Report on Regional Workshops focusing on the Implications of Climate Change for West Coast Fisheries and Fishing Communities

Introduction

Over the past year and a half, the Pacific Fishery Management Council (Council) has been conducting a climate change scenario planning exercise as part of the Fishery Ecosystem Plan (FEP) Climate and Communities Initiative (CCI). In 2020 four climate change scenarios, depicting possible futures for the California current ecosystem in 2040 were developed and described. (A written description and short video describing the scenarios may be found on the Council's website.) This output was informed by an initial workshop and a series of 'scenario deepening' online sessions.

In recent weeks, these scenarios have been used as a resource for a series of four online "implications" workshops held from mid-December 2020 to early February 2021. The purpose of this series was to use the scenarios as a platform for idea generation. *As we face into an uncertain future characterized by climate change, what should various stakeholders do now to prepare for the future?*

Although held online, each workshop had a regional focus as follows:

- December 16-17, 2020, Southern California
- January 13-14, 2021, Northern California
- January 20-21, 2021, Washington State
- February 2-3, 2021, Oregon

Each workshop was led by Jonathan Star, who has been contracted by the Council to lead the scenario planning process. Twenty to thirty participants attended each workshop including facilitators and note takers. Participants were recruited to represent an array of stakeholders including fishery participants, processors, fishing community members, fishery scientists, and fishery managers.

Each workshop spent time considering the four scenarios that had been created. Each scenario described a set of different conditions that could face fishery participants in 2040. These scenarios were challenging and provocative. They were designed to help stretch thinking towards new ideas for how best to prepare for such futures.

Each workshop progressed through a series of four sessions, each building on the previous one:

- Session 1: What aspects of each scenario are particularly relevant for the region?
- Session 2: What will harvesters / communities / managers be most concerned about and what are the potential upsides in each scenario?
- Session 3: Considering each scenario, what actions should be taken now to prepare for the conditions seen in the scenario?
- Session 4: Looking across all four scenarios, which suggested actions will be key in all or most scenarios?

Session 1 was conducted with the entire group while Sessions 2 to 4 employed breakout groups followed by a plenary report to all the workshop participants. The discussions in each session were recorded on

worksheets filled out in view of the participants as the conversations unfolded. These worksheets contain detailed notes of all the ideas raised in the workshops and are available on the PFMC website.

This Report provides a summary and synthesis of some of the main findings from the workshops. *It starts with the conclusion*, drawn from Session 4: a summary of action areas that participants saw as critical to address, no matter which future played out. The later sections of the Report provide details of the conversations that preceded the conclusion i.e., regional and stakeholder specific implications of each of the four scenarios, in response to the questions explored in Session 1, 2, and 3. The final section of the Report offers some brief reflections on how these findings might be considered and taken forward.

Priority Action Areas

The final conversations at the workshops dealt with 'priority actions.' Participants were encouraged to look across all the scenarios and identify actions that should be pursued no matter which future plays out. The following nine themes emerged from the discussions.

1. **Management flexibility**: Range shifts, ecological surprises, and potential species decline are sure to put pressure on existing management frameworks. To cope with uncertainty, flexibility and a willingness to experiment are essential. This may include the provision of portfolio permits, community-owned permits, piloting fisheries, temporary rule frameworks, and better processes for weak stock management. Management should prepare using "if-then" rules to speed up decision-making when conditions change. While exploring these possibilities, it will be essential to also take account of the potential effects on existing fisheries.

2. **Marketing, outreach, and education**: Shifting availability and changing consumer demand creates the need for improved marketing, especially at local and domestic levels. Fish stocks will be unpredictable, hence the need to educate consumers about new species, and ensuring that a relationship of trust is built between fishermen and consumers. This will involve new approaches to certification, brand identity, use of social media, influencers, and new ways of packaging wild-caught fish. The overall goal must be to change public perceptions about fisheries that work for an era of unpredictability and climate change.

3. **Council efficiency**: These scenarios tell us that Council business will only get more complicated over time. It will be essential to rethink how Council meetings are run. This might involve online meeting tools to make in-season management more flexible and less clunky than the current approach only involving five in-person meetings. Other approaches to advisory body input, such as scheduling part or all of some advisory body meetings well in advance of the Council meeting (possibly online), could save time on the Council floor. A clearer focus on time – limiting the duration of public comment – could also help.

4. **Community resilience**: Change is coming to fishing and coastal communities. We do not know the extent and outcome of that change, but communities must be prepared for shocks and surprises. There is a need for community-led processes that help us better understand the composition and identity of communities and enable ways to re-envision their futures. Such processes should explore the needs and preferences of communities in the face of demographic change, gentrification, and shifting sources of economic opportunity. The consequences of Covid-19 might make coastal communities more popular as remote work becomes increasingly possible (due to technology). Community resilience also requires being prepared for damaging future shocks, such as extreme weather and economic catastrophe.

5. **Collaboration across geographies and interest groups**: Effective collaboration between scientists, managers, fishermen, and the general public is always preferable. However, these scenarios highlight that such collaboration needs to be intensified and involve new players and interest groups. Range shifts require managers to better engage with their equivalents in other jurisdictions. Regional organizations could form centered around common interests. New ocean uses mean that commercial organizations and government agencies will need to be more directly involved in the management of ocean space, and it will be critical to communicate and collaborate to ensure that fishery interests are articulated and well-served. West coast fishery participants must learn from others, so collaboration with other those in other parts of the country is essential.

6. **Infrastructure**: Fishing communities need infrastructure to survive, but the nature of infrastructure will have to change to cope with more unpredictability for fishermen. Facilities might have to become mobile, or centralized (somewhere inland with fish trucked to them). Communities might look to co-develop and share infrastructure with other ocean users. Investing in facilities such as water quality and access points will help other members of coastal communities.

7. **Improved data collection, analysis, and communication**: Many other needs (management flexibility, community resilience, enhanced collaboration) will be best served through enhanced, timely data collection and analysis. Surveys and data collection can be improved by using new platforms (sail drones, fishing vessels, energy installations) and more co-operative research with fishermen. Data analysis will need to take advantage of machine learning, and there is a real need for recruitment of more data scientists. There is also a need for a broader realm of information: not just aimed at vessel/permit owners and fishery managers, but information that can be used by broader fishing/coastal communities. This will require new forms of communication and storytelling to reach the general public.

8. **Financial support for the industry**: Fishermen and their communities will need financial support as they face an uncertain, climate change-driven future. This will require improved connections with legislators, to help ensure that the industry is seen as a critically important provider of food security and treated in a similar fashion to farmers. Attention should be given to the levels of debt that many existing fishermen hold. This raises questions about how best to encourage and support new entrants into the industry. Financial support should also be considered in situations of disaster relief.

9. **Carbon neutral and sustainable activities**: The next 20 years will see a more intense push toward reducing greenhouse gas emissions across our society and economy. The fishing industry and coastal communities will be part of this. New propulsion technologies will come on stream (electric, but possibly also sail). Society will value industries and practices that promote sustainable development and certification.

Regional and Stakeholder Implications & Actions

Fortune and Favor: Overview

In Fortune and Favor, climate and ocean conditions do not vary wildly from year to year; coupled with abundant and accessible fish stocks, this is a mostly benign world for ocean users. Many important target species occur more widely, often appearing farther north than they do today. But industry economics are tough as pandemics and cyber conflicts lead to trade wars. The US fishing industry becomes less international and relies more on domestic demand. By 2040, there is a renewed emphasis on buying local and exploring community-based approaches to fishery management.

Regional Implications of Fortune and Favor

We asked participants about the issues in Fortune & Favor that felt particularly relevant for their region.

In **Southern California**, Fortune and Favor highlights the challenges of northerly range shifts. This will impact the region significantly; some species will shift north out of the region, while newly appearing species expanding their ranges from Mexican waters will be unavailable to catch under current management arrangements. Transboundary issues with Mexico will loom large. But there are plenty of positives for Southern California in this world: new opportunities might flow from the localization of demand; direct marketing and eating local could encourage small scale fishing to thrive. In **Northern California**, commercial fishing could become more attractive, brought along by a growing interest in local seafood. Participants stressed that many of the current structural issues will still apply, resulting in a decline of small vessel fleets, and infrastructure that struggles to accommodate new fishing opportunities due to range shifts.

In **Washington**, Fortune and Favor could provide improved access to various tuna species, and probably offers the best hope for the future of salmon fisheries. Generally favorable conditions might ease some of the conflicts (such as allocations of fishing opportunity for salmon) that we see today. However, trade wars and local demand will affect Pacific whiting markets. The main concerns will be harsh economic conditions, and the ability to mobilize a workforce. In **Oregon**, Fortune and Favor highlights something experienced by many during 2020: the reality of losing international markets, coupled with increased local demand. This shift has proved problematic, particularly for high volume fisheries, but it has also spurred innovation in local marketing and community outreach.

Stakeholder Implications of Fortune and Favor

We explored the implications of Fortune and Favor for three broad sets of stakeholders – harvesters, communities, and managers. We asked about the main issues that would concern these groups, and also about developments that might provide opportunities and upsides. The main themes of the conversations – across all regions – are reported here.

Fortune and Favor offers promise for harvesters. This is a familiar set of conditions, and most fishermen continue to make ends meet. A relatively abundant ecosystem will encourage collaboration between players. New stocks are good news – provided that they can be caught and processed, which requires thinking differently about permits and infrastructure at a time of range shifts. This scenario could offer a brighter future for fishing communities. There will be growth in charter and private recreational fishing effort. New stocks might create higher end markets. A shift towards domestic and local demand might encourage more ocean-related tourism and local interest in fisheries. More generally, a downturn in the

general economy might not hit coastal towns as hard if remote work becomes more popular (even as requirements to work from home recede post Covid 19), resulting in growing interest in relocating to coastal communities. These smaller communities might become more stable and connected, with a greater partnership between local government and local industry. Gradual change should allow for the industry to evolve better approaches and become more proactive in preparing for future surprises, trusting that science improves over time.

However, Fortune and Favor still implies change and challenge. Some species will disappear, and it will be hard to bring them back. Nearshore fishing might be less attractive; in fact, we might see a growing distinction between nearshore and offshore fleets. Transboundary issues will affect harvesters as range shifts become more apparent. A focus on domestic markets could challenge profitability for many. Direct sales to consumers offer promise, but this will require rethinking current regulatory restrictions, and developing new approaches to marketing and skill development. The dangers of intense gentrification will be present, which might accelerate cost pressures on the industry due to competition for water-adjacent land.

The biggest pressure on science and management will be range shifts, creating more discussion on who is allowed access to stocks, and raising critically important transboundary issues. The relatively gradual nature of change should help maintain the accuracy and reliability of data, but there will be a greater expectation to use data more effectively and proactively. Planning is mostly straightforward rather than chaotic. However, some significant challenges will emerge, such as managing mixed stock salmon fisheries, and ensuring that tribal interests are accounted for at a time of range shifts. The shift in markets will also require better assessment of the community impacts of local markets. More generally, Fortune and Favor poses a danger that complacency creeps in – in a gradual change scenario, the urgent need for changes in approach may not be obvious to many.

Possible Actions to prepare for Fortune & Favor

After considering the challenges and opportunities of Fortune and Favor, we asked participants to identify possible actions that should be considered to prepare for this future. Here are some of the main ideas generated across all stakeholder groups:

- Invest in monitoring, forecasting, and data analysis to help speed up decision-making in the Council process; translate data into more user-friendly products
- Maintain vigilance to ensure the continuation of survey data collection efforts, and accelerate the use and sharing of data (e.g., engagement of the fishing fleet for collection, machine learning for analysis)
- Increase the number of processors to boost the resilience of the distribution system
- Develop local / regional scale markets; encourage and facilitate direct to consumer sales, local awareness, and education campaigns, invest in social media campaigns
- Invest in and maintain access to fishery-related infrastructure (ice, hatcheries, roads)
- Prepare for range shifts by scrutinizing fishing permit transfer regimes, restrictions on gear use, and community-based permit portfolio arrangements
- Prepare fishing communities to anticipate change: which species/stocks are expected to shift?
- Study how to scale up community supported fisheries
- Consider methods to recruit new commercial fishery participants (e.g., enhanced access to capital, mentoring programs)
- Improve relationships with Mexico and Canada to deal with interjurisdictional issues; develop bilateral access arrangements as range shifts become more frequent
- Seek out ways to enhance federal government support (as with USDA support of farming)

Blue Revolution

In Blue Revolution, as low climate and ocean variability combines with decreasing stocks, the commercial development of new ocean uses takes off. Government and business join forces to invest in alternative energy and biotechnology. Large offshore energy installations and aquaculture farms now compete for ocean space. Available fish stocks become concentrated in certain areas, often the same places that whales, sea turtles, and others prefer. The public calls for more regulation so iconic marine mammals are not harmed.

Regional Implications of Blue Revolution

We asked participants about the issues in Blue Revolution that felt particularly relevant for their region.

In **Southern California**, aquaculture is likely to be a significant part of the ocean economy by 2040, possibly raising concerns about pathogens in warming waters. Users will compete for ocean space, with aquaculture, offshore energy, and the military as likely rivals to fishing operations. Transboundary issues will loom large, especially in a scenario where important species are in decline. In **Northern California**, competing ocean uses are likely to focus on alternative energy; current impacts from laying telecommunication cables on the ocean floor are a foretaste of competition over ocean space that could come with offshore renewable energy development. With more areas foreclosed to development of offshore facilities (e.g., by marine protected area designations), siting decisions for the remaining open area will be critically important for the fishing industry. There will be a need for new cross-jurisdictional task forces to manage fisheries when protected species are concentrated and interactions increase.

In **Washington**, nearshore aquaculture (seaweed, mollusks) is likely to grow under this scenario. Considering treaty rights (e.g., usual and accustomed fishing areas) coastal Tribes are likely to be central players in discussion about the use of ocean space. There is the possibility that conservation interests (e.g., habitat protection) might be served by the development of ocean uses that limit fishing grounds. On the other hand, fishery participants are unlikely to look positively on alternative uses that reduce access to fishing grounds. More broadly, competition over ocean space is likely to spark conflict among users. In **Oregon**, renewable energy development will likely increase in the coming years, raising questions about "who is at the table" when important planning issues are being discussed. Aquaculture will also be a major feature, with implications for the harvest of forage fish to be used as feedstock, with knock-on impacts on other ecosystem components, as well as market competition.

Stakeholder Implications of Blue Revolution

We explored the implications of Blue Revolution for three broad sets of stakeholders – harvesters, communities and managers. We asked about the main issues that would concern these groups, and also about the developments that might provide opportunities and upsides. The main themes of the conversations – across all regions – are reported here.

The biggest concern in a world of competing ocean uses is loss of access to fishing grounds, which becomes a tougher challenge as stocks decline and ranges shift. Big global players will have very different interests. Could wild harvest fishing lose out to more powerful players who stake their claims to ocean space? Harvesters and communities will be challenged if they do not have a seat at the table. We can expect regulations and costs to rise in this world, giving an advantage to players with deeper pockets. Larger vessels would likely win out over smaller vessels; but if stocks underpinning low cost, high volume fisheries decline this could give an advantage to smaller, more nimble vessels. These dynamics could create equity concerns across different fishery sectors. Habitats could be adversely affected by

aquaculture operations (e.g., harvest of forage species as an input, facility discharges). Onshore, there is a danger of losing the cultural history and skills associated with fishing. Harbors and infrastructure could become more influenced by energy and aquaculture interests, creating an "us versus them" divide in many communities. Crew availability will tighten, and wages may rise as energy industry support vessels increase their recruitment. These situations present many localities with a tough set of decisions: embrace new industries, or discourage them?

But there are potential upsides to Blue Revolution. There are no major surprises in ecological conditions, so this would allow for more careful planning and intentional siting decisions. Greater investment in the development of more fuel-efficient technology for vessels – and greater tracking of stocks – might provide an investment boost. Offshore facilities could function as habitats for certain species, encouraging pockets of growth in abundance even at a time when, on average, stocks are declining. Waters around facilities could become de facto or de jure marine protected areas, with conservation benefits. Existing laws, regulations, and physical conditions might limit many problematic installations, making it easier to manage tensions among ocean users. And competitive conditions and declining stocks might spur new ideas around discards and bycatch. Onshore, new industries could spur a more general increase in investment in new coastal infrastructure.

This is a scenario that poses major challenges for management. There will be a much greater workload for managers, who will need to increase the effectiveness of coordination between different agencies responsible for competing ocean uses (fishing, energy, aquaculture, etc.). Managers will be forced to think about how new ocean uses might help with existing management goals – e.g., could aquaculture raise fish that are currently overfished? They will also be in the crosshairs when it comes to spatial conflicts. Overall, resource managers will be under greater pressure to increase international (and regional) coordination. All these challenges will be present amidst a broader policy debate: what is the right balance between fighting climate change, securing west coast energy, and continuing our fisheries?

Scientists will be asked to identify whether declining stocks in a location are the result of range shifts, or stock-wide declines in abundance. They will need to determine the impacts of new ocean uses on fisheries. It might be more difficult to collect data as some ocean space might now be off-limits to research vessels and other data gathering platforms. There will be a much higher interest and need for mapping the distribution of resources, habitat, and other ecosystem components. The big question is whether there will be more funding and investment to conduct such research: declining stocks might suggest finding will fall, but new ocean uses might mean it will be boosted from different sources.

Possible Actions to prepare for Blue Revolution

After considering the challenges and opportunities of Blue Revolution, we asked participants to identify possible actions that should be considered to prepare for this future. Here are some of the main ideas generated across all stakeholder groups:

- Ensure that fishermen and communities have a "seat at the table" early in regulatory and siting discussions about alternative ocean uses; build relationships between offshore investors and fishing communities
- Foster concerted marine spatial planning efforts; understand baseline data for ocean zone planning
- Ensure that small vessel fisheries speak with a common voice (e.g., by developing cross-sectoral organizations to represent interests)
- Explore alternative data collection models because existing sampling locations might close
- Learn from Japan to explore how extensive aquaculture coexists with fishing
- Explore the opportunities for collaboration with aquaculture in some regions

- Determine the effect of new technology (e.g., alternative energy installations) on ecosystems and fisheries; recruit and train new scientific expertise to undertake this work
- Promote scientific collaboration between researchers studying different ocean uses
- Investigate international fishery management arrangements to ensure domestic fishermen are able to compete
- Increase communications and connections between federal and state agencies; encourage integration between Bureau of Ocean Energy Management and fishery managers; encourage public input (e.g., through stakeholder organizations like the Responsible Offshore Development Alliance)
- Rethink regulatory discards and reduce waste in a scenario of declining stocks

Hollowed Out

In Hollowed Out, high climate and ocean variability combine with stock declines, creating extreme and sometimes insurmountable challenges for many in the industry. Acidification, periods of low oxygen and episodes of extreme warming create surprises that affect the ocean food web. Extreme storms and rising tides cause regular damage. Most fish are scarce, and fisheries suffer. These supply shocks make wild caught fish a high-priced delicacy. By 2040, only a few large companies do most of the fishing and processing while small fisheries scattered up and down the coast try to survive on erratic and irregular catches.

Regional Implications

When we asked participants about the issues in Hollowed Out that felt particularly relevant for their region, responses were both very pessimistic and uniform across all four workshops. In all the workshops participants acknowledged this scenario presents a profound challenge to the viability of fishing and as a result the fabric of fishing communities could be irrevocably damaged. As fisheries and fishing related infrastructure disappears, gentrification could completely erase the identify of fishing communities.

Stakeholder Implications

We explored the implications of Hollowed Out for three broad sets of stakeholders – harvesters, communities and managers. We asked about the main issues that would concern these groups, and also about the developments that might provide opportunities and upsides. The main themes of the conversations – across all regions – are reported here.

A Hollowed Out scenario generates extreme challenges for harvesters. There is a loss of habitat, likely to particularly harm nearshore fisheries. Conditions might force the fishery managers and industry to triage which species could be saved. Extreme weather makes it difficult for vessels to get in and out of harbors. It becomes more difficult to serve customers, as variable conditions make it impossible to supply in a predictable fashion. Sustainability certification also becomes difficult. There will be pressure for managers to monitor fisheries more closely, threatening cooperation and trust between fishery managers and fishermen. Communities and the industry need to make tough choices about which infrastructure to save, pitting some locations against others. The overall dynamic results in a grim situation: a loss of knowledge and interest across fishing as a whole. This survival mode might make it hard to encourage collaboration, data sharing, and co-management. Most species suffer, but salmon will be particularly affected, possibly creating conflicts between states and tribes. Conditions could deteriorate to an extent where we see uprisings due to a loss of food security.

Such difficult conditions are likely to force some tough choices. Is there a keystone species that needs to be retained? It will also require creativity (e.g., in developing new markets, maybe for high-priced artisanal fisheries) and some radical thinking (could land based aquaculture become a complement to wild harvest?). New challenges could motivate more collaboration and accelerated efforts towards fishery sustainability plans. Communities could be forced to reinvent many aspects of their identity.

Managers will often be forced to ‘manage beyond the range of models,’ most likely resulting in more precautionary decisions. Managing bycatch will be difficult as so many species are under threat. In extreme circumstances, fishery management might not be as necessary, as attention switches more towards the challenges of handling severely reduced fisheries, or even to disaster relief. Overall, these difficult conditions might force society to recognize fishermen as vital food producers in the same way as it does farmers, leading to a greater support for various kinds of government aid.

A declining industry may make government less supportive of related science, so it is likely that there will be a need for researchers to focus on fewer stocks. However, the radical nature of change might create a more powerful push for more ecosystem science, as everyone seeks to understand the ecosystem-level effects of climate change on food webs. Management could end up being simpler, with fewer fisheries to deal with and thus fewer inter-sector conflicts. Innovation could come through the development of new provisional or experimental permitting systems. Fishery science might focus more on conservation, and also economic expertise, to understand the economic impacts of declining stocks.

Possible Actions to prepare for Hollowed Out

After considering the challenges and opportunities of Hollowed Out, we asked participants to identify possible actions that should be considered to prepare for this future. Here are some of the main ideas generated across all stakeholder groups:

- Prepare for hard policy discussions about what does and does not get protected in terms of species populations and habitat
- Explore permit flexibility through new arrangements such as a permit banking system for trading or loaning permits in specific areas, pan-fishery permits, experimental gear permits
- Educate consumers about eating lower in the food web
- Engage with fishing communities regarding their views on how they see their future identity; engage with local governments, and local groups to develop local plans for community transformation
- Explore how government and private-sector insurance vehicles, similar to those already used in other industries (e.g., farming, logging), can help prepare for tough times
- Make adjustments to weak stock and mixed stock management
- Build community and fishery resilience, encourage numerous sources of industry diversification
- Preserve cultural and institutional knowledge through oral history projects
- Continue to invest in science, to ensure we know if we are heading into this scenario
- Rethink the role of ports as more diverse assets as providers of food access and food security, a source of first responders, and potential sites for habitat restoration
- Increase catch value through better marketing; conceive of 'wild harvest' as a collective user group, rather than in terms of narrow fishery sectors
- Invest in less expensive, un-crewed monitoring platforms
- Address the current incentives that encourage fishermen to take on debt to target certain species; find ways to allocate limited entry permits on some basis other than price
- Explore ways to deal with stranded assets (e.g., vessels)
- Engage with legislators, create multiple alliances to promote fishery and coastal community needs
- Prepare for disaster relief, and develop oversight mechanisms for those processes (i.e., review previous experiences to ensure smooth and efficient administration and delivery

Box of Chocolates

In Box of Chocolates, as high climate and ocean variability combine with stock increases, technology helps temper massive unpredictability. A series of ecological surprises produce boom and bust cycles. Some fish populations shift northwards and into deeper waters, and there is a periodic influx of fish from warmer waters. Big swings in availability increase pressure on fishermen to be flexible, shifting their attention between different fisheries as conditions change. Marketing the catch proves difficult as seafood availability is so unpredictable. Operators, scientists, and managers invest in monitoring and sensing technology, helping them assess ecosystem conditions and find the fish.

Regional Implications

We asked participants about the issues in Box of Chocolates that felt particularly relevant for their region.

In **Southern California**, productive waters will be pushed against the coast, resulting in more nearshore fishing. Increased variability in stock abundance will force harvesters to search across a wider area, with potential management implications. As in the other scenarios, range shifts increase the need for effective transboundary management. Vessels will need to be designed for general use – and will need to be fuel efficient or approaching emission-free. In **Northern California**, the emphasis was on the need for flexible infrastructure that could cope with periodic influx of vessels as fishing grounds shift. Variable stock availability will test marketers; concepts like "catch of the day" will need to return.

In **Washington**, harmful algal blooms and warm water events will affect Dungeness crab. Salmon are also seriously affected – only the strongest stocks will survive. Managing bycatch is the biggest issue during boom-and-bust cycles. Management will be under significant pressure – it will be important to strike a balance and be careful not to overreact. Better data is critical to success in this scenario: there must be improvements in research, like regional-scale sampling off Washington, like the Newport Line off the Oregon coast. In **Oregon**, it will be critical to educate and build consumer trust so that they are willing to try new fish species as they appear in local waters.

Stakeholder Implications

We explored the implications of Box of Chocolates for three broad sets of stakeholders – harvesters, communities and managers. We asked about the main issues that would concern these groups, and also about the developments that might provide opportunities and upsides. The main themes of the conversations – across all stakeholders – are reported here.

Variable ocean and stock conditions cause the biggest challenge for harvesters: how can they best switch between target species? It remains difficult to plan fisheries with so much variability, particularly the challenges of catching abundant stocks while avoiding bycatch of depleted stocks. There are likely to be management challenges when boom years for a target stock coincide with increased abundance of protected species like whales. Fishermen may find themselves in situations where they are able to catch lots of fish but with no port infrastructure to process it or markets to sell into. Fishery monitors will need constant training to cope with new species. This boom-and-bust existence will inevitably lead to higher costs. New developments in technology can help gather data to anticipate changing conditions, but harvesters must be willing to collect and share data. In such dynamic conditions, aquaculture is likely to be a more predictable source of supply, providing it with a significant advantage over wild harvest. Harvesters and communities must also be prepared for regular surprises like harmful algal blooms.

More variable conditions might encourage new demand for wild caught seafood, focused on 'pop-up' restaurants or 'catch of the day' marketing. Changing situations can be managed by intercoastal planning and better relationships between community and regional organizations. As fleets shift to more protected ports, there could be a chance for new infrastructure investments. New monitoring technology could provide opportunities for collaboration, but any advantages from technology are also likely to require flexible management.

With highly volatile and variable conditions, scientists will face the challenges of communicating and interpreting risk and probability. There is a higher probability that inaccurate scientific forecasts lead to management errors, resulting in frustration among stakeholders. For example, biological reference points for stocks may be mis-specified due to changing environmental conditions. Management must find ways to cope with range shifts, in-season changes, and mixed stock/single stock fisheries.

However, this scenario does offer the prospect of boom years to withstand bust years. The rapidity of changes in species abundance and availability might also drive a movement towards ecosystem-based management focused on stock complexes. Science will be challenged in this scenario, but there are top-tier research organizations and strong expertise in building and testing models. Variability will push scientists towards a more accurate understanding of the implications of changing conditions.

Possible Actions to prepare for Box of Chocolates

After considering the challenges and opportunities of Box of Chocolates, we asked participants to identify possible actions that should be considered to prepare for this future. Here are some of the main ideas generated across all stakeholder groups:

- Invest in new technology for monitoring and real-time data; provides opportunities for scientists to translate predictions and models into usable management products
- Improve management flexibility; for example, through the development of "if-then" rules to encourage quicker decision-making as conditions change or a pre-approved menu of options that can be implemented rapidly
- Encourage fishermen to collect data that supports real-time management; involve harvesters in survey design and data interpretation; encourage citizen science
- 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
- Accelerate transportation of product to market
- 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
- Seek out ways to ensure Council's decision-making is more nimble, responsive, and flexible, e.g., investigate how to adjust in-season management measures between Council meetings
- Continue to push and promote adaptive management
- Explore ways for vessel crew to rotate among multiple vessels; same with processors to allow employees to work for multiple firms

Reflections and Next Steps

The main purpose of this scenario work was to generate ideas that could help prepare fishery stakeholders for an uncertain future of climate change. The next stages of this process will involve Council reflecting on the issues raised and determining whether and how best to pursue elements of these ideas.

The workshops revealed a great deal of interest in preparing effectively for climate change: a range of different stakeholders will play roles in securing a better future for west coast fishing. There may be some actions where Council might directly implement change, and others where the change will be led and coordinated through other stakeholders in the system. Part of the next steps will be to continue conversations to explore issues more deeply and build a clearer understanding of who should do what.

Finally, the scenarios used in this exercise can provide a platform for ongoing conversations. They can also be used as a 'map' to help use better understand the important ways in which conditions change over time. To help with that understanding, we polled workshop participants to give us their perspectives on (i) which of the scenarios best described the world we exist in today in 2021, and (ii) which of the scenarios best described the most likely future in 2040? Workshop participants are currently being surveyed for their views, and we will provide the results of this survey in a supplemental document prior to the March Council meeting.