# East Coast Climate Change Scenario Planning

**Draft Scenario Narratives**
**August 2022**

## Introduction

This document outlines four draft scenarios that describe different possible futures for east coast fisheries in an era of climate change. The scenario framework is based on initial conversations held at a scenario creation workshop on June 21-23, 2022, attended by approximately 75 east coast fishery stakeholders and support staff. Following the workshop, the project Core Team refined the original eight draft scenarios created by workshop participants, condensing them into four scenarios. These four scenarios maintain much of the underlying scenario ideas generated at the workshop, combining two critical uncertainties about the future:

1. What happens to stock production / species productivity as climate change continues? Does it result in declining productivity (alongside worsening habitat, and low rates of species replacement), or is productivity mostly maintained (with adequate habitat and sufficient levels of species replacement)?

2. How unpredictable are ocean conditions, and how well is science able to assess and predict stock levels and locations? Do conditions become far more unpredictable, where existing science is clearly unable to provide much useful information, or are conditions sufficiently predictable to allow science to provide mostly accurate information about stocks and location?

Combining these uncertainties results in a 2x2 matrix that creates four distinct quadrants. None of these quadrants are predictions of what will happen in the next 20 years. Instead, they merely outline what might happen to ocean conditions, stocks and other changes to coastal communities. The scenarios also contain storylines and suggestions as to how fishing industry participants, managers, other ocean use sectors, and seafood consumers might adapt, react to and prepare for such conditions.

While the scenarios are designed to be divergent from each other, it is also important to acknowledge that there are some aspects that are broadly predictable over the next 20 years, so these elements will be reflected in all of the scenarios.

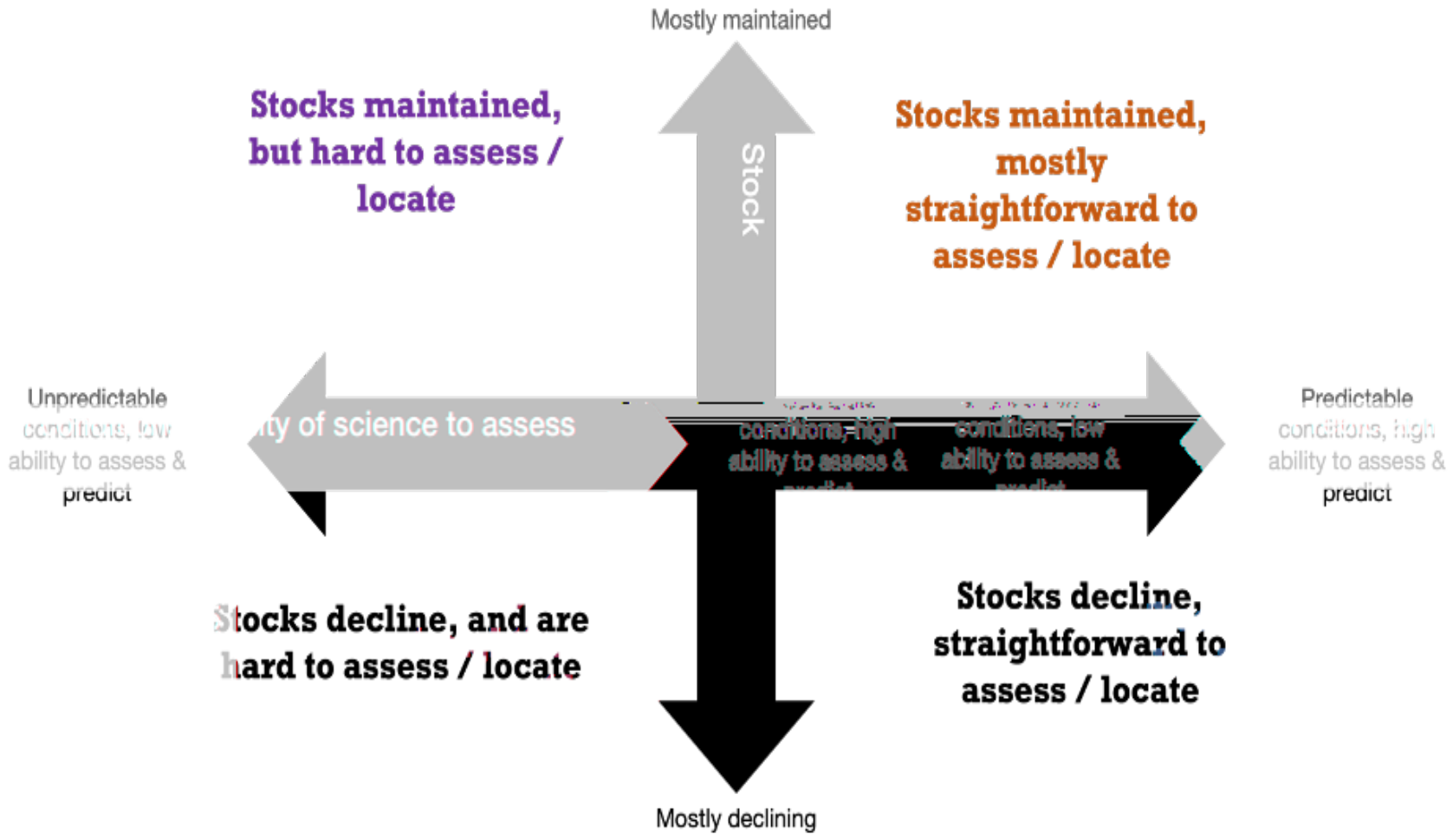
Across the scenarios, we can assume that ocean temperatures will increase in the next 20 years which will affect marine species biology and distribution. Regions are likely to exhibit differences in seasonal temperatures, and primary production will vary across different regions. We can expect that sea levels will rise. In terms of economic and social changes, it is likely that the coastal population will grow, and new and changing ocean uses will create more competition - for space and labor - for fisheries. These factors are features of each of the scenarios, but their impact might be different across quadrants.

## *How to Read and Use these Scenarios*

The purpose of these scenarios is to provide a platform for conversations about preparing for climate change. The next step is to ensure that these stories are as useful as possible for upcoming discussions about management and governance changes that may be needed. This means deepening the scenarios, to make each of the stories as plausible, challenging, relevant and memorable as possible, and to ensure that the 4 stories are sufficiently divergent from each other to allow us to stretch our thinking in different ways.

Please read each of these draft scenarios in advance of the Scenario Deepening webinars, and come prepared to comment on the stories. What would you add to or modify about these stories to make them sharper and a better platform for generating ideas about how to prepare for whatever impacts climate change throws at us?

## Draft Scenario Framework



## Main Themes of Each Scenario

| **OCEAN PIONEERS: Stocks maintained, but hard to assess / locate** | **CHECKS AND BALANCE: Stocks maintained, mostly straightforward to assess / locate** |
|---|---|
| • Crazy ocean conditions: pendulum swings, boom & busts<br>• Weather is weird, but the ocean is resilient – no damaging tipping points<br>• Extreme weather creates dangerous fishing conditions at times – but the pay-off is still there for many operators<br>• Traditional stock assessments are less reliable<br>• Seasons and locations of traditional fisheries have changed<br>• Differences in fishery times and locations lead to changes in interactions with protected species<br>• Balance of power in fisheries shifts towards the fishing operators; real-time data from vessels more valuable than traditional science<br>• Ocean activity dominated by entrepreneurs, technology, pioneers<br>• Winners have deep pockets, sharp elbows, new technology and a willingness to take risks<br>• Uncertainty about how long "abundant" stocks can keep delivering | • Predictable changes and tolerable conditions<br>• Gradual sea level rise<br>• Range expansion as stocks move predictably north & east<br>• Advances in pollution reduction, habitat protection, restoration largely offsets habitat damage and loss; climate mitigation efforts reduce greenhouse gas emissions<br>• Disease apparent in limited stocks<br>• Science capacity booms, delivering effective ocean monitoring, real-time catch reporting, food web/population monitoring and bycatch avoidance<br>• Carbon emissions growth has been limited and Atlantic coast water pollution is under control<br>• Species composition has changed - management can provide for a full and flexible balanced use of available fish stocks<br>• Investment in other ocean/coastal uses<br>• Recreational sector is healthy thanks to stable productivity and increased coastal wealth, but accessibility issues grow |

| **STRESS FRACTURES: Stocks decline, and are hard to assess / locate** | **SEAFOOD LEMONADE: Stocks decline, straightforward to assess / locate** |
|---|---|
| • Unpredictable conditions create climate tipping points with negative impacts to diverse harvest, forage and marine wildlife species<br>• Storms and population growth exacerbate pollution impacts, further reducing the quantity and quality of estuaries and other nearshore habitat<br>• Diseases are prevalent – marine heatwaves lead to die-offs<br>• Shift to lower trophic level species<br>• High stress on fishing operators with harvest opportunities reduced due to low abundance of traditional stocks and new area closures to protect endangered species<br>• Stock assessments challenged by insufficient scientific data<br>• Science is unable to help the fishery management community adapt and constant lawsuits drain management capacity<br>• Costs of harvesting fish rise and profits sink<br>• Government support needed to save domestic fisheries - only a few select fisheries get this support<br>• Stocks experiencing range shifts are incorrectly classified as overfished; these mistakes undermine the management process<br>• Fishing no longer the dominant activity in the ocean, competing with other industries for space | • Science is good, but the news is bad<br>• Warming trends, declining productivity and abundance for many species including harvest mainstays, choke species, and diverse marine wildlife<br>• Max fish size is smaller<br>• The cold pool continues to shrink in size and duration, negatively impacting diverse species that depend on this pelagic habitat<br>• Range shifts as species move N and E, but not much range expansion<br>• Aquaculture becomes prevalent as a source of seafood<br>• Effective management in some regions puts limits on newly arriving species, allowing establishment of new reproducing populations and subsequent harvest opportunities<br>• Some marine wildlife interaction/bycatch challenges are effectively addressed using improved forecasts and fishing community innovation<br>• Successful small-scale fishermen adapt to reduced catch limits and new stocks to supply limited but lucrative markets<br>• Unsuccessful regions have not developed effective responses to challenges like shifting stocks and new marine mammal interactions, leading to fleet consolidation, loss of markets to artificially cheap seafood imports and aquaculture products, and the permanent loss of historic fishing communities. |

## Scenario Narratives

### *Upper Left – Ocean Pioneers*

#### Ocean Conditions & Stock Productivity

In this scenario, ocean waters continue to warm, but rates of warming vary across regions. Environmental conditions and climate drivers are largely unpredictable, complex, and full of shocks and wild card events. Weather patterns and events become increasingly abnormal and harder to predict, including storms, heatwaves, localized warming, and severe weather events. Environmental change is not consistent, and there are spatial and temporal differences in the direction of climate drivers. Seasonal patterns and timing are changing, but with limited interannual predictability. Annual variability in currents and the cold pool contributes to the unpredictability of conditions.

Primary production is high due to increased upwelling and storms. Habitat generally remains of sufficient quality and quantity to support productive stocks. For some stocks, habitat is enhanced by the addition of more structure from wind farms on the continental shelf. Overall, fish stocks are doing well and the food web structure remains robust. Many species distributions have shifted, but species leaving an area are largely replaced by new species moving in. Most areas along the coast see slight to moderate differences in species composition, but fishermen report that they still have access to seemingly healthy stocks.

#### Volatility and Ability to Assess Stocks

The volatility in environmental conditions increases seasonal variability which makes it difficult to assess and forecast the health of specific marine resources in the current manner as stock availability and distributions are impacted. While overall productivity remains high, individual stock productivity is variable, with many species experiencing boom and bust years and frequent pendulum swings. Existing surveys struggle as more alternative energy and other ocean uses arise that restrict traditional trawl survey areas. Seasonal management regulations become more difficult to set and less successful as it becomes harder to predict where fish will be at a given time of year. Mismatches arise between how data is collected and where the fish are, both spatially and temporally. Assessments have a difficult time keeping up, and eventually it becomes difficult to assume that stock assessments are robust.

It is also difficult to determine "sustainable" biomass and fishing levels given changing distributions and fluctuating productivity of species. Because there is little baseline information about how stocks may fare under new ranges and conditions, it is often unclear what targets are appropriate. A new paradigm for determining sustainable fishing parameters emerges, with many 'historic' stock assessments being replaced with more 'pragmatic' methods for setting catch limits. It is also difficult for scientists to

predict species range changes, as it seems to vary by species and region, and there are few consistent trends across years.

In general, scientists struggle to keep up with changing conditions and increasing management needs and in many situations the traditional scientific process is too slow to provide advice on management-relevant time scales. Technology helps address some issues arising under this scenario, but isn't able to solve all problems. Increased use of transparent technology such as electronic monitoring and transmission of real time fishing data are able to give managers more information when traditional scientific methods and surveys struggle to keep up.

### Pressures on Governance

Governance is forced to evolve given uncertain science and the complexity of changing conditions. High levels of coordination between Councils, the Atlantic States Marine Fisheries Commission, and state fish and wildlife agencies becomes essential. Councils have reevaluated management plan structures, species jurisdictions, and mechanisms for additional flexibility.

### Fishing Practices and Pressures

Local ecological knowledge and innovative technological expertise is at a premium as fishermen adapt. Their data provides critical on-the-water observations and catch information. Management relies on the data and information collected and transmitted from fishermen on the water, as well as shoreside data collection at docks.

Variations and unpredictability in environmental conditions lead to variable fishing success from year to year, creating "boom" and "bust" years. In addition, sometimes harvesters must work around dangerous fishing conditions created by "weird" and extreme weather events that are difficult to predict. This creates market swings that cause frustration in the industry - it is hard to create stable seafood markets under these conditions. However, this is partially offset by increased public demand and willingness to pay a premium for sustainable seafood. The fishing industry struggles to bring in new players given so much variability and uncertainty about future income potential. The next generation pulls back on investing in fishing industry businesses. Recreational for-hire businesses suffer as demand for trips drops: it is difficult to keep clients coming back with inconsistent catch. Private anglers are more adaptable as information about locally abundant fish populations travels through the angling community quickly enough to provide quality fishing opportunities for anglers with access to private boats or productive shore fishing sites.

### Winners and Losers

Patterns of who is catching what changes quickly. Inequity issues arise as differences in adaptability, largely driven by access to capital, become clearer. For both commercial and recreational fisheries, those with access to more capital and other resources are able to take advantage of good stock conditions, while others struggle. Winners are

those who participate in highly mobile fleets as well as those who are able to invest in fleet and gear technology to adjust to fishing in deeper waters and/or to traveling further distances. Among those that do well are those who invest in more fuel efficient vessels, given fluctuations in the cost of fuel. More complex business models adapt better to a different species composition, changing environmental conditions and weather patterns, and market conditions. Vessels that are less able to diversify their target species and/or less able to travel to find fish are struggling. For some gear types, smaller, more nimble vessels are at an advantage.

Extreme weather also creates winners and losers at the shoreside community level. Depending on local resources and wealth, some communities struggle to reinvest after major storms, while others use these events as an opportunity to invest in improved infrastructure. Ports that have already invested early in the protection of the coastline, driven by sea level rise and previous storms, are benefitting. Regional factors also influence vulnerability to sea level rise and extreme weather events. For example, ports in Virginia are subsiding and accelerating sea level rise impacts while the rocky shoreline of Maine is rebounding and less vulnerable to erosion from storms. On the other hand, coastal areas off of the Chesapeake Bay, Delaware Bay, and Hudson Bay are more vulnerable to water quality changes due to freshwater and storm runoff.

### Impact of Alternative Ocean Uses

While stocks are overall productive, many players have lost access to historically important fishing grounds due to space competition with new ocean uses. Extensive offshore wind and other ocean energy uses are changing access to traditional fishing grounds, so many fleets have expanded into previously un-fished areas. Expansion into some new areas results in increased and unpredicted interactions with whales and other marine wildlife, further limiting opportunity. In addition, reduced available fishing area leads to increased user conflicts, between and among different gear types and between the fishing industry and adjacent uses. These changes have excluded participants who were unable or unwilling to modify their fishing practices.

## *Upper Right – Checks & Balance*

This is a world in which there is a good handle on the science needed to predict and assess the impacts of climate change. Ocean temperatures have increased, contributing to shifting stocks and range expansions. There is an increase in storm intensity but science is able to better forecast, and understand the impact of these storms.

### Ecosystem support through conservation and proactive science

Estuarine conservation, restoration, and enhancement have built a foundational support for the ecosystem, food web, and managed species. Regulations have been implemented to help limit the growth in carbon emissions. Science is well funded and its efficiency has improved, with effective ocean monitoring; real time fisheries reporting, and food web and population monitoring. With proactive and increasingly effective science, species productivity is better assessed, distribution shifts and range expansions are forecast and tracked, and interactions with protected species and bycatch fall to historically low levels.

Improved habitats have enhanced many stocks' production. Surveys are able to identify changes in species compositions, the habitats they are utilizing, and oceanographic characteristics all of which leads to a better understanding of the changes in the food web.

### Alternative Ocean Uses

East Coast waters are now being used for extensive alternative energy purposes including wind energy. These competing uses create issues related to fishing rights, opportunities, working waterfronts, and equity. Zoning issues on land combined with impacts of sea level rise create some user conflicts. For example, the expansion of wind power has led to a decrease of commercial spaces in working waterfronts causing commercial fishermen to have issues finding dock space and local dealers. An increase in ocean energy sources leads to less political leverage for fishermen as energy users become more powerful.

### Problems in the 2020s

Between 2022 and 2032, many commercial fisheries struggle with the changing locations of stocks, coupled with high operational costs and a decrease in product prices. Fishermen travel long distances for their catch and some diversify their employment across the seasons. Some fishery participants are able to adapt to the changing conditions by reconfiguring their vessels, moving to the new location of the fish, utilizing new technologies to find fish more effectively and use less fuel and resources. However, despite a broad abundance of stocks, some of the fishery participants sell their interest in fishing to corporations and are no longer involved in the industry. The corporations have better flexibility to operate larger operations over a

wider geographic area. While science is continuously improving, helping assess and predict stock levels and locations, more effective decision-making is slow to follow.

### Improving Conditions in the 2030s

By 2032, with an influx of resources, many fisheries adapt to the changing conditions. New markets develop and commercial fisheries are sustained. Management approaches evolve to provide for a full and flexible balanced use of available fish stocks that provides a more diverse array of marketable species along the coast. White and brown shrimp compete with the Maryland crabcakes in popularity and the grouper sandwich has now become a tourist draw in New Jersey. More generally, fisheries benefit from improved coordination with alternative energy operations, assisted by effective regulatory and management approaches.

### Accessibility for Recreational Fishers

Throughout this whole time frame the recreational sector is strong because of the increased and/or stable productivity. There is an increase in wealth along the coastlines which encourages an interest in recreational fishing. The for-hire sector adapts to new species and continues to expand creating an increase in overall recreational fishing. Fishers in the Southeast have transitioned to different species such as harvesting yellowtail snapper off the reefs of Georgia or conch in North Florida. In the Northeast, recreational trips target black sea bass and spotted sea trout. However, the accessibility to recreational fishing has diminished as the effects of sea level rise and gentrification have affected availability to piers, docks, and beaches. Those fishing recreationally have the economic means to either fish on for-hire vessels or travel offshore on personal vessels.

## *Lower Right – Seafood Lemonade*

In this scenario, scientific understanding of the oceanographic and biological conditions is very strong, even if the news is not good. Researchers are able to closely track the changes in water temperature and stock distribution using a variety of methodologies, including enhancements to the Federal trawl survey, cooperative research with the fishing, offshore energy, and aquaculture industries, and an ability to better model and predict future changes. Their findings indicate declining stocks and worsening habitat, but at least the accuracy of the information provides opportunities for some to manage through such problems.

### Oceanic Conditions

The earth and oceans continue to warm, particularly in the Gulf of Maine, where the average temperature has risen by ~1.5 degrees since 2022. The Gulf Stream has continued to become more prominent, bringing warmer water along the east coast, and edging out the cooler waters from the north. The cold pool historically present off of the mid-Atlantic is now a rare occurrence. New primary production varies with latitude, but generally, across all areas, we are seeing larger plankton being replaced by smaller species, resulting in lower fish productivity.

There is an increase in stronger and more frequent storms, impacting coastal communities most acutely. While predictive capabilities of these storms are good, impacts to fish habitat and infrastructure are high due to the lack of time between storms to repair and restore. Storms plus continued warming have impacted habitat type and function, resulting in a comprehensive shift in available fish stocks in each region. Some towns are faring well, despite these changes, because of the efforts made in 2032 to develop living shorelines, while providing incentives to private marina owners for ensuring 20 percent of the marina is available for commercial and for-hire vessel access.

### Biological Conditions

Despite similar climatic influences, the biological impacts vary between regions due in a large part to local adaptation efforts. Stock distributions have continued to shift, sizes of individual fish are smaller, and productivity of most stocks have decreased.

In some cases, previously defined management units have allowed unregulated access to species in a new jurisdiction before the management program can respond. This leads to distrust across fishing communities, as groups who have the permits and the regulations are unable to benefit from expanded stock availability.

However, the proactive efforts of one of the region's fishing industry collaboratives resulted in healthy and productive fisheries despite these changes. For example, their actions to limit fishing on the few newly arriving species allowed the establishment of reproducing populations that have generally replaced the cod, Atlantic mackerel, and lobster that have moved north into Canada.

### Adapting to New Conditions

Fish stock distributions have changed what is available for day-boat fishermen, but the ability to catch those species has stalled the shifts. Some fishermen have been able to adjust to fishing for different species, despite the expense associated with acquiring the gear necessary to make those changes. Importantly, a shift in 2025 toward "boutique fisheries" allowed some small scale fishermen to adapt to the reduced catch limits and new stocks yet still remain economically viable. This occurred because an Alternative Ocean Use area reopened to commercial and for-hire hook and line fishing, primarily targeting Atlantic migratory cobia. The closure of this area allowed for this previously southern stock to establish a strong sub-population without exploitation. The council added this species to an existing FMP, with provisions limiting access to previously permitted small vessels only.

Unfortunately, similar efforts were not implemented throughout the region, leading to varying levels of protection for newly arriving stocks, and limited establishment of new populations. This has been especially problematic as the loss of forage fish biomass has impacted all levels of the food web in these areas. Continuation of historical fishing methods and sales has led to the loss of almost all small-scale fishermen in some areas because they are being replaced by large corporations able to focus on quantity over quality. The management process is far behind the timetable necessary to allow smarter and more cost efficient permitting changes, resulting in an industrialization of the fleet, edging out owner/operators with less capital. Fishermen have also struggled to establish solid marketing of locally sourced fish because consumers are still able to access the popular stocks from imports.

Access to fishing areas and stocks by commercial and recreational fishermen is not just impacted by the availability of permits and gear. Privatization of marinas, docks, and other ocean access sites has made it difficult for average income participants to take advantage of new opportunities. Further impacting commercial and recreational fishing participation is the physical space available to fish in. The establishment of many offshore energy and aquaculture structures has narrowed the fishable areas that are not aligned with shifting habitat preferences of target species. Some participants in recreational fisheries have enjoyed an increased access to previously unavailable stocks closer to home, but most struggle to afford the ability to fish in deeper, colder waters.

## *Lower Left – Stress Fractures*

### Environmental Conditions

This is a world in which ocean temperatures are increasing, sea levels are rising, currents are unpredictable, and marine heatwaves have increased in frequency and duration. There is a climate tipping point where the Atlantic Meridional Overturning Current, AMOC, becomes unstable. Severe storms have increased in frequency, which creates brown water and temporary dead zones nearshore, which in turn disrupts spawning events. Temperature and pH changes vary with some areas warming and/or acidifying more rapidly than others. Unpredictability is a hallmark.

Under these conditions, fisheries production and habitat quality are declining. Species distributions are shifting, and some regions do not receive replacement species for those that have moved into other areas or declined in abundance. Generally, species diversity has declined. Range expansion and contraction are extremely variable. Overall, the fish community looks quite different from today. Abundance of lower trophic level species increases as top predators decline and generalist species tend to be more successful.

Estuaries, which are important fish nursery grounds, are experiencing declines in productivity due to habitat degradation. This is caused by several factors, including sea level rise and changes in salinity due to alterations of freshwater outflows. There is less larval dispersal and increased larval mortality. Saltmarsh areas are reduced due to droughts, and coastal population growth leads to increased demands for coastal armoring to protect infrastructure, which prevents natural landward migration of these habitats. Coral habitats, which support some southeastern species, decline in quality.

Productivity decreases due to enhanced stratification, including on Georges Bank. With the decrease in species diversity, those species remaining tend to be generalists or occupy places lower on the food chain due to nutrient-induced plankton blooms. These blooms lead to both unstable harvests of certain species (e.g., shellfish) and increased incidence of human disease. In this degraded ecosystem, invasive species and fish disease are more prevalent.

### Social and Economic Conditions

Science is not able to predict the changes occurring in this complex and unpredictable ocean; funding simply does not keep pace with ever-increasing demands. For some stocks, data streams and assessments lag behind current conditions, and are not useful for predicting stock dynamics. For these resources, science is unable to help the fishery management community adapt, further exacerbating challenges. However, other non-traditional data sources mitigate information gaps in other fisheries. Through advances in electronic monitoring (EM) some fleets have adopted 100% monitoring coverage. These fleets are able to provide more real-time data to managers and scientists,

allowing for more nimble management of stocks, both in-season and annually. While many fishery management plans and regulations remain inflexible and are slow to change, others, especially those with enhanced monitoring, develop new approaches to better suit the needs of the changing fisheries.

The costs of harvesting fish continue to rise and profit margins shrink. Fuel prices increase dramatically, and costs for other items such as ice, fishing gear, and other provisions are also high. Vessels are more transient, chasing fish northward and offshore, which increases transit times from home ports. This places stress on crew members and leads to higher fuel consumption. There is insufficient workforce for commercial harvesters and processors as existing workers retire and are not replaced. Recreational fishing by boat becomes very expensive and is only available to the wealthy. However, there are some bright spots for the industry. Battery technology improves to allow some vessels to switch to more efficient electric vessels and improvements in radar systems allow for safer navigation.

Coastal populations continue to increase which causes development-related stresses on nearshore habitats. Food prices continue to rise across the board. Given the limits of land-based agriculture to provide food for a growing population, demand for seafood protein increases. While this provides opportunities for fisheries, consumers are primarily concerned with price and taste and are willing to buy imported or tissue cultured products so long as they are inexpensive and enjoyable to eat. There is limited wide scale emphasis on locally caught seafood. Further complicating matters there are international tensions which also affect seafood trade.

### Policy Responses

As a response to these harvesting and marketing stresses, the Federal government increases support for domestic fishing. It supports the development of domestic markets for fish and reduces imports through tariffs. This includes market development, advertising, science, technology, and workforce training. Given limited resources, specific fisheries are targeted for these interventions because they likely have staying power under new environmental conditions. In fisheries that receive these interventions, there are successes around reduced operational costs, new markets, and innovative science programs.

Offshore aquaculture expands to both supplement and enhance Federal fisheries. Because both wild capture fisheries and aquaculture require processing infrastructure, aquaculture-related enhancements benefit wild capture fisheries as well. Shellfish aquaculture mitigates coastal water quality concerns in some areas, improving habitat for many species.

### Science and Stock Assessments

Stock assessment and status determination is challenged by insufficient scientific data; stocks experiencing range shifts are incorrectly classified as overfished, and these false

flags undermine the management process. New fisheries emerge to target species at the bottom of the food web, but a lack of knowledge of these stocks leads to overexploitation. In some cases there is limited ability to obtain permits to target locally available and abundant species. In other fisheries, scientists and managers eventually learn to use novel, real-time data streams from some stocks to conduct more frequent management track assessments. These new science and assessment approaches are needed to understand this unpredictable ecosystem.

Fishing is no longer the dominant activity in the ocean. Other industries such as offshore energy development and shipping are prevalent. As a result there are effects on nearshore and offshore fish and fisheries. Attention of scientists and managers follows the money, and is dedicated to these issues, sometimes at the expense of researching changes in fisheries. Atrophy in the fishing industry allows ports to expand and change to accommodate offshore wind and shipping, but often at the expense of supporting fishing operations. Smaller fishing ports are lost without targeted interventions. Such interventions are successful where the right mix of resources come together, and a few ports experience a renaissance, where fishery support services are diverse and the number of fishing vessels increases for the first time in decades.

## Scenarios As Platforms for Thinking About Adaptability

The scenarios above represent four different futures influenced by varying levels of stock productivity/abundance and the level or predictability of ocean conditions. Within each of these four stories, the success of players in the system varied according to whether they (and the system in general) were adaptable to the new and different sets of conditions.

Different degrees of adaptability were in evidence in the scenarios. Sometimes, the stories explained how some regions were more adaptable than others. Sometimes players in the system learned over time, so adaptability was higher in later years compared to earlier. In other storylines, adaptability was determined by the level of capital investment, or sometimes by the willingness to use technology.

It seems clear that the secret to success (for most players) in an era of climate change is an ability to adapt to changing conditions. But what does adaptability mean? Across the scenarios, ideas about adaptability were discussed across several dimensions.

- Many of the scenario stories recognize that fishing operators are inherently adaptable, as they have reacted to changing conditions over many years. Stock availability has varied, fish have changed their ranges, economic challenges have emerged from unexpected sources (like the pandemic). But a future of climate change will put even more pressure on the ability of operators to adapt. The optimistic see no reason why operators won't continue to adapt. The pessimists see that climate change alters conditions so much that it could get more difficult to do so.
- Elements of the scenarios also reflect the fact that operators have only so much influence over their ability to adapt. They might be constrained by external factors, such as "too much change", a lack of resources, or technology. They might also be constrained by more internal factors such as existing skills and conventional attitudes.
- The scenarios also raise questions about: who adapts? In some situations, new players come into the market for ocean resources. Energy and aquaculture companies might innovate and become more powerful players, creating a highly adaptable environment that poses real challenges for fishing operators. This links back to the question of the resources and attitudes available for adaptation.
- During scenario creation conversations, fishing operators saw their ability to adapt being constrained by existing fishery management and governance approaches. In a future of climate change, where stocks might move, ranges might expand, and new challenges could emerge from year to year, it is imperative that governance and management recognize the need for their own

approaches to adapt. There is a major concern that current arrangements will limit success, given the need for operators to travel further, catch different stocks, etc. etc.

- Adaptability was also referenced in terms of the legal and regulatory apparatus (mostly the MSA, but also including other federal and state regulatory constraints). At this stage, the scenarios have been written in a way that assumes that the legal and regulatory apparatus remains broadly intact. However, this should not constrain the next stages of the process from generating ideas based on possible changes in the legal and regulatory environment.

To sum up, these scenarios describe ways in which various players and places might adapt (or fail to adapt) to a range of new and different conditions in an era of climate change. The descriptions outline some of the broad contours of possible changes - to fishing practice, use of technology, governance and management etc. - but they stop short of suggesting specific actions. That is the purpose of the next stage in the overall process. These scenarios should be used merely as platforms, containing hints and provocations to help stakeholders discuss the actions to come.

## Using the Draft Scenarios: A Reminder

The purpose of these scenarios is to provide a platform for conversations about preparing for climate change. The next step is to ensure that these stories are as useful as possible for upcoming discussions about management and governance changes that may be needed. This means deepening the scenarios, to make each of the stories as plausible, challenging, relevant and memorable as possible, and to ensure that the 4 stories are sufficiently divergent from each other to allow us to stretch our thinking in different ways.

Please read each of these draft scenarios in advance of the Scenario Deepening webinars, and come prepared to comment on the stories. What would you add to or modify about these stories to make them sharper and a better platform for generating ideas about how to prepare for whatever impacts climate change throws at us?