East Coast Climate Change Scenario Planning

Scenario Creation Workshop Summary

June 21-23, 2022

Project Introduction

The East Coast Scenario Planning initiative is a multi-year effort to explore how climate change might affect fisheries on the US East Coast, and to identify the consequences for the future of fisheries management and governance. Since July 2021, the scenario planning work has engaged with hundreds of fishery stakeholders, gathering views and opinions on how climate change has affected – and is poised to further affect – fisheries on the East Coast.

It seems clear that climate change is bringing about a time of transition and change in East Coast fisheries. Fishing communities and fishery managers are already living through it. No one can predict exactly what future changes will be, but it is possible to anticipate some of them and imagine others. We need to be prepared for what the future might look like. More specifically, this scenario process is an opportunity to ensure that fishery governance and management is better prepared for the next twenty years, a time when we expect climate change to have a significant impact on many aspects of our fisheries.

The goals of the overall initiative are to:

1. Explore how East Coast fishery governance and management issues will be affected by climate driven change in fisheries, particularly changing stock availability and distributions.
2. Advance a set of tools and processes that provide flexible and robust fishery management strategies, which continue to promote fishery conservation and resilient fishing communities, and address uncertainty in an era of climate change.

Overview of Scenario Creation Workshop

This scenario creation workshop was held on June 21-23, 2022 in Arlington, VA (see Appendix 1 for workshop agenda). It brought together approximately 75 stakeholders and support staff (Appendix 2) from various disciplines to explore the possibilities of what climate change might mean for the future of fisheries. Specifically, the objective of the workshop was to: *develop a small number of divergent, plausible, challenging, relevant, memorable stories that outline possible conditions facing East Coast fisheries in the next 20 years.*

Participants were informed that this was not a typical strategy or fishery management meeting. The purpose of the session was not to directly solve a problem, or even to generate ideas to solve a problem. Instead, the purpose was to encourage participants to think carefully about the conditions that fisheries might face in future,

and to convey these in a creative way. The scenarios that result would then be used as a platform for idea generation and solution conversations later in the process.

It is important to note that this workshop (and the scenarios that result) are not the final output of the initiative. The ultimate outcome is a set of suggestions and recommendations for how fishery governance and management should change to be successful in an era of climate change. The conversations will occur later in 2022 and early 2023.

The components and outcomes of the workshop are described in more detail in the following sections. In brief, the workshop structure was as follows:

- On Day 1, workshop participants reviewed the previous work of the scenario process, particularly the exploration phase. Participants were reminded of the oceanic, biological, and socio-economic driving forces that had the potential to shape fisheries in the next twenty years. These forces were used to create more than 20 scenario 'building blocks.' -Day 1 continued with several small groups creating a total of 24 mini-scenarios out of the 'building blocks' provided - each offering a different potential story for how fisheries might be affected by climate change. Day 1 ended with each small group reporting out on their stories, and a discussion about the most important themes that emerged.

- On Day 2, workshop participants identified the 'critical uncertainties' that would define the scenario framework. Three axes of uncertainty related to stock production, ability to assess change, and adaptability resulted in eight different scenarios. Eight small groups each considered one of these scenarios, further developing a distinct scenario narrative in collaboration with other teams.

- On Day 3, participants started by expressing their hopes and concerns for the rest of the process. Each group discussed their main findings and the workshop concluded with an explanation of next steps.

Climate Change and Fisheries to 2042

To prepare for the scenario creation activity, participants were presented with some information from earlier phases of the scenario process. From the Scoping phase, we shared the examples of how climate change is already affecting ocean conditions on the East Coast. The following are examples among many observed and experienced changes identified at the scoping webinars held in Fall 2021.[1]

- Florida species shifting north
- Some species moving north / east
- Changes in productivity & fish size
- Shifts in timing and frequency of spawning
- Estuarine habitat loss
- New food web dynamics'
- Realigning business to adapt to new species
- Sea level rise impacting boat access

We then turned our attention to the possibilities of the next 20 years. If these are the conditions and changes we are already seeing, what might be in store for the next couple of decades?

To structure these conversations, we drew on the findings of the Exploration Phase of our scenario process. In Spring 2022, we held three webinars that each focused on a different set of driving forces that have the potential to shape the future. These webinars featured a wide selection of scientists, commercial and recreational fishery participants, fishery managers and others. We provided scenario creation workshop participants with a detailed summary of these webinars as pre-reading material, and also presented the main findings at the start of the workshop.[2] The three webinars each dealt with a different 'category' of drivers:

Physical/Climate Drivers

Climate change is poised to affect the oceans off the US East Coast in a number of ways. Ocean warming is occurring at an especially rapid rate in the Gulf of Maine. Other areas are also experiencing warming oceans, but there are seasonal differences across regions. Climate change affects the primary productivity of the oceans, again, with different impacts according to regions. Sea-level rise is poised to be a feature that will affect coastal communities and habitats. Climate change is also likely to increase

[1] A full summary of the scoping process is available at: https://www.mafmc.org/s/ECSP-Scoping-Summary_Dec-2021_final.pdf.

[2] A full summary of the exploration phase is available at: https://www.mafmc.org/s/ECSP-Exploration-Phase-Summary_Final_April2022.pdf.

storm intensity, although there are questions as to whether this will also mean more or less frequent intense storms.

Biological Drivers

Climate change has both direct and indirect effects on fish off the East Coast. Current and future direct effects include spatial shifts in species (which could result in range expansion or contraction), reductions and increases in population productivity, reductions in average size of fish, changes in seasonal timing of life stages including migrations, and changes in community assemblages. Indirect effects include changes in food availability, habitat availability and quality, trophic interactions, incidence of disease, and the resilience and stability of food webs / ecosystems.

Social & Economic Drivers

Some social and economic drivers are likely to be influenced by climate change (e.g., damage to coastal infrastructure from storms and sea level rise). Other social and economic drivers might include changes in coastal populations, changing economic costs of fishing operations, greater commercial activity in the oceans (e.g., from aquaculture or energy development). Changes to demand for fishery products and supply shocks are also likely to create different future market conditions. Another key driver will be the ability of players (operators, managers, communities) to adapt to changing conditions.

Reactions and Comments

Following a presentation of this material to workshop attendees, participants discussed a number of other factors or knock-on effects that have the potential to shape East Coast fisheries by 2042, and emphasized some of the factors in the briefing materials that they found to be particularly important. These included:

- the effects of climate change on snow melt and freshwater streamflow
- offshore wind modifying local environments
- rainfall events creating more pollution
- risks of human disease from seafood pathogens
- changes in spawning locations due to sea level rise
- access to capital for fishing businesses
- shrinking disposable incomes impacting demand for seafood and recreational fishing
- technological changes in processing, gear, infrastructure etc.
- shoreside fishing becoming less accessible

Mini-Scenario Creation

Building Blocks of the Scenarios

The purpose of this scenario planning exercise is to allow participants to explore how these different drivers could combine to create alternative pictures of the future. To do this, we categorized many of these drivers of change into different building blocks as follows:

- Predetermined Elements: these are drivers that are confidently predictable over the next 20 years. We can confidently assume that these trends will feature in any scenario that describes the future out to 2042. For example, we can confidently assume that oceans will continue to warm for the next 20 years, so we identify this as a predetermined element.

- Wildcards: these are surprising events and developments that could impact the future in significant ways over the next 20 years. A wildcard has the potential to reshape a system. For example, any significant changes in the Gulf Stream might be unlikely, but if that were to happen, it would undoubtedly reshape many aspects of fishing on the East Coast.

- Critical Uncertainties: these are important drivers that have the potential to move in various, alternative directions over the next 20 years. For the purposes of this exercise, we described the potential outcomes of the driver in two opposing directions. For example, we know that there will be ocean warming in the next 20 years, but there is uncertainty over the *rate* of warming. Accordingly, we create an uncertainty that outlines two outcomes: Will there be rapid warming in the NW Atlantic, or will the AMOC (Atlantic Meridional Overturning Circulation) swing toward a cooler state, stalling the warming trend?

The full list of building blocks is contained in Appendix 3.

Each group reviewed their lists and discussed whether to change any of the language in the cards, or whether to add other cards. This exercise ensured that participants became more familiar with the materials, and also were able to adjust the descriptions of the drivers of change in ways that made sense to them. Some of the most notable changes to the cards were as follows:

- Addition of a critical uncertainty card focusing on the predictability/ unpredictability of community interactions (e.g., predator-prey dynamics, communities, habitats)
- Several additions relating to potential for major habitat impacts (loss, degradation, failure to migrate) and consequences for fisheries
- Addition of a wildcard expanding disease impacts to include harmful algae blooms and invasive species

- Modification of alternative ocean use card: from 'competition' to 'conflicts'
- Addition of a critical uncertainty that related specifically to adaptability of working waterfronts
- Addition of a predetermined card that focused on inland population growth and flow dynamics to estuarine habitats
- Addition of a wildcard that focused on political changes affecting fisheries
- Simplification of a critical uncertainty about consumer preferences for seafood

Many of the groups commented that there were no critical uncertainty cards that related to management actions or decisions. It was explained that the purpose of the overall exercise was to identify and *solve for* management ideas. The mini-scenarios describe the conditions - then, the groups are able to consider what management actions are best suited to succeed in such conditions.

Mini-Scenario Development

On day 1, groups quickly generated 24 mini-scenarios (3 per breakout group):

- Expected Future: Groups were asked to use a combination of building block cards to create a mini-scenario that they thought was generally expected to be the future for East Coast fisheries in a time of climate change.
- Alternative Future: Subsequently, groups were asked to use a different combination of cards to create an 'alternative' scenario - one that was different in important and meaningful ways from the expected future (for this scenario groups were required to include the opposite potential future for at least one critical uncertainty they had included in their first scenario).
- Free-Form Future: Lastly, groups were asked to create one more scenario, using cards they had not previously used. The combination of these cards was intended to create a scenario different from either of the first two stories from each group.

Summary of Mini-Scenarios

The table below summarizes the main themes of each mini-scenario created during day 1. Additional details from each mini-scenario are contained in Appendix 4.

Breakout Group	Expected Future	Alternative Future	Free-Form Future
Atlantic Lobster	Winners & Losers: variations in stocks and in fishery success	Gone with the Wind: alternative energy limits access to fisheries	Rise to the Occasion: habitat challenges and tough choices from sea level rise
Red Drum	Consumer Palette Warms to Climate Change: new tastes are embraced as species shift location	We Hope Not: commercial struggles to adapt as recreational & aquaculture thrive	Rising Declines, Living Shorelines: sea - level rise leads to coastal armoring, damaging habitats
Winter Flounder	Disruption / Consolidation: climate and other disruptors upend industry structure	Have Our Fish & Eat Them Too: positive angles on tech, stocks and offshore wind	A Shellfish Solution: more popular coastlines affect pollution & habitat
Spanish Mackerel	Manage Fast, Not Half Fast: supply challenges in SA; accessibility issues further North	Total Annihilation: huge changes with no chance to adapt	The Fix is the Kill: powerful new competition from energy, aquaculture and lab-grown food
Horseshoe Crab	Littoral Lottery: a patchwork of high and low productivity habitats	Climate Catastrophe Creates Cash: a more efficient industry emerges from weather devastation	Rx For Prozac: steep declines in stocks leaves only boutique fisheries
Tautog	Elon Cusk: using technology to overcome challenges	Changing Oceans Local Oceans: local markets adapt to new species	Stinky Business: aquaculture provides a solution to shifting stocks and income pressures
Menhaden	Adapt & Survive: a story of how the industry reacts to expected challenges	Pork: It's What's for Dinner: storms, tech mismatches and missed opportunities:	Let Them Eat Cake: competing uses mean that oceans become a profitable space
Striped Bass	Fisher Innovation Outpaces Science: real-time data and citizen science provides better guidance	Weathering the Storm: science helps careful ecosystem based management	Sharknado: coasts get more popular and a lot more dangerous

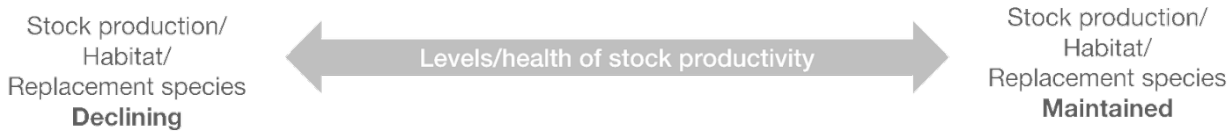
The final conversation at the end of Day 1 looked for interesting commonalities and differences across the 24 mini-scenarios. Some of the most notable comments were as follows:

- Many groups identified fishermen's ability to adapt to big changes as a key element of their scenarios. This ability to adapt is not only dependent on the skills and attributes of fishermen but depends on having access to fishing grounds and variable species.
- Descriptions of range expansions, shifts, and contractions were common.
- Many comments and references to science, and whether it can keep up with the changes that are being witnessed.
- There was a clear distinction between doomsday scenarios, and stories where the industry was able to adapt. In general, the doomsday scenarios involved issues that were beyond our control, while the rosier pictures were due to all actors taking decisions to adapt to changes.
- Stories about new advances in technology told different stories. For example, aquaculture has great potential as a vehicle for adaptation, but it could also be described as a story of decline for the fishing industry.
- We heard comments and questions about the plausibility of optimistic scenarios about technology and adaptation. We are struggling to get the science working today – is it realistic to consider that things could improve for tomorrow? Other groups thought that this was possible.
- A recognition that fisheries adaptation is not the only driver of success. It doesn't matter what we do if we do not take care of water quality and minimize the damage from HABs, pollution, disease etc.

Creating a Scenario Framework

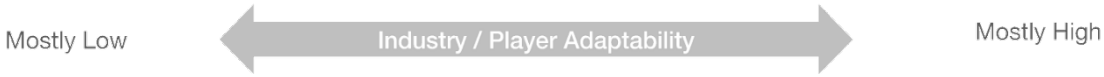
We analyzed the scenarios to see what were some of the most popular driving forces, and which driving forces emerged as critically important to distinguish scenarios from each other. Three main uncertainties were factored in:

1. Is species productivity maintained or does it decline? This also includes the idea of replacement from species that are moving.

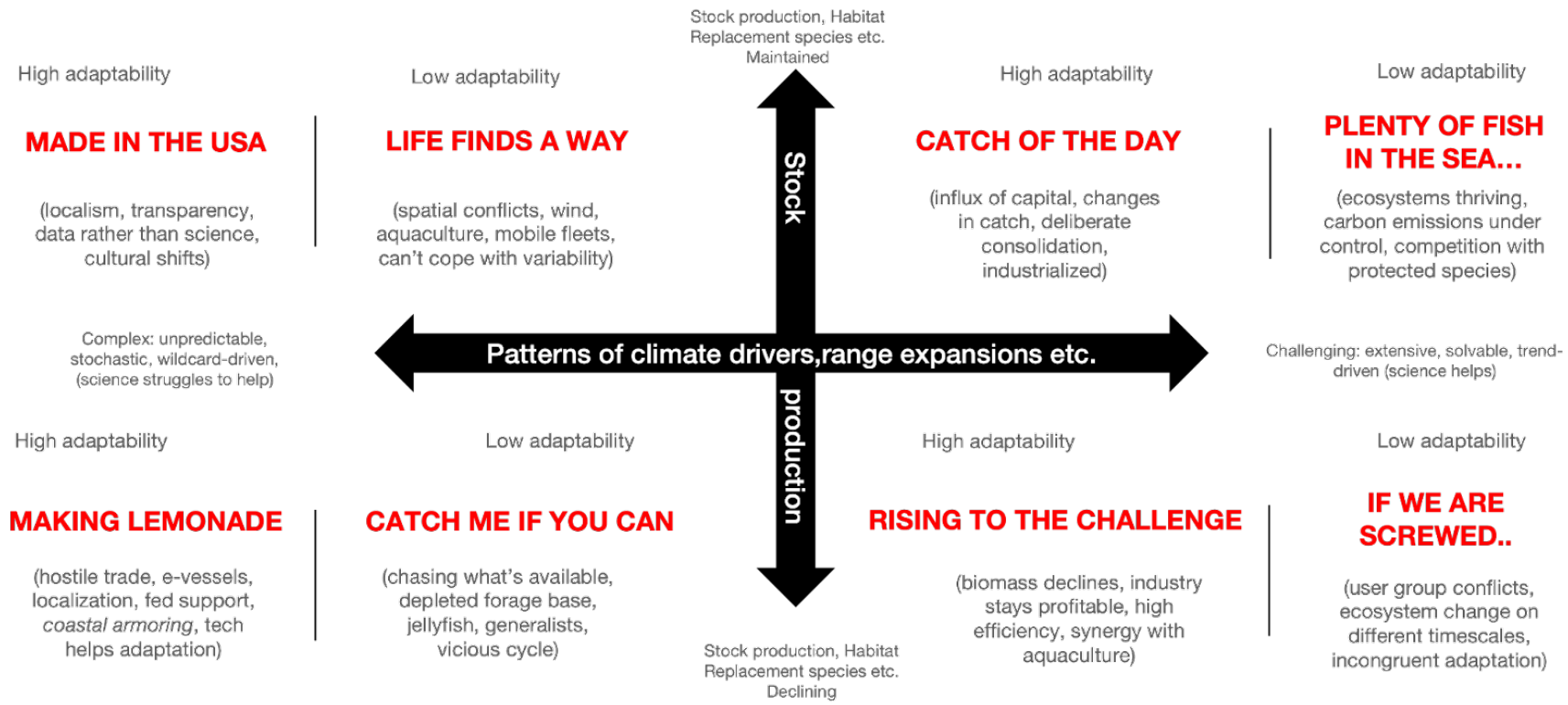


2. How unpredictable are ocean conditions and fish stock – i.e. how well is science able to assess and predict stocks and their location in future?

3. How adaptable are fishery / industry players to the changes and variability in conditions?



These three uncertainties can be conveyed in the following matrix below, where four quadrants are created by intersecting the first two uncertainty axes above. For each of these four quadrants, two stories were created: one telling the story of effective adaptability under those conditions, and the other telling the story of a lack of adaptability.



Summary tables describing each of these quadrants and scenarios are contained in the pages that follow. As noted in this graphic, the main difference within each of the quadrants was the extent to which industry players could adapt to conditions. We summarize many of the issues related to adaptability in a section following the scenario descriptions.

Elements of Each Scenario

UPPER LEFT: *Complex, unpredictable changes make science challenging, and result in different but mostly healthy stocks, adequate habitat and replacement levels.*

<table>
<tr><td colspan="2">Warming water, but rates of warming are different across regions
Unpredictable, complex, full of shocks – weird weather, including storms, heatwaves and severe weather events
Primary production is high due to upwelling / storms. Habitat is generally OK.
Volatility in conditions – hard to manage seasons and we see boom & bust years / pendulum swings
Fish have shifted, changing species groups with adequate replacement
Difficult to assume that stock assessments are robust: ‘pragmatic’ replacing ‘historic’ assessments
Greater genetic diversity, localized features, dangerous fishing conditions</td></tr>
<tr><td>MADE IN THE USA – high adaptability
Greater levels of collaboration to provide access to fisheries that move
Governance must be different in this world
Transparent technology (e.g. virtual fishing observers)
Fluctuating prices and strong locavore movement
Fishermen act on triggers without going through MSA
Function cooperatively and competitively
Require different gear to follow fish further
Fishers advise scientists
Efficient data collection – catch information that transmits data directly to Council
Technology is different for each fish
Culture and identity shift within fishing communities</td><td>LIFE FINDS A WAY – low adaptability
Enough fish around, but science & management struggles
Difficult to manage with shifting seasonal distributions
No consistency in fishing grounds
More user conflicts in squeezed fishing areas
Winners and losers create greater inequality
Early investors do well
Aquaculture is at risk and wind farms lose fishing grounds
Hard to reinvest after storms
Scientists still try to predict range shifts</td></tr>
<tr><td colspan="2">Recreational suffers
Conflicts and closed areas</td></tr>
</table>

LOWER LEFT: *Complex unpredictable changes make science challenging, and result in declining stock and habitat conditions. Fisheries experience climate tipping points as conditions worsen.*

<table>
<tr><td colspan="2">Worst of all possible environmental conditions: large temperature changes, Gulf Stream slows, and substantial ocean acidification
Harmful Algal Blooms prevalent, especially in estuaries; marine heatwaves occur frequently, ENSO impacts and unpredictable precipitation
Southern extent of many species moves north with minimal replacement species
Fish kills increase/interannual variability of stock availability
Regional changes to species availability
Patchy, reduced quality habitat
Extensive bio-fouling and disease
Recruitment is variable and dependent on storms
Decreased fish diversity; generalists cope best
Ocean is noisier; poor acoustic habitat
Increased stratification; alters upwelling, nutrient availability
Regulatory discards due to lack of permits/quota for species shifting into new areas.</td></tr>
<tr><td>MAKING LEMONADE – high adaptability
Fishing requires a lot of external support
A geopolitical shock – e.g. hostile trade war
US supports the development of domestic markets for fish
Imports are reduced
Better use of under-utilized species
Large scale kelp farms and aquaculture expands
Federal funds pay for radar, electric vessels, compensate fishermen for lost wages
Government intervention as ports are lost</td><td>CATCH ME IF YOU CAN – low adaptability
Regulation remains inflexible
False flags of overfishing
Data lags ocean conditions
Fishermen travel much further to catch fish, in uncertain conditions
Charter boats fare poorly
Costs of fishing rise
Consolidation; industry moves away from owner-operator
Fish down a resource and move on to the next stock
Forced to catch and eat further down the food chain (jellyfish)
Lots of change, not coping well</td></tr>
<tr><td colspan="2">Charter boats don’t do well</td></tr>
</table>

LOWER RIGHT: *Fairly predictable changes in ocean conditions and advances in science result in a more accurate set of predictions and assessments – but habitats suffer and overall stock productivity and replacement exhibits a fairly consistent decline.*

<table>
<tr><td colspan="2">Warming is consistent and fairly predictable
Science is better able to assess stock changes – and it's not often good news
Decreasing productivity – some boosts when storms occur
Cold pool breaks down
The center of species abundance will change
Maximum size of fish is reduced
Disease prevalence is increasing, pollution more prevalent
Food web dynamics become more problematic
Many species unable to cross the biogeographic barrier of Cape Hatteras</td></tr>
<tr><td>RISING TO THE CHALLENGE – high adaptability
More species diversity in Northern states
Public pallet adjusting to changing tastes
Innovation compensates for productivity loss
Collaboration on the science related to aquaculture and wind
Modelling improves
Some limited replacement of species</td><td>IF WE ARE SCREWED… – low adaptability
If species show up, they get fished immediately
Management is unable to adapt enough, even with good science
Human nature to resist change
No viable habitat for stocks to shift to
Industry disappears</td></tr>
<tr><td colspan="2">Can aquaculture be a replacement for fishing?</td></tr>
</table>

UPPER RIGHT: *Fairly predictable changes in ocean conditions and advances in science lead to more accurate stock assessments. Stock movements and range expansions are extensive and move predictably northerly and offshore. Habitat conditions improve (or at least are maintained), resulting in improvements in stock productivity and high replacement.*

<table>
<tr><td colspan="2">Warming is consistent and fairly predictable, within a tolerable range for most species
Science is better able to assess stock changes
Mostly predictable north – east range expansion for most species
Species composition changes, leading to choke species concerns
Gradual sea level rise helps some estuarine habitats
New species show up in surveys
Investments in habitat protections (e.g. wetlands) and climate mitigation
More non-fishing ocean uses
Some pollution and diseases in small proportion of stocks</td></tr>
<tr><td>CATCH OF THE DAY – high adaptability
Funding of tech improvements
Capital investment in coastal communities
Gear modification to adapt to changing fishery targets
Adaptations ensure less interaction with protected species, choke species
Wind farm funding reinvested to improve stocks / technology
Drones used to locate fish
Wild caught fish more valuable thanks to consumer / demographic change
Effective predictive science</td><td>PLENTY OF FISH IN THE SEA – low adaptability
Few local markets or infrastructure
Fishers don’t have the right boats
Downsizing and gentrification in ports
Emphasis on tourism rather than commercial fishing
Recreational fishing does well
Differences between north and southern ports and fisheries</td></tr>
<tr><td colspan="2">Consolidation of ports
Habitat restoration
Different ocean economy – tourism, recreational fishing, less commercial</td></tr>
</table>

The Importance of Adaptability

The scenarios above represent different futures influenced by varying levels of stock productivity/abundance and the level or predictability of ocean conditions. Within each of these stories, the workshop conversations revealed that the success of all the players in the system depends largely on the *degree of adaptability* exhibited. The stories where adaptability was high were generally framed in a positive manner, while the stories where adaptability was low described more problematic futures.

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? During the conversations, ideas about adaptability were discussed across several dimensions.

1. Much discussion recognized 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.

2. It was recognized that operators have only so much influence over their ability to adapt. They might be constrained or enabled by external factors, such as access to resources or technology. Adaptability might also be influenced by more internal or local factors such as existing skills and community norms and values.

3. There was also discussion about: who adapts? We can imagine scenarios where new players including energy and aquaculture firms may have high capacity to innovate and adapt, while fishing operators are more constrained and challenged. This links back to the question of the resources and attitudes available for adaptation and how they may not be evenly distributed amongst different ocean use sectors and human communities.

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

5. In addition, discussions related to conflicting adaptability and the impact on the success of an adaptation was important - if various stakeholders and

management are all adapting, but in ways that are at odds with each other, individual adaptations may be unsuccessful.

6. Adaptability was also referenced in terms of legal and regulatory frameworks (mostly the Magnuson Stevens Act, but also including other federal and state laws and regulations). Discussions focused on whether the recommendations that flow from this exercise should assume that the existing regulatory apparatus remains intact (and hence ideas for change must stay within the existing framework), or whether recommendations can and should assume that changes in the legal and regulatory apparatus are possible (in which case the set of ideas could be broader).

At its heart, this scenario exercise is designed to help generate new ideas for how fishery governance and management can be most effective in a future of climate change. There will no doubt be implications for science, research, technology, policy as we learn more about future conditions. But this workshop also revealed that part of the governance and management solution must be to evolve approaches *in order to allow operators to be more adaptable* as conditions continue to change.

Final Workshop Reflections

Each small group provided a detailed report-out of their scenarios. It was explained that the next step (after the workshop) would be to continue to review and refine these stories, so that the scenarios were plausible, challenging, relevant, memorable and diverse before moving into the next steps.

The final conversations then explored any broader participant reflections and questions that emerged during more than two days of intensive conversation.

- Participants asked whether the scenario conversations would also include a way to identify and define the values that we prioritize. For example, there was much discussion of equity during this week, but there is no clear view whether equity is a value that we should be aiming to promote as part of this exercise. There is no explicit idea to build in a discussion of values, but ut will likely play out later in the process as teams begin to prioritize ideas for governance and management.
- There is also the dimension of community adaptability and nimbleness. What will it mean for communities to successfully adapt in relation to climate change - and how might this be different when comparing fishing communities with other coastal communities etc.
- Certain ideas that emerged strongly on Day 1 did not play so powerfully into the final scenarios - such as shoreline restoration and coastal armoring. These issues might not be ones that we have control over, but it will be important to share the workshop findings with organizations that have a more central role in these developments.

- It is often helpful to have a conversation about some themes that did not feature strongly during the scenario conversations. What surprised us that we didn't hear about? This list included: (i) overcapitalization, (ii) ocean mining, (iii) ecosystem resilience (and ecosystem-based management in general) (iv) monument creation
- The group recognized that any suggested solutions and ways forward can be expected to pit agencies and issues against each other (e.g. National Marine Fisheries Service vs. Bureau of Ocean Energy Management)
- On a positive note, many observed that the tone and nature of these conversations was collaborative and productive. By focusing on what we might face (together) in the future, there is less of a sentiment of blame threaded through the discussions. Further, throughout the group there was a determination to continue these conversations towards the real goals of the initiative: ideas for governance and management that are better suited for an era of climate change.

Next Steps

The group was very keen to be updated and engaged as the process continued. The next steps will involve:

- Refinement of the scenarios and development of a narrative for each scenario.
- Scenario deepening webinars.
- Idea generation discussions at Council/Commission meetings and with other groups as appropriate (e.g., Advisory Panels).
- A summit meeting in early 2023 to prioritize and make suggestions about changes to fishery management and governance.

APPENDIX 1: Workshop Agenda

East Coast Climate Change Scenario Planning
Scenario Creation Workshop Agenda
June 21-23, 2022
DoubleTree by Hilton Hotel Washington DC Crystal City

*Sessions marked with an asterisk will be conducted in plenary and will be broadcast via listen-only webinar. Breakout group sessions will be limited to in person workshop participants. For additional meeting materials and webinar information, see https://www.mafmc.org/council-events/scenario-creation-workshop.

Tuesday June 21, 2022: Day 1

9.00am	Coffee and Registration
9.30am	Welcome, Overview & Introductions*
10.15am	Review of Drivers of Change* ● Discuss factors poised to shape the future of East Coast fisheries over the next 20 years
11.00am	Break
11.15am	Scenario Building Blocks ● Preparation for scenario creation activity
12.00pm	Mini-Scenario Creation ● Groups construct a brief scenario describing East Coast fisheries 2022-2042
1.15pm	Lunch – Catered at Venue
2.15pm	Mini-Scenario Creation, Continued ● Groups construct two additional brief scenarios describing East Coast fishing 2022-2042
3.30pm	Break, Including Time to Review Scenarios
4.30pm	Small Groups Report Out*
5.30pm	Adjourn

Wednesday June 22: Day 2

8.30am	Day 1 Reflections & Plans for Day 2*
9.00am	Constructing a Scenario Framework*
10.15am	Break
10.30am	Scenario Building - Breakout Groups • Groups create detailed scenarios describing various aspects of East Coast fisheries 2022 - 2042
12.00pm	Lunch – On Your Own
1.00pm	Scenario Building – Peer Group Review • Groups review others' scenario ideas and make connections
3.00pm	Break
3.30pm	Report Out and Summary Discussion* • Groups report out on their scenarios • Plenary conversation looks for patterns, differences, commonalities
4.30pm	Adjourn

Thursday June 23: Day 3

8.30am	Day 2 Reflections & Plans for Day 3*
9.00am	Selection of Final Draft Scenarios*
10.30am	Break
11.00am	Next Steps* • Suggestions and recommendations for finalizing the scenarios • Explanation of forthcoming conversations
12.00pm	Adjourn

APPENDIX 2: Participants

Workshop Participants

Fred Akers	Administrator, Great Egg Harbor Watershed Association
Katie Almeida	Sr. Representative, Government Relations and Sustainability, The Town Dock
Anna Beckwith	Down East Guide Service
David Bethoney	Executive Director, Commercial Fisheries Research Foundation
Bonnie Brady	Executive Director, Long Island Commercial Fishing Association
Walter Bubley	South Carolina Department of Natural Resources
Zachary Cannizzo	Climate Coordinator, NOAA Office of National Marine Sanctuaries
Chris Cash	Assistant Director, Lobster Institute
Al Cottone	Owner/operator commercial fisherman, Gloucester, MA
Kevin Craig	Supervisory Fishery Biologist, NOAA Fisheries
Dan Crear	Research Associate, Highly Migratory Species Management Division
Jeff Deem	VMRC/FMAC Chairman, Recreational Fisherman
Jynessa Dutka-Gianelli	Research Assistant Professor, University of Massachusetts Amherst Gloucester Marine Station
G Warren Elliott	Member, ASMFC; Recreational Fisherman
Robert Gamble	Ecosystem Modeler, NEFSC Ecosystem Dynamics & Assessment Branch
Patrick Geer	Chief of Fisheries Management, Virginia Marine Resources Commission
Lauren Gentry	Research Associate - Marine Ecology, Florida Fish and Wildlife Research Institute
Willy Goldsmith	Executive Director, American Saltwater Guides Association
Martha Guyas	Southeast Fisheries Policy Director, American Sportfishing Association
Earl "Sonny" Gwin	Commercial Fisherman; MAFMC Member
Jeremy Hancher	Recreational Angler/Hobbyist/Environmental Professional
Victor A Hartley III	Captain/Owner, Keyport Princess
Lisa Havel	Director, Atlantic Coastal Fish Habitat Partnership
Dewey Hemilright	Commercial Fisherman; MAFMC Member
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APPENDIX 3: Building Blocks for Scenario Creation

Scenarios are stories about the ways that the world might turn out tomorrow. Creating scenarios requires a broad understanding of the *drivers of change* that are poised to shape the future. This document outlines the drivers that we will use in the Scenario Creation exercise on June 21-23. Please review this material in advance. There will be time allocated at the workshop to discuss this with fellow participants, and to make any modifications or additions to the lists.

These drivers are categorized into three types:

A. **Pre-determined Elements**: these are drivers that are confidently predictable over the next 20 years. We can confidently assume that these trends will feature in any scenario that describes the future out to 2042.

B. **Wildcards**: these are surprising events and developments that could impact the future in significant ways over the next 20 years. A wildcard has the potential to reshape a system.

C. **Critical Uncertainties**: these are important drivers that have the potential to move in various, alternative directions over the next 20 years. For the purposes of this exercise, we have described the potential outcomes of the driver in two opposing directions. Your task is not to decide which outcome is more likely, but instead to imagine what would happen if specific outcomes were to occur in future. These have been categorized into three buckets: (i) oceanographic / physical / climate; (ii) biological, (iii) social & economic.

At the Scenario Creation workshop, you will be involved in exercises that combine these drivers of change to create scenarios.

A. **Pre-Determined Elements:** drivers that we can confidently assume will feature in any scenario that describes the next 20 years of East Coast fisheries, including:

   1. Ocean temperatures continue to warm, affecting marine species biology & distribution
   2. Regions exhibit differences in seasonal temperature changes
   3. Primary production changes differently in different regions
   4. Sea levels rise
   5. Changing ocean uses create more competition for fisheries
   6. Coastal population grows

B. **Wildcards:** surprising events and developments that could impact the future of East Coast fisheries in surprising ways over the next 20 years, including:

1. Changes in ocean current systems
2. Series of extreme marine heatwaves
3. Series of Harmful Algal Blooms
4. Regime shifts caused by losses of critical food resource or changes in food web dynamics
5. Extreme market disruption (e.g. trade war, more pandemics)
6. Devastating hurricane

C. Critical Uncertainties: important drivers that have the potential to move in alternative directions over the next 20 years. These are framed as 'either-or' directions. Critical uncertainties are listed in the tables below, grouped by physical/oceanographic, biological, and socioeconomic drivers.

For example, the first critical uncertainty can be read as. What might happen to ***rates of ocean warming*** *by 2042? Will there be rapid warming in the NW Atlantic, or will the AMOC (Atlantic Meridional Overturning Circulation) swing toward a cooler state, stalling the warming trend?*

Physical / Climate / Oceanographic Critical Uncertainties

Rapid warming in the NW Atlantic	◄	**1. Rates of ocean warming?**	►	Atlantic Meridional Overturning Circulation (AMOC) swings toward a cooler state, stalling warming trend
Major effects	◄	**2. Impact of saturation of calcium carbonate on shell-formation?**	►	Minor effects
Minor changes	◄	**3. Extent of changes in the Cold Pool?**	►	Significant reduction in size and duration
Become stronger but less frequent	◄	**4. Storm frequency and intensity?**	►	Become much stronger and more frequent
Impacts limited to specific locations / times & some positive effects	◄	**5. Impacts of sea level rise?**	►	Causes significant impacts to many facilities & habitats
Low, decreasing impact	◄	**6. Pollution & nutrient run-off in estuaries?**	►	High, increasing impact

Biological Critical Uncertainties

Varies by species & region – hard to generalize and identify	◄	**7. Evidence of range expansion / contraction?**	►	More evident, pronounced and consistent
Limited evidence of movement or unpredictable direction	◄	**8. Direction of species movements?**	►	Mostly northwards / deeper waters
Limited, minor	◄	**9. Extent of range expansion / contraction?**	►	Extensive, major
Low - species movement is not replaced by other emerging fisheries in the area	◄	**10. Replacement of moving species?**	►	High - most species movement is replaced by other emerging fisheries in the area
Mostly maintained, worst effects on overfished populations	◄	**11. Stock production?**	►	Declines markedly across many populations
Maintained / as now	◄	**12. Disease prevalence?**	►	Much higher
Low	◄	**13. Extent of predation on key species?**	►	High
Minor, occasional, generally manageable impacts	◄	**14. Impact of fishery interactions with protected resources or choke species?**	►	Major, ongoing impacts

Social & Economic Critical Uncertainties

Moderate tech advances, used by few	◄	**15. Development and use of technology to support fisheries?**	►	Widely available, used extensively (e.g. gear, tracking, vessels etc.)
Declining market and lower prices as market is saturated / highly competitive (e.g. aquaculture, lab-grown fish)	◄	**16. Consumer preferences for wild caught and local seafood?**	►	Growing market and higher prices as wild caught / local becomes a premium market
Marginal or positive effects on species distributions / research efforts etc.	◄	**17. Impact of offshore wind installations?**	►	Mostly damaging effects on species distributions / research efforts etc.
Costs are contained creating profitable opportunities for most	◄	**18. Fishing & related industry viability?**	►	Costs rise more quickly than revenues for most operators
Limited coastal armoring as 'living shoreline' alternatives become popular	◄	**19. Extent and impact of coastal armoring?**	►	Significant, with widespread effect on habitats
Leads to damaging competition and less prosperous fishing communities	◄	**20. Impact of alternative ocean uses, other coastal developments on fishing communities?**	►	Leads to more prosperous coastal and fishing communities

APPENDIX 4: Mini-Scenario Transcriptions

Mini Scenarios were developed using worksheets at each breakout group table. These worksheets have been transcribed in the tables below to the extent possible. The driving forces selected by each group are briefly described with reference to their corresponding number in the list of "Building Blocks" (Appendix 3). For these building blocks, "PDE" refers to "Predetermined Element," "CU" to "Critical Uncertainty," and "WC" to "Wildcard." For each critical uncertainty card, the breakout group selected one of two directions, denoted below as "A" or "B."

Menhaden Group

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Adapt & Survive**	**TABLE NAME: MENHADEN**
DRIVING FORCES	1. PDE #2: Regions exhibit differences in seasonal temperature changes (water and air) 2. CU #9b (bio): Extent of range expansion/contraction? B. Extensive, major 3. CU #21 (bio): Coastal habitat change, major shifts in type, or lack of ability to migrate rapid change 4. CU #23: New data streams-we are able to integrate these, apply to assessments (e.g.) 5. CU #22 (socio): Working waterfronts will adapt and still function as needed for fishing 6. CU #15b (socio): Development and use of technology to support fisheries? b. Widely available, used extensively.	
BRIEF SCENARIO DESCRIPTION: Major shifts in water and air temperatures and these will vary in space (north-south; inshore/offshore). Fish will move—some will lose habitat and some will gain. Key coastal habitats will not fully adapt or be resilient. But technology will allow/support adaptation of fisheries and waterfronts—will need to increase access to technology. Assume technology enables innovation.		
WHAT MAKES THIS INTERESTING? First 3 cards are realistic and occurring now. Last two cards suggest many possibilities. Working waterfront support efforts are active now. Public support/local interest in supporting ecosystems and waterfronts.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Access to technology and the internet is increasing. Promotion of equity and inclusion being actively discussed.		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Pork: it's what's for dinner!	TABLE NAME: MENHADEN
DRIVING FORCES	1. PDE #2: Regions exhibit differences in seasonal temperature changes 2. CU #13b: Extent of predation on key species? b. Highly variable matches/mismatches uncertain 3. WC #6: Devastating hurricanes in 4x in 20 years 4. CU #15a (tech): Moderate advances used by a few people/sectors 5. CU #22b: Working waterfronts will struggle to adapt	
BRIEF SCENARIO DESCRIPTION: Death by 1,000 cuts. Lots of differences between regions. Technology mismatches and missed opportunities, e.g. can catch fish, but not assess stocks. More big storms: effects on insurance, also affects fish distributions. Waterfronts destroyed and ability to rebuild is limited. Rebound will be slow. Barely current/functional as-is. Predator/prey shifts are not always aligned leading to unpredictable impacts.		
WHAT MAKES THIS INTERESTING? Short term effects on oceanography following storms, but could continue to play out for years more vertical mixing, less stratification. Seeing what areas/fisheries/species are resilient to this scenario or even thrive.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Results/aftermath of past storms. Waterfront privatization seems likely based on economic incentives. Willingness/need to buy inexpensive foods vs. local/sustainable foods.		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Let them eat cake!	TABLE NAME: MENHADEN
DRIVING FORCES	1. PDE #5: Changing ocean uses create more competition for fisheries 2. CU #11a: Stock production? a. Mostly maintained, worst effects on overfished populations (mixed bag) 3. CU #6b: Pollution and nutrient run-off in estuaries? b. High, increasing impact 4. WC #5: Extreme market disruption (e.g. trade war, more pandemics) 5. WC #1: Changes in ocean current systems 6. CU #3b: Extent of changes in the Cold Pool? Significant reduction in size and duration .	
BRIEF SCENARIO DESCRIPTION: Increasing prevalence of offshore wind, aquaculture, and carbon capture technology drives local trophic changes and leads to other impacts, e.g., larval impingement/entrainment. Restoration projects provide or maintain 'stepping stones' for species movements. New ocean uses and protected areas increase space-use conflicts, including some new uses we can't even really envision yet, e.g. submerged ocean data centers. Expect production will change, but not consistently across species. Oceanographic/cold pool changes affect pelagic fisheries that depend on size, duration and quality of cold pool habitat. Bottom up processes predominately run off, loss of estuarine habitats lead to change in production.		
WHAT MAKES THIS INTERESTING? Many moving parts + competing uses. Lots of changes from today's uses and users-management attention follows the biggest profits (energy, shipping).		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Already see international trade issues- e.g. due to subsidiaries in other countries. Already lots of pollution and we expect continued growth in coastal populations could make it worse. We are already seeing changes in stocks as a result of degraded habitat.		

Striped Bass Group

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Fisher Innovation Outpaces Science**	**TABLE NAME: Striped Bass**
DRIVING FORCES	1. PDE #5: Changing ocean uses create more competition for fisheries 2. [CU Y) *Science is Reactive* 3. CU #7a: Evidence of range expansion/contraction? a. Varies by species and region- hard to generalize and identify 4. CU #14b: Impact of fishery interactions with protected resource or choke species? b. Major, ongoing impacts 5. CU #18a: Fishing and related industry viability. a. Costs are contained creating profitable opportunities for most.	
BRIEF SCENARIO DESCRIPTION: Offshore wind increases along with other ocean use industries, increasing the need to share ocean space and interactions with protected resources are major and ongoing. While science continues to be slow to react- the pace of science is not able to keep up with the pace of stock/fishery changes (including range shifts). Many fisherman are able to be innovative with fishing methods and technology to remain profitable.		
WHAT MAKES THIS INTERESTING? Focused on longevity. Profitable, fairly, and realistic to happen.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Fisherman have proved adaptability and have seen that science occurs slower than changes in fisheries. New technologies have been seen. Seeing these changes is starting now.		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Weathering the Storm	TABLE NAME: Striped Bass
DRIVING FORCES	1. PDE #5: Changing ocean uses create more competition for fisheries 2. [CU X: Science becomes more forward-thinking, flexible, timely, included in management 3. CU #14a: Fishery interactions with protected resources and choke spp. are minor, occasional, generally manageable 4. CU #4b: Storm frequency and intensity? b. Become much stronger and more frequent 5. WC #5: Extreme market disruption	
BRIEF SCENARIO DESCRIPTION: Science is keeping pace (allowing greater adaptability with increasing ocean issues, i.e. competition for space) and has allowed for EBM, reducing the interaction between fisheries and protects/choke spp. Stronger and more frequent storms reduce number of days @sea and increases the catchability of some spp. Tariffs on foreign caught seafood increase the U.S. demand for domestically harvested fish, increase profitability and turning market disruptions to a positive. Sport fishers (including for hire) become more popular and profitable (for hire) because people are turning from buying imported fish to catching their own.		
WHAT MAKES THIS INTERESTING? Turning a negative to a positive, so much is riding on real time science. Storms are not the problem we anticipated.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Pandemic response (direct marketing, increasing for-hire). Improving science and monitoring.		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Sharknado: Humans on the menu	TABLE NAME: Striped Bass
DRIVING FORCES	1. PDE #6: Coastal Population Grows 2. CU #13b: Extent of predation on/by key species and invasive species 3. CU #11b: Stock production? b. Declines markedly across many populations 4. CU #12b: Disease is much higher in fish/shellfish populations, more HABs and more invasive spp. 5. WC #4: Regime shifts caused by losses of critical food resources or changes in food web dynamics	
BRIEF SCENARIO DESCRIPTION: It has gone to hell in a hand basket! Climate Change is increasing human immigration to coastal areas causing coastal congestion and increased pressure on limited infrastructure and resources. Working waterfronts are further gentrified (apex predators). The regime shift caused by increased coastal population caused disease and invasive spp and attracts marine mammals and sharks. Fisheries are being outcompeted by human induced changes and attacked by sharks.		
WHAT MAKES THIS INTERESTING? Sharks! Factors in many human changes from climate. Links non-fishing impacts to fisheries. Cascading effects from single species management.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Seal and shark populations have increased, seeing increased harmful algal blooms and invasive species, coastal human populations increasing (but not likely climate driven today). Diminished fishing infrastructure.		

Tautog Group

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Elon Cusk / Using Technology to Overcome Challenges with Trust**	**TABLE NAME: TAUTOG**
DRIVING FORCES	1. PDE #1: Ocean temperature continue to warm, affecting marine sp bio and distribution. 2. CU #9b: Extent of range expansion/contraction. b. Extensive, major 3. CU New: Community Interactions. b. Unpredictable and fluctuating 4. CU #18b: Fishing and related industry viability. b. Costs rise more quickly than revenues for most operators 5. CU #15b: Development and use of technology to support fisheries and build trust. b. widely available, use extensively	
BRIEF SCENARIO DESCRIPTION: Using technology to overcome challenges		
WHAT MAKES THIS INTERESTING? • Use social science to get to technology answers. • Trust is key. • Counting on technology and trust to industrial changes.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Many do not trust science now. • Greying of fleet. • Seeing N expansion of key species. • Total Allowable Catches for Gulf of Maine groundfish are not being fully caught. • Black Sea Bass and Dogfish are eating cod. • Lots of anecdotes show lack of trust in climate science.		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Changing Oceans leads to Local Notion$	TABLE NAME: TAUTOG
DRIVING FORCES	1. PDE #1: Ocean temperature continue to warm, affecting marine sp bio and distribution 2. CU #10b: Replacement of moving sp. b. High- most sp. replaced by emerging fisheries. 3. WC #5: Extreme market disruption & CU #16b: Growing market. b. High cost for low seafood. 4. CU #18a: Fishing and related industry viability. a. Costs are contained creating profitable opportunities for most. 5. CU #15a: Development and use of technology to support fisheries. a. moderate tech advances, used by few.	
BRIEF SCENARIO DESCRIPTION: • Market disruption- led to need for local seafood. • Local markets adjust to new species replacing historical species. • Shorter supply chains. • No need for new technology if fishing business is doing well.		
WHAT MAKES THIS INTERESTING? • Climate change impacting terrestrial agriculture more than seafood driving prices up/economics. • Trade War makes impacts more expensive than domestic production. • Very reliant on #10b.		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Stinky Business	TABLE NAME: TAUTOG
DRIVING FORCES	1. CU #4b: Storm frequency and intensity? b. Become much stronger and more frequent 2. CU #6b: Pollution and nutrient run-off in estuaries? b. High, increasing impact 3. WC #4: Regime shifts caused by losses of critical food resources or changes in food web dynamics 4. CU #11b: Stock production? b. Declines markedly across many populations 5. CU #20b: Impact of (Aquaculture) alternative ocean uses, other coastal developments on fishing communities? b. Helps offset impacts on coastal and fishing communities 6. WC #3: Series of harmful algal blooms	
BRIEF SCENARIO DESCRIPTION: Aquaculture provides partial mitigation of the impacts of shifting stocks and market pressures to fishing communities.		
WHAT MAKES THIS INTERESTING? • Real possibility. • Aquaculture man. • If fishermen move to aquaculture- provides alternative livelihood.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Shellfish closures due to sewage discharge increasing. • 65% reduction in phytoplankton reduces forage fish (e.g. herring, mackeral) stock (GOM). • In NE, they are seeing evidence for decreasing species productivities. • Storm events are increasing. • Degradation of important nursery habitat due to pollution. • Hazardous algae blooming increasing (PSP, ASP). • Cod production is down. • Aging infrastructure at cities will lead to increases in pollution (e.g. Philadelphia)		

Lobster Group

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Winners and Losers**	**TABLE NAME: LOBSTER**
DRIVING FORCES	1. PDE #1: Ocean temperatures continue to warm, affecting marine sp bio and distribution. 2. CU #7a: Evidence of range expansion/contraction? a. Varies by species and region- hard to generalize and identify 3. New: Stock productivity/predators. a. Variable regional and species-specific impacts 4. CU #10b: Replacement of moving sp. b. High- most sp. replaced by emerging fisheries. 5. CU #16b Consumer preferences for wild caught and local seafood. b. Growing market and higher prices as wild caught/local becomes a premium market	
BRIEF SCENARIO DESCRIPTION: • As oceans continue to warm, we have and believe will continue to see changes in species geography (expansion and contraction!) • With this, the productivity and species interaction (e.g. production) may change spatially • With said production and changes, species range shift, how wild caught and harvest and consumer preferences adapt to the "winners and issues" will be important • Possible fleet impact could be: attrition and consolidation, diversification/adaptation to new or other fisheries, exacerbated by loss of fishing grounds (e.g. offshore wind, area closures)		
WHAT MAKES THIS INTERESTING? • Not necessarily all doom and gloom depending on region and adaptability • Regional and species-specific differences		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Documented warming oceans • Measured species range shifts (e.g. deeper northern waters) • Incorporation of thermal habitat changes into stock assessment models for estimating changes in productivity • Market adaptations in limited scenarios • Attrition from fisheries based on age, management structures, gear type, infrastructure loss] & OSW on fishing		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Gone with the Wind; Bonnie's Doomsday Scenario	TABLE NAME: LOBSTER
DRIVING FORCES	1. PDE #1: Ocean temperatures continue to warm, affecting marine species biology and distribution 2. CU #7a: Evidence of range expansion/contraction? a. Varies by species and region- hard to generalize and identify 3. CU #17b: Impact of offshore wind installations? b. Mostly damaging effects on species distributions/research efforts, etc. 4. CU #10a: Replacement of moving species? a. Low- species movement is not replaced by other emerging fisheries in the area 5. CU #16a: Consumer preferences for wild caught and local seafood? a. Declining market and lower prices as market saturated/highly competitive (e.g. aquaculture, lab-grown fish)	
BRIEF SCENARIO DESCRIPTION: • Oceans continue to warm and the impacts of offshore wind (OSW) installments have an additive effect to climate change • Decrease in population distribution further exacerbates the ability of the fleet to adapt. • Imports and aquaculture fills void since species found in WEAs are not commercially viable and loss of commercial species in WEAs.		
WHAT MAKES THIS INTERESTING? • Possible loss of ocean productivity due to wind wake effect destroying ocean upwelling. • Uncertainties in ecosystem responses to OSW in the Northeast US Shelf and beyond. • Assume inability to adapt on science, comm fisheries, and markets		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • NE Atlantic OSW wake effects on North Sea (Hereon DE) modeled showing negative effects, but no modeling exists to model and forecast wake effects from much larger 10 gigawatt OSW fields on Northeast US shelf and beyond (e.g. potential increases in sea surface temperature. (https://www.frontiersin.org/articles/10.3389/fmars.2022.818501/full#h1)		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Rise to the Occasion	TABLE NAME: LOBSTER
DRIVING FORCES	1. PDE #4: Sea levels rise 2. CU #5b: Impacts of sea level rise? b. Causes significant impacts to many facilities and habitats 3. CU #19b: Extent and impact of coastal armoring? b. Significant, with widespread effect on habitats 4. CU #11b: Stock production? b. Declines markedly across many populations 5. WC #4: Regime shifts caused by losses of critical food resources or changes in food web dynamics.	
BRIEF SCENARIO DESCRIPTION: • SLR continues based on increasing water temp. and polar ice sheet melt • Human responses to flooding/SLR inundation= increases in shoreline armoring • Significant impacts to tidal marshes via inundation/no migration • Reduced fishery production due to loss of nursery habitat • Regime shifts of fisheries (nearshore vs. offshore fisheries)		
WHAT MAKES THIS INTERESTING? • Cascading effects= cause & effect • Presents opportunities to minimize climate effects using nature-based solutions		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Increased SLR • Coastal flooding/erosion • Declining salt marsh wetlands		

Horseshoe Crab Group

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Littoral Lottery**	**TABLE NAME: HORSESHOE CRAB**
DRIVING FORCES	1. PDE #2: Regions exhibit differences in season temperature changes 2. CU #11 Stock production a. Mostly maintained, worst effects on overfished populations 3. CU #7 Evidence of range expansion/contraction a. Varies by species & region – hard to generalize and identify 4. CU #18 Fishing and related industry viability b. Costs rise more quickly than revenues for most operators 5. CU *New*	
BRIEF SCENARIO DESCRIPTION: Regional changes in environment have led to a patchwork of high and low productivity habitats and fisheries along the coast. Fisheries industry and infrastructure have become consolidated in particular areas.		
WHAT MAKES THIS INTERESTING? Regional winners and losers are created in both commercial and recreational fisheries. Populations and food webs are less geographically homogenous.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Regional changes have historically (and recently) shifted populations and fisheries into non-traditional areas (e.g. shrimp in the mid-Atlantic area, northern shifts of Spanish Mackerel)		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Climate Catastrophe Creates Cash	TABLE NAME: HORSESHOE CRAB
DRIVING FORCES	1. PDE #2: Regions exhibit differences in season temperature changes 2. CU #11a: Stock production? a. Mostly maintained, worst effects on overfished populations 3. CU #14b: Impact of fishery interactions with protected resource or choke species? b. Major, ongoing impacts 4. CU #18a: Fishing and related industry viability? *Infrastructure Relocation.* a. Costs are contained creating profitable opportunities for most 5. WC #6: Devastating hurricane	
BRIEF SCENARIO DESCRIPTION: Stocks take advantage of regional temperature changes and production remains high enough to support profitable fishing. Initial devastation of hurricane removes latent/excess effort in the fishery and economic relief allows adaptation to new challenges such as interaction with protected resources leading to a fishery with participants who are resilient to change.		
WHAT MAKES THIS INTERESTING? Positive plausible outcomes to catastrophe		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Businesses have recovered from past hurricanes which provide increase resiliency. Take advantage of adaptability of successful fisheries.		

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Rx for Prozac**	**TABLE NAME: HORSESHOE CRAB**
DRIVING FORCES	1. PDE #5: Changing ocean uses create more competition for fisheries **&** PDE New: Inland growth putting pressure in estuaries 2. CU #2a: Impact of saturation of calcium carbonate on shell formation (aka impact of ocean acidification). a. Major Effects- broaden to include coral and plankton 3. WC New: Changes to non-major or local ocean current systems: Charleston Greys, Upwellings, Eddies 4. CU #6b: Pollution and nutrient run-off in estuaries? b. High, increasing impact 5. CU #16b: Consumer preferences for wild caught and local seafood ("Boutique"). b. Growing market and higher prices as wild caught/local becomes a premium market	
BRIEF SCENARIO DESCRIPTION: Increased competition combined with devastating acidification and current changes in pollution have led to massive decreases in fish stocks. A small number of boutique wild caught fisheries are able to capitalize on a high profit market for what is left. Lower shellfish leads to disruption to food web but decrease in commercial wild harvest fishery would increase subsistence/recreational fishing. Farm raised protein fills market demands including low-income community demand.		
WHAT MAKES THIS INTERESTING? Transition of the fishery from large commercial to recreational and boutique harvest		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? This is the southeastification.		

Spanish Mackerel

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Manage Fast, Not Half "Fast"**	**TABLE NAME: SPANISH MACKEREL**
DRIVING FORCES	1. PDE #1: Ocean temperature continue to warm, affecting marine sp bio and distribution. 2. CU #10b: Replacement of moving sp. b. High- most sp. replaced by emerging fisheries. 3. CU #18b: Fishing and related industry viability? (Fleet adaptability) b. Costs rise more quickly than revenues for most operators 4. CU #9b: Extent and impact of coastal armoring? b. Significant, with widespread effect on habitats 5. CU #4a: More storms but less frequent	
BRIEF SCENARIO DESCRIPTION: Ocean is warming, fish are moving, fisherman need to adapt to find fish- this could be related to weather and fleet adaptability. Some fleets will be able to adapt better.		
WHAT MAKES THIS INTERESTING? • Supply issue for South- where are the fish coming from? • Accessibility for North- weather and adaptability		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Already a challenge- fish are moving • Fishermen are already adapting- bigger boats • Landings of fish showing up in North		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Total Annihilation	TABLE NAME: SPANISH MACKEREL
DRIVING FORCES	1. PDE #1: Ocean temperatures continue to warm, affecting marine species biology and distribution 2. CU #10a: Replacement of moving species? a. Low- species movement is not replaced by other emerging fisheries in the area 3. CU #2a: Impact of saturation of calcium carbonate on shell-formation? a. Major effects 4. WC #4: Regime shifts caused by losses of critical food resource or changes in food web dynamics 5. CU #18b: Fishing and related industry viability? (Fleet adaptability) b. Costs rise more quickly than revenues for most operators	
BRIEF SCENARIO DESCRIPTION: Ocean warms and affects distribution- acidification crashes food web- barren ocean areas- regime shift. Species that are not viable for fisheries may move in but fishermen are not able to adapt.		
WHAT MAKES THIS INTERESTING? • Affects all fisheries on east coast • Big loss of culture • Scary, but plausible • Extreme outcomes more plausible when considering multiple effects		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Other examples of ecosystem collapses- Black Sea, coral reef ecosystems		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: The Fix is the Kill	TABLE NAME: SPANISH MACKEREL
DRIVING FORCES	1. PDE #5: Changing ocean uses create more competition for fisheries 2. CU #17b: Impact of offshore wind installations? b. Mostly damaging effects on species distributions/research efforts, etc. 3. CU #19b: Extent of impact of coastal armoring? b. Significant with widespread effect on habitats 4. CU #20a: Impact of alternative ocean uses, other coastal development on fishing communities? a. Leads to damaging competition and less prosperous fishing communities 5. CU #16a: Consumer preferences for wild caught and local seafood? a. Declining market and lower prices as market is saturated/highly competitive (e.g. aquaculture, lab-grown fish)	
BRIEF SCENARIO DESCRIPTION: Offshore wind and aquaculture compete for ocean uses. Offshore wind needs to build on-shore infrastructure to support. This leads to less prosperous fishing communities- fishermen are competing against major business players in energy, aquaculture and lab grown food. Premium prices for fish.		
WHAT MAKES THIS INTERESTING? • Mitigation becomes part of the problem • Lots of $ and political will		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Windfarms-current issues-Boston Globe • AirBnB has impacted coastal areas-wind farms will have a big impact		

Winter Flounder Group

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Disruption Consolidation**	**TABLE NAME: Winter Flounder**
DRIVING FORCES	1. CU #7a: Evidence of range expansion/contraction? a. Varies by species and region-hard to generalize and identify 2. CU #11b: Stock production? b. Declines markedly across many populations 3. CU #17b: Impact of offshore wind installations? b. Mostly damaging effects on species distributions/research efforts, etc. 4. CU #18b: Fishing and related industry viability? b. Costs rise more quickly than revenues for most operators 5. PDE #1: Ocean temperatures continue to warm, affecting marine species biology and distribution	
BRIEF SCENARIO DESCRIPTION: Due to warming ocean waters we will see a transition of the fishing industry as we currently understand it. There will be a consolidation of effort, ownership, and more vertical integration of business that can chase fish.		
WHAT MAKES THIS INTERESTING? Fishing industry isn't going anywhere. It will just look different.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Species ranges are shifting. Seeing non-climate change changes in fishing industry.		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Have Our Fish, and Eat Them Too!	TABLE NAME: Winter Flounder
DRIVING FORCES	1. PDE #1: Ocean temperatures continue to warm, affecting marine species biology and distribution 2. CU #17a: Impact of OSW installations. a. Marginal or positive effects on species distributions, research efforts, etc. 3. CU #11a: Stock production? a. Mostly maintained, worst effects on overfished populations 4. CU #15b: Development and use of technology to support fisheries and build trust. b. widely available, use extensively 5. WC #5: Extreme market disruption	
BRIEF SCENARIO DESCRIPTION: • Tariffs/isolationist trade policies • Increased domestic demand • Minimal positive impacts from ocean warming • Leveraging positive impacts of off-shore wind • Warming is causing increased/shifting stock productions • Catch more fish and avoid bycatch more efficient • Better data, faster management		
WHAT MAKES THIS INTERESTING? • Technology as positive! Filling data gaps for better management • Domestic, self-reliance		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Increase in seafood consumption during pandemic • Fish stock resilient when properly managed • Increased computer use		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: A Shellfish Solution!!	TABLE NAME: Winter Flounder
DRIVING FORCES	1. PDE #6: Coastal population grows 2. CU #19a: Extent of impact of coastal armoring? a. Limited coastal armoring as "living shoreline" alternatives become popular 3. CU #6b: Pollution and nutrient run-off in estuaries? b. High, increasing impact 4. CU #20b: Impact of alternative ocean uses, other coastal developments in fishing communities? b. Leads to more prosperous coastal and fishing communities 5. Cu #11a: Stock production? a. Mostly maintained, worst effects on overfished populations	
BRIEF SCENARIO DESCRIPTION: • Due to population growth, we are investing in living shorelines • Need to combat increased pollution • Synergistic effects of multiple coastline uses • Allow us to maintain fisheries stocks		
WHAT MAKES THIS INTERESTING? • Making climate change work for better fishing • Increase shellfish aquaculture to combat pollution		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Successful living shoreline e.g. Chesapeake Bay • Coastal development will continue to increase		

Red Drum Group

EXPECTED / ALTERNATIVE / FREE-FORM	**SCENARIO NAME: Consumer Palate Warms to Climate Change**	**TABLE NAME: Red Drum**
DRIVING FORCES	1. PDE #1: Ocean temperatures continue to warm, affecting marine species biology and distribution 2. Habitat sustainability. Major change 3. CU #9b: Extent and impact of coastal armoring? b. Significant, with widespread effect on habitats 4. CU #18a: Fishing and related industry viability? a. Costs are contained creating profitable opportunities for most 5. CU #16b: Consumer preferences for wild caught and local seafood b. Growing market and higher prices as wild caught/local becomes a premium market	
BRIEF SCENARIO DESCRIPTION: Ocean is warming and it will impact the ranges. We see major changes in habitat, but they are not necessarily negative. There are habitats that could bring in new species to that area. These new species/fisheries may cost more at first, but through marketing and consumer preference for local and wild caught brings profit.		
WHAT MAKES THIS INTERESTING? Positive spin- opportunity.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? Food planners, e.g. 30 by 30; Black Sea Bass		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: We hope not	TABLE NAME: Red Drum
DRIVING FORCES	1. PDE #1: Ocean temperatures continue to warm, affecting marine species biology and distribution 2. WC #4: Regime shifts caused by losses of critical food resource or changes in food web dynamics 3. CU #11b: Stock production? b. Declines markedly across many populations 4. CU #16a: Consumer preferences for wild caught and local seafood? a. Declining market and lower prices as market is saturated/highly competitive (e.g. aquaculture, lab-grown fish) 5. CU #18b: Fishing and related industry viability? (Fleet adaptability) b. Costs rise more quickly than revenues for most operators	
BRIEF SCENARIO DESCRIPTION: Ocean is warming lead to regime shift which has resulted in declining stock production. Because of rising costs, the commercial industry has not been able to be profitable (Can't access and can't afford to change gear fast enough). Not enough fish productivity to make the investment (may not have access to permit). The Rec fishery can adapt and change/have more flexibility to access the fish because there is less cost to adapt. Some of the commercial fleet might move to aquaculture. The consumer is looking for lower cost alternatives- may return to cheaper proteins.		
WHAT MAKES THIS INTERESTING? Divergent impacts between Rec. and Comm.; playing a card that leads to permanent changes.		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Temp warming • See a decline in some of today's fleet- less access to permits now • Rec fishery willing to switch target		

EXPECTED / ALTERNATIVE / FREE-FORM	SCENARIO NAME: Rising Declines in Living Shorelines (AKA Money Talks)	TABLE NAME: Red Drum
DRIVING FORCES	1. PDE #4: Sea levels rise 2. CU #4b: Storm frequency and intensity? b. Become much stronger and more frequent 3. CU #19b: Extent of impact of coastal armoring? b. Significant with widespread effect on habitats 4. CU #6b: And other coastal habitats and ecosystems. 5. CU #20a: Impact of alternative ocean uses, other coastal development on fishing communities? a. Leads to damaging competition and less prosperous fishing communities	
BRIEF SCENARIO DESCRIPTION: Sea level rising and storms are becoming stronger and more frequent. The impact of coastal community is to protect their property, more sea walls and other anthropogenic impacts. Less protected habitat and wetlands, less living shorelines. Leads to a decline in fish production because of habitat loss of estuarine areas. Also increase of runoff/pollution will lead to production loss. Incentive for offshore ocean uses because industry is no longer sing those areas because of fish decline. Alternative ocean uses have a competitive edge. Coastal armoring is leading to increase in coastal population which pushed the fishing community out (both via marina space, infrastructure, NIMBY (against commercial fishing). Rec fishermen have increase access to the waterfront to the wealthy but party/charter fleet may get squeezed out. Shore fishermen lose opportunity because more of waterfront is private.		
WHAT MAKES THIS INTERESTING? • Access and inequality issues • Using sea leave rise		
WHAT EVIDENCE EXISTS THAT MAKES THIS SCENARIO PLAUSIBLE? • Seeing this happen today even with incentives for natural structures, people still use harden shorelines • See economic dislocation now		