

ECOSYSTEM WORKGROUP REPORT ON THE CLIMATE & COMMUNITIES INITIATIVE

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1 Introduction

The Council discussed the Climate and Communities Initiative at its September and November 2018 meetings. In September, the Council directed the Ecosystem Workgroup (EWG) to meet with the Management/Technical Teams over the winter to assess existing management measures in each fishery management plan (FMP) that could be used to help our fisheries respond to climate variability and change. The Council also appointed an Ad Hoc Climate Scenarios Investigation Committee, which met on October 23, 2018, to refine direction on the initiative. At its November meeting, the Council provided direction on the initiative for the November 2018 through March 2019 period:

- The EWG should hold work sessions with the Management/Technical Teams to both assess existing management measures in FMPs, and to discuss scenario planning;
- The EWG should hold a webinar with a description of proposed process and products to expose Council advisory bodies and the public to the scenario planning process;
- The EWG’s March 2019 report to the Council should include 5-10 potential scenario planning topics for Council consideration, comment, and selection.

The EWG met with the Salmon Technical Team (STT) via webinar on November 28, 2018, to discuss Salmon FMP management measures that could aid in buffering salmon fisheries against the effects of climate change. We thank the STT for their creativity and willingness to brainstorm on this project. Our discussion with the STT raised many useful ideas in support of this initiative. The EWG also met with the Groundfish Management Team (GMT) on January 16 as part of our in-person meeting in Portland, OR. The GMT's engagement with us on these topics was also greatly appreciated.

On December 18, 2018, the EWG held an informational webinar with briefings for listeners on scenario planning for: North-central California coastal habitats (Sara Hutto of the Greater Farallones National Marine Sanctuary) and climate change effects on Atlantic Salmon and Atlantic Right Whale (Diane Borgaard and Dori Dick of the NMFS Office of Protected Resources). EWG Vice-Chair, Deb Wilson-Vandenberg, also reviewed the Tijuana National Estuarine Research Reserve's scenario planning process with Coastal Management Specialist, Dani Boudreau, for that project's applicability to our work.

We had planned to also hold a work session with the Highly Migratory Species Management Team (HMSMT) during our January 15-16 Portland meeting, but the HMSMT cancelled their meeting because of the partial government shutdown. The EWG will confer with them during their previously scheduled February 22, 2019, webinar. EWG Vice-Chair and California representative, Ms. Deb Wilson-Vandenberg, met with the Coastal Pelagic Species Management Team (CPSMT) informally by teleconference during their January 22-23 meeting.

The partial shutdown of the federal government in December and January occurred during a time when we had planned to pull together our work on this and other ecosystem agenda items. Our non-federal members are certain that group discussions and work would have been fuller had our two West Coast Region NMFS representatives been able to participate. We had also hoped for engagement and materials from NMFS science center staff (e.g., species climate vulnerability fact sheets). Although we do believe the Council can make progress with the information we provide here, and that we and others will provide supplemental reports and public testimony, we would like to highlight our view that more could have been accomplished if the shutdown had not happened or if it had ended sooner.

2 Existing Fishery Management Measures that May Mitigate for the Effects of Climate Change on Fish Stocks and Fisheries

As discussed above, the EWG was only able to meet with the STT and GMT before the February briefing book deadline. We plan to follow up with the HMSMT and CPSMT as those teams become available, and may be able to address those fisheries management processes and measures in a supplemental report for the March Council meeting.

Salmon Fishery Management Plan. For our November 28, 2018, meeting with the STT, we discussed:

- How can existing policies in the Salmon FMP address climate change impacts?

- What FMP tools or management measures would be most useful for adapting to climate induced changes in salmon fisheries? (Could broaden discussion to measures not currently available in the FMP or relevant statutes.)
- What are the most important climate drivers affecting West Coast salmon populations?
- If a climate scenario focuses on just one salmon species/stock, which one should it be?

The first three questions were intended to address our first assignment from the Council, that we look into existing management measures that might mitigate for the effects of climate change on fish stocks and fisheries. The fourth question builds on the first three questions and our discussion with the STT provided additional insight and information, which we address below, in Section 4 of this report.

The Salmon FMP and its implementing management processes and measures are explicitly designed for flexibility inseason, between years, and over longer periods. This flexibility is needed for managing populations that, even when abundant, are highly variable in year-class strength and distribution and run timing from year to year. Flexibility is even more needed to support fisheries that are challenged by widely migrating stocks that move through and are intercepted in Canadian and Alaskan waters, and by the need to target more abundant and hatchery-raised populations that commingle with natural populations in need of recovery.

While the Salmon FMP is nimble and the management process can address variability, that management flexibility depends on innovative prediction and monitoring science. The STT identified the abundance forecasting process as the most difficult part of the salmon assessment process. That forecasting process is becoming more difficult as the climate becomes more variable and the variability becomes less predictable, or less similar to past variability. For example, some populations are seeing changes in maturation rates in response to climate variability, and those changes in maturation rates and earlier-than-expected returns challenge the ability to estimate the abundance of mature fish in the ocean. Assessing ocean conditions is particularly challenging for salmon stocks both because of the large number of stocks with differing abundances, distributions, and behavior, and because there are few monitoring programs for ocean conditions.

Salmon are managed via a complex and swift science-to-management process, with the STT beginning their management year in January-February by reviewing the ocean fisheries reports from prior years, and developing a pre-season forecast for the current year by February. The STT looks at the ecosystem status report, available in early March, to understand what climate conditions might have been for salmon that first entered the ocean, as a factor influencing the adult abundance of fish 2-4 years later. For most salmon stocks, models that attempt to forecast abundance based on environmental variability do not perform as well as those based on sibling regression. The next step in the model improvement process may not be to look for the perfectly predictive environmental variable for any one stock, but to improve the quality of abundance forecasts with a better understanding of how less predictable climate variability is affecting stocks overall.

Over March and April each year, the STT brings abundance forecasts to the Council, gets estimates of catch and escapement, and helps the Council shape the fisheries for the upcoming year. Fisheries begin in May, and the Council reviews preliminary catch information in September.

Inseason fisheries monitoring is intensive, which allows for inseason quota adjustments and trading. The need for inseason salmon actions can sometimes be an early indication of unusual environmental conditions at sea. For example, 2015 landings reports for coho were much lower than had been expected and individual fish were smaller than usual, providing an early clue that ocean conditions were bad for colder water species.

The Salmon FMP's flexibility is both an asset and a challenge to scientists, managers, and the public. That flexibility depends heavily on a regular flow of data and other information into the management process, and depends on developing and maintaining a common understanding of what those data mean from year to year. As climate variability increases, and as we are faced with more frequent climate anomalies, that may challenge our understanding of the data and models used to support salmon fishery management.

Groundfish Fishery Management Plan. For our January 16, 2019, meeting with the GMT, the EWG asked the GMT similar questions to those we discussed with the STT. For the groundfish management process, we focused in on:

- What is your process for getting and using data for groundfish management? How does that fit within the larger biennial groundfish management process?
- Is there flexibility in the groundfish harvest control rules? What about the inseason management process?
- Are there points in the management process where climate information could be useful?
- What are the species or fisheries that most challenge flexibility in the management process?

Similar to the salmon fisheries, the groundfish fisheries are data-intensive, with data from different fisheries being reported and processed at different rates. Commercial fisheries data comes in relatively quickly, particularly for trawl individual fishing quota (IFQ) sectors. Fixed gear fisheries data is more limited, both in the quantity of data available and in the rate of speed at which the data moves into the management process. Coastwide movement towards an electronic fish ticket system should both increase the speed at which data moves from the docks to the management process and should make that data movement more uniform between states.

Recreational fisheries data is available on the Recreational Fisheries Information Network on a monthly basis with a one month lag. States have preliminary data on a weekly or monthly schedule, which although not considered "official," does give state fishery managers a sense of rates of recreational fisheries catches. There are a variety of logbook data collection programs for both recreational and commercial fisheries; however, compliance with logbook programs can be quite variable, which limits the quality of the data coming out of those programs.

Groundfish harvest specifications and management measures are developed and set on a biennial timeframe; the current management biennium is 2019-2020. Over 90 species are included in the Groundfish FMP, although stock assessment efforts are concentrated on 20-30 species. For the last 20 years, the Council's groundfish management has been notably shaped by the need to rebuild overfished groundfish stocks, particularly long-living and slow to mature rockfish species. Most of these species have been rebuilt over time, with the Council now facing the challenge of having to design a management system that allows our fisheries to benefit from the rebuilding years

without again pushing managed species to depletion. Efforts to minimize salmon bycatch in the groundfish fisheries continue, but groundfish fisheries are much less constrained than in past years by within-groundfish weak stock management.

A major challenge to fisheries management flexibility in the groundfish science-to-management process is the sheer number of species managed under the FMP, the majority of which are unassessed or infrequently assessed. Groundfish stocks that are regularly assessed may not receive a full assessment every two years, but may instead be subject to an assessment update. The ongoing need for more assessments and more data can be overwhelming. For stocks with less frequent assessments, our long-term quotas can be stable for a number of years and then jump dramatically (up or down) with new assessments. Many groundfish stocks have highly variable year class strength, which creates less predictable variability in overall recruitment and abundance. Time lags in stock assessments may also cause us to miss spatial distribution changes in our stocks, an increasing concern under variable climate conditions, and may artificially hold annual catch limits lower than conservation requires.

The groundfish regulations development and implementation process is fairly inflexible and generally does not allow for inseason changes to be made outside of Council meetings. Even seemingly small changes in regulations can take a long time to move through the Council process and then through the federal regulations process. With the states moving to electronic ticketing, more information will be coming into the management process at faster rates of speed, but the groundfish management structure is not designed with the flexibility of the salmon management structure. For nearshore stocks that have linked to state harvest guidelines, there is some inseason management flexibility to change management measures, but those also need to be planned for in advance and analyzed through the larger biennial management process.

Beyond the Council's groundfish management process, a major challenge to understanding the effects of climate on groundfish fisheries is trying to predict how fishermen who participate in non-groundfish fisheries may or may not drift into groundfish fisheries in different years or the reverse. For example, if the commercial Dungeness crab fishery is delayed due to a harmful algal bloom, will fishermen move to the groundfish fishery earlier in the year? Or, if recreational salmon fishing is poor, will there be a big shift to recreational groundfish fishing? West Coast fisheries are also indirectly affected by fluctuating participation in Alaska fisheries, where an unexpectedly poor fishing year for some Alaska species can drive fishermen southward to fish more intensively off the West Coast.

3.0 Scenario Planning Overview

In November, the Council requested that we propose ideas for scenario planning topics and process recommendations including a timeline and proposed meetings or workshops. In this report, we focus on topics. We will provide more detailed recommendations on process and timelines in a supplemental report.

The CSI report also provided general background on the purpose and desired outcomes for scenario planning. To paraphrase, scenario planning is a discussion tool that allows us to discuss and plan for future possible events, without assuming that we are perfectly predicting those events.

For this initiative, scenario planning would involve thinking creatively about how future climate variability and change might affect our managed species and fisheries and to look for opportunities to revise our management system so that we are better prepared for the future.

In thinking through topic ideas, the EWG found the five phases of scenario planning, as described in a National Park Service (NPS) handbook for that agency's processes, to be helpful:

Orientation: a “core group” articulates the purpose, desired outcomes, and scope of the project; decides who will participate in project activities, such as workshops; and develops a project schedule.

Exploration: the core group gathers background information to inform project participants, in particular the key critical driving forces and uncertainties underlying potential future states resulting from climate change.

Synthesis: Alternative scenarios are created through workshop exercises. Commonly, driving forces with associated uncertainty are transposed to help formulate alternative scenarios.

Application: Actions (management measures) and strategies can be tested against the scenarios to gauge effectiveness in the face of uncertainty about future conditions. This may be accomplished through a second workshop; alternatively, a single workshop can cover both the Synthesis and Application phases.

Monitoring: Project participants identify indicators effective in monitoring environmental change. This phase can be open ended by using ongoing monitoring to judge whether the world is tending toward any one of the alternative scenarios identified as part of the exercise.

The EWG also considered the information and experiences described by those who have conducted scenario planning exercises using the NPS model. Based on these discussions, the EWG has begun considering a simpler, more streamlined approach to achieving the goal of identifying strategies for improving the flexibility and responsiveness of Council management actions to near-term climate shift and long-term climate change. With time and resources, we believe we could take elements from the NPS handbook and tailor scenarios to fisheries management questions based on the topic or topics selected by the Council.

4.0 Scenario Planning Topics for Council Consideration

This section first lists out and provides brief summaries of the scenario planning topics the EWG drafted for deliberation by the Council, advisory bodies, and public. More detailed write ups follow in the appendix. These topics were informed by discussions but were not drafted in collaboration with the GMT or STT. The EWG's topic ideas are therefore not intended to replace any topic ideas offered by those groups independently. The EWG may modify or make more specific recommendations in a supplemental report to the Council, particularly if we are able to meet with the HMSMT or CPSMT before March.

Topic ideas center on possible changes to the abundance or availability of key fish and shellfish species. Changes in stock abundance and availability are what drive many fisheries management challenges. Climate change, ocean acidification, and phenomena like HABs and hypoxia will combine to influence new changes in abundance and availability in the California Current Ecosystem. Plausible changes to fish stocks and fisheries can be posited based on this general knowledge. We envision the topics focusing on those possible changes in abundance or availability and their consequences to fisheries more than on the causes of the changes themselves. For example, the focus of the whiting topic (Topic 4, below) would be on shifts in the stock and not on the degree of change in sea surface temperature or other factors that led to the shift.

Summary of Scenario Planning Topic Ideas (not listed in order of preference).

	Topic	Summary
1.	Snake River fall Chinook (Snake RFC) in the face of climate change	Snake RFC can make significant contributions to ocean fisheries off the coasts of Alaska, British Columbia and in the California Current north of Cape Falcon and to tribal fisheries in the Columbia River. What are the climate factors affecting Snake RFC production and what can be done to mitigate them?
2.	Sacramento Fall Chinook Salmon (SRFC): Changes in Abundance and Distribution	Scenarios would explore how stock distribution and freshwater and marine survival will change and how this could affect PFMC management, fisheries, and fishing communities.
3.	Northern coho	Coho were one of the first species to show the effects of the 2015 marine heat wave and place stress on Council fisheries and the management system. The scenarios in this topic would consider how coho populations would fare in the riverine and marine conditions that the warming California Current might bring.
4.	Changes in Whiting Abundance and distribution	Whiting is the most abundant and one of the more valuable of the federally managed West Coast stocks. The scenarios in this topic would explore the consequences of northward shifts in the stocks' distribution, changes in migration timing, shifts in bycatch stocks, etc. Shifts in distribution would help evaluate Council and international, transboundary management.
	Variations on 4: Changes in abundance and distribution of key target stocks (<i>no detailed write-up provided</i>)	The scenarios under these topics could be very similar to the whiting topic, but could focus on the management consequences of northward distribution shifts in sablefish, Pacific halibut, albacore tuna, or other key commercial and recreational target stocks.
5.	Rockfish	Rockfish have been the source of major conservation and management challenges. Key rockfish stocks have rebuilt or are rebuilding more quickly than anticipated when rebuilding plans began in 2000. Stock assessments have found them to be more productive than originally thought. At the same time, rockfish score as vulnerable to climate change in the California Current. The scenarios in this topic would explore the consequences of less productive recruitment and northward shifts in key rockfish stocks.

	Topic	Summary
6.	OR and WA benthic habitats and hypoxia	The benthic habitats off OR and WA are home to a diverse range of species, including halibut, lingcod, bottom dwelling groundfish, and Dungeness crab. These species are under increased exposure to seasonal hypoxic events. Hypoxic events lead to fish kills and loss of fishing grounds and displace fish populations to different areas as well as vertically in the water column. The scenarios in this topic would explore how fisheries could be impacted by increased hypoxia in combination with drivers such as the predicted northerly migration of some fish stocks, ocean acidification, increasing occurrence of HABs, etc.
7.	Shifts in the core distribution of key CPS stocks	CPS support lucrative commercial purse seine fisheries along the West Coast and are also highly valuable as live bait in other commercial and recreational fisheries. The scenarios in this topic would explore the southern-northern regional management issues the Council experienced in the 2000s. CPS abundance and population distributions fluctuate with changes in ocean conditions and prey abundance. Among other things, the scenarios would help explore how future ocean conditions may affect regional issues such as port infrastructure, area based effort controls, and other issues specific to northern and southern fishing communities.
8.	Regional mosaics	This topic would kick off scenario planning using broadly focused, regionally-based scenarios that combine “what-ifs” from multiple state and federal fisheries. With a broad-focus, the scenario planning discussions would be high-level and intended to lead to ideas for more narrowly tailored topics to be taken up at the next stage. The intent would be to provide participants with a panoramic look at plausible futures in their regions and to facilitate thinking about connections and combined effects between fisheries.

Appendix: Topic Descriptions

This appendix describes eight potential scenario topics for Council consideration. The first two topics, Snake River fall Chinook and Sacramento River fall Chinook are described in greater detail in order to give the Council and the public an idea of what a more fully fleshed out scenario topic might look like. Scenario topics are presented in random order. The EWG has no preferences for one scenario topic over others and welcomes ideas from other advisory bodies, the public, and the Council on alternate scenario topics.

1. Snake River fall Chinook (Snake RFC) in the face of climate change

Question or topic: What are the climate factors affecting Snake RFC production and what can be done to mitigate them?

Description: After completion of the four lower Snake River dams in 1975, Snake RFC numbers declined to less than 100 natural adult spawners in 1990. Since then, winter flow management at Hells Canyon Dam on the Snake River to prevent dewatering of redds, augmentation of summer flows with cold water from Dworshak Reservoir during the fall Chinook smolt migration, and a hatchery program to supplement natural spawning have rebuilt escapement numbers to near 60,000 annually from 2013 to 2015. Approximately one quarter of these were from natural area spawning. Since then, escapement has declined, and in 2018 escapement was near 16,000. Snake RFC can make significant contributions to ocean fisheries off the coasts of Alaska, British Columbia and in the California Current north of Cape Falcon. Snake RFC are also significant components of the Columbia River tribal and non-tribal commercial fisheries and to Columbia and Snake River recreational fisheries

Climate drivers: Fresh water: Temperature, Precipitation and snowpack. Marine: Temperature, ocean acidification (OA) and hypoxia.

Key factors: Freshwater: Access to most of the historical Snake RFC spawning habitat was blocked when hydropower dams were built in Hells Canyon of the Snake River beginning with Brownlee Dam in 1959. Since then, spawning has occurred in the Snake River below Hells Canyon Dam (completed 1967) and tributaries in Idaho and eastern Oregon and Washington. In years when flow is low and temperature is high, outmigrating smolts, which must pass through 8 reservoirs and dams before reaching the Columbia River estuary, suffer elevated mortality. The main factors are high temperature stress, disorientation in slow flowing reservoirs and predation by fish, both native and introduced, and birds.

Marine: When the ocean warms, the lipid-rich northern copepods that juvenile salmon and forage fish eat are replaced by lipid-poor southern copepods, leading to poor growth and survival. OA and hypoxic zones further reduce food availability due to reduction in usable habitat and reduction in crustacean forage.

If climate change results in more frequent and longer lasting warming events, then salmon survival in both freshwater and marine habitats will decline.

Goals: Increase Snake RFC survival where possible. Follow Fish Passage Center recommendations for flow management at Snake and Columbia river dams, reduce pinniped populations in areas where harbor seals have the most impact on smolts and where sea lions have the most impact on adult salmon. Continue creative hatchery management with yearling and sub-yearling smolt releases and geographic expansion of release sites. If it is shown that removal of the four lower Snake River Dams would be a major contributor to restoring healthy Snake RFC and all other Snake River anadromous fish stocks, as well as help rebuild the Southern Resident Orca population, then pursue that management option.

Affected groups: The north of Falcon, B.C. and Alaskan ocean salmon fleet and Columbia and Snake River fisheries. The most affected sector would likely be the Nez Perce, Umatilla, Warm Springs and Yakima tribes whose treaty fishing rights lie entirely within the freshwaters of the Columbia River system. Non-tribal commercial and recreational river fishers would also be affected. When nearly 60,000 adult Snake RFC escaped annually above Lower Granite Dam in 2013-2015, the state agencies and the Nez Perce tribe began discussions about how to best manage these fish for natural spawning and for harvest fisheries. If climate change prevents adequate escapement of Snake RFC above Lower Granite Dam, then these fisheries may not be possible or will be marginal and intermittent.

Snake RFC are part of a mixed stock Chinook fishery north of Cape Falcon, Oregon to Alaska. If this stock declines due to a warming ocean and the effects on the food web, the other components of the mixed stock Chinook fishery are likely to decline as well. Commercial and charter boat businesses will suffer and boat operators will likely switch to other species, such as albacore and groundfish.

Time frame: 15 to 20 years

Management tools: Fishery Regulation Assessment Model changes, aggressive management of piscivorous birds, marine mammals and freshwater piscivorous fish, improvement in water management of the four lower Snake River dams. Significant reductions in greenhouse gases is the only know solution to a warming climate and ocean acidification; however, eliminating excessive greenhouse gases and the accumulated carbon dioxide in the ocean will take many decades longer than the scope of the Chinook salmon scenario topic and is outside of the Council's purview.

Ecosystem impacts: When the largest Snake RFC escapement in recent memory occurred in 2013-2015, many bald eagles spent their late fall through mid-winter feeding on Snake RFC carcasses. Although not as obvious, many other Snake River species would have benefited from the addition of these nutrients brought back from the Pacific Ocean. If an abundance of Snake RFC spawned every fall, this would become the base of a broad food web that has been missing for several decades.

2. Sacramento River Fall Chinook Salmon (SRFC): Changes in Abundance and Distribution

Question or Topic: If climate scientists' observation of more and more warming that is happening at a faster and faster rate continues, how will this affect SRFC production in both the freshwater and marine components of their life cycle?

Description: The Sacramento River is the southernmost river to support indigenous Chinook salmon. The Sacramento River and its tributaries have been heavily modified over time by dam construction, flood control efforts, and water diversions for agriculture and domestic uses. Several hatcheries mitigate for the blockage to spawning and rearing habitats and thus SRFC are a mixture of hatchery and natural-area production. SRFC are the largest contributor to both the California and Oregon mixed stock Chinook fisheries.

Climate drivers: Warming temperature, prolonged droughts and decreased snowpack.

Key factors: Freshwater: Drought increases demand for agricultural and domestic water diversions while reducing stream flow for salmon spawning and rearing. Rising water temperature and reduced snowmelt causes mortality to pre-spawn adults and incubating eggs. Low, warm flows increases incidence of deadly Myxozoan parasites, increases susceptibility to predators, and decreases health of smolts. A large percent of hatchery smolts are transported to the estuary for release when flows are low and warm. This increases straying of returning adults which makes it difficult to obtain enough brood stock for hatcheries and decreases genetic purity on natural-area spawning grounds.

Marine: As the ocean warms, the zooplankton community becomes increasingly dominated by southern copepods and species of krill that have low caloric value for juvenile salmon and for the forage fish that are prey for older salmon. Salmon growth and survival decreases. Smaller and less abundant salmon reduce angler's catch, commercial fishers' income, escapement numbers and egg production per spawner. An increasing percent of Chinook return to freshwater to spawn at earlier ages, causing overforecasting of adult abundance for ocean fisheries and escapement.

Currently SRFC are rarely caught north of Cape Falcon. The marine distribution of SRFC may shift northward with a warming ocean. This could lead to a significant change in the mixed stock catch composition north of Falcon requiring changes to the harvest models.

Goals: Determine how and when the SRFC stock distribution will change and how this will affect fisheries and businesses. Determine how both freshwater and marine survival will change and how this will affect PFMC management relative to determining MSY and potential inability to rebuild the SFRC stock.

Time frame: 10 to 20 years

Management tools: Multi-agency fresh water management to shape seasonal flows from upstream reservoirs to provide adequate and sufficiently cool flows to meet the biological needs of several life stages of SRFC. Increased creativity to prevent disasters at storage reservoirs and hatcheries, and to increase smolt survival.

Ecosystem impacts: Salmon are important prey for marine mammals and various fish species as they grow from smolt to adult. Salmon are highly sought after by humans and if salmon were not available, humans would increase harvest on other marine species such as rock fish and tuna.

Primary Ports: All ports from Monterey Bay, CA to Newport, OR.

3. Northern Coho Scenario Planning

Northern coho stocks are an integral part of the OR and WA salmon fisheries. Coho stocks are generally managed by watershed, given that each river system has genetically distinct populations. As a result, northern coho are susceptible to stressors in freshwater conditions in their early life history and during spawning, and to marine conditions during their adult life history. In their early life history, coho are sensitive to stream temperature and low-flow events. In warmer conditions, juvenile coho will mature early, leading them to head to sea prematurely, causing much lower marine survival rates. Low flow events are an additional stressor that can lead to early outmigration of juveniles and increased mortality. Little is known about what drives marine survival rates for coho, especially on a stock by stock basis. A strong relationship between the abundance of northern copepods has been observed, and other key drivers are likely to be nearshore habitat, predation, and shifts in prey abundance. Marine heat waves have also been linked to salmon marine survival rates. Given the range of uncertainties facing salmon populations in the future it is important that managers are prepared early and give consideration to range of potential futures.

4. Changes in Whiting Abundance and Distribution

Whiting is the most abundant and one of the more valuable of the federally managed West Coast stocks. This topic would be relatively narrow in focus in that the main issues of interest would be specific to the shoreside, mothership, and catcher processor sectors and the Washington coastal treaty tribes. Whiting is particularly important for the ports of Newport, the Columbia River, and Westport, tribal fisheries in Neah Bay, and the at sea processing companies based out of Puget Sound. Northern shifts in whiting's distribution and migration would be the key variable to be explored. Changes in abundance or in the patterns of recruitment are other facets that could be varied in the scenario. Variation in the stock's movement, whether based on age, abundance, or environment is already an issue of importance to U.S.-Canada sharing of the stock, as well as access for the treaty tribes. Because of the U.S.-Canada treaty process, the Council is only indirectly involved with setting catch levels for the stock. However, the does Council play an advisory role in the process and has a formal representative on the treaty's Joint Management Committee as well as many stakeholders in common. Scenario planning could incorporate scenarios meant to explore bycatch management.

Bycatch has been the major focus for the Council as multiple species of rockfish, Chinook, and other species like sablefish and spiny dogfish have posed challenges in the last decade. Changes in the whiting stock, timing of the fishery, and changes in bycatch could all interact. Other potential connections in this topic include the pollock fisheries of the North Pacific, the other fishing strategies in the groundfish IFQ program, the Dungeness crab fishery, and more. Events in those fisheries can influence whiting fishery participants and businesses and vice versa. The whiting

sectors have also demonstrated strong self-management through co-ops. A scenario planning exercise could potentially benefit the co-ops, as well as direct regulatory tools used by the Council.

Lastly, the Management Strategy Evaluation for whiting includes the northern movement of the stock into Canadian waters as a key question of interest. Stock movement varies between years. The age distribution of the stock, large year classes, and environmental conditions are all possible factors for scenario planning. For whiting, scenario planning might also be best conducted through the treaty process or possibly in both arenas. If it were done through the Climate and Communities Initiative, it would provide more focus on West Coast fishery participants, processors, and communities.

5. Rockfish Conservation and Management

Rockfish have been the source of many challenges for the Council, fishing communities, and fisheries scientists. Species like canary rockfish, yelloweye rockfish, and cowcod are long-lived, late maturing, and difficult to monitor because they live in habitats that are difficult and costly to survey. Many efforts have gone into rebuilding rockfish since the early 2000s. All but two species have successfully rebuilt and the remaining two are scheduled to rebuild much faster than expected. The era of rockfish rebuilding was accompanied by notable changes in the understanding of rockfish productivity, with stock assessment results finding them to be more productive than previously thought. At the same time, rockfish rank as some of the more vulnerable species to climate change in the California Current. This topic would explore scenarios where rockfish experience lower productivity because of less favorable conditions in the ecosystem. The scenarios would also be designed to explore the potential consequences of northward distribution shifts of key stocks.

6. OR and WA benthic habitats

The benthic habitats off OR and WA are home to a diverse range of fisheries, including halibut, lingcod, bottom dwelling groundfish and Dungeness crab. These fisheries are an integral part of the region's fishing portfolios for both commercial and recreational fisheries. In recent years, these fisheries have been coming under increasing threats due to the increasing severity and duration of seasonal hypoxia events. During the 2006 hypoxia event, mass mortality of immobile benthic fauna and an exodus of mobile fauna was recorded off the OR coast and recent events led to the temporary shutdown of some tribal Dungeness crab fisheries.

Hypoxic events have the potential to impact fisheries dependent upon benthic habitat directly through fish kills and the effective seasonal loss of large areas of fish habitat, and indirectly through the vertical or horizontal displacement of impacted mobile species. The displacement of benthic species will have direct impacts on them in terms of energetic expenses and less-than-favorable habitat and impacts on the broader ecosystem through increased competition for suitable habitat and potential food web disruptions. How this will affect fisheries in the region is uncertain and this uncertainty will be compounded by drivers such as the predicted northerly migration of some fish stocks, ocean acidification, increasing occurrence of HABs, etc.

7. Shifts in the core distribution of some CPS

Coastal pelagic species (CPS) are schooling species that have supported lucrative commercial purse seine fisheries along the West Coast and are used as live bait in valuable recreational fisheries for HMS and groundfish. Their abundance is driven largely by variability in environmental conditions and subsequent abundance of their planktonic prey. The commercial fisheries for these stocks are limited entry south of Pt Arena, CA, and a mixture of limited entry and open access north of this point. In California, CPS fishermen are generally dependent on almost year-round availability of a portfolio of species; however, fishermen that fish for CPS off of Oregon and Washington often also fish for non-CPS species or move locations. These fisheries are also dependent on sufficient shoreside port infrastructure to rapidly process a fresh, high quality product. Recent changes in environmental conditions affecting the abundance and distribution of CPS species along the coast has challenged recreational and commercial components of the fishery by bringing more southerly distributed species north that may only be incidentally harvested, or because FMP species become unavailable by moving north to Canada following preferred water conditions. How would significant changes in core and also tail CPS distribution affect those fisheries and fishing communities?

8. Regional mosaics

This topic would kick off the Council's scenario planning activities using broadly focused, regionally-based scenarios. The scenarios would combine "what-ifs" from multiple state and federal fisheries to facilitate thinking about the combined effects of potential changes. Many fishery participants, seafood businesses, and local economies depend on revenues from more than one fishery. While the connections are generally known, they are rarely discussed directly at the Council.

We would envision having 2-4 scenarios per region that would vary changes in the abundance or availability (via distribution shifts, changes in migration, HABs, etc.) of key target fish and shellfish species as well as bycatch. For example, a northern scenario would likely center on Dungeness crab and would include albacore, salmon troll, groundfish, and more. The scenarios could be crafted with natural groups in mind, like small scale fishermen making their living with "three-legged stool" type portfolios (e.g. crab, salmon troll, and rockfish).

The crafting of the scenarios would be central to the effort. One purpose would be to take the best available scientific thinking of what might occur while keeping within the the spirit of the scenarios being postulated and plausibilities, not forecasts. Regional scenarios could be discussed at the same meeting to facilitate thinking across regions, or separately to allow more attention paid to each.

By taking a broad focus, the discussions of the scenarios would need to be kept high-level. For instance, we would describe the purpose as involving "issue spotting" than detailed examination of particular management tools. One key outcome of the discussions would include ideas for more narrowly tailored scenario topics to be taken up at the next stage. Participants will benefit from having been presented a panoramic view of possible future conditions in California Current fisheries.