Developing a workplan for the FEP Climate Change Module

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• Intro to module
• Brief background
• Module overview:
  a) Synthesize current & projected climate change impacts
  b) Rapid Climate Vulnerability Assessments,
  c) Operationalized climate change management strategy evaluations (MSEs)
  d) Project changes in species distributions and phenology
  e) Performance, validation, and operationalized delivery of 9 month seasonal forecasts
• Next Steps:
  o Taskforce
  o Products
  o Tracking progress
GOAL:

“support climate change adaptation pathways and long-term resilience for the coupled social-ecological system of the Eastern Bering Sea.”

✓ synthesize current knowledge regarding climate change effects on the EBS system,

✓ identify potential climate-resilient management measures that can improve adaptive capacity and avoid maladaptation

✓ evaluate the risk, timescale, and probability of success of various climate-resilient management policies under future scenarios of change.

Policy relevant not policy prescriptive

(climate-resilient management would go through the existing Council process)
✓ Risk inherently depends on values
✓ Include a “plurality of perspectives” *
✓ Consider interacting (non-linear) pressures

“Interconnections among risks can span sectors and regions with multiple climatic and non-climatic influences, including societal responses to climate change and other issues (Helbing 2013; Moser and Hart 2015; Oppenheimer 2013).”
- Mach et al. 2016
“One ongoing challenge is developing and addressing research questions from a Traditional Knowledge lens rather than solely from a western researcher's perspective.”


WHO?

Taskforce comprised of diverse knowledge holders and experts
WHAT:

a) Synthesize current and projected climate change impacts on the coupled social-ecological Bering Sea system through synthesis of diverse knowledge sources of understanding, context and impacts of change and evaluation of future impacts and risk.

b) Rapid Climate Vulnerability Assessments, which use expert knowledge to identify vulnerable species and communities to climate change and prioritize research needs.

c) Operationalized climate change management strategy evaluations (MSEs) of various alternative harvest strategies for key species under the most recent Intergovernmental Panel on Climate Change projections of carbon mitigation scenarios (sensu ACLIM: Alaska Climate Integrated Modeling Project). Include synthesis of current understanding from cross regional and global coordination of ensemble modeling projects aimed at evaluating climate-resilient management tools.

d) Project changes in species distributions and phenology which includes projected changes in habitat under future climate scenarios in order to estimate potential shifts in BSAI FMP species distributions and potential fishing grounds (sensu Predicting changes in habitat for groundfishes under future climate scenarios using spatial distribution modeling)

e) Performance, validation, and operationalized delivery of 9 month seasonal forecasts of Bering Sea conditions and fish and fisheries specifically aimed at informing the annual groundfish assessment cycle (sensu The Bering Seasons Project).
WHY?
We find that mean SST change was the dominant driver of increasing MHW exposure over nearly two thirds of the ocean, and of changes in MHW intensity over approximately one third of the ocean.
Consider nested scales of management & adaptation

Adaptation: increased flexibility

Adaptation: climate-enhanced stock assessments

Adaptation: nowcast/forecast maps of risk/sea Ice/spp distributions

Test new & existing tools

Adaptation

- incremental (normative) adaptation to preserve current livelihoods, health, and well being and meet future demands
- transformational adaptation, especially to address/prevent continued marginalization and promote diverse well being, values, and views

Build capacity to reevaluate & enable transformative actions

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Fig. 1 from Wise et al. 2014. Reconceptualising adaptation to climate change as part of pathways of change and response. Global Environmental Change 28: 325–336
HOW?
Fig. 4. The Dynamic Adaptive Policy Pathways approach.
Modeled effect of coastal biogeochemical processes, climate variability, and ocean acidification on aragonite saturation state in the Bering Sea

March 06, 2019


Due to naturally cold, low carbonate concentration waters, the Bering Sea is highly vulnerable to ocean acidification (OA), the process in which the absorption of human-released carbon dioxide by the oceans leads to a decrease in ocean water pH and carbonate ion concentration. Emerging evidence suggests that a number of important species in the Bering Sea (such as red king crab and Pacific cod) are vulnerable to OA due to direct (e.g., reduced growth and survival rates) and indirect (e.g., reduced food sources) effects. However, the harsh winter conditions, prevalence of sea ice, and large size of

ICES Journal of Marine Science


Contribution to the Symposium: ‘The effects of climate change on the world’s oceans’
Projected biophysical conditions of the Bering Sea to 2100 under multiple emission scenarios

Albert J. Hermann¹,²*, Georgina A. Gibson³, Wei Cheng¹,², Ivonne Ortiz¹,⁻⁴, Kerim Aydin⁴, Muyin Wang¹,², Anne B. Hollowed⁵, and Kirstin K. Holsman⁴
OBSERVATIONS

ROMSNPZ (downscaled)

GLOBAL MODEL

2003

Annual Groundfish Survey

Bering10K (July 1)

CFSR/CFSv2-Op.Anal. (July 1)

2009

Bottom temperature (°C)

[-2, 0, 2, 4, 6, 8, 10, 12]

Image: Kelly Kearney
Increased warming (2090-2099)-(2010-2019)

Δ Bottom Temp (°C) (whole basin)
RCP 8.5

HOW?

b) Climate Vulnerability Assessments
Methodology – Framework

**Species Vulnerability**

- Habitat Specificity
- Prey Specificity
- Sensitivity to Ocean Acidification
- Sensitivity to Temperature
- Stock Size/Status
- Other Stressors
- Adult Mobility
- Spawning Cycle
- Complexity in Reproductive Strategy
- Early Life History Survival and Settlement Requirements
- Population Growth Rate
- Dispersal of Early Life Stages

**Exposure**

- Sea surface temperature
- Bottom temperature
- Air temperature
- Salinity
- Ocean acidification (pH)
- Precipitation
- Currents
- Sea surface height
- Large zooplankton biomass
- Phytoplankton biomass and bloom timing
- Mixed layer depth

**Sensitivity**

**Slide credit: P. Spencer**
Example of Species Specific Results (from EBS)

Pacific ocean perch

Bootstrap outcomes:

<1 Very High
10 High
89 Moderate
<1 Low
OA Risk Assessment

Himes-Cornell and Kaspersky 2014

Fig. 11. Individual components of the final ocean acidification risk index for each census area.

Fig. 3. Components of the risk index. Each branch is evenly weighted relative to others at the same level.
Vessels, risks, and rules: Planning for safe shipping in Bering Strait

Henry P. Huntington a,*, Raychelle Daniel b, Andrew Hartsig c, Kevin Harun d, Marilyn Heiman b, Rosa Meehan e, George Noongwook f, Leslie Pearson g, Melissa Prior-Parks b, Martin Robards h, George Stetson i

Table 1
Comparison of environmental and cultural risks (columns) and regulatory measures (rows). The first four risks are environmental ones and also cultural risks for those who depend on the environment for food and well-being. Note that most or all regulatory measures can be implemented by voluntary, domestic, or international action. Which vessels would be covered by each type of action, and how much of the risk would be reduced, depends on the details of the shipping activities in question.

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<th>Ship strikes</th>
<th>Noise</th>
<th>Discharges and contamination</th>
<th>Accidental oil spills</th>
<th>Vessel collisions</th>
<th>Disturbance to hunting</th>
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HOW?

c) Operationalized climate change management strategy evaluations (MSEs)
Examples:

Hare et al. (2016) A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLOS ONE 11(2): e0146756. 
https://doi.org/10.1371/journal.pone.0146756

Holsman et al. 2017
Consider evolving interactions and pathways of adaptation.
The ACLIM team

Anne Hollowed  Kirstin Holsman  Alan Haynie  Kerim Aydin  Albert Hermann  Wei Cheng  Stephen Kasperski

Jim Ianelli  Andre Punt  Andy Whitehouse  Jonathan Reum  Amanda Faig  Kelly Kearney  Buck Stockhausen

Paul Spencer  Michael Dalton  Darren Pilcher  Tom Wilderbuer  Cody Szuwalski  Jim Thorson  Ingrid Spies

www.fisheries.noaa.gov/alaska/ecosystems/alaska-climate-integrated-modeling-project
Challenges to evaluating adaptation options:

- **long time horizons** of adaptation outcomes;
- the **shifting baseline and uncertainty** around climate hazards;
- assessing **attribution** of any results;
- addressing the **additional climate risk** and counterfactual scenarios.

“an **approach built on mixed methods, participation and learning helps alleviate some of the uncertainties** around interpreting results on adaptation.” Craft & Fisher 2018, Fisher 2015

Repeated engagement
Climate X management dynamic interaction

Pollock Spawning biomass

CEATTLE model
Holsman et al. 2016
Climate X management dynamic interaction

Pollock Spawning biomass

CEATTLE model
Holsman et al. 2016
HOW?

d) Project changes in species distributions and phenology
Future Essential Fish Habitat

(Chris Rooper, Ivonne Ortiz, Ned Laman, Al Hermann, *in prep*)

Used Slope, SE Bering Sea shelf and Northern Bering Sea data to build EFH models 1982-2017 except when noted

1) AK plaice
2) Arrowtooth flounder (1993- )
3) flathead sole
4) Northern rock sole (2001- )
5) Pacific cod
6) Walleye pollock
7) Red king crab (1996- )
8) Snow crab
9) Tanner crab
10) Yellowfin sole

Variables used: depth, slope, maximum tidal current, sediment grain size, mean bottom ocean current, bottom temperature

Slide credit: I. Ortiz
P.Cod
(Chris Rooper, Ivonne Ortiz, Ned Laman, Al Hermann, in prep)

Slide credit: I. Ortiz
Today

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