North Pacific Fishery Management Council
Climate Change Task Force
Final Report

November 2024

Disclaimer:

This report represents synthesis of ideas and discussions exchanged during CCTF meetings and in shared Task Force documents and reflects ideas offered therein but does not imply consensus of all member ideas nor is exhaustive of all existing and potential climate change challenges, opportunities, or future Council directions. Rather, this report is designed to be a resource to support NPFMC advancement of management policies, tools, and processes towards climate change adaptation and resilience in the Bering Sea, Alaska.

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Executive Summary

The Council convened the Climate Change Task Force (CCTF) in October 2019 to advance the goals of the Bering Sea Fishery Ecosystem Plan (BSFEP) Climate Change Action Module. The Module sought to evaluate the vulnerability of key species and fisheries to climate change and to strengthen resilience in regional fisheries management. The CCTF developed a 5 year work plan to further that effort, which was approved by the Council. This report which is the CCTF's final product, and which provides a high-level summary of the CCTF's work as well as a set of recommendations for meeting the objectives of the Climate Change Action Module and Council's stated goal to advance resilient, climate-ready fisheries management.

Develop a Climate Change Work Plan

In order to ensure that this work continues most efficiently and effectively, the CCTF **recommends that the Council develop and implement a climate change work plan**. The work plan should guide the Council in continuing efforts that will increase resilience in fisheries management and more effectively incorporate climate-related information and tools into decision-making. The CCTF recommends that this work plan be structured around three Key Elements (which each have several sub-elements):

Key Element 1: Expand existing (and create new, where appropriate) inclusive processes, collaborations, and partnerships that facilitate inclusion of multiple knowledge systems in climate planning

The CCTF acknowledges that there is available and emerging information that can enhance Council management decisions. Important sub-elements include: 1. integrating climate advice across existing Council processes, 2. providing regular opportunities for public-facing brainstorming and two-way information sharing (see Key Element 1.1), 3. advancing measures that promote inclusive decision-making (see Key 1.2), 4. reducing barriers to diverse participation (see Key 1.3), and 5. supporting equitable participation in Council processes through mentorship (Key 1.4).

Key Element 2: Consider management tools and options focused on the inclusion of existing and emergent climate information

The CCTF emphasizes the importance of incorporating information into existing processes while also recognizing the need to explore and implement new tools to enhance resilience. The CCTF identified a number of important near-term (next 2-3 years) and longer-term actions that should be considered and are described in this report. To help facilitate development of a work plan, the CCTF divided these actions into near-term actions (i.e., able to be implemented in the next 2-3 years) and longer-term actions, requiring a longer process to develop. **The CCTF recommends a work plan that initiates both (i.e., it is important to implement the near-term priorities and start processes to explore the longer-term priorities).** Near-term priorities include:1. considering climate forecast-linked management advice (see Key 2.1), 2. incorporating climate-driven interactions and cascading impacts through ecosystem indicators and models (see Key 2.2), and 3. developing dynamic management tools using early warnings, ocean and ecosystem nowcasts (daily; weekly), and forecasts (<2 yr) to increase in-season adaptation tools for management (see Key 2.4). Priority longer-term actions include: reviewing the tier systems and considering climate-informed biomass targets and limits, as well as climate-robust or forecast-informed Harvest Control Rules (HCRs; see Key 2.5)

Key Element 3: Establish a dedicated review group charged with reviewing and packaging climate information entering Council processes

Given the breadth and complexity of climate-related topics and issues, the CCTF recommends stabilizing and streamlining climate information by establishing a review group (and the CCTF provides 4 options

for composition of that group from externally appointed members to a small Council staff team). The CCTF recognized that this review group could have many effective roles including: regularly identifying and coordinating review of external evaluations relevant to climate-informed advice (see Key 3.4), reviewing emerging climate-specific resilience metrics for measuring progress towards climate readiness (see Key 3.5), and synthesizing and promoting climate smart management approaches (see Key 3.6).

Introduction

Over the past five years, the CCTF has documented, evaluated, and discussed the needs, processes, and information sources critical to achieving climate resilient fisheries and vibrant Alaska communities. As a final work product, we have synthesized our work into a final report and composed of a set of recommendations. This process began with a draft brainstorming shared document from June through Oct. 2024 available to all CCTF members to help synthesize overarching recommendations in advance of the final CCTF meeting November 6-7, 2024. At that time, the synthesized brainstorming document was made available to the public, and during the meeting, the CCTF collectively reviewed, discussed, and edited those recommendations to formulate this final report. The ideas offered below do not imply consensus of all member ideas nor are they exhaustive of all existing and potential climate change challenges, opportunities, or future Council directions. Rather the CCTF envisions the recommendations below can serve as a starting point for future discussions and next steps by the Council.

At a high level, the CCTF recognizes that its work will sunset, but the effort to advance resilience in fisheries management should continue. To best advance the Council's goals, the CCTF recommends that a work plan be developed to advance resilience in the face of rapid change. The work plan should guide the Council's ongoing efforts for evaluation and implementation of processes to incorporate climate-related information and to establish priorities for evaluation and implementation of measures to increase resilience. The recommendations below are structured to guide development of such a work plan.

As a starting point for its work, the CCTF compiled a "Climate Readiness Synthesis (CRS; Stram et al. 2023; Appendix C) intended to help the Council evaluate how "climate ready" the current management system is overall and to provide a baseline from which to identify opportunities for improved climate resilience. The synthesis determined that some existing management tools may be effective in the face of rapid change and that many of the measures presently used were not developed to respond explicitly to climate change. Overall, the system was ranked as "on the way to climate ready." This report builds from that baseline and provides recommendations for advancing climate readiness.

There is considerable evidence that climate change already has, and will continue to, exacerbate inequalities and challenges in the Council's current management system. To begin to address this, an approach is needed that includes stock and ecosystem (inclusive of humans) sustainability, well-being, equity, resilience, and management metrics (and targets) in the context of climate change risks and impacts.

Development of these approaches must acknowledge and account for the fact that failing to systematically include diverse perspectives in each step of the analysis and policy-making processes raises the risk that resulting management outcomes are inequitable and disproportionately impact divergent communities of place and practice, thereby undermining sustainability and resilience (New et al. 2022; Pascual et al. 2023). Conversely, inclusive approaches that bridge understanding from multiple knowledge systems can be the foundation for effective climate change adaptation (see box 14.1 in IPCC 2022). Accordingly, it is important to promote climate-integrated and inclusive processes that help illustrate and communicate potential tradeoffs (and associated vulnerabilities) across fisheries, fleets, communities, rightsholders, stakeholders, and other participant groups relative to climate-related Ecosystem-Based Management (EBM) decisions.

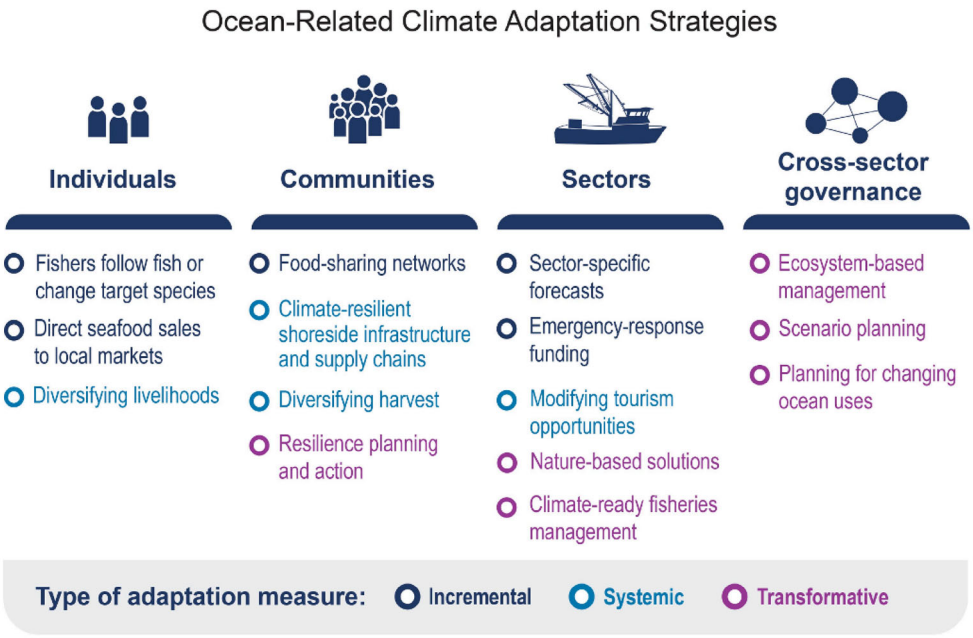

Figure 1: Adaptation can occur at many organizational scales—from individuals to governance systems.

Many types of adaptation measures are being undertaken, or are under consideration, as ways to respond to and prepare for climate change impacts on ocean activities and economic sectors. The measures range from small adjustments (incremental) to larger actions within current socioeconomic and management systems (systemic) and substantial changes beyond existing systems (transformative). Figure credit: Gulf of Maine Research Institute. Source Figure 10.4 5th National Climate Assessment, accessible from: nca2023.globalchange.gov/chapter/10/#fig-10-4).

Adaptation to climate change can occur at multiple scales, from individuals to governance and from incremental immediate responses to shocks to approaches that transform the system to be more resilient and sustainable on long-time scales and across potentially large climate-driven changes (Fig. 1; New et al. 2022). Multiple recent advancements in the development and expansion of observation and information sharing networks, knowledge databases (e.g., LKTKS Database), integrated modeling tools, and advanced monitoring and early warning systems provide the foundation for climate adaptation and climate-informed decision making (for more information see the Information section of the Climate Ready Synthesis). For example, recent investments by NOAA into predictive ecosystem forecasting tools provide operational predictions that can be used to bring climate information into stock assessments (CEFI 2024, Hollowed et al. 2020). Continued investment in rapid information sharing and platforms for knowledge exchange will aid in effective rapid response to climate shocks. Iterative development of such tools helps refine their effectiveness, and this approach relies on a transparent process for information sharing and consistent team of Council points of contact for climate advice and information.

As noted above, the CCTF recognizes that its work will sunset. To best advance the Council's goals related to climate readiness, **the CCTF recommends that a work plan be developed to advance resilience in the face of rapid change.** The work plan should be crafted inclusively through engagement with the public using best practices identified by the Community Engagement Committee (CEC) and the NPFMC Local Knowledge, Traditional Knowledge, and Subsistence Task Force (LKTKS Taskforce). The CCTF has identified three key elements that are recommended to guide the development of a climate

work plan: establish inclusive processes for bringing climate-related information to the Council (Key Element 1), evaluate climate-informed management tools and options (Key Element 2), and create a standing group to review climate information entering Council processes (Key Element 3). It is envisioned that the work plan will advance development and implementation of measures to support climate change planning, adaptation and effective responses to address climate-driven increased uncertainty and ecosystem volatility. Ultimately, such advancements have the potential to increase the effectiveness of management systems and support regional fisheries while also ensuring long-term sustainability of resources and communities through precautionary ecosystem-based management.

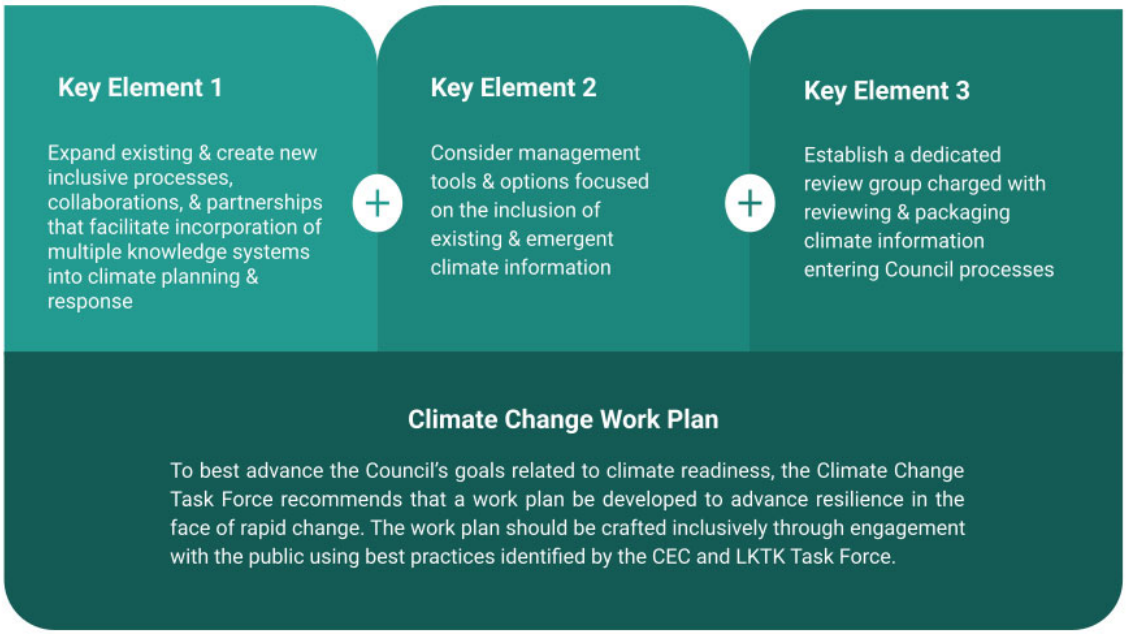

Fig 2: Summary of the final recommendation of the Climate Change Task Force to develop a climate change work plan.

The CCTF has identified three key elements that are recommended to guide the development of a climate work plan: establish inclusive processes for bringing climate-related information to the Council (Key Element 1), evaluate climate-informed management tools and options (Key Element 2) , and create a standing group to review climate information entering Council processes (Key Element 3).

Key Elements for a Climate Change Work Plan:

Key Element 1: Expand existing (and create new, where appropriate) inclusive processes, collaborations, and partnerships that facilitate incorporation of multiple knowledge systems into climate planning and response

The CCTF recommends that the Council build on existing successes to expand existing and create new inclusive approaches that provide rapid climate change information, observations, and responses in

Council processes, documents, and materials. The Council can help advance this element and the more specific sub-elements below by ensuring broad and equitable representation across Council bodies and within Council processes (e.g., using the LKTKS Task Force Protocol).

1.1 Continue to provide regular opportunities for public-facing brainstorming and two-way information sharing related to climate change impacts and response

Providing a space for informal information exchange is one of the easiest and most efficient ways to gather and include climate change-related information that can help inform Council responses to both rapid shocks and long-term climate shifts . The Council facilitated informal exchanges like this in the breakout sessions at the June 2024 Climate Scenarios Workshop (CSW), and future exchange could take various forms, including: annual round table discussions on various climate topics, dedicated evening sessions at Council meetings; breakout groups during workshops, semi-structured Climate Testimonials, and other forms. These informal exchanges should be guided by a code of conduct to promote respectful discussion, the sharing of multiple perspectives, and the fostering of safe spaces for the exchange of ideas.

1.2 Advance measures that promote inclusive decision-making

The Council can formalize on-ramps that incorporate information and perspectives from diverse knowledge sources into decision-making processes. As part of doing so, the Council can provide support and resources for collaborative and cooperative processes that are inclusive of diverse stakeholders and Tribes, such as promoting co-production of knowledge, promoting and integrating results of timely and meaningful Tribal Consultation, supporting and exploring collaborative and cooperative management and policy structures and processes, promoting co-stewardship, and promoting co-presentation on Council issues by Tribal entities.

1.3 Reduce barriers to diverse participation

Additional perspectives and information can be better integrated into management through increased information exchange, which is facilitated by appropriate utilization of diverse sources of available information. The Council can facilitate this exchange as appropriate and by using FAIR (Findable, Accessible, Interoperable, Reusable; e.g., Pirini et al. 2022) principles, CARE (Collective benefit, Authority to control, Responsibility, Ethics) principles, the LKTKS Task Force Protocol, and other existing protocols which pertain to information use and sharing. The Council can also continue to improve access to documents ahead of Council meetings to help promote equitable participation.

1.4 Support equitable participation in the Council process through mentorship

To build capacity for Council involvement and contributions, the Council can provide support and resources for mentorship programs (e.g., Marine Resource Education Program [MREP], UAF Tamamta Program).

Key Element 2: Evaluate management tools and options focused on the inclusion of existing and emergent climate information

One of the main tasks undertaken by the CCTF has been to consider and compile management tools that could be considered by the Council as it seeks to advance climate-ready fisheries management. The CCTF undertook a brainstorming and prioritization exercise that resulted in the list below. To facilitate evaluation of these tools, the CCTF identified overlapping time scales based on the availability of information and ease of implementation. The CCTF believes it is important to implement all of these

recommendations and to start on the ones that will take longer to develop while taking steps to evaluate actions that can be taken in the shorter-term.

The recommendations in this section focus on specific mechanisms through which the Council can incorporate climate-related information into management and new tools that could be evaluated. We recommend that, in a climate work plan, the Council identifies the timing and processes through which these activities can be evaluated and implemented. *Note that '*' indicates consensus high priority Key Elements.*

Near-ready to implement

The CCTF feels that the following information and tools are sufficiently developed to allow the Council to implement the recommendations in this category in the next 1-3 years. These measures are incremental and will help ensure that information is available to allow for improved management. As new measures, it will be important to monitor their performance and establish an approach for evaluation.

2.1 ***Incorporate climate forecast linked management advice**

Use climate and ecosystem forecasts to improve management advice through assessments and supportive documents:

a. **Incorporate forecasts of climate and ecosystem conditions (+1-2 yrs) in the harvest projections and specifications processes**, including through the assessment of maximum allowable catch, ABC and overfishing limit, OFL; as well as climate, ecosystem, and socioeconomic sections of Ecosystem Status Reports (ESRs), and Ecosystem and Species Profiles (ESPs) that are used in the Risk Tables (i.e., for ABC) and in the context of informing the TAC-setting process. For example, forecasts of Marine Heat Waves (MHW), pH or low oxygen events, or harmful algal blooms could be linked to changes in survival, growth, and species distributions, changes in access by harvesters, shifts in fish condition and changes in food quality and food safety (e.g., HABs).

b. **Include climate forecast information and vulnerability assessments** in management advice to inform Risk Tables and discussions around ABC or TAC. Climate information on risk could be communicated via updates and expanded climate risk sections of the Annual Community Engagement and Participation Overviews (ACEPOs), through an appendix to ESRs, or as a standalone report or assessment.

c. **Consider climate-forecast linked spatial management** measures (e.g., via climate specific species distribution models) to inform apportionments.

2.2 ***Incorporate climate-driven interactions and cascading impacts through use of ecosystem indicators and models**

Develop and use ecological indicators and multi-species, multi-fleet, or ecosystem models that quantify uncertainty, interactions, and risk across multiple fisheries or species. As part of this effort risk table discussions can be aligned around climate buffers/risks.

2.3 **Broaden observations through expansion of cooperative data collection and analysis**

Build on collaborative data collection methods, statistical approaches, and validation measures to bring real-time and fishery-dependent data into stock assessments and management actions (especially around climate and species and fishing effort redistribution).

Important to Begin Now

We feel the following measures have high potential to increase flexibility and resilience under climate change but likely will take longer to implement and thus should be initiated soon:

2.4 ***Consider and incorporate dynamic management tools to increase in-season adaptation capacity**

Dynamic management tools aligned with federal regulations and management could be used to trigger pre-season and/or within season adjustments, revaluations, or "red flag" responses (e.g., respond if realized catches are much lower than TAC as was the case for GOA Pacific cod in 2016, or higher as in the case of Pacific cod in the NEBS in 2018; see reports avail at https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-management-reports). Implementation would require a combination of regulatory changes and innovations, as well as a system designed to allow managers to take proactive actions as needed. This may also include developing opportunities that facilitate and incentivize industry based responses. The CCTF believes there is a good base from which to begin to implement these tools, but a longer-time horizon is needed to identify the most appropriate opportunities and develop needed regulatory analyses. Examples of these kinds of tools include:

a. **Using nowcasts (daily; weekly) and forecasts (<2 years) to inform spatial in-season and annual management actions**

   The Council can advance tools that allow for the incorporation of climate-information throughout the season and define measures based on that information (e.g., climate or ecologically-informed dynamic pre-defined spatial or seasonal measures (also see 2.12 below). As part of developing these measures, spatial management implications, such as divergent impacts of species redistributions under climate change and bycatch risk, can be considered during ABC and TAC discussions.

b. **Increase in-season flexibility and responsiveness in harvest measures through incorporation of real-time observations from a broader suite of observations and information**

   Along with creating new tools, the Council can ensure that information not currently incorporated in the management process (e.g., Skipper Science citizen science data, LKTK information) be considered in developing and implementing dynamic management measures.

2.5 ***Review tier systems, consider climate-informed biomass targets and limits and climate-robust or forecast-informed Harvest Control Rules (HCRs)**

As it undertakes this review, the Council should consider developing criteria for improvements in performance tier, HCRs and biomass targets that incorporate more than just stock sustainability (e.g., Ecosystem MSY, volatility over time, risk of collapse, fishery consolidation, biodiversity), and HCRs and biological targets that might increase improvement under future climate shocks (e.g., B50). These could use a suite of observations, ecosystem and climate hindcasts, forecasts and longer term predictions. This work also aligns with the Council IRA proposal item 3.

2.6 Periodically review spatial management effectiveness under changing conditions

Implement an ongoing process for evaluation of the effectiveness of fixed area closures, conservation areas, and habitat protection measures in the context of climate change using observations to validate and test the performance of measures based on longer-term climate and ocean predictions (e..g, 10+ year climate predictions).

2.7 Consider climate information in recovery plans

Consider climate change causality (hindcast climate reconstructions), climate predictions (now - 10 yrs) and climate scenario projections (now – 50 yrs) in recovery and rebuilding plans, reference periods, and recovery trajectories (e.g., as was done with climate attribution in EBS snow crab recovery plan evaluations).

2.8 Consider cumulative effects and system interconnections

In developing management measures and policies, include compound and interacting effects of changes in climate, fishery, ecological, and social or economic dynamics in understanding of management tradeoffs and knock-on effects under the lens of alternative climate scenarios (now – 50 years).

2.9 Utilize EBM structures to increase cross sector coordination

Use EBM and cross sector coordination to help address multi-mandate changes for climate resilience and provide feedback to align Council and Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and other protections. Use climate projections to scope potential intersections, opportunities, or challenges that might arise in the next 10-20 years and arrange discussions to minimize cross-mandate conflicts.

2.10 Reduce climate change impacts through low carbon incentives

Consider market dynamics and low carbon domestic market development in allocations and incentives to reduce climate change impacts and pressures over time.

Key Element 3: Establish a dedicated review group charged with reviewing climate information entering Council processes

In addition to recommendations 1 and 2, the Council should identify a process to receive, review, and synthesize alternative management measures (new or modifications to existing) to be considered by the Council to improve climate response and robustness and to iteratively and regularly re-consider potential strengths, weaknesses, and opportunities for improvement across management tools. The CCTF discussed four potential alternative structures for this approach:

(a) **The Council forms a new CCTF-like group** with a directive to provide advice through existing pathways (AP, SSC, Plan Teams, Committees and other existing working bodies, GPT and CPT, Council);
(b) **The Council uses a review group approach** to compose a small team of Council body representatives (no more than 2 representatives from each: AP, SSC, Council, Staff) that would convene, as appropriate, tactical sub- teams of experts and public roundtable discussions, to guide analysis and reporting on recommendations of management measures to the Council;
(c) **Existing Council structures expanded** to include climate; similar to (b) but reassignment of the following tasks (below) to existing Council bodies and committees; or
(d) **Staff only** to create work plan and filter climate advice to Council and no public process outside of general Council process (this option not favored by CCTF as this is less inclusive and transparent and is less feasible for implementation due to limited staff capacity).

The CCTF recommends that in establishing this review group, the Council:

1. **Consider establishing a longer time frame** for the group (with a membership rotation policy/protocol in place)
2. **Provide tasking that allocates time and resources** to complete recommendations or actions.
3. **Consider a set agenda item at each meeting** for climate change discussions and climate related management measures and identify a clear process for input into that agenda item.

The CCTF further recommends this review group conduct the following activities:

4. **Identify and coordinate review of external evaluations relevant to climate-informed advice**

   The review group could recommend initiating and identifying subteams to conduct analyses or evaluations to be approved by the Council and coordinate synthesis of outcomes for Council bodies . The review group could additionally consider how these needs align with the Council's research priorities and low-hanging fruit identified in CRS (and future updates). Example analyses could include: Management Scenario Evaluations (MSEs) that test the skill of climate-informed assessments or evaluate the role of uncertainty, climate informed tools, and alternative management measures; comparative review of alternative approaches for adding flexibility to existing management measures; evaluations of specific actions relating to risk and uncertainty, particularly more clearly defining risk as it relates to fisheries and ecosystem wellbeing

5. **Review of emerging climate-specific resilience metrics for measuring progress towards climate readiness**

   Re-evaluate risks and climate readiness (e.g., repeat the Climate Readiness Synthesis, CRS) on a regular basis and periodically reconsider metrics used to monitor climate readiness. Provide periodic review and evaluation of the Council actions and performance of actions previously taken over time and under various conditions.

6. **Synthesize and promote climate smart management approaches**

   Identify robust and equitable climate resilience-oriented strategies and tools (including identification of roadblocks to development and implementation of strategies and tools) and provide synthesis and assessment of various climate-related processes and initiatives as they relate to Council activities.

Implementation of Recommendations

The CCTF believes that the recommendations above can be best implemented through development of a Council climate change work plan that establishes a priority order and timeline for evaluation and implementation of the recommendations. In prioritizing actions, the CCTF strongly recommends beginning activities that can be implemented in the shorter-term as well as those that will take longer. These overlapping time frames will ensure that tools that will take longer to develop will be available to the Council as information becomes more readily available and integrated.

In developing and implementing the work plan, the Council can follow best practices - regarding engagement, diverse knowledge incorporation, EBM, and other goals - such as those established by the Community Engagement Committee, BS FEP LKTKS Taskforce, and BS FEP. In establishing workstreams and processes, the Council can prioritize clear, transparent communication to ensure that the public is kept informed. This can include putting a clear graphics and communication plan in place for illustrating the chain of evidence for climate and stock/species responses. Grounding implementation of the work plan in collaborative approaches will be of importance for maximizing its chances for success.

Lessons learned from the CCTF process

The text below summarizes synthesis by the co-chairs and some members of the CCTF of lessons learned (text does not reflect consensus).

The CCTF has been in place for five years. At the end of this charge, some members felt it could be helpful to provide some feedback and reflections on the process. The CCTF co-chairs and members hope that these thoughts can help guide future implementation of climate-related efforts and future FEP modules. CCTF members generally agree about the process challenges and recommendations identified below. This section is an initial effort to provide the Council a collection of perspectives and ideas, though not comprehensive, to guide future effort.

Elements of the CCTF process that worked

Many members of the task force felt that cross-disciplinary and cross-entity representation was an important asset, and it allowed the CCTF the ability to complete the Climate Ready Synthesis that covered multiple dimensions of the Council process. Given the nature of the dialogue and problem-solving the CCTF undertook, the opportunity for in-person meetings was also critical but was hindered by the pandemic during the first ~3 years of the CCTF. The FEP charging document and development of the CCTF work plan were important for setting a trajectory for the CCTF, and for providing the scope of work expected over the defined timeline of the CCTF. It was also important to be able to deviate from that work plan and direction as the team learned the full breadth of the challenges and opportunities to be addressed. The team spent considerable time mapping existing climate and ecosystem on-ramps in order to identify new and needed elements for climate advice. This work was done as part of the work plan, and although it took longer than originally envisioned, it was a vital step in the process.

Another key milestone for the CCTF was the Climate Ready Synthesis (CRS, Stram et al. 2023, Appendix C). Being able to review the current management process was key and helped the CCTF identify the effectiveness of on-ramps and places where information was already coming into the Council process. Through this review, it became clear that the way the process is structured does impact the type of information that is available to the Council and that there is a lot more information and expertise available that could be incorporated if the Council could establish new approaches (or expand existing processes) to synthesize that information efficiently and equitably. Response to the CRS in the form of feedback from the Council and public highlighted that while there are multiple information streams possible for bringing climate information into management, there are capacity limitations that underscore the need to be efficient and to streamline and synthesize information as much as possible. Finally, the CRS exercise was important to demonstrate that climate-ready management doesn't have to start from scratch, there were multiple products, processes, and information sources that could readily be modified slightly to incorporate climate change information for adaptation and planning. The scoring system helped identify those starting places and was an important communication piece about how much has been done to date and provide direction for the future. The CCTF feels this would be a useful periodic exercise to repeat in the future.

Through the CRS and discussions and workshops, the CCTF came to recognize the importance of identifying feasibility and timelines for each potential climate change information on-ramp or advice, which can help winnow options and prioritize efforts for implementation. Finally, the existence of the CCTF group, discussions and workshops the CCTF held, and public discourse around CCTF activities, helped highlight the importance of generating and using climate informed advice, and illustrated that there is a need and interest for climate information in the management process.

Several aspects of the CCTF process that could be improved

Asking a task force to be both a review body and workgroup was difficult. Members were appointed and served on the CCTF in addition to full time jobs and other Council duties, this inherently limited the capacity for intersessional work and slowed the process from initiation to completion of various documents. Given that it was the first of its kind and there were little prior road-maps for such a task

force, the CCTF achieved tremendous progress over the past five years, but fell short of some internal and external expectations. A more expedited or thorough process would require additional resources, especially dedicated personnel to assist the task force with meetings and public sessions, compiling information, drafting materials, and coordinating between public meetings.

As a Council body, the task force meetings were required to be public which was both beneficial and confounding. The goal of public sessions is transparency, but much of the detailed work of the task force was difficult to share with the public and does not match the model of other Council analytical work bodies (e.g., Council and Agency staff work on analyses which might develop products and then share publicly when ready for Council review). Importantly, if the Council prioritizes resilient, climate-ready fisheries, processes like the recommendations made in this report have to be resourced as priorities. In this CCTF members discussed the importance of building and utilizing, in activities and products, a well-constructed process for collaboration, timeliness, inclusivity, decisioning, and transparency.

Providing support to ensure the public has sufficient access to materials and can robustly track and engage in the process is critical for public involvement.The complex process of some of the brainstorming and conceptual modeling efforts, both effective methods to help map connections and identify needs and opportunities, is particularly hard to follow on-line, web based tools require training and pre-conditioning work that was beyond the scope of the CCTF. It was difficult for members of the public to follow CCTF work sessions (which were all public meetings) and the editing process on google docs can be tedious and difficult to follow. CCTF members expressed concern over inherent structural inequities in the process that might disproportionately impact inclusion and participation from Indigenous communities. A public process is of vital importance, but having work sessions was a harder thing to do in a public setting and frustrating for those trying to follow along. In hindsight, having a clear process for offline work and public feedback sessions with Council predefined tasks for public activities would have been helpful. Finding ways to effectively outreach to and engage with the public for the work process is needed going forward.

Other mixed challenges and successes

The CCTF was a multidisciplinary team and as is the case with any multidisciplinary team, there can be a loss of translation across disciplines and expertise. How Climate is discussed varies across social and biological scientists, fisheries, and managers and common terms don't always hold common meaning. Providing space for defining terms, using best practices like avoiding acronyms, and working to create safe spaces for respectable information and knowledge exchange is important. The CCTF generated a glossary of terms to aid in this internally (Appendix A), developed a dynamic / living definition of resilience and adaptation (Appendix B) but still found new terms needing definition and discussion (e.g., "climate-ready fisheries"). Ultimately this results in a better collective understanding if time and resources are dedicated to the development of shared common terminology; developing a process and terms of reference for this topic would be useful in future efforts.

The Climate Scenarios Workshop (CSW) grew out of a CCTF envisioned public series of workshops that ultimately were rolled into the broader (than EBS) Alaska CSW. The CCTF framing provided support for the CSW and some of the recommendations identified above do connect to the recommendations that arose out of the larger workshop. However, the CCTF had originally envisioned multiple distributed workshops to help facilitate diverse perspectives in identifying solutions to climate impacts. Additional workshops may therefore be needed to help continue to identify needs and solutions, ideally those workshops could take different forms, like a mix of large format CSW type events and smaller targeted round-tables (in different regions to allow for broad participation). These could help support the Council in a multi-year scenario planning process.

The CCTF discussed that things worked best when communication was clear and transparent and supported by visuals - building on the idea that more synthesis of the climate information as it comes to

the process could be achieved through infographics, interactive graphics, webstories, interviews, story maps and other effective communication tools.

Finally, the CCTF feels that the work initiated through this task force is just beginning and the CCTF hopes that future groups pick up and expand on where this task force leaves off. Climate change is expected to continue to alter Alaska marine systems and the people who depend on them for life and livelihoods. Yet there is immense information, knowledge, and wisdom in the system that can help shape a future of sustainable fisheries, vibrant marine ecosystems, and resilient and thriving communities. It is imperative that collaboration, cooperation, consultation, and coproduction of solutions and responses in climate change planning continues through the Council process. Doing so will facilitate inclusive solutions to climate change challenges facing the Bering Sea.

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Appendix A: Acronyms

ABC: Acceptable Biological Catch
ACEPO: Annual Community Engagement and Participation Overview
ACLIM: Alaska Climate Integrated Modeling Project
AFSC: Alaska Fisheries Science Center
BSFEP: Bering Sea Fishery Ecosystem Plan
BSFRF: Bering Sea Fisheries Research Foundation
CARE (Principles): Collective benefits, Authority to control, Responsibility, and Ethics
CCTF: BSFEP Climate Change Taskforce
CEC: Community Engagement Committee
CEFI: Climate, Ecosystems and Fisheries Initiative
CRS: CCTF Climate Readiness Synthesis
CSW: Climate Scenarios Workshop (June 2024, Kodiak)
ESP: Ecological and Socioeconomic Profile
ESR: Ecosystem Status Reports
FAIR (Principles): Findability, Accessibility, Interoperability, and Reuse
HABs: Harmful Algal Blooms
HCRs: Harvest Control Rules
MHW: Marine Heat Wave
MREP: Marine Resource Education Program
NCA5: Fifth National Climate Assessment
NOAA: National Oceanic and Atmospheric Administration
NMFS: National Marine Fisheries Service (a.k.a. NOAA Fisheries)
NPFMC: North Pacific Fishery Management Council
NRC: National Resource Council
OFL: Overfishing Limit
SSC: Science and Statistical Committee
TAC: Total Allowable Catch
UAF: University of Alaska Fairbanks

Appendix B: Definitions of Adaptation and Resilience

The CCTF utilized the following definitions as a starting point for its work in the Climate Ready Synthesis:

Adaptation

The IPCC defines adaptation as "the process of adjustment to actual or expected climate change and its effects" (IPCC 2014, p. 5). In the context of Bering Sea fisheries, adaptation to support climate resilient social-ecological systems includes ecosystem-based management policies that embrace uncertainty, adjust at a rate that is consistent with observed changes (e.g., allows communities and fisheries to adapt in a proactive rather than a solely reactive manner), are inclusive of diverse knowledge sources and information that may change and evolve over time, and consider both direct and indirect impacts and interactions with other species, sectors, and stakeholders and the environment. The latter relies on understanding and considering biological trajectories of change as well as the social, cultural and economic implications and scope of adaptation in the intricately coupled social-ecological Bering Sea ecosystem. Co-production of knowledge is essential for understanding changes as well as identifying, understanding and promoting pathways of adaptation in both fisheries and fishing communities. Some social and ecological changes could help promote adaptation, but others might intensify negative impacts of climate-driven change. Adaptation can include reactive responses as well as proactive, anticipatory planning and prevention. Adaptation is separate from, but can be synergistic with (i.e., have co-benefits for), "carbon mitigation" measures, which are actions at global or regional scales that aim to reduce or recapture atmospheric CO2. Climate adaptation planning is a multi-step and iterative process that includes evaluation of key risks and needs, assessment of available potential tools and approaches, understanding of institutional capacity and feasibility for adaptation planning and implementation (and evolving limits and constraints to adaptation), and interactive inclusive discussions regarding realized costs, trade offs, and benefits of adaptation measures (Meredith et al. 2019). This evolving definition will serve as the basis for ongoing climate-biological-social-economic evaluations of management actions that address climate-driven impacts, utilize novel opportunities, and identify and promote equitable adaptive pathways.

Resilience

Community resilience has numerous interconnected aspects, including the epistemic (e.g. access to information, rich involvement in scientific-management-policy activities, etc.), the individual (e.g. mental and physical health), and the sociocultural (e.g. social cohesion, self-determination, integration of community with natural resources, thriving intergenerational relationships, community sustainability and vibrancy, food security, economic diversity, adaptability to change, etc.). The biological resilience of marine resources likewise spans a wide array of considerations including genetic diversity, healthy habitats and populations, adequate resources, sustained recruitment, and a balanced trophic structure. Finally, resilience must be considered at the nexus of these two domains, i.e. coupled social-ecological systems. This includes, for example: sustained strong connections between harvest species and humans and communities that rely on them; management that is capable of being adaptive and flexible while also sustaining ecosystems and livelihoods; strengthened resource management through co-management, community engagement, and co-production of knowledge; alignment of knowledge, management, and

policy to challenges of variability and unpredictability; and strong information-based decision making that includes diverse knowledge sources and perspectives in order to ensure inclusive and just assessment of risks, impacts and tradeoffs.

Appendix C: Climate Ready Synthesis Executive summary

Climate Readiness Synthesis Climate change has already had large impacts on the Bering Sea fisheries and ecosystem and impacts are expected to increase over the next decade, with largest changes and risks associated with warmest future scenarios (i.e., higher carbon emission scenarios) (IPCC 2022). Recent national and regional strategic evaluations have identified the immediate need for climate integrated management advice and information (Peterson et al. 2021) and recent United States Government Accountability Office report to congressional committees (GAO-22-105132) identified two priority recommendations to (1) "publicly disseminate information on actions taken by the Regional Fishery Management Councils and NMFS' Atlantic Highly Migratory Species Division to enhance the climate resilience of federal fisheries" and (2) "identify and prioritize opportunities to enhance the climate resilience of federal fisheries… and develop a plan to implement them." This Climate Ready Synthesis helps advance these national and regional recommendations.

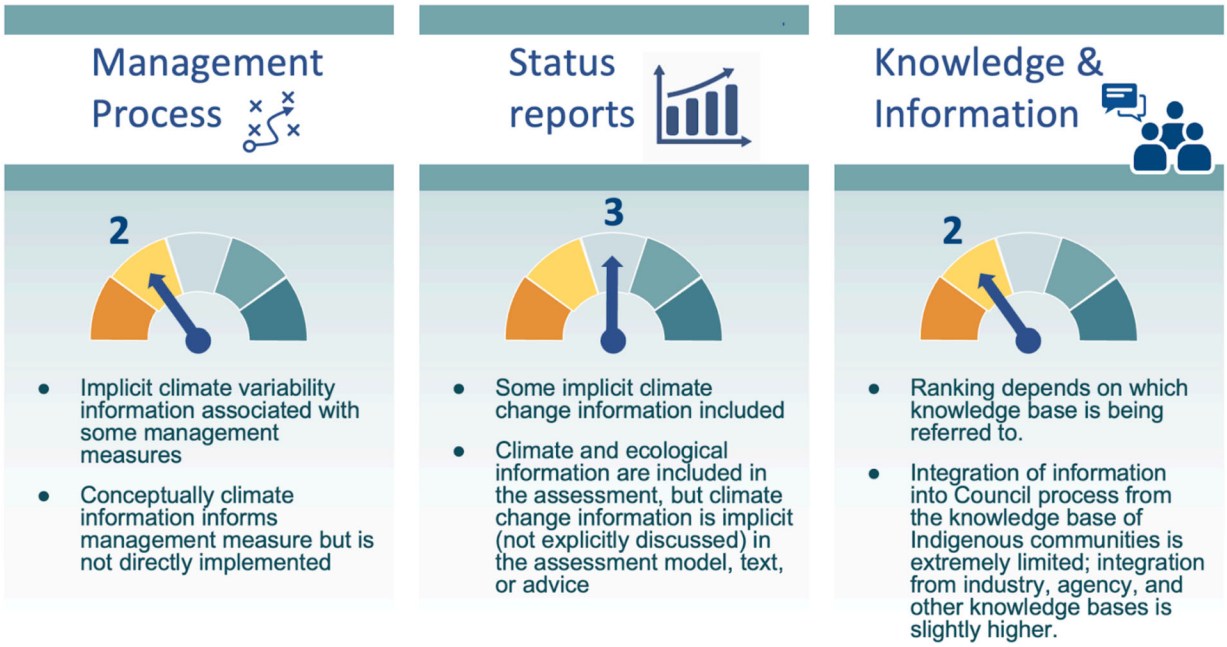

Figure D.1. Summary of the 2022 status of climate readiness for each focal section of the Climate Ready Synthesis (low = 1, high = 5).

The Climate Change Taskforce (CCTF) has compiled this climate readiness synthesis as a starting point for the North Pacific Fishery Management Council (Council) in ascertaining how "climate ready" the current12 management system is overall and to assist in augmenting existing management for improved climate resilience. This synthesis aims to understand the current state of "climate readiness', meaning whether management tools, assessments, and information on-ramps are designed to address and consider long-term climate change and the unprecedented conditions and unique challenges that it presents (in contrast to addressing natural climate variability). Importantly, this synthesis does not evaluate management effectiveness. Management measures and policies that are not designed to specifically address climate change can still be effective at managing resources in a changing climate, especially those that are designed to be robust to natural climate variability. However, climate change, the long-term trends, shifts in underlying ecological conditions, and especially the impacts of increasingly extreme

conditions do pose a novel and large risk that may require approaches specifically designed to address this unique challenge. The first step in understanding what needs to be evaluated and developed to support climate ready advice and decision making is to identify the current state of climate readiness.

As such, this synthesis is organized into three sections. Section 1 provides a management overview of the current system highlighting management measures comprising the Bering Sea system and to what extent they may or may not address climate change. Section 2 provides a review of information—including climate-related information–currently included in the stock assessment and fishery evaluation (SAFE) reports, which describe the past, present, and near future status (1-4 years) of Bering Sea fishery resources on a stock-by-stock basis as well as the role of the target species in the broader social-ecological system. Section 3 focuses on the various knowledge bases which support climate readiness and adaptation measures. Each section includes a table for ranking the various components included in that section. An overall ranking of the entire synthesis is also provided. These rankings represent expert opinion based categorical characterization of the readiness level to provide relative context for current and future climate informed advice and adaptation measures. Additional information regarding the rationale for the overall scores provided in the table below are included in the individual sections. Each overall score represents an average over the component scores when viewing each aspect separately. These scores are to be viewed in a relative context and are not a measure of effectiveness.

Full report is available at:

Stram, D and K. Holsman, B Raymond-Yakoubian , L Divine , M LeVine , S Goodman, J Sterling , J Gasper , S Martell , T Loomis. North Pacific Fisheries Management Council Climate Readiness Synthesis 2022.
https://www.npfmc.org/wp-content/PDFdocuments/Publications/Misc/ClimateReadinessSynthesis2022.pdf