



Workshop Report

EAST COAST CLIMATE CHANGE AND FISHERIES GOVERNANCE WORKSHOP

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Washington, D.C

Organized and hosted by:

The Mid-Atlantic Fishery Management Council (MAFMC)

In coordination with:

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Northeast Fisheries Science Center (NEFSC)

Atlantic States Marine Fisheries Commission (ASMFC)

New England Fishery Management Council (NEFMC)

South Atlantic Fishery Management Council (SAFMC)

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1.0 Executive Summary

In March 2014 the Mid-Atlantic Fishery Management Council convened a workshop in Washington, D.C. to explore the existing and potential climate-related impacts on the management and governance of East Coast marine fisheries. More than 70 fishery managers, scientists, policy makers, and stakeholders attended. The purpose of the workshop was to provide East Coast fishery managers, scientists, and decision-makers with a shared frame of reference regarding the potential impacts of climate change on managed fisheries.

During the 3-day workshop, participants worked collaboratively to:

- Explore the existing and potential impacts of climate change on the management and governance of East Coast marine fisheries, with an emphasis on the policy implications of shifting fishery distributions and changing productivity;
- Evaluate processes for documenting and acknowledging climate-related changes and initiating a management response;
- Identify key management questions, concerns, and information needs to guide future research and coordination between management bodies;
- Examine the flexibility of the existing management framework to accommodate climate-related governance challenges; and
- Discuss potential solutions and next steps for adapting and responding to climate change, and identify opportunities to maintain a dialogue between East Coast fishery management partners.

Through a series of facilitated plenary and breakout discussions, participants considered coastwide and regional impacts of climate change and began identifying strategies for responding to these impacts. The body of this report is divided into five sections that focus on the primary topics and themes of workshop discussion, summarized below:

Framing the Issues: Participants discussed a wide range of concerns and questions about the impacts of climate change on East Coast fisheries. While many of these concerns fall under the larger umbrellas of changing fishery productivity and shifting distributions of stocks, the breadth and diversity of issues discussed demonstrated that climate change impacts are likely to take many forms.

Managing “Climate Ready” Fisheries: While much of the workshop focused on how management systems will be affected by climate change in the future, participants also discussed current opportunities for managers to build more resilient, “climate ready” fisheries. Participants explored the qualities of responsive management, including what it means to be well equipped to respond to climate change, and identified specific management approaches that could facilitate greater flexibility and resilience.

Initiating Responses to Climate Change: Closely tied to the question of “if” managers should respond to climate change impacts is determining at what point a management response is justified. Establishing a threshold for response can introduce structure to difficult policy decisions. However, there are tradeoffs associated with establishing a specific threshold for response. Climate change may cause trends and reversals, and greater extremes. The conditions that managers are responding to may change quickly, along with the public’s perception of an issue and their support

for a management response. Participants emphasized the need to be responsive but also to recognize that responsiveness also includes risks, and to avoid “chasing noise” with overly rapid responses to changing conditions.

Governance Challenges: Management jurisdictions in the current management system are defined primarily by political boundaries rather than biological or environmental characteristics of the fisheries, meaning that permanent shifts in stock distributions could create jurisdictional disconnects or representation gaps. Workshop participants engaged in a critical examination of the current management framework and identified attributes of the Council and Commission processes that may present opportunities and challenges.

Science and Decision-Making: Managing climate-ready fisheries is a long-term endeavor that will require investing in the information needed to support informed decision-making, along with a commensurate shift in resources and attention. Participants identified specific information needs and explored current and future opportunities for improving alignment between climate science and management decisions.

2.0 Introduction

Climate change is already a topic of national and regional focus, and in recent years, the potential impacts of climate change on marine fisheries have become increasingly evident as scientists, fishermen, and fishery managers have observed oceanographic changes and associated shifts in the distribution, productivity, and life history characteristics of East Coast fisheries. While our understanding of climate change impacts on fisheries and marine ecosystems will continue to evolve, managers are already facing challenging questions about the ability of the East Coast fisheries management framework to respond to a changing environment.

A number of initiatives have already begun attempting to characterize the threat that climate change may pose to marine fisheries and develop response strategies to mitigate these impacts. NOAA Fisheries is developing a strategy that will help support climate-ready fisheries management. Climate change was a topic of focus at the 2013 Managing Our Nation’s Fisheries 3 Conference as well as at the Mid-Atlantic Council’s climate science workshop in February 2014. Questions and concerns about impacts of climate change on fisheries have also filtered into Congressional discussions of Magnuson-Stevens Act reauthorization.

The Mid-Atlantic Council’s recent focus on the impacts of climate change on fisheries has been largely driven by stakeholder input. Concerns about climate change emerged as a prominent theme of the Mid-Atlantic Council’s Visioning Project in 2011-2012, and the Council’s resulting strategic plan included several objectives related to climate change, one of which was the Climate Change and Governance Workshop.

2.1 Workshop Overview

In March 2014, the Mid-Atlantic Fishery Management Council convened more than 70 fishery managers, scientists, policy makers, and stakeholders for a 3-day workshop in Washington, D.C. to examine the implications of climate change on East Coast marine fisheries governance. The workshop provided opportunities for fishery managers to explore the range of impacts that climate change may have on East Coast fisheries. Participants explored a wide range of issues, including

the potential for climate change to affect fishery productivity and distribution, and discussed strategies for implementing effective responses to these changes. The workshop was designed to leverage the collective knowledge and expertise of participants, and take a cross-cutting look at East Coast fisheries to identify concerns and potential solutions.

Workshop Objectives

- Explore the existing and potential impacts of climate change on the management and governance of East Coast marine fisheries, with an emphasis on the policy implications of shifting fishery distributions and changing productivity;
- Evaluate processes for documenting and acknowledging climate-related changes and initiating a management response;
- Identify key management questions, concerns, and information needs to guide future research and coordination between management bodies;
- Examine the flexibility of the existing management framework to accommodate climate-related governance challenges; and
- Discuss potential solutions and next steps for adapting and responding to climate change, and identify opportunities to maintain a dialogue between East Coast fishery management partners.

2.2 Background

The management and governance of East Coast marine fisheries is complicated. At the federal level, fisheries are managed by the New England, Mid-Atlantic, and South Atlantic Fishery Management Councils under the auspices of the Magnuson-Stevens Act (MSA), with implementation and support functions provided through two NOAA Fisheries regions and headquarters. At the interstate level, the Atlantic States Marine Fisheries Commission coordinates the conservation of coastal and anadromous fisheries through a compact among the fifteen East Coast states and in partnership with NOAA Fisheries and the U.S. Fish and Wildlife Service under the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA).

Fishery management plans developed by the councils under MSA are implemented through federal regulations for federal waters, while management plans adopted by ASMFC under the ACFCMA are generally implemented through state regulations for state waters. Within the mandates of the MSA and the ACFCMA, decision makers follow different decision-making processes and are subject to different regulatory requirements and timelines. The council process for developing federal regulations must comply with the National Environmental Policy Act (NEPA), Administrative Procedures Act (APA) and other federal laws.

East Coast fishery management partners participate in managing 49 different federal and interstate fishery management plans, many of which include multiple species and stocks. The alignment of species distributions with management jurisdictions, the diverse and often complicated life histories of managed species, and interactions between fisheries often require collaboration among management partners. This complex system of authority and responsibility, information, and interests involves a corresponding network of interactions between management partners. This governance complexity is overlaid with management complexity, which derives from the wide range of biological, ecological, social, and economic management objectives identified for East Coast fisheries, and the array of tools used to support them. Climate change will introduce even greater complexity and uncertainty into an already complicated management process. These

changes will test the capabilities of the governance framework, as well as the responsiveness and flexibility of fishery-specific management measures.

2.3 Workshop Development and Structure

This meeting was developed in partnership with the Mid-Atlantic, New England, and South Atlantic Fishery Management Councils, the Atlantic States Marine Fisheries Commission, and NOAA Fisheries. The Fisheries Leadership & Sustainability Forum provided planning and facilitation support.

The majority of the three-day workshop was devoted to discussions and sharing experiences among the three regions. In order to explore these aspects of climate change response at the workshop, the following definitions were established:

- **Governance** refers to the structure, principles, and process for decision-making. Governance adaptation is the process of changing governance structure and principles in response to new challenges.
- **Management** refers to the decisions and tradeoffs that occur within this framework. Management response is the process of responding to specific issues, problems, and challenges as they arise

The meeting began with remarks by Council, Commission, and NOAA Fisheries leadership. Invited speakers provided introductory presentations on the biological, ecological, social, and economic dimensions of climate change, and reviewed the distinction between management and governance. Participants then engaged in a series of facilitated discussions exploring key management and governance challenges, regional observations and concerns, and the cross-cutting challenges associated with changing fishery productivity and distributions. The meeting concluded with a discussion of potential next steps and pathways forward.

2.4 Participants

East Coast fishery managers and staff, tasked with navigating a complex fisheries management framework, are the most knowledgeable experts on how the existing management framework may be tested by a changing environment. The workshop convened fishery managers representing all of the East Coast states, including representatives and staff from:

- New England Fishery Management Council
- Mid-Atlantic Fishery Management Council
- South Atlantic Fishery Management Council
- Atlantic States Marine Fisheries Commission
- NOAA Fisheries

2.5 Report Organization

This body of the report is organized into five main sections:

- **Framing the Issues** focuses on the types of climate change impacts that may affect East Coast marine fisheries. This section also describes regional differences in climate change impacts and perceptions among stakeholders.
- **Managing Climate Ready Fisheries** describes opportunities for fishery management organizations to begin preparing for the impacts of climate change through on East Coast fisheries.

- **Initiating Responses to Climate Change** explores strategies for responding to the impacts of climate change, as well as potential constraints and obstacles to doing so.
- **Preparing for Governance Challenges** discusses governance challenges that may arise as a result of climate change, including jurisdictional disconnects and representation gaps.
- **Science and Decision-Making** considers the role of science in preparing for, and responding to, climate change.

2.6 Additional Resources

The resources from this meeting including the final agenda, speaker presentations, and pre-workshop rapid assessments and discussion document are available through the Mid-Atlantic Fishery Management Council's website at

<http://www.mafmc.org/workshop/2014/east-coast-climate-change-and-fisheries-governance-workshop>.

3.0 Framing the Issues

3.1 Identifying Areas of Climate Change Concern

Participants discussed a wide range of concerns and questions about the impacts of climate change on East Coast fisheries. While many of these concerns fall under the larger umbrellas of changing fishery productivity and shifting distributions of stocks, the breadth and diversity of issues discussed demonstrated that climate change impacts are likely to take many forms. These concerns were broadly categorized as follows:

- **Impacts on marine ecosystems and the physical environment:** Changes related to how species interact with one another and their environment, including: changes in species composition, biomass, habitat, species interactions, forage base, and invasive species; ocean acidification, and changes to features such as currents and upwellings
- **Impacts on managed stocks and species:** Changes in productivity, distribution, range, physical characteristics and condition, and life processes such as migration, spawning, and recruitment
- **Impact on fisheries and stakeholders:** The ways that commercial and recreational fishery stakeholders interact with and are affected by changes to stocks, including timing, location, efficiency, and catchability; as well as social and economic impacts to people, businesses and communities

The management implications of these impacts could include jurisdictional disconnects, misalignment between science and management within the fisheries management enterprise, and diminished management effectiveness; in sum, the performance of the entire fishery management system.

3.2 Assessing Regional Impacts

Climate change impacts are expected to vary spatially and temporally. This variability among regions will make it even more essential that fishery management organizations communicate clearly and coordinate effectively with one another. While the impacts of climate change on East Coast fisheries cannot be fully understood within the context of a single region or fishery, discussing regional experiences can provide managers with valuable insight into the situations they

may encounter in the future. During a series of facilitated discussions, participants explored regional and fishery-specific climate change concerns. The following examples illustrate some of the issues that are at the forefront of regional climate change discussions¹:

- **Gulf of Maine (ME, NH, MA)²**: Impacts of ocean acidification on high-value fisheries (scallops, lobster), changing ecosystem dynamics, impacts of climate change on rebuilding overfished groundfish stocks, loss of the northern shrimp fishery, unusually high sea surface temperatures (summer 2012)
- **Southern New England (RI, CT, NY, NJ)**: Shifting stocks, including the retreat of coldwater species (cod, lobster) and increasing abundance of Mid-Atlantic species (black sea bass, summer flounder), increasing encounters with warmer-water species, state by state allocations of jointly managed stocks
- **Mid-Atlantic: (PA, DE, MD, VA, NC)**: Shifting stock distributions, including black sea bass and summer flounder, the additional complexity of joint Council-Commission management of several fisheries, state-by-state allocations of jointly managed stocks, the perception that stocks are shifting north
- **South Atlantic: (SC, GA, FL)**: Has not yet experienced highly visible impacts of shifting distributions, more conservative political attitude toward climate change, more concern about potential non-temperature driven impacts including loss of estuarine habitat and changes to oceanographic features (Gulf stream, upwellings)

The effects of climate change are most visible and acute in New England and the Mid-Atlantic, where climate change is already more widely discussed. By contrast, the impacts of climate change are less perceptible in the South Atlantic, and the issue is more politicized and controversial. Discussion of regional examples suggested that the nature and extent of climate change impacts vary significantly among region as well as by fishery, depending on factors such as stock status, ecosystem health, and oceanographic characteristics. Participants noted that the complexity or marine ecosystems may make it challenging to directly link changes in the fisheries with climate change.

Regional differences relative to climate change awareness will have an inevitable impact on managers' ability to initiate responses to climate change. These differences can influence how stakeholders and fishery managers perceive climate change impacts and can significantly affect the level of support for a management response.

4.0 Managing Climate Ready Fisheries

4.1 Defining Effective Management

The fundamental premise of fisheries management is that managers can set establish specific management objectives, and then make informed management decisions to achieve them. Climate change can undermine the connection between the decisions we make and their results, by affecting our understanding of the environment, our expectations for the level of productivity

¹ These topics are discussed in greater depth in the regional rapid assessments and pre-workshop discussion document.

²² These groupings were used to divide participants into groups for a regional breakout session and do not necessarily correspond to jurisdictional or ecological boundaries.

fishery resources can sustain, and the effectiveness of the tools we use to provide access and opportunity. Participants discussed four aspects of management effectiveness:

- **Biological reference points and expectations:** Biological reference points (BRPs) play an essential role in the management process. They are one of the primary metrics that managers use to quantify management objectives and evaluate the effectiveness of regulations. However, since BRPs are linked with the past condition of a stock, their utility to managers may decrease if climate change causes significant changes in fishery productivity. This may impact the achievability of current biological targets and the rebuilding timelines required by the MSA.
- **Management tools:** In a changing environment, management tools and decisions may not produce the expected or desired outcomes. In particular, static time and area-based management measures based on assumptions about the spatial and temporal distribution of a stock will be less effective. Fixed habitat protections may also be less effective as climate change impacts properties of marine habitats, the ecosystem services they provide, and/or the composition of species that utilize these areas.
- **Constraints:** The measures used to manage interactions among fisheries and protected species could constrain managers' abilities to achieve optimum yield. Under less predictable management conditions, the challenges of avoiding interactions with protected resources could increase the number of incidentally caught "choke" stocks that constrain harvest of target stocks.
- **Social and economic objectives:** The social and economic impacts of climate change on stakeholders will depend on attributes of dependence and adaptive capacity that are outside the control of fishery managers. Commercial and recreational fisheries will adapt to change in different ways, and methods of adaptation will vary among regions. Fishery managers may need to reevaluate existing social and economic objectives of fishery management plans and develop new methods of measuring social and economic impacts of management decisions.

4.2 Developing Responsive Management Strategies

A more dynamic environment will demand a management framework that can respond more quickly to change. Participants emphasized the need for flexible management strategies that enable managers and stakeholders to incorporate information more quickly and respond to changing conditions more effectively.

While concepts of flexibility and responsiveness seem fundamental to climate readiness, they can also encompass very different—and even contradictory—strategies for coping with change. For example, "responsive" could mean reacting quickly to change, but it could also describe instilling greater predictability and stability to buffer against variability. Participants recommended further defining these qualities, and examining whether they are supported by the existing regulatory processes and fishery management plans.

Participants drew on their experience with a wide range of East Coast fisheries to describe the features of management strategies that will perform well in a changing environment.

- **Follow the fish:** Management strategies should be designed to incorporate spatial and temporal variability and long-term change. Rather than basing future management

decisions on past conditions and expectations, dynamic management strategies will enable managers to “follow the fish” as environmental conditions change.

- **Facilitate industry flexibility:** Strategies that establish performance standards but devolve some decision-making to stakeholders may support industry flexibility. Participants mentioned market solutions, cooperatives, and tradability/transferability of permits but in some cases had different perspectives on how well these approaches would perform.
- **Explore pathways for improved responsiveness:** Managers should explore management approaches that allow for more nimble responses to fishery management challenges. Examples of such approaches include framework processes, exempted fishing permits, and other opportunities for responding rapidly to new situations and advancing new ideas.
- **Utilize management triggers and thresholds:** Managers will need to consider the optimal time horizon for responding to climate change impacts, and avoid chasing noise while also considering tipping points and the potential consequences of inaction. Predetermined thresholds and/or triggers that initiate an action or examination of an issue can help ensure timely response.
- **Examine potential scenarios:** Some climate change impacts can be predicted, but others will come as a surprise. Managers can prepare and strengthen their ability to respond by exploring and planning for a wide range of scenarios
- **Build a foundation of resilience:** The adverse impacts of climate change will depend, in part, on the starting condition and resilience of East Coast fisheries. Managers should consider ways they can help mitigate the adverse impacts of climate change with policies that support an adaptive fishing industry.

4.3 Incorporating Ecosystem-Based Management

Participants felt that climate readiness and ecosystem-based fisheries management (EBFM) are mutually reinforcing initiatives and that EBFM should continue to be a management priority. Climate change will impact entire marine ecosystems, and a single-species management approach will not be sufficient to understand and account for these changes. In particular, participants were concerned about impacts of climate change on important forage fisheries and the resulting impacts on trophic interactions.

Workshop participants generally agreed that focusing current management efforts on fostering ecological resilience could be an effective tool for building “climate ready” fisheries. However, ecosystem-based management remains a challenging and resource-intensive endeavor that managers must balance with other statutory obligations.

4.4 Managing Expectations

One of the most difficult challenges managers will confront is the prevailing expectation that past participation, conditions, and decisions set precedents for future patterns of allocation and access. Managers are already considering how to reconcile past patterns of use, dependence, and investment as the productivity and distribution of East Coast fisheries changes.

4.5 Learning from Experience

The different impacts of climate change along the Eastern seaboard create valuable opportunities to learn and share experiences across regions. One specific suggestion was to develop a template

or pilot program to explore climate change response in New England. A pilot program could provide a way to focus resources, test ideas and solutions, and formalize lessons learned. Other opportunities for learning can continue to build on the objectives and discussions at this workshop, and distill lessons learned through experience. Participants suggested continuing to identify management tools and features of fisheries and FMPs that create challenges now, such as state by state quotas, identifying the questions raised in fisheries where climate change impacts are most acute, and evaluating the effectiveness of coordination between regions. Outreach and communication materials will also be valuable.

5.0 Initiating Responses to Climate Change

Closely tied to the question of “if” managers should respond to climate change impacts is determining at what point a management response is justified. Establishing a threshold for response can introduce structure to difficult policy decisions. However, there are tradeoffs associated with establishing a specific threshold for response. Climate change may cause trends and reversals, and greater extremes. The conditions that managers are responding to may change quickly, along with the public’s perception of an issue and their support for a management response. Participants emphasized the need to be responsive but also to recognize that responsiveness also includes risks, and to avoid “chasing noise” with overly rapid responses to changing conditions.

An important dimension of developing an effective climate change response strategy involves identifying the impediments and disincentives to initiating an effective response. Workshop participants identified a number of impediments managers face to taking action, including:

- Climate change impacts are difficult to isolate and measure.
- There is no right threshold for response.
- Success is hard to measure and define.
- Setting and managing expectations for fishery stakeholders will become increasingly challenging.

5.1 Measuring Climate Change Impacts

Climate change impacts are likely to vary spatially and temporally, resulting in uneven distribution of impacts. Some participants expressed concern about the ability of managers to identify the impacts of climate change as they are occurring and understand the implications for East Coast fisheries and the fisheries management process. Climate change is only one of many factors influencing the structure and function of dynamic marine ecosystems. Therefore, it may be difficult to isolate the impacts of climate change from other changes that influence a stock. The difficulty of isolating climate as a driver of change may exacerbate other challenges of initiating a management response. Participants also noted the risks of attributing too much to climate change.

Participants were concerned about the prospect of “tipping points”—a term which was broadly used to describe a threshold at which the process of feedback and response is significantly challenged or past the point of reversibility. All of these potential impacts reflect an increase in uncertainty. From a management perspective, climate change may be the driver of change, but how those changes manifest, and the scenarios that will actually prompt a management response, remain uncertain.

5.2 Establishing Appropriate Response Thresholds

Closely tied to the question of “if” managers should respond to climate change impacts is determining at what point a management response is justified. Establishing a threshold for response can introduce structure to difficult policy decisions. However, there are tradeoffs associated with establishing a specific threshold for response. Climate change may cause trends and reversals, and greater extremes. The conditions that managers are responding to may change quickly, along with the public’s perception of an issue and their support for a management response. Participants emphasized the need to be responsive but also to recognize that responsiveness also includes risks, and to avoid “chasing noise” with overly rapid responses to changing conditions.

5.3 Defining Success

Climate change response is typically framed in terms of avoiding or mitigating adverse outcomes, and achieving conservation and management mandates under conditions of greater environmental uncertainty. Successful climate change response invokes existing interests and responsibilities, rather than a new and measurable goal, making “success” difficult to define and measure. Moreover, there’s no guarantee that even the most well-informed management response will yield a more favorable outcome. Discussions highlighted the fact that climate change response is often associated with high risk and uncertain or minimal reward. For this reason, it may be difficult for fishery managers to demonstrate that the benefits of taking action outweigh the associated management and political risks.

Climate change is only one of many factors influencing the structure and function of dynamic marine ecosystems. Therefore, it may be difficult to isolate the impacts of climate change from other changes that influence a stock. The difficulty of isolating climate as a driver of change may exacerbate other challenges of initiating a management response. Participants also noted the risks of attributing too much to climate change.

5.4 Managing Public Perceptions

One of the clearest takeaways from this discussion was the need to manage public perceptions relative to the intersection of climate change and fisheries management. The fishery management community needs to secure adequate resources, including time, attention, funding, and information to initiate an effective response to climate change. Participants felt that one of the most important steps forward will be to elevate climate change as a priority: to clearly communicate that this is “not another normal day,” and to make it clear that responding to climate change will be an essential element of successful fisheries management. This will be essential for building awareness, securing resources, and creating a decision-making environment that enables effective responses to climate change.

Developing Coordinated Messages

Participants agreed that it will be important for managers to communicate a clear and consistent message about the threats that climate change poses to East Coast fisheries. Effective messaging will empower stakeholders, managers, and other leaders to reinforce climate readiness as a top priority. Support from stakeholders and political leadership is crucial for securing the resources and buy-in needed to take meaningful action.

Participants emphasized that effective messages will provide specific, meaningful information about the potential impacts of climate change through the use of compelling real-world examples. The message should be developed and owned by multiple management partners, and should reflect a shared sense of urgency among state and federal fishery managers, NOAA Fisheries, and stakeholders. While the core message should be unified, it can also be tailored to account for regional impacts and differences in political climate.

Targeting Appropriate Audiences

Participants identified the following audiences as targets for climate change communication:

- **Congress**. Congressional appropriations are the only recourse for securing additional funding, and the fisheries management community needs to clearly assert its concerns and interests. Fishery managers can equip stakeholders and political leaders to deliver a clear and powerful message.
- **Political leaders**. Other political leadership, including state governors, can be influential in facilitating broader climate change discussions.
- **Stakeholders/industry**. Achieving buy-in and engaging the industry in the development and delivery of this message is crucial. The industry can be a powerful ally for bridging the management and political spheres, and reinforcing that climate change is a shared management-constituent concern.
- **State managers**. State fishery management agencies are the public face of fisheries management and are critical partners for engaging in outreach and making this message local and relatable.

The fisheries management community should also stay apprised of other climate readiness efforts, particularly in other natural resource arenas, and identify opportunities for partnership, collaboration, and information sharing.

6.0 Preparing for Governance Challenges

The governance of East Coast fisheries is uniquely complex. The jurisdictional boundaries of this system are defined primarily by political boundaries rather than biological or environmental characteristics of the fisheries, meaning that permanent shifts in stock distributions could create jurisdictional disconnects or representation gaps. Workshop participants engaged in a critical examination of this management framework and the attributes of the Council and Commission processes that may present opportunities and challenges. Participants identified two primary concerns that should be addressed:

1. **Gaps in representation** – Stakeholders are unable to access and/or fully participate in the management of a fishery in their region. “Stakeholders” could include states, as well as individual stakeholders.
2. **Gaps in management** – The health and management objectives of a fishery could be impacted by unregulated and/or undocumented impacts outside of the jurisdiction of the primary management authority.

6.1 Evaluating the Current Management System

An important step toward identifying potential solutions and next steps for addressing governance challenges is identifying which aspects of the system may need to adapt or change. Most fishery

management organizations already utilize mechanisms to facilitate coordination and representation of interests across jurisdictions. These include both formal arrangements, such as joint management plans and Council liaisons, as well as informal coordination of management activities. Perceptions of the effectiveness of these arrangements vary, and participants noted that differences in management philosophies and approaches between partners can make coordination more challenging.

Participants identified several key areas of difference between the Council and Commission processes that may affect their respective abilities to respond to climate change.

- **Process:** Participants remarked that the Commission structure and process is generally perceived as being more flexible and efficient. In contrast, the council system is seen as slower, more cumbersome, and less capable of responding quickly to change.
- **Membership:** Since the Commission spans the entire East Coast, it can respond to shifting distributions of stocks by modifying the composition of species management boards to add or remove states. The three regional councils, on the other hand, are separate decision-making bodies with fixed, geographically-defined memberships for a contiguous stretch of coast, making it more difficult for them to incorporate.
- **Legislative Mandates:** The federal council process also has stricter requirements for preventing and ending overfishing, and as a federal rulemaking process is also subject to regulatory requirements and federal statutes such as NEPA and judicial review, which the Commission process is not.

6.2 Addressing Representation Issues

Representation of stakeholder interests in the decision-making process has the potential to be one of the most challenging and politically charged issues associated with climate change. Representation is perceived as essential for states and stakeholders to have a voice in these decisions about how to provide access and opportunity in a changing environment. However, representation in the decision-making process remains linked to static jurisdictional boundaries, particularly at the council level. Participants were concerned about the potential for disconnects between the distribution of a fishery, stakeholder access to the resource, and representation in the management process.

Workshop participants discussed strategies for ensuring that the interests of states and stakeholders are well represented as stocks shift across jurisdictions. Suggestions ranged from leveraging existing arrangements, to solutions that would require legislative changes.

- **Expand opportunities for representation of interests between management bodies:** For example, through the use of council liaisons, membership on committees and advisory panels, and consider enhancing responsibilities and voting privileges.
- **Adopt joint management arrangements:** Evaluate costs and benefits of expanding existing partnerships and developing new joint management arrangements between management partners.
- **Consolidate management bodies:** As a more extreme solution, consider merging one or more management bodies, such as the New England and Mid-Atlantic Fishery management Councils.

- **Adjust council composition:** Authorize the Secretary of Commerce to add new voting members to councils according to an established set of criteria. Membership could be fishery/issue specific. As a concrete step forward, participants suggested bringing the issue of representation to council leadership, identifying perceived gaps and ways to address them, and revisiting this issue periodically.

Participants also considered the deeper meaning of representation, discussing questions such as: Which is more meaningful: participation throughout the decision-making process, or the final vote? Whose interests can and should a single vote represent? Should representation be place-based or interest-based? This conversation demonstrated a wide range of perspectives and questions regarding the privileges and obligations embedded in the concept of representation, which will also be relevant to determining the best course of action.

6.3 Maintaining Coordination and Alignment

Elevating climate change as an issue of coastwide importance will require an across-the-board commitment of time, resources, and attention, as well as improved coordination and alignment between all partners in the management process. Participants emphasized the need to leverage limited resources by building a culture of partnership and investment, and supporting improved coordination and information sharing. This coordination can take many valuable forms, including formal relationships, lines of communication, and meetings, as well as opportunistically and through personal relationships. The group focused on several specific opportunities for cultivating a sense of partnership and supporting improved coordination.

- **Between NOAA Fisheries and other management partners:** All management bodies should be acknowledged as equal partners in the management process.
- **Across regions and management partners:** Climate change will increase the need for cross-jurisdictional communication. While regional differences and priorities will exist, it's valuable to communicate across regions and avoid having parallel climate change discussions in isolation. Boundary crossers who work across regions and roles, such as council liaisons, are a valuable resource.
- **With industry:** Stakeholders are highly invested in the success of the management process. Industry should be closely involved in climate change response, from science and data collection to outreach and messaging. Mechanisms such as fishery performance reports can help facilitate communication and share industry observations.
- **With general counsel:** Regulatory considerations determine the process and timeline for all management actions. Managers need to understand and be able to manage expectations for responsiveness.

7.0 Science and Decision-Making

Managing climate-ready fisheries is a long-term endeavor that will require investing in the information needed to support informed decision-making, along with a commensurate shift in resources and attention. Participants felt that it will be challenging to shift toward longer term planning when short-term demands are perceived as more urgent and more clearly defined.

7.1 Improving Alignment of Science and Management.

Developing a climate change response strategy begins with the ability to recognize climate change impacts as they occur. However, there are significant lags between changes observed on the water, and the process for documenting changes and integrating information into decision-making. Participants also emphasized that fishery dependent and independent data needs to reflect the current spatial and temporal distribution of stocks, rather than being constrained by historical or jurisdictional boundaries. Keeping pace with these changes as they occur is critical for maintaining credibility and making informed decisions.

Successful management depends on the availability of timely and accurate information at all points in the decision-making process. In a changing environment, this will become increasingly critical, but it is likely to also become more challenging. Participants identified two concerns related to the alignment between science and decision-making:

- **Timeliness** – Management gaps or lags may arise at several points in the process, from identifying a problem, to initiating a management response, to decision-making and implementation.
- **Accuracy** – Identifying climate-related changes depends on having an accurate and reliable understanding of a resource and the impacts of management decisions. In particular, obtaining fishery dependent and independent data throughout a species' range will become more critical but also more challenging due to changes in productivity and distribution.

Participants suggested several directions for addressing the alignment between science and management needs. A first step would be to assess structural delays, particularly those associated with the stock assessment process. It's also important to establish clear expectations and timelines for processes that simply take time, such as modifying biological reference points. More timely catch and effort data is needed, and should be achievable with wider adoption of electronic reporting and monitoring technology. Finally, participants strongly emphasized engaging and leveraging the capacity of the fishing industry, and supporting cooperative research opportunities.

7.2 Strengthening the Science-Management Feedback Loop

Strengthening the science-management feedback loop is essential for integrating climate change information and supporting informed decision-making. Managers and scientists play equally important roles in this process. Managers can strengthen this relationship by identifying questions and priorities for climate science and research, and scientists can provide insight into the capabilities of models and interpretation of data. Participants identified several challenges of bringing climate science into the management realm.

- Information (data, models, tools, forecasts, etc.) needs to be presented in a useful way at an opportune point in the management process. This is an opportunity to improve dialogue between managers, who can ask questions and identify priorities, and scientists, who can help managers interpret data and understand the capabilities of models and tools.
- Integrating climate science into management decisions is also a matter of recognizing that decision-making under changing conditions means managing for higher levels of scientific uncertainty.
- Confidence and credibility in climate data is important, but so is the willingness to make (often difficult) decisions in response to changing conditions and new information.

- Climate science can inform decision-making, but decision makers may have very different perspectives on the implications for response (e.g., level of precaution).

Workshop participants wanted to be confident that existing climate information is integrated into the management process as it becomes available. In particular, climate information should be integrated into stock assessments and included in the terms of reference, since stock assessments are the primary means through which climate information can enter the management process. Participants also wanted to see coordination between the stock assessment and ecosystem science divisions at NOAA Fisheries. The group recognized that managers, for their part, will need to build capacity and familiarity discussing climate information as a stock assessment input.

Participants recognized that there are challenges to improving coordination and instilling the sense of partnership needed to elevate climate change as a priority. For example, planning horizons vary significantly among individuals and parts of the management enterprise, particularly where there are ties to political administrations. Most important is acknowledging that the capacity of our fisheries management enterprise is already fully allocated to meet existing demands. Elevating climate change as a priority will require reallocating time and resources, instilling accountability, and tracking progress.

7.3 Addressing Scientific Uncertainty

Climate change will increase scientific uncertainty, and the only way to reduce this uncertainty is by investing in climate science. NOAA Fisheries is developing a climate science strategy to support climate-ready fisheries management, and the Northeast Fisheries Science Center is embarking on a strategic planning process that will explore these challenges.

Workshop participants discussed the information that will be needed to support informed decision-making, and also reflected on the tradeoffs involved in distributing limited resources across many research priorities. Investing additional resources in climate science will require making tradeoffs and identifying priorities, including the tradeoff between investing in climate science and allocating resources toward ongoing fishery management needs, such as stock assessments.

Participants also perceived tradeoffs across time horizons, particularly between real-time data and monitoring and improving predictive capabilities. Finally, the group recognized that climate readiness is not just about having more, better, and timelier information but also developing the capacity and fluency for managers to integrate climate information into their decision making.

Workshop participants discussed a range of information needs, but converged on the following categories, questions, and concerns:

- **Updating information and expectations:** In a changing environment, the past will no longer be a good predictor of future conditions. Consider how past conditions and assumptions contribute to our data collection methods, models, and decision-making, as well as expectations for fishery productivity.
- **Identifying and interpreting current trends:** Identify current trends, and build the capacity to interpret these signals accurately. (For example, is a stock expanding? Contracting? Shifting?)

- **Developing indicators and early warnings:** Anticipate future challenges and identify changes as soon as possible by looking at trends, oceanographic signals, indicators, early warning systems, etc.
- **Integrating climate information into stock assessments:** Ensure that environmental parameters are integrated into stock assessments to the greatest extent possible, and understand the thresholds, limitations, and caveats of incorporating more climate information.
- **Coordinating research:** There needs to be coordination between the different areas of research with regard to climate change, particularly stock assessments, ecosystem dynamics, and habitat conservation.
- **Assessing risks:** Identify the areas that are at greatest risk of climate change impacts, including ocean acidification.
- **Meeting baseline data needs:** The uncertainty introduced by climate change underscores the value of basic life history data, particularly for data poor stocks.
- **Understanding social and economic implications:** Climate change response is ultimately about managing human behavior. Information about the social and economic implications of climate change is an important dimension of climate science.
- **Providing decision support:** Develop decision support tools to assist managers in evaluating the tradeoffs associated with multivariate decision making reflective of a changing ecosystem

8.0 Conclusion

A clear takeaway from this meeting is that climate change demands a response that is commensurate with the magnitude of the threat. The credibility and the performance of our management fishery processes are at stake. While fishery managers are unable to address the underlying causes of climate change, they are nonetheless tasked with meeting our conservation and management mandates in a changing environment. Climate change will continue to test the boundaries of our fisheries management framework, and require creative solutions to new challenges. Rising to these challenges will require establishing the support and the political will for fishery managers to be proactive, and tackle difficult decisions that often relate to managing access and expectations.

Fishery managers will need the support, the management tools, the governance structure, and the science to support climate-ready fisheries management. Fisheries management will continue to require managers to balance the tradeoffs between competing interests and user groups that are inherent to managing public trust resources. Meanwhile, along with increasing scientific uncertainty, climate change will introduce implementation uncertainty and other challenges to effective conservation and management. With these realities come the perception of amplified tradeoffs and difficult decisions, the fear of tipping points and lost or constrained options, and the social, economic, biological, ecological—and political—consequences of “getting it wrong.”

Workshop participants reflected on the difficult questions that arise from setting and managing new expectations in a changing environment. For example, is it more important to protect existing opportunities and investments, or to facilitate new opportunities? What is the appropriate role for fishery managers in mitigating losses and creating winners and losers? Is it better to cope with

change by instilling greater stability, or by becoming more accepting of disruption? And finally, what is our vision for the future and how does it align with our conservation and management mandates? Should we focus on restoring the fisheries we used to have, or look ahead to the fisheries we want to have in the future? Workshop discussions demonstrated that initiating a management response to climate change is also a leadership challenge that will require confronting tradeoffs and questions for which there is no template or simple answer.

Participants at the East Coast Climate Change and Fisheries Governance Workshop contributed to a groundbreaking conversation between management partners. The ideas and concerns at this meeting will provide a foundation for the East Coast fishery management Councils, Atlantic States Marine Fisheries Commission, and NOAA Fisheries to continue exploring the management implications of climate change, through regional initiatives as well as through collaborative efforts. Climate change is not a problem that can be solved by fishery managers, but is clearly a challenge for which the entire fishery management enterprise can and should be well prepared.

9.0 Appendix: Workshop Presentation Summaries

Impacts of climate change on marine fisheries

Dr. Jon Hare, Narragansett Laboratory Director, Northeast Fisheries Science Center, NOAA Fisheries

Dr. Hare provided an overview of NOAA Fisheries' climate science research, emphasizing the difference between climate variability and climate change, and the wide range of ways in which climate change may impact marine ecosystems and fish stocks. Climate variability is natural variability within the climate system, and can include known examples of interannual or decadal variability (e.g., Atlantic Multidecadal Oscillation, North Atlantic Oscillation). Climate change reflects long-term trends in the climate system such as long-term increases in average temperature. Data from the U.S. East Coast demonstrates that both climate change and decadal or other variability have occurred over the last 150 years, and will continue for the foreseeable future. Scientists have observed changes in temperature, acidification, salinity, wind patterns, precipitation, stream flow, lake ice out, nutrients, sea level rise and other attributes, and these changes vary along the East Coast.

Climate change will impact population dynamics such as abundance, density, dispersion, distribution, demographics, population growth rates and connectivity, which in turn will cause changes in fisheries. Reference points are not static, stock boundaries are not fixed, and trophic interactions and community make-up are changing. Multiple stressors are affecting fisheries beyond fishing pressure and changing climate, and scientists and managers must adapt their science and data collection accordingly. Ecosystem-based management can provide a framework for aligning the scales of management and climate change. Dr. Hare concluded by describing NOAA Fisheries' recent Northeast Fisheries Climate Vulnerability Assessment, which characterizes the relative climate change vulnerability of northeast region stocks based on exposure and sensitivity.

Economic dimensions of climate change

Dr. Doug Lipton, Senior Scientist for Economics, NOAA Fisheries

Dr. Lipton described the economic factors and considerations that can impact the fishing industry's adaptation to climate change, and emphasized the need to identify research questions and priorities to guide future research. Many economic factors how the fishing industry is able to adapt to change, including productivity, relative abundance, market demand, revenue, spatial distribution, searching costs, short and long run costs. Fisheries will adapt to climate change, but adaptation may be easy or difficult depending on a variety of factors.

Economic data collection and analysis are currently designed to model fleet dynamics on short time scales, corresponding to the time and spatial scales of management decisions. The decisions and factors that contribute to climate change adaptation are more complicated. In the short term, there are many fixed factors that affect decision-making (e.g., vessel, gear, crew, market conditions), but in the longer term nothing is fixed (e.g., stakeholders may replace vessels and gear, or invest in new opportunities; there may be changes to ports and infrastructure). An industry's ability to adapt to changing conditions also depends on whether these changes are gradual or abrupt. A better understanding of these factors, and the implications of management decisions and tools, requires different types of data and analyses than what are currently collected.

Dr. Lipton emphasized the need to identify questions and actionable items to guide and encourage investment in additional research.

Sociocultural dimensions of climate change

Prepared by Dr. Patricia Clay, Anthropologist, Northeast Fisheries Science Center, and presented by Dr. Michael Orbach, Professor of Marine Affairs and Policy, Duke University

Dr. Orbach described the sociocultural dimensions of climate change, including impacts to fishermen, fishing families, and fishing communities, and provided an overview of the tools the Northeast Fisheries Science Center (NEFSC) uses to track social and economic changes and characterize community vulnerability and resilience. Fishing means different things to commercial, recreational, and subsistence stakeholders, and there is value derived from the experience of fishing that is not expressed in economic terms.

Climate related changes will impact fishermen, fishing families, and fishing communities. For example, as fishery distributions shift, fishermen must shift their fishing activity or switch to other species. This may mean switching vessels or gear, moving to a new community, losing local knowledge of fishing locations and techniques, and changes to shoreside infrastructure and community support. As managers prepare for climate change, it will be important to create flexibility and consider the impact of place and time based management. The NEFSC uses a variety of tools and methods to track social and economic changes, including fishery performance indicators, community vulnerability indicators, community profiles, communities at sea, and collaborations between social and natural scientists.

Adapting to environmental change: Newfoundland and Labrador's experience

*Michael Alexander, Regional Director General, Newfoundland & Labrador Region, Fisheries and Oceans Canada
Kevin Anderson, Regional Director, Fisheries Management, Newfoundland & Labrador Region, Fisheries and Oceans Canada*

Mr. Alexander shared Newfoundland and Labrador's experiences with changing environmental conditions, and described the climate-related management challenges fishery managers have faced over the past few decades. The Newfoundland and Labrador regions are at the intersection of the Gulf Stream and the Labrador Current, and as the "canary in the coalmine," is first to experience the impacts of changing environmental conditions. In the early 1990s, Newfoundland and Labrador experienced a dramatic regime shift and collapse of the groundfish fishery, with most stocks eventually put under a fishing moratorium. Over the next two decades, the region experienced colder water temperatures and transitioned to a fishery dominated by snow crab and northern shrimp. Now the region is once again experiencing warmer temperatures and shellfish are declining while groundfish are becoming more abundant.

Newfoundland and Labrador's experiences with environmental change provide valuable insight to U.S. fishery managers, who may confront similar situations in the future. While investments, government policies, and management decisions were based on an assumption of stability, the past two decades demonstrated that the ecosystem is dynamic. Mr. Alexander discussed the management challenges that arose during this period of transition, such as providing access to emerging fisheries, and interpreting and applying decision rules and precautionary management approaches. Newfoundland and Labrador's experience also raises important questions about climate adaptation, including who "owns" the problem – government or industry? – and whether adaptation is a matter of adjusting to a new equilibrium, or continual change.

MAFMC Climate Science Workshop: Overview and themes of discussion

Rich Seagraves, Senior Scientist, Mid-Atlantic Fishery Management Council

Mr. Seagraves provided an overview of presentations and themes of discussion from the Mid-Atlantic Council's February 2014 Climate Science Workshop. This workshop was designed to inform the development of the Council's Ecosystem Approach to Fishery Management Guidance Document, a non-regulatory umbrella document that will guide Council policy with respect to ecosystem considerations across existing FMPs.

Presentations by invited experts explored the state of climate science, the potential impacts of climate change on marine ecosystems and fisheries, opportunities to address climate change in the management process, including stock assessments, biological reference points, ABC control rules, and optimum yield specifications; the concept of climate velocity, changing fleet dynamics, and the incorporation of environmental conditions into essential fish habitat designations. Workshop discussions explored the opportunities to integrate climate change considerations along the science-management continuum.

Resources from this meeting, including the agenda, presentations, and a workshop summary are available on the Mid-Atlantic Council's [website](#).

Governance and policy foundations

Dr. Michael Orbach, Professor of Marine Affairs and Policy, Duke University

Dr. Orbach provided an overview of U.S. East Coast fisheries governance, and encouraged participants to consider how governance adaptation and management response may be involved in responding to climate change. Governance structures and principles constitute the framework within which overall policies are set, and within which individual management decisions are made. Management is the process of making decisions about specific issues, problems, and challenges as they arise, most often involving tradeoffs. Both management and governance can be changed to adapt to new circumstances, including climate change, but the process and timeline is different.

On the East Coast, there are multiple fisheries governance systems.

- **Federal:** The three East Coast fishery management councils manage federal fisheries under the Magnuson-Stevens Fishery Conservation and Management Act
- **Interstate:** The Atlantic States Marine Fisheries Commission coordinates the management of interstate fisheries under the Atlantic Coastal Fisheries Cooperative Management Act
- **State:** State fishery governance systems operate under each state's individual laws

The complexity of East Coast fisheries governance introduces some challenges. There are multiple overlapping jurisdictions, with many managers and stakeholders participating at multiple levels. In many cases the system lacks adequate scientific, managerial, monitoring, compliance, and enforcement resources. There is also a lack of coordination among state and federal legislatures.

As a starting point for workshop discussions, Dr. Orbach encouraged participants to consider whether we are structured for effective governance in a changing environment. It will be important to identify the aspects of our current governance system that will be most challenged by climate change, and distinguish these from the management challenges that are likely to arise. In closing, Dr. Orbach reminded participants that changes to East Coast fisheries governance and management

have both happened with relative frequency, and that both may be involved in adapting to new circumstances.

Governance and management reflections

Eric Schwaab, Chief Conservation Officer, National Aquarium; Former Assistant Administrator for Fisheries, NOAA Fisheries

Mr. Schwaab suggested several pathways East Coast fishery managers could consider for supporting climate readiness, building on his fisheries management and leadership experience at the state, interstate, and federal levels. He identified opportunities in the areas of management coordination, uncertainty and the science-management interface, and habitat conservation.

In the area of management coordination, climate change is likely to happen more quickly than our governance structure can change. However, there are ways to make the existing governance structure better equipped to accommodate rapid environmental change. East Coast fishery managers have a long history of coordination across jurisdictions, and we could leverage existing mechanisms or develop new ones to coordinate better in the areas most impacted by climate change. We could also consider decision criteria or other mechanisms to trigger the evaluation of difficult issues, such as allocation, that will be magnified by climate change.

Mr. Schwaab then described his involvement in a collaborative effort to develop best practices for addressing uncertainty and variability in stock assessments and fisheries management. This project will examine uncertainty in several areas affected by climate change, including data inputs and data-poor species, stock assessment models, changing environmental conditions, and the interface between science and management. Drawing on this work, Mr. Schwaab considered several ways of coping with climate uncertainties, including decision rules to distinguish between short-term changes and permanent regime shifts, decision criteria that could trigger different treatment of an issue within the management framework, and mechanisms to support more iterative engagement between scientists and managers.

Finally, Mr. Schwaab described the need to think more strategically about habitat change within the fisheries management process, and take advantage of opportunities to build partnerships and share information beyond the fisheries realm. Opportunities include the Atlantic Coastal Fish Habitat Partnership, the Landscape Conservation Cooperatives, the NOAA Habitat Blueprint, and the National Fish, Wildlife, and Plants Climate Adaptation Strategy. In conclusion, Mr. Schwaab emphasized the need to consider potential changes and opportunities, so that we can manage—instead of being managed by—climate change challenges.