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[1] NMFS, West Coast Region, [2] Pacific Fishery Management Council, [3] Oregon Department of Fish and Wildlife, [4] The Nature Conservancy, [5] Ocean Outcomes, [6] Northwest Indian Fisheries Commission, [7] Washington Department of Fish and Wildlife, [8] Ocean Conservancy, [9] NMFS, Northwest Fisheries Science Center, [10] Scenario Insight, [11] NMFS Southwest Fisheries Science Center, [12] California Department of Fish and Wildlife

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U.S. Department of Commerce, Gina M. Raimondo, Secretary

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Janet L. Coit, Assistant Administrator for Fisheries

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Executive Summary

Scenario planning is a facilitated strategic thinking and planning process developed to help decision-makers explore alternate potential future states and consider the range of decisions that may arise in preparing for the future. Since 2017, the U.S. Department of Commerce's National Oceanic and Atmospheric Association's National Marine Fisheries Service has used scenario planning to explore future natural resource management challenges associated with the potential effects of climate change on managed species (Borggaard et al. 2019), following examples from other U.S. natural resource management processes (NPS 2013, Rowland et al. 2014) and the private sector (Varum and Melo 2010).

The Pacific Fishery Management Council's (PFMC's) scenario planning exercise grew out of work under its Fishery Ecosystem Plan, which provides regular opportunities for the PMFC to explore management challenges that cross multiple fisheries through ecosystem initiatives (PFMC 2013, PFMC 2022a). For the PFMC, scenario planning helped create a shared understanding of the future challenges climate change may bring to West Coast fish stocks and fisheries among fisheries managers and stakeholders. Through its scenario planning process, the PFMC explored uncertainty in future biophysical and societal conditions in order to prepare for mitigating and adaptating to a range of possible futures under climate change.

Over 2018-2021, the PFMC sponsored workshops to educate itself and the public about the potential effects of climate change on its fish stocks and fisheries, learned about and engaged in the scenario planning process described in this report, and emerged with new ideas for addressing the challenges associated with fisheries management under climate change. While the PFMC's scenario planning process could not individually address each of the 100+ PFMC-managed species, it did cover multiple example fish species and stocks from each of the four PFMC fishery management plans. The level of species and fisheries detail in this particular scenario planning process, and the opening of the process to broad participation created both more complexity for organizers and participants, and a greater sense of realism and process buy-in for participants. As noted by participants at one workshop, "We need to turn a scary situation into a positive product at the end…We need to think of things we can do to make fisheries better under any scenario, and things we can do to move us away from the worst scenario."

This technical memorandum summarizes the scenario planning process for U.S. Pacific Coast federal fisheries undertaken by the PFMC and the National Marine Fisheries Service, with additional support from The Nature Conservancy, the first entities in the nation to use scenario planning to explore the strategies for adapting fisheries management to climate variability and change for a suite of managed fish stocks and fisheries.

Introduction

Scenario planning is a facilitated strategic thinking and planning process developed to help decision-makers explore alternate potential future states and consider the range of decisions that may arise in preparing for the future. Scenario planning has been used in military and private sector applications for decades (Varum and Melo 2010), was used more recently in U.S. natural resource management (NPS 2013, Rowland et al. 2014), and is a prominent feature of global climate change research and preparation (Moss et al. 2010, O'Neill et al. 2017). Because it creates shared understanding among stakeholders and can help reveal blind spots, scenario planning is a valuable approach for exploring uncertainty in future biophysical and societal conditions in order to prepare for mitigating and adapting to a range of possible futures under climate change.

Since 2017, the U.S. Department of Commerce's National Oceanic and Atmospheric Association's (NOAA's) National Marine Fisheries Service (NMFS) has used scenario planning to explore future natural resource management challenges associated with the potential effects of climate change on species listed and managed under the Endangered Species Act (ESA, Borggaard et al. 2019). NMFS's use of scenario planning to explore potential impacts of climate change on the protected species Atlantic salmon (*Salmo salar*, Borggaard et al. 2019) and North Atlantic right whale (*Eubalaena glacialis*, Borggaard et al. 2020), inspired fisheries managers to consider whether scenario planning for climate change might also be useful for species managed under the Magnuson-Stevens Fishery Conservation and Management Act (MSA, Frens and Morrison 2020). This technical memorandum summarizes the scenario planning process for U.S. Pacific Coast federal fisheries undertaken by the PFMC and NMFS, with additional support from The Nature Conservancy (TNC), the first entities in the nation to use scenario planning to explore the strategies for adapting fisheries management to climate variability and change for a suite of managed fish stocks and fisheries.

The PFMC's scenario planning exercise grew out of work under its Fishery Ecosystem Plan (FEP), which provides regular opportunities for the PFMC to explore management challenges that cross multiple fisheries through ecosystem initiatives (PFMC 2013, PFMC 2022a). Ecosystem initiatives are multi-species or multi-fisheries science and policy processes to help coordinate actions across fishery management plans and to improve understanding and management of the California Current Ecosystem (CCE). Scenario planning was part of the PFMC's third ecosystem initiative, the Climate and Communities Initiative, which sought to better understand the potential impacts of climate change on West Coast fish stocks and fishing communities. While an FEP is not necessary to support a scenario planning process within a fishery management council, the Pacific Coast FEP provides the PFMC a ready framework for considering management challenges across multiple species, fisheries, management plans, and jurisdictions. Notably, the PFMC's work developing the FEP with NMFS, western states' natural resource agencies, tribes, and the public ensured that PFMC process participants were already relatively well educated

about CCE biophysical processes and their effects on fish stocks, fisheries, and fishing communities.

In addition to the FEP, NMFS's annual ecosystem status report for the CCE (e.g., Harvey et al. 2022) has significantly improved PFMC and public understanding of ecosystem interactions within the CCE. Among its benefits to the PFMC process, the ecosystem status report has helped the PFMC and public witness and understand climate variability, climate anomalies, and some of the physical and biological effects of those shifts in our ecosystems. Many of the government agencies and organizations collaborating with the PFMC process have done their own deep work on preparing for the effects of climate change on fish stocks and fisheries (NWIFC 2016, Chavez et al. 2017), which has created a larger awareness of the urgency of thinking about and planning for climate change now.

The PFMC began the scenario planning process in May 2019, following initial scientific and management background work conducted in 2018 and early 2019, as detailed below in the Methods section. Ultimately, the work associated with this effort supported the PFMC's goal for its Climate and Communities Initiative to "consider, develop, and implement strategies for improving the flexibility and responsiveness of management actions to near-term climate shift and long-term climate change, and strategies for increasing the resiliency of managed stocks and fisheries to those changes. This approach should better support West Coast fishing communities that depend on marine fishery resources" (PFMC 2018). The PFMC concluded the Climate and Communities Initiative in September 2021 with a suite of recommended actions and further questions for study and discussion (PFMC 2021). In 2023 and beyond, the PFMC will consider those recommendations as projects under one or more of its fishery management plans (FMPs) or as future ecosystem initiatives.

Climate and Communities Initiative: "consider, develop, and implement strategies for improving the flexibility and responsiveness of management actions to near-term climate shift and long-term climate change, and strategies for increasing the resiliency of managed stocks and fisheries to those changes…"

Overview of PFMC Responsibilities in the California Current Ecosystem

U.S. marine fisheries within the nation's Exclusive Economic Zone (EEZ, 3-200 nm offshore) are managed under the advice of eight Regional Fishery Management Councils (Councils), established and authorized by the MSA [16 U.S.C. §1801, et seq]. Councils develop FMPs and provide advice on associated federal regulations, which are reviewed and implemented by NMFS. Councils are unusual quasi-governmental bodies in American policymaking, composed of private citizen-stakeholders and state, tribal, and federal government officials. Council meetings are open to the public, encouraging public input on council deliberations and decisions. The MSA grants the Councils and NOAA jurisdiction over fish harvest within the EEZ, with the term "fish" broadly defined as: "finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds" [16 U.S.C.§1802]. Thus, while NMFS and the Councils have authority over fisheries and a wide variety of living marine resources, a complex suite of additional laws govern other human activities and the effects of those activities on the ocean's physical environment (deReynier 2014).

Ocean waters off the U.S. West Coast lie within the CCE, a dynamic, biodiverse eastern boundary current ecosystem of the North Pacific Ocean. Spanning nearly 3,000 km from southern British Columbia, Canada to Baja California, Mexico, the CCE encompasses the United States EEZ, the coastal land-sea interface, and adjacent terrestrial watersheds along the U.S. West Coast (PFMC 2022a). The CCE experiences strong coastal upwelling and is characterized by fluctuations in physical conditions and productivity. However, recent and surprising climate anomalies like the 2014-2016 marine heatwave have raised new concerns for fisheries scientists, managers, and the public (Jacox et al. 2018a, Jacox et al. 2020). Although the PFMC, participating agencies, and the West Coast fishing industry successfully collaborated to rebuild multiple overfished rockfish stocks, West Coast salmonid stocks and fisheries have been subject to a variety of climate-related disasters in recent years (Bellquist et al. 2021).

The PFMC has authority over fisheries in Federal waters of the Pacific Ocean seaward of the states of California, Oregon, Washington, and Idaho [16 U.S.C. 1852]. PFMC fisheries are managed under the following four FMPs:

- Coastal pelagic species (CPS), which includes Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicas*), market squid (*Doryteuthis opalescens*), northern anchovy (*Engraulis mordax*, two subpopulations), jack mackerel (*Trachurus symmetricus*), and krill or Euphausiids.
- Groundfish, which includes over 90 species of primarily benthic flatfish, roundfish, rockfish (Sebastes spp.) and smaller sharks and rays.
- Highly migratory species (HMS), which includes tunas, billfish, swordfish (*Xiphias gladius*), pelagic sharks, and dolphinfish (*Coryphaena hippurus*).
- Salmon, which includes Chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), and pink salmon (*O. gorbuscha*).

Photo: U.S. West Coast from space, NASA/Goddard Space Flight

The PFMC also serves as a forum to coordinate federal and state management of fisheries for species that range between state and federal waters. Western tribes with treaty reserved fishing rights co-manage a variety of anadromous and marine finfish and invertebrate species, and participate in the PFMC process to harmonize management processes and fishing seasons between tribal and non-tribal fisheries. Major West Coast nearshore fisheries managed by the states, tribes, or both together, primarily target high-value invertebrates such as Dungeness crab (*Metacarcinus magister*) and pink shrimp (*Pandalus jordani*).

The PFMC's scenario planning exercise addressed West Coast fishing communities and the fish stocks and fisheries managed under the four FMPs as well as other fisheries managed by the States but important to those same fishing communities. TNC facilitated a follow up scenario planning process for management of Oregon's Dungeness crab fisheries using a modified set of scenarios based on those developed through the PFMC's scenario planning exercise (Star and Kirchner 2021).

The PFMC's experience managing fisheries for a diverse combination of long- and short-lived species led to concerns about how the balance of species within the ecosystem might be affected by increasing climate variability and by long-term climate change. To better understand and prepare for future management challenges, the PFMC developed its Climate and Communities Initiative to feature a scenario planning exercise around the potential effects of climate change by 2040 on managed fish stocks and fisheries. This scenario planning process was made more complex by the PFMC's management authority for more than 100 species and its need to comply with the MSA's requirements for an open and public process. However, scenario planning is a fairly adaptable process and large-scale, cooperative strategic planning is a hallmark of the regional fishery management council processes nationwide (Latanich and Gordon 2018, Levin et al. 2018).

Advance Planning and Education

NMFS's Atlantic salmon and North Atlantic right whale scenario planning processes were not public processes and had a limited number of participants (~30 apiece). Holding scenario planning within a fishery management council process and as part of an ecosystem initiative meant that the process would be public [16 U.S.C. 1852(i)(2)] and that the PFMC could have hundreds of potential interested scenario planning participants. Therefore, the PFMC began its Climate and Communities Initiative with a public education process to ensure that participants would have some initial answers to their questions around the potential effects of climate variability and change on fish stocks and fisheries. From January through March 2018, the PFMC hosted four public webinars[1] featuring the work of NMFS scientists that explored:

1. Projected changes in the physical environment under climate change and their potential effects on biological systems and associated fisheries management challenges (Jacox, Mantua, and Bograd 2018).

2. The state of the art for ecological forecasting and understanding the skill of short-, medium-, and long-term models in predicting the effects of climate change (Kaplan, Trainer, Jacox, and Siedlecki 2018).

3. Projected change in the distribution of managed and protected species of the CCE (Hazen, Shelton, and Ward 2018). And,

4. The potential West Coast fishery participation and economic impacts responses to climate variability and change (Holland, Leonard, and Richerson 2018).

The educational webinars provided the initial scientific background for the Climate and Communities Initiative and for TNC to sponsor a May 2018 workshop in support of the initiative

[1] https://www.pcouncil.org/actions/climate-and-communities-initiative/#cci_webinar

(TNC 2018). These discussions revealed that more climate focused modeling and data based studies of the CCE and its fisheries were already planned or even underway (e.g., the Future Seas project[2]), but that the results would be at least a few years away. The PFMC identified scenario planning as an option to start considering the same type of questions of fisheries and climate change in a qualitative manner.

Following the workshop and additional PFMC discussion of the need to consider the impact of climate change more broadly and potential for the use of scenario planning as a process, the PFMC formed an ad hoc Climate Scenarios Investigation Workgroup (CSI) in September 2018. The CSI was charged with providing framing and guidance for the PFMC's Ecosystem Work Group (EWG) to:

- In consultation with the PFMC's management/technical teams (MTs) and advisory bodies (ABs), compiling proposed scenarios for Council consideration; and,
- Develop a more detailed description of activities that would occur under a scenario planning exercise, and a process and timeline for completion.

The CSI provided final recommendations to the PFMC in November 2018.[3] These recommendations included an overview of scenario planning processes, key definitions, and recommendations on the scale and potential topics to be covered in a scenario planning process. Importantly, the CSI recommended that the timeframe to consider should not be focused on short-term, interannual variations, nor look so far into the future as to be unusable. The CSI suggested a medium-term, 15-20 year window for describing future potential shifts in the physical, biological, social, and economic environments.

The 2018 workshop, in combination with the success of the 2017-18 Atlantic salmon scenario planning workshop, and recommendations from the CSI, led the PFMC to shift its work under the Climate and Communities Initiative to a scenario planning process in late 2018. In early 2019, the PFMC collected additional fisheries management background information in support of the scenario planning process by holding planning meetings with technical and policy advisors from each of its four fishery management plans

Advance Planning:

- **Educate potential participants and engage interested public**
- **Understand the process**
- **Agree on background and key term definitions**
- **Define scale and topics**
- **Set a timeframe for process**

[2] https://future-seas.com/

[3] https://www.pcouncil.org/documents/2018/11/agenda-item-h-1-a-supplemental-csi-report-1.pdf/

(coastal pelagic species, groundfish, highly migratory species, and salmon) to discuss:

1. How can existing policies in each FMP address climate change impacts?
2. What FMP tools or management measures would be most useful for adapting to climate induced changes in managed fisheries?
3. What are the most important climate drivers affecting the fish populations under each FMP?
4. If a climate scenario focuses on just one species or stock from each FMP, which should it be? (PFMC 2019 a,[4] b[5])

Preliminary science education and management discussions were essential to launching a successful broad-scale, multi-party scenario planning process intended to be held in public forums and to involve hundreds of participants. Early discussions prepared the PFMC, its many advisory body members, and the public opportunities to think about and compare notes on the potential effects of climate variability and change on species, fisheries, and fishing communities.

Photo: juvenile Chinook salmon, NOAA

[4] https://www.pcouncil.org/documents/2019/02/agenda-item-e-2-a-ewg-report-1.pdf/

[5] https://www.pcouncil.org/documents/2019/03/agenda-item-e-2-a-supplemental-ewg-report-2.pdf/

Methods

We followed the five phases of the scenario planning process described by the National Park Service (NPS 2013) and the Atlantic salmon and North Atlantic right whale scenario planning processes (Borggaard et al. 2019, 2020, Star 2019), adapting them to account for the PFMC's public process and larger number of participants:

Table 1: Outline of the process used for the Pacific Coast Federal Fisheries Scenario Planning exercise

ESTABLISH (Summer 2019)	DISCOVER (Aug-Sept 2019)	CREATE (Oct 2019 – Jan 2020)	DEVELOP (Feb-Aug 2020)	APPLY (Aug 2020-Mar 2021)
Train a core team in scenario planning. Clarify the focus and goals of the investigation (scope & time horizon). Design project structure. Describe a range of key people and perspectives to engage.	Review existing materials on forces driving change. Interview a selection of stakeholders for their perspectives on climate and the future fisheries ecosystem and economy. Hold discussions with PFMC and its advisory odies to gather additional views. Synthesize ideas to identify 'building blocks' for scenarios	Prepare for scenario creation workshop: draft agenda; identify participants, create briefing materials. Hold scenario creation workshop to rough out four scenarios and their potential effects across each of the four FMPs.	Refine, update and clarify first draft scenarios to share with Council and the public. Hold six public webinars, each targeted at different species groups or science/management priorities to get advisory body and public input on improving and enhancing draft scenarios.	Based on input from the *Develop* phase, update scenarios and draft briefing materials for four regional workshops to discuss scenario implications with stakeholders. Hold regional workshops discussing scenario implications for Southern and Northern California, Oregon, and Washington. Report out to the PFMC on findings from regional workshops and implications for coastwide fisheries management under climate shift and change.

Phase 1: Establishing the Process

In March 2019, the PFMC established the Climate and Communities Core Team (CCCT), to provide background coordination for the scenario planning process. The CCCT, composed of government representatives (state, tribal, Federal) and representatives of non-governmental organizations, was asked to: identify funding, facilitation, and advisory support for the scenario planning exercise; refine the topic of the scenario planning process; specify a detailed timeline; and identify participants for the exercise. The PFMC/NMFS contracted facilitator Jonathan Star and he began coordinating the scenario planning process in spring 2019. Following an introductory scenario training session conducted by Mr. Star, the CCCT adapted the process to accommodate the PFMC's annual schedule and broad array of participants.

Purpose and Focal Question

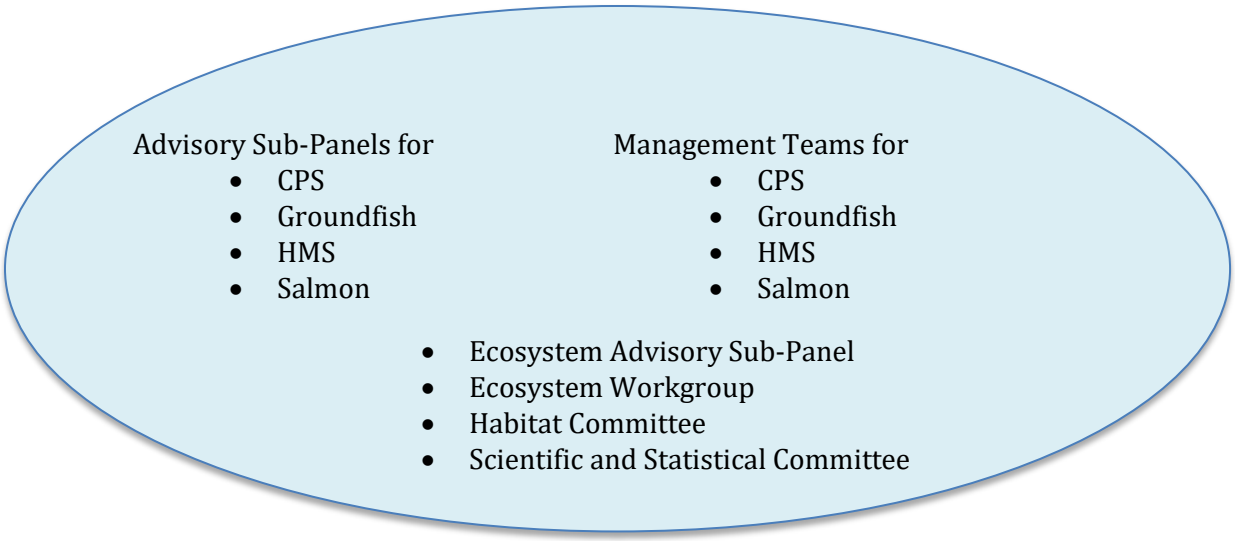
A key step at the beginning of a scenario planning exercise is to identify the focal topic or question for the exercise (NPS 2013). As part of the Climate and Communities Initiative and before the start of the scenario planning exercise, the PFMC had already discussed strategies for improving the flexibility and responsiveness of fisheries management actions to near-term climate shift and long-term climate change, and strategies for increasing the resiliency of managed stocks and fisheries to those changes. Climate change will affect fisheries management in two major ways, by shifting stock distributions and changing stock productivity (Karp et al. 2019). The availability of a particular species to a fishery or fishing community will change if it becomes more or less productive, and hence more or less abundant, if its preferred habitat areas move closer or farther away from the fishing community, or some combination of the two. These combined concerns about fish stock adaptability to climate change, about the potential for marine habitat to shift with climate change, and the effects of those changes on fishing communities, shaped the PFMC's March 2019 discussions of the focal question for the scenario planning exercise.

Using the CSI's recommendation that the scenario planning exercise address the potential effects of climate variability and change in the medium term, 15-20 years out, the PFMC recommended that scenario planning consider ecosystem changes through 2040. The PFMC identified a scenario planning focal topic of: *shifting stock availability (including shifting distribution) across species, FMPs, and communities across the West Coast.*[6] Combining their interest in understanding potential changes through 2040 with the focal topic, the PFMC asked: ***How will West Coast fishing communities be affected by climate-related shifting stock availability and other developments between now and 2040?*** The PFMC intended the scenario planning exercise to result in the definition of tools, products, and processes necessary to react to potential future ecosystem states resulting from climate variability and climate change.

[6] https://www.pcouncil.org/documents/2019/03/march-2019-decision-document.pdf/

Participation

In NMFS's Atlantic salmon and North Atlantic right whale scenario planning processes, participants were selected for their particular science and management expertise and participation was limited to facilitate discussion (Borggaard et al. 2019, 2020). The fishery management council process encourages broad public participation and necessarily includes a large group of knowledgeable experts from the sciences, industry, environmental organizations, educators, and policymakers. Traditionally, the PFMC has created time and space for smaller group discussions by appointing small advisory bodies (~8-20 members apiece) with a variety of expertise in different fish stocks, fisheries types, management programs, and ecosystem functions. To create an immersive scenario planning exercise while accessing the expertise of regular PFMC process participants, the PFMC opened the process to wide participation and lengthened the overall schedule with multiple updates for and contributions from these PFMC advisory bodies:



To engage a large and varying number of participants in this public scenario planning exercise, NMFS and PFMC staff developed numerous background materials, such as multi-species descriptions of potential scenario effects throughout the process.

Phase 2: Discovery

Over June-August 2019, the CCCT and Mr. Star conducted early research and interviews to solicit information on factors worthy of consideration in the scenario planning process and to bound scenario development. The PFMC and its advisory bodies received a briefing on the scenario planning process at the PFMC's September 2019 meeting, and provided input on the driving physical, biological, social, and economic forces that should be considered in drafting and exploring scenarios for the future of West Coast fish stocks, fisheries, and fishing communities

under climate change. Following the September 2019 PFMC meeting, the CCCT refined and re-framed the list of driving forces. Table 2, below, lists the driving forces initially developed in August 2019 and then refined in September-December 2019. Appendix A provides additional background information and details on the driving forces considered in this scenario planning exercise.

Table 2: Driving Forces for PFMC Scenario Planning Exercise

Preliminary Driving Forces (August 2019)	Selected Driving Forces (September 2019)
1. Climate change (including): a. Ocean temperatures b. Nature of range shifts c. Sea-level rise d. Ocean acidification e. Bio-physical shocks (marine heatwave, warm blobs) f. Intensity of storms 2. Global fishing industry developments 3. Trade policy 4. Regulatory / environmental policies 5. Development in coastal communities 6. Economic conditions 7. Global population trends 8. Consumer behavior / appetite for seafood (and its provenance) 9. Food production technology – e.g., synthetically produced proteins 10. Aquaculture 11. Industry structure (integration /fragmentation) 12. Aging of fishing fleet and expertise 13. West coast fishery management policies 14. Fishing community responses and cohesion	1. Ocean warming 2. Ocean acidification 3. Sea-level Rise 4. Hypoxia / Harmful algal blooms (HABs) 5. Range shifts and productivity 6. Ecological surprises 7. Terrestrial climate impacts 8. Marine pollution 9. Alternative ocean uses 10. Aquaculture 11. Societal values 12. Consumer demand 13. Global trade / industry policy 14. Regulation and environmental policy 15. Protected species status 16. Food technology 17. Data and monitoring technology 18. Fishing industry structure 19. Aging of fleet and expertise 20. Coastal community development

Since 2012, NMFS's Northwest and Southwest Fisheries Science Centers have been providing PFMC with reports on the status of physical, biological, social, and economic indicators for and drivers of the CCE.[7] At the request of the PFMC, NMFS produces and presents these ecosystem

[7] https://www.integratedecosystemassessment.noaa.gov/regions/california-current/california-current-reports#ecosystem-status-report-10

status reports on an annual basis at the PFMC's March meetings (e.g. Harvey et al. 2022). Under the second ecosystem initiative of the FEP, conducted in 2015-16, the PFMC held a comprehensive review of the ecosystem status report, working with its advisory bodies and partner agencies to better understand the CCE's drivers (PFMC 2022b). As discussed above, the PFMC also began the Climate and Communities Initiative with educational webinars that addressed CCE drivers. The years that PFMC process participants had spent learning about, assessing, and understanding the CCE's drivers through the ecosystem status report, ensured that the task of choosing driving forces for this scenario planning exercise was relatively swift and collaborative.

The driving forces that emerged from the CCCT's work over October-December 2019 were not significantly different from those summarized for the PFMC in August 2019. However, the period of background research and writing allowed the CCCT to describe and understand concepts that were first discussed in interviews through more research with information from scientific literature. An example important to the PFMC was shifting from the August 2019 colloquial term "bio-physical shocks," which referred to climate anomalies like marine heatwaves, to the term "ecological surprises." The West Coast fishing public and ecologists share a common understanding of "ecological surprises" term, and the CCE has been subject to many such surprises in recent years (King 1995, Paine et al.1998, Doak et al. 2008).

Phase 3: Synthesize and Create Scenarios

Over October-December 2019, the scenario planning process transitioned from Phase 2, *Discover,* to Phase 3, *Create*. The CCCT's work to refine descriptions of driving forces, as shown in Appendix A, helped create a shared and process-wide understanding of those forces, and created a launching point for describing and discussing scenarios. To get Phase 3 underway, the CCCT summarized its background research on ecosystem drivers in briefing materials intended to shape the creation of several plausible yet divergent scenarios of the future of the CCE under climate change.

Phase 3 came together on January 22-23 2020, when the PFMC and TNC hosted a scenario planning workshop with 80+ participants to: explore the drivers for West Coast fish stocks, fisheries, and fishing communities under climate change to 2040; select initial variables to bound the scenarios; and discuss potential details for draft scenarios (PFMC 2020a).[8] On the first day of the workshop, participants used the drivers identified in the Phase 2 to develop a shared understanding of the variety of ecosystem changes that might be plausible by 2040. On the second day of the workshop, participants identified from the drivers the two variables they

[8] https://www.pcouncil.org/documents/2020/02/g-3-attachment-1-developing-climate-change-scenarios-for-the-california-current-ecosystem-workshop-report.pdf/

considered most important for managing CCE fisheries in a changing climate and recommended crafting scenarios around:

- Magnitude of climate variability, meaning that the scenarios to be drafted for this scenario planning exercise would imagine different future CCE conditions as affected by more or less frequent and dramatic climate variability. And,
- Fish stock abundance and availability, meaning greater or lesser amounts of managed species available to CCE fisheries.

Workshop participants also acknowledged that some future ecosystem changes were so likely to occur that it was assumed that those changes would be common across all four scenarios. The trends occurring now and likely to continue on into the future are:

- Increasing global ocean warming, as indicated by changing sea surface temperatures;
- Increasingly acidic ocean waters, which has been particularly notable in the CCE;
- Increasing ocean hypoxia, possibly creating larger and more persistent dead zones;
- Increasing human population, both globally and in the western U.S.;
- Rapidly changing technology that could lead to more targeted fishing techniques and to new human uses of ocean space and new and increasing ocean pollution;
- Continuing difficult economic conditions and global supply chain challenges associated with the pandemic throughout the early 2020s;
- Shifting social values towards prioritizing reducing carbon emissions and sustainable energy technologies; and,
- Management of federal fisheries under MSA processes and principles, which are likely to continue to require sustainable fisheries conservation and management through 2040 and beyond.

Major scenario variables:

- **Magnitude of climate variability**
- **Fish stock abundance and availability**

Future Scenario Matrix

The two major scenario variables—climate variability and fish stock abundance and availability—were used to draft four distinct scenarios of different possible futures for the CCE. Like Borggaard et al. (2019 and 2020), the West Coast workshop participants combined the two variables in a 2X2 matrix to draft four plausible but divergent future scenarios that would

explore ranges of biological and human responses to different potential effects of future climate change.

At the January 2020 workshop, participants used the climate variability and ocean conditions scenario variable to ask: Over the next 20 years, will we see a future where climate and ocean conditions change (e.g., ocean warming, acidification, lower oxygen) in a relatively steady fashion, with a few extreme events OR will we see a future where climate and ocean conditions change along with more frequent and intense extreme events? This question created the first axis for the 2X2 matrix, shown in Figure 1, which posits future conditions of relatively lesser or greater variability in the climate and ocean conditions of the CCE.

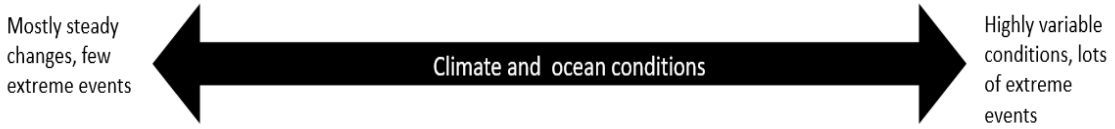


Figure 1: Climate variability axis for Pacific Coast fisheries scenario planning

Workshop participants chose fish stock abundance as the second major variable for an axis on the 2X2 matrix. For this axis, participants asked: Over the next 20 years, do our managed fish species increase in availability and abundance or do they decrease in availability and abundance? Participants recognized that this was both an essential question for the future of fisheries management in the CCE and a fairly simplistic summary about the possible futures of our biological environment. However, combining the fish stock abundance axis with the climate and ocean variability axis seemed appropriate to the CCE, where oceanographic and biological conditions are likely to be highly variable. Figure 2 illustrates the fish stock availability axis.

Figure 2: Fish stock abundance axis for Pacific Coast fisheries scenario planning

After selecting matrix axes, workshop participants broke into four Council FMP-based groups (CPS, HMS, Groundfish, and Salmon) to discuss how these scenarios might play out for each FMP. Participants also considered how market and other social, economic, and political developments might interact and create different future conditions. The matrices shown for each FMP in Figures 3-6 illustrate the interacting axes of climate variability and fish stock abundance, framing combinations of future plausible conditions in the CCE. For example, scenarios imagined for the upper left-hand quadrant would consider a future with relatively low climate variability and increasingly abundant fish stocks.

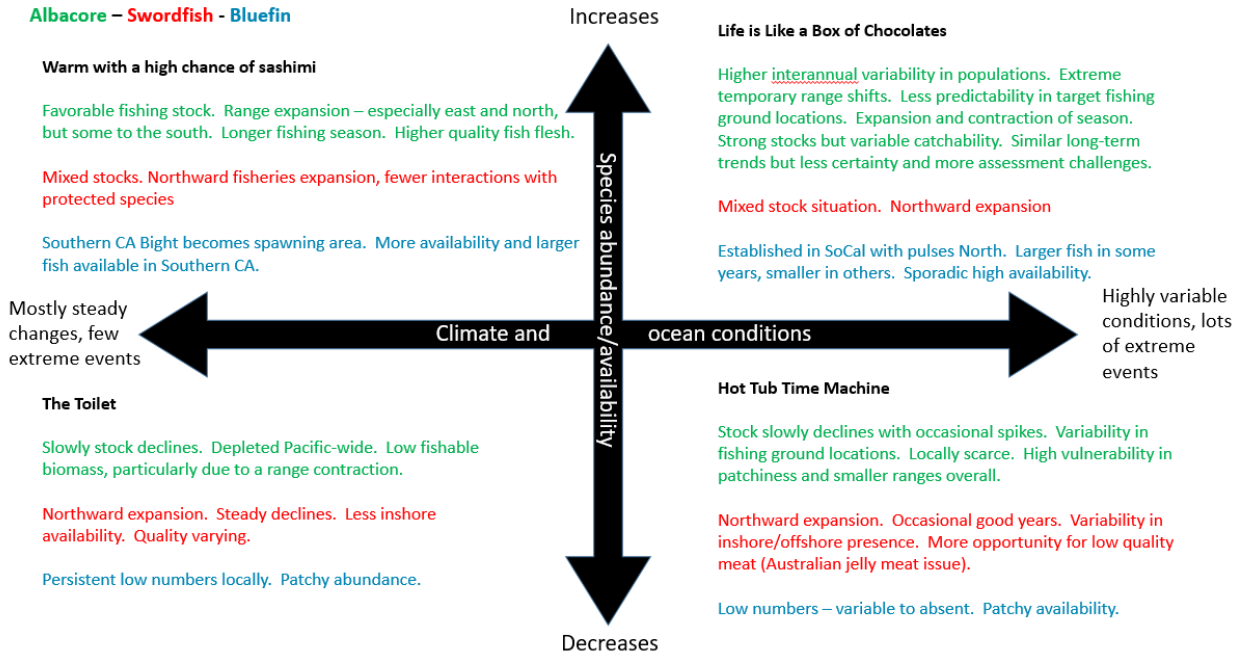


Figure 3: HMS matrix, January 2020

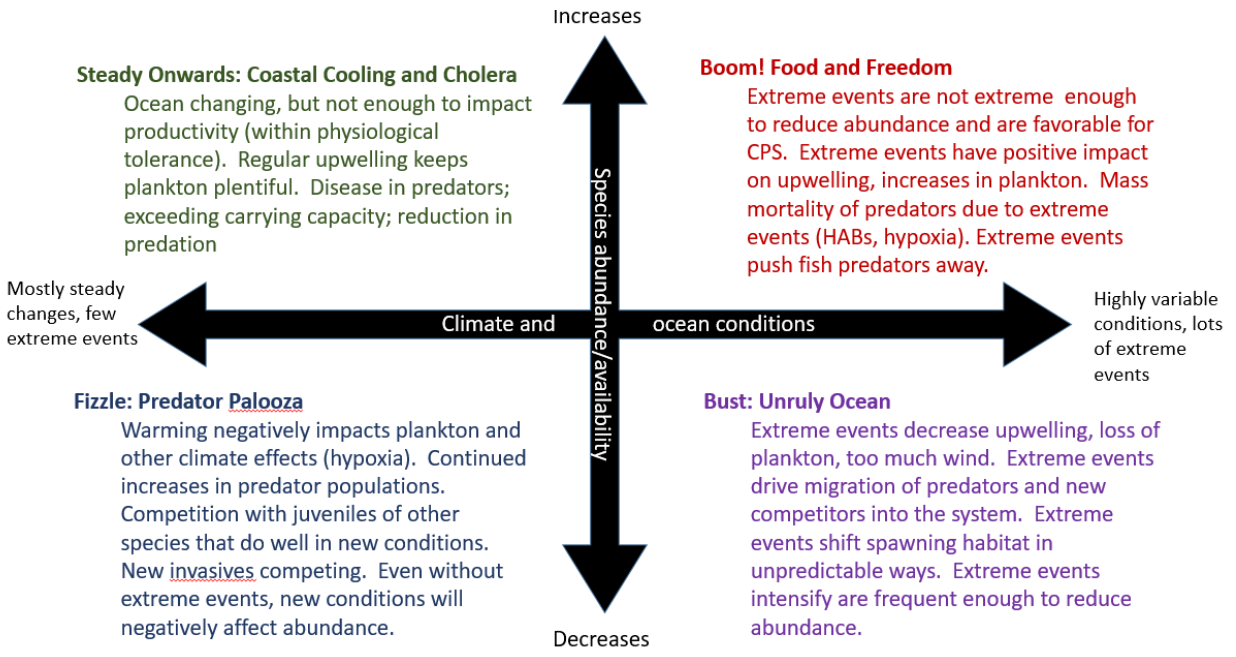


Figure 4: CPS matrix, January 2020

The four draft scenarios used to discuss each FMP were intended to be plausible enough to participants experiencing current climate variability in the CCE and divergent enough to represent a range of concerns around future fisheries management challenges. As shown in

Figure 4, the HMS group considered the potential effects of each scenario for three individual species (albacore, *Thunnus alalunga*, swordfish, and Bluefin tuna, *Thunnus orientalis*).

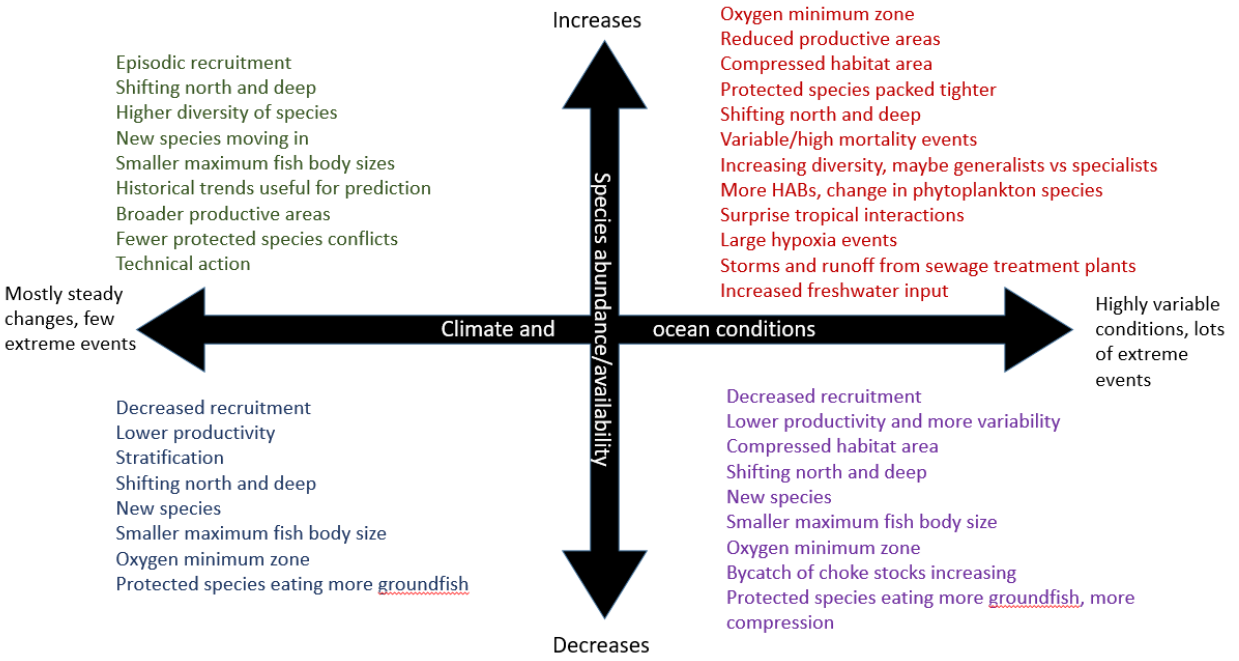
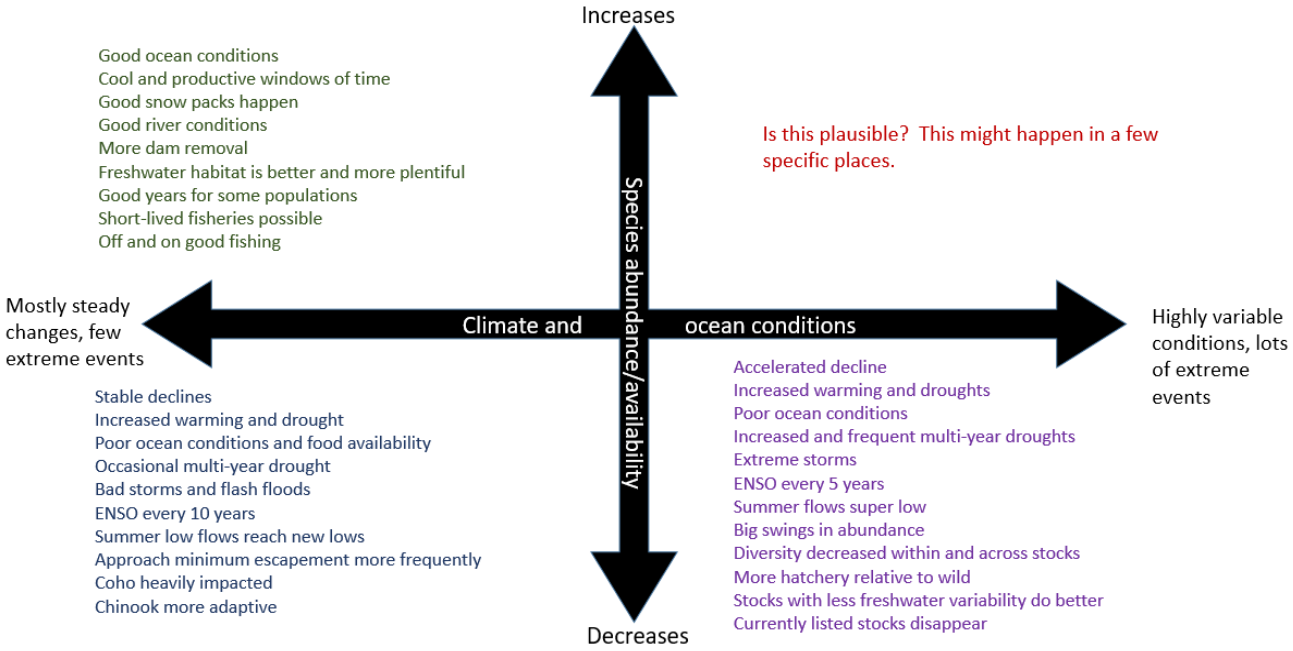


Figure 5: Groundfish matrix, January 2020



Increased management challenges. Shift towards terminal fisheries. Episodic opportunistic fisheries. Huge industrial investment maintains some fisheries. No in-river fisheries for listed stocks.

Figure 6: Salmon matrix, January 2020

The CCE is a highly variable ecosystem and ocean conditions in the 21st century have included climate anomalies like multiple marine heatwaves, dramatic interannual climate variability, and corresponding terrestrial effects like increased wildfires, flooding, and drought throughout the American West. Using the ocean conditions axis, two scenarios assumed greater and more dramatically shifting interannual climate variability and ocean conditions, while the other two scenarios assumed more gently shifting climate and ocean variability. Assuming a CCE with little-to-no climate variability would have been completely implausible for participants, and therefore was not included in discussions. However, this ocean conditions axis was also not formally compared to current ocean model projections (e.g., Pozo Buil et al. 2021).

The second axis, species abundance and availability, created two scenarios with greater species abundance and availability to fishing vessels operating off the U.S. West Coast, and two scenarios where species were both less abundant overall and less available for harvest in U.S. waters. Because the 100+ species the PFMC manages have such varied life histories, participants were interested in seeing the concept of species abundance and availability carefully explored in the scenario descriptions. For example, participants were skeptical that there were any scenarios where terrestrial and river conditions would improve enough for West Coast salmonids to increase in abundance over current levels. Participants were also fairly confident that large-scale ocean warming would likely mean increased availability of HMS to West Coast fishing operations under any of the scenarios. While the scenario descriptions discuss target species' availability to fisheries in general, species-specific examples of plausible future changes helped participants more easily imagine and discuss the potential effects of each scenario. As with the ocean conditions axis, the species abundance and availability axis was not formally compared to existing stock projections (e.g., stock assessments or species distribution models such as Hazen et al. 2013).

To finish the *Create* phase of scenario planning, January 2020 workshop participants created colloquial names for each of the four scenarios intended to describe the broad themes of potential futures with greater or lesser variability in climate and ocean conditions, and with increases or decreases in species availability: Fortune and Favor, Blue Revolution, Hollowed Out, and Box of Chocolates. The workshop closed with discussions of how to improve and provide detail for the scenarios so that they could be more effectively used in conversations with the Council and the public. Reports from that workshop were then immediately prepared as materials for Council consideration at its March 2020 meeting.

Phase 4: Develop

In March 2020, the CCCT reported back to the PFMC on the January 2020 scenario planning workshop (PFMC 2020a). Several PFMC members had participated in the workshop, which helped guide the full PFMC's discussion of the larger scenario planning process. Although the March 2020 PFMC discussion included some uncertainty about how to make the scenario planning process more clearly applicable to the PFMC's future work, PFMC members supported the process and recommended moving on to the *Develop* phase to ensure that the CCCT could return with more fleshed out scenario descriptions. The PFMC asked the CCCT to work with PFMC advisory bodies over the spring and summer to develop and deepen the scenario descriptions (PFMC 2020b). On March 9, 2020, the PFMC meeting ended concurrent with the rise of the COVID-19 pandemic in the U.S. and subsequent limits on meetings, travel, and gatherings. The remainder of this scenario planning exercise was conducted via online webinar meetings.

Scenario Narratives

In spring 2020, the CCCT drafted descriptions for each of the four scenarios. Developing scenario descriptions that participating physical, biological, and social scientists could agree were plausible enough to support future discussion proved challenging. Scientists, fisheries managers, and public participants often engage in the fisheries management process by questioning each others' assumptions and cooperatively exploring new scientific information and potential management responses. Developing plausible scenarios required participants to discuss and understand the physical climate challenges raised by the scenarios and the likely biological responses to those physical climate challenges, to choose the optimal species to focus on in the scenarios, and to speculate on the likely economic, social, and political responses to changes in all of these components of the CCE. For successful scenario development, it was essential for participants to suspend some of their disbelief to discuss the potential effects of those scenarios. One influence of the COVID-19 pandemic was to provide a real example of a completely unanticipated event that dramatically changed the PFMC's work, including this

Scenarios:

- ***Fortune and Favor*** **– low climate variability, increasing fish stock abundance.**
- ***Blue Revolution*** **– low climate variability, decreasing fish stock abundance.**
- ***Hollowed Out*** **– high climate variability, decreasing fish stock abundance.**
- ***Box of Chocolates*** **– high climate variability, increasing fish stock abundance.**

scenario planning process. Descriptions for each of the four scenarios are summarized in Figure 7 and provided in more detail below.

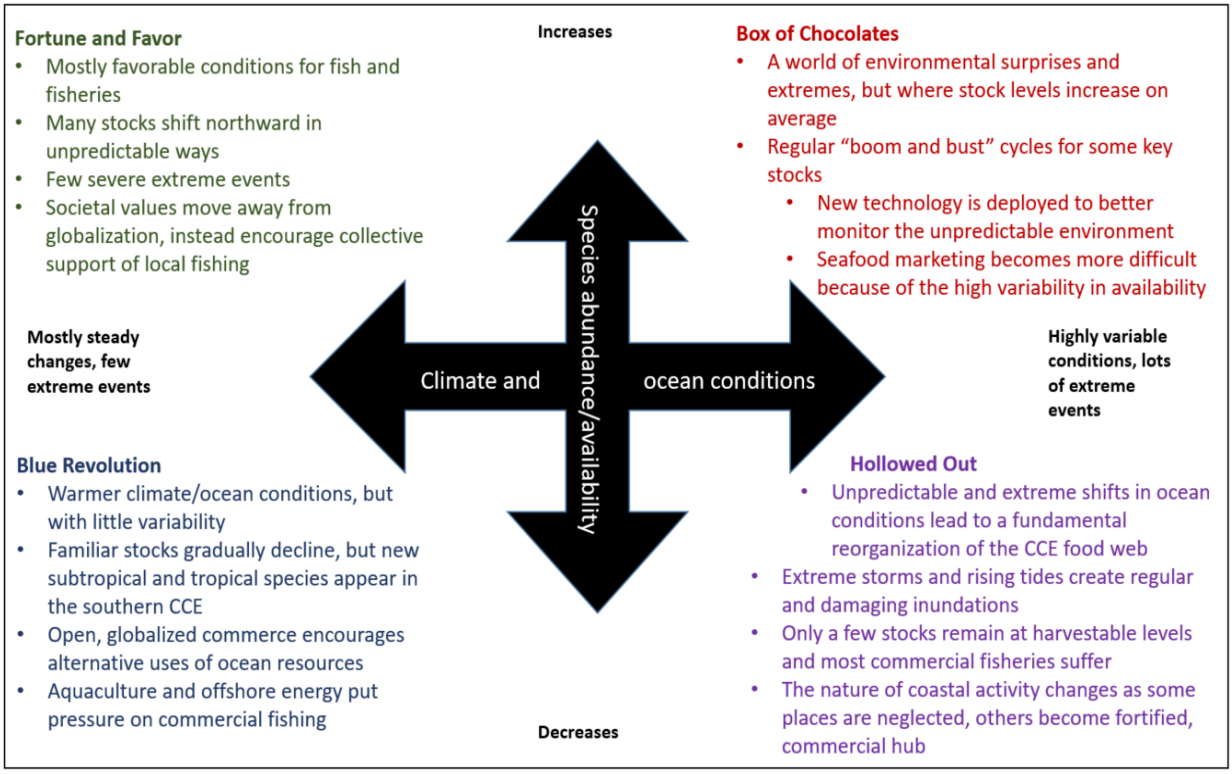


Figure 7: Final four scenario summaries for Pacific Coast federal fisheries scenario planning

1. ***Fortune and Favor*:** The natural environment in this scenario is not radically different from today. Conditions for fish and fisheries in 2040 are comparable to current conditions. The frequency of extreme events (such as marine heatwaves) is little changed from the 2000-2020 period, although high-end temperatures depart from a higher long-term average. Many economically important stocks are about as abundant as they were in 2020 and in some cases they have increased. Although the effects of climate change have been gradual and relatively benign, ocean conditions—and fish stocks—have been far from static. Societal values have turned decisively to favor reducing greenhouse gas emissions, and there is broad support for new collective action through a variety of policies and government interventions.

2. ***Blue Revolution*:** In this scenario, the climate warms but is less variable year to year. Many familiar stocks decline but new subtropical and tropical species appear in the southern CCE. Although new fishing opportunities arise, the growth in alternative ocean uses puts pressure on many commercial fisheries. An open and globalized economy is looking for inexpensive ways to supply protein, and fisheries targeting wild-caught fish struggle to meet those needs. Industry players don't suddenly go bankrupt, but interest in commercial fisheries gradually falls away as

stocks decline and ocean use competition intensifies. Fish are still valued in this scenario, but in different ways.

3. ***Hollowed Out*:** This scenario creates extreme and sometimes insurmountable challenges for the fishing industry. Ocean acidification, deoxygenation, and shifts in decadal oceanographic processes lead to a fundamental reorganization of the CCE food web. Only a few stocks remain at harvestable levels and commercial fisheries suffer—a few firms opportunistically engage in commodity fisheries while small, part-time operations deliver local, boutique products. Extreme storms and rising tides create regular and damaging inundations. Interest in recreational fishing continues on a long-term decline.

4. ***Box of Chocolates*:** This is a scenario of environmental surprises and extremes—but where average year-to-year abundance and availability of exploited species is at or near historical levels. Fishermen see "boom and bust" cycles for some key stocks. Species infrequently seen before on fishing grounds periodically appear in catchable amounts, while other species dwindle. New technology is deployed to better monitor the environment, predict environmental conditions, and exploit resources. Seafood marketing becomes more difficult because of the high variability in availability.

Scenario Deepening and Determining Example Species

To provide participants a deeper understanding of the scenarios, the CCCT chose initial example species from each of the four FMPs to add to the scenario descriptions as illustrations of the potential effects of the scenarios on PFMC-managed fish stocks. The scenario descriptions were vetted in a set of six public webinars, each focused on a different PFMC advisory body:[9] CPS Management Team and Advisory Subpanel, Groundfish Management Team and Advisory Subpanel, HMS Management Team and Advisory Subpanel, Salmon Management Team and Advisory Subpanel, Habitat Committee, and Scientific and Statistical Committee. These webinars were extraordinarily valuable to the CCCT in refining the species and stocks chosen as examples for the scenario planning exercise and in testing the plausibility of how the scenario descriptions addressed both ecosystem-wide issues and the example species and stocks.

For each of the four FMPs, participants recommended example species that varied in their life histories, importance to diverse fisheries, and geographic centers of distribution. Based on the recommendations and after consultation with the PFMC at its June 2020 meeting, the CCCT settled on final example species and stocks for each of the four FMPs shown in Table 3. For all four scenarios, the CCCT drafted narrative descriptions of how the physical, biological, social, and economic conditions of the scenario might specifically affect each of the example stocks from the four FMPs. Although it was time consuming to work through this level of detailed attention to

[9] https://www.pcouncil.org/climate-and-communities-initiative-scenario-deepening-webinar-series-various-dates-may-20-through-june-5/

different species and stocks, doing so reassured scenario planning process participants that the scenarios would plausibly reflect the CCE's highly diverse array of species and fisheries. Working through the challenges associated with different species, stocks and fisheries gave the PFMC's advisory bodies and the public time to discuss and shape the scenario narratives, which significantly improved both the narratives and the willingness of participants to engage in discussion.

Table 3. Fish stocks featured in the Pacific Coast Federal fisheries scenario planning process	
CPS ● Market squid ● Northern anchovy	Groundfish ● Black rockfish (*Sebastes melanops*) ● Canary rockfish (*S. pinniger*) ● Pacific whiting (*Merluccius productus*) ● Sablefish (*Anoplopoma fimbria*)
HMS ● Albacore ● Bluefin tuna ● Swordfish	Salmon ● Central Valley Fall Chinook stock complex ● Southern Oregon/Northern California coastal coho ● Lower Columbia River Fall Chinook

Photo: Market squid, NOAA

Phase 5: Apply – Implications and Options

By September 2020, more complete scenarios were ready to share with the PFMC and the public, with details for each of the featured fish stocks and fisheries to help better imagine West Coast futures under the different scenarios (PFMC 2020c). The goal of the *Apply* phase of the scenario planning process was to generate ideas about what to do to prepare for climate change by 2040 in a way that would be robust to all four future scenarios. To recognize the geographic diversity of the potential effects of the different scenarios on fish stocks and fisheries, the CCCT proposed managing this phase through a series of four geographically-distinct meetings. Planning intentionally diverged from practices in other scenario planning processes, where a single workshop for all participants might be used for scenario application and testing. The geographically-distinct workshops were announced to the public in advance, and each workshop had at least 20-30 invited and drop-in participants. Briefing materials provided before the workshop included both summary and detailed reading materials, plus a short video to tell the stories around each of the four scenarios.[10]

At the webinar workshops, conversations were structured to focus on geographic areas that reflected both the West Coast ecosystem biodiversity and regional governance structures: Southern California, Northern California, Oregon, and Washington. CCCT members participated in and helped facilitate the workshops, with particular attention to the workshops most connected to their own geographic areas. When possible, workshop participants were further divided into break-out groups, based on their represented constituency:

- Communities - including representatives from the communities that rely on fish or fishing as well as environmental non-governmental organizations representing members of the public at large;
- Harvesters - including individuals who fish commercially or recreationally for the species being considered;
- Scientists - including university scientists, researchers, and others with knowledge of the CCE science; and,
- Managers - including representatives of the various Federal, tribal, and state resource management agencies.

The four two-day webinars occurred between mid-December 2020 and early February 2021. For each workshop, participants discussed:

- Regional implications of the four scenarios for the geographic area discussed at the

[10] https://www.pcouncil.org/materials-for-online-workshops-on-the-implications-of-climate-change-in-the-california-current-ecosystem/

workshop, addressing the particular fisheries or communities that might be most affected under the different scenarios;

- Specific challenges and opportunities that each scenario might offer to harvesters, coastal communities, scientists/researchers, and fishery and coastal managers;
- Action ideas to prepare for the future under each scenario for harvesters, coastal communities, scientists/researchers, and fishery and coastal managers; and
- Priority actions that could work across any or all scenarios for harvesters, coastal communities, scientists/researchers, and fishery and coastal managers.

Ultimately, the goal of scenario application and testing at these workshops was to generate the ideas for what the Council and its partners could do to prepare for climate change by 2040, regardless of scenario. For the final set of discussion questions, participants were asked to review the suggested actions for each scenario and discuss:

- Which suggested actions seem to work across all or most scenarios?
- What actions are important to do because they prevent the worst-case situation?
- What actions are important because they would enable a good future?
- What actions help build flexibility to cope with the future?
- What should you stop doing given these scenarios?

Photo: Canary rockfish, NOAA

Workshop participants rapidly understood that this set of questions asked them to think about the same issue from multiple angles, designed to elicit more and different details as they proceeded through the questions. Participants at the Washington workshop aptly summarized the overall goal of the scenario planning process as "We need to turn a scary situation into a positive product at the end. The Hollowed Out scenario is really intimidating, as bad as it may get. We need to think of things we can do to make fisheries better under any scenario, and things we can do to move us away from the worst

scenario." Summary worksheets filled out by the participants are provided in Appendices B through E and are available online.[11] Below and in Appendices B-E are observations and ideas that arose in each of the four geographically-distinct workshops.

Southern California

Participants in the Southern California workshop (December 16-17, 2020) shared ideas on:

- The unusual biodiversity of the Southern California Bight portion of the CCE.
- The need for ongoing and improved communication and work with Mexico's fisheries science and management entities and fishing communities and industry.
- Uncertainty about the potential effects of opening Southern California marine waters to ocean aquaculture.
- The need for improved understanding of the connections between nearshore and offshore ocean environments, including concern for the status of kelp forests and the ecosystem services they provide. And,
- The declining funds available for ocean science to support fisheries management; and, the need within fishing communities and the fishing industry to retain institutional knowledge and access to port facilities that support high volume fisheries, while modernizing and improving wild seafood marketing.
- Workshop participants shared a common understanding that scenario planning could help develop strategies for adapting fish stocks and fisheries to climate change, but that the cause of climate change must also be acknowledged. Participants discussed the need for a global shift to net zero carbon emissions, including carbon sequestration, and they were interested in and curious about how to support that shift in the ocean environment and industries.

Participants agreed that communication and collaboration between scientists, managers, and the public has been essential to successful West Coast fisheries management and will be needed to address challenges under climate change. Participants from the science and research community expressed interest in conducting more cooperative research with the fishing industry, including asking whether fishing vessels might be used more often as data collection platforms, while fishing industry participants separately commented that they were interested in working more closely with scientists to provide fisheries and ocean data that would support fisheries management.

[11] https://www.pcouncil.org/climate-change-scenario-planning-series-of-online-workshops-various-dates-december-2020-through-february-2021/

In addition to improved fisheries science and management relationships with Mexico, workshop participants suggested that ocean use planning off the West Coast could learn from Japan's experience with managing competing seafood uses of ocean space (aquaculture, artisanal fishing, and industrial fishing), Australia's experience with tuna ranching, and Norway's experience with salmon farming.

Detailed notes from the workshop's breakout group answers to the strategic questions listed above are provided online and in Appendix B. Below, responses to the strategic questions and suggestions are summarized by the category of actions recommended by workshop participants.

Photo:Swordfish,, yellowfin tuna, and yellowtail, caught with rod and reel at Santa Catalina Island, Bulletin of Fisheries 1908, NOAA Photo Library

Fisheries Management and Ocean Planning Approaches

- Strengthen international relations around fisheries science and management, especially with Mexico, since climate change will cause managed species to change their geographic distribution, both northward within the CCE and throughout the larger Pacific Basin.

- Anticipate future need for policies that address managing fish stocks that shift across international, national, and state management areas and boundaries. Policies could include geographically mobile access privileges so that fishing privileges for those species can follow species as they change distributions.

- For both offshore ocean planning and development, and for shoreline development to accommodate new and changing ocean uses, ensure broad stakeholder participation to support continued fishing industry involvement in decision making.

- If we're going to pursue aquaculture, how can it be designed so that it better incorporates local fishing businesses? Prioritize native species? Offshore fish ranches?

- Longer term thinking, including modeling for sea level rise, is needed to address port infrastructure challenges. For example, ports may become unusable if storms are more frequent and severe, or inaccessible with sea level rise. Beyond concerns about specific ports, infrastructure needs to be updated coastwide to accommodate range shifts for fish stock and the fishing fleets that target those stocks.

- Where possible, manage to increase fish stock statuses to levels where overfished species management is not needed, and so that we can avoid stock collapse in a highly variable environment.

- Are management programs flexible enough to support fishing businesses interested in broadening their fishing portfolios? Can we design regulations that make it easier for fishermen to work in multiple fisheries while still meeting conservation objectives? Consider permit banking for communities, so that fishing vessels can access different stocks in years when those stocks are more or less available. Could a multi-fishery permit help fishing businesses access different stocks in different years? Creative permit banking and permit leasing might improve flexibility for fishery participants.

PFMC and Associated Fisheries Management Processes

- The PFMC should develop broad foundational goals for management actions, like those in the FEP, so that they are less likely to be pushed from issue to issue through political influence. These goals should be rooted in the MSA and the National Environmental Policy Act (NEPA). In addition to the FEP, the PFMC needs some big picture goals, key priorities at the beginning of each new management cycle, not just "we're doing it again because the calendar has moved forward," but what goals are we trying to meet this time? Take the NEPA Purpose and Need discussions seriously. Consider the potential future state, uncertainty, and risk, when making programmatic analyses.

- Incorporate ecosystem science into management. Improve understanding of ecosystem interactions to more clearly understand where and how species are moving, and to understand how ocean productivity is changing.

- Update and revise the fisheries management framework so that it allows for the use of data during the fishing season and more timely management responses.

- How can management foster an environment for innovative research, including gear

development, and advances in stock assessments? Exempted fishing permits (EFPs) are often used to support gear development and test new fishing methods, but the EFP process is cumbersome and PFMC decision-making associated with EFPs is slow. There should be improvements to the EFP process so that the PFMC doesn't have to sift through so many details.

- PFMC and associated fishery management agencies at every level need to improve permit flexibility, so that fishing businesses have more options in a variable environment.
- How can the Council rethink its own process so that it's more efficient—are there actions that can be taken via short online meetings in between the ponderous five in-person meetings per year, hopefully shortening those in-person meetings? More efficient meetings and a more efficient decision making process are needed, and we can use what we've learned about online meetings during the pandemic to help.
- Government assistance and improved funding is needed for activities that support:
    - Science and management;
    - Proactive management that helps avoid disaster;
    - Upgrades for sensing technology;
    - Bridging financial support for fishing industry when stocks are at low levels;
    - Community and port infrastructure maintenance and upgrades—(funding for dredging); and
    - US Department of Agriculture (USDA) support similar to that for agricultural products. Harvest insurance could prevent total industry decline.
- Allow more species harvest flexibility
    - For example, allow some commercial harvest of recreational only species, but avoid recreational fishermen selling fish (like Pacific bluefin);
    - Newly occurring species: like Wahoo (*Acanthocybium solandri*) or Round herring (*Spratelloides gracilis*);
    - Incidental catch; and
    - Consistency of supply with variable catch (species).
- Finish the Swordfish Management and Monitoring Plan.
- Look for more ways to work with SeaGrant and related groups and leverage relationships to improve communication with coastal communities.

Science

- We need to improve and modernize data collection, management, and distribution to support better and faster-paced decision making. More flexible, rapid-response management can help head off the worst-case scenarios that may emerge with rapidly changing conditions.
- Fishermen need better predictive modeling of interannual fluctuations in species abundance and availability so that they can improve their advanced business planning.
- Managers and scientists need to share knowledge, scientists should write their papers and communicate their findings in ways that reach the general public at levels they can understand.
- Explore data collection collaborations between scientists and fishermen to support science and management.
- New survey and data collection needs are an overarching concern across the four scenarios. Dramatic declines in species' abundance or changes in distribution will negatively affect fisheries, but will also impede traditional data collection. The different scenarios posed different data collection needs, and possibly different strategies for collecting data.
- Need a better understanding of the Southern California Bight forage base and how it may be different from ecological communities north and south of the area.
- More social and economic considerations in decision making, especially in crisis situations. Are there improvements to social and economic science, or to the products delivered by those scientists that can help limit or mitigate disasters?
- We need the science and data to understand baselines and where we're going so we can monitor changes and identify tipping points and manage in real time (as much as possible); include non-standard data, e.g., historical/industry/traditional knowledge.
- Reconcile or replace traditional single-stock approach to assessment with emerging needs for ecosystem-based assessment approach.

Fishing Industry and Fishing Communities

- Involve fishermen in co-management and cooperative research. Leverage fishermen's institutional knowledge to improve fisheries science and management.
- Attract younger and new entrants to the fisheries.
- Market fish and fisheries to the public in a positive light (Seafood Watch program as an example)
    - Communicate what fishery participants are about and fisheries that do great things;

    - Fishermen as conservationists;
    - Product promotion - branding (similar to Marine Stewardship Council but on a local/regional scale); and,
    - How do you beat the public perception that fisheries aren't well managed? (e.g., terminology - overfished vs. depleted).

- Job training for fishermen that would allow them to use their boats for other purposes, particularly in ports that are shifting emphasis away from fishing.
- Work with industry to develop local markets, to reduce dependence on imports and improve domestic food security.
- Outreach to underserved communities. What are food preferences, what is their vision for the future? How can people rethink the species and cuts of fish that we're marketing?

Northern California

At the Northern California workshop (January 13-14, 2021), participants discussed:

- The decline in Northern California fishing fleets and loss of basic maritime infrastructure; recent interest in offshore energy development off Northern California.
- The growth in Northern California's wealthy "foodie" culture and their interest in wild, local seafood, and the growing public interest in pursuing recreational fisheries as a way to interact more with the natural world.
- Learning from the fishing industry's adaptation to the pandemic through local marketing and educating the public about more varied seafood choices; the challenges of minimizing fisheries interactions with protected species in an ecosystem with high climate variability and the need for problem-solving bodies like the Dungeness Crab Task Force.
- The need for developing new technologies for environmental monitoring by fishermen to predict fish movements, for vessel and catch monitoring systems that support real-time fisheries management for swifter decision-making. And,
- The need for agencies to share more of their data with the public and at faster rates than in the past.

While less concerned about interjurisdictional interactions with Mexico's fisheries, Northern California workshop participants recognized that coastwide interjurisdictional issues are all connected and that there will be more fishing pressure in the central coast if fisheries issues shared with Canada and Mexico are not addressed.

Infrastructure needs from a variety of different perspectives were the focus of several discussions at the Northern California workshop. Participants noted that when, a few years ago, stocks of CPS shifted northward, port infrastructure (offloading facilities, roads from isolated ports in Northern California, etc.) was insufficient to allow many local fishing businesses to take advantage of the temporary local CPS abundance. A more variable climate will mean more variable local availability of harvestable species, which will in turn mean that port managers and port facilities will need a longer view so that ports can accommodate periodic influxes of vessels. Workshop participants also discussed the need to update the digital infrastructure underpinning fishing, and fisheries science and management. New technologies are needed to support better and faster monitoring to provide real-time catch and landings reporting, and to reduce management uncertainty for stocks with quotas. Lack of human resources throughout the fisheries and fisheries management system, from fishing vessel crew to data analysts, was also a worry for workshop participants. They wondered who would teach new fishermen about stewardship, how to build a career from deckhand to boat owner, and how to participate in the fishery management process. The 2021 signing of the Young Fishermen's Development Act was seen as a positive affirmation of a continued national commitment to maintaining sustainable wild seafood as part of the Nation's food security.

Workshop discussions about the fisheries management process raised the need for flexibility in management and regulations, infrastructure, and for markets to be better prepared for uncertainty in catch availability and composition. Many participants were concerned that the more drastic scenarios could turn fishery managers into disaster managers, focusing primarily on preparing for disaster relief. Participants were particularly worried about the effects of climate change on salmonid populations, many of which were seen as not recoverable without intense investment of funds and staff in terrestrial and freshwater habitat improvements.

Northern California workshop participants were mindful of ocean use conflicts between the fishing industry and newer non-fishing ocean users, particularly offshore energy and

Photo: Lake Oroville reservoir in drought, California Department of Water Resources

aquaculture. They raised concerns about the need for new ocean use data, the potential effects of offshore wind exploration and installations on fishing grounds under climate change, and the need for better understanding about and taking into account the effects of new industries on historic fishing ports. Although ocean aquaculture was not as extensively discussed as at the Southern California workshop, participants at the Northern California workshop also saw a need for mixed use ocean planning. Finally, the PFMC has already implemented one of the ocean planning recommendations from the Northern California workshop, which was to form a new advisory body to interact with various ocean users beyond fisheries. Workshop participants noted that the PFMC's Habitat Committee was serving multiple roles beyond their habitat science and management charge, including guiding PFMC comments on the effects of non-fishing ocean activities on fisheries. In summer 2021, the PFMC appointed its Marine Planning Committee, an advisory body designed to address the concerns raised at the Northern California scenario planning workshop and beyond.

Detailed notes from the workshop's breakout groups are provided online[12] and in Appendix C. Below, workshop responses and suggestions responding to the strategic questions are summarized not by the group that made the recommendations, but the category of actions recommended by workshop participants.

Fisheries Management and Ocean Planning Approaches

- Multi-jurisdictional management of fisheries, both domestically and internationally, needs attention and planning specifically to address potential fish population shifts from climate change.
- Reconstruction of the West Coast Governors Agreement could address multi-sector use ocean plans and ensure that all stakeholders and managers are part of the process.
- Tourism should be used as a natural partner to preserve fisheries and coastal communities, while agricultural interests can serve as a model for better engaging legislative and other political entities so that they can better understand and support fisheries interests.
- The California Coastal Act includes language to protect fishing critical features, which might help the fishing industry in facing conflicts with other ocean users.

PFMC and Associated Fisheries Management Processes

- The Council should ensure that they create a process to move the actions and ideas that arise from this scenario planning process into their near-future agenda items.

[12] https://www.pcouncil.org/documents/2021/02/northern-california-climate-implications-workshop-completed-worksheets.pdf/

- Flexibility and nimbleness in fisheries, management, and infrastructure:
    - Increase Council flexibility for inseason management processes, including timeliness of responses, and make better use of tools like automatic actions;
    - Investigate whether other fishery management councils have processes or ideas that could make PFMC management more efficient;
    - How can fisheries regulations have more flexibility and nimbleness without being disruptive to existing plans to stabilize fisheries? Need to start thinking about this now before change creates acute problems.
- Investigate the feasibility for community entities or fishermen that hold permits to lease permits for shifting stocks and allow others to take advantage of available opportunities.
- Provide flexible gear options and/or portfolio permits for multiple species, support industry, agency, and academic efforts to explore new gear types that meet conservation goals, and prepare for more requests for experimenting with exempted gear/fishery permits. Streamline the federal EFP process to make the process more efficient.
- Eliminate transferable permits entirely to address asset value inflation - there are historical examples of approaches like this (other basis for obtaining permit such as skill demonstration).
- Look for ways to reduce the barriers between different fisheries to allow cross participation (example of prohibited species regulations that require discarding). May need to have multiple permits on one boat and opportunities to take advantage of ecological surprise, e.g., *de minimis* sardine fishing opportunity.
- For new entrants: small allocation linked to merit based permit allocation. Currently there are high barriers to entry including costs (permits, vessels) and social preference for "white collar" or service sector jobs.
- Reevaluate limited entry programs to ensure they are meeting their initial program goals and whether fishing opportunity has become more geographically concentrated as a result of limited entry programs.

Science

- Gather and share information and data in real-time. Improve technology for doing so (electronic logbooks, data portals - e.g., CENCOOS,[13] gliders, etc.). Data portals (CCE-centric) especially help anticipate changes in advance; this will facilitate a more nimble approach to

[13] https://www.cencoos.org/

assessment to management.

- Use EFPs for collecting new data, testing new gear types.
- Invest in developing environmental monitoring and reporting technology and processes so that fishermen can more easily keep track of stock availability. Fishermen need to know when new stocks become regionally available to them, and fisheries managers need to provide more responsive and flexible inseason management.
- Infusion of funds and people is needed for salmon habitat restoration, coupled with a need for a cultural leadership shift to address salmon issues so that salmon stocks are not suffering death by a thousand cuts.
- Managers need information and analyses on the connectivity of critical habitats for various life stages of prey and predator species, so that they can better understand interactions with fisheries.
- Management could explore ways to include predictions of major shifts and climate anomalies, like marine heatwaves, into management processes.

Fishing Industry and Fishing Communities

- Develop direct market strategies both regionally and at the local level to increase awareness of diverse seafood species. Industry needs to become better organized across sectors to better coordinate on marketing, like in the Alliance for Sustainable Fisheries.[14]
- Ice infrastructure requires large investment and maintenance with a feedback loop with fisheries (no ice, no fishing; no fishing, no ice) and keeping access to this infrastructure.
- Stability is necessary, especially for capital intensive operations (big vessels but even smaller vessels can be very expensive); solution has to be scalable.
- Community-owned permits can be scalable and can maintain stability. How can the fisheries management process facilitate more use of these types of permits?
- Invest in multiple gear types to capitalize on different stocks when they are abundant.
- Infrastructure needs:
    - To facilitate flexibility, make fishing and processing facilities more mobile;
    - Loss of processing infrastructure means less capacity to adapt to different conditions;

[14] https://www.alliancefisheries.org/about

- Cost of living is increasing in coastal communities, so it may mean having centralized processing facilities in inland areas with fish trucked to them; and,
- Fishery management agencies should pay attention to land use policies in the coastal zone so that fishing related infrastructure is preserved.

Oregon

Participants in the Oregon workshop (February 2-3, 2021) discussed similar themes to those covered in the California workshops, but with an understandable additional focus on the challenges of being the middle state between the jurisdictions of California and Washington. Issues covered at the Oregon workshop included:

- Aging port infrastructure, including the need for ice facilities in many ports and how new industries like offshore aquaculture and wind might affect infrastructure.
- Concerns about how the changing distribution of protected species, such as leatherback sea turtles, might present new challenges for fishing vessels needing to avoid bycatch.
- Concerns about increasing populations of protected species, such as California sea lions (*Zalophus californianus*), depleting populations of other protected species, such as salmonids.
- Alternative and supplemental vessel power systems, like sail power, to reduce the use of fossil fuels in the fishing industry.
- Expanding the understanding of the term "climate refugee" to think about how to help fishing people and businesses move to new locations while options are available. And,
- Improving communication across all groups participating in the fisheries, in fisheries science and management, and between fishing communities and legislators at all levels of government.

Seafood marketing was heavily discussed at the Oregon workshop, with participants sharing ideas about how to improve marketing so that fishery businesses could be more flexible under climate variability and change. Participants were interested in better educating the public about seasonal availability of different species of fish, about the benefits of buying frozen seafood, and in developing niche markets with groups of restaurants or direct buyers who understand that species availability will shift with climate change. There was concern that focusing too heavily on domestic markets could challenge profitability for some fisheries and fishery targets, since many U.S. consumers are limited in the species they eat and foreign markets are important to West Coast fishing businesses. Participants were also concerned about whether processors were adaptable enough to handle more highly variable species compositions of catch, or adaptable enough to continue operating through more extreme year-to-year variations in catch availability. Participants wanted to make the public more aware of the seasonality of seafood availability,

helping consumers understand that the same species won't always be in the market throughout the year. Workshop participants expressed pride in the quality of Oregon-caught seafood and in the science and management that supports sustainable Oregon fisheries. Participants also discussed needed improvements to marketing the ocean recreational fishing experience and recognizing the importance of recreational fishing to many ports.

Oregon workshop participants discussed the need for more nimble fisheries science and management programs to ensure an ongoing supply of West Coast seafood and to support fishing communities and the fishing industry. Fishery surveys gather data for long-term data sets that increase understanding of the effects of climate variability and change on managed species, but will surveys need to change in anticipation of climate change? What new data streams are needed to increase nimbleness in the fisheries management process, and how can data improve across ports and fisheries, including recreational fisheries? Oregon participants also recognized recent trends in fishery disaster declarations in response to climate anomalies and suggested developing new insurance vehicles similar to crop insurance for agriculture businesses. Workshop participants expressed interest in community level climate change risk assessments that would assess the likelihood and level of potential risk from climate change against the resiliency of those communities to climate change.

Photo: Trawl net filled with Pacific whiting, NOAA

Oregon workshop participants shared many ideas about needed revisions to the Council's management process. Participants were interested in fishery management regimes that allow fishing vessels more choice in when to operate, so that more fishing can occur during more favorable weather conditions. Many participants were interested in seeing the Council work faster, suggesting that the Council should develop a pre-approved menu of management options that could be implemented rapidly without much Council process or input (e.g., state-level temporary rules or federal automatic actions). In support of actions like these, participants were concerned about the rate at which Council-participating agencies process the data streams that support fisheries science and management.

Another notable theme at the Oregon workshop was strong support for ongoing study of and improvements to fishing gear, fish processing, and fisheries monitoring technologies. Participants were interested in seeing a fisheries engineering program at Oregon State University,[15] or other public academic institutions, to help develop gear innovations. With the need for ongoing gear research, there will be a need for a faster regulatory process for authorizing the use of innovative new gear types. Improving ocean and fisheries monitoring technologies could provide the public with more confidence in understanding current ocean conditions and could speed management decision making in reaction to changing ocean conditions and changing species' abundance and distribution.

Detailed notes from the workshop's breakout groups are provided online[16] and in Appendix D. Below, workshop responses and suggestions responding to the strategic questions are summarized by the category of actions recommended by workshop participants.

Fisheries Management and Ocean Planning Approaches

- We need good maps of benthic habitat, water column, and other habitat aspects to better understand: areas and habitats under climate stress, potential siting for and effects of offshore wind and aquaculture.
- Offshore aquaculture should be developed so that it complements wild fisheries, including:
    - Kelp for carbon capture;
    - Species that can be processed using the same processing plants and infrastructure as wild-caught species; and,
    - Siting to minimize competition with local fisheries, disease outbreaks, and opportunity for non-native species' escape, concentration of aquaculture waste

[15] https://hmsc.oregonstate.edu/iLab

[16] https://www.pcouncil.org/documents/2021/02/oregon-region-climate-implications-workshop-completed-worksheets.pdf/

products, and aggregation of predators like sea lions.

- The ecological impacts of new infrastructure, like offshore wind, will need to be carefully assessed. How will wind turbines impact fishery independent surveys? Is it possible to adjust fisheries surveys to ensure accurate information for stock assessments?

PFMC and Associated Fisheries Management Processes

- Fishery flexibility means different things to different people. The Council needs more flexibility (as defined by the Council) and speed in its management process, while continuing to achieve conservation goals and prevent overfishing. Set up fisheries regulations to have more responsive frameworks, such as if/then statements and triggers to initiate responses (e.g., salmon or halibut inseason management).

- The Council's efforts to raise the catch levels of the most abundant stocks (e.g., Dover sole, *Microstomus pacificus*) that co-occur with more restricted species drag on and use up a lot of Council time for little positive effect.

- Regulations need to be able to shift quickly, similar to the salmon inseason process, so they can address changes in stock availability and distribution in real time.

- We need to make Council meetings more available to more people by continuing with some online meetings. Online meetings with new technologies to enable more stakeholder involvement became the norm during the COVID-19 pandemic, and can help Council advisory bodies complete their work sooner in the decision process.

- The Council process needs mentorship opportunities, like the Marine Resources Education Program, so that new people can join and understand how to participate in the Council process.

- Reduce the amount of time given to individuals and groups in public testimony to save meeting time. In the North Pacific Council process, testimony time limits are 3 minutes for individuals and 6 minutes for groups.

- The whole EFP process should be made simpler, with standards and benchmarks that apply to all FMPs. The Council's EFP process could also be better aligned with the Saltonstall-Kennedy grant process so that the Council clearly explains the types of EFP proposals they would like to see and problems they would like to solve.

Science

- Fisheries managers need more and better scientific information to support management under climate change. Funding and personnel are needed to continue to support:
    - Fish stock surveys;

- Fish biological responses to climate anomalies and variability, and longer-term climate change;
- Diverse sampling strategies that give use time to compare research platforms (sail drones, NOAA ships, fishing vessels); and,
- Collaboration between the different agencies, academia, and industry.

- Some key new questions of interest to scientists:
  - Impacts of the "Blue Revolution" on fisheries - Can scientists learn about potential outcomes and getting ahead of changes from other ecosystems and scientists around the world (e.g., Norway and wind development).
  - Early detection of species' range shifts is a key area of research to help prepare fishing fleets and industry. How do scientists and fishermen know when changes in ocean conditions are causing a dramatic shift in the ecosystem?
  - What are the mechanisms driving ecosystem responses – and the need to get past correlations to develop reliable forecasts.
- We need people who are capable of analyzing, visualizing, and reporting on data. A lot of data streams and large amounts of data will need to be processed. Collaborative work between NOAA scientists and academics can help develop pipelines of data analysts and scientists.
- Can the United Nations' Decade of Ocean Science for Sustainable Development[17] be used to increase focus on fisheries, climate, climate action, clean energy, and the many of the points brought up during the workshop? In the wider public there's not enough visibility on ocean issues.

Fishing Industry and Fishing Communities

- Develop programs that help small vessels and businesses better adapt to changing conditions, including:
  - Identifying barriers to adaptation and finding ways to remove them;
  - Guidance on navigating the regulatory process;
  - Marketing training and opportunities, including developing new direct marketing opportunities focused on small vessels; and,
  - Business development training.

[17] https://www.oceandecade.org/

- To maintain diversity of processors and their capabilities, reserve waterfront public land for fishery infrastructure. State, county, and local authorities will need to be involved, as will entities like chambers of commerce.

Washington

Like participants in the Southern California workshop, the Washington workshop participants (January 20-21, 2021) discussed international boundary issues and shared ideas about managing transboundary stocks. Washington workshop participants understood fisheries off their coast as potentially benefiting from the northward movement of PFMC-managed fish stocks in response to climate change. However, they also viewed their ocean waters as being at the southerly end of a three-part ocean policy system (Alaska, U.S.; British Columbia, Canada; West Coast, U.S.) affecting large, dynamic, and interacting ocean ecosystems.

Washington workshop participants were interested in seeing new science programs developed to better monitor species' range shifts, particularly calling for a long-term ecological research site like the Newport (OR) hydrographic line to be managed from a location on Washington's outer coast, like Westport. More flexible fisheries management was seen as one of the potential major benefits of closely monitoring and forecasting conditions off the Washington coast, which could allow fisheries to capitalize on fish population booms, and dial back during busts. As in the other workshops, Washingtonians wanted improved science communication so that fishery managers and fishing communities could better understand the difference between natural climate variability and the variability and changes resulting from long-term climate change.

Photo: Black rockfish, NOAA

Washington workshop participants viewed the outer Washington coast as highly likely to continue to be a strong seafood producer, citing the state's long shellfish mariculture history in combination with wild fisheries, salmon hatcheries, and strong intertidal and ocean harvest traditions among the coastal tribes. Workshop participants were concerned about the

effects of a variety of external policies and environmental changes on the region's diverse seafood industry, including:

- Detecting and understanding HABs.
- Outdated salmonid hatchery infrastructure and lack of cohesive and clear hatchery policies and planning for the future.
- Declining seafood processor presence on the outer Washington coast. And,
- The need for improved physical and marketing connections between the coast and the state's Puget Sound population centers.

As in the other scenario planning workshops, there was deep concern about the state of terrestrial and freshwater habitat and the need for habitat improvement projects to ensure that salmonid stocks survive to 2040.

Brainstorming in the Washington workshop raised a host of ideas for solving some of the coast's challenges. Workshop participants wondered if Washington's reduced wild seafood processing capacity could be improved by working with aquaculturists or by combining at-sea processing with increasing shoreside ice and freezing capabilities. Discussion of at-sea processing led to questions about whether more private fishing businesses could cooperate in a formal structure like the Pacific whiting mothership fleet. Opportunities for vessel crew and processing staff to have more steady employment within that cooperative structure by rotating among vessels and facilities were also seen as beneficial for outer coast communities.

As in other workshops, Washington workshop participants saw fisheries management as part of the problem and part of the solution to challenges arising from the effects of climate change on fish stock abundance and fisheries stability. On marketing, workshop participants recalled past NOAA seafood marketing programs and discussed how to consider wild seafood under U.S. Department of Agriculture programs that provide trade relief for products where the U.S. has a production deficit. Workshop participants also suggested that the USDA increase its seafood purchases, which are sold at discounted prices to schools, nursing homes, and other large-scale entities. Wild seafood, including production from smaller-scale fisheries should be part of nationwide movements to get healthy foods onto the plates of young children. On regulatory flexibility, workshop participants wondered if the Council would have to change its governance structures to become more nimble, responsive, and flexible. They suggested that allocation in rationalized fisheries reduces flexibility for existing participants and potential new entrants, and called for opportunities for the industry to develop cooperative structures that might increase quota shifting between sectors and vessels.

Detailed notes from the workshop's breakout groups are provided online[18] and in Appendix E. Below, workshop responses and suggestions responding to the strategic questions are summarized by the category of actions recommended by workshop participants.

Fisheries Management and Ocean Planning Approaches

- Government agencies should be urgently planning for climate change and identifying mitigation measures. Key to this planning is reducing greenhouse gas emissions nationally and worldwide.

- Is there a role for the government to subsidize capital investments that lead to greenhouse gas emissions reductions, such as for new power systems for vessels? What about opportunities for shoreside fisheries infrastructure, such as processing plants, to shift to carbon neutral energy sources?

- In considering zero carbon/carbon neutral energy sources the full range of impacts must be considered. For example, dams produce "green energy" but have adverse impacts on salmon, habitat, etc.

- We need more international engagement, especially with Canada, as stock distribution shifts north. A positive example of that work is the inter-agency collaboration on sablefish stock assessment happening right now, which includes looking at the stock distribution throughout its range in the eastern North Pacific Ocean. With the exception of albacore, there are almost no arrangements to allow vessels from Canada and the US to fish in the other country's Pacific waters. Does the US need to negotiate these types of agreements for more stocks?

- International arrangements like Regional Fisheries Management Organizations are needed to address transboundary issues now, before distribution changes happen. There are example collaborations on particular species and stocks (Pacific hake/whiting, Pacific halibut (*Hippoglossus stenolepis*), Pacific salmon, etc.), but the U.S. really can't afford to create a new commission for each species. A near-term action might be a multilateral science meeting to discuss vulnerabilities of different stocks to climate change.

- Government agencies and the public need to give higher priority to freshwater and terrestrial habitat restoration and urban growth management to mitigate climate change impacts. This includes continued focus on priority habitat protection for anadromous species.

- Wide-scale salmon habitat restoration could be either extremely costly with few benefits in a rapidly warming environment, or could be the key to helping stocks survive climate change. How can agencies and interest groups build more community around watersheds, so that the

[18] https://www.pcouncil.org/documents/2021/02/washington-region-climate-implications-workshop-completed-worksheets.pdf/

general public gets a big picture of the watersheds they call home? The Federal government may not have a choice on habitat restoration in support of salmonids because that is part of public trust responsibilities to treaty fishing tribes. Managers and fisheries will be facing challenging choices over where to invest resources to maintain important values to some communities, particularly place-based tribes in urban environments.

- The disaster relief program under the MSA takes a long time from the time the disaster declaration is requested to the time when fisheries participants receive benefits. Is there a better way to allocate funds to better support fishermen in communities?

PFMC and Associated Fisheries Management Processes

- Promote more flexibility in management decision making framework in the MSA, especially in periodic management cycles, e.g., annual harvest specifications. Hopefully PFMC comes out of the pandemic thinking about how they can use online meeting tools to make inseason management more flexible for both participants and managers.

- Management flexibility has to come with increased data and analysis. Need for better inseason data tools.

- We need to take a hard look at fishing capacity (both commercial and recreational) and overcapitalization, taking into account avenues to facilitate entry to replace those aging out. The primary focus is on the West Coast but there is an international dimension to this.

- We need flexibility in permitting programs while ensuring it doesn't contribute to overcapitalization.

Science

- We need to better prepare fishing communities for the coming change. Good monitoring of ocean conditions, modeling and forecasting. What can fishing communities and managers expect? Scientists might need to reach out to communities, make sure data and information is accessible.

- More focus is needed on social and economic analyses to better understand the linkages between climate and human communities. In fisheries-related social science, the data that is collected tends to be focused on vessel captains and permit owners, but data from the broader communities – including vessel crew and processor staff – are needed to understand the role of fisheries in the communities.

- Gradual or sudden changes in species distribution and abundance are expected, so science that allows change and adjustment of reference points is needed. People don't want to be stuck in a situation where they are trying to rebuild a species that can't be rebuilt or constrained by bycatch of species that can't recover. Reference points are often set in terms of mortality rates, harvest rates, or biomass levels based on historical data that assumes that

species are still in equilibrium or that the baseline hasn't shifted. We shouldn't hold onto indicators/relationships that aren't functional anymore.

- Real-time monitoring is needed for better decision making. Data products (e.g., predictive models) that build off real-time data may be more valuable to and more useable by the end users. There is a need for more data products for use by managers and fishing communities in the near-term, such as monitoring for the health risk of HABs, and there is a need to make data collection more understandable.

- Data sharing and collaborative science with Canada and Alaska in the north and with Mexico in the south will be essential to understanding species migration patterns and distribution shifts.

- There will be more movement and mixing of different stocks and species. Assuming that the PFMC will have to continue with weak stock management – fisheries management that focuses on avoiding the least abundant species that co-occur with target species – there needs to be better real-time information on stock locations. More could be done in analyzing multi-stock/species associations pre-season.

- New technologies such as autonomous gliders and new genetic tools for faster stock identification are becoming available. How can these new data sources improve understanding of fisheries and ecosystems and how should these new types of data be incorporated without compromising existing work? One example is from the Antarctica Living Marine Resources program, where the program moved to using new autonomous drones and data from fishing boats to balance new and existing data types to maintain continuity in science and management.

- Coastal tribes are already collecting scientific data from their fishing vessels. Could their work be a model for cooperative data collection between fishermen and scientists? The Washington coast fishing community is already fairly understanding of what science can and cannot do and what they can get from fish and ocean science. Could cooperative science fieldwork be conducted out of coastal Washington, similar to Newport, Oregon?

Fishing Industry and Fishing Communities

- There is a need to make investments in marketing infrastructure that could benefit Washington communities under any of the scenarios. Better understanding of where products are going and how market orders are set up is needed to help optimize fisheries and seafood processing. There is a need to bring more technology to bear on this information problem and re-envision seafood marketing, such as meal delivery services.

    - Who are the likely actors to start these discussions? Marketing coops, producer associations. There could be some benefits to collectively organize to be able to afford needed improvements and technology.

    - Could start with a workshop of processors, marketers, and others to brainstorm solutions and engage the communities.

- There are physical infrastructure needs and capacities that could also benefit Washington communities under any of the scenarios. Physical infrastructure improvements should help protect water quality (pump out facilities, access points like boat ramps, etc.).

- Workers in coastal communities, including deckhands, need training in alternative activities, like aquaculture, derelict gear removal, etc. Disaster relief funds help if participants can wait patiently for the payout, but an investment in job transition plans is needed.

Photo: Harmful algal bloom, NOAA

Results

The Council received a summary of the results of the regional workshops at its March 2021 meeting (see Agenda Item I.2.[19]) From a survey of the participants from all four regional workshops, the Council learned that the scenario planning process participants thought that the scenario that seemed most likely to reflect the future of the CCE in 2040 was the "Box of Chocolates" scenario. Under that scenario, climate conditions are highly variable and abundance of managed species is relatively high, but species abundance is subject to dramatic increases and decreases. Workshop ideas for managing fish stocks and fisheries under the "Box of Chocolates" scenario, across all stakeholder groups and all geographic areas included:

- Invest in new technology for monitoring and real-time data to provide opportunities for scientists to translate predictions and models into usable management products.
- Encourage fishermen to collect data that supports real-time management; involve harvesters in survey design and data interpretation; encourage citizen science.
- Ensure Council's decision-making is more nimble, responsive, and flexible, e.g., investigate how to adjust inseason management measures between Council meetings.
- Improve management flexibility; for example, through the development of "if-then" rules to encourage quicker decision-making as conditions change or with a pre-approved menu of options that can be implemented rapidly.
- Implement education and awareness campaigns to connect consumers with fishermen; for example, by highlighting seasonality through "catch of the day" marketing and building consumer connections to fishermen, not just to the species they harvest.
- Facilitate investment in multiple gear types to capitalize on different stocks when they become abundant.
- Promote and fund research for ecosystem-based management/ecosystem-based fishery management as traditional stock assessment frameworks are most vulnerable under conditions of rapid variation in stock abundance and availability.
- Continue to push and promote adaptive management.
- Explore ways for vessel crew to rotate among multiple vessels or multiple processors to allow employees to work for multiple firms, and accelerate transportation of product to market.

Workshop participants viewed *Box of Chocolates* (increased climate variability and increased fish stock abundance) as most likely scenario to occur by 2040.

[19] https://www.pcouncil.org/march-2021-briefing-book/#I

After hearing comments from its advisory bodies and the public, the Council directed its CCCT to report back to the Council in September 2021 with recommendations for finalizing the scenario planning process and ecosystem initiative. The Council asked the CCCT to make recommendations on: follow-on ecosystem initiatives for consideration under the FEP in March 2022 and beyond; immediate recommendations to advisory bodies and the Council for ongoing work; and, ideas for collaboration with partner agencies and stakeholder groups.

Scenario planning process resulted in recommendations to the PFMC on:

- **Needed scientific information.**
- **Revisions to PFMC and associated fisheries management programs.**
- **Collaborations PFMC could initiate with other entities.**

In September 2021, the CCCT reported back to the Council and made recommendations for actions that could be taken by the Council or by agencies participating in the Council process, grouping those possible actions into three categories – science, management, and collaboration outside the Council process. Recommendations from the CCCT September 2021 report:[20]

1. The Council could ***initiate science-focused activities*** to provision the Council with actionable information:

    a. The Council could task the EWG and the Ecosystem Advisory SubPanel to work with NMFS scientists to

        i. Develop a report for Council consideration that specifies processes to address the following science concerns: Incorporating climate variability and change data and information into stock assessments, ecosystem assessments, scientific advice, and decision-making such that decision-makers have a sense of any expected shifts in stock abundance and distribution, and ecosystem conditions, over the next 5-20 years. The report would also include recommendations to help address the movement of stocks across jurisdictional boundaries and support stock and ecosystem sustainability. Stocks that may shift across jurisdictions could be targeted for transboundary assessments, and pronounced shifts in ecosystem conditions could be used to update stock and ecosystem reference points, if needed. This activity would best be conducted in conjunction with FMP-specific advisory subpanels and management teams, who could provide input on opportunities and challenges to the use of this information in the Council process, including in long term planning. Finally, the report would identify implementation needs for addressing potential challenges identified in the scenario planning process and larger initiative, including a) research and data and b) Council process and policies.

[20] https://www.pcouncil.org/documents/2021/08/h-2-a-ccct-report-1.pdf/

ii. Use NOAA's climate vulnerability assessments to prioritize stocks for climate management strategy evaluations intended to develop climate-ready harvest control rules and other management measures.

iii. Bring FMP-specific ecosystem reporting into the Council process at times when it is most needed and useful. This reporting would be supplemental to the annual ecosystem status report and harvest decisions that are under development.

iv. Request that the Integrated Ecosystem Assessment team include an appendix in the annual State of the California Current Ecosystem Report that would provide information specific to climate change and take into account the scenarios developed through the scenario planning process as well as develop climate early warning indicators.

b. The Council could also task advisory bodies to explore the use of "civic science," including traditional ecological knowledge, through community-based, and collaborative efforts in the collection of data that could be used to track changing climate conditions. In developing any such program, the following questions should be considered: Which climate data might be collected by fishing vessels acting as scientific platforms? Could agencies use basic sea/air temperature data from an array of small platforms? Which fishing vessels are more or less conducive to carrying sensors? Has anything like this been tried elsewhere in the world and, if so, have the data collected been useful and used in ongoing management processes where this could be integrated? What are the cost implications?

2. The Council could ***implement revisions to ongoing management processes***, including actions to be undertaken through FMPs:

a. The Council could task advisory bodies to explore activities to increase flexibility, responsiveness, and adaptability within the Council process:

i. The Council could define flexibility and adaptability in the context of shifting West Coast stocks and identify appropriate considerations, based on the results of the scenario planning process and informed by the informational report provided by TNC (Bell and Kirchner 2021). Additionally, the Council could develop priorities for directly addressing climate impacts. This would provide guidance necessary to effectively move forward with 2.a.ii (below).

ii. All FMP-specific advisory subpanels and management teams could report back to the Council on:

1. Administrative, process, and scientific barriers in the management of their fisheries to addressing the effects of ecological or management surprises and shifting stocks through inseason management actions, and on measures the Council could take to increase management nimbleness pre-season and inseason, while supporting long-term stock and ecosystem integrity.

2. Priorities and processes for review of EFP applications and recommendations about how such permits could be deployed to advance climate-ready fisheries. And,

3. Opportunities for and challenges to embedding climate variability and change

into assessments, decision tables, and scientific advice for fishery management unit species, with advice and input from the Scientific and Statistical Committee. The Council could then review advisory body recommendations and determine whether revision to FMPs or regulations are needed to implement those recommendations about what kinds of ecosystem information, data, and monitoring are needed.

b. The Council could plan a future workshop involving members of the Council family that engage with regional fishery management organizations and other international forums that have management responsibility for West Coast fish stocks. Participation should include the Council's non-voting member from the U.S. Department of State and staff from the NOAA Office of International Affairs, Trade, and Commerce. The workshop would develop recommendations to address adapting to and mitigating for the effects of climate change on fish stocks and fisheries at the international level. A second topic could be the identification of measures to improve current transboundary coordination to prepare for shifts in the distribution of managed fish stocks. Workshop outcomes would be communicated to relevant U.S. delegations as priorities for the development of U.S. positions.

c. The Council could direct the EWG to include a statement in the Council's Guidance Document on Offshore Non-Fishing Activities on the role of greenhouse gas emissions in climate change and related implications for West Coast fisheries.

d. The Council could direct its staff to provide an update to the Council at each March meeting on actions taken by other fishery management councils throughout the U.S. to better prepare their fisheries for climate change. This information could support development of future ecosystem initiatives.

e. The Council could direct its staff to create a permanent Council webpage for climate-related work and resources to assist in educating and engaging the public across platforms. This would help share what the Council has done, and is doing, and could facilitate increased stakeholder participation in relevant management forums.

f. The Council could task the EWG to include a reference to the final Scenario Planning Report(s) in the FEP as an example of potential impacts of climate change.

3. The Council could ***continue its collaboration*** with partner agencies and stakeholder groups and seek to engage new partners as appropriate:

a. The Council could ask that NMFS provide a report to the Council on the West Coast fisheries' disaster determinations made in response to events that could be characterized as climate variability or change since 2010 (Magnuson-Stevens Act at 312(a) and 315, Interjurisdictional Fisheries Act 308(b) and 308(d). NMFS could note whether there are trends in the causes of fisheries disasters and whether there are changes needed to federal policies that could prevent these disasters from recurring. This analysis could be informed by a recently released paper called The Rise in Climate Change-Induced Federal Fishery Disasters in the United States (Bellquist et al. 2021).

b. The Council could ask that NMFS provide a report to the Council on how the federal government is coordinating its hatchery, habitat, and hydropower policies to buffer

Pacific salmon stocks against the effects of climate change. Are policies aligned with each other towards common goals of supporting a future with sufficient salmon in streams and the ocean to support sustainable fisheries? If the report requested in 3a, above, shows that West Coast fishery disaster determinations are primarily made for salmon fisheries, what changes in hatchery, habitat, and hydropower policies are needed to minimize climate-related disasters?

c. The Council could ask that NMFS draft a report evaluating the Council's scenario planning process and outcomes.

The Council reviewed the CCCT's recommendations and took comments from its advisory bodies and the public on the initiative, the scenario planning process, and CCCT reports. At its September 2021 meeting, the Council recommended concluding its scenario planning process and asked that its EWG resume primary responsibility for work on the Climate and Communities Initiative. The Council asked the EWG to return in March 2022 with a list of potential Council tasks flowing from the results of the Climate and Communities Initiative, grouping those tasks according to whether they are part of the ongoing work of the Council under its FMPs, a potential future FEP initiative, or other Council-relevant activities outside of the first two categories.[21]

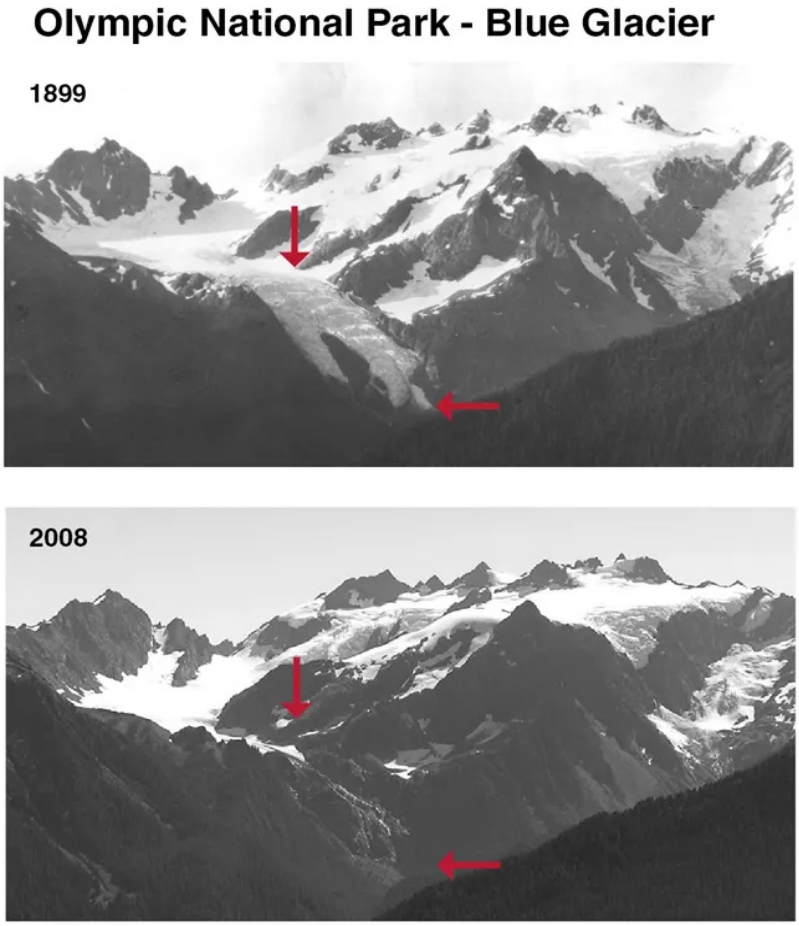


Photo: Blue Glacier, Mount Olympus, 1899 and 2008, National Park Service

[21] https://www.pcouncil.org/documents/2022/03/h-3-a-supplemental-ewg-report-2.pdf/

Discussion

The Pacific Coast fisheries scenario planning exercise provided a framework for a multi-fishery, big-picture, strategic planning discussion about the future of West Coast fisheries under the uncertain effects of climate variability and change. The process built on the ideas and processes used by the National Park Service (NPS 2013), and by NMFS for Atlantic salmon (Borggaard et al. 2019) and for North Atlantic right whale (Borggaard et al. 2020). Morrison and Termini (2016) had described scenario planning as one potential management tool within the larger suite of management tools available for managing fisheries in a changing climate. Interestingly, participants in this scenario planning exercise independently identified several of the other management tools discussed by Morrison and Termini (2016), including: incorporating environmental parameters into stock assessments and management measures, enhancing stocks, protecting key habitats, using ecosystem models, expanding flexibility in fisheries permitting and management, insurance programs similar to the USDA crop insurance program, and improving flexibility in the supply chain.

The scenario planning process complemented the PFMC's simultaneous efforts to update its FEP, particularly influencing the FEP's examination of complex interactions between physical, biological, social, and economic systems in Chapter 4, and the FEP's discussion of ecosystem science in the PFMC process in Chapter 5. The PFMC scenario planning process began with the understanding that discussions would take into account ecological surprises like marine heatwaves and their effects on the CCE's biological environment. By the close of the scenario planning process, all of the process participants, CCE fisheries, and every other industry in the world had been affected to some degree by the surprise of the COVID-19 pandemic. These challenges of addressing unexpected changes to the CCE, and to its fish stocks and fisheries, spurred creative and cooperative discussions during the scenario planning process.

Multi-species, multi-party, multi-jurisdiction scenario planning for climate change is possible, but requires additional time, patience, and engagement.

While any scenario planning process has its own complexities, scenario planning in a fishery management council process offered some unusual challenges. Opening this scenario planning exercise to considering multiple species managed under four FMPs significantly increased the complexity of discussions, but was necessary for a fuller exploration of management issues that might arise in a highly biodiverse system affected by a changing climate. Providing time during the *Development* phase for the PFMC's advisory bodies and the public to discuss and shape the scenario narratives, and to

provide guidance on the example fish stocks used to represent the different FMPs, significantly improved both the narratives and the willingness of participants to engage in discussion.

Scenario planning process participants wanted to *know more* about the potential effects of climate change on fish stocks and fisheries, wanted to *plan more* for the future, and *generated ideas* for new work in science, management, and industry.

Some of the complexity of addressing multiple species and issues was mitigated during the final *Application* phase, with separate workshops for different large geographic areas, and by providing breakout sessions within each workshop for participants in different constituencies. Ultimately, managing the scenario planning process within the MSA's requirements that fishery management council discussions be held in public forums created intricate scheduling challenges for PFMC staff, yet enriched discussions far beyond what might have been possible in a smaller arena. Developing this scenario planning process to accommodate fishery management council schedule and process requirements gave participants time at every stage to sit with, think about, and debate over the potential effects of climate change on West Coast fish stocks and fisheries, and over potential management challenges and opportunities associated with those effects.

Throughout the PFMC scenario planning process, participants were willing to join in drafting and discussing the suite of fictional yet plausible scenario narratives. However, many participants commented during the process that they would have appreciated an opportunity to better understand what scientific models may help us know about the most likely future for the CCE's physical environment by 2040, and possible associated changes to the biological, social, and economic environments associated with that future physical environment. Similarly, many participants were interested in seeing more concrete management actions emerging from the process.

Scenario planning is an exercise in widening the possibilities considered to more fully explore options for meeting the challenges of the future. The multi-species and multi-fishery process used by the PFMC was not necessarily suitable for identifying management tools intended to respond to challenges with particular fisheries and stocks. More work is needed on many fronts to actually address the ideas raised and to make fish stocks, fisheries, and science and management robust to the challenges associated with a changing climate. Nonetheless, scenario planning can help guide new approaches to science and management in support of adapting fish stocks and fisheries to climate change, as discussed at the close of the updated FEP (PFMC 2022a):

> *The scenarios developed [in the scenario planning process] provide guideposts for considering the priorities and concerns of the fishing communities reliant upon the CCE. New*

management processes may be needed, such as initiatives to identify and evaluate spatially explicit emerging and fading fishing opportunities. New decision contexts may develop, such as how to determine harvest levels when the biomass of individual stocks within the fishing closed areas created by offshore energy or aquaculture development is unknown and unknowable. And, we will have to consider challenges like how to allocate target and bycatch quota spatially (across regional and international borders) in years with anomalous environmental conditions that massively shift the distributions of target species. Forward-looking, transdisciplinary science focused on managing toward future conditions will in turn support fisheries and fishing communities (Kleisner, et al. 2021) [from PFMC 2022a at p. 116].

In 2023 and beyond, the PFMC, its associated agencies, and its stakeholders will be driven by the changing climate to consider and develop new approaches to fisheries management. This scenario planning process serves as a repository of ideas for moving forward into an uncertain future.

Photo: Staff from the City of Los Angeles show kids how to properly fillet a fish to reduce their intake of contaminants, NOAA

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List of Acronyms and Abbreviations

AB	Advisory body (for the Pacific Fishery Management Council)
AG or Ag	Agriculture, usually the agriculture sector or industry
BOEM	Bureau of Ocean Energy Management
CA	California
CCE	California Current Ecosystem
CCCT	Climate and Communities Core Team
CENCOOS	Central and Northern California Ocean Observing System
COVID or COVID-19	Coronavirus Disease 2019
CPFV	Commercial passenger fishing vessel
CPS	Coastal pelagic species
CSI	Climate Scenarios Investigation Workgroup
D crab	Dungeness crab
EFP	Exempted fishing permit
ESA	Endangered Species Act
EWG	Ecosystem Workgroup
FAD	Fish aggregation device
FEP	Fishery Ecosystem Plan
FEMA	Federal Emergency Management Agency
FMP	Fishery Management Plan
HAB	Harmful algal bloom
HMS	Highly migratory species
IPCC	Intergovernmental Panel on Climate Change
MPA	Marine protected area
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MT	Management Team (for the Pacific Fishery Management Council)
N Ca or NorCA	Northern California
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWIFC	Northwest Indian Fisheries Commission
OR	Oregon
PFMC	Pacific Fishery Management Council
SCB	Southern California Bight
SK funds	Saltonstall-Kennedy funds
SoCA	Southern California
TNC	The Nature Conservancy
U&A	Usual & Accustomed fishing areas or fishing grounds [of treaty Tribes]
USFWS	United States Fish and Wildlife Service
WA	Washington

Appendix A: Summary of driving forces prepared for January 2020 scenario development workshop.

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Ocean warming	Globally, the ocean has continued to warm unabated and has absorbed ~90% of the excess atmospheric heat due to greenhouse gas (GG) emissions since the industrial revolution. Year-on-year marine temperature in the California Current Ecosystem (CCE) is driven by regional wind speed and direction, and short- and long-term global processes such as El Niño and global warming.	The ocean will continue to warm in future, with the magnitude of the warming dependent on current and future GG emissions. The surface ocean will continue to warm fastest and deep ocean more gradually. Ocean warming has already increased stratification, and this is set to continue.	It's uncertain how severe future stratification will be and how warming will impact circulation within the CCE. Increase stratification could increase the frequency of marine heatwaves, and warming oceans could also cause an intensification of El Niño events. Timing of the upwelling season is also uncertain.	Species have a narrow thermal range in which they prefer to live and are thus susceptible to ocean warming. It is predicted that ocean warming will cause a northward shift in marine species. Marine heatwaves have significant negative effects on marine fisheries, and they can take years to recover. What happens to the CCE if marine heatwaves begin to occur faster than species can recover? In general, the colder nutrient rich waters that are found in normal years are lipid rich—essential for the growth of many fish species. During El Niño years, warmer nutrient poor subtropical waters move up.
Sources: Cai et al. 2018 Morley et al. 2018 Peterson et al. 2017 Pörtner et al. [Eds.] 2019				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Ocean acidification	Globally, ocean acidification refers to the uptake of atmospheric carbon dioxide by the ocean. Locally, ocean acidification is driven by respiration. Organic matter breaks down as it sinks through the water column and settles on the sea floor, consuming oxygen and releasing carbon dioxide.	Globally, oceans are becoming more acidic. Based on current emissions, this trend will continue through 2040 and beyond. The CCE is acidifying more rapidly than the global average. The nearshore and northern and central regions of the CCE experience the most severe and persistent acidification. In addition to the long-term increase, many parts of the CCE experience highly variable conditions, including the upwelling of highly acidified water, leading to extreme conditions.	Much of the uncertainty refers to the *impact* of ocean acidification on specific marine species and the marine food web. Rising ocean temperatures might change the timing and intensity of upwelling, likely driving more intense upwelling in the spring and weaker upwelling in the summer. This could make the negative impacts of upwelling events more severe and worsen conditions for benthic / deep water species.	Ocean acidification will have impacts on organism survival, development and behavior. Negative impacts have already been observed in shellfish (e.g., oysters, mussels, crabs) and shell-forming organisms such as pteropods. Observed behavioral impacts include decreased predator avoidance, impaired food detection, and impacts on spawning.

Sources:
Brady et al. 2017
Christian, J.R. and Ono, T. [Eds.] 2019
Marshall et al. 2017
Pörtner et al. [Eds.]. 2019

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Sea level rise	Sea-level rise is an effect of climate change driven by melting glaciers, thermal expansion and increasingly, melting Greenland and Antarctic ice sheets	Sea-levels have been rising for decades, and virtually all models now show that this rise will accelerate in future years, especially under high emissions scenarios. Global mean sea level rise between 2006-2015 is 2.5 times the rate of 1901-1990. Extreme sea level events that are historically rare (once per century in the recent past) are projected (with high confidence) to occur at least once a year at many locations by 2050. Coastal California is already experiencing the early impacts of a rising sea level, including coastal flooding and erosion. Under high emissions scenarios, it is projected that sea levels could be 1m higher by 2100 compared to today.	There are minor differences in projections for sea level rise under different emissions scenarios up to 2050, but they diverge significantly in the later years of this century. The main sources of uncertainty relate to the core emissions scenarios, to model uncertainty, and also to other aspects of ocean / climate variability (such as oscillations and storms). Along the Pacific coast, the net effects of sea level rise could be offset by tectonic processes (uplifting). Also, even though the long-term trend is towards rising levels, we can expect significant annual variability.	Rising sea levels are a major contributor to increased coastal hazards (storm surges, flooding and erosion), so we can expect to see more destructive activity in coastal regions in the decades ahead. This will have a direct effect on fishing communities. Even without storm surges, rising sea levels will affect fishing port infrastructure, which might need to be relocated further inland.
Sources: Church et al. 2013 Griggs et al. 2017 Pörtner et al. [Eds.] 2019				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Hypoxia and harmful algal blooms	Hypoxia refers to low or depleted oxygen concentrations that can impair marine life. HABs occur when the rapid growth of marine algae is sufficient to impact fisheries and human health.	Hypoxia is caused by ocean warming. It is compounded by increased ocean stratification (which is also due to warming). Thus, we can expect hypoxia to increase given these underlying drivers. There is also evidence that, due to seasonal upwelling, the CCE has experienced—and will continue to—experience severe and persistent hypoxia. HABs occur when conditions are right for rapid growth of marine algae (i.e., immediately after an upwelling event). It's likely that the frequency and intensity of hypoxic events and HABs will increase, especially in the northern CCE.	We cannot be sure about the magnitude of these events in the coming years. The conditions that cause some algal blooms to produce toxic compounds is still poorly understood, but early evidence suggests temperature and nutrient limitations are key factors.	Prolonged hypoxic events have been shown to displace local fish populations, which will lead to a restriction in fishable waters and habitat restrictions / competition in neighboring areas. Short-term severe hypoxia (anoxia) can cause localized or widespread fish kills as well. Reduced oxygen concentrations can increase stress on fish, reducing growth rate and size. (Continued on next page) Large scale algal blooms can increase or trigger hypoxic events and will also shade or smother immobile species (i.e., shellfish and seagrasses). Toxins produced by HABs routinely lead to the closure of some fisheries and can also impact other marine fauna such as marine mammals and seabirds.

Sources:

Brady et al. 2017
Chan et al. 2008
Christian, J.R. and Ono, T. [Eds.] 2019
Church et al. 2013
Feely et al. 2018

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Ecological surprises	An ecological surprise is an unexpected and often dramatic shift in the environment. Examples of recent surprises in the CCE include the Humboldt squid invasion (2010- 2012), the more recent pyrosome invasion, and the dramatic decline in sea star populations due to wasting disease. The frequency and intensity of future ecological surprises will be exacerbated by climate anomalies and by climate variability and change.	Nothing is predictable about ecological surprises except that they are certain to occur: • *Dynamic surprises:* population numbers or community compositions change in unexpected ways, based on our prior knowledge (e.g., pyrosomes) • *Pattern-based surprises:* past patterns of abundance and spatial migration are not a reliable guide to current and future patterns (e.g., inshore feeding behavior of migrating humpback whales) • *Intervention-based surprises*: unexpected changes arising from management actions or other human disturbances, such as the worldwide influence of agricultural nutrient runoff or the spread of marine dead zones.	While we should expect more surprises, it is difficult to predict the nature, location and effect of any particular ecological shock.	By definition, an ecological surprise creates a shock to the ecosystem that can have serious and significant effects. Squid invasions delivered a new predator and affected fish stocks. The recent pyrosome invasion has clogged fishing gear, and there are concerns that a die-off of pyrosomes could lead to reduced oxygen levels.
Sources: Diaz and Rosenberg 2008 Doak et al. 2008 Filbee-Dexter et al. 2017 Harvey et al. 2019 NFWPCA 2012				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Extreme weather conditions	Extreme weather conditions" refers to intense heat events, storms, rainfall / wind events that create disruption and damage to fishing operations and coastal communities	As the atmosphere warms and absorbs more heat, extreme storms will become more intense and more frequent, according to predictions from global climate models. However, current models lack the precision to predict which local areas / fishing communities will be impacted the most from such storms.	Will we be able to more accurately predict extreme weather events in future? Could more frequent unsettled weather be followed by longer periods of calm, settled weather? If so, will this change the behavior of recreational and commercial fishermen?	Increased storminess makes fishing more dangerous, putting lives at risk. Intense storms can flood estuaries with saltwater and cause fish to evacuate large areas. Storms can also benefit fish by strengthening upwelling, thus allowing phytoplankton and zooplankton to thrive. Intense wind/rain events can cause structural and flooding damage to vulnerable coastal infrastructure.
Sources: Siciliano et al. 2018 USGCRP 2018				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Terrestrial climate impacts	Terrestrial impacts from climate change directly affect anadromous species such as salmon and steelhead and species that depend on estuarine habitats for spawning and rearing young.	Climate change will affect freshwater and estuarine hydrological systems and habitats. Reduced snowfall and increased droughts will alter the magnitude and timing of stream flow, sediment loading, and nutrient loading. Increased water and atmospheric temperatures will change animal and plant species compositions, degrading spawning and rearing habitats. Sea level rise and changes to salinity in estuaries will have detrimental effects on sea grasses.	How quickly, and to what extent, will the terrestrial environment be impacted by climate change? How are river-estuary systems influenced by climate change effects in both watersheds and the oceans? Changes to stream flow may result in changes to anadromous species spawning and outmigration timing. Habitat quality degradation will reduce the ability of species to identify suitable spawning and rearing habitat, thus reduce the ability of species to thrive. However, the changes to ecosystem communities are difficult to predict.	Habitat restoration and conservation must be flexible and adaptive to adjust to increased understanding of impacts and mitigation strategies. Land-use patterns may need to be modified, especially in urban areas, to reduce the impact on hydrological components such as runoff and streamflow.
Sources: Bryant 2009 Marshall and Randhir 2008 Short and Neckles 1999 Cloern et al. 2011 Lin et al. 2012				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Marine pollution	The U.N defines marine pollution as "the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities." Marine pollution has many forms, including plastics, light, noise, and chemicals. Globally, 80% of marine pollution comes from land-based activities, including oil, fertilizers, sewage, plastics, and toxic chemicals.	Pollutants will continue to affect the marine system into the foreseeable future. While there is considerable movement underway to reduce single-use plastics, it is expected that we will be producing three times as much plastic as we do today by 2050 (accounting for ~20% of petroleum consumption and 15% of annual carbon emissions), when there may be more plastic than fish in the world's oceans. Non-point source pollution, such as oil from cars on the road, fertilizers, sewage, pesticides, and herbicides cannot be measured in the ocean; however, monitoring occurs in many river systems. These chemical pollutions can be damaging to individuals and habitats. These impacts will only magnify climate change impacts to habitat and species.	Most of the uncertainty around this driving force is related to the impact that it will have on the marine environment. The future of microplastics in the marine environments is uncertain. Plastics break down into microplastics and can be found in nearly every environment on earth, with over 99% being microfibers from clothing and other artificial fabrics. Microplastics have been found in many species, including bivalves, fish, birds, and marine mammals.	Marine pollution affects the health of ocean ecosystems, so any reductions in marine pollution will improve the overall health, thus increasing the ability of the marine system to be resilient to the impacts from a changing ocean. There are several campaigns to educate the public about the impacts of single-use plastics and new awareness of the wide-spread impacts of microplastics in high-profit countries. However, more needs to be done to reduce use globally and identify effective alternatives.
Sources: Baechler et al 2020 Barboza et al. 2019 Lebreton and Andrady 2019				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Alternative ocean uses	Technology advances and a growing human population have created proposals for new and alternative uses of ocean space including submarine cable installation, water desalination, offshore mining, renewable energy, intensive waste disposal and aquaculture.	The basic underlying drivers will lead to increased demand and more intensive use of ocean waters. Under a future of climate change, scarce fresh water supplies are likely to increase demand for desalination plants. Wind energy technology will also increase in popularity as finding alternatives to fossil fuels become more urgent. However, the topography of the U.S. West Coast (a narrow continental shelf) makes permanent ocean installations more challenging far offshore.	Will ocean energy delopment become viable for all areas of the West Coast, or will it be focused mainly closer to densely settled urban areas? Will regulatory and legal hurdles be overcome to enable offshore aquaculture? Will state and tribal interest in nearshore aquaculture grow enough to support significant new installations? Will alternative ocean use work in concert with existing ocean resources (e.g., devising systems to deal with marine waste), or will alternative uses further contribute to ecosystem damage?	Alternative ocean uses will cause disturbances (e.g., sound, pollution) that will affect marine life and fisheries. New uses could also provide new and different economic and employment opportunities to coastal communities. As the industries and skill sets are different, new investments could change the character and socio-economic make up of coastal communities. Interactions between fisheries and alternative uses have been occurring off the West Coast for many years, with some promising indications of success (e.g., submarine cable installation).
Sources: Melillo et al. [Eds.] 2014 Robbins 2019 http://www.ofcc.com/about_ofcc.htm				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Aquaculture	Aquaculture is defined in U.S. law as "the propagation and rearing of aquatic species in controlled or selected environments, including, but not limited to, ocean ranching..." The United Nations Food and Agriculture Organization define it as "The farming of aquatic organisms in inland and coastal areas, involving intervention in the rearing process to enhance production and the individual or corporate ownership of the stock being cultivated." Aquaculture includes shellfish and finfish in both fresh and saltwater environments, in either contained or open systems.	Aquaculture will remain a global tool of seafood production across multiple types and geographies.	The U.S. currently has a fragmented legal and regulatory management system for aquaculture. What will it look like in 2040? What will global aquaculture look like? What pressures will it put on wild U.S. fisheries and aquaculture? What will our cultural attitudes towards aquaculture be? Can finfish aquaculture and wild capture fisheries thrive economically and socially on the U.S. West Coast at the same time?	If finfish aquaculture continues to grow globally and in the U.S., we could see market pressures challenge U.S. wild fisheries. If aquaculture grows off the U.S. West Coast, we could see environmental damage to coastal areas as well as federally-managed areas.
Sources: National Aquaculture Act of 1980 NOAA 2011 Naylor et al. 2000				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Societal values	Societal values represents the standards and preferences that groups of humans hold in common. This is a fundamental set of forces, and changes can lead to consequential political, economic and technological change. For our purposes, we will focus mainly on societal values in relation to climate change.	Societal values change over time. Values held on the U.S. West Coast may shift to reflect changing demographics. (e.g., an aging population, or movements into / out of coastal communities). At present, societal values regarding concern about the state of the environment remain low relative to other public policy priorities. However, opinions on climate change are shifting towards a greater acceptance of the realities and a recognition of the challenges that it brings. (Public concern tends to rise in association with large-scale natural disasters).	Will rising awareness of the impacts of climate change lead to a societal pressure for fundamental changes in how economic, regulatory and business systems operate? Will rising awareness of the impacts of climate change lead to meaningful shifts in human behavior (e.g., what we eat, where and how we travel, what we consume)? Will society conceive of oceans and ocean resources differently by 2040? Could this lead to more attention placed on protection and preservation? Or will our values encourage more commercial exploitation?	Shifts in societal values can affect all aspects of the fishery system. Changing demographics and attitudes toward healthy living can drive consumer preferences towards wild-caught seafood. Greater awareness of environmental concerns could lead to public policies that encourage protection of species. Societal values could also emphasize commercial growth or national security, which could in turn create pressures on stocks, or international cooperation.
Sources: Capstick et al. 2015 Cusack et al. 2017 Honkanen et al. 2005 Potera 2018 Rokeach 1973				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Consumer demand	This driver captures major changes in the demand for seafood over the next 20 years and explores the underlying causes of such changes.	There will be more mouths to feed. Global demographic trends paint a picture of a growing global population, from 7.7bn in 2020 to 9.1bn by 2040. Much of this growth will be concentrated in Africa and South East Asia. A growing middle class is likely to demand higher quality proteins. In richer nations, we already see an emerging trend towards demand for seafood and plant-based proteins, and away from animal-based.	Will there be demand for wild-caught seafood driven by consumers who value supporting local providers and sustainable practices? Or, will consumers opt more for farmed seafood for price, value and/or safety reasons? Or, will consumers embrace plant-based proteins as the best route towards healthy proteins? Will wild-caught seafood be seen as a healthy, sustainable alternative in 20 years? Could environmental contaminants damage consumer demand? Will there be changes in the species consumers choose to eat—because of changing tastes, availability, sustainability or safety concerns?	Major shifts in consumer demand will have a profound effect on all parts of the seafood industry and ecosystem. If consumer demand shifts towards aquaculture, this will force significant changes on the traditional practices of fishing communities. Demand for different species could affect stocks in specific areas. The nature of consumer demand will affect fishing practices (e.g., encouragement of sustainable practices).
Sources: Blank 2014 United Nations 2019 Wilsterman 2019				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Trade/ industry policy	Trade in fish and fishery products is extensive, and hence changes to trade (and industrial support) policies have the potential to shape the global fishing industry. Trade measures can include tariffs, subsidies, safety and sustainability requirements.	Changes to international agreements over trade usually take many years to negotiate and come into effect, so change typically happens slowly. The global trading regime is currently experiencing relatively low tariffs, and there are increased measures in the pipeline to further lower tariff levels. Many advocate for additional reform of fishery subsidies to prevent overfishing, but change is politically and economically difficult, thanks to powerful players and vested interests in the status quo.	While trade policy tends to move slowly, a more volatile and uncertain geopolitical environment could herald more dynamic changes in the years ahead (e.g., U.S. raising tariff levels on goods in trade disputes with China and the EU, and China imposing 25% tariffs on U.S. lobster.) To what extent will concepts of sustainability and safety become essential requirements to trade with other nations? If U.S. policy becomes more progressive, concepts like the "Blue New Deal" might rise in prominence, providing incentives to favor U.S. fish rather than imports. More generally, will we see more unification and multi-lateral collaboration with larger trading blocs (e.g., the EU), or will we see the collapse of multi-lateral agreements and the rise of bilateral deals, or no deals at all?	Removal of fishing subsidies for developing countries could deliver a more advantageous environment for U.S. fishing. New sustainability and safety requirements could make seafood more expensive but could also favor quality U.S. products.
Sources: Sumaila et al. 2014 https://www.filesforprogress.org/memos/blue-jobs.pdf				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Regulation and environmental policies	This force describes the nature of policies and regulations that are designed to protect various aspects of the natural environment. In this summary, we focus primarily on U.S. policy (e.g., NEPA, ESA).	Public support for existing environmental protection is relatively strong. Major federal environmental legislation is unlikely to be rolled back, nor will major new legislation get passed in the short/medium term. State and local actions will continue but can only be partially effective. Large-scale environmental concerns will require concerted federal action.	Will the current drive for deregulation regarding environmental protection continue in the U.S.? This largely depends upon the political environment and the nature of the administration in power. Will environmental problems (e.g., climate impacts, air and water quality) become sufficiently visible and concerning to shift public attitudes and political will in a meaningful way? Will demographic changes in the U.S.—as younger generations become more influential—bring about changes in environmental attitudes and political preferences? Will environmental protection and economic growth be seen as competing goals, or will new technologies/approaches/regulations allow us to see the pursuit of both as complementary?	Policy and regulation has a pervasive effect on the ecosystem by influencing/controlling behavior that ultimately affects the environment. Deregulation could affect water quality; changes to the ESA could affect the scope of fishing grounds and the timing of seasons.
Sources: Meyer 2018 Newport 2018 The Economist 2019				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Protected species status	This driver captures major changes in the number, condition, and relationship to harvested species of legally-protected species over the next 20 years and explores the underlying causes of such changes	Declining global biodiversity and changes in ecosystem productivity will continue, increasing stress on most food webs, including those that protected species depend on. At the same time, recovery of some protected species will likely continue, impacting fisheries through increased predation on target stocks and in other ways. These impacts will manifest differently across geographies—globally and within the California Current—and across protected species.	What will the legal framework for protected species look like? How will it relate to fisheries management? What biophysical drivers will most impact protected species? What anthropogenic drivers? What will protected species and fishery target species interactions look like? What will our societal relationship with protected species be? What protected species populations will be healthy and which will be declining?	Recovery of some species will put additional competing pressure on target stocks, furthering current management challenges around balancing the needs of protected species and fishing. Food web degradation will continue adding pressure on the entire ecosystem, likely further affecting populations of some protected species, both target stocks (such as salmon) and non-target species (such as birds). Both recovery and decline will create challenges for managers; sometimes these species are the same (e.g., sea lions) creating complex questions even without the additional stressor of climate change. We will likely see an increase in these challenges.

Sources:
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Magera et al. 2013
Paleczny et al. 2015
Tulloch et al. 2019
www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-species-stock

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Food technology	This force describes how the world will use technology to satisfy our need / desire for food in the next 20 years.	Given demographic trends, some estimates suggest that the world will need 60% more food by 2050. And this needs to be made available at a time when existing food production practices are causing environmental damage. There is little doubt that we need—and will experience—innovation in food production. This will include lab-grown meat, vertical farming, insect proteins, aquaculture, drought-resistant crops, use of data for more effective tracking and farming	How important will new technology advances be in the fishing industry over the next 20 years? Will they transform aspects of the industry, or be of marginal importance? Which new technologies will rise to the fore and become influential or transformative in how we grow/manufacture food? How will consumers respond to new food technologies, and will there be unintended consequences (e.g., safety concerns)?	Advances in food production technology could mean that seafood demand is moderated (as alternative sources of protein come on stream). New technology and processes could increase the quality, safety and sustainability of seafood, thus boosting demand. *Examples of Innovation* DNA testing that allows resellers and consumers to verify that the species being sold Advances in the fish feed industry with non-fish alternatives (e.g., algae, soybeans, oil seed, insects and bacteria). Waste byproducts could be turned into valuable co-products, providing new uses for products like fish skins (leather) and scales (solar applications). Or, new food uses for waste byproducts (such as cured roes or jerky).
Source: Jain 2017				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Data and monitoring technology	This driving force captures major changes in the types of data, data availability, and monitoring capabilities available to support fisheries management over the next 20 years.	NOAA has identified four strategies to keep pace with emerging data capabilities and technologies, including artificial intelligence, unmanned systems, 'omics (a suite of advanced methods used to analyze material such as DNA, RNA, or proteins), and cloud computing. New surveillance technologies like electronic monitoring and VMS will enable better data collection on fisheries catch and vessel behaviors. Remotely-sensed data from unmanned systems and tagging of living marine resources will improve surveys available to support fisheries assessment. The use of cloud computing will allow all these new data sources to be processed more efficiently, providing closer to real time information to decision makers.	What new technologies will develop in the next 20 years that are not available today? What will the legal framework for data and monitoring technology look like? How will it relate to fisheries management? How will public and stakeholder support for the use of new technologies and data change?	Rapid advances in data and monitoring technology will challenge the ability of legal frameworks, fisheries managers, and scientists to use them in a timely, ethical, and rigorous manner to support fisheries management. New data and monitoring technology could replace the need for certain jobs associated with fisheries and create opportunities for new jobs that require different skill sets. The costs of R&D and purchasing new data and monitoring technology are enormous initially and decline as they scale. It is unclear how these costs can and should be borne by government, industry, and others.
Sources: Hazen et al. 2013 Kroodsma et al. 2018 Lynch, Methot, and Link [Eds.] 2018 NOAA 2019				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Fishing industry structure	Over the past 40 years, a combination of technology, regulatory and consumer trends has led to significant changes in the structure of the fishing industry, leading to greater concentration and less diversity amongst operators.	Most observers expect these trends to continue, resulting in more concentration, agglomeration and less diversification—in a similar way to trends in agriculture over the past century. Consolidation is evident in catch. In the 1980s, 22,000 vessels averaged $20k in revenue. By 2011, 5,600 vessels averaged $86,000 in revenue. Similar trends are also present in processing	How far will consolidation go? Could we see a future where there are just a handful of large operators and processors, and very few independent operators in existence? While consolidation is expected to be the main theme, there are still some significant pockets of diversification and specialization. Where will these occur? Will societal attitudes, consumer demand and technology lead to a reversal of concentration trends, and a renewal of smaller operators who bypass the main industry players and sell more directly to restaurants and consumers?	Greater industry consolidation and efficiency is likely to affect fishing community employment, and the character of fishing communities. In such situations, fishing continues, but fishing communities themselves are hard hit. In more rural and isolated communities, there may be few comparable employment opportunities as concentration increases (although this could change if new sectors such as offshore energy and aquaculture grow). If trends combine in favor of more independent operators, there might be new opportunities in marketing. Other non- consumptive services (recreational fishing, charters, wildlife viewing) could also be sources of revenue and employment.
Sources: Harvey et al. 2019 https://pacfin.psmfc.org/				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Aging of expertise and fleet	The average age of fishermen is increasing as retirement ages and lifespans increase, while fewer young people are entering into fishing.	2012 data (from West Coast groundfish trawl fishery) showed that over 27% of fishermen were over 61 years old, and this proportion has increased by five percentage points in two years. Conversely, the number of fishermen under 30 fell by 5 percentage points to 6% over the same two-year period. These trends are typically attributed to changes in policy (e.g., rationalization), resulting in fleet consolidation and increased cost to enter the industry. There are fewer family- owned fishing businesses as younger generations choose to move away from coastal communities.	How quickly, and to what extent, will the graying of the fleet continue? Global studies have shown more "climate losers" than "climate winners" in terms of impact to fish stocks from climate change. The increased uncertainty of what fisheries will look like as our ocean experiences changes will exacerbate this issue. Recruits to the fishing industry may be less likely to enter fishing due to such uncertainty. However, an aging industry can often provide space for new, innovative entrants and ideas to thrive. Could this happen in an important way on the West Coast?	An aging fleet will find it more difficult to cope with unpredictable changes in stock availability and other shocks to the system. An older workforce might have less incentive to invest in new gear and new technology, leaving the industry more likely to be influenced by larger vessels. Aging expertise and fleet might also be associated with a declining sense of community vibrancy.
Sources: Donkersloot and Carothers. 2016. Free et al. 2019 Russell et al. 2014 Schumann 2018 voices.nmfs.noaa.gov/collection/graying-fleet?page=1				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Coastal community development	Coastal community development refers to the social and economic evolution of communities along the U.S. West Coast.	Social and economic forces will change the characteristics of all communities. Coastal communities worldwide continue to see upwards trends in in-migration; this is true for the West Coast, where total migration rates are positive coastwide. These trends differ by individual community. The impacts of climate change, for example sea level rise and increased storm surge, will have direct impacts on community development. Existing governmental frameworks—federal, state, local—are likely not well designed to address the multiple, competing, and changing needs of coastal communities given expected population growth and increased demand on natural resources	Which communities will see development and to what degree? To what degree will commercial, recreational, subsistence, and/or cultural fishing be included in development? How and for whom? Will important ecological areas be protected and/or restored to ensure sustainable fishing and other natural resource goods are maintained? Will development occur equitably for different members of coastal communities?	Increased development without sufficient planning for fishing needs could result in unintentional loss of fishing opportunities of all types. Changing social fabrics of coastal communities could change the way fishing is viewed and valued societally, positively or negatively, impacting how development occurs. Increased development poses additional pressure on natural resources, particularly sensitive coastal habitats
Sources: Bagstad et al. 2007 Dolan and Walker 2006 Pörtner et al. [Eds.] 2019 www.census.gov				

Driving Force	What's this driving force?	What is predictable about this driving force to 2040?	What is uncertain about this driving force to 2040?	How might changes in this driving force affect the system?
Range shifts and productivity	Range shifts and productivity capture the predicted changes in geographic location of stocks and the changes in amount of fish that a stock can support removal of.	Under climate variability and change, some stocks may move north-south, east-west, or deeper, and some may expand or contract. Compared to other North American regions, the expected shifts in distribution in the CCE are relatively high, certain, and predominantly northwest. These shifts create a suite of challenges as existing management assumes static location of stocks. Changing conditions affect habitat and fishery bycatch rates, further complicating management. Oceanographic conditions greatly influence the productivity of stocks, for example habitat suitability like temperature, ecosystem dynamics like predator-prey relationships, and recruitment success.	What range shifts will occur, for which species, and in what direction/s? Which stocks will experience changes in productivity and to what magnitude? What associated management concerns—protected species, habitat preservation, social and economic goals—will be most impacted?	Shifting stocks will create challenges for managers as adaptation from a geographically static system to one that incorporates moving stocks is required. These challenges will be mirrored by fishermen and industry as they not only navigate a changing management system, but the on-the-water realities of capturing stocks. Changing productivity creates challenges for fisherman by adding variability. Although changing productivity and subsequent quotas are part of management today, the challenges that new conditions place on traditional stock assessment will additionally increase uncertainty around these assessments.

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Appendix B: Worksheets from December 16-17, 2020 Southern California workshop.

These worksheets have not been edited to revise or remove the workshop participants' emphasis fonts, emojis, or humor. Where needed, abbreviations have been edited for clarity. Questions without replies were unanswered by participants during the workshop.

Plenary: Regional Impacts of Fortune and Favor

What aspects of this scenario are particularly relevant for Southern California?

- Closest to reality for this moment and next 2-3 years, as far as rebuilding stocks, the marketing situation has turned on its head due to tariffs. Marketing has been strongly affected by COVID
- CPFV fleet HMS fishing has been exceptional, especially for P bluefin, wahoo, dorado, blue marlin
- For CPS fisheries precautionary management has excluded access to finfish stocks. But the markets need sustainable volume and our landings have been a shadow of traditional level recently. Maintaining access to CPS in the water right now is very important -- fishermen are seeing lots of sardines but can't catch because it's the southern stock. Any stock in waters below 62 degrees is subtracted. Species shift north is going to be a significant problem, including squid; the SoCA fleet will have diminished opportunity but we won't have access to fish shifting up from Mexico waters. Looking for help from the Council. Continuing constraint on our markets. Need more flexibility and science improvements.
- We have seen good fishing for HMS and other pelagic species. But nearshore species (e.g., barracuda) aren't doing as well as the pelagic species. So half day CPFV trips don't fare as well as long range trips. So it's uniform across all species.
- Related to less international trade; some bright spots in SoCA such as San Diego facilitating a lot of direct marketing; waterfront revitalization plays into that.
- Impacts on marketing and trade = we're already in it.
- SoCA could be in a good place in terms of range shifts
- SoCA is an extra prominent place in terms of extremely small scale fishing including semi-subsistence..
- More emphasis on eating local -- call out to pier and jetty fishing
- There is a long way to go on permitting and legislation to facilitate direct and local marketing.
- Fractured international relations could particularly affect HMS since the science and management occurs at the international level
- Climate shifts bring along ecosystem shifts as well, as much as we can lose fisheries there are also opportunities for new fisheries to be created. Like mentioned our geographic location really puts us in a center spot for the "best of both worlds" kind of fishing. With a shift in fisheries we could be either more dependent on other fisheries or become more independent.

What parts of fishing or specific communities in Southern California might be most affected by developments in this scenario?

- Different CPFV fleets and having to go offshore presents a challenge as far as maintenance and regulatory constraints. Recent tragedy of vessel fire will likely result in more regulation. Some boats will fall out of fleet and there's not the money to build new vessels. Fuel prices also increase costs if having to go far offshore. COVID social distancing is also an issue
- The smaller processors will be most impacted. The emphasis on direct marketing will cut them out and they will have to rely more on imports. Legislative developments will affect communities across the board.
- Fisheries that depend on international trade like spiny lobster, or processed overseas, will be affected if international trade is interrupted.
- Even the large processors will be affected if access is limited.
- The scenario indicates problems with weak stock management, which could be affected by ecosystem based managed; if the Council could adopt a more flexible approach managing on a complex level; consider stocks to coming up from Mexico
- Collaborate with industry on the science

Plenary: Regional Impacts of Blue Revolution

What aspects of this scenario are particularly relevant for Southern California?

- SoCA has been identified as an aquaculture area, which will pose challenges particularly for CPFV fleet creating competition
- Biosecurity - spread of pathogens from aquaculture farms, and they may thrive more in warm environment
- Another challenge is military operations and as Navy advances blue engineering they are doing more operations that exclude fishers. Example of autonomous vehicle testing, exclusion from San Clemente Island area.
- Commercial fleets will be impacted too by Aquaculture Opportunity Areas --
- also wind energy facilities will preclude fishing.
- Other types of energy facilities, which could have ecosystem impacts
- There are projects both at northern end of Southern California Bight (SCB) and north…
- Transboundary issues are also relevant to US-Mexico, especially if stocks move across that boundary
- [Could be F&F scenario] - greater pressure on coastal use could affect success of local marketing. The benign climate could help with local markets, people will still visit them in winter months.
- This scenario worse than F&F in terms of consistent supply. As stocks shift north, there are regulatory constraints on the purse seine fleet to fish in those waters. And no options to obtain state limited entry permits. This will really hurt local processing, example of San Pedro berthing permits. All of this will need more regulatory flexibility - federal and local. Serious competition for port access -- how to do maintain traditional uses?
- If less interest in commercial fishing, there will be less investment in fishing related port infrastructure. That will lead to a loss of traditional fishing knowledge
- [F&F could spur more investment in fishing infrastructure]
- Example of Ventura mussel farms as a means to increase investment in port infrastructure; something similar could happen in San Diego [possible silver lining]

What parts of fishing or specific communities in Southern California might be most affected by developments in this scenario?

- Losing access to squid
- SoCA has a lot more small boat fisheries… and prevailing winds allow access to the islands; it's almost always coming off our beam. This region will favor those technologies for powering vessels such as wind and electricity. [State/national policies for net zero carbon.]

What specific storylines could you imagine happening in this scenario in Southern California?

- Marine mammals and sea turtles impose constraints on HMS fisheries. And HMS fisheries are targeting transboundary stocks we see a lot of importance. An uneven playing field in terms of regulations of foreign fisheries versus domestic
- Lack of regulation in foreign fisheries could hurt protected species stocks, creating a vicious circle -- although greater international cooperation could address this
- Legislative actions not based on concerns of harvesters or subject matter experts; in whose interest are those actions taken? How to connect?
- As marine mammal stocks continue to increase - possible interactions with fisheries (trap, etc) - it may have negative consequences on those fisheries – i.e. what the Dungeness crab fishery is experiencing this year.

Plenary: Regional Impacts of Hollowed Out

What aspects of this scenario are particularly relevant for Southern California?

- Fish as boutique food … [Hubbs aquaculture operation for hamachi] High value low abundance fisheries a very real possibility. A $100 restaurant dinner for sardines. is another example of this possibility.
- Only markets that are very adaptable will survive. They will need to be flexible to process/market small volumes of different species
- Population density and gentrification on coast will add an extra level of pressure; coupled with changing consumer tastes will have a big impact ("fake meat" etc.) Sea level rise will also put pressure on coastal infrastructure. [Could be true for other urban coasts, Bay Area, Puget Sound]; impact on direct marketing
- Attracting new folks into commercial and recreational fishing is difficult. How many people will be ready, willing and able to jump into this industry/pastime? True in all scenarios but really brought into focus in this one. Particularly acute.

What parts of fishing or specific communities in Southern California might be most affected by developments in this scenario?

- For CPFVs this will be extremely difficult because low catch will reduce demand
- Wetfish fleet has produced the majority of commercial seafood, based in San Pedro and Terminal Island. But these volume fisheries will not survive on very low catch limits. Economic importance of squid. Loss of fishing infrastructure, especially San Pedro.
- This scenario could eliminate the CPFV fleet -- anglers monitor closely the catch and decide whether to go; also much fishing occurs in Mexico waters.
- HMS fisheries, highly variable conditions will particularly affect their occurrence.
- Further thought on Hollowed Out, related to Barb's comment: If local availability of popular species becomes less predictable, the higher prices which result when local catch declines may translate into increased demand and dependence on imports.

What specific storylines could you imagine happening in this scenario in Southern California?

- There is the possibility of fishing species to extinction as the fish and collapse of ecosystems as fish will be impacted from conditions from Climate Change which will be further exacerbated with more competition from fishermen and wildlife. Additionally, wildlife will have difficulty adjusting to extreme conditions due to lack of food. For continued survival, populations of wildlife will have to rely upon the good years of breeding as they may not be as successful during years where abundance is lacking. If this occurs over the long term, populations of marine wildlife will decline and face extinction.
- More offshore fishing in federal waters searching for fish -- an increase in fishing effort presents regulatory challenges

Plenary: Regional Impacts of Box of Chocolates

What aspects of this scenario are particularly relevant for Southern California?

- Flexibility is key. CPS fisheries fish on a complex [switching target]. Managers will have to develop flexible approach and work with industry on assessing stocks.
- Productive waters will be pushed against the coast, resulting in fishing nearshore; science will have to account for that.
- HAB/DA intensified will affect some fisheries more than others. D. crab clearest example.
- Vessel design -- at present vessels are specialized versus the old days of "combo vessels". This scenario may favor that approach combined with fuel efficiency.
- CPFV fishery, we've seen variability from year to year, vessels drop out in lean years and then capacity is limited when the fishery bounces back.
- Many of rules and regulations might have to be rewritten to help fishers adapt to possible new target species movement. Like was mentioned, more interactions with non-targeted/protected species can be possible. This could lead to new gear design etc.
- For biologists and management in this region and elsewhere, a lot of difficulty and challenges in monitoring populations of fish and impact on populations if fish are using different geographical areas and behavior where fish are occurring is unpredictable. Collaborative management efforts outside of this region would be needed to ensure that sustainable fishing is occurring if fish not typically seen in this region show up in this area.
- On Box of Chocolates, if we're expecting more variability and more unusual events, does that make us want to think even more carefully about where alternative ocean industries (aquaculture, energy) occur? In other words, will our target species be moving around enough that we will think about needing to retain larger areas available to fishing? This may be a particular challenge in So. CA. Always seems to be whether new competing uses are going to impact existing uses, and how to reduce that impact but, it may be that they cut off existing uses under a shifting baseline
- Will wind farms act as Fish Aggregating Devices (FADs)?
- How will more frequent/severe HABs affect fisheries? And if it closes down fisheries what do we do with those fishermen? What do we do for specialists when their fishery goes away?
- Already see commercial fishery dying over the past 20 years. And it will be a problem down the line. Permits are limited making it hard to jump in and out of different fisheries. Also, needing to switch between different gears is difficult - cost, etc.
- General observation based on Gary's comments (above): Greater uncertainty in fisheries may require a more flexible and rapid response regulatory regime in order to avoid inadvertently killing off fishing opportunity when conditions require quick adjustment.
- NEPA analysis - programmatic approach could be used to evaluate more flexible approaches. Perhaps more flexibility to make "in-season" changes.

What parts of fishing or specific communities in Southern California might be most affected by developments in this scenario?

What specific storylines could you imagine happening in this scenario in Southern California?

- Managers consider stock complexes and manage accordingly.
- Modernizing data collection -- example of electronic logbooks in CPFV fleet -- technologies to allow faster reaction times for fisheries and managers
- Our region becomes more similar to Mexico. This will require more cooperation with Mexico, because these will be the opportunities in the future. Much more dealing with transboundary management.
- Other thoughts (not necessarily BoC):
    - Maintenance of processing capacity.
    - What about a world with greater bacterial resistance affecting fish products?
    - We are in an energy transition. It's happening fast on land, especially in CA. It will affect power systems, refrigeration, and any other energy systems

Breakout 1: Implications for communities in Southern California

For each scenario:

1. *What will communities in SoCal be most concerned about?*
2. *What's happening that provides a potential upside for communities in SoCal?*

fortune & favor

Question 1:

- Nearshore fishing less attractive with the decline of kelp forests and related decline of fish species that use that habitat; as water warms, kelp recovery will be more difficult
- May need larger vessels to access farther offshore spp, possibly more of a distinction between nearshore and offshore fleets? Maybe loss of smaller vessels and loss of access to shorter trips?
- Drought may affect amount and types of nutrient runoff, consequently affecting nearshore stocks
- Increased tourism demand from folks escaping hot interior areas -- good for sport fishing, but increased competition for local resources
- Management needs to embrace new species (e.g. coming from south)

Question 2:

- More people interested in going fishing in the summers, when they're escaping inland heat
- As niche seafood becomes more popular, more accessible to local buyers, possible that prices on niche seafood comes down?

box of chocolates

Question 1:

- Becomes even more stressful to follow changing markets, adapt management processes
  More intense need for scientific monitoring so that we know whether species populations are increasing/decreasing or just moving; need for scientific flexibility in SoCal Bight

Question 2:

- Fishing businesses that are able to be flexible, could become ever more creative about marketing their seafood, create a rising interest in wild-caught seafood, maybe create foodie/dining experiences in coastal areas.
- Creativity in marketing could keep supply chain moving but with variety of species (more than the traditional "salmon, tuna" categories)

blue revolution

Question 1:

- Overall species decline is a concern, certainly in our ability to just have our fishing businesses survive
- Greater need to monitor stock status to assess whether historic West Coast species are surviving in their new/changed habitats/environments
- Need to revise and update our international relationships to account for different movements in species we manage -- current relationships may not address some of the challenges our species will face
- Possible big shift away from the seafood arm of food security -- fancier offshore species still available, but nearshore and frozen fish fillet species, or pier fishing species may be less abundant in SoCA (social equity concerns)

Question 2:

- Maybe brave new tech world will benefit us with more/better data that will help us better monitor our managed stocks
- We currently fish in Mexican waters for tropical species, so having those species move to CA/US waters would help us in requiring fewer and less complex permits for American boats
- Could new offshore energy areas serve as de facto marine protected areas (MPAs) that help rebuild/maintain declining stocks?

Hollowed out ☹

Question 1:

- Losing these industries would also be a giant knowledge loss, any new fishermen coming in would come into a really grim situation, possibly not understanding what we've had in the past.
- Loss of infrastructure will be critical, especially b/c there's already a lot of gentrification pressure, so where do ocean-dependent industries go, just disappear?
- If we're not able to track species/populations, risking extinction and ecosystem collapse
- Popular uprisings based on loss of food security (collapse of public faith in governance)?

Question 2:

- Reduced ocean use, lower pressure on ocean, possible for recovery of some species that are most resilient to climate change? (This is a stretch.)
- Housing prices will decline
- Could aquaculture succeed in this scenario?

Breakout 1: Implications for harvesters in Southern California		*For each scenario:* 1. *What will harvesters in SoCal be most concerned about?* 2. *What's happening that provides a potential upside for harvesters in SoCal?*
fortune & favor Challenges: ● Political climate ● Ability to adequately access stocks ● Loss of harbor infrastructure because landing volume doesn't justify allocating to fisheries including cold storage space. Volume fisheries /consistent supply underpin infrastructure provision ● Slow change and calm climate means more coastal development, gentrification crowds out fisheries (could be good for CPFV) ● Across scenarios, interannual fluctuations in abundance a reality already, it is a challenge for management, could become more extreme ● Self marketing technology to maintain power and freezers at home and ability to cut your own product project well into the future if certain regulatory constraints are relaxed. ● For CPFV external problems such as depressed economy or emission reduction requirements ● Climate induced interactions e.g. D crab fleet - humpbacks; management constraints ● Increasing struggles due to diminished harvest opportunity; northward range shifts limiting access; all sorts of follow on effects ● Stock variability Opportunities: ● We are used to managing in this sort of scenario even with known challenges ● Pursuing subtropical/HMS, good prospect for obtaining live bait ● Most fishermen will be able to make ends meet; ports will be able to make investments in infrastructure ● Rockfish stock rebuilding will create more opportunity in combination with local markets, +affordable permits ● Things will go along fine except for politics hindering us; SCB is already really variable so maybe climate change won't be that different ● Science improvements, more adaptability, hope for more access to fish, growth in direct marketing for small scale fisheries but doesn't help volume fisheries; need to be alert to changing social values; overall benefits		box of chocolates Challenges: ● Having the flexibility to switch among targets and modify fishing strategies frequently Opportunities: ● Golden opportunity for ecosystem based management focusing on stock complexes so fisheries can focus on abundant stocks when they are available. Ability to "roll with the punches." ● Some ports will have more opportunity based on experience with marketing different species. ● A way to expand the number of limited entry permits during boom times ● Call on the many top tier research institutions in SoCA to find solutions to variable conditions ● Create/preserve open access fishing opportunities ● NorCA fleets shift to more protected ports such as San Francisco or the SCB? But could be an opportunity in terms of rationale for more infrastructure Cross-cutting thoughts ● Flexibility ● Lack of new entrants ● Flexibility in assigning quotas ● Need more support for regular stock assessments, and related science improvements ● Need to change the minds of the protectionists to allow more access to fish ~ the political climate ~ conversely, figure out a way to get the environmentalists to have "skin in the game" -- appeal to common interest in consuming seafood and possibility of making it a priority
blue revolution Challenges: ● Ocean spaces used up for other uses; wind projects on edge of SCB; area closures for offshore rocket launches - uses we can't foresee that take up ocean space ● When major infrastructure gets diverted harbor districts will not be able to maintain it specifically for small vessels, less opportunity for a fishing opportunity ● Global protein demand spikes foreign fisheries and imports adversely impact domestic ● Transfer effect per above ● Marketing new species ● Increase in military testing taking up ocean space ● Fishing will not be allowed around floating structures due to anchors and cables [could we figure out a way to allow it?] Opportunities: ● Upside of technology: one-day shipping of product; pressures		Hollowed out Challenges: ● Extreme weather events/tides destroying wetlands; resulting of armoring of coastline has harmed nearshore fisheries; will there be "staged retreat" for multi-million dollar properties or more armor ● Loss of habitat such as kelp forests and rocky reefs impacting nearshore fisheries ● Current analogy is Fort Bragg nearshore Opportunities: ● Have to maintain to keystone species; send a life buoy to remaining species ● Avoid "long slow death" of fisheries; have to choose what infrastructure to save, and for what fisheries (we lose almost all commercial fisheries with many lobster, some salmon and live bait surviving) ● Extreme shocks could motivate radical action -- "pickled

will force people to adapt to more efficient systems suited for small producers ● New species appearing could present opportunities ● Progress in electronics and science leads to better understanding of when and where fish occur ● Increased rockfish availability backed up by ROV science to know which stocks are where ● Round herring is a Shared Ecosystem Component species that shows up occasionally - demonstrates need for flexibility [Round herring are pretty common off San Diego nowadays, however they make lousy live bait as they usually don't survive in our bait tanks] ● Offshore facilities could function as FADs, habitat for rockfish; question of whether they can be accessed ● Tuna grow out pens offer a good example of challenges and opportunities of offshore facilities: worked great as FAD until fishing vessel ran into it!		pyrosomes" ● Creatively in developing new markets for unused but periodically abundant species (e.g., red crab)

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Breakout 1: Implications for scientists/researchers in Southern California		*For each scenario:* 1. *What will scientists in SoCal be most concerned about?* 2. *What's happening that provides a potential upside for science and scientists in SoCal?*
fortune & favor Question 1: ● Similar to status quo (?) In that case, questions will be very similar to those of interest today; continuum of what is happening today, w/o major divergence from current questions of interest ● Might be a bit different; continued steady warming under this scenario => more species coming up from Mexico might require more international collaboration and agreements. More discussion of who owns rights to which stocks. Only just beginning, and will become more challenging over time if range shifts become more pronounced. Heatwaves like the recent one becoming more frequent could increase this dynamic. ● Upside to stability: not chaotic => predictable, planning for the future is more straightforward in this than other scenarios ● Long term, would have empirical evidence to back up that range shifts are occurring, if this in fact plays out. ● Need for innovative gears, bycatch mitigation techniques, help industry evolve to accommodate necessary changes ● How is gear developed here? Information on species behavior, in conjunction with current technology, inform fishing in a more productive, less detrimental way than current practices Question 2: ● Currently don't have good valuation of community impacts of local markets. We don't currently have good information on direct/local markets and if they become more important in this scenario, getting that info will be more critical to really understanding impacts on fishing communities.		box of chocolates Question 1: ● Unpredictability tends to make science reactive to new developments ● Fewer point estimates; more range estimates that quantify uncertainty (case in point: what is the threshold for "overfished" or "overfishing" if the results of an assessment are stated as a probabilistic range?) ● Challenges of communicating and interpreting risk for management become greater with increase in uncertainty ● Perceptions gap between science findings and fishermen's experience may improve due to greater availability of information to fill knowledge gap Question 2:
blue revolution Question 1: ● More demand for ecosystem science (E.g. "Are we on the verge of ecosystem collapse?") ● Economic expertise needed to quantify relationship between food web status and value of sustainable fisheries (or absence thereof) ● Not familiar yet with the impacts of new technology on fisheries => need to research the impacts ● Greater international coordination, cooperation information sharing in the interest of understanding the world versus self-interested science by individual countries ● Range compression leads to more data available(?) ● If aquaculture is able to raise fish that are currently overfished, might reduce pressure on scientists to answer questions on wild stock status ● More competing uses in the ocean might make it harder for scientists to do data collection (e.g. due to areas with new dedicated uses becoming off limit to NOAA research vessels) ● Likely more interest in a higher degree of spatial resolution in scientific conclusions Question 2: ● Demand for new science may increase (e.g. shift to aquaculture science): more opportunities for scientists, given need for new science. ● New expertise may be needed to answer questions that were not part of the past discussion.		Hollowed out Question 1: ● Scientists asked to provide greater resolution in terms of oceanic conditions ● Less money => less support for science => less work for scientists ● Less work for fisheries scientists, but more work for others who study the ocean ● Research on which stocks can be successfully exploited (and research on THOSE stocks) ● Given so much variability, where are we currently? ● How will food webs be affected is a question of interest under this scenario. Question 2: ● More demand for ecosystem science (E.g. "Are we on the verge of ecosystem collapse?") ● Economic expertise needed to quantify relationship between food web status and value of sustainable fisheries (or absence thereof)

Breakout 2: Potential actions for communities in Southern California		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
fortune & favor ● make sure the science can support future needs in tracking status of stocks in the future ● fishing communities will need to develop suite of flexible approaches which will depend on accurate and informative science on abundance and stock health (e.g. looking at higher buffers in stock Total Allowable Catch) this may require higher tradeoffs between conservation and access ● more creative patterns for how we are managing species with the introduction of new species; while still maintaining conservative approaches for the current managed species ● look for opportunities to engage the fleet and improvise data collection; opportunities to fill data gaps; collaborative efforts with nongovernment organizations and the industry to fill key data gaps ● developing thresholds and limits for monitored and actively managed species (e.g., marine heat wave and appropriate actions that fisheries can take to respond beyond current management limits) adding in fishery independent variables into the process ● using possible benefits of deeper water provided by offshore development planning (i.e. aquaculture and wind energy) to see that they most benefit possible growth of nearshore kelp ecosystems ● fostering/improving relationships with Mexico to use in helping address immigration of southern species for future management ● improve or further develop marketing of local available, familiar seafood ● find ways to maintain the institutional knowledge of participants in all sectors to capture the shifting baselines [more Sea Grant involvement] ● baseline data (inventory) for current coastal infrastructure similar to the habitat maps to see current and future capabilities understanding impacts on fishing communities.		box of chocolates ● Increase efforts or further develop new marketing of local available, familiar and mainly new seafood this will be critical for the greater fluctuations in availability ● includes the points in Fortune and Favor ● develop management structure that tracks the movement of stocks along the coast ● develop permit banking system for trading or loaning permits in specific areas while maintaining the overall harvest limits; provides more "real-time" accessibility to moving/ stocks (harvest trading; geographic banking units) ● provide more flexibility for fisheries to optimize fishing activity with changing conditions (e.g., crop insurance?? revisit established time frames for fisheries regulations -- permit timelines, stock threshold limits) ● need to build more bridges between the industry, fishers and management on improved public understanding of existing, changing future conditions and stock availability) [bigger role for Sea Grant] ● reframe the "climate change" discussion to remove the taboos to the idea ● consider the individual incentives for recreational anglers to find ways to increase their participation ● find ways to maintain the institutional knowledge of participants in all sectors to capture the shifting baselines [more Sea Grant involvement] ● baseline data (inventory) for current coastal infrastructure similar to the habitat maps to see current and future capabilities
blue revolution ● find ways to maintain the institutional knowledge of participants in all sectors to capture the shifting baselines [more Sea Grant involvement] ● baseline data (inventory) for current coastal port infrastructure similar to the habitat maps to see current and future capabilities ● consider forage fish roles and determine most critical domestic or international needs (e.g. aquaculture over direct consumption) ● double down on understanding baseline data for ocean zone planning and understanding the role and uses of fishing groups in those waters and ensure they are represented (commercial, CPFVs, small use fleet) so that their activities are accounted for and maintained prior to "yachtification" ● fostering/improving relationships with Mexico to use in helping address immigration of southern species for future management ● increase efforts to market immigrating species (to fishers, consumers) ● ensure that wildlife management is effectively protecting species dependent on fish species ● monitoring wildlife dependent on fish species		Hollowed out ● find ways to maintain the institutional knowledge of participants in all sectors to capture the shifting baselines [more Sea Grant involvement] ● baseline data (inventory) for current coastal port infrastructure (similar to the habitat maps) to see current and future capabilities ● develop permit banking system for trading or loaning permits in specific areas while maintaining the overall harvest limits; provides more "real-time" accessibility to moving/stocks (harvest trading; geographic banking units) ● increase our understanding of the ecological basis of the nearshore and offshore ecosystems to determine top down or bottom up importance to identify the least damaging opportunities for future consumption ● consider forage fish roles and determine most critical domestic or international needs (e.g. aquaculture over direct consumption) ● insure that wildlife management is effectively protecting species dependent on fish species

Breakout 2: Potential actions for harvesters in Southern California

For each scenario:

If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).

fortune & favor

- marketing
- co-management
- recruiting new commercial fishery participants
- reduce financial and social barriers to entry to fishery participation (government role)
- more balanced approach in international HMS management: Eastern Pacific Ocean-Western Central Pacific Ocean, US-Mexico, example is Pacific bluefin allocation to US, need >=1,000 mt for ranching to be viable
- Look to Japan to understand managing across aquaculture, artisanal, industrial fisheries

box of chocolates

- More rapid and better access to data
- Use fishermen to collect data to support real time management;
  - involve them in survey design;
  - subsidize sensor installation on FVs (high res sonar for stock assessment) - involve fishermen in data interpretation (leverage knowledge);
  - customize installations fitted to vessel characteristics for consistent data (feasibility?) - corroborate with catch;
  - data confidentiality issues need to be carefully thought out
  - connect human observers with electronic monitoring (observers focus on bio sampling (example of need for otoliths); electronic monitoring focus on compliance monitoring)
  - innovation to automate interpreting bio samples (e.g. otolith reading)
- When new species appear ...

blue revolution

- Get fishermen involved in aquaculture; need to bridge the divide (overcome fishermen's perceptions); fishermen become the "sea ranchers"
- Work on market niche differentiation of wild caught versus aquaculture
- Harvesting shellfish growing on offshore installations
- Industry involvement in siting decisions
- Science-informed reduce unknowns about siting decisions
- Understanding Ensenada "fishery ecosystem": fish pens, artisanal fishermen, CPS harvesters
- Fishermen could get maritime jobs on other ocean sectors
- Explore methods to "close life cycle loop"
- Australia: bluefin ranching knowledge

Hollowed out

- Fishermen involved in habitat restoration projects including invasive species (lionfish example)
- Fishermen reduce costs, new markets, new fisheries
- Innovating fish processing, preparation for new / unutilized species; examples include blue shark, opah
- Outreach to underserved communities to learn food preferences
- Food banks and other institutional settings (USDA policies)
- What if there's no fish to catch?
  - Fishermen could get maritime jobs on other ocean sectors
  - Affiliated onshore work
  - Ocean education

All scenarios, summarizing:

Marketing

- Greater support for sustainable harvest among fishermen to find common cause with environmentalists and the public.
- Take environmentalists out on fishing boats to get buy in.
- Educate the public about what [commercial] fishing is about. Not just innovative gears but existing gears. (Morro Bay co-op example).
- Similar to ecotourism; take the dockside market a step further into taking people out on the fishing boats. But issues with safety, liability.
- The dockside market is a (safer) opportunity for the public to interact with fishermen.
- Media role
- Commercial fishermen could speak to recreational fishing groups
- Aging of the fleet -- agriculture and land grant colleges; ways to bring young people into the fishery or make them aware. Junior colleges could have classes on commercial fishing and commercial fishermen could speak at high schools

Co-management / citizen-science

- fishermen are out on the water much more than scientists so there is a data gathering opportunity. Would require an education effort. Examples include the groundfish surveys that informed stock rebuilding.
- Greater collaboration with scientists on research and management using the exempted permit process
- Embed process: Document and allow for small fisheries targeting research when fishing
- Manage at the complex level

New entrants

- Upsell fishing as a career, reaching out to disadvantaged communities; first have to get people interested in fishing; reinstate public perception that fishing is an honorable profession
- It is very expensive to buy in many fisheries these days -- address the many barriers to entry; asset value of limited entry permits
- Big money in fisheries is gone so it's hard to find crew; in many cases one-man boat
- Government subsidies needed - engines and fuel / government buys permits …? (facilitates collective ownership)
- Co-op approaches to permits -- community ownership of limited entry permits / catch shares / fishing limits (gear, quota, etc.); mechanism to transition to this model
- New approaches shouldn't detract from existing investments
- Collectively owned permit / quota leasing

Breakout 2: Potential actions for scientists and researchers in Southern California		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
fortune & favor ● Need to be more aggressive in collaborations with Mexican colleagues (e.g. INAPESCA, Instituto Nacional de Pesca y Acuacultura). If we expect more fish and local abundance in our waters, need to collaborate w/ international partners to determine allocation available to U.S. fleet. ● Species move north in predictable ways (e.g. albacore have moved from San Diego in the early 20th century to the Pacific Northwest -- but not sure if this was predictable before it happened?) ● Change in general in fisheries science is complicated because it results in a period of uncertainty in the signal we think we are seeing; can be hard to get everyone onboard, given inherent uncertainty during period of change. Would be good to reduce the period of inaction due to the presence of uncertainty. Better statistical methods for quantifying uncertainty in the presence of limited data on changing conditions could help adapt to change. ● Predictive modeling could help determine if we are in "fortune and favor" world versus other scenarios. ● If we know we are in Fortune and Favor, scientists might be asked to consider what management measures would be helpful to maintain the best of all possible worlds.. ● CalCOFI asked the same question: What are we doing now, and what do we need to do in the future? Stated goal: Translate data on hand into more user-friendly product (temperature, species, abundance, harmful algal blooms, etc.). More "uncrewed" data collection going forward. ● Economics and social science considerations: More focus on local and direct markets to understand value and impacts of management on communities would be useful to assessing economic impacts. ● Emphasize the importance of management. ● Managers need to really focus on management that allows for flexibility and efficiency to address changing management needs; less management may be needed in this scenario. ● "Framework changes" rather than major management changes.		box of chocolates ● Need to be louder about need to fund research for ecosystem-based management because traditional stock assessment frameworks may be most vulnerable (to being not able to give good management advice) under this scenario ● Evolve how we're using information so that we're not so focused on single stock management. ● May be a need for scientists to be able to communicate what answers these new capabilities can provide. Potential for scientists to deliver more real-time information; managers need to figure out how to make use of this effectively in management to quickly take advantage of what we are seeing now and hedge for significant change around the corner. ● New technology for better monitoring creates an opportunity for scientists to translate predictions and models into usable products for management, etc. ● Scientists are needed with strong coding skills for creating graphical user interfaces and analyzing large amounts of data ● Fisheries management needs to adapt and operate differently ● Need to consider how to take volatility and uncertainty in conditions into account when determining regulatory limits, given underlying healthy stock conditions ● Need to be able to think more about how to adjust inseason management between Council meetings to maintain opportunity in the face of rapid change ● Adaptive management process at the Council is ongoing, taking into account what is known about stock conditions and how management should respond. But adaptive management is more about having a system of learning from changing conditions, and making management more responsive to rapidly changing conditions in a more automatic fashion. Truly adaptive management also involves taking on additional management risk in order to create more opportunities for learning from what is happening.
blue revolution ● Train / hire new expertise needed (e.g. aquaculture) ● Determine effects of new tech (aquaculture, offshore wind energy, etc.) on ecosystem and fisheries ● Range compression suggests studying which species are affected, species ability to adapt to a smaller range, impacts on population size, behavioral effects, how different species are affected, possible need for marine protected areas or other management measures, effects on fisheries that target species whose ranges were compressed (e.g. would shrinking fishing grounds lead to more conflict on the water between fishing vessels and fisheries that have less potential fishing area available) ● Scientists need to consider changes in fishery-dependent data, and fisheries independent data may also be affected. May need to extrapolate into areas no longer available to be surveyed (e.g. if alternate use makes traditional survey techniques infeasible) ● New technologies may be needed to survey areas where traditional methods don't work ● Science may require more collaboration between groups of		Hollowed out ● Consider work to more fully utilize the available catch (e.g. parts of fish not traditionally considered as food) ● Southern California's diversity and restaurant culture is conducive to experimentation ● Increase value of the catch through better marketing (e.g. to high-end consumers) or better product handling ● Need good science to keep management updated on the limits to which marine resources can be exploited in the face of deteriorating environmental conditions ● Less money for science, more money for other scientists, move towards uncrewed monitoring (get more resolution in monitoring of ocean conditions at lower cost) ● May be harder to send out crewed vessels to monitor ocean conditions, further supporting uncrewed approach ● From management perspective, need to think of "wild harvest" as a collective user group, rather than "swordfish fisherman", "groundfish fisherman", etc. The portfolio approach to fishing creates challenges for fishermen to adapt to greater uncertainty in

Breakout 2: Potential actions for scientists and researchers in Southern California		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
scientists who study different ocean uses (energy, aquaculture, capture fisheries, etc.) ● International regulations need to be adjusted to balance opportunity for domestic fishermen in the face of regulation against foreign fisheries which may be regulated differently. Under this scenario, may be important to implement restrictions on imports from countries with less conservatively managed fisheries sooner rather than later. ● Need to balance regulations affecting import fisheries versus food security needs ● Need to consider the implications of range shifts (e.g. highly migratory species) ● What can be done now in international context? One option: Informally start conversations and collaborations with scientists in other countries with shared fishery interests…		which species are available. ● Need for food web / ecosystem approaches to support need for fishermen to move in and out of different fisheries in order to survive ● Flexibility between fisheries raises question of possible need for a pan-fishery permit that gives right to participate in multiple fisheries in years when primary species is in decline and another is on the rise ● Congress has considered a federal infrastructure bill for years. West Coast distribution of communities into large urban areas interspersed with small ports with bad roads and poor digital resources begs question of what is needed for physical and digital resource upgrade to support market access to fishing ports. ● In Gulf of Alaska, some management policies inadvertently encourage fishermen to take out large loans to target certain species; consider the effect management regulations have on incentivizing fishermen to take on debt. Heavily-indebted fishermen invested in targeting a particular species or narrow range of species sets the stage for a future management dilemma, if changing conditions result in fishermen being unable to catch enough fish to service the loans. ● Encourage aquaculture development for native species with declining populations

Breakout 3: Looking Across Scenarios - Communities Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Southern California communities to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Maintain institutional knowledge
- Science & data - understanding baselines and where we're going so we can monitor changes and identify tipping points and manage in real time (as much as possible); include non-standard data, e.g. historical/industry/traditional/citizen science knowledge
- Strengthen international relations, especially w/ Mexico since we'll be seeing more warm water spp.
- Marketing as a category of action - it will look a bit different depending on scenario
- Develop policy for shifting stocks to be more ready for when they do shift (Make access privileges geographically mobile to track w/ species movement)
- Given offshore and shoreline develop, ensure all stakeholders participate in decision making so where such development is put is beneficial for the most
- Modernizing data sets/collection to support fast-paced decision-making

What actions are important to do because they prevent the worst-case situation?

- Make science a priority - to support good decision making and to prevent population collapses
- Develop policy for shifting stocks to be more ready for when they do shift (Make access privileges geographically mobile to track w/ species movement)
- Strengthening international relations and collaborations
- Harvest insurance to prevent total industry decline

What actions are important because it enables a good future?

- Passing down institutional knowledge to new generations
- Following sea level rise guidance wrt infrastructure
- Continue to engage industry in management given likely fast-paced decision making; ensure/increase transparency in decision making
- Diversifying fishing portfolios to allow for flexibility; and flexible management to allow for diversification

What actions help build flexibility to cope with the future?

- Diversifying fishing portfolios to allow for flexibility; and flexible management to allow for diversification
- Science & data - understanding baselines and where we're going so we can monitor changes and identify tipping points and manage in real time (as much as possible); include non-standard data, e.g. historical/industry/traditional knowledge
- Improving and modernizing data management including data collection and data distribution to support better decision making
- Ensuring proper infrastructure exists coast wide to accommodate range shifts

What should you stop doing given these scenarios?

- Avoiding acknowledging cause of potential scenarios
- Relying on single species to make a living
- Allowing for monopolization of fisheries by a few participants who are vertically integrated
- Expecting market stability
- Overfishing

Breakout 3: Looking Across Scenarios - Harvester Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Southern California harvesters to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Attract new entrants
- Co-management and cooperative research - involve fishermen
- Adequate funding (for co-management and cooperative research)
- Better predictive modeling of interannual fluctuations in species abundance and availability to allow fisherman to advance plan
- Improve international relations (esp. Mexico)
- Government assistance of activities that support
    - science and management
    - To act proactively and avoid disaster
    - Upgrade sensing technology
    - Bridging financial support when stocks are at low levels
    - Financial support more generally
    - Infrastructure maintenance and upgrades -- (funding for dredging)
    - USDA support similar to that for agricultural products
- Innovate co-management -- more efficient meetings / decision making process! (pros/cons of online meetings)

What actions are important to do because they prevent the worst-case situation?

- Global shift to net zero carbon emissions including carbon sequestration. Explore enhancing phytoplankton
- Without disproportionate burden to any particular user group
- Job training for fishermen that would allow them to use their boats for other purposes
- Leverage fishermen's knowledge

What actions are important because it enables a good future?

- Permit flexibility, no matter how achieved - more socioeconomic considerations in decision making, especially in crisis situations
- New entrants: Job training and marketing of fishing as a way of life
- Marketing fish and fisheries to the public in a positive light (Seafood Watch program as an example)
    - Communicate what we are about and fisheries that do great things
    - Fishermen as conservationists
    - Product promotion - branding (similar to Marine Stewardship Council [MSC] but on a local/regional scale)
    - How do you beat the public perception that our fisheries aren't well managed? (e.g., terminology - overfished vs. depleted)

What actions help build flexibility to cope with the future?

- Longer term thinking about port infrastructure; for example, ports that may become unusable if storms are more frequent and severe. In the SCB Ventura is the main example but also Oceanside.
- Allow more species flexibility
    - e.g., allow some commercial harvest of recreational only species -- but avoid recreational fishermen selling fish (like Pacific bluefin
    - Newly occurring species
        - Wahoo
        - Southern sardine
        - Round herring
        - Incidental catch
    - Consistency of supply with variable catch (species)
- "Permit banks" -- community organizations (combine with co-management concepts)
- Accommodate more geographically mobile fishing strategies

What should you stop doing given these scenarios?

- Static permits / inflexible regulations
- Management workload

Breakout 3: Looking Across Scenarios – Fishery Manager Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Southern California fishery managers to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Build stocks' statuses to levels where we're not managing overfished species; however, we may not be able to avoid collapse of certain stocks;
- Have a management framework that allows for more inseason and interannual flexibility, use more data inseason, respond inseason;
- Broaden fishing portfolios -- how can management make it easier for fishermen to work in multiple fisheries?
- Understanding of stock status, dealing with international management, need to expect more interactions and engagement with multiple nations and within RFMOs;
- How can management foster an environment for innovative research: gear development, stock assessment advances
- EFPs take soooo long to develop new/revised gear types -- how can we speed that up? Also, can we make the EFP decision-making process more efficient, sort of narrow down the minutiae that the Council has to consider? Maybe Council doesn't have to weigh the merits of each application, but NMFS to develop a program under which industry participants could apply directly to NMFS under broad parameters, not getting Council into nitty gritty.
- Be more visionary about programmatic analyses, NEPA/ESA/etc; provide more education about how to deal with uncertainty and risk?
- Aquaculture -- if we're going to pursue that off our coast, how can it be designed so that it better incorporates local fishing businesses? Prioritize native species? Offshore tuna ranches fed with local forage fish?
- How can the Council rethink its own process so that it's less clunky -- are there actions that can be taken via short online meeting in between the ponderous five in-person meetings per year, hopefully shortening those in-person meetings?
- Permit banking, permit leasing, some sort of pan-Federal permit system so that when some stocks are low in some years, fishermen who target those stocks can flex into other fleets. Also need more flexibility between areas so that fishing effort can be moved around to where stocks are distributed in any particular year.

What actions are important to do because they protect us from the worst outcomes ~~prevent the worst-case situation~~?

- Outreach to underserved communities -- Council needs better outreach. What are food preferences, what is their vision for the future? How can we rethink the species and cuts of fish that we're marketing?
- Do more work towards ecosystem-based fisheries management, better understanding of ecosystem interactions to more clearly understand where and how species are moving, how productivity is changing?
- Management needs a foundational plan/belief/goal as far as what it is that they want to accomplish through management. They need that foundation to keep in perspective what their management actions are doing, prevent too much political influence pushing them from one action to another. <u>It is there, if we look at MSA, particularly OY sustained over time, connection with communities emphasized over time. Maybe the Council needs to come up with some big picture goal, state-of-the-union, key priorities at the beginning of each new management cycle, not just "we're doing it again because the calendar has moved forward," but what goals are we trying to meet this time?</u> (Take the NEPA **Purpose and Need** discussion seriously, not turn-the-crank.)

What actions are important because it enables a good future?

- Finish the Swordfish Management and Monitoring Plan
- Managers really need to start learning to think outside the box -- we've always done it this way, so we're going to do it that way again next year, push the boundaries of what we do or we're never going to find anything that works better than what we've been doing. If you don't do this, there's always going to be more work than there's time to do it.
- Look for more ways to work with SeaGrant, leverage relationships with/through SeaGrant

What actions help build flexibility to cope with the future?

- All of the above
- Real-time monitoring, better data, monitoring equipment on the vessels
- Identify the science needs that will help us manage the way we want/need to manage, allow us to be flexible.
- How to take risks so that we're learning from those risks -- do we have the science in place to help us understand and learn from our risks?

What should you stop doing given these scenarios?

- Stop being reactive all the time and start looking ahead
- Stop giving in to political pressure and getting distracted from the main missions, stop taking actions without taking into full scope of fishery, or multiple fisheries, into account
- Stop taking single-species, or single-FMP actions without understanding the interacting effects of those actions on other fisheries
- Stop being so devoted to doing things the same way that we've always done them.

Breakout 3: Looking Across Scenarios – Fishery Science Priority Actions

Review your suggested actions across all 4 scenarios.

What does this tell you about the priorities for Southern California scientists to prepare for these futures?

- Communication and collaboration between scientists, managers and general public is essential. The fishermen and conservation authorities have a common interest in resource conservation, as sustainable management helps ensure the fisherman's source of livelihood.
- Work with industry to develop local markets, to reduce dependence on imports and improve domestic food security
- Managers and scientists need to share knowledge, rather than keeping it to themselves or within their own colleague groups
- NOAA Storytelling for Scientists workshop (last week) emphasized the importance of scientists writing their papers and communicating their findings in a way that reaches the general public at a level they can understand.
- Fishermen spend 280 or so days at sea per year, versus 20 days to two months at sea for scientists. Suggests the possibility of asking fishermen to assist in data collection, to support science and management decisions.
- Same approach used to encourage fishermen to trust NMFS observers is an approach that might be adapted to getting better communication between scientists and the general public and industry. Generally speaking, more connectivity between different parts of the fisheries science and management process could be helpful.
- New survey and data collection needs, including economic data collection, are an overarching concern across the four scenarios. E.g. Hollowed Out scenario may not only impede fisheries, but also traditional data collection. Different scenarios pose different data collection needs, and possibly different strategies for collecting data. New technologies mentioned in several scenarios could also help make management more agile.

What actions are important to do because they prevent the worst-case situation?

- Improved data collection and more flexible, rapid-response management can help head off the worst-case scenarios that may emerge with rapidly changing conditions. Need to ensure decisionmaking keeps up with the pace of change.

What actions are important because it enables a good future?

- Figure out how to bring back younger fishermen. Media can play a vital role. Have to make a convincing case that hard work, incursion of debt, and cost investment in starting a fishing career will be rewarded with fishing success and financial return on investment.
- Provide adequate funding to support the investment in new approaches. E.g. EBFM is not adequately funded to implement it well. Need to replace unicorns with qualified expertise. Also need to overcome inertia in current reliance on single-species assessment.
- Many other countries have effectively developed aquaculture to supplement wild harvest (e.g. salmon aquaculture in Norway, bluefin tuna farming in Australia).
- Management needs to change their approach for science to change. Leadership needs to be on board in order to support the necessary science. Consumers of science can help lead the direction of science producers to address emerging challenges.
- There is a great deal of ecosystem science going on, but managers are not sure of how to utilize the information in their decision process. It's not clear how emerging science should be incorporated into the management process. The current scope of decisionmaking is geared towards single-species management or related-species group management, rather than an overarching ecosystem approach.
- Council and regulatory process is set up to support Magnuson-Stevens Act approach, which mandates single-species management. May require new interpretations of existing law, or revision of laws to support a shift to ecosystem-based approach.

What actions help build flexibility to cope with the future?

- Need to plug ecosystem based management more, given evolution from single-species management to overarching, cross-species management of the ecosystem. Prioritizing people with a focus on ecosystem approaches is a first step.
- Scientists need to recognize fishermen as the primary users of fish stocks.
- Think of effects of pollution on climate change.
- Need to address regulation at an international level, not U.S. only. Hold other countries responsible for their environmental impacts; a U.S.-only approach to ecosystem and environmental impacts related to shared stocks creates an unlevel playing field.
- With range shifts, need to collaborate with Mexico; HMS requires wider international collaboration. The need for more extensive collaboration comes up across many scenarios. Existing collaborations should be adjusted to enable more rapid adjustment to quickly changing conditions.

What should you stop doing given these scenarios?

- Move away from studying individual species without considering ecosystem context. Move away from studying ecosystem without considering human context.
- Reconcile or replace traditional single-stock approach to assessment with emerging needs for ecosystem-based assessment approach. Many fishermen have multiple permits, which makes them intrinsically dependent on multiple stocks.

Appendix C: Worksheets from January 13-14, 2021 Northern California workshop.

These worksheets have not been edited to revise or remove the workshop participants' abbreviations, emphasis fonts, emojis, or humor. Questions without replies were unanswered by participants during the workshop.

Plenary: Regional Impacts of Fortune and Favor

What aspects of this scenario are particularly relevant for Northern California?

- N CA between warm and cold water producing high variability.
- Impact of weather as evidenced by fires. Particular impact on salmon but sediment runoff could affect species in the marine environment.

What parts of fishing or specific communities in Northern California might be most affected by developments in this scenario?

- The small vessel fleet is declining for a variety of reasons due to consolidation of buyers (evident in D. crab fishery). This connects to specific communities.
- Shrinking of fleets is not confined to small boat fleet.
- Loss of infrastructure; competition among coastal uses (tourism businesses edge fishing related businesses). A warming climate could drive an increase in these nonfishing uses on the N CA coast.
- The biggest cold storage plant in N CA closed in 2008; an example of being challenged by infrastructure loss.
- The Coastal Commission is a very important player in determining coastal dependent uses.
- Range shifts are not accompanied by the ability to open and close fisheries in response. A community doesn't get any benefit from the availability of such a stock. Particular impact on small vessel fleet.
- Decline of small boat fishery may be due to management policies
- (Potential) Competition with renewable energy facilities [more relevant to Blue Revolution but it is already happening in our region]
- Growing interest in local seafood
- This scenario may make commercial fishing more attractive to new participants. Currently there are high barriers to entry including costs (permits, vessels) and social preference for "white collar" or service sector jobs.
- Similarly, recreational fisheries participation could grow with increase in species abundance coupled with social desire for more interactions with the environment.
- There could be a positive tipping point, coupling the eat local preference and related recreational fishery growth
- Higher variability has resulted in fewer buyers conflicting with variability in fishery participation. People enter the fishery in good years but when things go down prices decline forcing people out of the fishery.
- Fishery consolidation could work against a buy local trend.

What specific storylines could you imagine happening in this scenario in Northern California?

- We experienced a northern shift of CPS a few years ago and the infrastructure in nearby ports wasn't there including offloading facilities and roads inadequate to trucks hauling fish from isolated ports. Increase in commercial fishing also coincided with increased tourism.

Plenary: Regional Impacts of Blue Revolution

What aspects of this scenario are particularly relevant for Northern California?

- There will be a need to tap into new data streams to facilitate spatial management of ocean uses. The energy sector has much more financial clout than the fishery sector so there will be a need for collaboration in this regard (and in arriving at beneficial outcomes).

What parts of fishing or specific communities in Northern California might be most affected by developments in this scenario?

- How does the Department of Commerce support the fishing fleet in the face of expanded ocean uses for energy and aquaculture? (This support needs to be from a higher level than the Council.)

What specific storylines could you imagine happening in this scenario in Northern California?

- Wind power happening now with potential siting on fishing grounds. This includes the laying of submarine cables. The permitting process has not adequately addressed these impacts. Fishing community concerns are being disregarded.
- This is the direction we are heading in N. California.
- Aquaculture could expand as an ocean use as well.
- The development of a mixed use plan for ocean use similar to terrestrial plans is needed
- D. crab task force is an example of what will be needed when protected species are concentrated in certain areas and interactions with fisheries increase.
- Non target species impacts: will burden fishing communities and fishery managers with task of developing more dynamic management responses. Will we have the capacity to do that, especially in a fast changing situation?
- MPA (NMS) management -
    - regulatory framework focuses on habitat protection. Alternative energy platforms are prohibited in many of the west coast sanctuaries (may be allowed in some in limited circumstances).
    - consider resiliency of top level predators including promoting forage fish protections. This could also benefit fishing communities
- More effective tools and processes to make siting decisions. So far [NMFS] aquaculture has done a much better job than energy regulators [Bureau of Ocean Energy Management (BOEM)].
- Fishing associations are mapping generic fishing grounds. (Current characterization of fishing grounds is not accurate.)
- Critical to think about the change in fishing grounds in relation to other (future) ocean uses?

Plenary: Regional Impacts of Hollowed Out

What aspects of this scenario are particularly relevant for Northern California?

What parts of fishing or specific communities in Northern California might be most affected by developments in this scenario?

- Potential loss of fishing leads to the growth of non-water dependent coastal uses. It will not be possible to get that space back for fishery/water dependent uses.
- Severe weather and tidal influx will force the relocation of coastal infrastructure especially for small boat fleet
- Could offshore development provide benefits to coastal communities as far as fishery related infrastructure? Are there common interests in this regard that could be leveraged?
- A significant shift in how coastal communities are supported. For example Bodega Bay and … would get more support from other economic activities. Shift from "fishing community" to "coastal community."
- Recognize that all fishery sectors share common interests, especially when it comes to infrastructure. (For example, lobbying Congress for support in this regard.)
- Could offshore development benefit fisheries/fishing communities? So far mitigation programs have been problematic, varied among fishing communities. The example is submarine cable mitigation in terms of revenue stream directed to particular users. Skeptical that non water dependent uses are going to support fisheries/communities/infrastructure.
- Fishing communities need their self-sustaining social capital.
- If there is a high variability in fishing it will be hard to maintain fishing related infrastructure. There will likely be a need for government support when there is less steady revenue from fishing.
- Monitoring of product quality
- Need for mentoring programs to support new entrants.

What specific storylines could you imagine happening in this scenario in Northern California?

Plenary: Regional Impacts of Box of Chocolates

What aspects of this scenario are particularly relevant for Northern California?

What parts of fishing or specific communities in Northern California might be most affected by developments in this scenario?

What specific storylines could you imagine happening in this scenario in Northern California?

- The salmon industry provides a good example of conditions under this scenario, looking back at 2018. The salmon fleet was concentrated in Morro Bay, which hadn't seen that many boats in a long time. Since then the salmon have moved north. The point is, fleets will have a wide range of fishing areas and as they move, the ports will need to have the facility for periodic influx of vessels. Port managers will need to have a longer term view in terms of the level of infrastructure.
- This scenario mimics the 1982-83 El Niño in N. California. Many southern species appeared in the region. Fishermen could do little in terms of accessing markets for these species that appeared. A scramble to try to figure out how to capitalize on these conditions.
- Challenges to processors and buyers dealing with new species, increased costs will be reflected in lower prices offered to fishermen
- A recent example of having tuna unexpectedly appearing off Morro Bay. Not all fishermen could take advantage of that.
- A need for public investment in monitoring to have a better idea where species are.
- Bringing back the catch of the day concept to capitalize on more variable availability. Need connections throughout the community to address this. Could involve more local, flexible marketing.
- Technology increases the odds of success in fishing. Currently available technology for environmental monitoring by fishermen to predict where the fish are. Are there lower cost vessel monitoring systems? Development of common technology standards and platforms to lower cost. Opportunities to innovate in vessel monitoring to lower costs.
- Temper some optimism around variability especially in regards to HMS due to the international management framework.
- Need for interjurisdictional/transboundary management arrangements. Although N CA is "in the middle" these issues will affect adjacent areas with downstream effects on our area. If the "ends" aren't taken care of, our area will see greater pressure, for example due to vessels from those adjacent areas moving into our region.

Breakout 1: Implications for communities in Northern California

For each scenario:

1. *What will communities in NorCal be most concerned about?*
2. *What's happening that provides a potential upside for communities in NorCal?*

FORTUNE AND FAVOR

Question 1:

- societal values; moving away from globalization i.e local squid fisheries being impacted by climate variability
- current concerns of the unknown, year to year uncertainty
- there is a problem in gaining support and organizing fisherman themselves into common interest pools and organizing communities to engage the political process given the scale of the northern California region
- Need for mentorship of new participants and need for infrastructure to support
- Potential conflict in increased participation of commercial and recreational
- Support for local fishing can be enhanced by local markets which are not an easy programs which are difficult to establish. Direct market programs require a lot of effort initially and to maintain.
- Where and how will the fisheries leaders be developed and/or emerge. The fleet needs leaders to represent interests
- Gentrification and how to continue allow access for people to go fishing and support current coastal communities and fishing infrastructure.
- Shifting stocks and protected species (i.e. salmon) will continue to be an issue

Question 2:

- increase in support of local economy and purchasing local seafood
- Smaller communities are more connected to local economic features in their communities
- Could make commercial fishing for attractive to new participants
- Currently in a technology revolution and fisheries are using technology including NOAA data modernization platform allowing data to be more real time. This will allow for more data that can be used to create more nimble management
- More collaboration and co-management (at the local level) harvesters use of technology will allow more data in the public domain and thus more transparent
- Interest in local seafood means local governments will be more interested in supporting industry as well as interest in the development of new technologies
- CA Coastal act has protective language to protect fishing critical features
- Poised to benefit from shifting stocks as long as there is flexibility

BOX OF CHOCOLATES

Question 1

- In smaller coastal communities the infrastructure to get fish to market where roads, transportation are challenging can be hampered by insufficient infrastructure
- Need for consistency in markets and the yearly variability will make this difficult
- New species that are available may not have markets which will require more adaptability
- Need to promote and utilize other species as they become available
- Technology will need to improve in order to be more nimble, adaptive, and creative. Proper investment in data collection to add to nimbleness
- Need for more flexible management to allow for industry to take advantage of new opportunities
- Marketing efforts need to increase including buyers, restaurants by educating consumers on new products.
- Challenge for processors on how to train staff given changing species
- If wild fisheries are more variable than there is a concern to lose markets to more consistent products like aquaculture and manufactured proteins

Question 2

- Partnerships and learning opportunities between the fishing community and ag community to learn how to deal with variability
- Wild capture seafood could be marketed as more high-end as a market niche given low volume

THEMES:

Solution:

- Organizations (community and regional) are going to be needed to facilitate communication, supply leaders, and work with political entities. The broader the organization can be the better though this is a tall ask. More inclusivity with regards to fishery issues the better and will help industry and individuals be more resilient.
- Seafood marketing will be critical across all the scenarios
- Industry needs to be well organized and have strong voice and coordination. These scenarios will result in potential increased division between sectors and therefore organization and coordination is critical to prepare for these scenarios.
- Flexibility to deal with uncertainty. Including flexibility in management, infrastructure, markets, etc. Nimbleness and quickness in the management process (Council, state management, etc) to allow for timely responses.
- Being more **responsive** rather than **reactive**.

Question 1

- Spatial conflicts (open ocean) between aquaculture, offshore energy, and fisheries
- Energy and aquaculture sectors are well organized and how do fisheries counteract, given the public outreach and the money of the energy and aquaculture sectors
- On a cultural level there is more separation again through spatial conflicts creating an "us vs them" divide
- Not sacrificing MSA
- Not losing the cultural history and skills associated with fishing and fishing communities both the knowledge and the skill sets

Question 1

- Few stocks remain at harvestable levels
- Survival mode given the dire conditions which does not bode well for data sharing, collaboration, co-management, etc.
- New development of land based aquaculture which will outcompete wild fisheries
- Coastal infrastructure will not support fishing activities and access and coastal infrastructure will be at risk from inundation and erosion
- Losing the cultural history and skills associated with fishing and fishing communities both the knowledge and the skill sets.

Breakout 1: Implications for communities in Northern California		*For each scenario:* 1. *What will communities in NorCal be most concerned about?* 2. *What's happening that provides a potential upside for communities in NorCal?*
are not lost and are available in the future • Potential loss of fishing communities and jobs • Alternative livelihood in fisheries where members might need to diversify in order to maintain • If larger commercial operations are pushed out than there will be a loss of infrastructure for smaller vessels • Potential negative impacts to habitats due to offshore aquaculture and energy installations • Impacts to harbors and infrastructure to be dominated by offshore energy/aquaculture and this could change the community identity (i.e. Morro Bay) • As stocks and effort move harbors and communities may not have the infrastructure to accommodate shifting stocks Question 2 • Responsible Offshore Development Alliance (RODA) west coast chapter will emerge as an opportunity and voice for west coast fisheries • Potential shifts between industry (fishing, aquaculture, offshore energy) jobs • Increase in jobs potentially as a whole for the coastal community • Alternative livelihood in fisheries where members might need to diversify in order to maintain • "Rigs to Reef" might be a potential plus allowing more recreational activities		Ensuring that they are not lost and are available in the future • Harbors and fishing activities will need to migrate based on conditions Question 2 • If all the collaborators build a foundation that there is less of a breakdown given this scenario. This is the strongest incentive to build the most resilient management and community systems to prepare for this scenario. • New development of land based aquaculture allowing for continued seafood

Breakout 1: Implications for harvesters in Northern California

For each scenario:

1. *What will harvesters in NorCal be most concerned about?*
2. *What's happening that provides a potential upside for harvesters in NorCal?*

FORTUNE AND FAVOR

Challenges:

- Challenges to supply chain
- Scale of access to resources in the face of changing abundance. Cases where small scale fishermen could take advantage but it would problematic if larger scale operations exploited a resource that may be temporarily available.
- Management based on BSIA may lag the appearance of new species. Wrestling match between desire for access and precautionary management.
- Lack of human resources to analyze the data on newly emerging conditions. Need to recruit new/more talent.
- Careers in fishing have to be lucrative and viable. Harder to achieve that in an unstable environment. Linked to the need for the flexibility to capitalize on available stocks.
- While demand for seafood could increase, the challenge will be at what price point? Will domestic fishermen be able to compete?
- Who's going to teach new fishermen about stewardship?
- Costs will keep going up making it hard to get into a fishery.
- New entrants will need to learn how to participate in the management process to influence their fishery.
- Look at all these challenges in this more positive scenario! A lot of these concerns apply to all four scenarios -- especially the theme of flexibility.
- Interjurisdictional issues between Northern CA and OR.

Upside:

- With range shifts if there is a mechanism to allow fishermen and managers to allow fishing on those stocks, it would be a benefit [permit flexibility]
- Local access to new stocks depending on what barriers in place. (Barriers have been traditionally how to ensure stock sustainability)
- At least things wouldn't get worse! Things aren't changing from what we're experiencing today (we'll know what to expect).
- Flexibility will be especially important in this scenario to realize the benefits under this scenario. If variability is not extreme, it will be easier to come up with solutions, especially if we're not simultaneously dealing with other serious problems.
- Ecosystem abundance could encourage more fishery participation and more consumption of ocean protein (health benefits for society). Enhance public perception of fisheries too.
- Non-traditional distribution models would flourish, better compete against traditional marketing approaches.
- Greater dialog between fishermen and fishery managers.

BOX OF CHOCOLATES

Concerns:

- If offshore development is a factor, greater periodic abundance could increase conflicts among ocean uses.
- What if there is a boom year overlapping with a situation where more whales are around? Likely to be more tricky situations.
- Market responsiveness and flexibility -- lots of fish but no market or no port infrastructure.
- Science will be much more difficult -- hard to gather real time data about current status of the environment.
- With a lot of boom and bust cycles there will be more costs to fishing operations (& other elements in the supply chain).
- What are the social priorities for different species? i.e., conflicts between fisheries and protected species. Where is the balance? -- Have to factor in the changing abundance of protected species=whales, etc.
- Scientists/managers need to be more open to accepting data from the fishing sector. Need for rapid assessment. Fishermen will need to be willing to share data and managers willing to use that data.

Upside:

- If new technology is developed maybe some of it lowers costs.
- Environmental monitoring equipment could help fishermen to keep track of stock availability so they can be less frantic about jumping on new stocks.
- Technology to track abundance could allow rapid reallocation of fishing opportunities. But the technology needs to be coupled with responsive, flexible management.
- Even in the next 5 years the situation with salmon and yelloweye rockfish will push for flexibility.

Concerns/challenges:

- Aquaculture impacts including facility discharges and competition with wild fish. Potentially more competition from local aquaculture operations.
- Loss of fishing grounds to other marine uses. Right now it's submarine cables but could be other activities in the future.
- If you are losing "normal" species and seeing new species you may have a harder time keeping the market, especially locally.

Challenges:

- More frequent/severe storms will prevent vessels from getting in and out of harbors. It's already a problem and will get worse. (Santa Cruz, Half Moon Bay). Funding needed to upgrade infrastructure.
- Bridging fisheries, need to pivot among stocks,
- Harbor dredging requires certain permits and can only occur at certain times of year -- need to bring together multiple agencies

Breakout 1: Implications for harvesters in Northern California		*For each scenario:* 1. *What will harvesters in NorCal be most concerned about?* 2. *What's happening that provides a potential upside for harvesters in NorCal?*
• Squid harvesters have demonstrated flexibility in terms of capacity to offload product in different ports. That fleet adapts well because the squid resource can be quite mobile. • Depressed ex-vessel pricing across the board due to consolidation among buyers. • The bigger boats (>40 ft) have a capacity to follow the fish, which the smaller vessels can't do. That portion of the fleet would disappear. • You're not going to build a new fleet regionally; rather vessels will relocate. While there will be stocks available for local vessels, they could get crowded out at the dock by transplanted vessels. (The size and mobility of different vessels is a factor.) • Don't think we're doing ourselves any favors if we replace fishing with renewable energy generation. • Lack of commercial fisheries representation will impact the relative mix of ocean uses. • Squid is a good example of stock shift where landings are not being made by local boats. There's not going to be a local fishery on shifting stocks without support. • We don't have a seat at the table for fishermen to engage in the decisions about wind energy facility siting. Contrasts to the tools developed for aquaculture siting. Who do we have to convince to get a similar tool for other ocean uses? Potential upside: • More variation in species added to the local market base. COVID situation shows possibility of direct sales locally. • Pressure from competing users could motivate fishermen to unite to educate and advocate. • Another lesson from COVID is people's interest in cooking at home and trying new products presents new possibilities. • Possibly more consistent supply of squid and albacore.		and breaking away from the niches we each work in. • Loss of recreational fishing will also impact maintenance of harbor infrastructure. • Loss of community fabric as many aspects fall away. • Looking at the North Coast from a statewide perspective, will there be a decision to reallocate limited resources to maintain infrastructure in other areas. And this could pit communities against each other Upside: • Motivate greater collaboration among local/state/federal agencies • Example of fisheries sustainability plan for Eureka -- one outcome was recognition of the lack of social capital, meaning the connection with the greater community to solve problems. Most fishing ports don't have that. Made worse due to lack of interactions.

Breakout 1: Implications for fishery managers in Northern California

For each scenario:

1. *What will managers in NorCal be most concerned about?*
2. *What's happening that provides a potential upside for managers in NorCal?*

FORTUNE AND FAVOR

Question 1:

- Infrastructure as well as management structure may not be in place for handling species range shifts
- Changes to modeling information and understanding of what is sustainable (ocean acidification, ecosystem, food web). How will this affect harvest limits
- Migration of labor or mechanism needed to transfer permits (transferability processes for some permits, not all)
- Need for fishing gear, as well as monitoring adaptability
- Ability to identify ahead of time, the connectivity of critical habitats for various life stages of prey & predator species
- With info we have now, we are better able to predict major shifts (e.g. marine heatwaves). Emphasis on being able to model & predict these. Management should be more proactive in reading these major shifts, and better able to use the research tools that are there.
- Being able to have sampling in place for range shifts, and having the fleet ready to assist with sampling.

Question 2:

- More players in the game, more interest in being involved and invested in the future of sustainable fishing (helps managers get the info they need)

BOX OF CHOCOLATES

Question 1:

- Concerns could span all of the concerns listed for the three other scenarios
- Infrastructure as well as management structure may not be in place for handling species range shifts
- Workload - have to expand or broaden the amount of agencies who are involved with crossover issues.
- How do we allow more opportunity/educate new fishers when there is restricted access in place?
- How does management and society keep the fishing culture alive?

Question 2:

- Emerging technologies/advancements could help managers

BLUE REVOLUTION

Question 1:

- Workload - have to expand or broaden the amount of agencies who are involved with crossover issues.
- The mismatch and siloed conversations between agencies and stakeholders.
- Two national marine sanctuaries in nor Cal. Both older, and have strong regulations against disturbance. Only Congress has the ability to change regulations.
- Challenge for managers to determine regulatory what/where/who (what agency)
- Aquaculture is a complex matchup of interests. Tricky for management bc of established fishing grounds and difficulty sharing that info (due to confidentiality). Investment from afar, unfamiliarity with the area and its issues.

Question 2:

- More competition could push more interest/investment
- Conflicting interests are not insurmountable, it's doable, just takes planning. (e.g. sanctuaries are cognizant of maritime history and value of fishing history)
- All parties are interested in planning for the future
- More attention/investment in good science bc of the realization that it is now more important than ever.

HOLLOWED OUT

Question 1:

- Changes to modeling information and understanding of what is sustainable (ocean acidification, ecosystem, food web). How will this affect harvest limits. More resources needed for this
- The mismatch and siloed conversations between agencies and stakeholders.
- How do we handle severely reduced or recovering fisheries (from a management perspective). How do we ensure sustainability
- Does management's role become solely a disaster relief role?
- How does management and society keep the fishing culture alive?

Question 2:

- Ecosystem based management - where do we fit in to improve the ecosystem broadly.
- Potential increase in invertebrate fisheries

Breakout 2: Potential actions for communities in Northern California		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
FORTUNE AND FAVOR • More social capital and organizations • Build higher level support in the department of commerce (start with local representation engagement). Including more funding etc. • Need to allocate funds to a diversified portfolio of fisheries • Small business stimulus to have scientists work with new fisheries [Saltonstall-Kennedy (SK) funds currently works towards this goal] • Infusion of funds and people for habitat restoration (i.e. for salmon interests) need for cultural shift for leadership shift to address salmon issues (death by a thousand cuts) • Port infrastructure is a long term issue and needs to be addressed by specific components to identify which pieces are critical and fisheries specific activities that would need to have funding generated to maintain (potentially employ similar strategies as AG). • Create a real time notification for port access • Ice infrastructure requires large investment and maintenance with a feedback loop with fisheries (no ice no fishing, no fishing no ice) and keeping access to this infrastructure • Healthy fish stocks, infrastructure, markets, diversity of fisheries and gear types, supportive environment (government, community partners, etc.) are all dependent on each other. o Healthy Fish Stocks and habitat: Effective management, Local stewardship o Access: Fishing rights, Fishing grounds o Infrastructure: Ice, Fuel, Hoists, Storage, Processors, Mix of businesses o Markets: Diversity, Choice o Diversity: Fisheries, Gear types (at ports and for individual fishing businesses) o Supportive Environment: Government, Consumers, Community partners, Lenders/Business support • Robust data collection so that fishing communities and fishermen can be more proactive in responses on what is needed to take advantage of future opportunities. Data also allows for conservation goals to be met given variability. With more data, managers will be able to be more confident in decisions. • Different management mechanisms need a way to account for real time data streams and be able to adjust in a more timely manner. • To take advantage of local availability potentially have a set aside to allow for opportunities to a broader group (example adaptive management trawl individual quota program) • Key ways to get flexibility can require long timelines to get implemented • Way to promote and allow more access for fish destined for human consumption within an FMP as a set aside		BOX OF CHOCOLATES • Fishermen and ports have easy access to diverse portfolios • Diversification of portfolios includes • choosing between different fisheries (permits) • market development • infrastructure • increase information on availability (i.e. app) • Data will be critical as well and allow for fishery to take advantage of opportunity and meet conservation goals. Real-time data and technology will allow managers to be more nimble. • Advancing data limited models and technology through investment to develop and increase the acceptance of these methods for making management decisions • More collaboration between fishing ports with regards to collaboration between fisheries, managers, nongovernment organizations, etc. This could be promoted through cultural shifts as well as providing opportunities for different groups together through set aside funding, processes, and policies to promote this collaboration.
BLUE REVOLUTION • With regards to new species, acquire more information and data on how they interact with current species and create a better understanding of the fishery implications from these range shifts		HOLLOWED OUT • Build resiliency in remaining fisheries that can function in this scenario and that they are as strong as possible with regards to the needed markets and infrastructure that these fisheries depend

Breakout 2: Potential actions for communities in Northern California		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
• Efforts needed to engage fishery stakeholders and management that has supported fishery stakeholders and involve stakeholders in the process to thoughtfully engage relationships. Envolve communities in addition to fishermen in this process as offshore development is considered. • Fishermen would have the potential to diversify businesses by taking advantage of other opportunities provided by offshore energy and aquaculture. Building relationships between offshore investors and the fishing industry early in the process to foster local community involvement. An example of fishermen collecting data for wind farms: David Bethoney and his organization is the Commercial Fisheries Research Foundation http://www.cfrfoundation.org/ • Ensuring the fishing community and other stakeholders are part of these regulatory processes as these new developments move forward to ensure representation.		upon. • Marketing is essential to make the most from anything that is able to be brought into the market. • Science and data collection are essential to be able to make the most of any potential opportunities. • Boutique fisheries (due to low quotas) that are permitted could institute a lottery so that expectations are set in advance so that participants can plan accordingly. • Help to diversify fishery portfolios for business (permitting, financing to diversify permits, etc.) as well as diversifying ports • Ensuring that there is equity to ensure that the benefits from the small number of opportunities are distributed • Create a pathway to engaging legislators, and create multiple alliances to promote fishery and coastal community needs • Fishing community needs to actively engage with new CA state senator on fishery issues and create have established groups to promote and lobby for the CA fisheries and coastal communities(need to better organized as an industry to have better representation) • do we care who has access to fish

Breakout 2: Potential actions for harvesters in Northern California		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*

FORTUNE AND FAVOR
• Be prepared for range shifts: Southern California stocks appear more consistently in the area. How do gain access to them given management "boxes"? [applicable to all four scenarios]
• 3 options for individual response [also applicable across scenarios]
  ○ Identify new opportunities in invest gear for those
  ○ Move boat to more productive waters based on my knowledge
  ○ Sell out and retire
• Figure out how to sell directly from the boat, embracing social media to find new marketing paths
• Given constant production (compared to others) so best place to improve infrastructure, which is a gap in N. CA.
• In N. CA there is a huge opportunity for above marketing ideas because foodie culture is strong in the region and there is a lot of wealth here
• Infrastructure improvements are difficult but can be easier to get done compared to changing management to access new stocks (e.g., permits, gear restrictions)
• Programs to mentor new entrants: partner with educational institutions to bring in young interns; teaching kids skills like filleting fish, get them to think beyond college as they only path to a good career; Young Fishermen's Act is an example of legislation to accomplish this (and there are other examples of ways to open up alternative, non college career paths). Emphasize path - from deckie to captain
• Other examples of programs to encourage young people to get involved and motivate them to sculpt their future
• But don't necessarily discount value of a college education
• Fish moving in and out of our waters -- need to think now about interjurisdictional issues now
• Need to figure out how we do flexibility now without detracting from our current opportunities (robbing Peter to pay Paul)
• Limited entry programs - purpose has been sizing fishery to stock (mitigate overcapitalization); rethink approach (ex. trawl rationalization, loss of fleet in CA). Limited entry concentrates opportunity, coupled with ability to have multiple permits on one boat
• Example of opportunity of *de minimis* sardine opportunity; lower barrier entry -- managers need to figure out how to regulate small scale artisanal fisheries without harming the larger fisheries.
		BOX OF CHOCOLATES
		• Invest in multiple gear types to capitalize on different stocks when they are abundant
		• Get more real time data on stocks using fishing vessels as platforms (including recreational); investigate and develop new technologies for this that are affordable; this will facilitate a more nimble approach to assessment to management
		• Managers understand in real time, fishermen capitalize on that, markets set up to switch to different species
		• Develop methods to use anecdotal/empirical information within the science process
		• Accelerate transportation of product to market (coupled with expanded market access). Present day example: surf smelt available to catch with lampara nets. The limiting factor was markets not transportation

BLUE REVOLUTION • Very focused marketing because fewer stocks are abundant (perhaps hyper local) • Capitalize on fishermens' knowledge about habitats and ecosystem to work with other ocean users to mitigate the effects of those activities • Japan is a good example of extensive aquaculture coexisting with fishermen; co-ops are organized to both and figure out how make them complementary • Be "in the room" for political/policy discussions on ocean uses • Local markets and consumer education even more important in this scenario;		HOLLOWED OUT • Sell your boat and do something else… • Reduce debt and operational costs, crew, etc. Recognize reduced income stream • Fishermen will need to protect their position and be more vocal in management forums to protect what you have • Probably not a scenario to encourage new entrants to fisheries • Drive collaboration between local/state/federal agencies, and do it sooner rather than later • Create as much fluidity as possible among a much smaller number of players; this would be a wholesale change in regulating access • Figure out how to keep some remnant of the large, more

Breakout 2: Potential actions for harvesters in Northern California		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
• co-ops may be an effective mechanism to speak with a common voice on the range of issues we are talking about • Fishermen should be open to pivoting to mariculture (not Atlantic salmon but species more in tune with the local environment); mariculture could also attract wild fish to the area • "Regain community": fishermen need to come together - resolve inter-sector conflicts and understand we're all in this together; organizational reps (FMAs, agencies, etc.) talk to local fishermen and regain their trust. We have lost culture and values of our parents' generation in terms of social cohesion and need to regain that • HFMA is working with mariculture operation knowing we can't stop it and need to mitigate the effects; our approach is different compared to approach to wind power		industrial fleet since they provide basis for port infrastructure; IFQs might be one way to allow more flexibility to scale size up and down • How do we deal with stranded assets (e.g., vessels)? • Limited entry permits controlled by an organization that does allocation on some basis other than price; this is the only way to have younger, new entrants
Cross cutting actions/ideas • Flexibility - allocation, markets, … How to make it happen without being disruptive to existing plans to stabilize fisheries? Need to start thinking about this now before change creates acute problems • Marketing - develop strategies for different approaches to marketing • Engage in discussions around aquaculture and other ocean uses -- this does seem cross-cutting, not just Blue Revolution		

Breakout 2: Potential actions for fishery managers in Northern California		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
FORTUNE AND FAVOR • Do everything in our power to reduce hurdles to regulatory change / allow flexibility • Work with ports and fishing communities to ensure they are prepared for new species/fisheries/gear types/processing • Provide the ability to transfer the permit to a new person or new gear type • Provide flexible gear options/portfolio permits (for multiple species) • Use fishing cultural history as a tool for promoting and ushering through fishing community sustainability plans • Community-owned quota shares & leasing (e.g. Monterey) • Allow the connection between fishing industry and local community (i.e. reduce regulatory hurdles for ability to sell/buy local). Provide latitude in permitting local sales • Capacity-building technical support. Educate the public on sustainable fishing, available species, seasons, where the ports are, where you can buy fresh-caught fish locally (spread the word!)		BOX OF CHOCOLATES • Adopt new technologies for better monitoring - addresses/mitigates enormous uncertainty (e.g. electronic fish tickets provide real-time reporting and reduce management uncertainty for stocks with quotas) • Interdisciplinary approach to building digital capabilities, for more real-time monitoring/reporting/management. Frees up workload for managers • Digital opportunities to connect and submit reports are great for all scenarios, as well as sharing and analysis. • Educate the public on available species as they arise
BLUE REVOLUTION • Form new advisory groups to interact with various ocean-users (Habitat Committee serving that role now for all users) • Understand the effect that new structures have on fish aggregation • New analyses on how new structures will affect fishing grounds (e.g. wind farms). Where will that fishing effort go? • Strive for a competent marine spatial planning process and outcome • Aggregate/synthesize information from various data streams to provide a more comprehensive understanding • Consider how aquaculture can affect water quality and the integrity of the environment • Create a unified voice when it comes to knowledge/policy • Utilize interdisciplinary approaches to answer new questions/address new issues (whether intra-agency or across agencies) • Preserve infrastructure for ups and downs (short-term fluctuations) • Provide flexible gear options/portfolio permits (for multiple species) • Do everything in our power to reduce hurdles to regulatory change / allow flexibility		HOLLOWED OUT • Provide flexible gear options/portfolio permits (for multiple species) • Do everything in our power to reduce hurdles to regulatory change / allow flexibility. Find opportunities/maximize harvest opportunities and allow efficient access to them. Catch limits should reflect lower stock abundance • Prepare for more requests for experimental gear/fishery permits • Short term disaster relief: Prepare for more fishery disaster relief/overseeing those processes (review previous experiences, how could the next time go more smoothly/be more efficient). Preserves infrastructure • Long term disaster relief: Chronic situations must be addressed in a different way. Important to recognize when a fishery is no longer viable • Support small-scale wild-caught fishing (in depressed conditions, large-scale operations will likely flee). Large-scale, land-based aquaculture operations could still be supported • Correct/alter regulatory language to prevent getting sued! • Consider how carbon taxes will affect fishing viability

Breakout 3: Looking Across Scenarios - Communities Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Northern California communities to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Flexibility and nimbleness (fisheries, management, infrastructure, etc.)
- Increase Council flexibility for in season management processes (timeliness of responses)
- Investigate whether other Council's employ a grouping strategy like a group maximum sustainable yield (North Pacific Fishery Management Council) that could be used in the PFMC process
- Developing direct market strategies both regionally and at the local level to increase awareness
- Collaboration among Northern CA ports (i.e. form regional organizations centered around common interests like the Alliance for Sustainable Fisheries)
- Invest in robust data sets and technology to inform management decisions
- Streamline the federal exempted fishing gear permit process to make the process more efficient
- Investigate the feasibility for community entities/fishermen that hold permits to lease permits to help address shifting stocks and allow others to take advantage of available opportunities
- Increase political engagement to bring fisheries topics to the forefront

What actions are important to do because they prevent the worst-case situation?

- Making sure that there is basic infrastructure available to the fisheries
- Making sure that fisheries stakeholders are engaged and participating in the process
- Developing a new generation of fishery leaders and participants
- Investing in robust data sets to inform climate variability and the potential impacts of climate change on fisheries
- Maintaining and increasing funding where appropriate
- Establishing a mechanism for multi jurisdictional management of fisheries both domestically and internationally

What actions are important because it enables a good future?

- Partnering with the AG community to learn techniques for planning for unpredictability
- The role the fisheries play in the social context, consider how to switch or direct social trends that are pro-fisheries where possible (promote sustainable fisheries, local products, etc.)
- The Council should ensure that they have a process that this scenario planning process to move these actions forward
- Reconstitution of the West Coast Governors agreement to address multi-sector use ocean plans and ensure that all stakeholders, managers, are part of the process
- Tourism should be used as a natural partner to preserve fisheries and coastal communities

What actions help build flexibility to cope with the future?

- See above ☺
- Diversification of fishery portfolios
- Marketing diversification and building consumer interest in a broader group of species
- Creativity is needed in all sectors (management, fisheries, marketing, science, technology, etc.).
- Engaging new audiences and groups by bringing in new generations
- What should you stop doing given these scenarios?
- Stop status quo, in order to re-evaluate and improve upon the status quo
- Stop cutting science funding

Breakout 3: Looking Across Scenarios - Harvesters Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Northern California harvesters to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

What actions are important to do because they prevent the worst-case situation?

What actions are important because it enables a good future?

What actions help build flexibility to cope with the future?

What should you stop doing given these scenarios?

Permit flexibility

- Flexibility - allocation, markets… How to make it happen without being disruptive to existing plans to stabilize fisheries? Need to start thinking about this now before change creates acute problems
- Need to have a discussion right now around flexibility. Such a discussion needs to take into account potential effects on existing fisheries
- Permitting: consider state owned non-transferable permits.
- For new entrants: small allocation linked to merit based permit allocation
- Include a mechanism to cut off landings to avoid going over a quota
- Stability necessary, especially for capital intensive operations (big vessels but even smaller vessels can be very expensive); solution has to be scalable
- Alternatively, community owned permits, which is very scalable and can maintain stability
- Eliminate transferable permits entirely to address asset value inflation - there are historical examples of approaches like this (other basis for obtaining permit such as skill demonstration). But these approaches have not been popular / successful historically so have to figure out how to make them feasibility
- Need for training to accompany privileges that come with a permit (to operate "a monster piece of equipment")
- These strategies are especially important for community based fisheries, probably more applicable to smaller vessels versus "industrial scale" operations. And it's more likely that new entrants are going to start out in these smaller, community based fisheries.

Marketing

- Develop strategies for different approaches to marketing
- Consumer awareness
- COVID has been a real lesson in expansion of consumer tastes for fish
- Retailers doing a crummy job with handling and quality reflects poorly on fishermen and the industry; need to pressure them for quality
- Matching small buyers to small, high quality sources of supply -- especially for bycatch (nontarget) product landed in small quantities
- Fishermans' responsibility for product quality
- Skill set for promotion not natural for fishermen

What should we stop doing?

- Look for ways to reduce the barriers between different fisheries to allow cross participation (example of prohibited species regulations that require discarding) - another example is market squid bycatch by shrimpers

Infrastructure needs

- To facilitate flexibility, e.g., make facilities mobile…
- Loss of processing infrastructure means less capacity to adapt to different conditions
- Cost of living is increased in coastal communities so it may mean having centralized processing facilities in inland areas with fish trucked to them
- Fishery management agencies should pay attention to land use policies in the coastal zone so that fishing related infrastructure is preserved

Across the scenarios, what concerns you the most?

- Loss of the history and culture of fishing - fishing, fishing communities, ecosystem is not valued
- That we keep the same management processes without adapting to rapidly changing conditions; the management process needs to respond more rapidly based on the provision of real time data (electronic reporting/monitoring, big data); let's think outside the box from a blank slate to innovate the management system
- Losing the fishing industry because we can't replace fishermen that are aging out
- That we don't consider the ecosystem holistically

Science:

- Look at data from "abnormal" years to forecast what future conditions will be like
- Fishermen need to be part of the science and management process - cooperative research, view fishermen as collaborators, think in terms of "platforms of opportunity"
- Engage in discussions around aquaculture and other ocean uses

Breakout 3: Looking Across Scenarios - Scientists Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Northern California scientists to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Provide flexible gear options/portfolio permits (for multiple species). Do everything in our power to reduce hurdles to regulatory change/allow flexibility
- Anticipate vs react. There will be northward movement in most range shifts. Management needs to understand connectivity and where those EFH are. Anticipation allows flexibility
- Flexibility implies adaptive management
- Speed up management responses. Apply adaptive management in a more timely fashion
- Gathering information and data in real-time. Improve technology for doing so (electronic logbooks, data portals - e.g. CENCOOS, gliders, etc). Data portals (CCE-centric) especially help us anticipate changes in advance. Voice needs for what is included in data portals
- Utilize experimental permits for collecting new data
- Pay attention to the needs of local fishing communities and don't apply a broad set of rules to all
- Ensure equity so that limited opportunities can be enjoyed by all sectors
- Work on the dilemma of untangling the past as far as regulatory structure goes, pursue pilot programs that experiment with new regulatory structure
- Explore the use of different metrics used in management
- Bring stakeholders into more of the processes
- Provide incentives and alternate paths as opposed to roadblocks. Identify common purpose

What actions are important to do because they prevent the worst-case situation?

What actions are important because it enables a good future?

What actions help build flexibility to cope with the future?

What should you stop doing given these scenarios?

Appendix D: Worksheets from February 2-3, 2021 Oregon workshop.

These worksheets have not been edited to revise or remove the workshop participants' abbreviations, emphasis fonts, emojis, or humor. Questions without replies were unanswered by participants during the workshop.

Plenary: Regional Impacts of Fortune and Favor

What aspects of this scenario are particularly relevant for Oregon?

- When the resource (specifically crab) is low fishermen are more likely to reach out to local markets through direct sales. Will this continue when the resource rebounds?
- Relatively steady change in this scenario will make it easier to respond from a management perspective with reasonable confidence about assessment of stocks and related management decisions.
- In terms of range shifts, there is an opportunity for recreational fishing opportunity but need to think how those opportunities can be facilitated. Consider how this will benefit local communities. Opportunities can also connect people to the ecosystem.
- We will still experience extreme events even in this benign scenario. Oregon is in the path storm tracks which will change as weather patterns shift northward.
- Local markets favor fresh over frozen, advantage to smaller vessels.

What parts of fishing or specific communities in Oregon might be most affected by developments in this scenario?

- We've just experienced the loss of international markets for crab, blackcod, etc. coupled with increase in local markets like the description in this scenario
- Pandemic related shrink in restaurants has a big impact on processing/marketing. How will restaurants do business when (some) reopen?
- We have also seen interruptions in the supply chain because of plant closures due to COVID outbreaks. Similar to vaccine distribution in terms of logistics challenges.
- What happens to the fisher community? Recent events in the crab fishery are illustrative in terms of strike over prices. There are outstanding equity issues that would need to be addressed.
- Changes in the way harvesters behave (times and areas of fishing) will affect the research community since a lot of data gathering occurs on fishing vessels.
- With range shifts commercial fishers will need to gear up to harvest them. A contemporary example is the appearance of market squid off Oregon.
- It has been difficult for the Oregon trawl fleet to plan their operations over the past year, particularly because it is a high volume fishery that can't easily focus on local markets alone. There are also regulatory constraints that have combined with the effects of the pandemic.

What specific storylines could you imagine happening in this scenario in Oregon?

Plenary: Regional Impacts of Blue Revolution

What aspects of this scenario are particularly relevant for Oregon?

- More sophisticated data gathering will be necessary and provision of data in near real time. Example is putting oxygen sensors on crab pots to detect hypoxic zones
- Increase in autonomous data gathering needs to be accompanied with increased data processing capabilities. It is very challenging to stay ahead of big data demands when government resources for this are limited.
- Need to fish smarter, not harder.
- With offshore energy development there will be a reduction in fishing opportunity and will be more concentrated in some areas. This will lead to more interaction with protected species like whales and sea turtles. We will need to find new methods to protect these species from fishery bycatch.
- With wind energy development the key issue is marine space for the fishing industry. How much marine space will be taken up by energy facilities? While this may offer opportunities for recreational fisheries, it will present challenges for the commercial sector in terms of being able to make a living when fishing areas are constrained.
- From central Oregon to N. California is a very rich environment for wind energy development. Stakeholder groups like fishers need to be part of the conversation early with respect to siting.
- Oregon is likely to see offshore wind energy development.
- It will be necessary to look at the use of northward shifting species (such as forage fish) in aquaculture on other wild species that may be also shifting north.
- Demand from marine aquaculture for forage fish as feed stock could adversely affect wild stocks and related fisheries. Harvest of forage fish for this purpose will also affect other ecosystem components such as seabirds and whales.
- With the development of offshore wind it will be important not to chase what's "trendy." We will likely see a lot of government edicts and the fishing industry will need to be very diligent in terms of poorly planned development of these energy resources. A historical example is hydro development.
- With policy decisions promoting "blue/green" energy development, care will need to be taken of the full range of effects. (The Aral Sea is another historical development of poorly planned development with cumulative effects.)

What parts of fishing or specific communities in Oregon might be most affected by developments in this scenario?

- The fishing industry will need to modernize (propulsion) technology. Will it be economically feasible to do this when we are in a low abundance situation? [Recent announcements from the auto industry about going all electric are a harbinger of what could be applied to marine propulsion.] -- Another option to consider is sail technology for carbon neutral propulsion.

What specific storylines could you imagine happening in this scenario in Oregon?

Plenary: Regional Impacts of Hollowed Out

What aspects of this scenario are particularly relevant for Oregon?

- Loss of infrastructure is very relevant for Oregon. If your infrastructure goes away, even if environmental conditions improve the capacity for fisheries to rebound will be limited. Salmon has been a big driver of the historical loss of fishery related infrastructure, followed by groundfish.
- Coastal communities have become more dependent on tourism and recreation which has cultural implications.

What parts of fishing or specific communities in Oregon might be most affected by developments in this scenario?

- Fishers are likely to abandon their boats and there are not well developed programs for dealing with abandoned and derelict vessels. Right now it falls on the port and the costs of removing and breakup vessels can be quite high.
- This scenario will have a much greater impact on smaller, less diversified coastal communities that are primarily dependent on fishing. In response, we need to start thinking now about business/income diversification in these communities.
- Fishing dependent communities will need to develop more resilience. This will need to be a conscious effort by these communities. Resilience will include the development of reserve capacity to get through hard times.
- There will be a need for the fishing fleet to transition without becoming too corporate. The effects on small vessels needs to be considered in particular.
- Local appreciation for the environment in fishing communities will have huge implications in a larger political social context. Hopefully, communities will be asking questions about environmental conditions in this very adverse scenario.

Plenary: Regional Impacts of Box of Chocolates

What aspects of this scenario are particularly relevant for Oregon?

- As new species move in, there will be a need to reconsider the regulatory environment with respect to permits.
- Technological innovation to gather and process will need to be coupled with an agile regulatory response.
- A more agile/nimble regulatory response will be needed. We won't have the luxury to have a process that takes 2-3 years for a new management measure to be implemented.
- The scientific enterprise will need to better track range shifts. For Oregon the common division of stocks at the 40-10 line (Cape Mendocino) will be a factor. Stock boundaries may need to be reconsidered to accurately assess stock status.
- Discussions about management will need to be international as stocks cross international boundaries.
- Regional-scale sampling nodes, increase in research off the Oregon coast is very important. What has to be done to make that happen?
- The revolution in communications technology opens new ways to inform consumers about market/product shifts.
- Boom bust cycles make monitoring and assessment more challenging but it will be essential to allow predictability. New modeling approaches could help us to predict rapid change.
- Historically, variations in food supply have triggered new food production methods. So aquaculture could become an important source of supply in this scenario.

What parts of fishing or specific communities in Oregon might be most affected by developments in this scenario?

- Marketing will need to be more adaptable as the availability of species rapidly shifts.
- When new stocks appear, there will be a need to build trust of harvesters among consumers so they appreciate consumption of new stocks. There will be a need to encourage consumers to diversify their consumption habits.
- Harvesters will need to form good relationships with buyers and consumers. With a boom and bust situation it can be very difficult to re-establish markets once species become abundant again. Planning will be needed.

Breakout 1: Implications for communities in Oregon

For each scenario:

1. *What will communities in Oregon be most concerned about?*
2. *What's happening that provides a potential upside for communities in Oregon?*

Concerns:

- Status Quo: unpredictable fisheries, different environmental impacts, changing prices and availability, impacts to different sectors of the communities
- from processor standpoint- one size does not fit all especially for something that brings in 30,000-40,000 lbs-- does not fit the local market turn around
- rapid changes that require being nimble and agile→ how does that get put into the real world? ex. gear changes, how many different tools can you have on your multitool before it doesn't fit
- Keeping employment opportunities consistent in unpredictable markets is a challenge, mechanization is also a challenge: people start hoarding their money, don't invest in their plants etc.
- Aquaculture- both a challenge and an opportunity
- maintaining infrastructure in times where the fishery sways the other way, maintaining ice facilities etc. especially in smaller ports
- local markets-- what is the scale? just as much fish if not more, trying to move as much product as we have currently (offset from the volume that now goes abroad)
    - groundfish is super important in Astoria-- but need to move that local product to other areas -- regional scale networks and supply chains
    - domestic market v. local market
- Do we have the infrastructure to accommodate the different fleets needs and volume
- Radiation in tuna-- being prepared for the extreme events

Upsides:

- opportunity to create direct to market opportunities "selling off the boat"
- people themselves are agile and can adapt--> what are the upper limits to that flexibility
- Economic development: Tourist stuff→ economic viability, coastal development, revenue to offset the fishing costs. Plants are leaving and art galleries are coming in
- Aquaculture
- Increasing opportunity to develop niche markets to a group of restaurants or a group of direct buyers that understands the new expanded ranges -- distilling information to the public. Need infrastructure to go along with local markets
- Community Supported Agriculture model (or Community Supported Fisheries)- subscribe to a local set of boats with information and with fish
- Infrastructure that we have matches the communities that we are working in, how do we want to grow?

Concerns:

- smaller ports do not have a consistent flow of a single product, don't have the structure to keep going
- someone has to pay for it, cost associated with the infrastructure: owner or investment to maintain the infrastructure- have to have a plan of how you are going to support it
- hard to sell something if you can't say when, or if
- retail has consolidated (ex. Alberston's bought Safeway, Kroger bought Fred Meyers)-- they want absolutes so that you can fill the observes (<80% fill rate often don't want to do business)
- scale things down, how much revenue are you going to get in a local market?
- multi-species markets and infrastructure, transportation and cold storage, will need a smoothing factor, be able to move it around and keep it in good quality
- what can you do to piggyback on local infrastructure?
- flexibility and nimbleness to management- allow opportunities as they become available
- shift from one fish to another could be a challenge if not presented properly
- Aquaculture- space use conflicts, marketability
- moving to non-ocean protein sources-- because of extreme events making it more unpredictable & harder to harvest
- increase in unpredictability in choke species-- so the target might be there but the access might not be

Upsides:

- technological advancement to develop indicators, where managers can take advantage of indicators of fisheries that are up and coming
- partnering with other cold storage processors: what can you do to piggyback on local infrastructure?
- thinking outside the box of chocolates
- developing artisanal products -- make sure that the opportunities are available -- marketing opportunities
- Co-op type structures to take advantage of different markets and maintaining infrastructure
- shifting from fish to fish could provide an opportunity for education and how to prepare it, market development
- Aquaculture- helps to smooth out boom and bust cycles
- Aquaculture and wild caught be processed in the same plant - same infrastructure

Concerns:

- Alternative energy (offshore wind)- space and use conflicts, limitations to the fleets. If all of the affected stakeholders are not at the table, people can get left out
- cultural bias against adapting to service potential alternative energy
- unknown impacts of hypoxia, and other climate change
- loss of sense of community-identity→ some might not want to hybrid their activities

Concerns:

- It is awful!
- Not as many opportunities to engage in the fishing industry
    - finding culturally acceptable employment and livelihoods
    - generally-turn to tourism or other visitor based economies, often not accepted by the culture
- loss of identity
    - they don't fish, they are fishermen, that is who they are
    - how do we do that?

Breakout 1: Implications for communities in Oregon		*For each scenario:* 1. *What will communities in Oregon be most concerned about?* 2. *What's happening that provides a potential upside for communities in Oregon?*

• potential to lose the fishing knowledge
• potential loss of infrastructure
• Potential for boom and bust- in offshore wind, infrastructure -- the next generation might go with fusion energy. When you move on from wind energy the original fisheries infrastructure wouldn't be there
• challenges how we define communities :getting fishers to the table might be easy with the 12 month trawl fleet, might be harder to capture the folks who move (to AK), tuna stakeholders
• wages: regional markets instead of hyper local markets, we pay PNW better than many other areas
  ○ will our products be able to stand up in those regional markets at the price point that we are used to
  ○ make this region attractive but presents challenges when moving products out of the area
• How do we define community?
  ○ rural, traditional, families involved
  ○ who is included, there could be room to expand our definition to include DEI concepts
• How do we apply clean energy to the fishing industry?
• Challenges with examples that are going on on the East Coast with the fleets
• Wind turbine blade arc 700 feet(in diameter)-- might limit who can actually diversify into that wind energy industry
• outside group coming into-- transfer of wealth away from our small local communities
• cumulative impacts- ex.whale entanglement in dungeness crab fishery
  ○ would that make it too hard to continue
  ○ what is the right balance, between fighting climate change, having west coast energy, and continuing our fisheries
• what is the proper process to get the stakeholders in the room, so that we can ask the right questions?
• compensation for fishermen to attend meetings for their input
 	
Upsides:
• opportunity to bring people together and pre-plan
• fishing businesses diversify to potentially service that industry, develop niche fishing
• interesting alliances
• fishermen could be the ones who get cross trained to repair windmills (as an example)
• how do we define community?
  ○ rural, traditional, families involved
  ○ who is included, there could be room to expand our definition to include DEI concepts
• Innovations that could be applied to the fleet that is in the clean energy umbrella
• diversifying the data collection to involve more of the fleet could provide more live data that could feed into more agile management
• Is there opportunity to come in at a local scale, as opposed to a multinational company?
		• loss of critical infrastructure--impact to the tax base, water use, fewer kids, fewer people doing to the hospitals
		  ○ multiple effects-gear stores, cold storage
		  ○ don't have the ability to support the infrastructure for the few who can still fish
		  ○ lower wages in the communities
		• water is toxic, if not totally wiped out there might be some fishing opportunities
		• domestic relationships between states would need maintained-- if you only have one stock that is moving, it will be vital to be able to move "freely" between states or internationally
		• decrease in supply will increase value
		Upsides:
		• starts conversations in communities about what people can transition to
		  ○ What do we want to look like?
		  ○ We have the opportunity to put programs in place to figure out what we want to look like, training etc.
		  ○ We have the ability to craft the stories we tell right now, since we are planning now
		• Cultural component- other values other than the product. Focus on the community aspect, maintain support and invest in the enduring existence in the culture-- opportunity is that we can start telling that story and making that market for the community and culture of fishing
		• Finding the culturally acceptable livelihood that fishing industry can transition to
		• Aquaculture- protein base
		• increase in value because of decrease in supply
		
		Overarching across all scenarios: social marketing if we can get ahead of it on a global level

Breakout 1: Implications for harvesters in Oregon		*For each scenario:* 1. *What will harvesters in Oregon be most concerned about?* 2. *What's happening that provides a potential upside for harvesters in Oregon?*
Concerns: • Government agencies need to be adaptable in domestic and international management (this applies across all the scenarios). • The traditional user pay funding system will be challenged as the user base declines. This applies specifically to ODFW (state level). This is also an issue with federal agencies as well. Cost will have to be shared more broadly. • Interactions with marine mammals will change over time and management agencies will have to be proactive by finding solutions to mitigate fishery interactions. • A focus on domestic markets could challenge profitability for some fisheries and fishery targets. Many harvesters rely on foreign sales for some species (sablefish a prime example). Domestic tastes could make marketing hard. Some sort of fill in species will have to be found that are appealing to US consumers. Alternatively, methods to build the domestic markets need to be found. • [applies to all scenarios] Uncertain effect on traditional sources for capitalization. New capital will be needed but it is unclear where it will come from. The effect on permit valuation is related to this; permits are a big part of a firm's assets (and value could change). • Dearth of new entrants if fishing faces a bleak future. • The costs of gear innovation have to be considered in terms of economic feasibility. • There will need to be a faster process for developing and authorizing new gear types. And people with ideas about gear design/innovation will need to get out on fishing boats to see how those operations work. Collaboration among harvesters, researchers, and managers will be essential. Upsides: • With a stable and growing opportunities could allow new people to enter fisheries. It could allow small scale fishermen to diversify (similar in Box of Chocolates). • Harvesters using new and innovative selective gear could find a niche. Could offer new market opportunities. • Across all permit classes, a decline in permit value could have benefits such as lowering entry barriers, especially for people who are willing to assume risk of innovations. Likewise, crew could purchase permits to have a stake in fisheries. • This is the best of the four scenarios but there's always uncertainty when it comes to fishing! • Science driven management can continue under this scenario. • Potential buy in of communities based on fishing opportunity.		Concerns: • Caution will be needed in making predictions since we will experience new ocean conditions compared to what has occurred historically. Even with new technologies rapidly changing conditions will make modeling and prediction much more difficult. • Different knowledge domains between fishermen and scientists. • Distribution of protected species (leatherback sea turtles) presents new challenges. • Increasing need to control abundant protected species impacting other, less abundant species (e.g., sea lions versus salmon). • [all scenarios]: processing costs will go up with highly variable availability of fish. These costs could be passed onto harvesters. • [all scenarios] expansion of marketing boards. More collaboration and expansion of seafood awareness and promotion. • Processors will have to be more adaptable to varying conditions. Upsides: • Potential benefits for both small and large boats as long as there is flexibility. Small boats could do some of the Community Supported Agriculture (CSA) type stuff while large boats could travel farther to find fish. • Monitoring technology could provide more confidence in current ocean conditions could speed management decision making, opening fisheries for shifting, newly appearing species. • PFMC harvest strategies lend themselves to this type of scenario given experience with weak stock management. The basic structure of the management system could still function while the challenge will lie with fishermen figuring out when to fish. • Opportunity for technological innovation, for example in tuna fisheries. This would include forecasting habitat and the development of more effective fishing gear. • New markets will need to be developed with the appearance of new species the public is not ready for, especially if it's in large volume. • Direct to consumer sales could help fishermen adapt to varying stock abundance.
Concerns: • Other ocean uses (energy production) could displace fisheries; alternatively, fisheries could be destabilized and then pushed out. • Small vessels have a disadvantage because of the inability to travel longer distances to find fish. Bigger impact on ports with only small boat fleets. Could see further consolidation of fishing into a fewer number of ports. • Smaller vessels could benefit from "Locavore" marketing but this scenario would favor large vessels. • The disappearance of small vessels affects the culture/lifeways		Concerns: • Trickle down from challenges to recreational fleet in terms of the construction and sale of fishing vessels. Possible loss of production facilities when sales volume declines below some threshold. • Fishery managers are going to want to monitor fisheries more closely. This could increase costs to harvesters to an unsupportable level. • There could be a downward spiral of increasingly tighter management restrictions on fisheries. • Will we be less precautionary when constraints on fisheries

Breakout 1: Implications for harvesters in Oregon		*For each scenario:* 1. *What will harvesters in Oregon be most concerned about?* 2. *What's happening that provides a potential upside for harvesters in Oregon?*
of fishing communities. • Displacement leads to concentration of fishing in smaller areas; focusing on the species in that area leads to resource damage/depletion. • Loss of port infrastructure supporting the fishing industry if the small boat fleet declines. Fishing vessels displaced by sailboats/recreational vessels. • Competition for CPS stocks as feedstocks for aquaculture; loss of this forage for wild species. • The loss of small vessels will hasten the decline in community cohesion and social resources. If you no longer buy off the boats, there is a loss of a connection between communities and fisheries. You will also lose a lot of local knowledge. • Risk of corporate ownership of fishing sector. • Loss of connection to the ecosystem and coastal communities. • Due to lower fixed costs to fish and ability to share space with other users, small boats could fare quite well under this scenario, where fewer fish are available. They might fish in traditional sports fishing areas. This would present a challenge to large vessels, which would be a disadvantage. • There would be competition for crew who would be recruited to work on industry support vessels. (And those jobs could be more stable and better paying). But would those industries recruit from the same pool of workers? Upsides: • Large vessels/firms could benefit under this scenario. • Recreational vessels could fish around offshore facilities (wind energy). But need some sort of management regime to allow this. Prompts the need to think proactively about sharing marine space among different users. • Other ocean users (energy) could share in resource management costs. Plus those facilities could become monitoring platforms (or energy source for monitoring platforms). Could take some of the pressure of the fishery sector. • If offshore facilities can be an at-sea energy source it could help in the development of electric propulsion systems for fishing vessels. (But some skepticism about the feasibility.) • Sail power systems could be developed.		become extremely tight? This could have ecosystem impacts. • Direct to consumer sale will need to be facilitated. • Management regimes where fishing seasons are set independent of weather constraints (decline in fishable days) will need to be rethought so when good weather comes it's possible to fish. • The level of cooperation between harvesters and managers we have now could be eroded. There could be a real loss of trust among fishermen. This could reduce the potential opportunities that could be found through cooperation. The bad news going to worse news erodes these relationships. • Doubt the PFMC will allow overharvest (but conditions could be so bad that the management system can't cope). Upsides: • A more flexible experimental permitting system could facilitate needed innovation. • Catches could pay fishermen better as a boutique offering (high prices for limited supply). • Globally there are fisheries in similar environmental conditions as we would see off Oregon; we could learn from the adaptations that fishermen have made in those other parts of the world. • An opportunity to expand recognition of fishermen as food producers on the same scale as farmers are treated. There should be economic support to maintain the capital stock of fisheries. (But no takeover of fish management by the USDA!)

Breakout 1: Implications for fishery managers and scientists in Oregon		*For each scenario:* 1. *What will managers in Oregon be most concerned about?* 2. *What's happening that provides a potential upside for managers in Oregon?*
Concerns: • A lot of mistakes could be made, we may think that what has worked in the past will work in the future, science may lag which could lead to bad decisions. Scallop example - poor or incomplete science led to scallops being wiped out. • If change is gradual, the need for change in management and regulation may not be obvious, i.e. lack of urgency. • We could be complacent in data needs, we need to do better with the information that we do have and are collecting. Change is coming and we need to prepare for it even if it seems gradual. • Usual parameters for recruitment may not hold true under this scenario. It's a dangerous assumption that they will hold over time. • We need to look at global demand and how it is changing markets when thinking about impacts of ocean change and what fishers will have to cope with. • There is a need to better understand how biology will respond to changing ocean conditions, not just shifts in distribution but basic changes in biology (e.g. feeding, growth, reproduction, etc.). There is a lot we still don't know. Upsides: • We will have time to respond in a more measured way. • There will still be a good earning base for the fishing fleet and resources to support innovation to adapt to future changes. • We will have more time to improve societal narratives and behavior, and outreach opportunities • We have time to be proactive rather than reactive • There is confidence in science and our ability to prepare for change which could lead to more funding for science		Concerns: • Management currently cannot handle quick changes, we need 'if/then triggers', for example, so we can act more quickly. Need to update management to be more flexible. • We will be overwhelmed with data streams if we don't get processes in place. Need to process data faster so that it can be used in a more timely manner so we can react faster • Need more modeling / management strategy evaluations (e.g. whiting) to develop different scenarios and better understand how stocks might respond to changes, could provide a better understanding of risk and uncertainty. Could help improve and speed up the management decision process. • Because of the variability, there is a risk of undermining public confidence in our ability to model and predict the responses of marine resources to environmental changes to support management decisions. Upsides: • Again, opportunity for innovation, exploration of new methods, products, value added products, etc. • We will be forced to do more long range thinking. Need to take a longer view and look past noise / interannual variability • If some or several stocks do really well, we can feed a growing population • New technologies will really help fishery managers respond to real time conditions and lead to better management.
Concerns: • Immediate need for inclusiveness and good communication structure among different groups and sectors. Train is leaving the station and multi-sector activities are affecting fisheries/fishing grounds. • Communication is only as good as the understanding of legitimate information and critical thinking skills within the general public. This applies across all scenarios and especially in the Blue Revolution scenario because there are a lot of competing interests and information. • Changes in species' ranges will require the public to adapt to what resources are available. e.g. Dungeness crab and seasonal shifts / start dates of fisheries • Aquaculture concerns around siting, feed stocks, impacts of products competing with local fisheries, disease outbreaks; aquaculture species are replacing wild caught species, it will become even more important to know where fish are coming from (e.g. aquaculture vs. wild) and about the sustainability of aquaculture and fisheries. • How will wind turbines impact fishery independent surveys? How do we need to adjust to provide accurate info for stock assessments? • We will need to consider ecological impacts of new infrastructure		Concerns: • How do we allocate shrinking resources among fishing communities and also protect marine mammals and other species that depend on marine resources for sustenance • How do we best allocate space to avoid good fishing areas and other unintended consequences, e.g. need to consider overlap between hypoxic zones and fishing grounds • How we do build resilience in different communities, e.g. science, fishing, and coastal communities • A lot of competition for federal and state funding resources within and outside of fisheries science and management (disaster relief funding) • What can we do to help communities that rely heavily on the fishing industry - the most vulnerable communities? Who do we help? • Equity issues will arise as access to fishing opportunities shrink Upsides: • Our society responds to crises so this could get people's attention, support, and increase funding. Could force people to react before it gets too bad. • May increase value and potentially the quality of fish, lead to creativity around developing higher value uses for fish that are currently undervalued (fish meal, 'trash' fish), opens the door for a lot of innovation

- If species shift north, surveys may not capture them and it may be challenging to interpret catch information (e.g. shift in distribution vs. reduction in population abundance)
- Range compression of commercial and recreational fisheries due to infrastructure/platforms will lead to challenges associated with incidental catches, whale entanglements, etc. Could have negative impacts on habitat but there's also potential to create new habitat/substrate.

Upsides:

- Other employment opportunities beyond fishing that might benefit ports and coastal communities
- Species may shift more gradually so we will have more time to plan and adjust fisheries independent surveys. Sudden shifts are harder to adjust to in terms of time, budget and where to sample.
- Other industries can help improve infrastructure in ports that can support a diversity of industries
- Aquaculture - Lower trophic level species/ shellfish can provide benefits, e.g. value added habitat, but we need to carefully consider and minimize the potential negative impacts.
- Need to make sure distribution of benefits go back to the public and not just to a select wealthy few - equity issues need to be considered.
- A lot more ocean sensors can be added to ocean platforms

Breakout 2: Potential actions for communities in Oregon		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*

• Cost-- where are the resources going to come from to implement the changes that are needed?
• How do we enhance access to capital for incoming fishermen?
  ○ new entrants into the fishery, young, agile newcomers
  ○ We need to make sure that they can make $
  ○ also applies to infrastructure developments
• Federal budgets that have climate change on the forefront-- make our needs known to federal representatives, making our voices heard and understood
• Regulatory- fishery management plan alterations, council process needs to move faster to take advantage of opportunities (legal access to the fish)
  ○ Plan for how the Council is going to work faster
  ○ Action: Council Process for regulating gear changes and more dynamic opportunity
• Developing local/regional scale markets-- regulatory structure around transport and food safety -- helping people navigate that process to develop new distribution: action could be to simplify the process
• Investment in monitoring so that the science is there to allow for expedited Council process
  ○ Climate, Oceanographic Indicators and Fishery monitoring
  ○ Tipping points need to be developed in our system-- especially for those species that we think will be here in all the scenarios
• Efforts to develop new markets domestically-- knowledge gap of what is actually being landed in OR
		• Lots of other fish that can fill our markets if we can't provide the fish
		• (pull marketing discussion from fortune and favor)
		• Efforts to develop new markets domestically-- knowledge gap of what is actually being landed in OR
		• Awareness campaign- funding for Trawl commission, and Positively Groundfish to expand on the markets that we presently have to show what we are landing in OR
		  ○ Does raised awareness mean changed behavior, how do you know if it is making a difference?
		  ○ How do we evaluate the impact of our actions?
		  ○ restaurants can help lead the charge with this
		  ○ Action is that we need money to do this
		• Point of Sale campaign-- promote deeper awareness of WHERE that fish actually came from "OR CAUGHT"
		• linking awareness campaign to point of sale - here is what we catch in OR and here is where you buy it…
		• starting with local places-- ex. Local Ocean dockbox, watching it grow from local to regional
		  ○ if you have everything together to make a meal, everything is contained within
		  ○ coming from the community, then you can infuse the identity of the community into that box
		  ○ this is a good entry point that can have the consumer looking for the fish species after they have made the recipe
		  ○ POSS is doing a similar box, where everyone gets their box and then the consumers make it and get on a zoom call to talk about it

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  ○ Port Orford Sustainable Seafood is doing a similar box, where everyone gets their box and then the consumers make it and get on a zoom call to talk about it
• Infrastructure- local seafood access point -- seafood hub at the Port, seafood market within that structure
		• Infrastructure- local seafood access point -- seafood hub at the Port, seafood market within that structure
		• (start new discussion)
		• ACTION: Co-op regional, local, domestic - other coasts will be also having climate challenges, partner with other domestic fisheries (ex. other Coast) to make sure that those markets stay open
		• Ex. NE is already in this process with lobsters moving North and Black Sea Bass moving in
		• Tie in CSF, investing in the fishing business, product will change over time, there is not always going to be your favorite fish, variability, we make sure you get quality and support that experience
		  ○ Seasonality- nothing but change, helping people understand the dynamic system
		  ○ Trust your fishermen, more radical fluctuations in supply but it will be okay, here is how you make these fish
		  ○ recipes to go along with new fish and appropriate spices
		• Large processors are also doing the recipes-- frozen seafood
		• throw away a lot of fresh currently
		• Action: we will need to smooth out the supply-- freezing will be a potential way, aquaculture can perhaps be a substitute to fill the same niche
		• Space use planning to figure out how to pursue aquaculture and make sure it is compatible with current fishing industry
		• technological advancements--predictability of ecological and fisheries indicators -- to feed into the management cycle to allow the Council to be more agile
		• FDA commodity boards and Dept of Commerce-- big difference in promotion
		  ○ If NOAA becomes more involved in promotion, Council level concerned with management, may not understand how it affects fishermen, processor and markets → action might be more education
		  ○ industry will have to put money into not a sure bet-- so the Council needs a little more understanding on the interaction the business, marketing and supply chain so that the Council can make the best management decisions
		  ○ Economist and Marketing person on each team- strengthen the link between those two things
		• Council promoting funding to explore other marketing or develop different fisheries
		• legislative support for funding to make sure the infrastructure remains, as well as, development of marketing or different fisheries
		• Manage things in silos right now- how will each of these FMPs interact
		  ○ Action: Portfolio analysis to match how people fish would help us understand- Portfolio risk analysis
		  ○ This coordination has started to happen between Groundfish, salmon but needs to be strengthened-- >ones that interact as bycatch or choke species

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• Action: Risk assessment of Spatial use stakeholders
• Technology actions: central to this scenario, decentralization, diversification for fishing vessels, disbursement of information, where are you, where can you fish
• regulations become even more complicated and on a finer scale
• Technology on shoreside, data processing technology, AI technology?, computational technology to inform fisheries management
• risk assessment -BOEM is doing independent risk assessment on wind turbines, need an independent review
• monitoring surveys need to be prioritized for the Council process (NMFS surveys etc.)
• Ability to develop new fisheries on newly moved species
• better integration between BOEM's process for developing new technology and the Council process so that the Council can provide input
• BOEM does not have to have public input-- there is a lot of planning and action already underway
• RODA can help inform the stakeholder process-- as a way to enter and give information to the BOEM reps
• OCEAN is trying to pass information to the BOEM reps and get involved in the process
• funds that are identified and set aside for mitigations for the project, if you are not early input you don't have as strong of a voice
		• Action: strengthen supports for mental health in our communities (identity component)
		• preparing people for a change in identity- reframe the loss of fishing identity, how do we transform ourselves into something different
		• Council continuing to invest in science-- have a handle on what scenario we are actually dealing with
		  ○ Extremely hard to make a decision when it is highly volatile
		  ○ understanding of still trying to maintain infrastructure
		• Recreational conversation has not been present-- storm chasers, people who want to see the big changes
		  ○ Deadliest Catch into something that is safe for the community
		  ○ Looking at what people in areas of significant environmental concern, tying fishermen identity to where we are now to the future
		• industry reaching out to influencers-- crowdsourcing, marketing type hackathons, there is a lot of public interest and it is a way to get quick feedback and a lot of reach
		• suite of social services are probably insufficient for the loss of income and identity
		• Science will tell us what we have to work with: schooling species might be opportunities for bigger boats, working waterfront idea, rethink the fleet structure
		• start preparing for the worst, what type of resources do we need in the communities?
		• Action: Community level risk assessments, dealing with infrastructure, rank the risk, only a couple vessels in one (?) port, social services are built out in the other communities, some communities can start building up their resiliency, putting resources towards those communities
		• Role of the port as an asset, food access, food security
		  ○ Ports and fisherman essential components of disaster relief
		  ○ future where communities are in need, supply chains are dried up, front line workers could be the fishermen
		  ○ funding question to Federal Emergency Management Agency (FEMA) to have our fishermen be first responders for our rural communities

Breakout 2: Potential actions for harvesters in Oregon		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
Fortune and favor • Cut out the middlemen - facilitate direct to consumer sales as part of harvester sales portfolios. There can be 2-3 middlemen between harvester and consumer. Identify regulatory restrictions holding up direct to consumer sales. (A challenge to corporate America.) • Challenge of direct sales / dock sales is the small population in most fishing communities. So perhaps this is part of a portfolio of sales opportunities. Consider a vertical integration strategy where individual harvesters work through co-ops, specialist processors, marketing experts. • Direct marketing in Alaska doesn't mean "selling off the boat" but lining up marketing opportunities. It isn't in competition with incumbent processors. They can co-exist and work together. [System concept] • In Half Moon Bay direct D. crab sales were at $9/lb and people lined up. Created some problems for the port manager (crowding, etc.) • Find ways to increase the number of processors (or sales channels). A distribution system with few processors is more fragile - if one shuts down it has a big impact on harvesters. This would also benefit fishing communities. • Encourage fishermen/communities to take a more proactive stance in preparing for the impacts of climate futures. What groups do we need to reach out to? - Politicians (e.g., state and fed. leg. staff, Governor's office), port commissioners, fishing associations, chambers of commerce in coastal communities; all these play a role in the direct marketing approach • Figure out what stocks are in adjacent waters, which will need survey work. • Fishermen need to develop more selective gear and get it through the regulatory process. This will be needed as stock availability changes.		Box of chocolates • [Monitoring = identifying opportunities in real time so harvesters can take advantage of abundant stocks] • Management flexibility will have to improve. The PFMC process will need a pre-approved menu of options that can be implemented rapidly without a lot of process. Example of temporary rules at the state level. They last 6 months and only require an administrative process rather than a full decision making process. But temporary rules are usually used to stop something but in this scenario they would need to be used to allow something - open up a fishing opportunity. This could be a challenge because that sort of action causes a lot more debate. Start thinking about this now because it will take much work! Build "if-then" structure into regulations. • Aspects of the PFMC salmon process provide examples of flexibility. • Recreational fishing will be a more solid, steady component of a port's fishery portfolio. • Federal process needs a lot more flexibility for recreational management. • Recognize the importance of recreational fisheries in many ports. • Educate the public and the politicians: A PR strategy
Blue revolution • Start now figuring out how to make the EFP process work for smaller vessels. Especially thinking through it could be deployed for targeting new species. Find alternatives to costly monitoring methods (e.g., observers) where costs are prohibitive for small vessels - . Think through risk mitigation for someone taking on a new, different method. • Take a look at regulatory discards - valuable fish that have to be thrown over the side. Perhaps a system where such fish would be segregated and sent through a distribution channel of some kind to meet protein needs of society. Reduce waste when stocks are declining. [Example of prohibited salmon retained in whiting fishery within regulatory framework; P. halibut bycatch quota system to discourage bycatch] • Opah is an example of an unmanaged species where markets are being developed in Southern California. But need to have some assurance as to regulatory framework - reducing uncertainty about future regulation facilitates market development. • Lobby for more funding to subsidize innovation in gear technology. • Protect wild stocks from impacts of aquaculture. Forage species, ocean zoning, aquaculture waste products, aggregation of		Hollowed out • [Direct marketing - see Fortune and Favor] • [Monitoring - see Blue Revolution] • A piece in the direct marketing puzzle is for harvesters to work together to truck fresh fish inland. • High value species like bluefin tuna, opah would be easy to market if / when they appear in Oregon waters • Establish a fisheries engineering program at Oregon State University (OSU) to help with gear development and other innovations. Would address a lot of the ideas brought up here (marketing, gear, etc.) PSMFC has a bycatch engineering grant program. • Think about other occupations for fishery participants considering the cultural dimension. In Southern Oregon fishing is a big part of the community fabric so in a bleak future consider occupations that sustain local culture. • How do we capture fishermen's knowledge? Is land based aquaculture part of the puzzle? Preserve cultural history; oral history projects to tell people about what things were like. • Ports will diversify away from fishing such as small scale lumber shipping, convert gear storage areas to other uses. Reserve a portion of a port area for any fishing fleet that remains.

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predators like sea lions • Costs of electronic monitoring is falling offering opportunities		• An expanded definition of climate refugee could apply to this scenario. Think about how to help people who want to keep fishing to move to new locations where there are still options.

Breakout 2: Potential actions for fishery managers and scientists in Oregon		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
• Science: need to maintain vigilance in the survey data collection effort. Are there extreme events happening? • (All scenarios) - accelerate our use of data between NOAA and academia • (All scenarios) - important for researchers and mgrs to appeal for increased resources. Tax revenue gutted, and will affect science teams. We are asked to do a lot - the asks are not decreasing in frequency. • Re: survey data - expect surprises. Must look in new locations (as well existing survey approaches). If things are changing, then LT data sets are not enough. • Continue and expand the opportunity for collaborative work re survey and research science. Offers from fishers - what data can we help provide? It's a big challenge to take them up on offers. Provides the best opportunity. • Don't become complacent. There is a sense of urgency driven by the amount of data. Leverage the efficacy of machine learning, and the systems to post processes and make it applicable. (all scenarios) • Changing the narrative and how we communicate about this. We need to keep and increase this. Even in this scenario, we will see surprises. Narrative - the need to respond to changing climate. Not just that we need to describe physical environment, but what are the connections we are expecting in biological environment (e.g. a year out) • Needing more flexibility in the management process - data streams in in pursuit of this goal. Re management data - are we working towards electronic fish tickets fast enough? Strong push towards this - esp in OR. In terms of recreational management data, we are more timely than other places. • FaF provides thriving local fisheries. Look at how we could scale up community supported fisheries. There are nascent efforts to do this. Who has studied this? • (all) Scaling up - need for skills training to partner with community colleges (marketing, processing) • (all scenarios) - workforces no longer tethered to urban environments. Start building more of a community into coastal communities. Some energy and ideas there.		• Build more timeliness and flexibility into the regulatory process, so able to react more quickly to changing conditions. Speed up the federal process of regulatory changes • Better facility collaboration, academia, public, agencies. Better facilitate working relationships • Use citizen science • Get ready for all of the wonderful data, do NASA style mission team to get ready. Work the problem really hard. Simulating sail drones, how does that go into the model, predictions. Need head organization--NOAA. Would also include citizen science. • Seafood marketing and availability. Return to "Fish of the Day", what do we have available and make the best use of it. Rather than trying to be dependent on the same species every day. • Modeling and management strategy evaluation exercises are very valuable. Time, effort, and resource intensive. Takes years, knowledge, and technical facilities. Need to make investments by agencies in this type of thing. Need to improve capacity to bring in management side to some of this modeling. Fishery and resource responses. • 2010 by Levin and Dufault. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-2979.2010.00355.x
• Get a seat at the table. Really effective communications from the beginning. Feel like they have a voice. Get all of the players involved. • (all scenarios) How can we add energy and approaches within communications. How we communicate the science and		• Have to stay on education about eating lower in the food web, move away from flagship species we eat now. Marketing challenges. • A lot we can do that impacts how much fish is being caught, but don't know whether the "fishing communities" want to continue

Breakout 2: Potential actions for fishery managers and scientists in Oregon		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
management decisions, and why it is important. Good scientific communication skills, tools, outreach needed • Communications/ connections across agencies, between/among scientists, between federal and state agencies. share information with each other, at every level, so we can share with fishery participants • Get good maps of benthic habitat, water column, other habitat aspects, for areas under stress. • Habitat is really important when looking at not only wind, but offshore aquaculture. Not all negative, able to do carbon capture with something like kelp. • Deal with all levels of new entrants, small scale up to corporate level • Example: In Feb, PFMC's Habitat Committee is having a briefing on offshore wind and aquaculture and impacts to the environment. an initial opportunity to share information across all PFMC advisory bodies. • Get information on what other national council's are doing on similar issues • What are other nations doing, how are they approaching these types of scenarios • Re other nations reviews an interesting paper was published "The future of ocean governance." Rev Fish Biol Fisheries • https://doi.org/10.1007/s11160-020-09631-x • get credit for carbon offset for fishing communities giving up areas		being "fishing communities". Need to know what direction our communities are going. Will need help from local governments, local groups, local plans. Communication/ coordination at different government levels. • (all scenarios) infrastructure a big issue, how do we target infrastructure aid • Community issue is a circular argument, want good economies, realize want to be more diversified. Lack of communication of economic value. Build resilience in terms of structures, carbon sequestration issues. More connecting of the dots in understanding of what is driving the communities. • Do some homework in respect to insurance vehicles on the hurt that is going to happen to fisheries, similar to agriculture on land. Proactive, rather than disaster relief afterwards. Help soften the blows. • Want to start putting more thought into how to provide flexibility for our fishing fleets in when and how they harvest allowable catches. Think about IFQ systems, or other management systems. • What are the effects of climate change that will fall out of the action that we are currently contemplating. Is it something the PFMC discusses regularly as part of their actions. More warning if part of regular practice. • Will need to adjust how we do weak stock and mixed stock management.

Breakout 3: Looking Across Scenarios - Communities Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Oregon communities to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Marketing piece connects across all scenarios, primarily fortune and favor and box of chocolates
    - Council can educate themselves about marketing but have little to do with it
        - Use platforms to educate others on the things that they are doing to improve fisheries sustainability -- be careful that they don't step outside their "bounds" -- weekly post about why you should feel good about eating West Coast fish
        - Improving on what we have done so far since we have done a lot of sustainability practices
    - Need a good supply chain in order to impact the market
- More flexibility and quick response of the Council
    - What does flexibility mean?
    - Need to plan on how you are going to make flexible regulations, so that it can occur in quick time and react to changing species or other considerations
- Social labor issues: Standard of MSC, Dolphinsafe are all standards that were developed outside of the US-- labor laws will change how business is done, helping to plan the transition of the fishing culture
    - Understanding outside influence and impact in labor laws example: Plant- 48 hours of working, Fishing vessels- 72 hours, not based on a monthly salary unlike the most of the world
    - FISH? Stakeholders who can then impact the International conversation -- as they are dealing with it in a culturally relevant way to the country that they are in
    - Change how many people you will have to have, room & board

What actions are important to do because they prevent the worst-case situation?

- Starting the conversation to make things more efficient on the regulatory side, where do you put the effort and limited time available

What actions are important because it enables a good future?

- Online meeting and mentorship to involve more people in the Council process

What actions help build flexibility to cope with the future?

- We have never defined what flexibility in fisheries management is-- depends on who you ask
- What does flexibility mean to communities?
    - Mechanism that gives you the ability to circumvent the long process that allows for different opportunities
    - Boats are out fishing, processor and families all need the flexibility
    - Mix of data, stock assessments to get flexibility in the Council process
    - We go through everything possible to not overfish, sometimes we are not close to the ACL-- prioritize not dealing with those stocks that we have low % of ACL caught (ex. Dover Sole), prioritize other things
- Online meetings with new technologies to enable more stakeholder involvement
    - To get critical inputs of all the community members that have been affected, different language barriers
    - We need to understand our own communities better in order to move forward ex. Different diverse communities of different language, binary/ nonbinary, "family" occupation where labor laws tell us that people shouldn't be on the boat before 18 years old
- MREP program of mentorship-- very intimidating for people outside of the Council family
- Foster local use product for immediate consumption CSF (Community Supported Fishery) -- expand market to frozen, could still have the same box structure, seasonal species v. what is available
    - Expand number of fish species that are used

What should you stop doing given these scenarios?

- Council process is cumbersome
    - Advisory bodies can do a lot more homework and save time on the Council floor (ex. Workload planning)
    - Focusing on time--10 people gave 4 minutes testimony instead of 5 minutes, you could pick up an extra agenda item, public record, but being cognizant of when we talk and what we are talking about could allow for more agenda items
    - North Pacific - 3 minutes per individual, 6 for a group
    - Issues that have been going on for a long period of time, drags on
    - Focusing on the most important things, only will get more complicated as these scenarios go on
    - Optimum yield - if we are delaying fishing that can occur you are not going to get OY
    - Time is valuable to all of us, not utilizing the time efficiently

Breakout 3: Looking Across Scenarios - Harvesters Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Oregon harvesters to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Maintain diversity in the commercial fleet while maintaining recreational opportunities. (Also keep in mind opportunities for traditional/subsistence fisheries).
    - Develop programs that help small vessels/businesses better able to adapt to changing conditions:
        - Identify the barriers and finding ways to remove them
        - Guidance on navigating the regulatory process
        - Marketing opportunities; how to do marketing
        - Training on business development
    - Likewise, consider diversity in the marketing of fishery products
        - Development of direct marketing opportunities focused on small vessels. (Those marketing channels probably don't work for large vessels)
        - To maintain diversity of processors and their capabilities reserve waterfront public land for fishery infrastructure. Likely state, county and local authorities involved. And other entities like chambers of commerce.
- Regulatory structures:
    - Revise to facilitate new marketing opportunities, particularly directly connecting harvesters to consumers, who may be at a distance from coastal communities. (This may be mostly within state authority.)
    - Create regulatory structures that are more flexible and nimble. Examples:
        - temporary rule framework used by Oregon
        - "if then" regulatory frameworks
    - Reduce bureaucratic layers involved in the decision making process to allow a faster reaction time.
        - Explore ways to transfer regulatory authority from the federal government to the state government, since the state is more nimble.
    - If there are new fishing opportunities exempted fishing permits are the way to develop them; we need to make this permitting process faster.
- Awareness and education
    - Target audiences
        - Legislators - funding opportunities and reform of regulatory frameworks
        - Communities: Stewardship; support for local seafood
        - Consumer education - try new fish!
        - Those involved in the supply chain for newly available fish: How to harvest? Process? Market?
    - Who is the best voice to bring these messages to these audiences?
        - Develop brand identity for fishery products.
        - Trusted thought leaders, e.g. chefs and other influencers. Channels include cooking shows, websites (fish specific recipe site)
        - Example of cattlemen's wives as an effective promotional entity.
        - Fishermen need to embrace social media to get messages across to the public. Capitalize on existing fishing related affinity groups (anglers, etc.), which often spread the word about what kinds of fish are appearing in local waters.
        - Change public perceptions about fisheries using social media opportunities. We need professional help for marketing like a marketing specialist to work with fishermen in this realm.
        - We all need to be proactive versus reactive: harvesters, consumers, regulators.

What actions are important to do because they prevent the worst-case situation?

- Fishing industry and communities need a united voice to to address climate change issues and solutions across the board

What actions are important to do because they prevent the worst-case situation?

What actions are important because it enables a good future?

What actions help build flexibility to cope with the future?

Breakout 3: Looking Across Scenarios - Scientists Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Oregon scientists to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Robust and diverse sampling strategies as possible, give ourselves time to compare platforms (sail drones, NOAA ships, fishing vessels). Alternatively, accelerate effort to use existing data and data coming online - proactive effort to address the scenarios.
- Fishing vessels are ready to serve as platforms, host instruments, etc. - early warning system built into the system - train fishermen to help with providing real time data.
- Need to prioritize data and analysis efforts that address key questions that need to be answered.
- Some key questions / items on agenda of scientists:
    - impacts of blue revolution on fisheries - can learn from other ecosystems around the world (e.g. Norway and wind development). How can we be more intelligent about potential outcomes and getting ahead of them?
    - There is room to bring in other relevant sciences (behavioral, psychology) to inform reactions to ocean change.
    - Early detection around range shifts is a key area of research to help prepare fishing fleets and industry. How do we know when changes in ocean conditions are causing a wholesale shift in the ecosystem?
    - What are the mechanisms driving ecosystem responses - need to get past correlations to develop reliable forecasts.
- Need capabilities to analyze, visualize and report on data. A lot of data streams and large amounts of data will need to be processed. Challenges with hiring skilled analysts / data scientists at NOAA for various reasons. Important to develop a pipeline of data analysts and scientists (e.g. NOAA/OSU faculty positions).
- Decade of the Ocean - use this to increase focus on fisheries, climate, climate action, clean energy, many of the points brought up during the workshop. Currently not enough visibility on the issues facing the oceans.
- Data information transfer is important for communication and relationship building between different groups and communities.
- Communication about many different aspects of ocean change is critical, how can it be in service of communities? Scientists are increasingly becoming great communicators.
- Having fishing community at the table - which is also at the root of equity issues
- Better job communicating with legislators at all levels and must occur regularly to keep up with pace of change. Work with groups associated with emerging technologies and activities

What actions are important to do because they prevent the worst-case situation?

What actions are important because it enables a good future?

What actions help build flexibility to cope with the future?

What should you stop doing given these scenarios?

Breakout 3: Looking Across Scenarios – Fishery Managers Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Oregon fishery managers to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- Communication and collaboration on multiple levels
  - Management and science
  - Management and industry
  - Multiple levels of government
  - Stakeholders and all levels of management
- Marketing strategies
  - Forum to inform (example Positively Groundfish)
  - Potentially diminishing returns for certain scenarios
  - Economic explanations on west coast products (currently in a market penetration mode)
- In scenarios with species abundance increase there may be a need for flexibility in management (i.e. EFP) especially for smaller boats for species that are not as abundant. Since EFPs have monitoring requirements this can be cost prohibitive.
- Need for more information to inform Council decisions. Continued and more science to inform management of fisheries. This includes fish biology responses to climate variability in order to set appropriate catch levels etc.
- Support and funding are needed to support monitoring efforts and have the capacity to continue the surveys and the collaboration between the different agencies, academia, and industry.
- There should be prioritization of research about biology and changing climates as well as gear research and development and funds should be used to increase not only funding for this research but also the personnel to conduct this research.
- Communication strategies are needed to be clear with fishing industry members and public and the uncertainty with predictions (i.e. stock assessments). There is a need to utilize and hire communication specialists to bridge the gap between the different communication styles.
- Changing the regulatory process to make it more reactive and nimble. Reduce the timeframe of responses for regulations or set up the regulations with a framework that is more responsive. This could include if/then statements and triggers to initiate responses (example the halibut catch sharing program).

What actions are important to do because they prevent the worst-case situation?

- Flexibility to adjust harvest levels depending on the changes in abundance of species
- The last 14 months (COVID) could be an example of the worst case scenario (loss of businesses, surveys, etc.) and we should use this as a learning experience.
- Continue to stay informed about the state of the environment (these data streams were not always available and should be prioritized in order to maintain information about changing climates and variability)

What actions are important because it enables a good future?

- Flexibility and nimbleness (from managers, harvesters, processors, markets. etc.)
- EFP (exempted from regulations) there are also experimental fishing and could consider new gears, new approaches, etc.
- The whole EFP process should be re-evaluated (simpler and more well defined) with standards and benchmarks since it varies between FMPs
- Reevaluate and simplify the process for EFPs for industry so that the requirements are not limiting participation (especially for smaller vessels)
- Morphing the SK process with EFP is a potential idea -- can the Council be more directed about the types of EFP proposals they would like to see? Problems that Council would like to solve?

What actions help build flexibility to cope with the future?

- Making Council action NEPA compliant
  - Green light/red light approach
- A lot of things listed above (if/then approaches to rule making process)

What should you stop doing given these scenarios?

- Bogging things down with process and procedure ;)
- Reducing funding to basic monitoring programs
- Reduction in staffing levels through attrition
- The Council meeting process could be more flexible
  - For most people going to a Council meeting and speaking can be intimidating
  - Online can increase participation from smaller vessel owners
  - Do not want to have distrust with industry and management in the process through lack of participation
  - Increase communication on participation process

Appendix E: Worksheets from January 20-21, 2021 Washington workshop.

These worksheets have not been edited to revise or remove the workshop participants' abbreviations, emphasis fonts, emojis, or humor. Questions without replies were unanswered by participants during the workshop.

Plenary: Regional Impacts of Fortune and Favor

What aspects of this scenario are particularly relevant for Washington?

What parts of fishing or specific communities in Washington might be most affected by developments in this scenario?

What specific storylines could you imagine happening in this scenario in Washington?

- WA will benefit from increased access/opportunities from tuna fisheries
- Fishermen are flexible (business operations, target species); as long as there's something to fish for out there fishermen will take advantage of it. Fishermen will move around as needed.
- There may be some fishermen that will be able to pursue fish, others that won't.
- More localized markets, whiting focused on international markets will have to shift product forms to adapt to local markets (e.g., shift from surimi to more fillet product forms); shoreside does a lot of heading & gutting, interesting to think about what changes would be needed in those product forms
- Impact on Idaho related to salmon, these fish can't move further north because they are evolved for migration to Idaho. People will shift to other recreational fisheries but may be looser connection to PFMC managed stocks for Idaho.
- Salmon stocks are a cultural icon for Tribal communities and may be maintained in this scenario, a positive. It will allow Tribes to maintain an important part of their economic base. But Tribes will have to adapt within the constraints of their usual and accustomed fishing areas.
- With harsh economic conditions, it will be difficult to mobilize a workforce for processing. Also, it can be difficult to find workers if there is competition from other sectors for employment.
- Even now WA is struggling with HABs and under this scenario that could get worse.
- Some species will have a hard time thriving so we won't be able to depend on them for harvest; how will fisheries adapt?
- With northerly distribution shifts, recreational fishing (and commercial) opportunity off the WA coast will contend even more with mixed stock management. This will make adaptation more difficult.
- Under this scenario stock status will be similar to today but we will see changes in human behavior/aspirations as we've seen during this pandemic. For example, recreational boat sales were huge in 2020. With a shift to local and do-it-yourself we could see a lot more involvement in recreational fisheries, with a focus on fishing for food. This could put more pressure on a resource that may not increase abundance significantly.
- More favorable conditions could ease conflicts between fisheries and protected species (like recent Council action on Southern Resident Killer Whales).
- There may be salmon fisheries under this scenario but given we're struggling to maintain Puget Sound fisheries we might expect serious problems under other scenarios.
- Greater collaboration could make us more effective in managing/conserving natural resources.

Plenary: Regional Impacts of Blue Revolution

What aspects of this scenario are particularly relevant for Washington?

What parts of fishing or specific communities in Washington might be most affected by developments in this scenario?

What specific storylines could you imagine happening in this scenario in Washington?

- Growing interest in mariculture. seaweed production in Washington. Unclear if it will result in marine space conflicts
- Saw a situation like this in the late 70s/80s. The attitude was fishermen could switch over to servicing other offshore operations, which runs counter to the ethos of most fishermen. It's likely these attitudes will arise again in this scenario -- fishermen are unlikely to transition to a role servicing offshore facilities.
- Tribes have limited areas to exercise treaty rights in the ocean [Usual and Accustomed fishing areas (U&As)] so that imposes a big constraint on adaptation in the face of increased competition for ocean space.
- Like Fortune and Favor, wild salmon populations are likely to decline and all fishery sectors are likely to become more dependent on hatchery production. So their fate will rest in the hands of those who set hatchery policy.
- Shellfish aquaculture is a big source of revenue in Washington; with OA success will depend on shellfish hatchery technology.
- Siting decisions for offshore facilities could differentially affect fishery sectors. [Potential for legal/regulatory processes affecting siting and relationship between marine use sectors. Conflict and hostility possible.] Adding that on top of climate change could be a make or break for a lot of fishery operations.
- Certain conservation interests might value offshore energy platforms as de facto MPAs where fishing would be prohibited; a positive could be due to spillover effects.
- [Spatial data crucial to decisionmaking in this scenario.]
- Marine uses could affect survey designs and related indexing in stock assessments.
- From SAS, we hear concern about offshore wind conflicting with fishing operations; aquaculture competing with wild caught fish. Salmon migrate up and down the coast, targeting them would be complicated if areas are taken up by other uses.
- A plus would be employment in coastal communities in support roles for offshore facilities (even if ownership is distant), which could offset potential employment losses in fisheries.
- We don't have the policy framework for managing these potential spatial conflicts nationally or regionally. This creates uncertainty about policy and will likely be addressed nationally/federally with risk of poor fit to local conditions.
- Specific to Washington, treaty U&As and national marine sanctuaries are mechanism for resource protection; in conjunction with strengthing of marine spatial plan, that will mitigate potential conflicts with energy development and similar uses.
- Potential impact on bycatch/bycatch avoidance due to range compression. The more spatially constrained fishermen are, the harder to avoid bycatch species (from whales to overfished stocks).
- Commercial fishery adaptation with local/niche marketing/markets, are there particular challenges in Washington to doing this?
- CSAs in collaboration with Tribes could be a benefit.

Plenary: Regional Impacts of Hollowed Out

What aspects of this scenario are particularly relevant for Washington?

What parts of fishing or specific communities in Washington might be most affected by developments in this scenario?

What specific storylines could you imagine happening in this scenario in Washington?

- Stocks that do okay such as small pelagics or squid are also important forage for top level predators; concern about the effects could further constrain harvest on these species, especially during periods of low abundance.
- This scenario would be the death of many fishing communities
- Anybody fishing on mixed stocks will face serious challenges and there will be a need for improved bycatch mitigation technologies when trying to focus on abundant stocks
- PFMC uses weak stock management for salmon; you will see more and more weak stocks, to the point it won't be possible to fish for salmon without impacting weak stocks. Do you stop fishing? Figure out main sources of man made mortality (other than fishing) that can be addressed?
- We should be concerned about the long lasting impacts on important species; we will have to focus on mitigating impacts within our control/authority (we can't directly influence global greenhouse gas emissions policy).
- Will large fishery firms be able to continue to operate (per scenario description)? Seems unlikely.
- May have more conflict with Canada in management of transboundary stocks, especially those where distribution is not primarily in US waters.
- State managed stocks (e.g. D. crab) will be seriously challenged resulting in less of a safety net for PFMC/federal management. On the other hand some of those impacts are predictable so we can prepare for them.
- HAB events could make beaches inhospitable. [Impact on coastal communities, tourism.]
- Safety of sea concerns when harvesters try to capitalize on sporadic availability during severe weather (more common off Washington coast).

Plenary: Regional Impacts of Box of Chocolates

What aspects of this scenario are particularly relevant for Washington?

What parts of fishing or specific communities in Washington might be most affected by developments in this scenario?

What specific storylines could you imagine happening in this scenario in Washington?

- HABs and warm water events impact D. crab fishery.
- Range compression of whales during warm water events and D. crab fishery conflicts
- Mitigation opportunities relative to reducing buoy lines on fixed gear.
- Profound impacts on salmon stocks such that only the strongest stocks will survive. Highly variable conditions are the "death of thousand cuts" for many salmon stocks.
- Bycatch will be the biggest issue during boom and bust cycles; a current example is the recent year class of sablefish impacting other groundfish fisheries.
- More economic considerations in setting catch limits such as to avoid flooding the market and depressing prices. Do we have the information to make decisions this way? Stock assessment methods can forecast but considering economic effects may take new approaches.
- Example of 1982 El Niño, when salmon fishing didn't see any feed and the salmon were emaciated.. But just a couple years we saw one of the biggest biomasses of silver salmon seen in years. It was a similar situation with crab in 1983 in terms of experiencing boom and bust. From a management perspective we have to be careful not to overreact and recognize that fishermen are prepared to adapt to changing conditions.
- Opportunities may present themselves due to failures elsewhere. This may require more coordination between fisherman and processors to quickly shift between products and markets.
- The variability in this scenario will necessitate managers being more flexible both inseason and between years.
- Research in gear technology/bycatch mitigation will be important and needs adequate funding.
- Bycatch technology (e.g., avoidance) and management measures (innovations like risk pools) will be important to deal with high variability in this scenario.

Breakout 1: Implications for communities in Washington		*For each scenario:* 1. *What will communities in Washington be most concerned about?* 2. *What's happening that provides a potential upside for communities in Washington?*
Fortune and Favor Question 1: • Balance between people historically engaged in fishing / maritime efforts and whether that will shift to include people who want to be near the coast but may hold different value sets and do not necessarily participate in fisheries • Potential for completely different oceanside community (from fishermen to people with fortunes)? Turnover to folks with less concern for fisheries. • **Fewest changes from marine system and in terms of fisheries in this scenario, things that will concern communities may not originate from marine environments but rather from larger social/political/economic conditions (e.g., gentrification, demographic change within industry [graying of the fleet])** • Loss in processing capacity. Jessie's Ilwaco closing last year, will continue to be a concern. • **Graying of the fleet X gentrification: avg age of vessel owners is 60, younger people that come in may find it hard to buy property and integrate into communities** • **New fish stocks coming in X gentrification could open up new markets interested in local fish (higher-end), could cause seafood prices to rise and lead to inequities in access to fisheries** • Fewest changes implies that some coastal WA communities may continue to desire innovative approaches to making more vibrant fishing communities (reducing poverty, drug use, etc) • Tribal communities traditionally rely on local seafood, increased interested in local seafood from markets more broadly could put pressure on tribal fisheries • Razor clams especially important to tribal communities ("school close dig" along 23mi of WA coast), also impt recreationally and culturally and for hospitality industry -- challenged by HABs, potentially microplastics • **with stocks shifting north, will fishery participants have access to these opportunities (permits, quota, etc)?** • **if this scenario is most similar to present, we run the risk of doing nothing (no "sense of crisis") but WA coast may need infusion of infrastructure $. frog in boiling water, no incentive for innovation** • what happens with major int'l markets for fisheries continues to be a concern for Washingtonians Question 2: • New fish stocks coming in X gentrification could open up new markets interested in local fish (higher-end) • Gentrification could lead to benefits such as sportfishing charters • Currently there are seasonal pulses of vibrant (sport- and commercial-) fishing along WA coast, also some years are better than others (e.g., when tuna is more available) • Limitations in port facilities (processing, access to markets) could be remedied to help stabilize and potentially diversify catch. solutions include technology, marketing, etc • Variability but a bit more stability than other scenarios • **Whale migrations remain late in the year, avoiding major conflict with crab fishery compared to other west coast states** • **WA maritime heritage area (includes all of puget sound as well as coast north of grays harbor)**		Box of Chocolates (boom/bust) • **processing capacity in WA coastal communities may be even more challenging to maintain in this scenario.** o possibility of mobile processing facilities that could be repositioned as booms and busts occur. could include refrigerated land based operations o leveraging other food processing facilities outside of the fishing industry and/or in remote locations • connecting harvesters and marketers more directly • prices go down when booms occur and when there is a lot of variability (lack of steady supply), but **consumer attitudes/preferences may be malleable and open to flexible 'catch-of-the-day' marketing** • if boom/bust extends to other regions, it may create opportunities if WA booms occur when other regions bust and seafood can be exported to bust regions • additional monitoring capacity and technology may imply better forecasting of boom/bust conditions, which could **enhance predictability for markets and supply chains. could buffer impacts of boom/bust conditions** • **better monitoring and forecasting may facilitate more flexible management** that capitalizes on booms but dials back during busts • **in WA we are starting from a sound basis of science infrastructure for ocean and fisheries forecasting (JSCOPE, etc)** • if booms and busts have spatial component, transboundary issues (e.g., allocation) may be strongest in WA compared to other states (or at least OR) • **spatial allocation will be very important under this scenario, require more sophisticated intercoastal planning and increased collaboration to optimize opportunities and mitigate impacts** • **wild caught vs aquaculture based seafood. will offshore aquaculture experience booms/busts or have an advantage over wild caught fisheries?** • How do booms/busts for fisheries species interact with recoveries of protected species like marine mammals (including sea otters)? impacts on crabs, razor clams? competition between people and mammals for food • HABs impacts on crabs may continue and become more frequent, is it possible to build infrastructure to allow crabs to depurate (impoundment facilities a la lobsters on east coast)? • importance of D crab in terms of cross-fishery participation (portfolio stability) and for coastal communities, and impacts of environmental change on D crab, **may imply need for increased fed-state collaboration on preparing for this future** • Sea lions may suffer during busts along with the rest of us, but will also affect the amount of fish available for fishermen

Breakout 1: Implications for communities in Washington

For each scenario:

1. *What will communities in Washington be most concerned about?*
2. *What's happening that provides a potential upside for communities in Washington?*

Blue Revolution

Question 1

- Not especially rosy for traditional harvest fisheries, but implies opportunities for other industries. **presents communities with a choice: embrace or push away? risk that big corporations or non-residents gain big without local benefits if the latter.**
- inequity in that southern WA coast has fewer protections from offshore development than northern WA coast
- Scale of blue revolution activities -- more appetite for smaller scale efforts
- Blue Revolution may also include alternative industries and activities like recreation, tourism, research (and associated technologies), etc., which also can have strong impacts
- **Zoomtown component → gentrification concerns**
- offshore aquaculture could degrade marine habitats, with negative impacts on fisheries
- **installation of offshore energy and aquaculture infrastructure will affect Dungeness crab habitat and habitat for other benthic-associated species**

Question 2

- **gaining traction for non-fishing offshore uses in WA may be more difficult than in other states, between legal challenges (OCNMS, tribal U&As), physical challenges given at-sea conditions, and the fact that we have so much hydropower on land and less need for energy from offshore sources (vis a vis Nationally Determined Commitments in other nations to mitigate carbon emissions)**
- aquaculture potential high. how might this intersect with greying of the fleet? depends on returns from labor-- are aquaculture jobs high or low paying?
- tribes have rights when it comes to use of ocean space. all U&As extend beyond OCNMS boundaries in all directions, entitled to 50% of allowable catch in those areas. [see WA MSP reports?]
- seafloor disturbance and/or discharges have to be permitted by OCNMS and State, treaty rights interact here wrt habitat degradation

Hollowed Out

- WA may have fewer impacts than other states under this scenario save for salmon.
- Some **salmon** runs may disappear entirely, unclear whether hatchery production can even succeed under this scenario. Will lead to more **conflict between State and Tribes, and also with protected species that depend on salmon and are themselves recovering**
- fundamental questions for WA communities wrt portfolio of economic activities that support them → significant policy challenge.
- analogy with timber industry, we could look for lessons learned there. **need for communities to reinvent themselves**
- **Gentrification** may happen more rapidly in this scenario than others, and communities could make an active choice in this direction
- Gone vs public display of demise. **The pathway that gets us to Hollowed Out could influence societal response.** Slow moving disaster vs acute shock a la a pandemic? 2017 hypoxia event made halibut impossible to catch in WA (fish were just gone), very different than the spectacle of seabirds and whales washing up dead on beaches
- Salmon also coping with climate impacts in FW habitat (doubles risk)
- What does it mean if we know salmon are not coming back? does habitat restoration $ get invested elsewhere, reconceptualized, etc?
- **suggestions that policies and preparation may look very different if we know this scenario is what is coming. but will we know it is coming?**
- salmon: fish passage center studies show high mortality from hydro system, others that show most mortality occurs in ocean, currently under review by independent science advisory board
- will Hollowed Out look very different in WA communities than in OR/CA? is Hollowed Out more different from today's WA communities than in OR/CA?
    - WA may experience less dramatic shifts in physical env, more vulnerable in social env on outer coast
    - **Bigger contrast between outer WA coast and Puget Sound/Salish Sea communities (which are already urbanized and gentrified).**
- how do we account for the fact that much of the Alaska fleet is operated out of Seattle/WA?

Breakout 1: Implications for harvesters in Washington		*For each scenario:* 1. *What will harvesters in Washington be most concerned about?* 2. *What's happening that provides a potential upside for harvesters in Washington?*
Concerns: • Changing conditions will cause a change in the mix of species; if everything stayed the same as today we would be okay. But in this scenario some species will disappear and it will be hard to bring them back. • Will we be able to access healthy species if bycatch of weak stocks constrains us? • While some pelagic species may be more abundant less mobile benthic species may suffer. • Continued climate creep: with small incremental changes are harder it's harder to perceive impacts and manage accordingly. Current OA conditions are a good example. • Transboundary/straddling stocks: what sort of management problems will we see? Maybe managers from both countries can begin collaborating now to anticipate effects of range shifts. The US-Canada whiting treaty is a potential model. • What species are we thinking will shift northward? ○ P. whiting ○ albacore ○ other tuna species? • Harvest of albacore is basically unrestricted right now, they are wide ranging so big environmental changes needed to affect long term abundance. However, they could shift further into Canada • Do we have the management flexibility to respond to these changes? (And fishermen and processors) • Federal guidelines and rules are not set up to deal with the problems we foresee. Need to identify changes to the Magnuson Act. • We've rationalized west coast fisheries, but they are not as flexible because of allocations to sectors. How do we ensure flexibility under this management approach? • Does it make sense for harvesters to market directly? Time and skills are necessary which take away from primary occupation of fishing. Also, scale issues (volume doesn't justify time investment) • Need for sufficient lead time to develop new market opportunities, especially with other environmental and economic uncertainties. Potential upsides: • There is a lot of opportunity from stocks that shift north into waters off WA assuming harvesters can take advantage of them. • Slower more steady change will allow evolution of more flexible approaches for managers, harvesters, processors, etc. • Will subtropical/tropical tunas (or other HMS) appear off Washington presenting new opportunities? • Development of new markets a potential upside but will management allow that to happen? i.e., as new species - opportunities emerge will management allow those to be taken advantage of? • If stocks are more abundant maybe there is possibility to change management approaches? • Positively Groundfish a potential model		Concerns: • Can fishermen, communities plan their fisheries with so much variability? • We will need the markets that are responsive/receptive to highly variable supply; so there will be a stronger partnership between harvesters and processors. • Data from harvesters may not be accepted by scientists. Need successful dialogue for this type of data provision to be successful. • Larger vessels may have less versatility than small vessels, unable to switch/adapt • Challenges catching abundant stocks, avoid bycatch of depleted stocks. • Examples of tribal harvesters trying to enter new fisheries is cautionary as to whether fishermen can adapt to boom and bust. Upsides: • Fishermen are well positioned to pick out the fisheries they can capitalize on, especially if they can participate in multiple fisheries. • With new monitoring technology there will be more opportunities for collaboration between harvesters and scientists/managers. • Increased investment in innovation from big tech companies?
Concerns: • Loss of access to fishing grounds. • Huge interest in mariculture development (specifically kelp and other seawards). • Offshore energy companies are powerful - well funded with legal		Concerns: • Shortbelly rockfish is a great example of the effects of boom and busts (or some species becoming much more abundant). • "Nuisance species" such as tunicates become much more abundant. Interferes with fishing operations.

Breakout 1: Implications for harvesters in Washington		*For each scenario:* 1. *What will harvesters in Washington be most concerned about?* 2. *What's happening that provides a potential upside for harvesters in Washington?*
political clout. So there is a risk they could steamroll the harvester sector. • Risk of leases occurring without sufficient attention from harvesters or in fishery management forums. Upsides: • Sanctuaries are protected from offshore wind • Within the Quinault U&A the Tribe would have some say over any development. • But the area south to the Columbia River could be developed. • Opportunities for positive management frameworks to reduce ocean use conflicts including forging partnerships and spatio-temporal approaches. (Example of kelp growing season in winter months when less conflict with fisheries, other uses) • Small scale mariculture could be more compatible and likely not sited in offshore areas. • Washington coast probably not suitable for alt energy development due to severe weather conditions. But the technology could evolve to make it feasible. • Fishermen will still have the ability to take advantage of opportunities arising from periodic high abundance. They are used to approaching business operations this way.		• We will have to "triage" what species can be saved and harvested. • It's very hard to sign up long term customers if supply is highly variable. Boom and bust cycles will make it very hard to market fishery products. Example from recent history is rockfish that became overfished and now it's hard to rebuild a market. • How will sustainability certification (e.g., MSC) work in a world of low abundance/high variability? (Current MSC work on "yo-yo fisheries" to avoid constant decertification/recertification.) • Will science be current? (Relates to above point) Upsides: • If land based aquaculture production ramps up, what does that look like? Can it be complementary to wild harvest in some way? • Could a premium be placed on wild caught seafood if there is limited supply? Higher prices could offset decline in volume somewhat. "Artisanal fisheries"? • Consumer awareness of seafood sustainability keep rising - the "blue aspirationals". This could present new opportunities

Breakout 1: Implications for fishery managers in Washington		*For each scenario:* 1. *What will managers in Washington be most concerned about?* 2. *What's happening that provides a potential upside for managers in Washington?*
Question 1 (FF threats): • Mixed stock salmon fisheries; weak stocks will continue to be weak into the future • HABS frequency/intensity will increase; shellfish fishery problem; HABs worsening is association with more extreme weather events • Crab fishery closures (climate-induced reasons) and management needs associated with related fishery effort shifts • Salmon int'l cooperation/treaties on management with BC/AK has increasing importance; lower 48 cannot directly impact salmon management in the north. • Salmon fishery/population success reliant on ecosystem based management and nexus with pinniped populations and management • Trans-boundary fisheries effects for many FMP species (salmon, hake, etc.) • Species range shifts; those at edge of their range in the CC will be of particular concern/opportunity (depending on the species). • Species ranges affect Tribal U & A's particularly, since those are defined/bounded. • OA will be of concern, even if it is less in this scenario than in others. • Allocation between sport/commercial/Tribal will become Question 2 (FF opportunities): • Predictability of lesser changes/extremes makes reacting to this scenario easier. • Society may focus on more local product, more local fisheries. Lead to greater community stability, even as ocean changes. • Transition to science opportunities: • range shifts will affect research survey design - how do we re-tool the survey approach? collaborate more with AK? • May lead to a different type of science - how might this change? • International markets will be challenging, but international scientific collaboration may (need to) increase to assess stocks. • Decreased globalization of fisheries (more local) - steady environmental conditions; public may have a stronger connection to/understanding of the importance of local resources. • Managers need to be able to respond to shifting markets, wider variety of species (e.g. bycatch species). • CA workshop - fisheries impacts from pandemic has been to see increased boat-consumer sales. This may be similar to changes from ocean change?		Question 1 (BoC threats): • We'll see more fisheries (economic) disasters. E.g. 2015 salmon/crab disaster from the Blob. Species north of the U & A, for example. • Species reference points, scientific uncertainties. Impacts management of catch; need to be more comfortable with uncertainty, managing risk. • In-season management difficult (time-lag between when decisions are made, and when harvest occurs). FMPs decisions are made well-ahead of a season. In-season management needs to get more attention/investment. Particularly with mixed stock fisheries. • Need to find a way of both taking advantage of increasing abundance species, while being robust to managing declines. • Mixed stock vs. single stock fisheries: shift to terminal fisheries (e.g. around hatcheries). • Differential response by species - economically valuable species (now) may not be available in future. Question 2 (BoC opportunities): • Boom years may allow us to withstand the bust years (get us through - Fricke's 7-years economic resilience). • Transition to science/research: • building models, testing models - we are good at this! BoC management may be more successful because of our success at modeling (in uncertain times). • Variability in the system - it will challenge us to better understand variability and how to predict futures. (through modeling, etc.). • BoC may be the most difficult for science - the probability that science is "wrong" may be high, in the face of extreme variability. Fisheries could invest in "wrong" predictions and get frustrated by mistakes (this is a risk for science). • Models can be used to screen alternatives/predictions (rather than give "the" answer). Climate-robust management actions through simulation modeling.
Question 1 (BR threats): • Decreasing resources ($$) for management, research, monitoring may occur as a result of species declines; compounding the problem. • NOAA budget likely to be stable; allocations within NOAA budget may change (e.g. shift to aquaculture away from fisheries investments). • New species appearing would require new funding to manage/understand those • Spatial uses conflict and competition (wind vs. crab, etc.);		Question 1 (HO threats): • Bycatch as stocks decline (mixed stock fisheries) will be increasingly difficult; challenge to harvesting the fewer species that remain healthy/harvestable. • Working at the extremes of our predictive models, and appropriate levels of harvest; we will often (always?) be managing beyond/outside the range of the models, which increases risk (decision-making with too little information; requires making more precautionary decisions as managers). • If there is little to manage (species), then there is no need for

fisheries managers will be in the cross-hairs.

- Subsistence harvest, native species are key. Species shifts will impact "first foods" choices and harvest opportunities.
- Spatial use conflict - habitat/wild species vs. industrial uses (aquaculture, wind). Does the policy framework exist to arbitrate this? Treaty tribe co-management framework exists (still a work in progress to achieve 50:50). But, trading species (through ocean change) does not have precedent. And then the policy to intersect with sport/comm harvesters is not clear.
- PFMC/RMC's managing aquaculture will fragment the bandwidth of managers; problematic both for fisheries and aquaculture management.
- Transition to science/research:
- Capacity (people, funding) is always the challenge. If scientists are asked to evaluate new uses, without the capacity to do so, it will be a challenge (managing in uncertainty).

Question 2 (BR opportunities):

- More funding for new spatial uses?
- creative ways to fund new science - new uses may help answer science questions (provide funding).
- Trans-boundary science need/opportunity, could be beneficial.
- Likely to see new monitoring platforms (to support the new uses/users) could be useful in general for understanding ocean/change/species assessments.
- Markets for new species; new ways of marketing and selling species.
- BR may lead to more int'l markets - what markets should we be reaching out to? Shellfish is now being shipped across oceans (but expensive). Cheaper to sell locally.

fisheries management (capacity). Societal focus is elsewhere. Communities need to be supported by other endeavors.

- Management challenge - which phase do we manage for? Transition (decreasing fisheries) vs. future state of few fisheries (given up).
- Reactive vs. Proactive management considerations (as we approach thresholds). HO scenario is more about conservation.

Question 2 (HO opportunities):

- Fisheries management will be more simple. Fewer fisheries, fewer inter-sector conflicts.
- Transition to science/research:
- Reimagining the roles of the FSC's. Originally, designed to serve the commercial fisheries. Maybe it becomes focused on conservation/protected species.
- HO disrupts all the models, based on equilibrium and how we define harvest levels. Challenges our assumptions, need to fill/reimagine how ecosystems/species work.
- Will drive industrial solutions to recovery. This will be outside of what we might consider now. Carbon removal included.

Breakout 2: Potential actions for communities in Washington		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
Fortune and Favor • Focus on terrestrial habitat projects that improve habitat for our strongest salmon stocks, so that those stocks make it to 2040. • Strategize on and improve our communication efforts so that communities understand the difference between natural variability and variability that may result from climate change. • Preparing fishing communities for anticipating change, species/stocks predicted to shift and change. Give communities some picture of what changes are coming so that they can develop responses instead of being surprised. • What changes do we need to make in fishery monitoring to ensure that we can get useable information to communities -- do we track infrastructure? -- how many people are involved in fishing outside of vessel owners? -- better social and economic data? • Community lobbying for infrastructure would be important under this scenario if they're going to drive their futures in one direction or another -- continued fishing presence vs. gentrification. • If there are species that were not present before and that are moving into the area, WA will need receiving/processing infrastructure for those new species.		Box of Chocolates • Processing capacity and flexibility will be important. Can processors become more flexible -- different product types in different years, different species -- to account for the shifting species availability and abundance. • More ocean/beach monitoring needed to deal with more frequent HABs.
Blue Revolution • Planning for aquaculture out on coast, potentially sablefish aquaculture? What might the communities want to have or not have, particularly in Puget Sound? What opportunities for shellfish mariculture are there on the coast? Biggest thing that stops aquaculture in the U.S. is regulatory planning/zoning. • Will populations in Puget Sound support higher end markets for seafood? How do we make more connections between the coast and the Sound? • Thinking more about CSAs that are direct to consumers, need consumers to understand that seasonal abundance is variable (maybe this works better under F&F?) With declining abundance, looking for flexibility on the consumer end, rather than supply end? • Work with area community/technical colleges and high schools to provide training opportunities for new industries. How can communities smooth out the transition, rather than just being dumped from one world into another? • Are coastal communities ready for or interested in gentrification? Are they interested in becoming locations for e-commuters? Shoreline Master Plan of potential use? What is the tipping point where local fisheries no longer sustaining community economies in a viable way, where maybe offshore development is the best option for ensuring that communities have year-round populations and income?		Hollowed Out • Gentrification challenges likely to be highest under this scenario. How do we get a planning process started that maybe understands that we're in F&F now, but think about actions that might mitigate the potential for this future? • This scenario will likely require some very hard policy discussions on what we do and don't protect in terms of salmon populations and habitat. Would certainly need to make decisions on whether we're going to preserve our hydropower priorities and the economies that rely on dams and associated transportation, or if we're going to try to preserve fishing and wildlife economies. • The approach where you put your time, efforts, funds into supporting the strongest salmon populations and habitats now would have the biggest payoff under this scenario. Discussion about the challenges of implementing this approach with respect to tribal trust responsibilities and the differences in habitat conditions (and associated population strength) across the range of tribal communities, from urban to pristine environments? • Can we add significant infrastructure investment under this scenario to prepare communities for this future, or is that a failed use of funds if we're ultimately moving away from fishing communities to gentrified communities with limited resource-extraction? The communities themselves will be under more pressure to think about reinventing themselves -- more work outside the Council process than inside. Maybe there are some lessons learned from logging communities, how some of those communities reinvented themselves.

Breakout 2: Potential actions for harvesters in Washington		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
Fortune and Favor • Groups like Positively Groundfish, Genuine Alaska Pollock Producers are needed to build more local demand and awareness of sustainability with More local marketing. • Washington seems to be jumping in with local marketing efforts. • NMFS used to be involved with seafood marketing with recipe cards and trade shows. Increased government funding/involvement would be needed. • USDA has provided trade relief for products where the US has a deficit. There is a lot of government funding of agricultural production and that should be increased to fishing. • Increased USDA seafood purchase: species like pollock are purchased in large quantities by the government (USDA) and sold at discounted prices to schools, nursing homes etc. - getting young kids to eat seafood from an early age is a big focus of GAPP because that's where food preferences are formed, so getting seafood safely in schools is a huge benefit for long-term domestic seafood demand. Also the use of different product forms such as "seafood noodles." • During COVID sale of seafood in bespoke ways and through pop up enterprises occurred offering examples of innovation avenues. • MAFAC recommendation to revive national seafood council as national forum to advocate consumption of US seafood. • More promotion of small scale and local harvesters. Perhaps a focus on multi species harvesters? • State agricultural production boards are another example of a mechanism to promote local/regional marketing; CA sustainable seafood initiative had a number of elements in terms of certifications, etc. but it died due lack of funding. • Oregon seafood commodity boards are an example of government support for seafood marketing. Washington may be moving in this direction. BUT downside include cost to harvesters and resistance from fishermen and sometimes the processors has frustrated the development of these types of efforts. • Better data acquisition, surveys, and infrastructure needs to be better funded on a continuous basis. This is needed to better forecast conditions. • Continued strong of advocacy for greenhouse gas emission reductions. • Government marketing support tends to focus more on large scale fisheries; how do we get a focus on small scale fisheries? • Environmental nongovernment organization marketing collaboration/support is possible through trust building with harvesters • The Council may have the tools to address bycatch concerns that would arise in this scenario.		Box of Chocolates • A lot of marketing flexibility will be needed. • We are unprepared for situations where species actually go extinct due to climate change. • Don't think the Council has the tools it needs under this scenario. Mandates under the MSA prevent needed flexibility. Thinking out of the box, set allowable catch in range rather than a point value. Can't do that now under MSA constraints. • With different species interactions the need for real time data on encounters with constraining species to better understand how to avoid catching them. • Some species range will move north and we need good data on that so we don't mistake a range shift with steady abundance for stock depletion. • A shift towards cooperative management akin to what the whiting MS co-ops are doing. • Washington needs a long term ecological research (LTER) site like the Newport Line. Call it the Westport Line. The Council should support finding the funds to implement this. • Increased harvester participation in research enterprise. Takes cooperation from both sides. • With variability in abundance, build a system for fishing vessels to gather data on every trip including environmental parameters. If the government paid for it, it would provide some supplemental income to buffer boom and bust conditions. • We need to implement systemic improvements to address changes in stock distribution and management system responses. Right now we are not good at dealing with that or catching up with rapidly changing conditions. Example of northward range shift means we will be managing the tail end of the distribution without regard to overall stock status. • Vessel crew could rotate among multiple vessels. Same with processors to allow employees to work for multiple firms. This would be a way to address boom and bust cycles. • Allocation in rationalized fisheries reduces flexibility. The ability for industry to develop cooperative structures will be important. And the management system will have to facilitate this by allowing the shift of quotas/allocations among sectors/vessels. • Examine the reasons for permits to figure out how to increase flexibility. This goes for allocations as well (since they are often associated with permits). • Will the Council have to change its governance structures to become more nimble, responsive, and flexible?
Blue Revolution • Renew and reinvigorate marine planning efforts to reduce conflict • Evaluation of the geographic distribution of fisheries shows they occur everywhere. This emphasizes the need for concerted spatial planning. • Bigger companies have good representation; under all scenarios		Hollowed Out • With salmon management, when abundance falls below a threshold then the fishery is closed. This also impacts the groundfish trawl fishery with respect to salmon bycatch. If this is caused by ocean conditions do we shut down a fishery? What should the Council do in these situations? • The Council should advocate for retraining programs for the

Breakout 2: Potential actions for harvesters in Washington		*For each scenario:* *If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).*
there will be increased reliance on communication and collaboration. Small vessel fisheries will need to further develop mechanisms to speak with a common voice. (There are some ongoing efforts in this regard.) • All-encompassing workshops on wind energy are occurring but they can be very hard for fishermen to keep track of. Improved ways of communication will be critical in this scenario. Necessary for fishermen's views to be heard. • With more offshore development there will be a need for alternative data collection methods. For example, survey locations may be closed due to facility installations so alternatives will have to be found. • RODA is an effective forum for the fishing industry to push back on rapid expansion of offshore wind. WA equivalent needed? • Research on compatibility among ocean uses is needed to feed into siting decisions. Who are the best neighbors? • With the appearance of new species, we will need to understand stock status and have a management system that can flexibly respond so they can actually be harvested.		fishing industry. Give the small boat fleet the opportunity to exit fisheries without being bankrupted. • NMFS disaster funding and buyout programs will need to be expanded. Recognize the historical role of fishermen in providing protein to the nation. • Leverage land based aquaculture to sustain a limited wild harvest fishery. • Recognize that fishery institutions are facing a major challenge across the board. • Develop markets for non-traditional species like jellyfish and other invertebrates.

Breakout 2: Potential actions for fishery managers and scientists in Washington

For each scenario:

If you knew this scenario was going to be the future, what should you do now? What should you consider doing in this scenario in the future? (i.e. identify actions to prepare for this situation, to ensure it happens, or to avoid it happening).

Fortune and favor (ADAPT)

- invest in forecasting tools to manage fisheries in-season. Salmon and other species. HABs too.
    - HABs will increasingly impact fisheries, lead to effort shift (e.g. CA events evaluated in recent Holland manuscript).
    - Managers will need to anticipate fishermen behavior (choice of participating in one fishery or another). What are needs here?
- monitor/research any changing in timing of reproduction (life cycle timing) - apply to all scenarios or FF? Applies to most/all but FF in particular because it is a rosy fisheries scenario.
- Range shifts - do we need to rethink treaties timeframes for trans-boundary stocks? (e.g. is our knowledge robust enough to enter an agreement for 2 decades?)
- balancing/addressing needs of 3 governance areas (AK, BC, lower 48)
- wild stock/hatchery fish prioritization - what role do hatcheries have in future fisheries? Will it grow or decrease? Salmon but also other species. Hatchery infrastructure takes a lot of time and $$ to build.
    - Still disagreement on what role hatcheries should play in our future.

Box of chocolates (MANAGE RISK)

Build flexibility into management, but manage risk: take advantage of surplus, constrain harvest when not

Regulatory barriers to flexibility in management

- e.g. federal process is not flexible (review timelines, etc.)
- ESA/MSA/NEPA are rigid to improve sustainability.
- limited entry is a barrier to flexibility but is also helpful in improving sustainability by controlling effort.
- Question: are flexibility and sustainability mutually exclusive?

Information needs to support flexibility:

- in-season data (e.g. from observer program) - is this useful in providing flexibility in-season to managers?
- yes. already used for in-season attainment of quotas or harvest caps.
- in-season data for many weak stocks is not currently available. This would be helpful, if spatially explicit, to direct harvesting away from weak stocks.
- GMT uses in-season data. e.g. increase in short-belly rockfish bycatch in whiting fishery (probably from range shift and/or recruitment boom).
- PSC Fraser River salmon - test fishery is genetically evaluated; structure fisheries accordingly. Costly ($$ and workload) but effective. Could be applied to other fisheries.

Extreme/variable events will help us learn, vet & test models (may give us better ideas about cause/effect on ecosystem change and biological response).

- Action is to be prepared to respond to swings.
- Action is to invest in modeling/research to understand

Blue revolution (TOUGH CHOICES)

Prepare fisheries for new markets:

- international markets may require/prefer certain types of fisheries management.
- E.G. sustainability certification requirements - this is a need/opportunity for US managers to prepare US fisheries. Species/product preferences.

New uses, new management challenges:

- e.g. aquaculture-transmission of disease and/or invasive species.
- Managers will need to better coordinate and prepare for this (across agencies within states, between states, between states-feds-Tribes). Room for improvement here.

Mitigate spatial conflict as spatial uses increase

- spatial users relationships/planning - managers need to engage more.
- Promote co-location of uses (e.g. energy and aquaculture), to minimize space conflicts; do this early in the process.
- Are managers well-positioned to engage?
- Yes, and, managers need more information to be better-prepared to engage early, meaningfully. Invest in information.

Hollowed out (REINVENT)

Give up some biodiversity for maintaining some stocks

- Prioritization of stocks (actions, conservation) becomes more important. Some weak stocks may not have a chance. Give up some biodiversity, to maintain some more robust species/stocks. Barriers?
- ESA policy framework needs to be relaxed/reimagined. Other federal legislation: MSA, MMPA, etc.

Aid for fishery disasters: Expecting more federal disasters; need to improve delivery of aid (timeliness). Also relevant to BoC, but maybe most relevant in HO.

Reduce fishing capacity

- MSA NS1 (optimum yield) and NS9 (minimizing bycatch) - fishing capacity is over-capitalized. Further reduction of fishing capacity (limited entry, buy-back, etc.). Recent example - groundfish fishery.
- pay attention to all parts of the fishery system, when adjust capacity (not just harvester, or just buyers…).
- "Trailing actions" in implementation of ITQ for groundfish - should avoid this piecemeal approach in future actions.
- Atlantic cod example - was over-capitalized. Could provide additional lessons learned.

Breakout 3: Looking Across Scenarios - Communities Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Washington communities to prepare for these futures?

- Some synthesis highlights from community 'action space':
- Flexible local/niche marketing and processing capacity as part of creative infrastructure development
    - Informed community planning leading to explicit decisions about adaptation and intentional design in a changing environment - related to gentrification, changing demographics, sources of economic opportunity etc
    - Monitoring and collecting key (multi-dimensional) information needed to understand importance of fishing and fishing support businesses in relation to other socio-economic factors
    - Providing communities information about potential climate driven factors to support local discussions about implications - defining infrastructure needs across dimensions from fishery support to basic community physical/safety needs (sea level, etc)
    - Thinking about possible trigger conditions that could be partial likelihood indicators 'scenario states'
    - Support thinking/planning across a range of possible needs from adaption (best case) to reinvention
    - Possible actions to position communities optimally, in logical ways
- Salmon landscape -> not exactly discussed this way but do local communities have an opportunity to create a watershed based component of community environmental-social-economic fabric and knowledge that could contribute an improved capacity to influencing informed thinking around tough policy decisions and potential; trade-offs that could lead to constructive community evolution rather than reactive change
- Better linkage of Council process elements of fishery/stock assessment and planning (including needed for more predictive capacity) that would assist communities better anticipate changing conditions for support businesses (including recreational fishery tourism)
- Salmon and habitat was particularly important- and making sure lifecycle and habitat was aligned
- Alignment between future status quo and policy framework; International treaty timelines are a potential mismatch between policy framework and SQ
- Regulatory inflexibility is built into system and need to build more flexibility is a bit of a quandary
- Winding down activities (fishing capacity, reliance on moving species/inaccessibility of some species, gears that won't be possible)- will have to figure out how to do that

Which suggested actions seem to work across all or most scenarios?

- The individuals, people who are entrenched in the coastal communities, if we were to express all of this to them, some would go with the flow and some would see the sky is falling. Will have to begin and let the public know what direction we may be going- frame the situation.
    - We have a need to motivate change, communicate things that are scary. But research shows that communicating scary scenarios shuts people down. Need to turn a scary situation into a positive product at the end- here is as bad as it may get, here are the things we can do to make it better, here are the things we can do to move us away from the worst scenario.
    - Show solutions and highlight how communities can re-envision their future along with information about expected changes and guiding people to thinking about the switches that may be needed.
- Investments in marketing infrastructure that could benefit WA communities in all scenarios. Understand where products are going and how market orders are set up. Could bring more technology to this information problem and re-envision seafood marketing, such as meal delivery services.
- Who are the likely actors to start these discussions? Marketing coops, producers associations. Hard because it is a competitive industry. Could be some benefits to collectively organize to be able to afford needed improvements/technology.
- Could put together a workshop of processors, marketers, and others to brainstorm solutions and engage the communities.
- Monitoring: make sure we have real time monitoring for better decision making- from a boat captain determining whether to fish that day to managers
    - Seems more meaningful and relevant. People engage more immediately and deeply. Cultivates a culture of awareness of ocean conditions and harvest attainment
    - Can roll out more cost effective equipment and engage fishers in data collection and interpretation. Through collaboration we can build trust and lead to stronger partnerships
    - Data products (eg predictive models) that build off real time data may be more valuable to the end users.
    - Increasing monitoring and preparedness- need to see the data in understandable ways, especially with the health risk of HABs
    - To collect good data, it needs to be systematic or random- NOT haphazard. Need a good data collection plan in place.
    - Could use the fishermen and science group as a model for project/data collection project development- use science/fishermen working groups to look at common interests and design projects (Newport example)
    - What ingredients are needed to get folks together in this way? It is really community dependent. Newport is already a hub of science. The fishing community across the coast is more understanding of what science can and cannot do and what they can get from science.
    - Quinault fishers are collecting data
    - New technology is coming that could provide some insight- ferry data, NANOOS visual data service, HAB Bulletin, Marine Conditions Bulletin (NWIFC)
- Infrastructure: improvements that help protect water quality (pump out facilities, access points like boat ramps, etc). Do things that benefit communities that may not be fishing. Infrastructure needs and capacities that benefit all scenarios.
- Reduce lost gear-
- Make fishing something that everyone wants to go to bat for.
- Training in aquaculture- protein consumption is not going to decline under any scenario. May provide transitioning activities.

What actions are important to do because they prevent the worst-case situation?

- Hard to distinguish between various questions in this form.
- Need to prioritize resources where it makes the most sense. Hard to do with the science available- using our best sense. Don't put all eggs in one basket

- By not prioritizing, you decrease your ability to save anything
- How can you influence fish in the ocean?
- Regulatory flexibility for changing ocean conditions

What actions are important because it enables a good future? See monitoring discussion above

What actions help build flexibility to cope with the future?

- We are at the stage of acknowledging that we need to build in flexibility while ensuring sustainability
- Key ingredient to future success
- No ideas… yet
- Need to invest more time into regulatory flexibility (piloting fisheries, permits, changing allocations, etc).
- Need to put some ideas on the table soon to achieve an outcome in 20 years
- People may need to feel a risk to existing schemes before they are ready to move to another model
- May need to dial back existing harvest to give space- special allowance for something that doesn't fit within current regulatory scheme. Need provisional approaches to create incentives.

What should you stop doing given these scenarios?

- Making investments in areas that don't make sense- things we have done by practice and design that will not be adaptable in the future
- Example of possible illogical money investment - wide scale salmon restoration such as culvert replacement if invested in areas under the 'Hollowed Out' scenario where natural salmon production might no longer be supported. This generated a discussion about tribal trust responsibilities and the challenge for place based tribes in urbanized areas where future conditions could be disproportionately impactful on salmon runs. What investment of resources could realistically maintain important values for individual communities? Choices about prioritization of investment and policy considerations and decisions are particularly challenging in these circumstances.
- Don't continue to invest disaster relief funds to fisheries- incentive to stay in a business that may not make sense in the future. Invest in transition plans (job transition) that make more sense (e.g., derelict gear removal)
- Opportunity to make connections to communities that have been previously challenging, outside of the Council process. There are community planning needs that go beyond the Council process. There are community choices to be made- how will they invest their resources (offshore energy, fishing, aquaculture, tourism, etc.).

Discussion:

- previous group talked about putting more emphasis on providing disaster relief and this group talked about reducing disaster relief.
- There may be funder fatigue by those that are responsible for allocating funds and allocation would need to shift to look at better ways to help support fishermen in communities
- The current disaster relief program is ludicrous. If it continues, it need to be corrected (just got 2016 relief 3 months ago). There are better ways to support the communities

Breakout 3: Looking Across Scenarios - Harvesters Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Washington harvesters to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

What actions are important to do because they prevent the worst-case situation?

What actions are important because it enables a good future?

What actions help build flexibility to cope with the future?

What should you stop doing given these scenarios?

- Grow the science and data enterprise to support management flexibility.
- Promote more flexibility in management decision making framework in the MSA, especially in periodic management cycles, e.g., annual harvest specifications. Hopefully PFMC comes out of covid thinking about how they can use online meeting tools to make inseason management more flexible for both participants and managers. Less "clunky" than the 5 meeting process.
- Management flexibility has to come with increased data and analysis. Need for better inseason data tools.
- The harvester community has to be adaptable as range shifts bring new stocks
- The market side is critically important for harvesters / processors to provide protein sources.
- New markets and marketing approaches will be necessary to support a good and sustainable future
- It is important to not lose sight of the key role of advocacy for greenhouse gas emission reduction measures. Agencies have a role to play in terms of educating the public about information on climate change and effects.
- Agencies also need to energetically plan for climate change and identify mitigation measures
- There is a need for more international engagement, especially with Canada as stock distribution shifts north. This would involve inter-agency collaboration e.g., interagency collaboration on sablefish stock assessment going on now (looking at the stock distribution across its range from west coast, Canada, to Alaska...).
- International arrangements (RFMOs) to address transboundary issues need to be further developed proactively (before distribution changes happen). There are species/stock specific examples now (whiting, P. halibut, salmon, etc.)
- We really can't afford to create a new commission for each species. Maybe a near-term action (2022-ish) is some kind of bilateral science meeting to discuss vulnerabilities of different stocks to climate change?
- Currently there are almost no arrangements to allow vessels from Canada and the US to fish in the other country's waters. (Albacore is the exception.) Do we need to negotiate these types of agreements for more stocks?
- To deal with the worst case scenario,
    - develop retraining programs to move people out of fisheries to sector.
    - Prepare for a future where disaster funding will be necessary on a regular basis. Also, the timeline from when a disaster is declared and the funding is distributed is currently too long. The process needs to be compressed.
    - Does the disaster funding model need to be shifted to an insurance model to support food security? [Mitigate boom and busts]
    - International lending institutions are starting to look at the status of stocks relative to loan risk. [Triple bottom line?]
- We need to give higher priority to (terrestrial) habitat restoration to mitigate climate change impacts. More broadly, more consideration needs to be given to growth management. This includes continued focus on priority habitat protection for anadromous species. (Look to examples in coastal Washington.)
- We need to take a hard look at fishing capacity (both commercial and recreational) and over capitalization taking into account avenues to facilitate entry to replace those aging out. The primary focus is on the west coast but there is an international dimension to this.
- We need flexibility in permitting programs while ensuring it doesn't contribute to over capitalization.
- Capital costs are outstripping potential returns, i.e., the cost of a new boat (and permits) can't be made up by what you can catch.
- Is there a role for government subsidizing capital investments, especially if it leads to GhG reductions (e.g. new power systems for vessels)? Is there an opportunity for shoreside infrastructure such as processing plants to shift to carbon neutral energy sources? And transportation.
- In considering zero carbon/carbon neutral energy sources we will have to consider the full range of impacts. For example, dams produce "green energy" but have adverse impacts on salmon, habitat, etc.

Breakout 3: Looking Across Scenarios - Scientists Priority Actions

Review your suggested actions across all 4 scenarios. What does this tell you about the priorities for Washington fishery scientists to prepare for these futures?

Which suggested actions seem to work across all or most scenarios?

- **Increase our monitoring and the amount of data we have from within communities and participation.** Without sufficient data it is hard to evaluate the situation
- Preparing fishing communities for coming change. **Good monitoring of ocean conditions, modeling and forecasting.** What can fishing communities and managers expect? Scientists might need to reach out to communities, make sure data and information is accessible.
- Socio-economic and demographic change independent of CC, **need to better understand linkages between climate and communities.**
- The data that is available tends to be focused on vessel captains and permit owners, **need data targeted at the broader communities.** Data products need to be tailored to broad groups.
- Greater investment in surveys and other community data gathering tools. Ex. Alaska crew information database, could allow for more monitoring of folks who are involved in the industry.
- We expect to see gradual or sudden changes in species, key thing is **science that enables us to change and adjust reference points.** Don't want to be stuck in a situation where we are trying to rebuild a species that can't be rebuilt or constrained by bycatch of species that can't recover. Reference points are set in terms of mortality rates, harvest rates, biomass levels based on historical data that assumes that we are still in equilibrium (or that the baseline hasn't shifted. Baselines assume static, unfished biomass). Spatial analysis, distribution - movement of species ranges over time. Important for species that are moving out of the US West Coast range (or new species moving in).
- Need data on hand as more challenges arise (multiple uses such as aquaculture, offshore energy).
- Steady movement with change vs highly variable time periods, requires different approaches.
- Good monitoring of ocean conditions, models and forecasts - challenges of bycatch. **Need to improve models of bycatch and species overlap.**
- Importance of sharing data and collaborative science with Canada/AK (and Mexico)

What actions are important to do because they prevent the worst-case situation?

- Could ecosystem modeling be useful in generating a bigger picture/holistic view of the ecosystem? If a particular stock crashes how does that impact the broader food web? Could be used to prioritize stocks for protection.
- If we assume some species are not going to survive should we move into triage mode and prioritize those that can be saved. Do we have sufficient information to do this? Risk of putting all your eggs in one basket. Ex. Salmon - trade off between protecting stronger components of a population vs more widespread protection.
- **Ecosystem level modeling**

What actions are important because it enables a good future?

What actions help build flexibility to cope with the future?

- As there is more movement and mixing of different stocks/species - **weak stock management will require avoiding encounters with them. Need realtime information on stock locations.** More could be done in analyzing associations pre-season.
- New technologies - autonomous gliders, new genetic tools for faster stock ID**. How can these new data sources improve our understanding of fisheries and ecosystems?** Challenges of incorporating new data types? Ex. Antarctica Living Marine Resources program - has moved to using autonomous drones and data from fishery boats. Used new data while maintaining continuity.
- In social sciences - ability to monitor vessels at sea. Has led to new ways of looking at communities. Communities on shore and communities at sea using similar gear, etc. Will there be new monitoring systems from different groups?
- **Council may need to broaden the family of managers, scientists and stakeholders that are involved.** Focus is on federally managed species, many issues that are coming up involve a broader group of managers and stakeholders. With communities, NMFS is not well positioned to gather data at the local level, other agencies such as SeaGrant might be better able to. Need to involve scientists and others that are involved in research and fisheries that aren't managed by Council (such as state level fisheries such as crab). Scientists working on these issues are not necessarily involved in the Council process.

What should you stop doing given these scenarios?

- **Data collection - is there any that aren't that useful? Given scarce resources should we re-prioritize.** Do we have an assumption that more is better? What criteria should we consider? Investment in some areas (such as biophysical) can be quite expensive while some social data can be quite cheap.
- On the West Coast we have moved away from using the White Ships (NOAA), this offers some flexibility**. Should we build more large research vessel or invest in smaller, cooperative platforms.** Smaller platforms can access more nearshore areas that are data poor.
- Indicators of ecosystem change - Ex stoplight chart of salmon return. Have been using the same indicators for 20 years, some have broken down**. We shouldn't hold onto indicators/relationships that aren't functional anymore.** Be aware that they can change over time.

Discussion

-Ecosystem evaluations that we currently have - a lot is based on the Newport Line. Does WA need something similar or will Newport suffice? Saildrones don't have the same type/quality as the Newport Line, but could be an opportunity. Use new autonomous technologies to cut costs. And partnerships with tribes, etc.

Other

-What is this telling us in terms of the science needs?