

Meeting Summary

Workgroup on Developing a Climate-Resilient Fishery Management Plan for Maryland

July 30, 2026

4:00-6:00 PM

Tawes State Office Building, Room C-1 Conference Room and Virtual

Attendance

Workgroup Members:

Kiley Dancy, Mid-Atlantic Fishery Management Council (In-Person)
Jorge Holzer, University of Maryland, College Park (In-Person)
Harry Hornick, Retired DNR (Virtual)
Henry Legett, Smithsonian Environmental Research Center (In-Person)
Mariah Livernois, Maryland Coastal Bays Program (Virtual)
Will Poston, Chesapeake Bay Foundation (In-Person)
Julie Reichert-Nguyen, NOAA Chesapeake Bay Office (Virtual)
Kenneth Rose, Horn Point Laboratory UMCES (In-Person)
Dave Sikorski, Coastal Conservation Association (Virtual)
Ward Slacum, Oyster Recovery Partnership (Virtual)
Troy Tuckey, Virginia Institute of Marine Science (Virtual)
Taylor Woods, USGS Eastern Ecological Science Center (In-Person)

DNR Staff:

Amanda Malagari, DNR Project Lead (In-Person)
Tammy O'Connell (In-Person)
Jacob Holtz (Virtual)
Mike Luisi (Virtual)
Marek Topolski (Virtual)
Sarah Widman (In-Person)
Andrew Loftus, Workgroup Facilitator (In-Person)

Workgroup Members Not Attending:

Greg Casten, ProFish Seafood Company
Sonny Gwin, Commercial Fisherman, Ocean City Maryland
Bill Sieling, Chesapeake Bay Seafood Industries Association

Pre-Meeting Background Materials

- Agenda (See Appendix A)
- Adaptation and Resilience Planning Worksheet

Workgroup Objectives

1. Exchange existing climate and fisheries data and industry knowledge.
2. Collaboratively develop a climate resilient fishery management plan (FMP) for state-managed fisheries in the Chesapeake Bay and Atlantic coast.

Meeting 2 Objectives

1. Presentation of DNR's FMP process
2. Gather Workgroup input into priority management and adaptation strategies

Welcome

Andrew Loftus, Group Facilitator

- Work Group members were welcomed with a review of the Objectives of this planning process and expectations for Meeting 2, A brief recap of the highlights from Meeting 1 was outlined as:
 - We shared experiences with climate-related impacts on fisheries.
 - We heard about the climate-related changes actually observed/measured in the Chesapeake region.
 - Workgroup members shared ways that the environment has changed over their lifetime and what they have done to cope with or adapt to it. These were categorized as fishing resources, fishing industry, or management.
 - We discussed what this working group can contribute to the development of an FMP and how that will integrate into other FMPs.
 - We discussed what types of information that the workgroup would find useful to help in future discussions.
 - Including: more information and specifics of how the climate adaptation FMP will integrate with and influence other DNR FMPs. This is the focus of Meeting 2.
- For a full summary of Meeting 1, please refer to the Meeting Summary.

Presentation: Overview of Fishery Management Plans

Tammy O'Connell and Jacob Holtz
(Appendix B)

- This topic is one of the questions that came from Meeting 1 of this workgroup.
- DNR is provided the authority to develop and implement Fishery Management Plans (FMP) by the legislature.
- A Fishery Management Plan (FMP) serves as a framework for conserving and wisely using fishery resources.
- The goal of an FMP is to protect the resource while allowing sustainable harvest.
- Most FMPs have been used to manage single species or species whose management is related
- However, changes the statute in 2025 directed DNR to create the Adaptation and Resilience FMP, which will be a more broad management tool than prior FMPs
- A fishery management plan may include:
 - Proposed limitations on the catch of fish, based on area, species, size, number, weight, sex, incidental catch, total biomass, or other
 - factors that are necessary and appropriate for conservation and management of a fishery;
 - Incorporation of relevant fishery conservation and management
 - measures proposed or adopted by interstate bodies of which Maryland is a member; and
 - Other proposed measures, requirements, or conditions and restrictions that are necessary and appropriate for fishery management.

At this point in the development process, DNR is in the information gathering phase. There are several other steps once this has been done; a draft FMP will be developed and then proceed through the FMP steps which include a public comment phase. This work group will help the DNR with the content and language which goes into the initial FMP.

Questions and Discussion

Question: How does this differ from an FMP for a specific species?

Answer: It won't take the place of an existing FMP but will work in conjunction, perhaps allowing DNR to take additional actions or work with other entities that they are not currently allowed.

Comment: the plan should be more strategic and less tactical because you can't envision what might apply to every species.

Comment: this may offer a more structured approach to addressing events such as new species showing up.

Current Maryland FMPs are very specific and contain series of specific actions and tasks. Conversely, California has developed a climate action plan that is very general; basically, bullet points that managers need to consider in managing fisheries.

Comment: the California plan was supposed to be followed up with an Implementation Plan.

The plan that Maryland DNR develops may end up being very broad or may be more specific.

Presentation: Adaptation and Resilience Planning Worksheet

Amanda Malagari (Appendix C)

Amanda presented the definitions that will be used during this process. Some guiding principles of adaptation and resilience include:

- Prioritization and triage
- Flexible and adaptable management
- "No Regrets" decisions – actions that befit us no matter what happens
- Precautionary actions for reducing risk in the near term
- Vulnerability and uncertainty
- This plan will focus more on adaptation rather than mitigation.

This project started in 2022 and began by seeking information from staff of Fishing and Boating Services about challenges and opportunities related to observed impact of climate change. This Workgroup's role is to identify and fill gaps and build out the FMP's objectives, strategies, and actions.

Questions and Discussion

Question: Should we limit thinking to actions that can be taken by DNR

Answer: We encourage the Working Group think broadly; items that don't fall into the current authority of DNR or FABS can be potentially elevated for potential changes to the current system or develop pathways for working with entities that have the authority.

Discuss management strategies and actions

(under the topics in “Adaptation and Resilience Planning Worksheet” and propose new topics and management strategies as needed)

(See Appendix C for suggestions)

Note: *these bulleted items supplement the thoughts of the Working Group that are captured in Appendix C.*

- Extremes – some work going on at UMCES to look at impact of deviations from trends etc. (Genny Nesslage).
- Question: Is DNR looking at impact of “regime change” - e.g., changes in fish community structure from the norm?
- If you look simply at “means” you will miss the impact of large swings in factors such as temperature. Are things like this detectable in current monitoring?
- Organizations of the tables – some of the species-specific tables are likely more overarching across species/fisheries so consider separating the table to capture that.
- Industry: Is the goal for creating a fishery for invasive species extirpation or creating a sustainable fishery. Know this is important for industry.
- Perhaps the FMP should include a provision that every time this management action is employed (e.g., encouraging development of a market), then the DNR must answer the question of extirpation or sustainability (potential longevity of the market to aid industry with business planning).
- There is a definition of invasive species with required management actions.
- May require potential changes in law for specific species about whether the species is still considered invasive.
- There are current discussions with industry about changes in licensing structures to better adapt to emerging fisheries etc.
- A Climate Adaptation FMP may include a broad statement such as “consult with industry groups about needed changes to licensing structure.”
- One thing this FMP can do that a single species FMP cannot is to address “unintended consequences” of actions to control invasive species on other species.
- New technologies (e.g., AI) will greatly change the way that we utilize and analyze data.
- Some current work ongoing analyzing data to look at overlap of species and species distributions in various habitat.
- Consider employment of Management Strategy Evaluations (MSEs).

Appendix A. Meeting Agenda for Workgroup on Developing a Climate-Resilient Fishery Management Plan for Maryland

July 30, 2026

4:00-6:00 PM

In Person: Tawes State Office Building, Room C-1 Conference Room

Or

Virtual: meet.google.com/nbn-fwja-rgc (see below for phone connection)

Background Materials

1. "Adaptation and Resilience Planning Worksheet" – REVIEW AND CONSIDER INPUT PRIOR TO MEETING!

Workgroup Objectives

1. Exchange existing climate and fisheries data and industry knowledge.
2. Collaboratively develop a climate resilient fishery management plan (FMP) for state-managed fisheries in the Chesapeake Bay and Atlantic coast.

Meeting 2 Objectives

1. Presentation of DNR's FMP process
2. Gather Workgroup input into priority management and adaptation strategies

Meeting Agenda

- | | |
|---------|---|
| 4:00 PM | Welcome – Andrew Loftus, Group Facilitator <ul style="list-style-type: none">• Objectives of Meeting 2• Brief recap of Meeting 1• Self-introductions |
| 4:15 PM | Presentation – Overview of Fishery Management Plans
Tammy O'Connell and Jacob Holtz <ul style="list-style-type: none">• Structure and function of FMPs• FMP development and review process |
| 4:30 PM | Questions and Discussion |
| 4:40 PM | Presentation – Adaptation and Resilience Planning Worksheet
Amanda Malagari <ul style="list-style-type: none">• Review principles of resilience in the context of FMPs• Background on the input developed by staff of the Fishing and Boating Services• Workgroup role to identify and fill gaps and build out the FMP's objectives, strategies, and actions |
| 4:50 PM | Questions and Discussion |

4:55 PM Discuss management strategies and actions under the topics in “Adaptation and Resilience Planning Worksheet” and propose new topics and management strategies as needed

5:55 PM Closing Remarks

6:00 PM Adjourn

Connection to Google Meet

By phone: Dial 1-615-608-4284 PIN: 157 189 568#

By internet: Video call link <https://meet.google.com/nbn-fwja-rgc>

Appendix B.1. Examples of FMP Objectives, Strategies, and Actions

Example 1: Tidewater Catfish (p. 26-27, MDNR)

Objective 2. Promote fishing for tidal populations of catfish in the Chesapeake Bay using available tools for disseminating information.

Strategy 2.1. Encourage consumptive and non-consumptive uses of invasive catfish.

Action 2.1.1* Identify incentives and remove regulatory barriers for harvest and processing of invasive catfish.

Action 2.1.2* Create invasive catfish derbies or tournaments, or work with existing tournaments.

Action 2.1.3* Include blue catfish and flathead catfish in public awareness campaigns targeting invasive species, including efforts to prevent new introductions and instead, encourage harvest.

Action 2.1.4* Conduct collaborative research with partner agencies to identify non-consumptive, ecologically beneficial uses of invasive catfish, such as protein sources for livestock or fertilizer for agriculture.

Action 2.1.5 Create or support the creation of more fish processing plants.

Action 2.1.6* Use data from surveys of diet preference for invasive catfish to promote ecological consequences of invasive species.

Objective 3. Create a framework for routinely soliciting public input when reviewing progress toward the goal of this plan.

Strategy 3.1. Routinely update management plan with most current available science.

Action 3.1.1 Collate and disseminate science reports and research updates to a list of stakeholders (e.g., biologists, recreational and commercial sectors, non-profit organizations, managers) who agree to meet regularly and agree to review progress on the plan.

Action 3.1.2 Collate and disseminate science reports and research updates to the general public using social media and other digital communications.

Example 2: Cownose Ray (p. 20-21, MDNR)

Objective 1. Utilize the best available data to support science-based management of the Atlantic cownose ray resource.

Strategy 1.1. Develop scientifically defensible data streams that can be used to assess management strategies for Atlantic cownose rays occurring in Maryland.

Action 1.1.1 Obtain biological and improved fishery related data to increase understanding of fisheries in Maryland waters.

Action 1.1.2 Monitor the status of the resource, including fishery-dependent and independent surveys.

Objective 2. Determine the biologically appropriate levels of harvest and allocation of the resource. Given the lack of information on the population and low reproductive potential, controls on the harvest are necessary, but there are ways to consider a harvest so that overfishing is prevented and young are protected.

Strategy 2.1. Determine current recreational and commercial harvest levels and methods of catch.

Action 2.1.1 Determine the recreational and commercial harvest using commercial harvest records and the best available recreational data.

Action 2.1.2 Determine the methods used to catch and harvest Atlantic cownose rays recreationally and commercially.

Action 2.1.3 Evaluate gear to maximize survivability. Determine if there are gear adjustments that can be made to maximize survivability for the rays or modifications that would deter the rays from certain gear types.

Strategy 2.2. Include socio-economic considerations when making allocation management decisions.

Action 2.2.1 Work with an economist or partner entity to analyze socio-economic data that will allow the Department to make appropriate management decisions.

Example 3: Red Drum Amendment 2 (p. 91 and 94, ASMFC)

4.1 RECREATIONAL FISHERIES MANAGEMENT MEASURES

4.1.1 Recreational Bag and Size Limits

In lieu of mandating specific bag and size limits for each management area, Amendment 2 specifies that all states must implement an appropriate bag and size limit which will attain the management goal of 40% Spawning Potential Ratio (40% SPR) (Tables 19 & 20). For states in the northern region which still have a commercial harvest of red drum, the overall harvest restrictions for commercial and recreational combined must be sufficient to attain a 40% SPR. The estimated reductions in fishing mortality due to recent changes in North Carolina's commercial regulations have been incorporated into the analyses (Table 19) (Please note that additional analyses were conducted which varied both the minimum and maximum size limits and these results may have been presented during public hearings in some states. Due to the number of possible combinations these were not included in Amendment 2. Appendix A contains one such analysis conducted for the southern region using a minimum size of 15 inches total length.)

4.1.2 Maximum Size Limit

No red drum larger than 27" total length (TL) shall be harvested. All states must implement a 27" TL or smaller maximum size limit for red drum.

4.3 FOR-HIRE FISHERIES MANAGEMENT MEASURES

4.3.1 Bag and Size Limits

In lieu of mandating specific bag and size limits for each management area, Amendment 2 specifies that all states must implement an appropriate bag and size limit which will attain the management goal of 40% SPR (Tables 19 & 20).

4.3.2 Maximum Size Limit

No red drum larger than 27" total length (TL) shall be harvested. All states must implement a 27" TL or smaller maximum size limit for red drum.

4.3.3 Data Collection and Reporting Requirements

4.3.3.1 For-Hire Catch/Effort Data Collection Programs

This amendment does not institute a separate data collection program for for-hire red drum fisheries. The ACCSP is conducting an evaluation study to determine the best method(s) of data collection for for-hire fisheries. A minimum set of standard data elements are being evaluated by ACCSP for collection in all for-hire catch/effort surveys (refer to the ACCSP Program Design documents for details).

Example 4: State of California's MLMA Master Plan (Ch. 11, CA DFW)

Maintaining socioeconomic resiliency

As fish stocks adjust their distributions and abundances, fishing effort may also have to adjust by changing the species targeted and the locations and times fished, as well as landing or processing locations. To adapt to a changing climate, fishermen may need to adjust where, when, and what they catch depending on conditions. Enabling them to do so may require changes in management, including permitting. The impacts of changes to the composition, magnitude, and timing of landings could be amplified if the shore-side processing and supply chain is not adaptable as well. The following approaches are designed to help evaluate and maintain socioeconomic resiliency associated with fisheries affected by climate change:

- **Evaluate options for flexible permitting:** Flexible permitting mechanisms could provide a means to allow fishery participants to hedge their risk, adapt to variable production or unexpected closures, and respond to shifts in species spatial distribution or range shifts. Flexible permitting could include transferrable permits and integrating gear flexibility into permits or other regulations. One of the challenges of flexible permitting mechanisms, however, is effectively controlling effort and balancing the interests of all affected stakeholders. Any such increase in flexibility would need to be consistent with the Commission's restricted access policy([opens in new tab](#))([external link](#)). As resources permit, the Department and Commission will work with stakeholders to conduct an analysis of permit transferability in California fisheries and the Commission's policy on restricted access fisheries. This analysis will include how permits are retired and new permits are issued, and the potential for gear switching. Permitting considerations will also be included in the development of new FMPs. A working group comprised of stakeholders, outside experts, and Department and Commission staff could help to interpret analyses and develop policy recommendations.
- **Evaluate community vulnerability:** Some communities will be more affected by climate change than others. There is a need to consider vulnerabilities of fishing communities to climate change impacts. For example, a vulnerability index that incorporates social and ecological indicators would allow communities to be ranked by their vulnerability, and could enhance the abilities to minimize adverse impacts on fishing communities when developing management plans and regulations. Vulnerability assessments should be scaled appropriately and should consider the interconnectedness of fishing communities at a regional scale.

Strengthening monitoring and data used for management

Monitoring will be an important component of any strategy to detect and respond to climate change, including the following:

- **Prioritize additional monitoring:** Current monitoring programs may benefit from re-evaluation of their design and scope in light of climate change. It may be possible to use existing data collection in a new way to monitor climate change. For example, tracking the spatial distribution of fishing effort and landings may alert managers to range shifts. Newer technologies could also be considered when planning monitoring programs, to improve information acquisition while keeping costs low. For example, cell phones allow stakeholders to provide real-time catch or

sightings information, and results from satellite remote sensing can be used to estimate area-specific phytoplankton productivity and predict the fish distribution and abundance. Development of new indicators—such as duration of spring blooms and the size or species composition of phytoplankton—could provide even better information relevant to predicting climate effects on fishing resources (Chassot et al. 2011). Understanding the link between physical oceanographic conditions and ecosystem health is critical and supporting and partnering with organizations that conduct monitoring should be a priority.

- **Incorporate environmental parameters into stock assessments, MSEs, and HCRs:** There is strong evidence to suggest that the productivity of many fish stocks is directly influenced by environmental variables. For species whose productivity is known to be dependent upon environmental conditions, appropriate environmental parameters may be integrated into stock assessments, MSEs, and HCRs. See Appendix L for more details. As knowledge of relationships between managed fish stocks and environmental dynamics continues to improve, there will be more basis for incorporating environmental factors into stock assessment and management.
- **Incorporate spatial information into stock assessments, MSEs, and HCRs:** Changes in species distributions can create management challenges, particularly when they cross jurisdictional boundaries. As the abundance or distribution of fish species is impacted by a changing climate, it may no longer be appropriate to follow the common practice of basing allocations on historical catch rates. Fish may be in a new location because their distribution has shifted or because the population has expanded into new habitat. Additionally, changes in habitat availability may result in changes in fish distribution. Including spatially-explicit information in stock assessments will assist in capturing regional differences in environmental conditions that affect stock productivity. This may require coordination with neighboring states and countries.

Appendix B.2. Overview of Fishery Management Plans Presentation

Tammy O'Connel and Jacob Holtz

See the following slides for the presentation content.

Meeting 2



Meeting 2 Objectives

1. Presentation of DNR's FMP process.
2. Gather Workgroup input into priority management and adaptation strategies.

FMP Workgroup



Workgroup Objectives

1. Exchange existing climate and fisheries data and industry knowledge.
2. Collaboratively develop a climate resilient fishery management plan (FMP) for state-managed fisheries in the Chesapeake Bay and Atlantic coast.

Meeting 1 Recap

- We shared experiences with climate-related impacts on fisheries.
- We heard about the climate-related changes actually observed/measured in the Chesapeake region.
- Workgroup members shared ways that the environment has changed over their lifetime and what they have done to cope with or adapt to it. These were categorized as fishing resources, fishing industry, or management.
- We discussed what this working group can contribute to the development of an FMP and how that will integrate into other FMPs.
- We discussed what types of information that the workgroup would find useful to help in future discussions.
 - Including: more information and specifics of how the climate adaptation FMP will integrate with and influence other DNR FMPs. This is the focus of Meeting 2.

Fishery Management Plans

Jacob Holtz and Tammy O'Connell
Fishing and Boating Services
Maryland Department of Natural Resources

Statutory Framework



- [Natural Resources Article, 4-215, Annotated Code of Maryland](#)
- A Fishery Management Plan (FMP) serves as a framework for conserving and wisely using fishery resources.
- The goal of an FMP is to protect the resource while allowing sustainable harvest.
- Historically have been used to manage single species or species whose management is related
- Based on changes to the statute in 2025, DNR is now creating the Adaptation and Resilience FMP, which will be a more broad management tool than prior FMPs

FMP Requirements



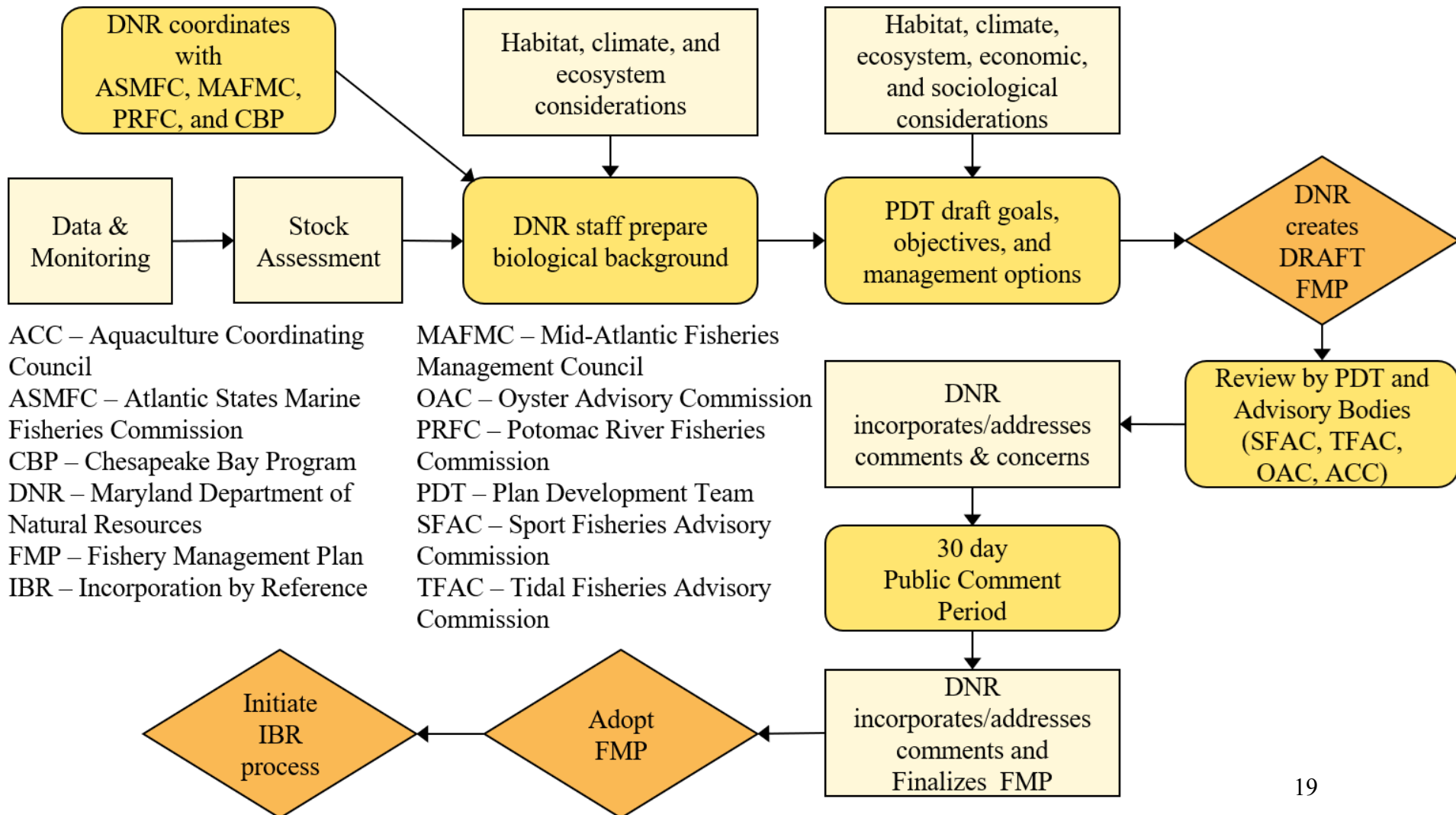
- FMPs may be created based on the population, distribution, or habitat needs of the species, or other biological, **ecological**, **climatological**, or socioeconomic factors concerning the species or Chesapeake Bay region
- A fishery management plan may include:
 - Proposed limitations on the catch of fish, based on area, species, size, number, weight, sex, incidental catch, total biomass, or other factors that are necessary and appropriate for conservation and management of a fishery;
 - Incorporation of relevant fishery conservation and management measures proposed or adopted by interstate bodies of which Maryland is a member; and
 - Other proposed measures, requirements, or conditions and restrictions that are necessary and appropriate for fishery management.

Actions under FMP



- Using the authority created by an FMP, the Department may implement conservation and management measures
- Conservation and management measures implemented under a fishery management plan, to the extent possible:
 - Shall prevent overfishing while attempting to achieve the best and most efficient utilization of the State's fishery resources;
 - Shall be based on the best information available;
 - May not discriminate unfairly among groups of commercial and recreational fishing participants, including individuals licensed to guide fishing parties and charter boat captains, or have economic allocation as its sole purpose;
 - Shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches;
 - Shall avoid duplication of regulatory efforts and unnecessary costs to the State and to any other person; and
 - Shall take into account changes in environmental factors, including climatological factors

FMP Development Process



Contact us for more information

Jacob Holtz, jacob.holtz@maryland.gov

Tammy O'Connell, tamaral.oconnell@maryland.gov

We will post project updates on our website:

FMP Page



Regulations Page



Appendix C. Adaptation and Resilience Planning Worksheet

Adaptation and Resilience FMP Workgroup

Adaptation and Resilience Terms

Term	Definition
Adaptation	Action to prepare for and adjust to new conditions, thereby reducing harm or taking advantage of new opportunities.
Climate Adaptation	Actions taken to reduce vulnerability to the impacts of climate change, aimed to enhance the resilience of natural and human-based systems.
Climate Change	Changes in long-term weather patterns on a global, continental, regional, or local scale occurring as a result of greenhouse gas emissions.
Fishery Management Plan (FMP)	A systematic description of a given fishery or fisheries and the objectives and conservation and management measures for the fishery or fisheries. A fishery management plan serves as a framework for conserving and wisely using fishery resources.
Mitigation	Human intervention to reduce emissions or enhance the sinks of greenhouse gasses.
Resilience	The capacity of natural and human-based systems to anticipate threats, reduce vulnerability, and respond to and recover from heavy disturbances and chronic stresses.
Vulnerability	The characteristics of exposure, sensitivity, and adaptive capacity that make a system, asset, or the natural environment more or less susceptible to harm or change.

Guiding Principles for the FMP

The FMP should be designed so that it incorporates both adaptation and resilience.

Principles of Adaptation

Principle	Description
Prioritization and triage	Based on vulnerability of fisheries resources and on the anticipated effectiveness of actions that attempt to reduce vulnerability
Flexible and adaptive management	Incorporates new knowledge and experience over time; Aligns with the existing fishery management framework
“no regrets” decisions	Actions with variety of benefits and minimal risk; Good place to start
Precautionary actions	Reduce risk in the near term, even when future uncertainty is high
Vulnerability and uncertainty	We won’t be able to account for every variable
Integrating mitigation	Investigate ways fishery management intersects with carbon sequestration strategies

5 Pillars of Climate Resilience (Rutger de Graaf-van Dinther)

1. Threshold Capacity = Ability to withstand levels of stress before failing
2. Coping Capacity = Immediate response to manage impacts
3. Recovery Capacity = Ability to bounce back and restore normalcy
4. Adaptive Capacity = Ability to adjust practices and policies
5. Transformative Capacity = Potential for fundamental changes in systems

Previous Planning Exercises

Fishing and Boating Services (FABS) staff completed a series of resilience planning exercises.

Step 1: Identify potential management challenges (C) and opportunities (O) using a matrix table. Staff recognize that ecosystem and habitat changes are the underlying driver for both challenges and opportunities.

Fisheries Components	Warming Temperatures	Precipitation and Storms	Sea Level Rise	Acidification
Ecology	C/O	C/O	C/O	C/O
Industry	C/O	C/O	C/O	C/O
Governance	C/O	C/O	C/O	C/O

Step 2: Discuss flexibility needs and prioritize focus areas

- Fishery management plans
- Monitoring and data
- Writing regulations

Step 3: Discuss key management challenges

- Low recruitment
- Local distribution shifts
- Coastal migrations
- Invasive species
- Data collection, staff capacity for monitoring, stock assessments

Step 4: Review the Impacts and Actions Tables that present management challenges/opportunities and associated adaptation actions (starting on page 5).

Table 1. Supporting fisheries resources through ecological resilience

Table 2. Supporting a resilient management system through species-specific actions

Table 3. Supporting a resilient management system through core management processes

Workgroup Planning Process

Meeting 2 Outcome = Identify gaps in the management topics to be included in the FMP.

Review the Impacts and Actions Tables and consider the following:

- Do the proposed actions address the challenges/opportunities?
 - Are there additional actions FABS could take? If so, add them to the worksheet.
- Are the actions implementable?
- Are there any topics, challenges, or opportunities that are not addressed in the table? If so, add them to the worksheet.

Add your thoughts in the areas marked **OTHER**. Come prepared to discuss the table at the remaining workgroup meetings:

Meeting 3 Outcome = Organize the management topics into objectives, strategies, and actions.

Meeting 4 Outcome = Review and edit a draft outline of the FMP.

Impacts and Actions Tables

This series of tables presents management topics, key climate change impacts, and potential adaptation actions to address those impacts.

Workgroup input is listed under each heading labeled **OTHER**.

Table 1. Supporting fisheries resources through ecological resilience

Topic	Environmental & Climate Impacts	Adaptation Actions
Stock Dynamics	- Shifting spawning behavior - Exceed thermal or other water quality thresholds for eggs/larvae (low recruitment) - Shifting survival, growth, and maturation rates OTHER: - Changes in fecundity and reduced egg production due to stress. - Extreme events (heat, cold) vary in frequency, duration, and intensity and could occur in sequence. There is a potential for fish to respond to extreme deviations, and for those responses to be delayed with recovery time. Ex: If early warming triggers early spawning and a cold snap follows, could recruitment be impacted? (Ex: NOAA, UMCES, using AI) - The environment could present a new regime. Ex: speckled trout and red drum during cold snaps triggered an immediate management reaction; striped bass triggers for low recruitment may not fit the new regime. - The relationship between an environmental parameter and a stock parameter may not be linear and not proportional to the mean, so the variance is more informative than the mean. Ex: temperature and growth relationship is nonlinear; fish move with the temperature gradient rather than the mean temperature.	Biology and Ecology - Monitor seasonal and long-term changes in population dynamics parameters (e.g. growth, mortality, spawning, recruitment). - Consider how changes to population dynamics influence the availability of the fishery and the corresponding adaptive management measures. - Consider how changes to population dynamics impact that data used in stock assessments. OTHER: - In addition to gradual trends, consider the impacts of nonlinear environmental changes due to extreme events. Assess how multiple environmental parameters are deviating from the norm, how those deviations could impact fish species, and if there is a pattern to those deviations. - Current monitoring may not be adequate for detecting changes outside of the timeframe or methodology of monitoring. Ex: Stress limiting energy available for female fecundity (egg production); difficult to detect due to methodology. Ex: We don't start monitoring early enough to detect spawning due to sampling limitations.

Topic	Environmental & Climate Impacts	Adaptation Actions
Food Web Robustness	- Shifting communities of species interacting with each other - Need to manage forage and predator species	- Expand the scientific understanding of dynamics between forage and predatory species. - Consider the interactions between fished and non-fished species. OTHER: - Monitor spatial/temporal changes in forage composition.
Spatial Distribution	- Shift, expansion, or shrinking of coastwide distributions: - Southern species more abundant in MD waters. Some may be novel, and others may be present but increase in abundance. - Mid-Atlantic species less abundant in MD waters - Agency staff capacity will be limited to monitor and manage species that are no longer abundant in addition to species that are becoming more abundant - Potential lack of recreational and commercial demand for new species OTHER: - Potential increase or change in bycatch composition. - We may have an idea of which species could survive in a new environmental regime, and which ones may need onboarding. - Challenges to governance.	Monitoring - Assess changes in the spatial distribution of species within Maryland waters and along the Atlantic coast. - Assess changes in migration patterns within Maryland waters and along the Atlantic coast. Onboarding/Offboarding - Establish a process for determining when a population <u>no longer supports</u> a fishery and which management actions are most appropriate. - Establish a process for determining if a novel or emerging species <u>could support</u> a fishery and setting up a monitoring and management program. - Assist in building recreational and commercial demand for novel species. - Adjust spatial and temporal gear use requirements to reduce conflicts with species during sensitive life history stages. - Assess licensing and gear structures to allow for flexible permitting of spatially and temporally available species. OTHER: - Question of whether DNR is obligated to ensure that a new market is sustainable before creating a new fishery. - Question of commercial licenses and how those will be passed down if fishing resources become limited (some are limited entry). The licensing workgroups are currently talking through this issue. We could include a license item in the FMP and mirror that in the licensing law. The FMP will allow us to create pilot programs related to fishing and gear use. - Explore developing a program to help commercial and recreational fishermen transition towards alternative fisheries if their preferred species becomes scarce.

Topic	Environmental & Climate Impacts	Adaptation Actions
		- Establish/enhance processes for cross-jurisdictional coordination and monitoring.
Physiology: Habitat Stress, Fish Health, Disease, and Parasites	- Shifting or extended growth periods - Shifting food availability - Thermal stress, release mortality - Habitat squeeze with low oxygen - Degraded water quality - Habitat expansion for warm water species - Decarbonation and impaired shell growth - Potential spread of diseases and parasites	- Determine the physiological limits of fish species. Establish sensitivity thresholds for parameters like DO, pH, salinity, and temperature. - Prioritize a suite of ecological parameters to monitor. - Consider the appropriate timeline for implementing safety measures (e.g., public notices). Coordinate with existing protocols.
Habitats and Ecosystem	Nontidal - Water Quality: influx of chemical and thermal pollution - Erosion of stream banks Tidal - Water Quality: influx of chemical and thermal pollution - SAV: temperature and pH stress, widgeon grass replacing eelgrass - Wetlands: inundation and erosion with limited opportunity for migration - Oyster Reefs: water quality stress, reproduction	- Incorporate ecosystem-based management principles and strategies into the existing fisheries management framework. - Identify pathways to connect fisheries ecosystem priorities with habitat management entities. - Assess the current status and the potential future condition of coastal habitats and the fishery resources that occupy them. - Determine priority areas for habitat conservation and restoration based on current and projected distributions. OTHER: - Improve our understanding of how fish use nearshore habitats. - Implement shoreline protection and restoration strategies to maximize and preserve as much quality fish habitat as possible. - Connection with the Bay Program's Adaptation WG: Focus on resilience for coastal communities, marsh migration, and promoting nature-based solutions. Tradeoffs: There is a competing dynamic between trying to protect shorelines from flooding and trying to maintain habitat. We lack information on how to implement these strategies to maximize fish habitat for multiple species. NOAA is funding a study on design of restoration projects in the high marsh to prepare it for becoming low marsh. Supporting the transition may not support the fish habitat. How can we preserve good quality habitat with SLR? We need to understand how the fish are using habitat so we can design them more effectively under change.

Topic	Environmental & Climate Impacts	Adaptation Actions
Invasive Species	- Expansion of previously introduced species - Habitable environments for future introduced species to become invasive	- In coordination with existing management plans (ANS FMP), determine if there are science gaps in understanding the potential impacts on existing fisheries. - Determine if new markets can be established or expanded for invasive fish and shellfish species (e.g., licensing for commercial fishing in nontidal waters). OTHER: - Think carefully about creating the market because people will invest in that new fishery and have expectations. Is this going to be a sustainable fishery? Is the goal extirpation or a sustainable market? Extirpation might not be possible after a certain threshold. Assess and communicate that expectation. DNR is also obligated to manage the fishery. Give DNR a series of questions to consider before making the decision. - DNR has definitions for invasive vs naturalized species. - Ex: There are currently a few options for blue catfish licenses. - Prioritize early detection monitoring and proactive actions rather than reactive. Look ahead to other species that we could anticipate coming into our waters. There is a list of known species we are actively working to prevent, and we can do a risk assessment for Maryland (Invasive Species Matrix Team, MD Invasive Species Council, Federal ANS Task Force). The public and partners can use the Maryland's Invasive Species Tracker to report invasives and track the spread. - Promote public awareness and education about the spread and impact of invasive species. Share voluntary best practices and regulatory requirements for invasive species management and control.

Table 2. Supporting a resilient management system through species-specific actions

Topic	Environmental & Climate Impacts	Adaptation Actions
Stock Assessments	- Growth, mortality, reproduction, survival, etc., may be impacted by climate parameters - Current stock assessment methods may not include temperature or other environmental-related parameters that would allow for more accurate estimations and projections of stock status	Data Analysis - Assess if established stock parameters have shifted over time. - Incorporate environmental and climate parameters into stock assessment analyses to project current and future impacts to species. - Assess the specific environmental drivers that influence fished species. Initial focus on understanding the basic relationship between environmental factors and stock parameters. - Explore the possibility of establishing environmental reference points (e.g., heat, hypoxia, impervious surface). OTHER: - Consider employment of Management Strategy Evaluation (MSE) and forecast modelling: Simulates what would happen under the future climate if we did x or y based on game theory. It can help incorporate social fishing preferences. Ex: MAFMC used for summer flounder EAFM; NOAA used for climate-ready initiative. - Consider the use of dynamic reference points.
Monitoring and Data	- Connects to agency-wide challenges with data management	- Develop a data stream that operates across the state. - Establish a repository for fisheries and environmental information. - Assess current survey designs so that they can be adapted if needed while maintaining the integrity of the datasets. - Assess if surveys could be modified to monitor multiple species. OTHER: Consider each point of the data stream: data collection, data management, data processing, data sharing, and data analysis. Data Management - Establish adequate data processing and sharing plans to fully utilize data that are collected. - Establish a process for data sources to be linked together. Ex: Datasets that monitor different life stages can inform species life history patterns. - Explore using novel technologies to collect, process, and share data. Ex: Establishing a multi-partner telemetry array in the Chesapeake Bay and spawning tributaries to track changes in movement and

Topic	Environmental & Climate Impacts	Adaptation Actions
		migratory species. We can also incorporate the buoy environmental data and link to movement. Data Collection - Assess how DNR could utilize data from multiple surveys to supplement each other and use existing datasets for novel analyses. Ex: Striped bass JI survey collects data for multiple species, the habitat survey collected additional JI data. - Expand electronic reporting across fisheries so that commercial fishing data are more readily available for monitoring and detection purposes. - Develop options for electronic self-reporting to collect recreational fishing data. Data Analysis (what do we do with the data) - Assess if Maryland has a recommended set of climate change scenarios that are specific to the region. These could be standardized across modelling efforts. Modelling and projections could help us envision what the future could look like. Ex: SLR projections from UMCES. - Utilize species distribution models and projected overlaps. Ex: Studying the physiology of species x climate projections to find out where the ideal habitats between the suite of species overlap. The results can identify where we can allocate resources to maintaining and restoring key habitat areas bay wide (Troy). Could we also identify specific regions or habitat qualities that are more susceptible or accommodating to new species. - Use climate projections to inform decision making. Ex: marine heat waves can help establish fishery closures.
Engagement and Partnership (with fishing communities and network partners)	- If fishing community members are not active participants in decision-making processes their capacity for resilience is reduced - There is a lack of understanding in how the current science informs management	- Build and expand effective engagement and partnership strategies with interested and impacted parties that interact with fishery resources. - Leverage existing pathways for interested and impacted parties to be involved in collaborative and inclusive decision-making processes. - Encourage interested and impacted parties to exchange knowledge (e.g., scientific, technical, historical, cultural, industry).

Topic	Environmental & Climate Impacts	Adaptation Actions
Industry Operations	- Weakened coastal infrastructure due to flooding and storm damage - Reduced fishing access due to severe weather - Increased travel distance to fishing grounds OTHER: - Increased insurance costs for the fishing fleet due to extreme events. We lack robust data but can use high premiums as a signal to assess risk in operations. - Decreased economic resilience due to inflation/rising costs and other broader economic trends	- Explore the use of new technologies and gear types (e.g., FACTS™). - Explore expanding aquaculture as an alternative to supplement wild-capture fisheries. - Explore options to maximize fishing access in response to severe weather events. OTHER: - Develop a better understanding of economic struggles/choke points/changes in operating costs?

Table 3. Supporting a resilient management system through core management processes

Topic	Environmental & Climate Impacts	Adaptation Actions
Regulations	- Limited ability to respond to rapid or acute changes in fisheries - Limited authority in what can be regulated through public notice	- Enable DNR to take timely management action in the case that severe or acute changes to fishery resources occur. - Assess how adaptive management actions could integrate with existing emergency response processes. Coordinate response actions across managing bodies. - Assess thresholds for environmental tipping points. Develop management protocols that can be triggered when environmental conditions are unsuitable. - Assess at what point an advisory could convert into a regulatory closure. OTHER: - Facilitate the transition to electronic reporting (FACTS). - Public notices to implement short-term or temporary actions - Process for making decisions when we need to act quickly (nimbleness)
Alternate Management	- Pilot programs must be associated with an FMP, but new species do not have FMPs	- Develop pilot programs to test adaptive management strategies.
Interjurisdictional Management	- Challenges in streamlining management - Multiple directives and priorities OTHER: - Lack of a centralized portal where fish monitoring data are available; requires contacting agencies. Data are often packaged differently. Collecting and standardizing takes considerable time. - Representation concerns.	- Initial focus on centralizing resources within DNR, then prioritizing implementation of interjurisdictional management requirements. OTHER: - Explore the possibility of establishing a data portal for sharing across state and federal agencies. Easily accessible data would offer greater opportunities for data analysis and enable more timely decision making.

OTHER topics not addressed in the tables:

- Community resilience and engaging with communities could be its own category in the plan. Some aspects are overarching while others are species specific.
- Industry operations could also be its own category for similar reasons.
- Interactions with protected resources.

Overarching thoughts:

- Using the word “shift” may not accurately represent the change, since parameters could expand or compress.
- The [Resist-Adapt-Direct Framework](#) (RAD) is a tool that can assist with decision-making.
- We should consider the possibility that the actions we take could have unintended consequences. This could be a guiding principle of adaptation. It complements the principle of no regrets where we prioritize actions that could be beneficial across multiple potential future scenarios.
- Scenario planning could help us focus in on which models and projections could be the most useful.
- Include actions in the FMP that describe what we can do with the data once it is collected and prepared. We did this in the stock assessment topic and need to expand it to the other topics.
- We may generally need to be more conservative given uncertainty. This guiding principle could be helpful when engaging with industry members and justifying collecting better commercial and recreational data.
- Losing historic species will have an impact on the culture.
- There is much uncertainty around climate change, but there are things that we do know and we can use them.
- The striped bass program collects data on many species. This dataset could provide a solid baseline.
- The FMP will increase DNR's nimbleness by enabling DNR to take more timely management action and write regulations.