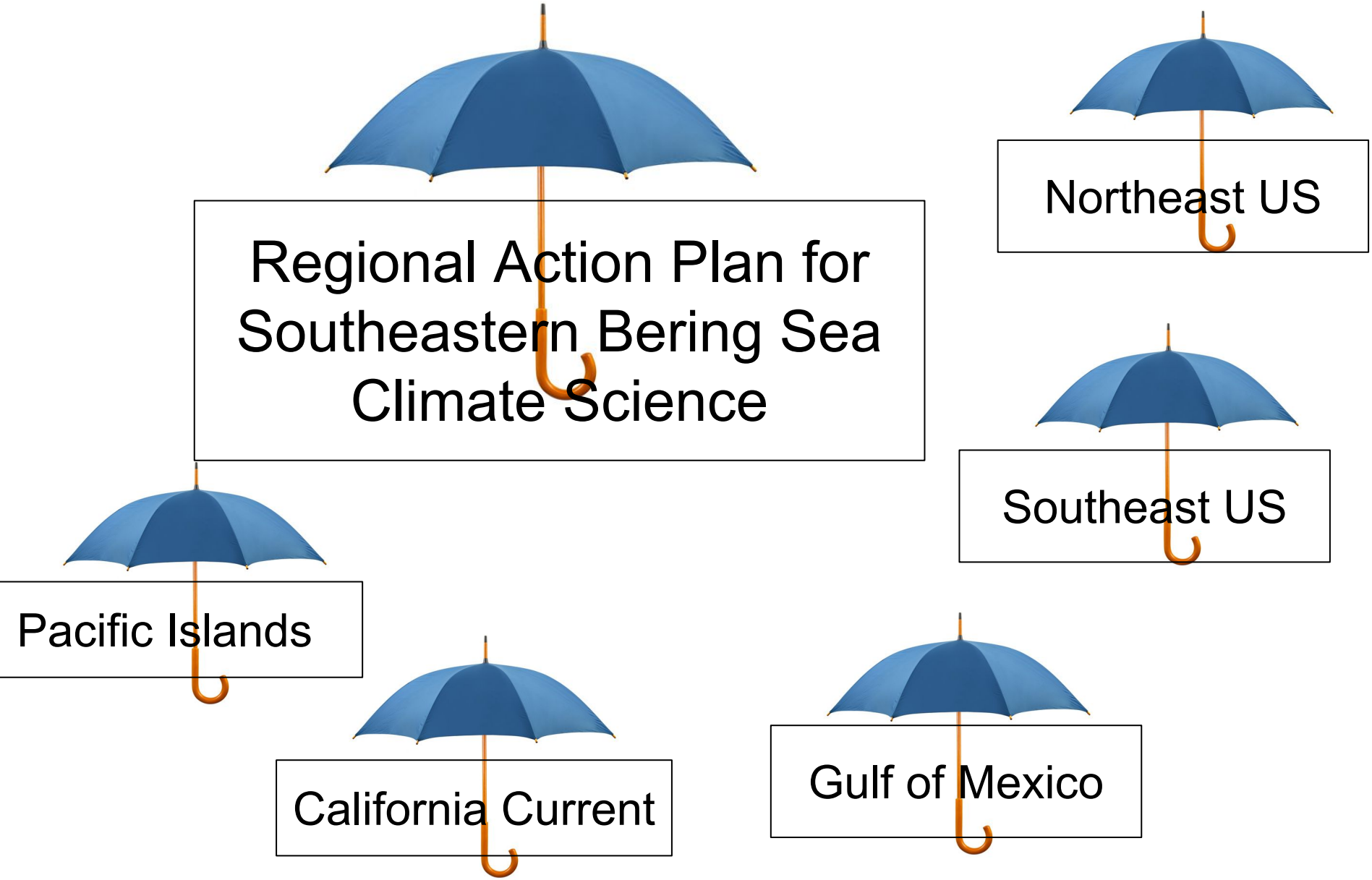
- Research is conducted to understand processes affecting recruitment strength, including effects of climate.
- To date, understanding of these ecological mechanisms sufficient only to quantify effects on 3 fisheries (pollock, red king crab, northern rock sole).
- A significant fraction of AFSC resources are invested in this effort (e.g., ~15% of labor).

Challenge 2 (Obj. 3)

The NPFMC currently has a process that adapts harvest actions to changing measurements from fishery independent surveys. What is not well worked out is how and when the North Pacific Fishery Management Council should react to climate-induced reference point changes.



NMFS Climate Science Strategy



Most important steps to improve efforts to identify and adapt to climate change impacts on fisheries:

- Identify winners and losers and adjust management programs (i.e., catch share programs) as necessary
- Identify and monitor thresholds in ecosystem parameters that signal the need to adjust management strategies