North Pacific Fishery Management Council

Simon Kinneen, Chair | David Witherell, Executive Director
1007 W. 3rd Avenue, Suite 400, Anchorage, AK 99501
Phone 907-271-2809 | www.npfmc.org

Bering Sea Fishery Ecosystem Plan Climate Change Taskforce

REPORT

Webex meeting: January 21, 2020 9:am-4:00pm (AK time)

Due to weather, this taskforce meeting was postponed from a three-day in-person meeting planned the previous week. Instead, a one-day Webex meeting was held to provide the kick-off to the taskforce and begin the process of revising the workplan and the planning horizon for work products moving forward. Taskforce members provided edits and comments on the work plan and filled out an online survey. Those edits, comments and survey results formed the basis of the discussions by the taskforce on work plan revisions, which were then made directly on the draft work plan, which is attached to this report. The intention is that this meeting allowed for a first draft of the revised work plan and that the Taskforce will continue these revisions at the subsequent meeting planned for February. The report below discusses the topics addressed by the taskforce during the meeting as well as which discussions led to specific revisions to the work plan.

Taskforce members in attendance:

Lauren Divine (Aleut Community of Saint Paul Island)
Scott Goodman (Natural Resources Consultants/ Bering Sea Fisheries Research Foundation)
Kirstin Holsman, **Co-Chair** (AFSC-Seattle)
Steve Martell (SeaState)
Joe Krieger (NMFS-Regional Office)
Brenden Raymond-Yakoubian (Sandhill. Culture.Craft)
Mike LeVine (Ocean Conservancy)
Jeremy Sterling (AFSC Marine Mammal Lab)
Diana Stram, **Co-Chair** (NPFMC)

Members of the public and other state and agency staff:

Kerim Aydin (AFSC-Seattle), Diana Evans (NPFMC), Sarah Wise (AFSC-Seattle), Steve Marx, Melissa Parks, Ali Whitman, Megan Williams

Overview and introductions

Taskforce members provided a brief overview of their backgrounds and interest in participating in the taskforce. An eAgenda for the meeting with all background information, presentations and schedule is available at https://meetings.npfmc.org/Meeting/Details/1203. Two specific presentations are appended to this report and formed the basis for much of the discussion at this meeting.

FEP overview and origin of action module taskforces

Diana Evans provided a brief overview of the Bering Sea Fishery Ecosystem Plan (FEP) and the development of the action modules for climate change and local and traditional knowledge. FEPs are a method for putting ecosystem-based fishery management (EBFM) into action. In part, the FEP is intended to provide context for fishery management decisions and function as a communication tool to help build upon a transparent public process for identifying ecosystem values and management responses. The FEP also serves as a framework for strategic planning, identification of research needs and a framework for considering policy options and risks and tradeoffs affecting FMP species and the broader Bering Sea ecosystem. Process objectives relevant to action modules that are being developed include the improved incorporation of local knowledge (LK) and traditional knowledge (TK) in Council management; increased facilitation and communication of ecosystem science, LK,TK and Council policy between scientists, communities and stakeholders; establishing a process for the use of ecosystem information to inform decisions for adaptive management under a range of different circumstances and stressors; and providing a framework for considering management strategies within the context of the Council's managed species considering ecological, economic, social and cultural factors of fishery harvest. The FEP is a strategic document to provide information to help guide Council, but it is not action forcing. The Council has identified five core action modules with prioritization on the first two: LK/TK/Subsistence Taskforce and the Climate Change taskforce.

The Climate Change taskforce (CCTF) members discussed the intention to create an overarching plan for effective communication internally and externally. The taskforce workplan will be likewise be action informing not action forcing. The taskforce was reminded to consider action advice that is not prescriptive.

Overview of LK/TK/Subsistence Taskforce meeting

Sarah Wise provided an overview of the first meeting of the LK/TK/Subsistence taskforce. The taskforce worked on providing clear definitions of LK TK terms that are modified slightly from their draft work plan. The taskforce intends to discuss and refine the definition of subsistence at a subsequent meeting. Sarah provided some modified draft goals and objectives of the LK TK workplan. She noted that the taskforce is very interested in opportunities to communicate and coordinate with the CCTF and suggested a joint meeting. The LK TK taskforce is specifically interested in documenting examples of how climate change is affecting knowledge and subsistence activities.

Overview of climate change impacts and adaptation overview

Kirstin Holsman summarized the results of the taskforce internal survey designed to provide information about taskforce members perceptions and expectations. She then provided an overview of existing information on end-of-century climate change impacts for sea surface temperature (SST) and ocean ph anomalies under two IPCC scenarios. She noted the potential for increased warming specific to the Bering Sea based on Hermann et al., 2019 as well as for longer and more frequent marine heatwaves and more frequent extreme events. She also described a framework for considering how to respond (from Gatttuso et al., 2015) and nested scales of management and adaptation (from Holsman et al., 2019). The presentation is attached to this report as Appendix 1.

The taskforce discussed the draft work plan module goals and objectives. The group noted a desire for a clear and transparent process for coordinating with the TK/LK taskforce. The group noted the importance of coordinating meetings and work products with appropriate timing for fishing and other activities in conjunction with Council meetings.

LK, TK and co-production of knowledge

Brenden Raymond-Yakoubian provided an overview of terminology and definitions for LK and TK as well as a conceptual model of the co-production of knowledge (CPK). He noted some ideas and emergent issues for bringing TK participation into both the Council process and for use within the CCTF. A summary of these ideas and issues and the conceptual model are attached as Appendix 2.

Workplan Goals and Objectives

The CCTF discussed the overarching broad goal and two draft sub-goals in the workplan and made minor modifications to these goals based upon the ensuing discussion. The CCTF agreed that the work plan should include considering both the evaluation of tools as well as eventually providing recommendations on management strategies and actions for the Council to consider. These may include recommending new tools, measures, and short-, medium-, long-term approaches based upon the work plan. The CCTF recognizes and understands that any action based on these recommendations is up to the Council and that explicit action by the Council would be needed to initiate management changes. The overarching goal of the module was updated to reflect these discussions. The CCTF also noted that it is critical to both communicate effectively and meaningfully engage with stakeholders and also added this as a specific goal of this module in the work plan.

What is meant by adaptation/maladaptation

The CCTF had a discussion of the meaning of adaptation and maladaptation, noting the desire to develop a living list and process through which to define statements of adaptation. This could include supplementing winners/losers and tradeoffs concepts with a richer understanding of these ideas as well as thorough examination of concepts of adaptation and maladaptation. In developing the proposed one-page feedback/vignettes for a Climate Briefing Workshop to come (see below section on Climate Knowledge Briefing as well as section on Milestones in work plan) the CCTF could include a request for feedback on 'What does adaptation and maladaptation mean?" Some questions included: What would a climate resilient system look like? It was suggested the taskforce could start with some examples and then get additional inputs on tools through the Climate Knowledge Briefing. It was also noted that maladaptation can be manifested in stock collapse or impacts to communities. Specifically, tools that may work for fisheries management may not work for communities that are adapting to other priorities beyond commercial fishing, and a desirable outcome would be a flexible management system that would allow for policy change at a rate that is consistent with changes being seen on the ground, thus not just a reactive system.

Discussions by the taskforce members included that recommendations should be made in a broader ecosystem context (i.e. to incorporate lower trophic levels, consider non-western science); and that it is desirable to have a proactive policy framework incorporating predictive information on how changes may occur as well as the flexibility to incorporate information in a more dynamic way. The outcomes could include some additional goals of community food security and sustainability of resources. The taskforce needs to outline potential risks and processes for evaluating risks and tradeoffs and identifying management measures that provide scope for fisheries adaptation to future climate conditions while establishing a process that ensures diverse perspectives are considered when assessing risks, impacts and tradeoffs. The overarching goal would be to recommend adaptation pathways not mitigation pathways. A new draft section on "Adaptation" was added to the workplan to reflect this discussion. The CCTF intends to further develop a working definition of adaptation at a future meeting.

Climate Knowledge Briefing

The CCTF proposes to hold a climate knowledge briefing in the spring at which experts would provide proposed one-page reports, testimonials, and vignettes in response to a structured request from the CCTF. These would be developed at a subsequent meeting of the taskforce and then ideally reviewed in conjunction with a proposed public workshop with the LK TK Subsistence taskforce. These one-page reports from diverse participants could include characterization of the contribution (e.g. testimonials, research, observations), identifying the management connection or relevance to the Bering Sea ecosystem and defining the scope in time and species such as whether a core species or a non-focal species and whether the time scale is short-, medium-, or long-range. The workshop would be designed to review and provide feedback on these one-page summaries as well as other issues of interest for coordination and collaboration from the LK TK Subsistence taskforce.

Additional information was added to the workplan milestones to include the development of these one-page overviews into a form of climate report card specific to the Bering Sea ecosystem. The taskforce noted that it would be important to identify how these would be additive or different from the current ESR and other climate briefing materials in order to augment the Bering Sea and Arctic report cards. The intent would be to specifically refine the general climate information in the ESR to hone to climate-relevant fisheries management in the Bering Sea region. In addition, a ‘living list’ was proposed for consideration which could provide an annually updated list of short-, medium-, and long-term projects that would be designed for providing forward-looking management activities. This type of living list could also help provide a measure of efficacy (i.e. items are observed ideally moving from medium- to short-term).

It was also noted that the taskforce process and framework developed is a work product in itself. The taskforce discussed the example of planning for changes in the cod fishery by industry for business planning. It will be important for the taskforce to develop scenarios and questions to ask as a part of this framework in order to be relevant and forward looking. This is also true of the incorporation and involvement of TK and LK and co-production of knowledge. Elements of framework should map to policy relevance such as management mandates (National Standards, Council’s management objectives). These concepts were included under the milestones and deliverables in the workplan for further refinement at the next taskforce meeting.

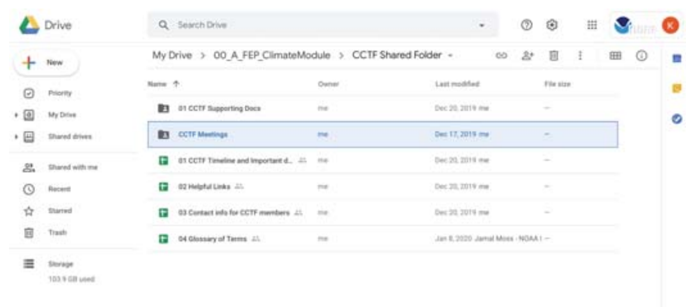
See attached presentations and supplementary information

Developing a workplan for the FEP Climate Change Module

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

Climate Task Force Meeting 1
Jan, 2020

Google docs

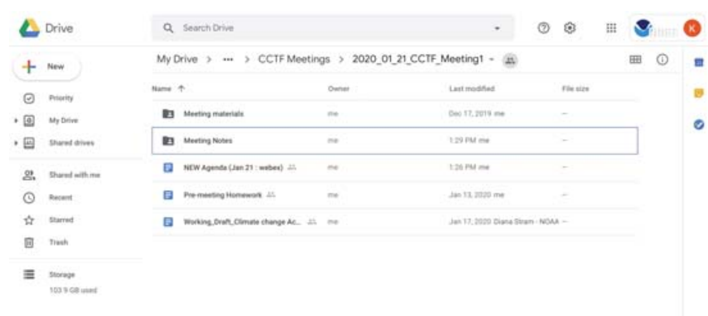


Today: Agenda

- Intro to Task Force
- Brief background
- Module objective & goals
- Module outcomes & products
- CCTF planning & logistics

kirstin.holsman@noaa.gov

Google docs



TODAY'S GOALS:

1. Finalize a draft workplan to send to the Council next week
2. Derive a list of issues / questions we'd like feedback on specifically
3. Clarify our goals, process, and logistics

Survey results

Connection to the Bering Sea:

17 years with NPFMC, have coordinated plan teams for BSAI groundfish, BSAI crab, worked on BSAI halibut and salmon bycatch issues and management amendments

21 years of marine mammal research in Alaska

extensive work with communities and other partners on fisheries management, climate change, marine mammals, marine debris, governance, and other issues in the Bering Sea

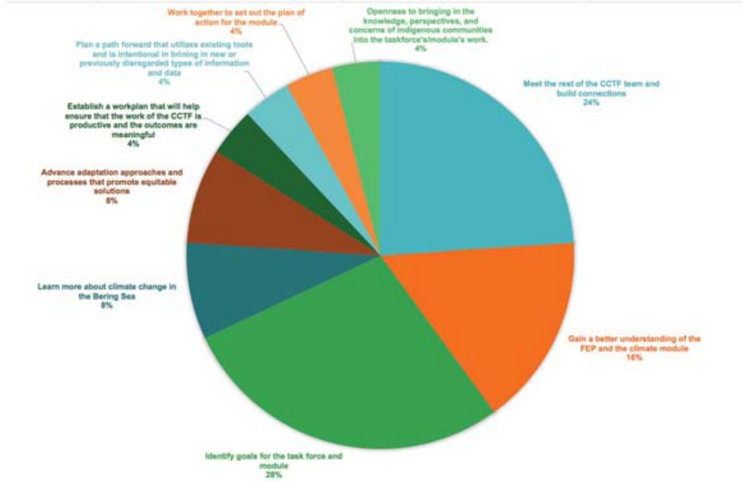
Fisheries Management Specialist with the Alaska Regional Office.

I work as a social scientist with Bering Sea Tribes, Tribal organizations, and communities. I also used to live in Nome.

Run a natural resources department for a tribal government

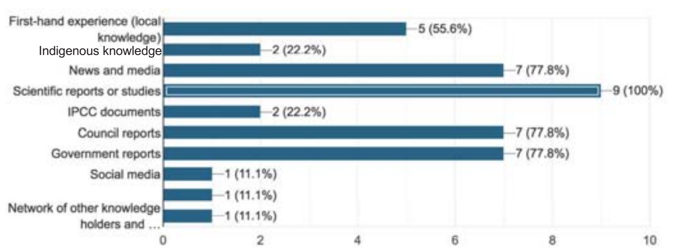
Work with the Fishing Industry and Council on Data & Policy issues

What are your TOP 3 goals for this first CCTF meeting?



What are some of your primary sources of information on current climate impacts on the Bering Sea?

9 responses



Background

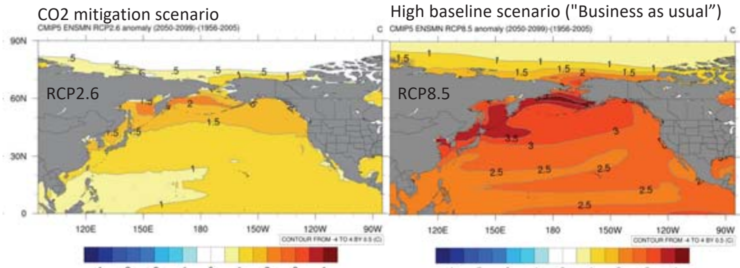
What do you hope the Climate Change Task Force / Climate Change Module can accomplish in the next 3-5 years of the Task Force timeframe? (2020-2025)

What do you hope the Climate Change Task Force / Climate Change Module can accomplish in the next 10-20 years?

CMIP5 ENSMN Annual SST anomaly (°C)
(2050 to 2099) - (1956 to 2005)

CO2 mitigation scenario

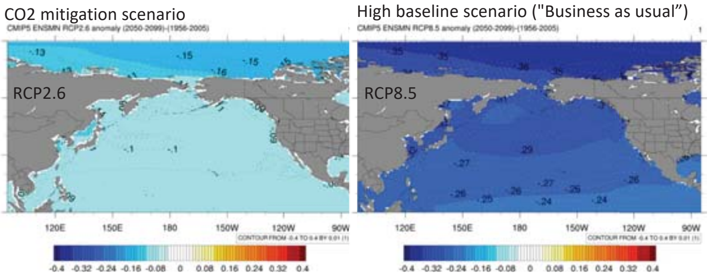
High baseline scenario ("Business as usual")



Projection data from CMIP5 (Taylor et al., 2012) avail. at: www.esrl.noaa.gov/psd/ipcc/ocn

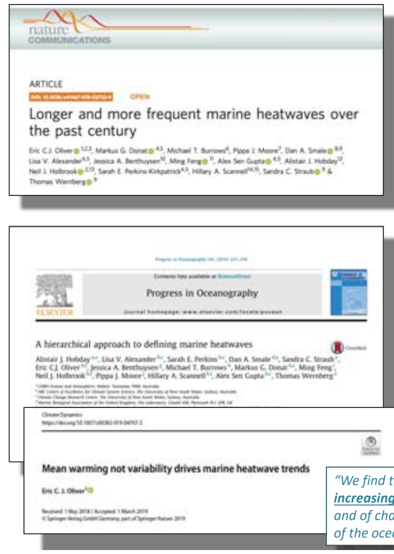
Modified from Fig. 6.2 Holsman et al. 2018 [in] Barange et al. (Eds.) 2018. Impacts of climate change on fisheries and aquaculture. TP 627.

CMIP5 ENSMN Annual Ocean pH anomaly (2050 to 2099) - (1956 to 2005)



Projection data from CMIP5 (Taylor et al., 2012) avail. at: www.esrl.noaa.gov/psd/ipcc/ocn

Modified from Holsman et al. 2018 [in] Barange et al. (Eds.) 2018. Impacts of climate change on fisheries and aquaculture. TP 627.


nature COMMUNICATIONS

ARTICLE

Longer and more frequent marine heatwaves over the past century

Eric C.J. Oliver, Markus G. Donat, Michael T. Burrows, Pippa J. Moore, Dan A. Smale, Lisa V. Alexander, Jessica A. Benthuysen, Ming Feng, Alex Sen Gupta, Alistair J. Hobday, Neil J. Holbrook, Sarah E. Perkins-Kirkpatrick, Hillary A. Scannell, Sandra C. Straub & Thomas Wernberg

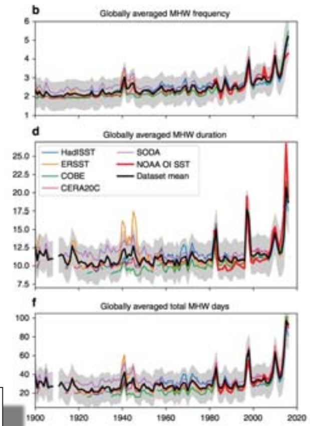
Progress in Oceanography

A hierarchical approach to defining marine heatwaves

Climate Dynamics

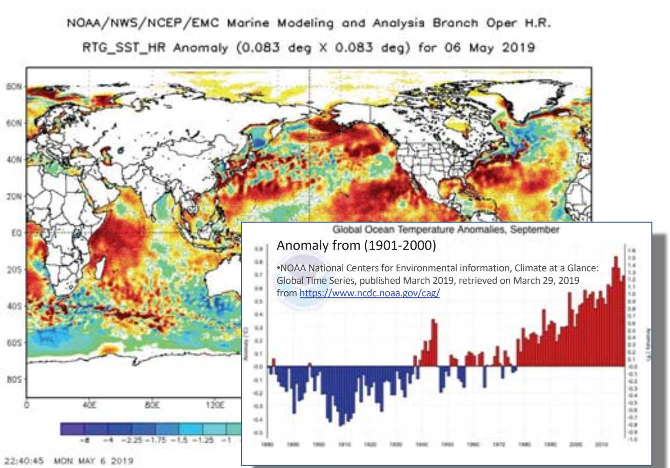
Mean warming not variability drives marine heatwave trends

Eric C. J. Oliver



*"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. "*

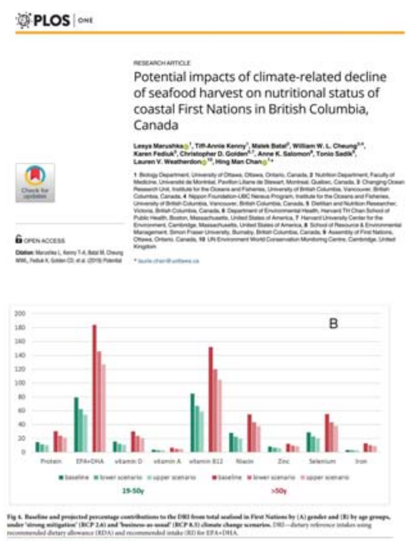
Anomaly from 1961-1990 climatology, 1 degree, weekly resolution



http://polar.ncep.noaa.gov/sst/rtg_high_res


COMMENT

Fall in fish catch threatens human health

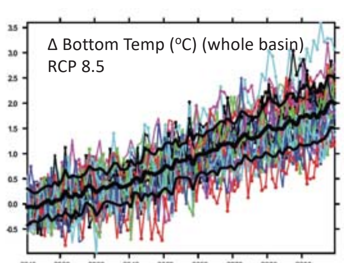

PLOS ONE

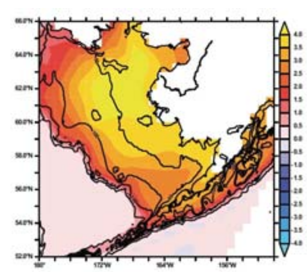
RESEARCH ARTICLE

Potential impacts of climate-related decline of seafood harvest on nutritional status of coastal First Nations in British Columbia, Canada

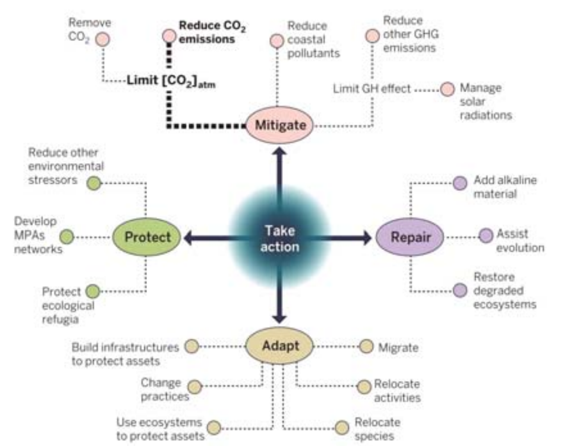
Lesya Marushka, Tiff-Annie Kenny, Malek Batal, William W. L. Cheung, Karen Fediuk, Christopher D. Golden, Anne K. Salomon, Tonio Sadik, Lauren V. Weatherdon, Hing Man Chan

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



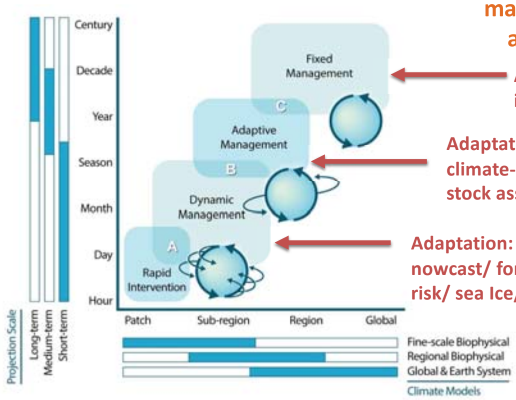


(2019) Hermann, A. J., G.A. Gibson, W. Cheng, I. Ortiz1,K. Aydin, M. Wang, A. B. Hollowed, and K. K. Holsman. Projected biophysical conditions of the Bering Sea to 2100 under multiple emission scenarios. ICES. doi: 10.1093/ices/fsz043



Gattuso et al. (2015). Contrasting futures for ocean and society from different anthropogenic CO 2 emissions scenarios. Science, 349(6243), aac4722. https://doi.org/10.1126/science.aac4722

Consider nested scales of management & adaptation



Adaptation: increased flexibility

Adaptation: climate-enhanced stock assessments

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

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

Module goal:

"facilitate and support equitable climate change adaptation pathways and long-term resilience for the coupled social-ecological system of the Eastern Bering Sea"

i) evaluate management tools to develop incremental (normative) adaptation measures to preserve livelihoods, health and wellbeing across fisheries and dependent coastal communities

ii) enable transformative adaptation needed to ensure the productivity and sustainability of the coupled social-ecological Bering Sea system

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

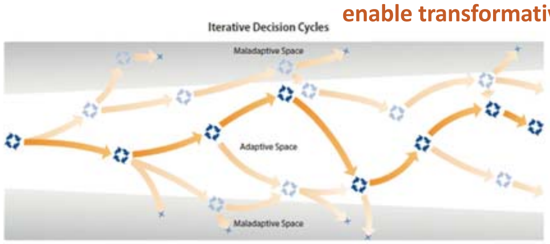


Fig. 1 from Wise et al. 2014. Reconceptualising adaptation to climate change as part of pathways of change and response. Global Environmental Change 28: 325–336

"knowledge and culture construct societal limits to adaptation, but these limits are mutable"
- Adger et al. (2009).

HOW?

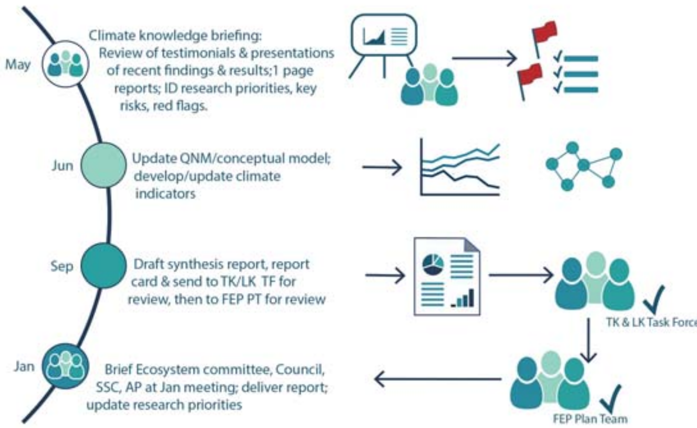
FEP Climate Change Module

- ✓ Risk inherently depends on values
- ✓ Include a "plurality of perspectives" *
- ✓ Consider interacting (non-linear) pressures

**Allison & Bassett. 2015. Climate change in the oceans: Human impacts and responses. Science 350 (6262), 778-782. [doi: 10.1126/science.aac8721]*

- ✓ 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.

How best to coordinate with TK / LK module?

PAUSE

Objectives / tasks:

" To achieve this, the climate change module will be used to…"

- ✓ **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
- ✓ *provide prioritized recommendations for ~~actions~~ research and MSEs that could be taken to advance the goals and minimize the risks identified.*

Policy relevant not policy prescriptive

(climate-resilient management would go through the existing Council process)

Workplan: Goals & objectives

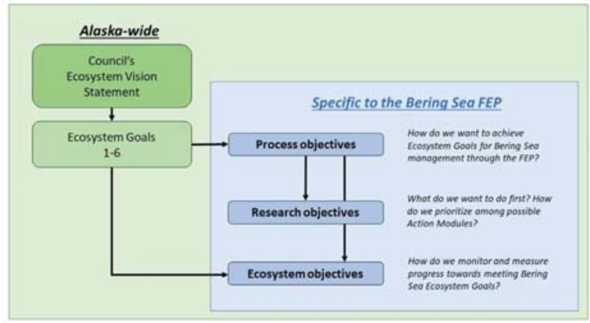
GOAL:

"facilitate and support equitable climate change adaptation pathways and long-term resilience for the coupled social-ecological system of the Eastern Bering Sea"

i) evaluate management tools to develop incremental (normative) adaptation measures to preserve livelihoods, health and wellbeing across fisheries and dependent coastal communities

ii) enable transformative adaptation needed to ensure the productivity and sustainability of the coupled social-ecological Bering Sea system

Objectives



"The primary goal [objective?] of this climate module is to provide information, pathways, and tools that can be used to ensure climate resilience in the region's fishery management. Specifically, the module will leverage ongoing, proposed, and completed projects at AFSC and [ADD other institutions] to address the following objectives:"

Ecosystem Goal	Ecosystem Objectives	Module evaluations	Metrics & indicators
Ecosystem Goal 1: Maintain, rebuild, and restore fish stocks at levels sufficient to protect, maintain, and restore food web structure and function	*1. Maintain target biomass levels for target species, consistent with optimum yield, using available tools.*	MSE: test climate informed biological reference points; test spatial and temporal regulations to address shifting distributions	long-term B/B0 ; total yield; volatility in B or C; access to subsistence resources; catch-->wellbeing analyses
	2. Maintain healthy populations and function of non-target and forage species.	Identify species at Risk/exposure to Climate change for non-target species (maybe based around long-term projections, scenarios, and recent extreme events)	Rapid vulnerability and Risk synthesis (IK/TK based and expert opinion); LK observations of change; long-term shifts in monitoring timeseries; ID uncertainty/gaps
	3. Adjust fishing-related mortality from the system to be commensurate with total productivity and continue to limit optimum yield to 2 million metric tons for the BSAI groundfish fisheries.	MSE: test climate informed multispecies reference points; test spatial and temporal regulations to address shifting distributions	Aggregate yield; long-term B/B0 ; total yield; volatility in B or C; access to subsistence resources; catch-->wellbeing analyses
Ecosystem Goal 2: Protect, restore, and maintain the ecological processes, trophic levels, diversity, and overall productive capacity of the system	*4. Maintain key predator/prey relationships.*	MSE & spatial analyses: evaluate changes to species overlap; project food-webs	Risk of collapse; changes in overlap; changes in diet & food web interactions
	5. Conserve structure and function of ecosystem components.	MSE and spatial analyses: project scenario changes in Fishing X Climate change scenarios through coupled social-ecological system	Benthic/pelagic productivity ratios; length of food-chain; access to key subsistence resources; economic and social indicators

LINK TO EXCEL SPREADSHEET

Discussion: Outcome & goals

- How best to monitor and measure success towards CC Module goals?
- Should the BSFEP Team monitor? Or should the CCTF monitor?
- Can we develop metrics and outreach to evaluate goals and outcomes?
  - "e.g. asking key stakeholder groups who are engaged at the Council (e.g. 'Do you feel management measures are sufficiently adaptive in addressing climate effects on fisheries?')"
  - doing keyword analysis of Council meetings
  - Working with some of the Council bodies - e.g. Ecosystem Committee and CEC
- Can we try to link to the ecosystem goals of the council?

Discussion: Adaptation

- What do we mean by adaptation/maladaptation ?
- What helps EBS communities and commercial fisheries adapt?
  - New fisheries and FMPs for novel species in the EBS?
  - Flexibility and diversity in subsistence and target fisheries?
  - There was a suggestion to cut "and , develop or expand fisheries for species anticipated to be favored under climate change" , thoughts?
- **Perhaps we need to be specific with regards the potential risks** and outline the ideal process for evaluating risks and tradeoffs?
- The challenge that remains is to
  - **identify management measures** that provide scope for fisheries adaptation to future climate conditions and
  - **to establish a process** that ensures that diverse perspectives are considered when assessing risks, impacts and tradeoffs.

Discussion: Other topics

- Geographic boundaries for CC module (FEP boundaries) – add a map?
- Rather than winners and losers, frame in terms of maladaptive risk? [BRY, JS, LD]
- Climate resilient tools: maybe make ”living” as a web based spreadsheet and or table in our report to the council?

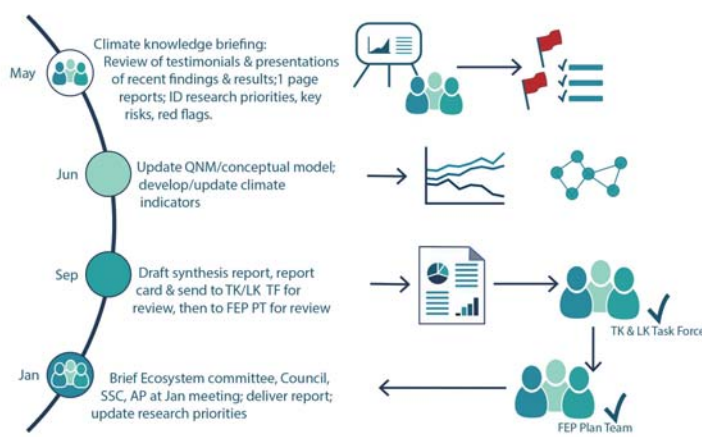
” To achieve this, the climate change module will be used to…”

- ✓ **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
- ✓ *provide prioritized recommendations for ~~actions~~ [research? MSEs?] that could be taken to advance the goals and minimize the risks identified.*

Policy relevant not policy prescriptive

(climate-resilient management would go through the existing Council process)

PAUSE



Workplan: Deliverables

1 Page reports from each contributor

- Characterize contribution (testimonial, research, observation)
- ID management connection/relevance
- Define scope in time and species:
  - CORE spp and BROAD (non-focal spp)
  - Short, medium, long term

ID red flags and emergent issues:

- Flag these for the report next step

ID Research needs and priorities

- Identify indirect impacts of climate driven changes

1 Page reports from each contributor

- Characterize contribution (testimonial, research, observation)
- ID management connection/relevance
- Define scope in time and species:
  - CORE spp and BROAD (non-focal spp)
  - Short, medium, long term

ID red flags and emergent issues:

- Flag these for the report next step

ID Research needs and priorities

- Identify indirect impacts of climate driven changes

Report card

- Summary of climate related trends/ indicators

Synthesis

- Emergent issues
- Future risks
- Novel/emerging tools

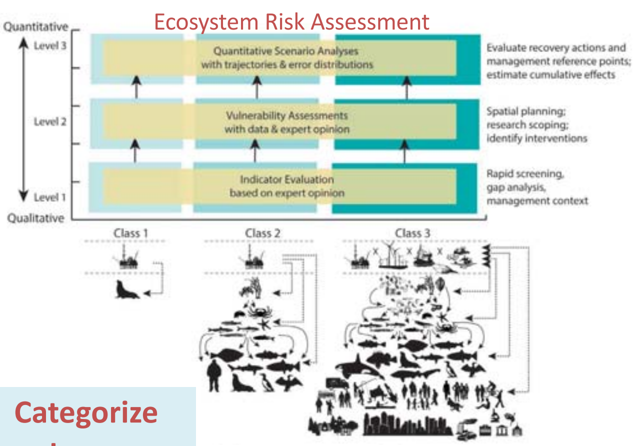
Contributions (based on form)

- **See example**

Table of Example Management/adaptation actions:

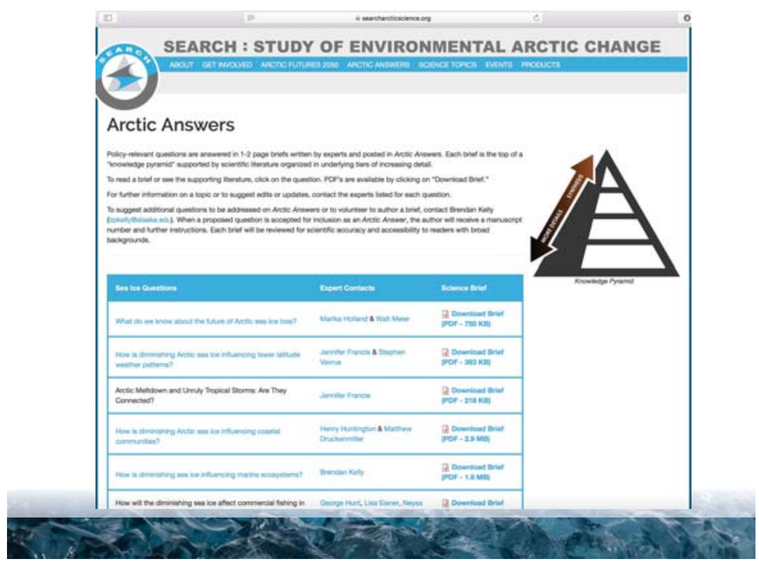
- short, medium, long term
- Tactical vs strategic
- ID who should be included in risk assessment process
- Rapid response vs incremental adjustment

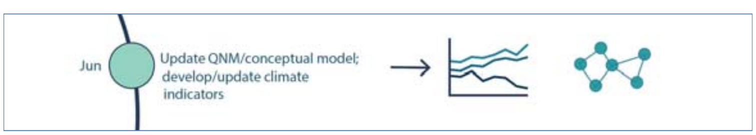
Research needs and priorities



Categorize types of information

Holsman et. al 2017. An ecosystem-based approach to marine risk assessment. Ecosystem Health and Sustainability 3(1):e01256. 10.1002/ehs2.1256



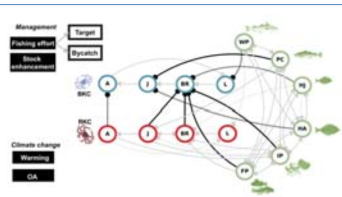


Indicators (aim for ~10)

- Climate trends
- Productivity trends
- Upper trophic trends
- Human dimension trends

Conceptual model/ QNM:

- Identify direct known and potential connections
- Identify indirect impacts of climate driven changes
- Identify indirect impacts of management actions

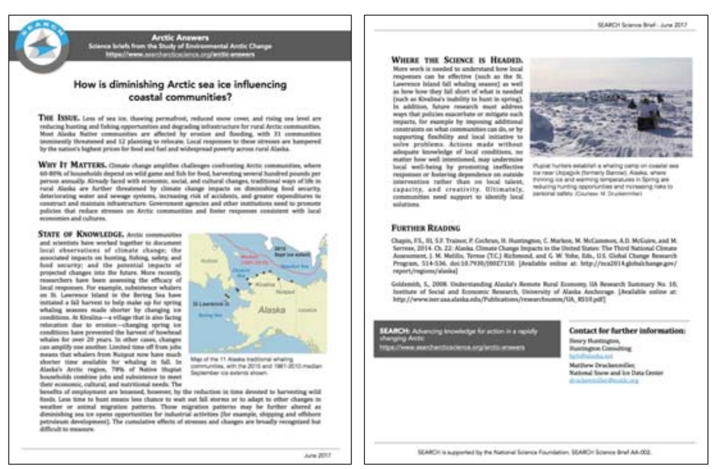


Reum et al. 2019

Research needs and priorities

- Use model to identify needs

Reum et al. 2019. Rapid assessment of management options for promoting stock rebuilding in data-poor species under climate change. Cons. Bio. https://doi.org/10.1111/cobi.13427



Report card
- Summary of climate related trends/ indicators

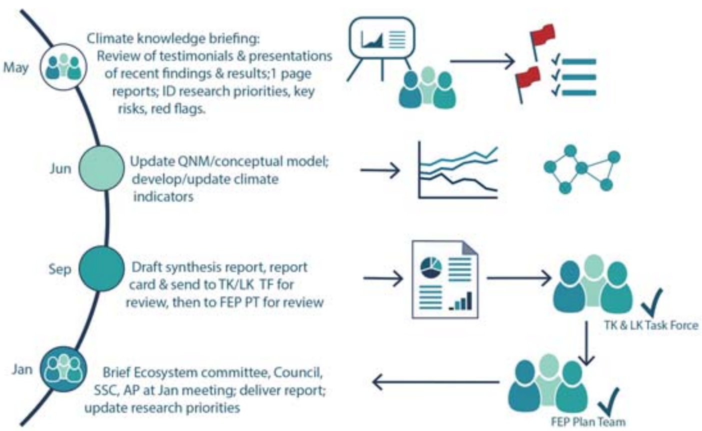
Synthesis
- Emergent issues
- Future risks
- Novel/emerging tools

Contributions (based on form)
- **See example**

Table of Example Management/adaptation actions:
- short, medium, long term
- Tactical vs strategic
- ID who should be included in risk assessment process
- Rapid response vs incremental adjustment

Research needs and priorities

PAUSE



Workplan: Logistics

Discussion: Products & deliverables

- Proposed products and tasks:
  - Is there anything missing here?
  - How do we promote co-production of knowledge through this process?
  - Will it be responsive enough for unexpected change?
  - Will it be useful for addressing long-term gradual change?
- How prescriptive should we be? Should we aim for "Policy relevant"?
  - "**specifying**" [reviewing? Suggesting? Highlighting?] short-, medium-, and long-term management actions to build climate resilience in regional fisheries and fishing communities
- Short, med, long-term examples?
  - add to and edit this and can we make this living as part of the report?
- Facilitate information to council and ppt:
  - [BRY]"While not holistic analyses or TK documentation sessions, these vignettes, testimonials, and summaries by, for example, TK experts (representing communities, orgs, co-management bodies, etc.) could be very useful supplementary material that accompanies the on-ramped climate change data into the Council process as well as ongoing evaluations of management strategies."

Discussion: Planning & logistics

- TORs for our group
- Coordination with LK/TK module
  - Meetings/ joint meetings?
- Coordination with other efforts
  - [BRY] integration with some other as-of-yet not finalized efforts which will have long-term Council impacts
  - LK/TK/Subsistence AM TF, the CEC, and the ongoing work of the Ecosystem Committee and the SSPT.
  - ESR/ESP or stand alone report?
- TF communication – Slack? Google drive, email? Website?

EXTRA SLIDES

Marine Policy 97 (2018) 101–108

Contents lists available at ScienceDirect

Marine Policy

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

ELSEVIER

An Indigenous approach to ocean planning and policy in the Bering Strait region of Alaska

Julie Raymond-Yakoubian[a,*], Raychelle Daniel[b]

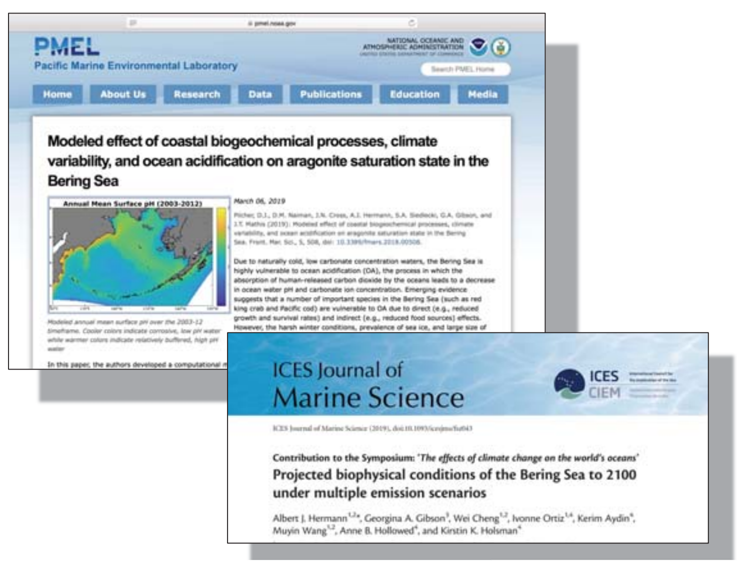
[a] Kawerak Incorporated, PO Box 948 Nome, AK 99762, United States

[b] The Pew Charitable Trusts, 901 E Street NW, Washington DC 20004, United States

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

Table 1
Ocean values from the Bering Strait region and example applications to the governance and decision-making component of ocean planning.

Ocean Values	Example	Application to ocean planning
Ecosystem	Knowledge of food web connections	Along with science, provides the knowledge base to better understand impacts
Health and well-being	Time on the water observing and hunting marine mammals	Informing vessel traffic routing measures
Economic	Walrus ivory carving	Provides means and ability to actively participate in walrus management
Cultural	Knowledge of ocean currents	Ability to effectively plan for and respond to maritime disasters



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PMEL
Pacific Marine Environmental Laboratory

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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

Annual Mean Surface pH (2003-2012)

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 m

ICES Journal of Marine Science

ICES CIEM

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]

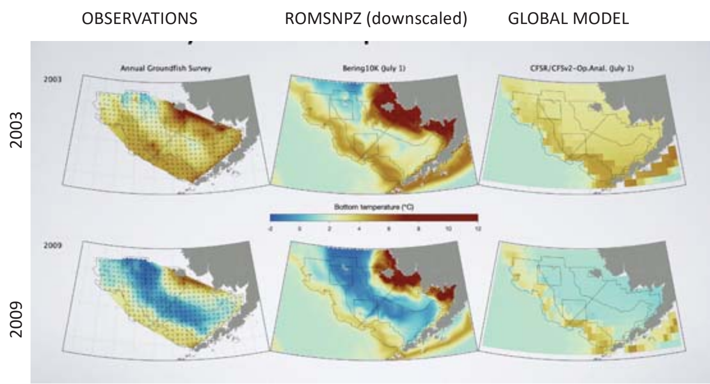


Image: Kelly Kearney

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

Declines in large zooplankton

(2090-2099)-(2010-2019)

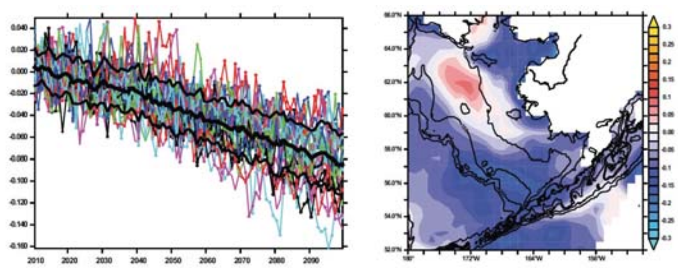
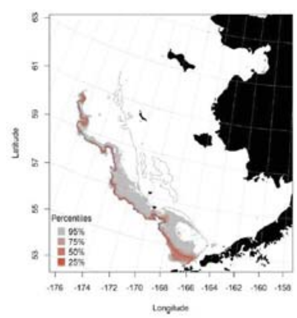


Figure 13. Ensemble results as in Figure 12, for $\log_{10}$ (large crustacean zooplankton).

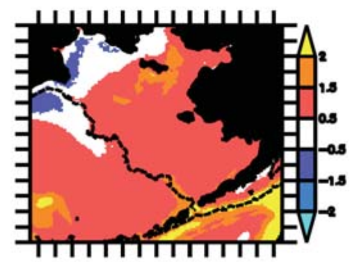
(in press) Hermann, A. J., G.A. Gibson, W. Cheng, I. Ortiz1,K. Aydin, M. Wang, A. B. Hollowed, and K. K. Holsman. Projected biophysical conditions of the Bering Sea to 2100 under multiple emission scenarios. ICES. doi: 10.1093/ices/fsz043

Exposure scoring, general methodology

Compare maps of exposure factors to maps of stock distributions and qualitatively estimate their overlap. Example for Pacific ocean perch shown below



Z-score for annual bottom temperature



Slide credit: P. Spencer

HOW?

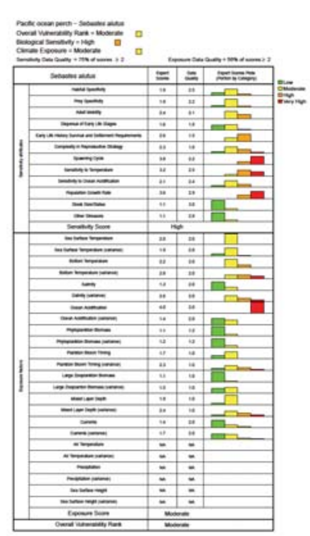
b) Climate Vulnerability Assessments

Example of Species Specific Results (from EBS)

Pacific ocean perch

Bootstrap outcomes:

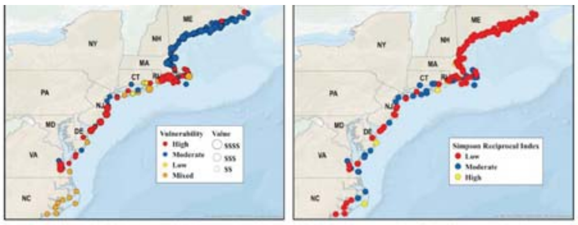
<1 Very High
10 High
89 Moderate
<1 Low



Slide credit: P. Spencer

Potential next step – linking to social-economic variables

For northeast US study, information on the species composition of different fishing ports was combined with species vulnerability to estimate vulnerability of fishing communities (Colburn et al 2016)



5. New England and Mid-Atlantic Fishing communities' climate vulnerability classification based on categories of dependence on vulnerable species (left), and catc
sity scores (Simpson's Reciprocal Index (right)). Only communities with total landings value of 100 thousand dollars or more were mapped.

Marine Policy 51 (2015) 119–127
Contents lists available at ScienceDirect
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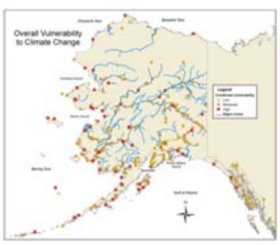
Vessels, risks, and rules: Planning for safe shipping in Bering Strait

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

OA Risk Assessment



Himes-Cornell and Kaspersky 2014

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

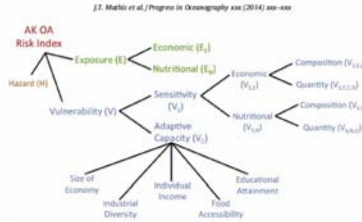


Fig. 3. Components of the risk index. Each branch is evenly weighted relative to others at the same level.

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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 2
Categories of regulatory implementation. Although mandatory measures are not necessarily dependent on having voluntary measures in place (and domestic measures are not required prior to international measures), in practice the development of regulations typically starts with voluntary and domestic measures and moves on from there.

Category of implementation	*To whom the measures apply*	*Effectiveness at reducing risk*
Voluntary	All vessels, but with no enforcement power	Depends on compliance, but there is likely to be pressure to comply Can be enhanced if insurers and others regard such measures as appropriate standards of care Can be enhanced by monitoring and communication
Mandatory (domestic)	Vessels addressed by the regulations that are either (a) registered in the country issuing the regulations, or (b) traveling to or from a port in that country	Depends on the proportion of vessels in the area that are subject to the regulations Other vessels may comply voluntarily or be required to do so by insurers Can be enhanced by monitoring and enforcement
Mandatory (international)	All vessels addressed by the regulations	Compliance can be enhanced by monitoring and enforcement

PNAS

Vulnerability of Arctic marine mammals to vessel traffic in the increasingly ice-free Northwest Passage and Northern Sea Route

Donna D. W. Hauser [a,1,2], Kristin L. Laidre [a], and Harry L. Stern [a]
[a] Polar Science Center, Applied Physics Laboratory, University of Washington, Seattle, WA 98105

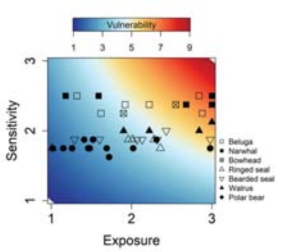


Fig. 2. Vulnerability plot expressing sensitivity and exposure scores across Arctic marine mammal subpopulations exposed to the Northwest Passage or Northern Sea Route. Vulnerability is the product of exposure and sensitivity.

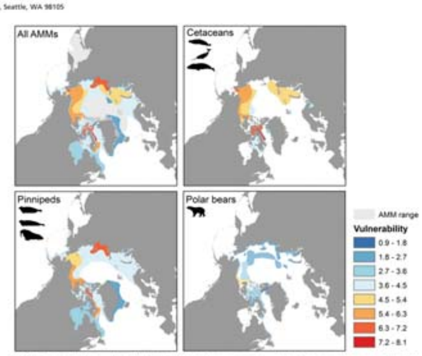


Fig. 4. Maximum vulnerability scores for all AMM species (Top Left) and taxonomic groups exposed to the Arctic sea routes. Vulnerability color shading corresponds to the vulnerability plot in Fig. 2. The combined ranges of all other AMM subpopulations that did not overlap the Arctic sea routes are shown in gray in the Top Left, including portions of polar bear subpopulations that range onto land during the open-water period.

HOW?

c) Operationalized climate change management strategy evaluations (MSEs)

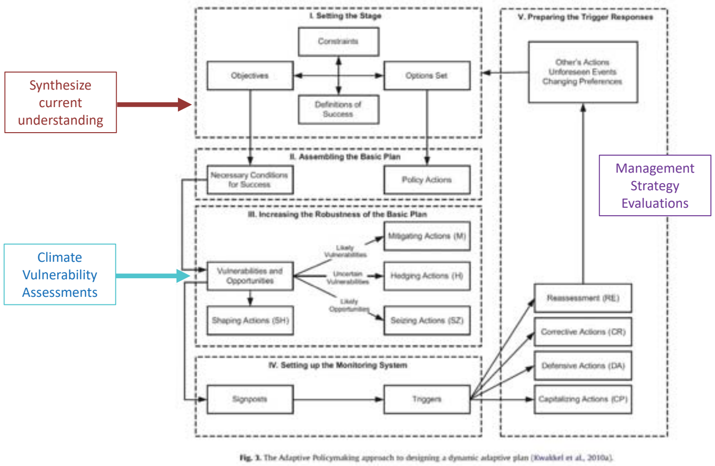
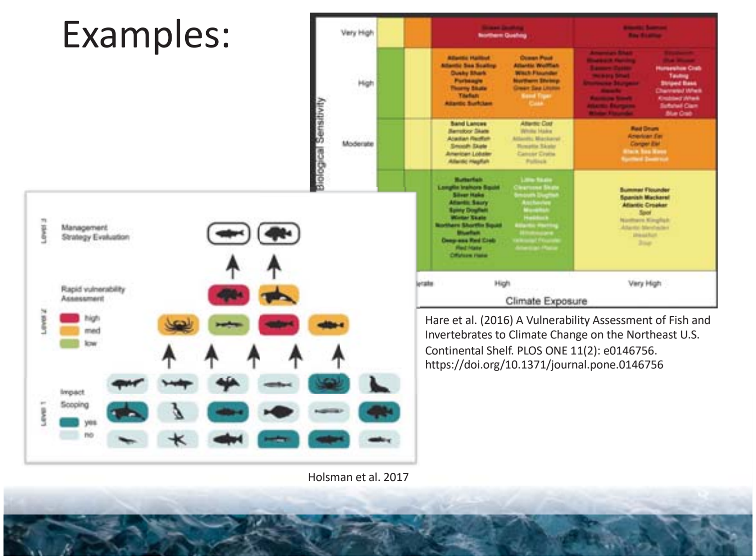


Fig. 3. The Adaptive Policymaking approach to designing a dynamic adaptive plan (Kwakkel et al., 2010a).

M. Haasnoot et al. / Global Environmental Change 23 (2013) 488 485–498



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

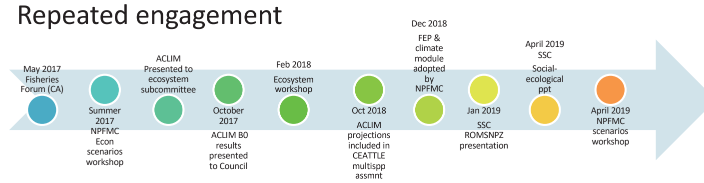
Holsman et al. 2017

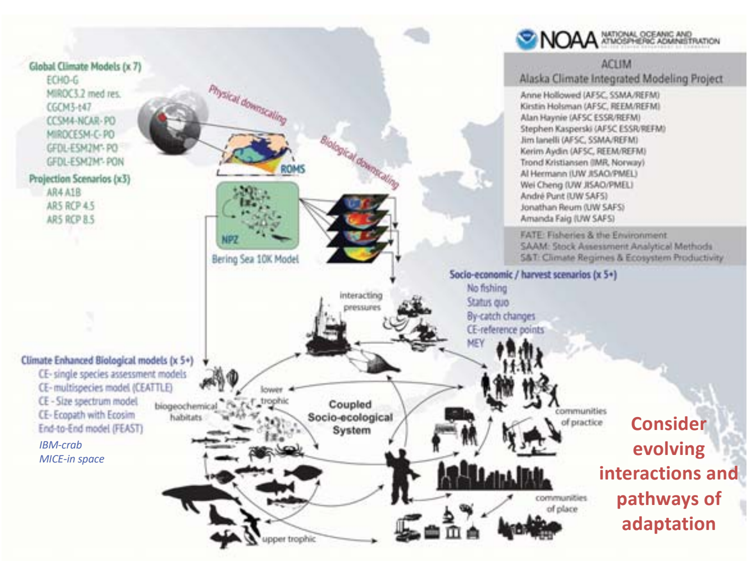
Challenges to evaluating adaptation options:

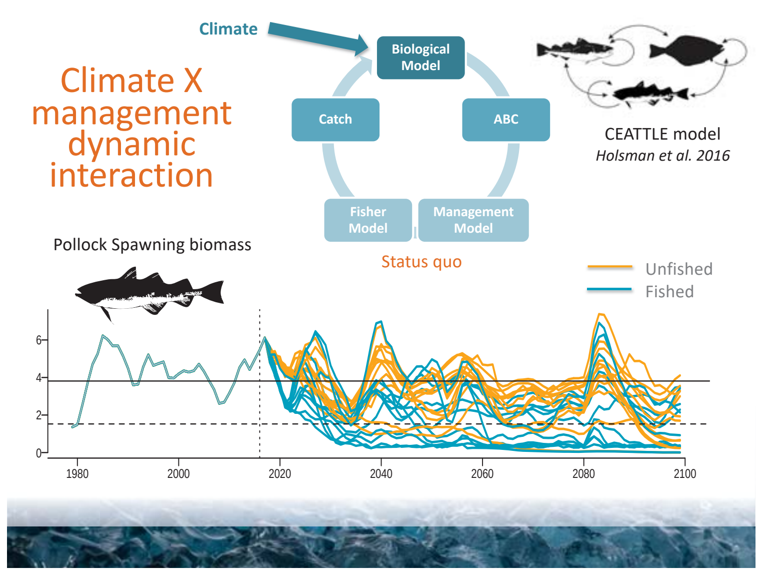
- **long time horizons** of adaptation outcomes;
- the **shifting baseline and uncertainty** around climate hazards;
- assessing **attribution** of any results;
- addressing the **additional climate risk** and counterfactual scenarios

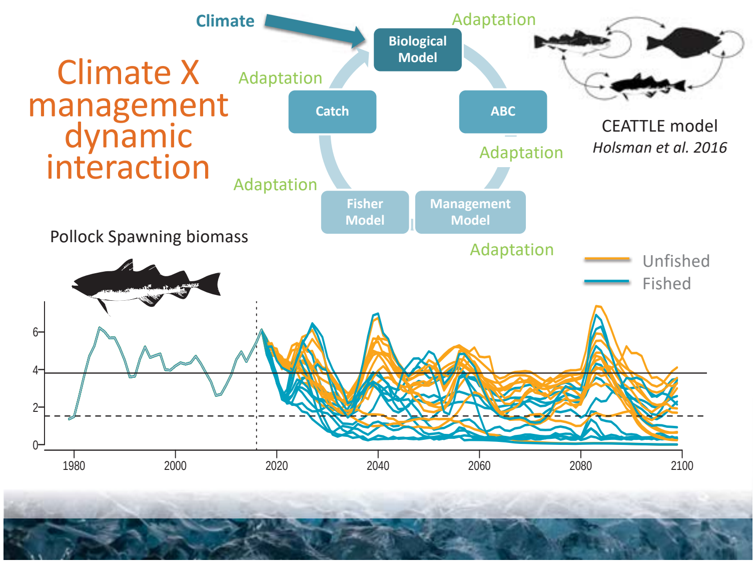
"an ***approach built on mixed methods, participation and learning helps alleviate some of the uncertainties*** around interpreting results on adaptation." Craft & Fisher 2018, Fisher 2015

Repeated engagement









Future Essential Fish Habitat

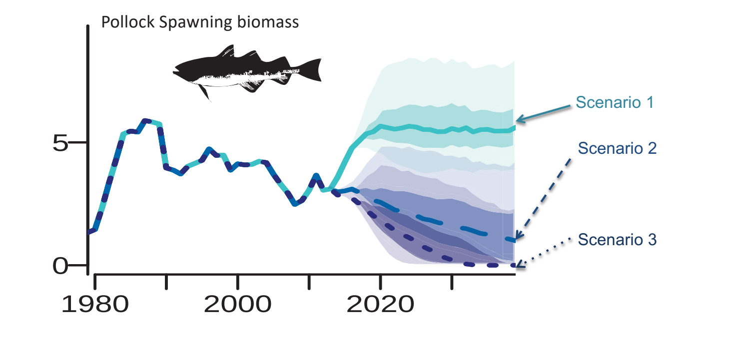
(Chris Rooper, Ivonne Ortiz, Ned Laman, Al Hermann, *in prep*)

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

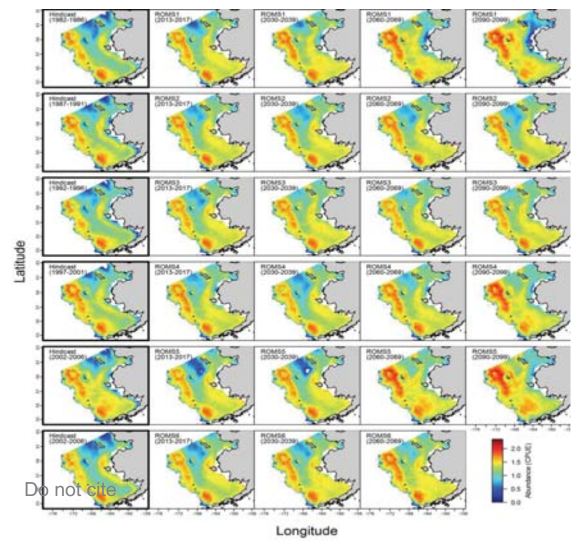
Slide credit: I. Ortiz



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

P.Cod

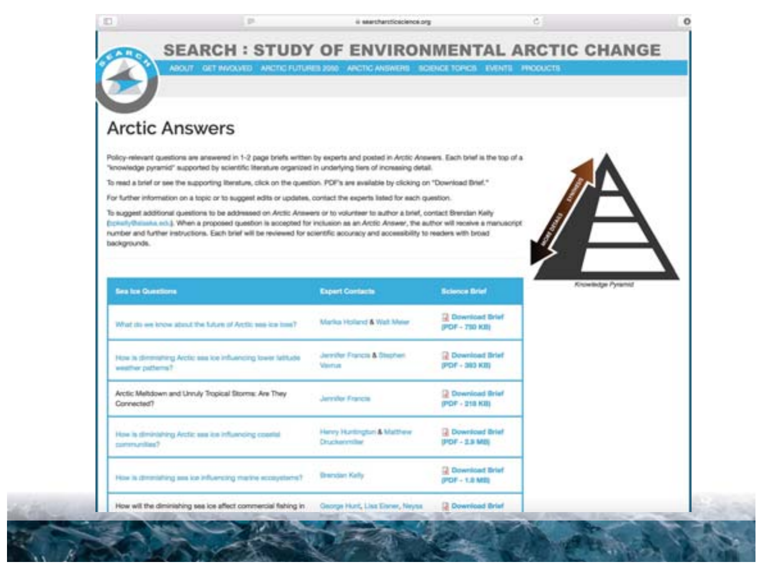
(Chris Rooper, Ivonne Ortiz, Ned Laman, Al Hermann, *in prep*)

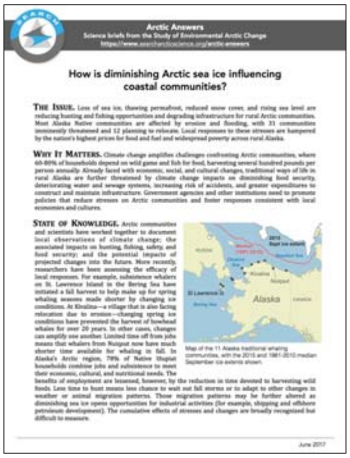


Slide credit: I. Ortiz

HOW?

d) Project changes in species distributions and phenology





Arctic Answers
Science briefs from the Study of Environmental Arctic Change
https://www.searcharcticscience.org/arctic-answers

How is diminishing Arctic sea ice influencing coastal communities?

THE ISSUE. Loss of sea ice, thawing permafrost, reduced snow cover, and rising sea level are reducing hunting and fishing opportunities and degrading infrastructure for rural Arctic communities. Most Alaska Native communities are affected by erosion and flooding, with 31 communities imminently threatened and 12 planning to relocate. Local responses to these stresses are hampered by the nation's highest prices for food and fuel and widespread poverty across rural Alaska.

WHY IT MATTERS. Climate change amplifies challenges confronting Arctic communities, where 60-80% of households depend on wild game and fish for food, harvesting several hundred pounds per person annually. Already faced with economic, social, and cultural changes, traditional ways of life in rural Alaska are further threatened by climate change impacts on diminishing food security, deteriorating water and sewage systems, increasing risk of accidents, and greater expenditures to construct and maintain infrastructure. Government agencies and other institutions need to promote policies that reduce stresses on Arctic communities and foster responses consistent with local economies and cultures.

STATE OF KNOWLEDGE. Arctic communities and scientists have worked together to document local observations of climate change; the associated impacts on hunting, fishing, safety, and food security; and the potential impacts of projected changes into the future. More recently, researchers have been assessing the efficacy of local responses. For example, subsistence whalers on St. Lawrence Island in the Bering Sea have initiated a fall harvest to help make up for spring whaling seasons made shorter by changing ice conditions. At Kivalina—a village that is also facing relocation due to erosion—changing spring ice conditions have prevented the harvest of bowhead whales for over 20 years. In other cases, changes can amplify one another. Limited time off from jobs means that whalers from Nuiqsut now have much shorter time available for whaling in fall. In Alaska's Arctic region, 79% of Native Iñupiat households combine jobs and subsistence to meet their economic, cultural, and nutritional needs. The benefits of employment are lessened, however, by the reduction in time devoted to harvesting wild foods. Less time to hunt means less chance to wait out fall storms or to adapt to other changes in weather or animal migration patterns. Those migration patterns may be further altered as diminishing sea ice opens opportunities for industrial activities (for example, shipping and offshore petroleum development). The cumulative effects of stresses and changes are broadly recognized but difficult to measure.

Map of the 11 Alaska traditional whaling communities, with the 2015 and 1981-2010 median September ice extents shown.

June 2017

SEARCH Science Brief - June 2017

WHERE THE SCIENCE IS HEADED. More work is needed to understand how local responses can be effective (such as the St. Lawrence Island fall whaling season) as well as how how they fall short of what is needed (such as Kivalina's inability to hunt in spring). In addition, future research must address ways that policies exacerbate or mitigate such impacts, for example by imposing additional constraints on what communities can do, or by supporting flexibility and local initiative to solve problems. Actions made without adequate knowledge of local conditions, no matter how well intentioned, may undermine local well-being by promoting ineffective responses or fostering dependence on outside intervention rather than on local talent, capacity, and creativity. Ultimately, communities need support to identify local solutions.

Iñupiat hunters establish a whaling camp on coastal sea ice near Utqiagvik (formerly Barrow), Alaska, where thinning ice and warming temperatures in Spring are reducing hunting opportunities and increasing risks to personal safety. (Courtesy: M. Druckenmiller)

FURTHER READING

Chapin, F.S., III, S.F. Trainor, P. Cochran, H. Huntington, C. Markon, M. McCammon, A.D. McGuire, and M. Serreze, 2014. Ch. 22: Alaska. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 514-536. doi:10.7930/J00Z7150. [Available online at: http://nca2014.globalchange.gov/report/regions/alaska]

Goldsmith, S., 2008. Understanding Alaska's Remote Rural Economy. UA Research Summary No. 10, Institute of Social and Economic Research, University of Alaska Anchorage. [Available online at: http://www.iser.uaa.alaska.edu/Publications/researchsumm/UA_RS10.pdf]

SEARCH: Advancing knowledge for action in a rapidly changing Arctic
https://www.searcharcticscience.org/arctic-answers

Contact for further information:
Henry Huntington,
Huntington Consulting
Matthew Druckenmiller,
National Snow and Ice Data Center

SEARCH is supported by the National Science Foundation. SEARCH Science Brief AA-002.

What do you hope the Climate Change Task Force / Climate Change Module can accomplish in the next 3-5 years of the Task Force timeframe? (2020-2025)	What do you hope the Climate Change Task Force / Climate Change Module can accomplish in the next 10-20 years?
Synthesize observations, identify information gaps, and **improve our predictive capabilities** to better inform climate related management measures/decisions	Implementation of a **climate-resilient management** measure(s).
Finalize a working Action Module which **brings together western science, IK and TK, and LK** - and related concerns, perspectives, information, and values - in a way which provides **valuable guidance and tools for the Council** to best take into account climate change in Alaska federal fishery management.	Building on what I noted above, I would hope it could have provided useful information, activities, and tools for **ensuring sustainability in the face of climate change** for fisheries, habitats, and communities which are involved in and impacted by fisheries activities.
Identifying and **framing issues and concerns which pose immediate and long term threats** to fisheries and ecosystem in the Bering Sea.	Develop **adaptive management measures to help predict impacts of global climate** change to the Bering Sea.
Ideally **make some forward looking management recommendations** for addressing climate change impacts on fisheries management	Predict how **climate change and management choices interact** and respond
Inform the Council on elements required to make informed policy decisions when considering climate change impacts.	Guide policy.
Identify tools and pathways for the Council and NMFS to account for and **integrate climate change modeling and information (western science and indigenous and local knowledge)** into fishery management decisions in a holistic, meaningful, and inclusive way.	Broadly, the hope is that we continue to **advance ecosystem-based fisheries management in such a way that it becomes increasingly resilient** and adaptive to changing conditions. The Module and Task Force can be important, ongoing vehicles to help advance that goal and to ensure that the Council has the information and tools to make the best possible decisions.
Bringing together **already developed tools and models with LTK** and increased involvement and participation/ contributions of indigenous stakeholders to inform policy in innovative ways	Shifted paradigm of how **different types of information and data are viewed by science and managers, more inclusive and open partnerships** with more folks on the ground, strengthened partnerships with agency and communities

Brenden Raymond-Yakoubian
NPFMC BS FEP Climate Change Action Module Taskforce (CCTF)
Presentation at 21-January-2020 meeting

Concepts and Terminology
- Caveats (e.g. terms and uses vary; importance of conceptual clarity; MSA/National Standards; etc.)
- One possible suite of definitions: see Kawerak white paper on terminology (in supplemental materials)
  - Indigenous Knowledge(s) (IK)
  - Traditional Knowledge (TK)
  - Also: Local Knowledge (LK), subsistence, etc.
- Addressing some misconceptions

Co-Production of Knowledge (CPK)
- Defining and understanding CPK
  - What CPK is in general: definition, purpose, elements
  - One proposed model/framework (see CPK graphic in supplemental materials)
- Potential for applications to climate change work

Western Alaska Indigenous Communities and Research
- Brief discussion of some key western Alaska indigenous community perspectives and concerns regarding research. E.g.:
  - Increasing the level of involvement and recognition of indigenous people, communities, and their knowledge in research
  - Changing the mechanisms and processes involved in research as it pertains to indigenous peoples and their communities
- Indigenizing research - what does this mean?

Western Alaska Indigenous Communities and Climate Change
- Thousands of years of environmental observations and their application and integration into social and cultural systems
- Decades of documentation and analysis in and outside social science regarding IK/TK and climate change
- Cascading and concatenating impacts in communities
- Food for thought: the indigenization of climate change
- Some recent regional and national discussions: NCA4 “Tribes and Indigenous Peoples” chapter; Arctic Report Card pp. 88-94 “Voices from the Front Lines of a Changing Bering Sea: An Indigenous Perspective for the 2019 Arctic Report Card” (see supplemental materials)

Some Preliminary Ideas of Possible CCTF Activities re TK and Climate Change
- Recognizing the importance of working with diverse knowledge bodies and systems for understanding climate change and tackling issues it presents
- On-ramping:
  - CCTF as on-ramp for TK into Council process
  - CCTF as generative of on-ramps for TK into Council process
- Pilot project: Bringing TK experts to speak to the Council regarding climate change and integrating that with work of the CCTF
- Working with other Council bodies engaging TK-related issues
  - Especially: BS FEP LK/TK/Subsistence Action Module Taskforce, Ecosystem Committee, Community Engagement Committee (CEC), Social Science Planning Team (SSPT), SSC
  - Regarding: Processes for incorporation, Engagement and outreach, Collaborative work, Metrics for success, Sharing information, Long-term iterative activities regarding Council and climate change, etc.
- Cross-walking a topic/question with the LK/TK/Subsistence Action Module
  - Possibility: Engaging a co-productive project related to climate change