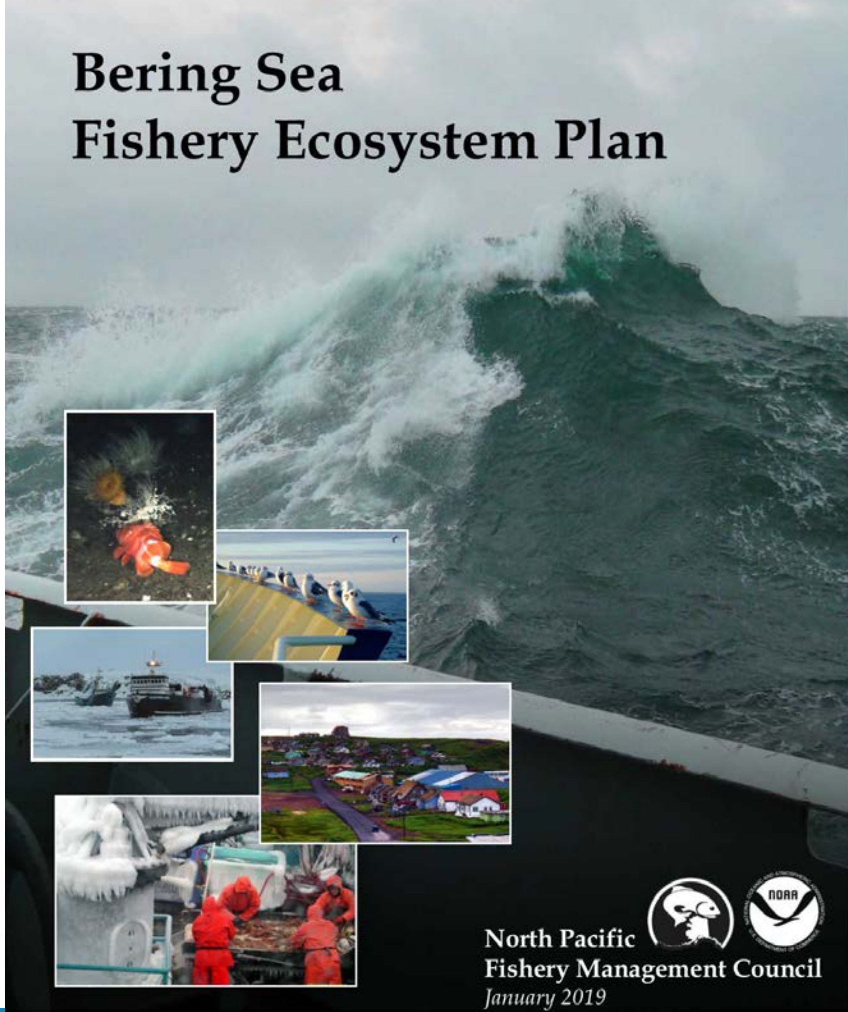


Bering Sea Fishery Ecosystem Plan

Diana Evans and Kerim Aydin

Presentation to the North Pacific Fishery Management Council, June 2019

Bering Sea Fishery Ecosystem Plan

Dec. 2018

Council adopts BS FEP

- Tasked staff with Action Module workplans

Jan. 2019

Final BS FEP document

- Includes Council's approval of 5 action modules
- Minor edits from December meeting

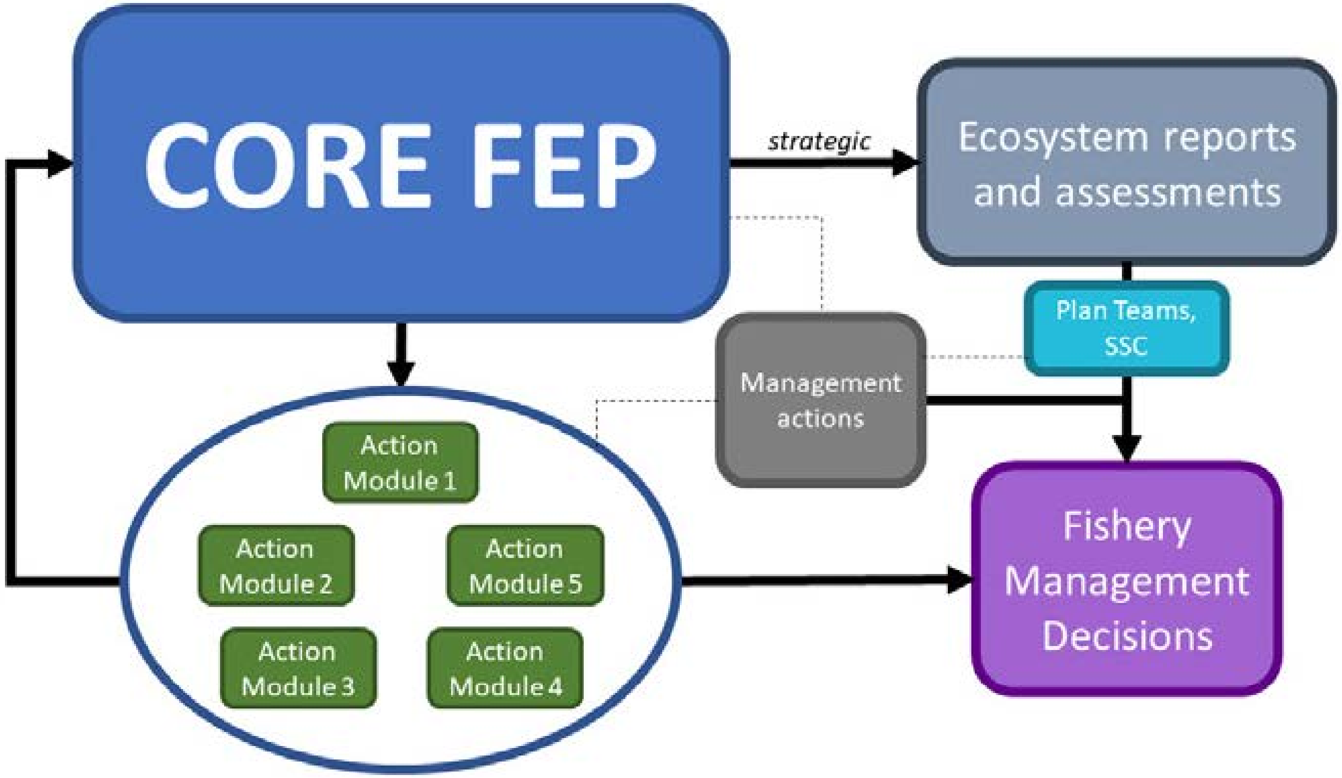
May 2019

BS FEP Team meeting

- First annual meeting in ongoing implementation role

Structure of the Bering Sea Fishery Ecosystem Plan

- Strategic planning document
- Action informing but not action forcing
  - Management action continues to occur through the FMPs



Core FEP and Action modules

Core FEP

- Contains strategic components of FEP
- Identifies goals and objectives
- Describes how FEP works as a framework process

Action modules

- Specific analyses or research efforts approved by the Council as valuable
- Council initiates individual modules when resources allow
- Each has its own scope, tasking, timeline
- Directly linked to FEP objectives
- Designed so that outcomes will be useful to the Council decision process

Why did the Council develop a FEP for the Bering Sea?

- Serve as a **communication tool** for ecosystem science and Council policy
- Create a **transparent public process** for the Council to identify ecosystem values and management responses
- Provide a **framework for strategic planning** that would guide and prioritize research, modeling, and survey needs
- **Identify connected Bering Sea ecosystem components**, and their importance for specific management questions
- Assess Council management with respect to ecosystem-based fishery management best practices, and **identify areas of success and gaps** indicating areas for improvement on a regular basis
- Provide a **framework for considering policy options** and associated opportunities, **risks, and tradeoffs** affecting FMP species and the broader Bering Sea ecosystem
- **Build resiliency of Council management strategies**, and options for responding to **changing circumstances**

FEP explicitly includes the human dimension

- Core FEP aims to define LK and TK clearly, and work towards formalizing their use and review alongside natural and social science

Local Knowledge	Traditional Knowledge
• Close environmental observations • Place-based • Empirical • Pragmatic • Often inter-generational	• A living body of knowledge • Acquired through long-term sociocultural, spiritual, and environmental engagement • Defines human – animal reciprocal relationships • Defines human – human kinship and reciprocity • Embodies rules about right conduct that intertwine the pragmatic and spiritual • Transmitted inter-generationally through oral history and ritual • Rooted in time and place, while having wide applicability • Rooted in tradition, while adaptable and dynamic

Ecosystem Goals

FEP also identifies ecosystem objectives under each of these ecosystem goals

- Maintain, rebuild, and restore fish stocks at levels sufficient to protect, maintain, and restore food web structure and function;
- Protect, restore, and maintain the ecological processes, trophic levels, diversity, and overall productive capacity of the system;
- Conserve habitats for fish and other wildlife;
- Provide for subsistence, commercial, recreational, and non-consumptive uses of the marine environment;
- Avoid irreversible or long-term adverse effects on fishery resources and the marine environment;
- Provide a legacy of healthy ecosystems for future generations.

Role of the Bering Sea FEP team

- Provide strategic support for the Council's goals and objectives for ecosystem-based fishery management (EBFM), as described in the BS FEP

Bering Sea FEP Team

- Transitioned from developing the FEP to ongoing FEP implementation role
- First meeting in new role May 6-7, 2019, at AFSC
- Agenda structured around tasks identified in the BS FEP

__Members__

- *Kerim Aydin, co-Chair (AFSC REEM)*
- *Mike Dalton (AFSC ESSR)*
- *Benjamin Daly (ADFG)*
- *Anne Marie Eich (NMFS AKR)*
- *Diana Evans, co-Chair (NPFMC)*
- **Brad Harris (APU)*
- *Jim Ianelli (AFSC SSMA)*
- *Jo-Ann Mellish (NPRB)*
- **Heather Renner (USFWS)*
- *Elizabeth Siddon (AFSC ABL)*
- **Phyllis Stabeno (NOAA PMEL)*
- **Ian Stewart (IPHC)*
- *Stephani Zador (AFSC REFM)*
- *Davin Holen (Sea Grant)*

**unable to attend*

Bering Sea FEP team: Four tasks

Strategic guidance for monitoring Bering Sea ecosystem status	• Develop and track ecosystem indicators appropriate to BS FEP ecosystem objectives • Strategic review of ecosystem products
BS FEP Action Modules	• Track progress of ongoing Action Modules • Recommendations on identifying new Action Modules
Maintain the Core BS FEP	• Consider how completed Action Modules inform the Core FEP, update core FEP as appropriate • Track how ecosystem information used in Council process
Outreach and communication	• Provide Council with periodic overviews of ecosystem products and research, including LK and TK progress • Work collaboratively with Plan Teams and other partners

Strategic guidance for monitoring Bering Sea ecosystem status

Team discussion and recommendations

- *Kerim powerpoint*
- Team recommends development of an Ecosystem Health Report Card
  - Organized around the Council's 6 ecosystem goals and the 17 ecosystem objectives
  - Should be developed in partnership between the FEP Team and other Plan Teams, the ESR team, the SSC, the Council process generally
  - FEP Team workgroup (led by Ebett Siddon) to work on an initial framework proposal
  - Timeline:
    - present outline to Groundfish Plan Teams and SSC in Sep/Oct
    - Draft Ecosystem Health Report Card available for March 2020 FEP Team meeting
    - SSC/Council feedback in April 2020
    - Complementary revisions to ESR in Nov/Dec 2020

Maintaining the Core FEP

Team discussion and recommendations

Ongoing Core FEP work

- Identifying ecosystem indicators that match to the FEP's ecosystem objectives
- Continued work on physical/biological synthesis of Bering Sea ecosystem *(will also be informed by an FEP action module)*

Tracking FEP uptake

- Diverse participatory process – esp through FEP Team and Ecosystem Committee
- Discussions of engagement/ 2-way communication
- LK and TK inputs (and not LTK)
- Explaining Council process and Council's EBFM approach (esp graphics)

Team discussion and recommendations

- Team has proposed Terms of Reference for approval by Council
- Modeled on other Plan Team TORs
- Includes:
  - FEP Team objectives and tasking (from FEP)
  - Membership requirements, co-Chairs
  - How meeting will be organized (public participation, rules of order)
  - Process for reporting recommendations
  - Meeting schedule for FEP Team
    - Annual meeting in March, reporting to Council in April
    - Provision for interim meeting in fall, likely via teleconference

Managing Action Modules

Five Action Modules approved in the FEP

first two initiated by the Council in December 2018

- Climate change
- Local, Traditional Knowledge / Subsistence
- EBFM gap analysis
- Interdisciplinary conceptual models
- Research

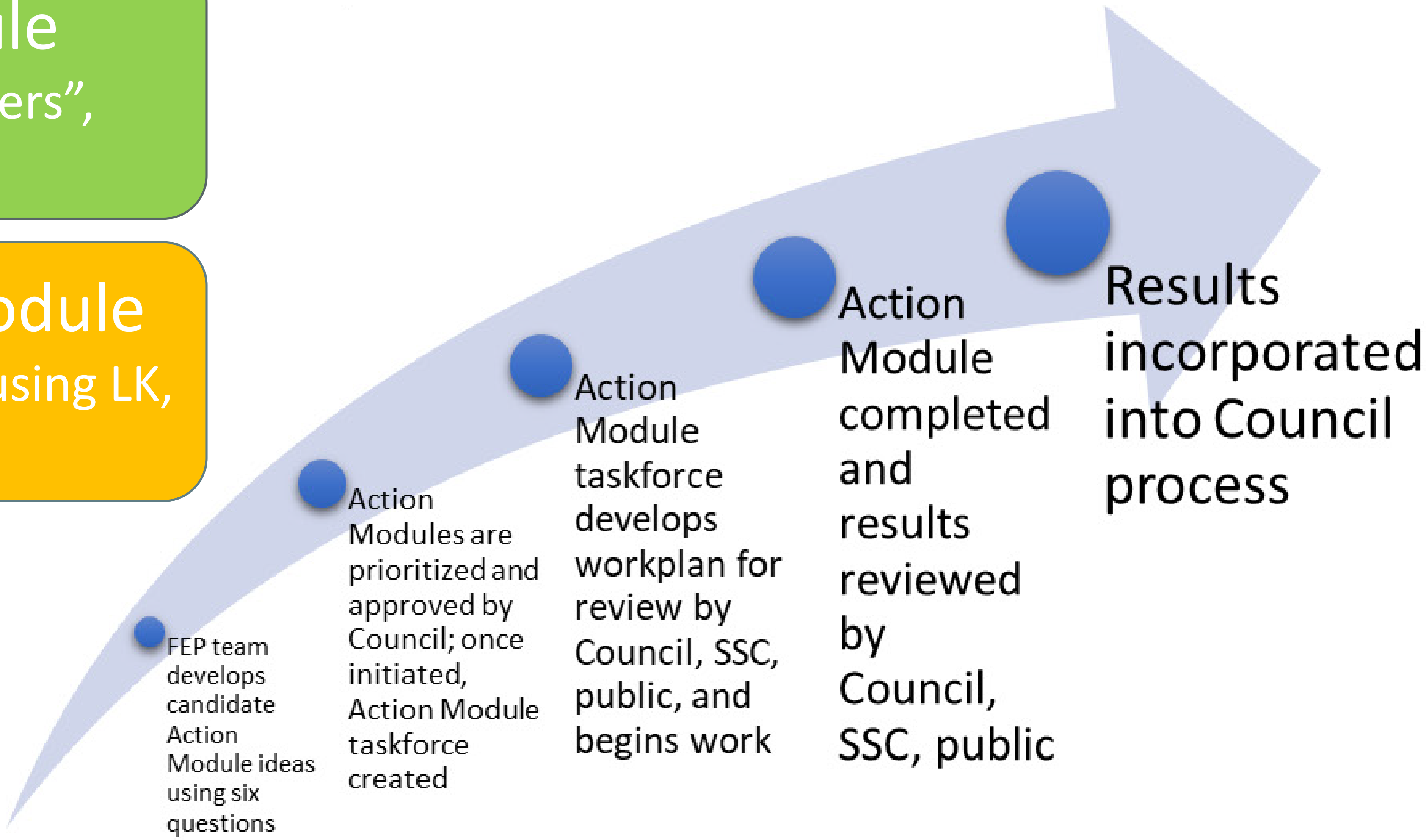
Action module cycle and first modules

Climate change module

Identify “winners and losers”,
Council action options

Subsistence, LK TK module

Methodology for better using LK, TK, and subsistence data



Action Module Workplan:
Evaluate effects of climate change and develop management considerations

Developing a workplan for the FEP Climate Change Module

Kirstin Holsman
kirstin.holsman@noaa.gov
Alaska Fisheries Science Center

FEP Meeting, Seattle WA
May 7, 2019


Mark Holsman

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)

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 revaluate & enable transformative actions

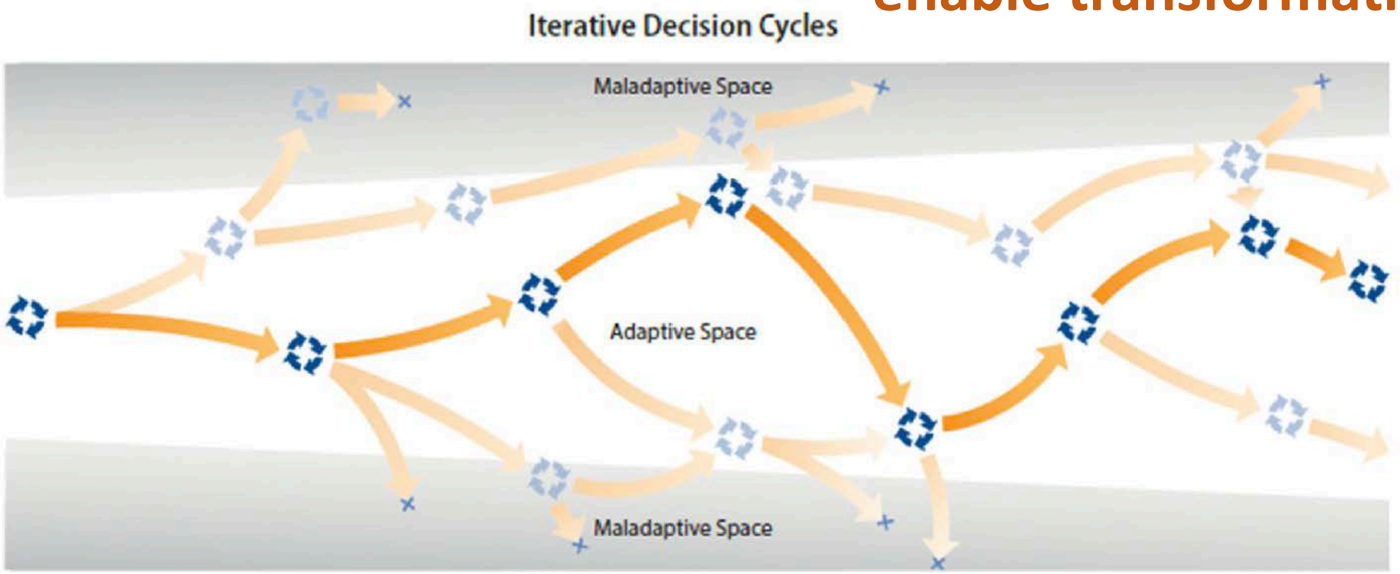
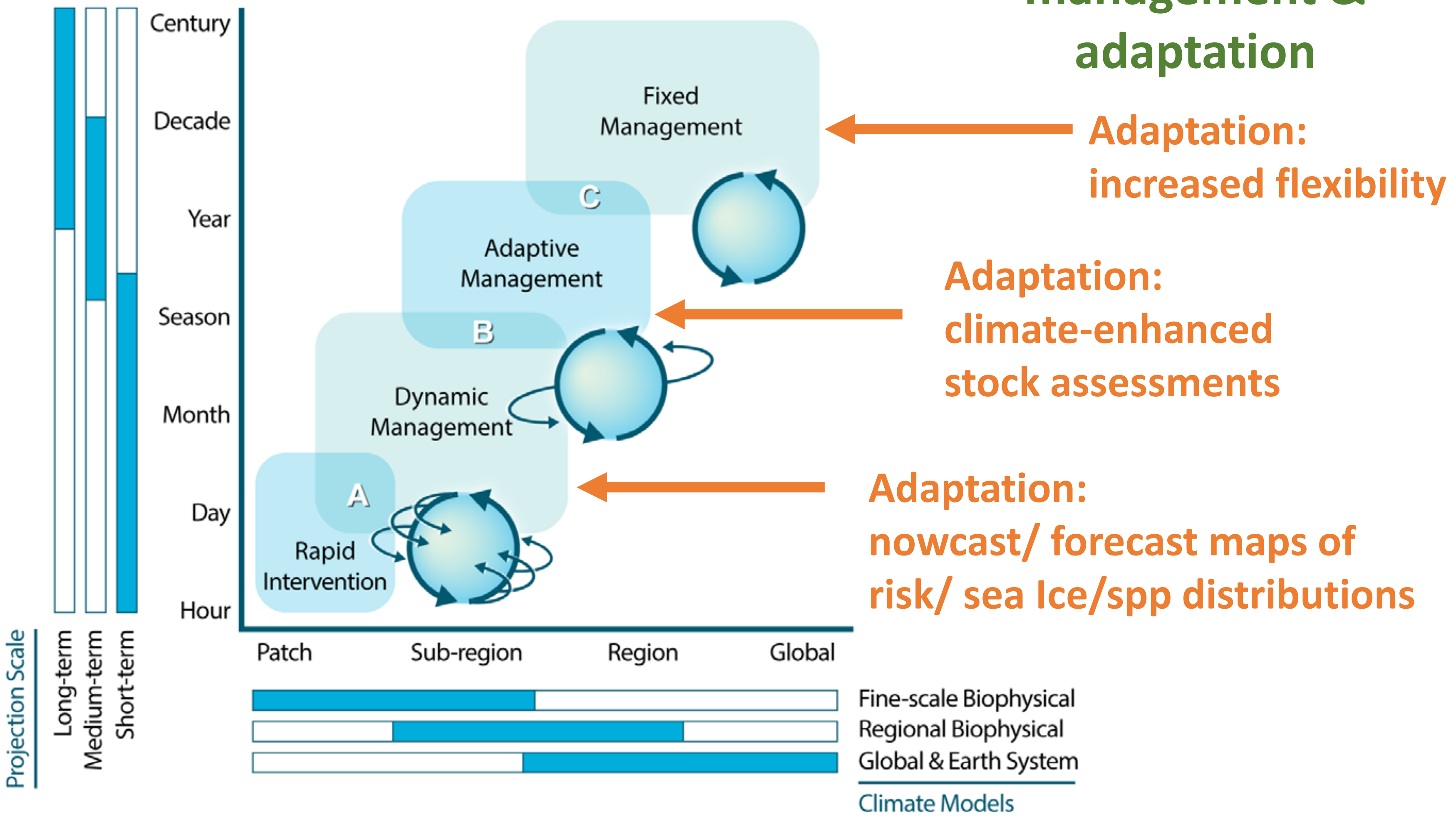


Fig. 1 from Wise et al. 2014. Reconceptualising adaptation to climate change as part of pathways of change and response. Global Environmental Change 28: 325–336

Consider nested scales of management & adaptation



Holsman, K. K., Hazen, E. L., Haynie, A., Gourguet, S., Hollowed, A., Bograd, S. J., … Aydin, K. (2019). Towards climate resiliency in fisheries management. ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsz031

- ✓ 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."

Raymond-Yakoubian, J., & Daniel, R. (2018). Marine Policy, *97:*101–108.

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).*

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UNITED STATES DEPARTMENT OF COMMERCE

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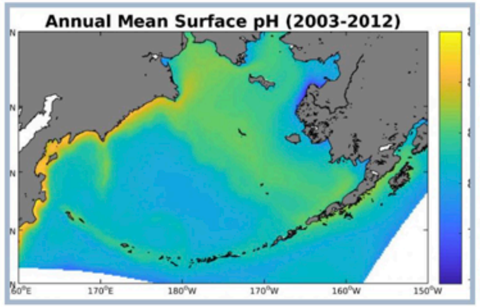
Modeled effect of coastal biogeochemical processes, climate variability, and ocean acidification on aragonite saturation state in the Bering Sea



Modeled annual mean surface pH over the 2003-12 timeframe. Cooler colors indicate corrosive, low pH water while warmer colors indicate relatively buffered, high pH water

March 06, 2019

Pilcher, D.J., D.M. Naiman, J.N. Cross, A.J. Hermann, S.A. Siedlecki, G.A. Gibson, and J.T. Mathis (2019): Modeled effect of coastal biogeochemical processes, climate variability, and ocean acidification on aragonite saturation state in the Bering Sea. Front. Mar. Sci., 5, 508, doi: 10.3389/fmars.2018.00508.

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

In this paper, the authors developed a computational

ICES Journal of Marine Science

ICES CIEM International Council for the Exploration of the Sea / Conseil International pour l'Exploration de la Mer

ICES Journal of Marine Science (2019), doi:10.1093/icesjms/fsz043

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. Hermann[1,2]*, Georgina A. Gibson[3], Wei Cheng[1,2], Ivonne Ortiz[1,4], Kerim Aydin[4], Muyin Wang[1,2], Anne B. Hollowed[4], and Kirstin K. Holsman[4]

OBSERVATIONS ROMSNPZ (downscaled) GLOBAL MODEL

2003

2009

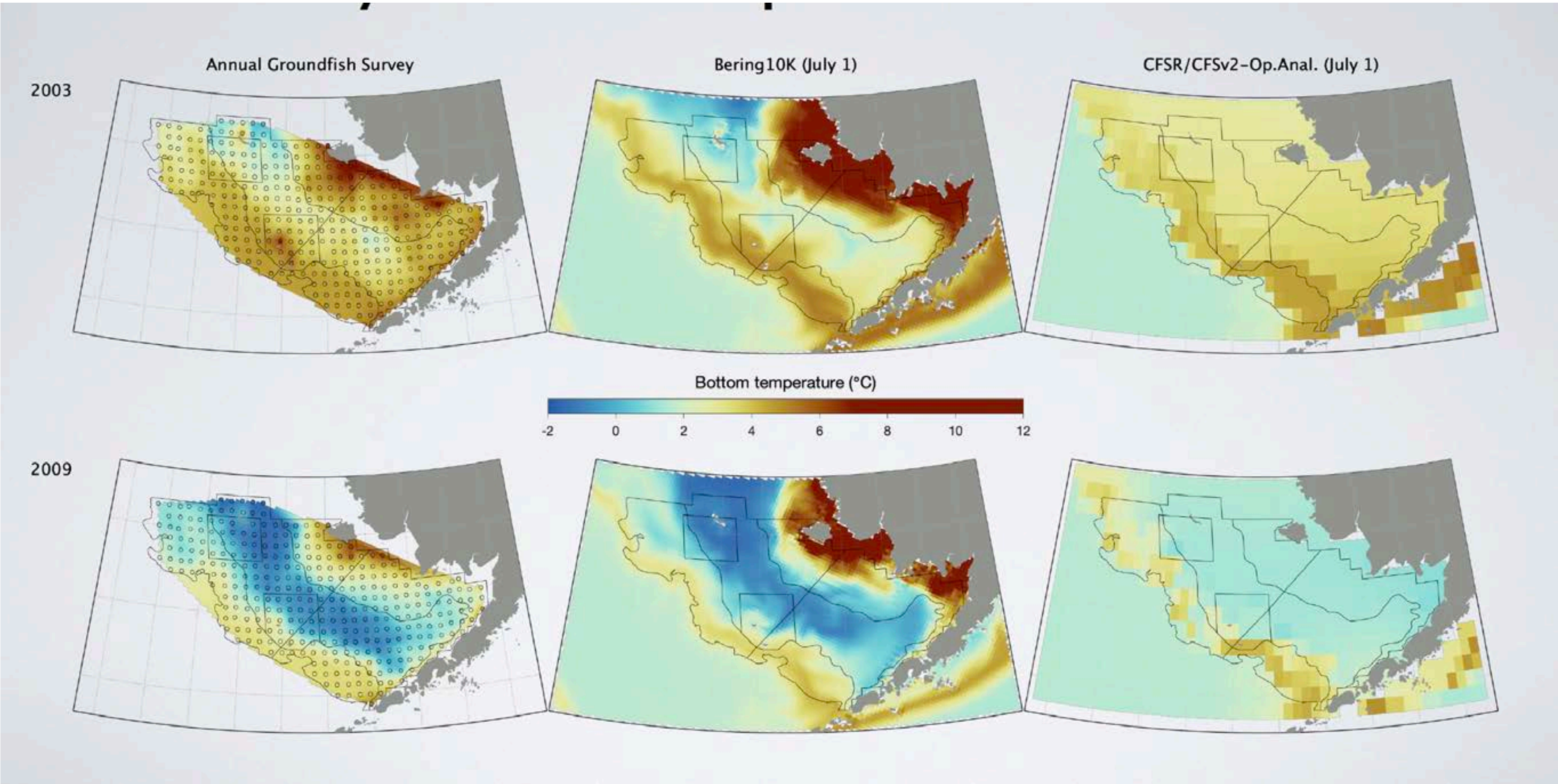
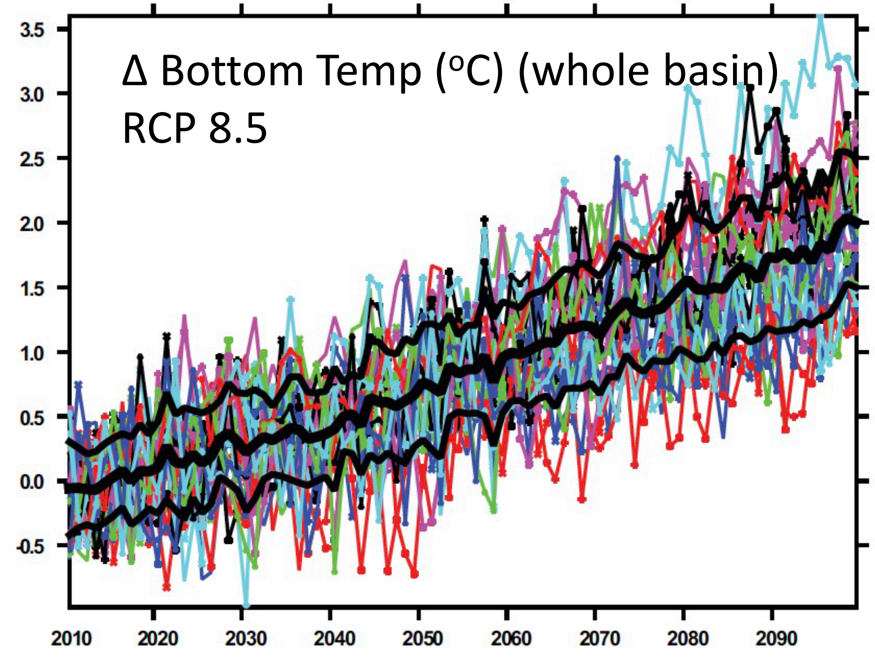
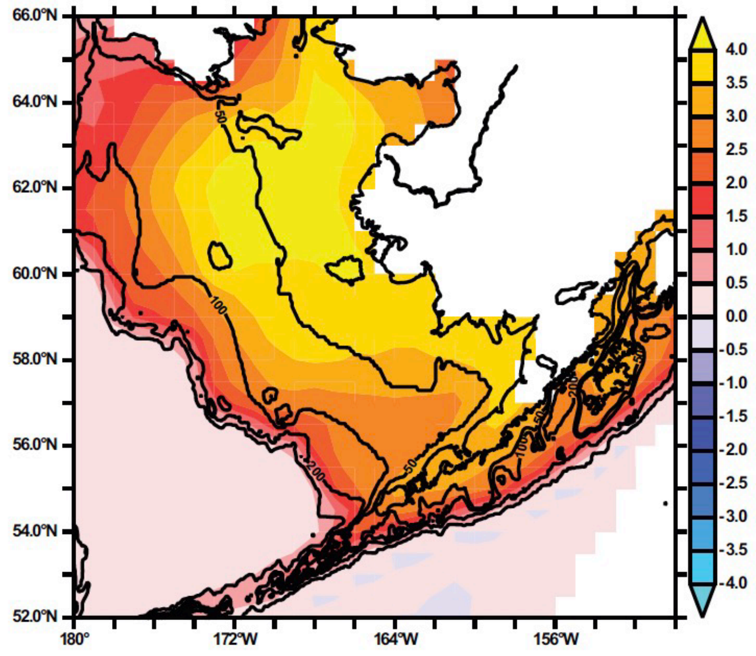


Image: Kelly Kearney

Increased warming (2090-2099)-(2010-2019)





(2019) Hermann, A. J., G.A. Gibson, W. Cheng, I. Ortiz1,K. Aydin, M. Wang, A. B. Hollowed, and K. K. Holsman. Projected biophysical conditions of the Bering Sea to 2100 under multiple emission scenarios. ICES. doi: 10.1093/ices/fsz043

HOW?

b) Climate Vulnerability Assessments

Methodology – Framework

Species Vulnerability

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

- 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

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

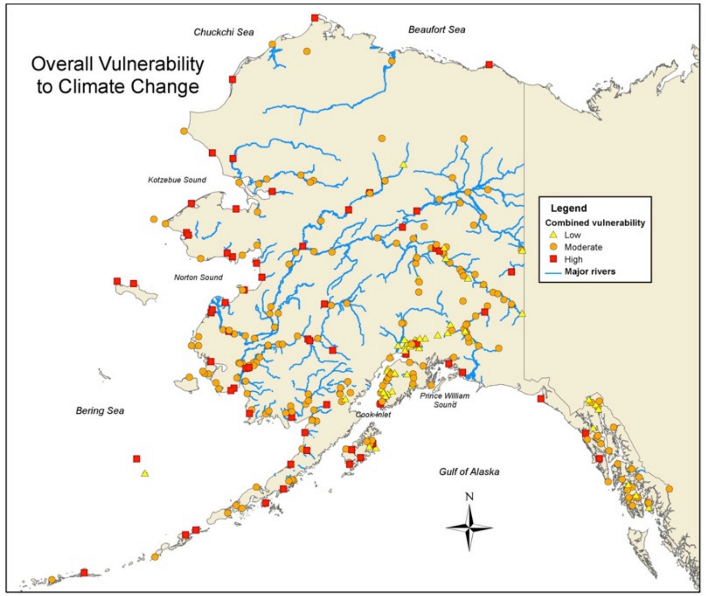
Pacific ocean perch – *Sebastes alutus*
Overall Vulnerability Rank = Moderate
Biological Sensitivity = High
Climate Exposure = Moderate
Sensitivity Data Quality = 75% of scores ≥ 2
Exposure Data Quality = 56% of scores ≥ 2

	Sebastes alutus	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Habitat Specificity	1.9	2.5	
	Prey Specificity	1.9	2.2	
	Adult Mobility	2.4	2.1	
	Dispersal of Early Life Stages	1.6	1.8	
	Early Life History Survival and Settlement Requirements	2.6	1.5	
	Complexity in Reproductive Strategy	2.3	1.8	
	Spawning Cycle	3.8	2.2	
	Sensitivity to Temperature	3.2	2.5	
	Sensitivity to Ocean Acidification	2.1	2.4	
	Population Growth Rate	3.6	2.9	
	Stock Size/Status	1.1	3.0	
	Other Stressors	1.1	2.8	
	Sensitivity Score	High		
Exposure factors	Sea Surface Temperature	2.0	2.0	
	Sea Surface Temperature (variance)	1.9	2.0	
	Bottom Temperature	2.2	2.0	
	Bottom Temperature (variance)	2.8	2.0	
	Salinity	1.3	2.0	
	Salinity (variance)	2.6	2.0	
	Ocean Acidification	4.0	2.0	
	Ocean Acidification (variance)	1.4	2.0	
	Phytoplankton Biomass	1.1	1.2	
	Phytoplankton Biomass (variance)	1.2	1.2	
	Plankton Bloom Timing	1.7	1.0	
	Plankton Bloom Timing (variance)	2.3	1.0	
	Large Zooplankton Biomass	1.1	1.0	
	Large Zooplanton Biomass (variance)	1.5	1.0	
	Mixed Layer Depth	1.9	1.0	
	Mixed Layer Depth (variance)	2.4	1.0	
	Currents	1.4	2.0	
	Currents (variance)	1.7	2.0	
	Air Temperature	NA	NA	
	Air Temperature (variance)	NA	NA	
	Precipitation	NA	NA	
	Precipitation (variance)	NA	NA	
	Sea Surface Height	NA	NA	
	Sea Surface Height (variance)	NA	NA	
	Exposure Score	Moderate		
	Overall Vulnerability Rank	Moderate		

Low
Moderate
High
Very High

Slide credit: P. Spencer

OA Risk Assessment



Himes-Cornell and Kaspersky 2014

J.T. Mathis et al. / Progress in Oceanography xxx (2014) xxx–xxx

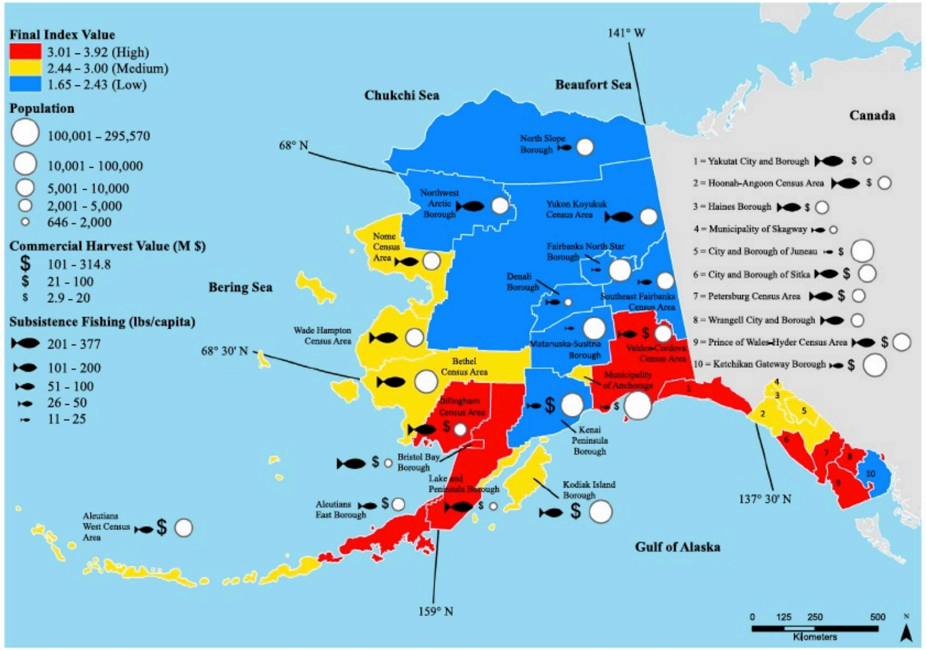


Fig. 11. Individual components of the final ocean acidification risk index for each census area.

J.T. Mathis et al. / Progress in Oceanography xxx (2014) xxx–xxx

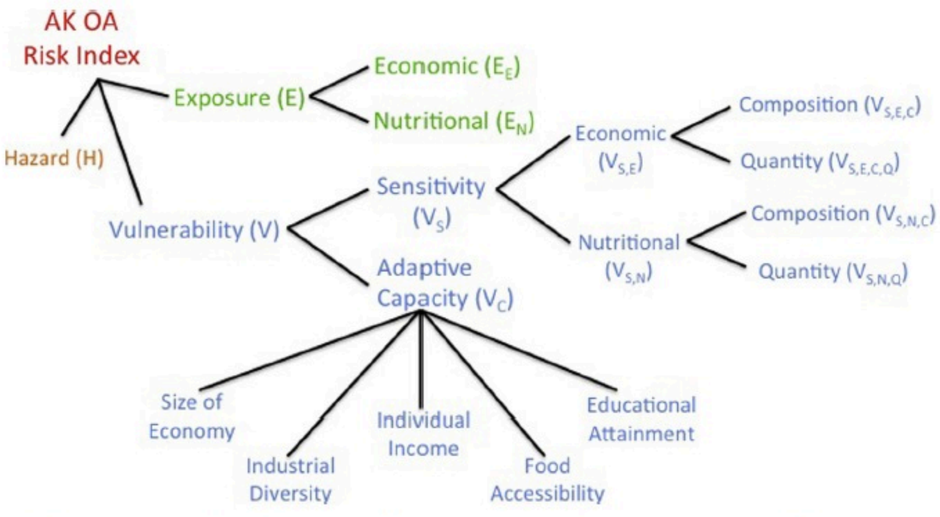


Fig. 3. Components of the risk index. Each branch is evenly weighted relative to others at the same level.

Marine Policy 51 (2015) 119–127

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Vessels, risks, and rules: Planning for safe shipping in Bering Strait

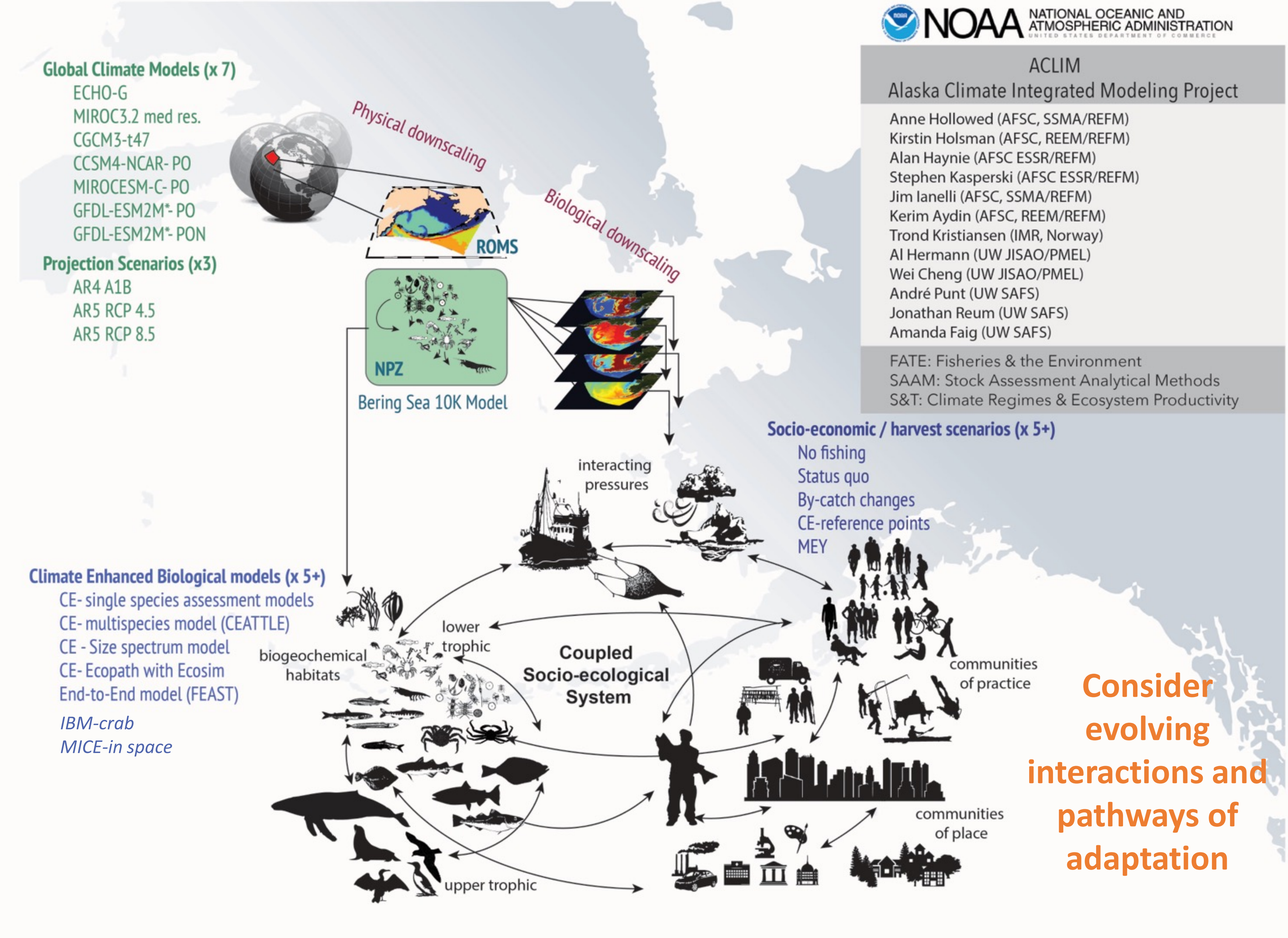
Henry P. Huntington [a,*], Raychelle Daniel [b], Andrew Hartsig [c], Kevin Harun [d], Marilyn Heiman [b], Rosa Meehan [e], George Noongwook [f], Leslie Pearson [g], Melissa Prior-Parks [b], Martin Robards [h], George Stetson [i]

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.

Risk/Regulatory measure	Ship strikes	Noise	Discharges and contamination	Accidental oil spills	Vessel collisions	Disturbance to hunting	Damage to cultural heritage
Shipping lanes	X	X		X	X	X	
Areas-to-be-avoided	X	X		X	X	X	X
Speed limits	X			X	X	X	
Communications	X				X	X	X
Reporting systems					X	X	
Emission controls		X	X			X	
Salvage and oil spill prevention and preparedness			X	X			
Rescue tug capability			X	X			
Voyage and contingency planning	X			X	X	X	X
Charting				X			X

HOW?

c) Operationalized climate change management strategy evaluations (MSEs)



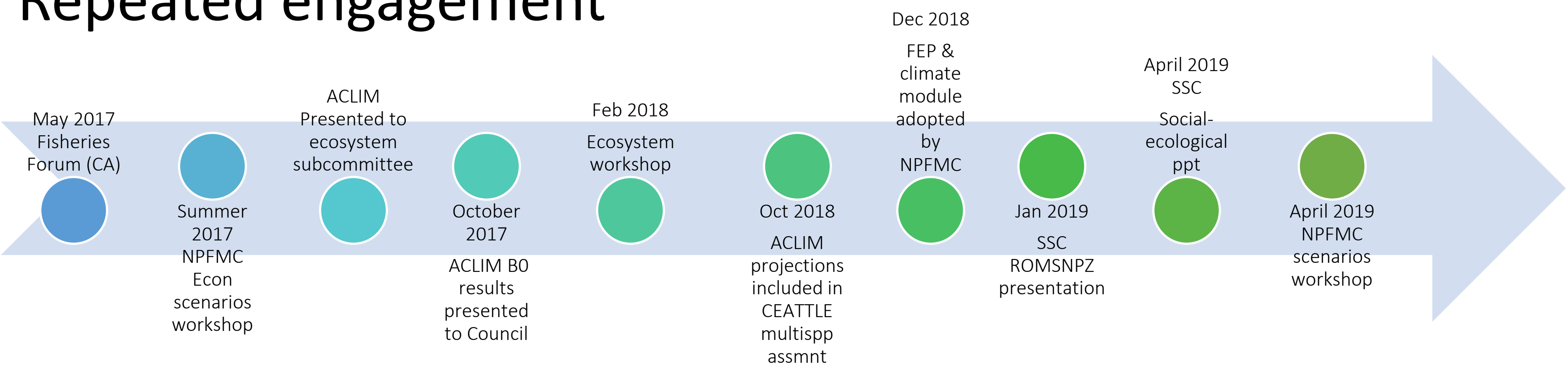
Consider evolving interactions and pathways of adaptation

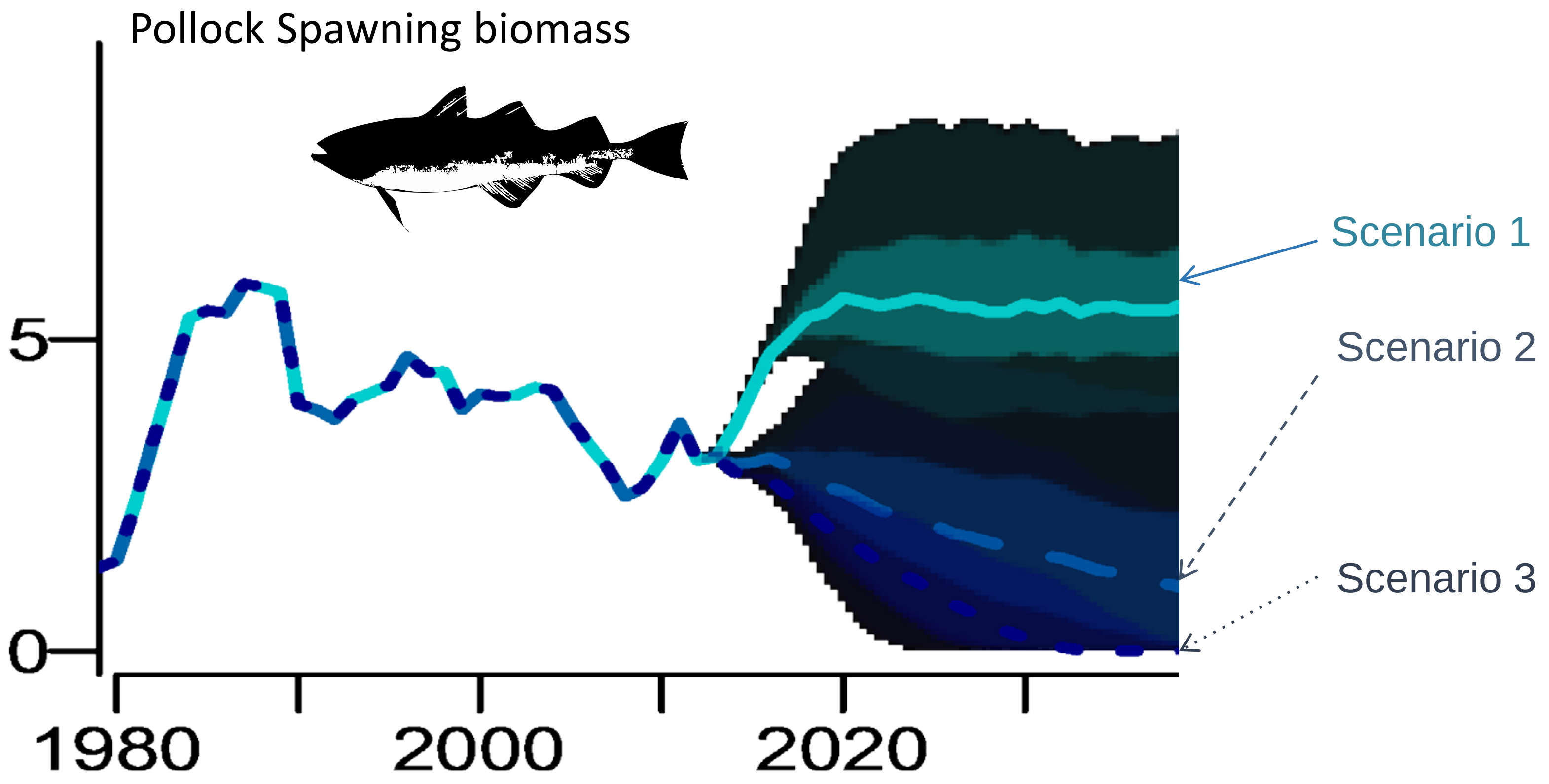
Challenges to evaluating adaptation options:

- **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





Ianelli, J KK Holsman, AE Punt, K Aydin (2016). Multi-model inference for incorporating trophic and climate uncertainty into stock assessment estimates of fishery biological reference points. Deep Sea Res II. 134: 379-389 DOI: 10.1016/j.dsr2.2015.04.002

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

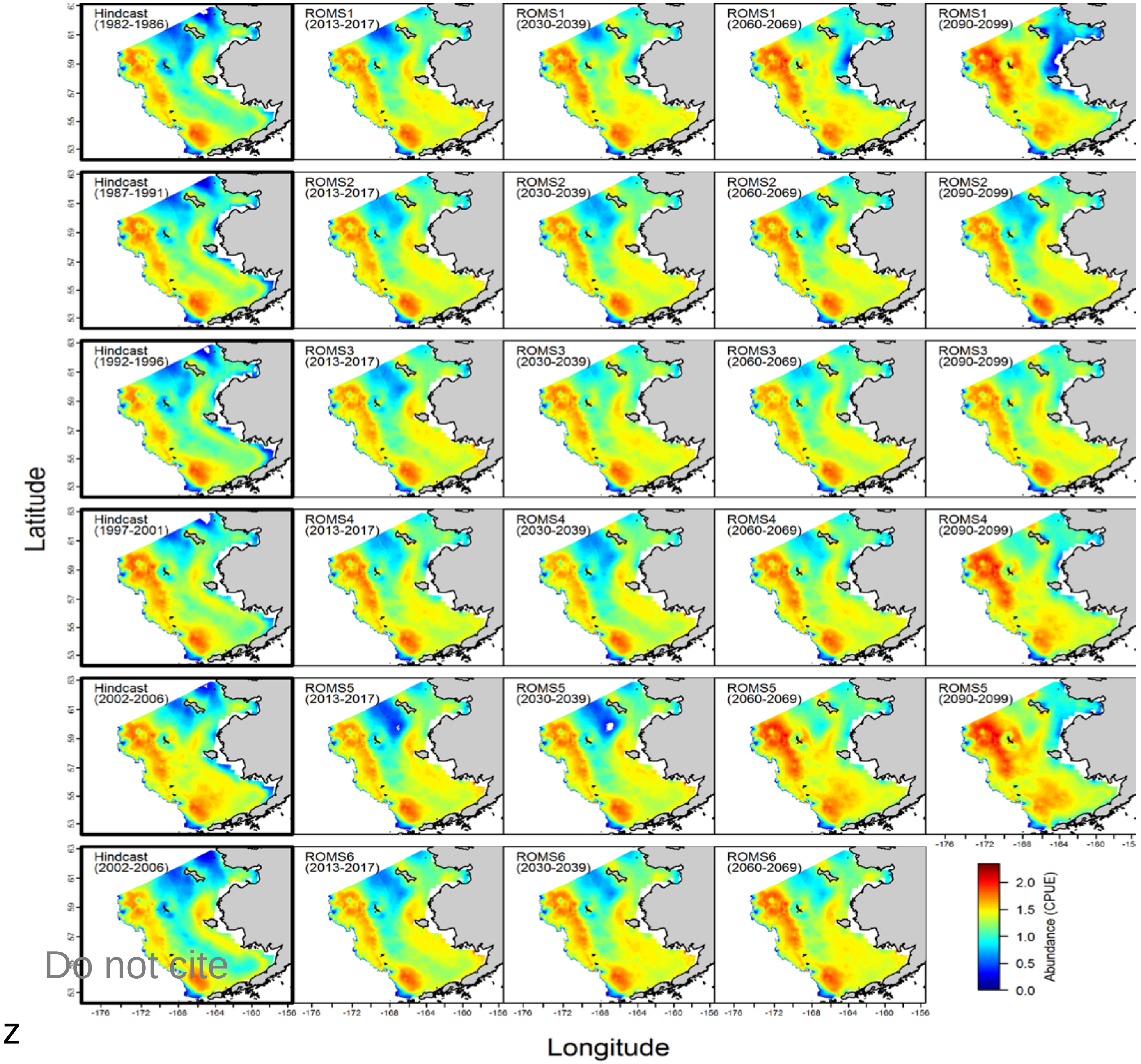
1) AK plaice
2) Arrowtooth flounder (1993-)
3) flathead sole
4) Northern rock sole (2001-)
5) Pacific cod
6) Walleye pollock
7) Red king crab (1996-)
8) Snow crab
9) Tanner crab
10) Yellowfin sole

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

WHO?

Taskforce comprised of diverse knowledge holders and experts

Mark Holsman

Action Module Workplan:

Develop protocols for Local Knowledge, Traditional Knowledge, and Subsistence

Action Module Goal (p. 1)

- To develop protocols for using local knowledge (LK), traditional knowledge (TK) in management and understanding impacts of Council decisions on subsistence resources, users, and practices.
- This Action Module is meant to positively inform the overall Council process and decision-making structure.

ROADMAP (p. 1)

Provide a **roadmap for operationalizing LK and TK** as well formulating methods for **assessing the likelihood a given Council action may affect subsistence.**

3 PARTS (p. 2)

Part 1: Processes for incorporating LK

Part 2: Processes for incorporating TK

Part 3: Processes for assessing impacts of Council actions on subsistence

3 PARTS (p. 2)

Separating this Action Module reflects acknowledgement of differences in the current state of incorporating LK, TK, and subsistence information in the Council process.

MEMBERSHIP (p. 5)

Stakeholders have recommended the Taskforce be composed of a diverse group of individuals geographically representative of the entire BS FEP area, including local residents and people from multiple age groups.

TIMELINE (p. 4)

The Taskforce for this Action Module will likely need to schedule a check in with the Council during the winter of 2019 or the spring of 2020, after a succinct list of objectives has been agreed upon by Taskforce members.

Team discussion and recommendations

- Team recommends the Council endorse the 2 workplans in principle
- Taskforce formation: Team recommends the following:
- Climate change – approx. 10 person taskforce
  - Balanced mix of interdisciplinary and specialist members
  - Includes those familiar with the Council process
  - Leverages people with connections to other partnerships
- LK/TK/Subs – max 15 person taskforce
  - 7-10 appointed, 2/3 TK and subsistence, 1/3 LK
  - Up to 5 agency staff

Outreach and Communication

Team discussion and recommendations

- Council staff have developed story maps for BS FEP website
  - https://www.npfmc.org/bsfep/
- Useful visualizations for outreach about what BS FEP is, what action modules the Council has prioritized
- Team members will try to connect educators to FEP website information, as appropriate, as well as share at regional science conferences

Council action in June 2019?

FEP Team recommendations

- Approve FEP Team Terms of Reference

Action Module Workplans

- Endorse workplans in principle
- Appoint taskforces
  - Call for nominations
  - Council Chair will appoint members