PDE CCMP CLIMATE VULNERABILITY REPORT

April 2017

This report provides an assessment of the vulnerability of preliminary Comprehensive Conservation Management Plan (CCMP) strategies of the Delaware Estuary Program to climate change stressors. This document is a companion to the Partnership for the Delaware Estuary (PDE) CCMP process, and provides a summary of the Climate Vulnerability workshops, which were used to collect feedback from experts in order to modify preliminary CCCMP strategies and complete a climate vulnerability assessment.

CONTENTS

LIST OF TABLES

APPENDIX B TABLES

INTRODUCTION

The Partnership for the Delaware Estuary (PDE), on behalf of the Delaware Estuary Program (DELEP), invited input for revising the Comprehensive Conservation Management Plan for the Delaware Estuary (CCMP). Input was solicited from approximately 300 scientists and experts on topics related to *Healthy Waters, Healthy Habitats, and Healthy Communities,* the thematic areas proposed for the revised CCMP. (These thematic areas later became Clean Waters, Healthy Habitats, and Strong Communities.) In Spring 2016, over 150 of these experts provided responses to a series of open-ended survey questions on actions underway and actions needed to address these topics. Input was also received from three public listening sessions held in Summer 2016 for feedback on a basic set of draft goals for each theme. PDE compiled feedback from surveys and listening sessions into an "Ideas Document," along with additional feedback collected from its Science and Technical Advisory Committee (STAC) and Estuary Implementation Committee (EIC) in Fall 2016. Over 1,700 ideas were collected and categorized into this document, without regard for their feasibility or suitability as CCMP actions.

Following this initial collection exercise, all surveyed experts were invited to participate in a series of workshops to further refine the Ideas Document for inclusion in goals, strategies, and actions of the CCMP. Information gathered at the nine CCMP Expert Workshops was used to create a "Core Elements" document, a rough outline of goals and strategies for the CCMP. (Please refer to **Appendix A** for the Core Elements Document that was used during the process.) The Core Elements Document made it possible to undertake an assessment to identify whether the preliminary CCMP strategies were vulnerable to climate change. In order to undertake a climate vulnerability assessment for the preliminary CCMP strategies, PDE held a series of workshops to gather further input from experts.

The process and products described in this document have been adapted from the first five steps of the US Environmental Protection Agency's (EPA) Climate Ready Estuaries *Being Prepared for Climate Change: A Workbook for Developing Risk-Based Adaptation Plans*. The EPA workbook was used to help determine the types of information needed for a climate vulnerability assessment, as well as the methods by which to analyze such information. **Table 1** summarizes the five steps of the EPA workbook and relates them to the Delaware Estuary climate vulnerability assessment process.

TABLE 1: EPA WORKBOOK STEP AND RELATED PROCESS STEP

EPA Workbook Step	Related Process Step
Step 1 – Communication and Consultation	Outreach to experts who had attended the initial CCMP workshops
Step 2 – Establishing the Context for the Vulnerability Assessment	Production of the Core Elements document (with draft CCMP strategies) from results of the CCMP workshops
Step 3 – Risk Identification	Addressed at the Climate Vulnerability workshops
Step 4 – Risk Analysis	Addressed at the Climate Vulnerability workshops
Step 5 – Risk Evaluation: Comparing Risks	Consequence/Probability Section of this report

As described in the table, all five steps of the climate change vulnerability assessment were addressed by the PDE climate vulnerability assessment process. First, experts on the subjects of Clean Water, Healthy

Habitats, and Strong Communities who were already engaged in the CCMP development process were invited to provide further feedback regarding climate change impacts on strategies that had been developed from the Expert Workshops. Second, the Core Elements document, which contained draft strategies for the CCMP, was created and shared with the list of experts. Third, PDE created a series of three workshops with the goal of assessing climate change impacts on the Core Element draft strategies and invited experts to attend. During these workshops, experts helped to identify risks posed by climate change as well as analyze consequence and likelihood of these risks. Finally, this report summarizes the work undertaken throughout the process and compares and evaluates risks identified by experts in the climate vulnerability workshops.

CLIMATE VULNERABILITY WORKSHOPS

PDE hosted three Climate Vulnerability workshops in late March:

- Healthy Habitats, March 21st at the Ashland Nature Center in Hockessin, DE;
- Strong Communities, March 28th at the PSEG Energy and Environmental Resource Center in Salem, NJ;
- Clean Water, March 30th at the Delaware Valley Regional Planning Commission in Philadelphia, PA.

Each workshop focused on CCMP strategies related to a different theme—Clean Waters, Healthy Habitats, or Strong Communities. In total, 57 people attended the climate vulnerability workshops: 22 attended the Clean Waters workshop, 12 attended Strong Communities, and 23 attended Healthy Habitats. Of the 57 participants, 47 were unique individuals. Participants represented over 20 different organizations, agencies, and institutions. **Appendix B** includes the full list of participants.

The goals of the climate vulnerability workshops were to:

- Reflect on progress made in previous CCMP Expert Workshops;
- Provide additional feedback on draft objectives and strategies outlined as core elements for the revised CCMP; and
- Assess the impacts of climate change to draft strategies through conducting a vulnerability assessment.

In order to achieve these goals and best utilize participants' time, the workshop agenda was crafted to include different types of participant engagement. First, Jim Eisenhardt, RK&K welcomed participants, provided an overview of the day, and introduced the project team. Jim then provided a brief summary of the CCMP Expert workshops, including results and participation numbers. Jen Adkins, PDE, then walked the group through the CCMP Core Elements document for the workshop's theme (Clean Waters, Healthy Habitats, or Strong Communities). A facilitated group discussion followed the presentation of the CCMP Core Elements to solicit further feedback and recommendations from the group.

Following the Core Elements feedback discussion, Jim Eisenhardt provided instructions for climate vulnerability break-out sessions. Depending on the workshop theme, there were either two or three goals to be assessed for climate vulnerability. There would be a break-out group to discuss the vulnerability of each goal, but only two break-out sessions on the agenda. Participants were asked to self-sort into groups

as per the Core Element goal for which they had the most interest or expertise. Once in their groups, participants worked with a facilitator to populate the worksheet detailing climate change risks and consequences for each strategy. For the second break-out session, participants were offered the opportunity to change groups or remain with their group to provide additional feedback. Emily Baumbach, PDE, and Sari Rothrock, RK&K, facilitated the break-out groups alongside Jim Eisenhardt.

Following the break-out sessions, participants engaged again in a facilitated group discussion regarding outcomes of the climate vulnerability assessment. Participants also further discussed opportunities to add greater resilience to goals and strategies. Finally, Jim Eisenhardt provided the group with information regarding next steps in the CCMP Revision process.

WORKSHEETS

The worksheets created for the workshops were adapted from the EPA workbook. Worksheets were broken out by CCMP Core Element strategy. Each strategy worksheet was broken into seven columns:

- Column 1 listed the CCMP Strategy being evaluated.
- Column 2 listed potential climate stressors (as defined by the EPA workbook).
- Column 3 provides a space to list the potential risks posed by the climate stressor to the CCMP Strategy.
- Column 4 asked participants to rate, from a to c, the consequence that the risk would have on the strategy were it to occur.
- Column 5 asked participants to rate, from a to c, the likelihood of the risk coming to fruition.
- Column 6 asked participants to rate, from a to c, the spatial extent of the impact of the identified risk.
- Column 7 asked participants to rate, from a to c, how soon the particular risk might be expected to happen.

The “a” on the a to c ranking scale described “a” as mild, unlikely, site-specific, or with impacts happening in the future. At the other end of the spectrum, “c” has high consequences, high likelihood, is watershed-wide, and has immediate impacts. If a strategy scored a “c” in consequence, the strategy would be deemed very vulnerable to climate change impacts and would need to be reconsidered. The worksheet instructions are included in **Appendix C**.

Worksheets were sent to participants in advance of the workshops. Column 3, the risk column, was prepopulated with suggested information. At the workshops, participants were asked to react to the prepopulated information and to suggest changes, edits, and additions. They were then led through an exercise to populate the remaining columns with the letters a, b, or c. Break-out group worksheet results can be found in **Appendix D.** The worksheets summarize the recommendations of experts that provided input in the climate vulnerability workshop break-out groups.

CONSEQUENCE/PROBABILITY MATRICES

Consequence/Probability matrices have been prepared below, using the consequence and likelihood columns of the climate vulnerability worksheets. The purpose of a Consequence/Probability matrix is to gain “a broad, risk-based assessment of climate change vulnerability in your system,” and to find

"agreement among management and key stakeholders about how the climate change risks will affect your organization" (EPA, 2014).

Tables 2, 3, and 4 chart the intersections of low (a), medium (b), and high (c) climate change stressor consequences and likelihoods. Risks have been highlighted in green, yellow, or red according to the EPA workbook's Consequence/Probability Matrix. Please note that these tables do not take into consideration benefits conferred as a result of climate stressors.

While neither **Table 2, 3, or 4** cataloged any risks in the far-right "high" category of consequence, there were several risks that fell within the red vulnerability area of the table.

Under the Healthy Habitats goals and strategies, the following risks stood out as greatest:

- Climate stressors are likely to create a high risk to the successful implementation of BMPs for forests (H2.2).
- The task of inventorying, mapping, and enhancing habitat for fish and crabs was deemed very vulnerable as a result of climate change impacts biasing assessments, shifting species range, shifting food, and inducing earlier spawns or otherwise changing spawning habitat (H3.1).
- Storminess and sea level rise were seen as threats to protecting and restoring horseshoe crab habitat, eroding it away, reducing spawning events, and impacting opportunities for volunteer activities around horseshoe crabs (H3.4).

Under the Strong Communities goals and strategies, the following were regarded as higher risk:

- Restoring working waterfronts while confronted with increasing storminess that could damage waterfronts and wetlands, diminishing fish populations and impacting local industry; as well as sea level rise that threatens to overtake waterfronts altogether (C1.1).
- Utilizing natural areas and waterfronts to connect people to the Delaware Estuary is vulnerable to sea level rise, which may lead to a loss of waterfronts and coastal areas (or access to these areas) over time.

Finally, for the Clean Waters goals and strategies, the most vulnerable were judged to be:

- Sea level rise permanently inundating contaminated waterfront sites before they've been remediated (W1.2);
- Increasing storminess disturbing installations and limiting opportunities available for installations and maintenance (W3.2); and
- Warmer water impacting monitoring on salinity impacts and flow needs for biological/ecological endpoints by increasing the risk of algal blooms and oyster disease (W3.5).

Again, while these strategies were ranked as most vulnerable, no strategies were deemed too highly risky as to render them unachievable.

TABLE 2: HEALTHY HABITATS CONSEQUENCE/PROBABILITY MATRIX

Likelihood of occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	H3.1: Warmer summers necessitate more frequent assessments and inventories. Both warmer summers and warmer winters will change the habitat baseline. H3.2: Warmer summers, warmer water, and drought can make oysters more susceptible to disease. Warmer summers and storminess may impact days available for fieldwork and commercial harvest. Warmer winters, salinity change, and sea level rise may shift range. Warmer water may impact food sources and create a shorter harvest in a smaller area for commercial interests. Increasing storminess and accompanying flooding can impact oyster beds. Sea level rise may cause oysters to fall deeper in the water column (leading to food challenges). Turbidity due to sea level rise will also impact food.	H2.2: Warmer summers, warmer winters, increasing drought, increasing storminess, sea level rise, and salinity change puts implementation of BMPs for forests at risk. H3.1: Warmer water will bias assessments, induce an earlier spawn, shift food and species range. Drought can create a change in salinity which will shift where species go, and can create changes in spawning habitat. Increasing storminess will change habitat baseline, determine whether SAV is present, and impact horseshoe crab spawning. SLR will also change baselines and put impoundments at risk. H3.4: Increasing storminess will erode horseshoe crab habitat; will impact days available for volunteer activities, and will reduce spawning events. SLR will erode and reduce horseshoe crab spawning habitat.	N/A
Medium	H1.1: Warmer summers, warmer winters, drought, and increasing storminess could impact the results of wetland baselines and long-term tracking through abnormal monitoring measurements, and could impact fieldwork schedules. H2.1: Increasing storminess and warmer summers could impact fieldwork schedules. H2.3: Warmer summers, warmer winters, drought, sea level rise, and salinity change could impact land that is being acquired so that it is no longer the right land to protect. H3.2: Ocean acidification may have impacts to spat.	H1.1: Sea level rise and salinity change could impact the results of wetland baselines and long-term tracking through abnormal monitoring measurements, and could also impact fieldwork schedules. H3.3: Fluctuations in salinity may create a barren zone for mussels, and may shift species geographically.	N/A
Low	H1.2: Warmer water and ocean acidification may impact bivalve shellfish integral to wetland health and water chemistry H1.3: Warmer summers and warmer winters may create a shift in community species composition in wetlands that will need to be reflected in installations. Warmer water may impact the bivalve shellfish integral to living shoreline installations. H1.4: Warmer summers, warmer winters, and warmer water will impact community species composition and make protecting non-tidal wetlands difficult. H3.3: Warmer summers will shift timing for glochidia release, will impact food sources, and will create species shifts. Warmer winters and warmer water may create a shift or loss in host fish species. Increasing drought would result in a loss of habitat and additional predation. Increasing storminess may change where habitat is appropriate for restoration, limits fieldwork during and immediately afterward, increases erosion, and reduces habitat. Sea level rise may create a species shift due to salinity change and will erode habitat for ribbed mussels. H3.3: ocean acidification may impact ribbed mussel larvae. H3.4: Salinity change may cause the spawning range to shift.	H1.2: Warmer summers, warmer winters, and salinity change may cause shifts in community species composition, and increasing drought may alter flow and salt line, impacting the restoration of wetlands. Increasing storminess may harm wetlands, making it more difficult to restore them. Sea level rise will compromise wetland health, making managing them more difficult. H1.3: Increasing drought may impact water flow and the salt line and lead to desiccation of marsh sediment which would create issues protecting wetlands. Increasing storminess can damage living shoreline installations and infrastructure. Sea level rise will make it difficult to protect tidal wetlands. H1. 4: Increasing drought may degrade non-tidal wetlands. Increasing storminess and sea level rise can introduce salt water due to storm surge. H2.1: Warmer summers, warmer winters, increasing drought, sea level rise, salinity change, and seasonal uncertainty could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements. H3.4: Warmer water will lead to earlier spawning for horseshoe crabs and will impact food.	N/A
	Low	Medium	High
	Consequence of Impact		

TABLE 3: STRONG COMMUNITIES CONSEQUENCE/PROBABILITY MATRIX

Likelihood of occurrence	Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
High	N/A	C1.1: Increasing storminess could damage waterfronts and wetlands, diminishing fish populations and impact the local industry. Sea level rise may lead to waterfront loss over time and potential water supply impacts. C1.4: Sea level rise may lead to loss of waterfronts and coastal areas (or access to these areas) over time.	N/A
Medium	C1.2: All climate stressors will impact the demand for technical assistance and the types of tools used. Warmer summers and increasing storminess would impact fieldwork and resource-based economy work. Warmer winters could create an insect/invasive impact that reduces days available for fieldwork as well as shifts species composition. Access issues could result from warmer winters (less snow creates less flow), warmer water (algal blooms), increased storminess (due to flooding), and sea level rise (inundation). C1.3: Warmer winters and warmer water could shift species composition in natural areas. C2.2: Sea level rise could affect participants' ability to access waterfront events.	C1.1: Increasing drought could create difficulties working on boats in channels that have not been dredged. Salinity change could create a species shift that impacts the local industry, as well as water supply and restoration efforts. C1.3: Warmer summers and salinity change could shift species composition in natural areas. Warmer summers and increasing storminess will lead to fewer fieldwork days. Warmer summers, storminess, and sea level rise could lead to damage and degradation of infrastructure and access points over time. C1.4: Warmer summers could decrease opportunities due to increased number of high heat days. Warmer water may increase the possibility of algal blooms or change the range of fish and crabs, reducing recreational use of the water. Increasing storminess could damage waterfronts and natural areas, reduce the number of days the public has access to the water, and damage signage and infrastructure.	N/A
Low	C1.1: Warmer summers may create an increased risk of asthma for people working in urban areas; increased risk of heat fatigue; fewer field work days. Warmer winters would worsen insects and invasives. Warmer water could create a species shift that impacts local industry and create issues with algal blooms. Ocean acidification could have an impact on oysters and the local industry. C1.3: Increasing drought and ocean acidification could create a shift in species composition in natural areas. Drought could also impact structural integrity (submerged vs. not submerged). C1.4: Increasing drought could impact natural areas and reduce water flow, leading to recreational boats unable to leave docks. Salinity change may change the composition of fish and plant communities. C2.2: Warmer summers, increasing storminess, and a change in air quality may limit days available for experiences, as well as interest in events. C2.3 and C2.4: Warmer summers and increasing storminess could impact the days available for certain types of experiences. Sea level rise may impact the areas that could be used for experiential learning.	N/A	N/A
	Low	Medium	High
	Consequence of Impact		

TABLE 4: CLEAN WATERS CONSEQUENCE/PROBABILITY MATRIX

Likelihood of occurrence		Consequence of Impact: Low	Consequence of Impact: Medium	Consequence of Impact: High
	High	W1.2: Warmer summers may increase the number of high heat days, impacting days available for work. Warmer summers will also increase the risk of asthma for working in urban areas. W3.2: Warmer winters may cause species composition to shift, which would change some plans. W3.5: Increased number of high heat days may limit days available for research in the field.	W1.2: Sea level rise may permanently inundate waterfront contaminated sites, rendering this strategy unable to be fulfilled. W3.2: Increasing storminess may disturb installations as well as limit times available for installations and maintenance. W3.5: Warmer water could increase the risk of algal blooms and oyster disease, both of which would impact monitoring.	N/A
	Medium	W1.4: Warmer water, drought, and sea level rise would necessitate a change in resources and monitoring. W3.2: Warmer summers may increase the number of high heat days and limit days available for BMP installation and maintenance. Seasonal irregularity affects days available to work in the field and impacts planning. W3.5: Seal level rise and seasonal irregularity would cause the frequency of data collection to change in order to gather sufficient data.	W1.2: Increasing storminess may limit the number of days for work at toxic sites and make spills more difficult to contain. W2.5: Warmer summers and increasing storminess may limit days available for research in the field. Warmer summers, warmer winters, and warmer water may necessitate a shift in what is being studied. Increasing drought, storminess, and sea level rise may disturb installations and monitoring equipment, as well as limit times available for monitoring or would necessitate modifications in monitoring program duration and frequency. W3.2: Increasing drought and sea level rise will make it challenging to maintain certain BMPs, and water table height may impact BMP feasibility. W3.5: Warmer winters would impact the length of monitoring (issue for funding), and can create inconsistency in the data. Increasing storminess may disturb monitoring equipment and samples, as well as limit times available for research and monitoring in the field. Increasing drought would cause the frequency of data collection to change in order to gather sufficient data.	N/A
	Low	W1.1: Warmer summers and increased storminess may impact the days available for activities like storm drain marking and river cleanups. W1.3: Businesses and offices may close due to severe weather events and be unable to fulfill coordination on certain days. W1.4: Warmer summers and increasing storminess may limit days available for monitoring activities. W1.5: Warmer summers and increasing storminess may limit times available for monitoring. Increasing storminess may also disturb installations and monitoring equipment.	W3.1: Difficult to convey a water conservation message in wetter conditions.	N/A
		Low	Medium	High
		Consequence of Impact		

NEXT STEPS

The climate vulnerability assessment process, including the workshops and this report, are important steps in the PDE CCMP Revision process. The climate vulnerability assessment provided PDE with an opportunity to further vet preliminary CCMP strategies with expert stakeholders in order to ensure that the Delaware Estuary Program is thoughtfully investing time, effort, and resources in strategies that will continue to be meaningful and important in the face of climate change stressors.

REFERENCES

EPA, 2014. *Being Prepared for Climate Change*. EPA 842-K-14-002. https://www.epa.gov/cre/being-prepared-climate-change-workbook-developing-risk-based-adaptation-plans

APPENDIX A: CORE ELEMENTS DOCUMENTS

CCMP Core Elements

A First Draft of Strategies for the Revised Comprehensive Conservation and Management Plan for the Delaware Estuary

Partnership for the DELAWARE ESTUARY

Strong Communities

Goal C1: Increase Community Resilience and Access

Objectives:

- ***Improve working waterfronts with fewer brownfields, more wetlands and visitors***
- ***Increase access to the River; sustain and enhance access to the Bay***
- ***Increase protected land with public access/benefits***

Strategy C1.1 Restore working waterfronts through:

- □ Cleanup and productive use of previously used and abandoned sites and sharing of best practices between brownfields programs
- □ Using nature based tactics for stormwater management and to improve ecological function and resilience (s.a. wetlands)
- □ Providing/improving public access

Proposed focus: working waterfronts in urban and rural areas including Environmental Justice (EJ) communities

Likely partners: states, Urban Waters Federal Partnership (UWFP), waterfront municipalities, PDE

Strategy C1.2 Provide tools and technical assistance to waterfront communities & partners to improve economic and environmental resilience, including:

- □ Access (trails, amenities, PR)
- □ Trash Free Waters activities
- □ Resilience tools and planning (weathering change, cc roundtable)
- □ Outreach to promote recreation and stewardship

Proposed focus: building capacity of waterfront communities (including EJ communities) through collaboration, tech transfer, demonstration and signage.

Likely partners: PDE, DVRPC, Association of New Jersey Environmental Commissioners, League of Municipalities, Sustainable Jersey, Delaware Valley Coastal Zone Task Force, County Planning Depts, states, Bayshore Center at Bivalve / Bayshore Council

Strategy C1.3 Protect and restore natural areas and public access, including (where appropriate) infrastructure like trails, boardwalks, piers, parking, restrooms, etc. for public access.

Proposed focus: public/protected natural areas; particularly those with water access, EJ communities

Likely partners: states, municipalities, Bayshore Tourism & Economic Development Task Force (NJ), Delaware Bayshore Initiative (DE), The Circuit Trails (PEC-PA), UWFP

Strategy C1.4 Utilize natural areas and waterfronts as opportunities for connecting people to the Delaware Estuary, through

- □ Education programs, displays, signage
- □ Promoting recreation opportunities (EcoDelaware.com)
- □ Green Jobs

Focus: natural areas with water access, strong partnerships, EJ communities
Likely partners: states, PDE, local partners (environmental centers network), UWFP

Goal C2: Improve Public Awareness and Stakeholder Engagement

Objectives:

- ***Improve access to information about the Estuary measured by web site visits, downloads, newsletter subscriptions, and social media following***
- ***Improve the engagement of citizen scientists, stewards, and key stakeholders measured by increases in participation in programs and volunteer activities***

Strategy C2.1 Employ marketing & mass communications to build awareness and affinity, and provide access to information, including:

- □ Estuary News
- □ DelawareEstuary.org (visual representation of resources and projects online)
- □ Press and social media

Audience[i]: the interested (environmentally aware) public
Message: the Estuary is an amazing resource in need of your stewardship and protection (and here's what you can do)

Strategy C2.2 Hold events to build awareness and affinity and engage new people:

- □ Annual Coast/Bay Day events with experiential learning opportunities
- □ Festival events in each state/watershed
- □ Events/presentations to affinity groups representing key stakeholders/users

Audience: the interested public and key affinity groups (nature lovers, recreational users, businesses)
Message: the Estuary is an amazing resource in need of your stewardship and protection (and here's what you can do)

Strategy C2.3 Develop and promote programs that engage teachers and schools in stewardship of the Estuary, including:

- □ Training and materials for teachers (teachers' workshops, resource guides, classroom materials)
- □ Opportunities for schools and classrooms to be hubs for community engagement, or involved in experiential learning (contests/awards, and outdoor/floating classrooms, Green & Healthy Schools)
- □ Partnerships with institutions of higher education to provide experiential learning (internships, fellowships)

Audience: teachers/educators, schools, youth groups, and nature centers

Message: the Estuary is an amazing educational resource, and here's how you can use it (including citizen science)

Strategy C2.4 Develop and promote programs with local communities and partners that foster volunteer stewardship and experiential learning, like:

- □ Storm drain marking
- □ Volunteer monitoring / citizen science (water quality, horseshoe crabs, fw mussels)
- □ Shell recycling
- □ River/Watershed cleanups

Audience: local communities, partners, and groups of volunteers (including youth groups)
Message: Non-point source pollution is a major problem in our waterways, and here's what you can do

Strategy C2.5 Publish and share outreach materials and scientific results in the form of:

- □ Publications, including State of the Estuary (interested public)
- □ Technical reports/publications, including Technical Report for the Estuary and Basin (scientists/practitioners)
- □ Delaware Estuary Science & Environmental Summit and other conferences (scientists, practitioners, and interested public)

Audience: key audiences in parentheses above
Message: Various, about the status, trends, latest research, successes, and lessons learned

Strategy C2.6 Engage key stakeholders to coordinate science and management of the Estuary through regular meetings and communication, including:

- □ Core/MOU partners in the Delaware Estuary Program (Board, EIC, and Steering Committee)
- □ Scientific, monitoring, and technical partners (PDE Science & Technical Advisory Committee, DRBC Monitoring Advisory Coordinating Committee, other technical committees)
- □ Sub-watershed collaborations and other project and program partners, citizen scientists

Audience: partners/stakeholders identified above
Message: coordination of management, collaboration on projects/programs for greater impact

Strategy C2.7 Assess impacts of outreach through:

- □ Short term: Program/event attendance and evaluations (annual)
- □ Mid term: Focus group / surveys (every 5 years)
- □ Long term: Explore new/improved ways to track behavior change over time

Audience/Message: N/A

[i] For engagement strategies, audience/message is identified (instead of focus) and it's assumed that PDE will play a leading role working with a variety of partners specific to those audiences/messages

CCMP Core Elements

A First Draft of Strategies for the Revised Comprehensive Conservation and Management Plan for the Delaware Estuary

Healthy Habitats

Goal H1: Prevent Wetland Loss

Objectives:

- ***Measure and minimize loss of wetlands***
- ***Track and improve wetland conditions***

Strategy H1.1 Establish clear baselines for wetland conditions and track changes over time by:

- □ Growing/sustaining Mid Atlantic Coastal Wetlands Assessment (MACWA)
- □ Utilizing MACWA data to guide tidal wetland planning and management for the Delaware Estuary

Proposed focus: on tidal wetlands
Likely partners: PDE, states

Strategy H1.2 Restore and manage wetlands for maximum health and resilience, including:

- □ Use MACWA data to identify high-value wetland protection and restoration opportunities and strategies, and evaluate results (marsh futures, monitoring protocols)
- □ Use/Improve traditional BMPs for things like mosquito management, phragmites eradication
- □ Conduct R&D for new practices and ecosystem service valuation to inform/improve restoration and management taking climate change into account
- □ Implement key recommendations from the Regional Sediment Management Plan (s.a. beneficial use of sediment)

Proposed focus: tidal wetlands
Likely partners: PDE, states

Strategy H1.3 Develop and implement living shoreline techniques to restore eroding shorelines, and build and protect wetlands, infrastructure, and other key resources through:

- □ Implementation of the Delaware Estuary Living Shoreline Initiative (DELSI)
- □ Use of innovative tools (like marsh futures) and monitoring protocols to guide projects, assess results

Proposed focus: tidal shorelines
Likely partners: PDE, states, The Nature Conservancy (TNC), Rutgers University, National Fish & Wildlife Foundation (NFWF)

Strategy H1.4 Protect non-tidal wetlands through:

- □ Land acquisition and stewardship
- □ Education and outreach
- □ Utilizing the regulatory framework

Proposed focus: protecting high-value wetlands, using ecosystem service values to educate/motivate
Likely partners: states, land trusts, DRWI partners, PDE

Goal H2: Stem Forest Loss

Objectives:

- ***Measure and minimize loss of forest cover***
- ***Track and improve forest management***

Strategy H2.1 Establish clear baselines for forest health, loss/causes, connectedness, and priority forest for water resource protection.

Proposed focus: utilizing existing information (from SAN, TNC, DRWI, forestry agencies)
Likely partners: states (forestry), US Forest Service / US Dept of Agriculture, DRWI partners

Strategy H2.2 Promote the use of best management practices by local partners for the health and sustainability of forests, including:

- □ Forest conservation plans
- □ Riparian corridor management/protections (including streams, wetlands, and floodplains) management/protection
- □ Incentive programs
- □ R&D to develop new tactics for increasing forest resilience and ecosystem services (including water filtration/infiltration)

Proposed focus: riparian areas and large forested areas in headwaters
Likely partners: states (forestry), US Forest Service / US Dept of Agriculture, DRWI partners

Strategy H2.3 Protect forests through:

- □ Land acquisition and stewardship
- □ Education and outreach
- □ Utilizing the regulatory framework

Proposed focus: forests of high value for water filtration, using ecosystem service values to educate/motivate
Likely partners: states (forestry), US Forest Service / US Dept of Agriculture, DRWI partners

Goal H3: Increase and Improve Fish and Shellfish Habitat

Objectives:

- ***Measure and improve shellfish abundance and oyster productivity***
- ***Measure and improve habitat for fish and crabs***

Strategy H3.1 Inventory, map, and enhance habitat critical for fish and crabs including:

- □ Assessing benthic and SAV habitat (building on Delaware Estuary Benthic Inventory)
- □ Restoring fish passage

- □ Creating/sustaining reef habitats
- □ Research on sturgeon spawning habitat

Proposed focus: habitats/conditions specific to the above

Likely partners: states, EPA, American Rivers, University of Delaware Water Resources Agency, PDE

Strategy H3.2 Restore oyster beds and productivity in and around Delaware Bay through:

- □ Living shorelines
- □ Aquaculture
- □ Shell planting and bed management
- □ Shell recycling
- □ Promoting Delaware Bay Oysters

Proposed focus: areas/audiences specific to the above

Likely partners: Delaware Bay Oyster Restoration Task Force (includes PDE, states, Rutgers)

Strategy H3.3 Restore and manage mussel populations for water quality, through:

- □ Implementation of the Freshwater Mussel Recovery Program
- □ DELSI tactics employing mussels (fresh and ribbed)

Proposed focus: freshwater streams, shorelines

Likely partners: PDE, PWD, Academy of Natural Science

Strategy H3.4 Protect and restore horseshoe crab habitat through:

- □ Beach habitat restoration
- □ Volunteer stewardship (sanctuary communities, flipping & counting programs)
- □ Telling the story (plush toy)

Proposed focus: beaches and communities around the Delaware Bay

Likely partners: PDE, American Littoral Society (ALS), Ecological Research Design Group (ERDG), states, US Fish & Wildlife Service (USFWS)

Strategy H3.5 Coordinate management of rare, endangered, invasive or otherwise important species through species management plans, including

- □ Cumulative impacts (impingement/entrainment)
- □ Contingency planning (Zebra mussel)
- □ Using models, research, ecosystem services evaluations, and removing barriers
- □ Shad propagation

Proposed focus: key needs of specific species/issues

Likely partners: states, USFWS, PWD, PDE

CCMP Core Elements

A First Draft of Strategies for the Revised Comprehensive Conservation and Management Plan for the Delaware Estuary

Clean Water

Goal W1: Reduce Toxic[i] Pollution and Its Impacts

Objectives:

- ***Measure reductions of toxins in fish tissue and sediment***
- ***Measure reductions of toxic discharges (PCBs at least)***
- ***Estimate reductions of toxic/PCB loads (point and non-point sources)?***
- ***Track/reduce spills?***

Strategy W1.1 Conduct outreach and technical assistance programs to reduce non-point sources of toxins and other hazardous substances, including:

- □ Storm drain marking
- □ Household (and Farm) Hazardous Waste education and collection
- □ Boater and marina education
- □ Pharmaceutical and PCP education and take-back
- □ River Cleanups and other plastic debris reduction (Trash Free Waters)
- □ Road & vehicle maintenance (oil, salt)

Proposed focus: relevant target audiences for each

Likely partners:[ii] PDE (Partnership for the Delaware Estuary), Phildelphia Water Department (PWD), states, DRBC (Delaware River Basin Commission), EPA (Environmental Protection Agency)

Strategy W1.2 Accelerate the cleanup/stabilization of contaminated sites and sediments by:

- □ Leveraging private sector resources
- □ Promoting/using Best Management Practices
- □ Employing the best available technology and a watershed approach (WATAR)

Proposed focus: brownfields and contaminated sites (Superfund)

Likely partners: states, EPA

Strategy W1.3 Coordinate regional management of toxins for reduction over time utilizing the regulatory framework

Proposed focus: PCBs especially; chlorinated pesticides and other legacy contaminants as well

Likely partners: DRBC, states

Strategy W1.4 Prevent and reduce impacts from toxins and other hazardous substances by doing and utilizing research, development (R&D) and monitoring (including biological monitoring)

Proposed focus: pharmaceuticals, personal care products, microplastics, legacy contaminants

Likely partners: DRBC, states

Strategy W1.5 Prevent harmful impacts to people through continued monitoring and improved communication about fish and shellfish consumption, including:

- □ Monitoring of toxins in fish
- □ Shellfish sanitation
- □ Consumption advisories
- □ Education and messaging to clarify and reach diverse audiences

Proposed focus: sensitive areas and populations

Likely partners: DRBC, states, PDE

Strategy W1.6 Implement key recommendations of the Delaware River and Bay Oil Spill Advisory Committee and sustain/enhance early warning systems

Proposed focus: actions to prevent/reduce/minimize impacts from spills

Likely partners: US Coast Guard Local Area Committee, Delaware River Coop, DRBC, PWD

Goal W2: Reduce Nutrient Pollution and Its Impacts

Objectives:

- ***Measure increases in dissolved oxygen in the Estuary***
- ***Measure increases in ecosystem health in the Estuary***
- ***Measure decreases in nutrients in tributaries?***

Strategy W2.1 Promote the use of Best Management Practices (BMPs) to reduce nutrients from stormwater and agricultural runoff (non point source), including:

- □ Low-impact land management/preservation/restoration (including use of native species)
- □ Riparian corridors (including streams, wetlands, and floodplains)
- □ Nature based tactics for stormwater management (*Green City, Clean Waters* techniques)
- □ Agriculture BMPs

Proposed focus: building capacity of sub-watershed partnerships, schools, and companies, for using and promoting these practices, including through demonstration sites

Likely partners: PDE, states, subwatershed collaboration partners (Schuylkill Action Network, Delaware River Watershed Initiative (DRWI) clusters, South Jersey Bayshore Council, Christina Basin Task Force)

Strategy W2.2 Promote land use planning by local municipalities to prevent/reduce stormwater runoff (non point source), including:

- □ Low-impact development (compact, redevelopment) and land management/preservation (including use of native species)
- □ Nature based tactics (including riparian corridors: streams, wetlands, and floodplains) for stormwater management
- □ Erosion, sediment and post-construction stormwater controls

Proposed focus: building capacity in MS4 communities for using and promoting these practices, including through demonstration sites and signage

Likely Partners: PDE, DVRPC, Association of New Jersey Environmental Commissioners, League of Municipalities, Sustainable Jersey, Delaware Valley Coastal Zone Task Force, County Planning Depts, states

Strategy W2.3 Promote and incentivize traditional and innovative infrastructure improvements to reduce nutrients from wastewater discharges, including:

- □ *Green City, Clean Waters* tools & techniques (in Philadelphia and beyond)
- □ R&D of reduction and mitigation technologies (s.a. mussels)
- □ New management approaches (like regionalization, where it makes sense)
- □ New/increased sources of funding for water infrastructure

Proposed focus: places most impacted by discharges

Likely partners: PWD, DRBC, PDE, Water Resources Association of the Delaware River Basin

Strategy W2.4 Provide outreach and information to homeowners for changing behavior to reduce non-point sources of nutrients, including:

- □ Septic system maintenance
- □ Fertilizer use (Liveable Lawns)
- □ Dog waste management
- □ BMPs to filter stormwater (rain gardens, rain barrels, native plants)

Proposed focus: relevant target audiences for each

Likely partners: PDE, PWD, states

Strategy W2.5 Conduct research on nutrient impacts and dissolved oxygen needs for biological/ecological endpoints

Proposed focus on nutrient impacts related to dissolved oxygen and other factors (s.a. ammonia, nitrogen/phosphorous ratios)

Likely partners: PDE, DRBC, states

Goal W3: Sustain Flow for Drinking Water and Ecosystems

Objectives:

- ***Achieve and maintain flow at key locations for the protection of downstream water users***[iii]
- ***Develop and begin measuring flow/salinity for shellfish and wetlands***

Strategy W3.1 Promote water conservation by utilities through the use of:

- □ Conservation rate structures
- □ Retrofitting
- □ Conjunctive use
- □ Integrated resources plans
- □ Other conservation techniques

Proposed focus: utilities in priority areas (PRM, Triassic, K-C aquifers, groundwater protection areas, areas with stream diminution problems)

Likely partners: DRBC, PWD, states

Strategy W3.2 Promote water conservation and infiltration by residential and commercial users and communities through outreach and technical assistance on Best Management Practices, including:

- □ Reuse (Rain Barrels)
- □ Stormwater infiltration BMPs (rain gardens, berms/trenches, native trees/plants)
- □ Flow restoration (dam removal, floodplain restoration)
- □ Agriculture and irrigation BMPs

Proposed focus: users in priority areas (PRM, Triassic, K-C aquifers, groundwater protection areas, areas with stream diminution problems)
Likely partners: PDE, states

Strategy W3.3 Work with states, DRBC and decree parties to adaptively manage main-stem Delaware River flows to meet needs of the Estuary.

Proposed focus: research on salinity and ecological endpoints, taking climate change and sea level rise into account; coordination with states, DRBC and decree parties
Likely partners: DRBC, states, decree parties

Strategy W3.4 Implement the Regional Sediment Management Plan

Proposed focus: actions that prevent sediment accumulation in unwanted places (for flow, access, toxins) and promote sediment accumulation in beneficial places (for wetlands)
Likely partners: US Army Corps, states, DRBC, PDE

Strategy W3.5 Conduct research on salinity impacts and flow needs for biological/ecological endpoints

Proposed focus: the interaction of flow and salinity in the tidal estuary through various impacts including but not limited to flow (volume, force, function)
Likely partners: PDE, DRBC

[i] Working on improving language
[ii] Partners identified in this document are not exclusive lists
[iii] Working on improving language

APPENDIX B: WORKSHOP PARTICIPANTS

Prefix	First Name	Last Name	Organization, Agency, or Company	Workshop Attended
Ms.	Kelly	Anderson	Philadelphia Water Department	Clean Waters
Ms.	Sarah	Bouboulis	PDE	Strong Communities
Mr.	Gregory	Breese	US Fish & Wildlife Service	Healthy Habitats
Mr.	Kurt	Cheng	Partnership for the Delaware Estuary	Healthy Habitats
Mrs.	Kaitlin	Collins	Partnership for the Delaware Estuary	Strong Communities
Mr.	Greg	Czarnecki	PA Dept. of Conservation and Natural Resources	Healthy Habitats
Ms.	Rachel	Dawson	National Fish and Wildlife Foundation	Healthy Habitats
Mr.	Justin	Dennis	New Jersey Conservation Foundation	Clean Waters
Dr.	Thomas	Fikslin	Delaware River Basin Commission	Clean Waters
Ms.	Beth	Garcia	EPA	Clean Waters
Ms.	LeeAnn	Haaf	Partnership for the Delaware Estuary	Healthy Habitats
Mrs.	Karen	Holm	Delaware County Planning Dept.	Strong Communities
Mr.	Douglas	Janiec	Sovereign Consulting Inc.	Healthy Habitats
Mr.	John	Kennel	DNREC	Strong Communities, Healthy Habitats, Clean Waters
Mr.	Matthew	Konfirst	EPA	Strong Communities, Clean Waters
Dr.	Danielle	Kreeger	Partnership for the Delaware Estuary	Healthy Habitats
Ms.	Kimberly	Long	Exelon Corporation	Healthy Habitats
Mrs.	Megan	Mackey	US EPA	Strong Communities, Healthy Habitats, Clean Waters
Mr.	Sebastian	Malter	Philadelphia Water Department	Clean Waters
Mrs.	Rhonda	Manning	PADEP	Healthy Habitats, Clean Waters
Dr.	Tom	McKenna	University of Delaware	Strong Communities
Mr.	Joshua	Moody	Partnership for the Delaware Estuary	Clean Waters
Dr.	Kenneth	Najjar	DRBC	Healthy Habitats
Ms.	Esther	Nelson	USEPA, Region 2	Clean Waters
Mrs.	Angela	Padeletti	Partnership for the DE Estuary	Clean Waters
Dr.	Kurt	Philipp	Wetlands Research Services	Healthy Habitats
Mr.	Chad	Pindar	DRBC	Clean Waters
Ms.	Regina	Poeske	USEPA Region 3	Healthy Habitats
Mr.	Will	Price	Pinchot Institute	Healthy Habitats
Ms.	Irene	Purdy	US EPA	Clean Waters
Mrs.	Kristin	Regan	EPA R3	Healthy Habitats
Mr.	Alexandre	Remnek	US EPA Region 2	Clean Waters

Prefix	First Name	Last Name	Organization, Agency, or Company	Workshop Attended
Ms.	Nora	Reynolds	First State National Historical Park	Healthy Habitats
Dr.	Jessica	Rittler Sanchez	Delaware River Basin Commission	Strong Communities
Ms.	Julia	Rockwell	Philadelphia Water Department	Clean Waters
Mrs.	Alison	Rogerson	DNREC Wetland Monitoring and Assessment	Healthy Habitats
Dr.	Robert	Scarborough	DNREC/DCP	Healthy Habitats
Ms.	Amy	Shallcross	Delaware River Basin Commission	Clean Waters
Mr.	Joe	Sieber	PA DEP	Strong Communities
Ms.	Kelly	Somers	US EPA Region 3	Strong Communities, Healthy Habitats, Clean Waters
Mr.	Jay	Springer	NJDEP	Clean Waters
Ms.	Abby	Sullivan	Philadelphia Water Department	Clean Waters
Ms.	Carrie	Traver	USEPA Region 3	Healthy Habitats
Mr.	Brett	Wiley	NJDEP	Clean Waters
Mr.	Brian	Winslow	Delaware Nature Society	Strong Communities, Healthy Habitats
Ms.	Meghan	Wren	Bayshore Center	Strong Communities
Mr.	John	Yagecic	Delaware River Basin Commission	Clean Waters

APPENDIX C: WORKSHEET INSTRUCTIONS

HOW TO USE:

Review the draft CCMP strategies on the following pages. For each strategy, there are six columns for information. Two columns have been tentatively populated and four columns have been left blank. Workshop participants should:

1. React to/comment on the draft information provided in the first two columns.
2. Add "a," "b," or "c" in the remaining four columns.
3. Add notes to the worksheets for further discussion at the workshop.

Remember: consider the impact of the climate change stressor on CCMP strategies. Please refer to the following table while completing the worksheets:

Column	**What to consider**
Climate Stressor	Are the climate stressors identified for the strategy correct? Are any key climate stressors missing? Add missing stressors to the blank row provided.
Risk	Are the risks associated with the climate stressors correct? Are there other risks that will be incurred by the strategy?
Consequence (a-c)	Rank the effect that the risk would have on the associated strategy if it were to occur. - Use "a" if the consequence would be nonexistent, mild, or less disruptive than others, or if we could adjust the strategy to reduce its vulnerability. - Use "b" if you would anticipate moderate disruptions, or if, with adjustments, the strategy would still be attainable. - Use "c" if the consequence would cause a major disruption and make the strategy unattainable.
Likelihood (a-c)	Rank the likelihood of the risk occurring (i.e. probability). Determine how likely the risk is to affect the goal. - Use "a" if it is very unlikely, - Use "b" if it is more likely to occur than risks in the low category, - Use "c" if it is more likely to occur than risks in the medium category.
Spatial Extent of Impact (a-c)	What is the likely spatial extent of the impact? - Use "a" if it would impact strategies on the site level (e.g. few waterfront lots, a bridge, a sewage treatment plant) - Use "b" if it would impact a place or a region (e.g. community, harbor, state park, wildlife refuge, sub-watershed) - Use "c" if it would have extensive impacts (most of the watershed or most of the estuary)
Time Horizon (a-c)	What is the likely time horizon until the impact begins? High-impact problems already occurring need attention right away. - Use "a" if the impact is more than 30 years in the future - Use "b" if the impact is likely 10-30 years in the future - Use "c" if the impact is already occurring or will in the next 10 years

APPENDIX D: BREAK-OUT GROUP WORKSHEET RESULTS

Results of break-out group discussions are displayed in the worksheet format below. Please note that different break-out groups approached ideas differently, and that information recorded on the tables below represent amalgamations of results rather than full-group consensus. Where possible, however, the answers recorded were approved of by the full break-out group.

TABLE 5: GOAL H1: PREVENT WETLAND LOSS - H1.1

Goal H1: Prevent Wetland Loss - H1.1						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H1.1 Establish clear baselines for wetland conditions and track changes over time	Warmer Summers	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements; could impact fieldwork schedule	a	b	c	c
	Warmer Winters	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements; could impact fieldwork schedule	a	b	c	c
	Increasing Drought	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements	a	b	c	c
	Increasing Storminess	Increasing storminess could impact the number of field days available for monitoring work.	a	b	c	c
	Sea Level Rise	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements	b	b	c	c
	Salinity Change	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements	b	b	c	c

TABLE 6: GOAL H1: PREVENT WETLAND LOSS - H1.2

Goal H1: Prevent Wetland Loss - H1.2						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H1.2 Restore and manage wetlands for maximum health and resilience	Warmer Summers	Shifts in community species composition	b	a	c	c
	Warmer Winters	Shifts in community species composition; may protect by reducing impacts of ice; may prolong growing season	a/b	a	c	c
	Warmer Water	May impact bivalve shellfish integral to wetland health	a	a	b	c
	Increasing Drought	May impact flow and salt line	a/b	a	c/b	c
	Increasing Storminess	Can harm wetlands	b	a	c	c
	Sea Level Rise	Wetlands that can't keep pace will drown; may introduce saltwater into freshwater wetlands	a/b	a	b	c
	Ocean Acidification	May impact bivalve shellfish integral to wetland health/chemistry	Uncertain	a	b	b
	Salinity Change	Shifts in community species composition	b	a	b	c

TABLE 7: GOAL H1: PREVENT WETLAND LOSS - H1.3

Goal H1: Prevent Wetland Loss - H1.3						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H1.3 Develop and implement living shoreline techniques to restore eroding shorelines, and build and protect wetlands, infrastructure, and other key resources	Warmer Summers	Shifts in community species composition in wetlands themselves will need to be reflected in installations	a	a	c	c
	Warmer Winters	See above; also, may aid in protecting certain installations by reducing impacts of ice; may prolong the growing season	a	a	c	c
	Warmer Water	May impact bivalve shellfish integral to the installation	a	a	b	c
	Increasing Drought	May impact flow and salt line; desiccation of marsh sediment	b	a	c	c
	Increasing Storminess	Can damage installations	b	a	c	c
	Sea Level Rise	Wetlands that can't keep pace will drown; may introduce saltwater into freshwater wetlands	b	a	b	c

TABLE 8: GOAL H1: PREVENT WETLAND LOSS - H1.4

Goal H1: Prevent Wetland Loss - H1.4						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H1.4 Protect non-tidal wetlands	Warmer Summers	Shifts in community species composition	a	a	c	c
	Warmer Winters	Shifts in community species composition; may prolong growing season	a	a	c	c
	Warmer Water	Will impact species composition	a	a	b	c
	Increasing Drought	May degrade/ disappear, desiccation	b	a	c	c
	Increasing Storminess	Can introduce salt water due to storm surge and increased energy - sediment and nutrients	b	a	c	c
	Sea Level Rise	Can introduce salt water due to storm surge and salt line move and levels	b	a	b	c

TABLE 9: GOAL H2: STEM FOREST LOSS - H2.1

Goal H2: Stem Forest Loss - H2.1						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H2.1 Establish clear baselines for forest health, loss/causes, connectedness, and priority forest for water resources protection	Warmer Summers	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements; could impact fieldwork schedule	a/b	a/b/c	c	c
	Warmer Winters	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements; could impact fieldwork schedule; greater possibility of disease	a/b	a/b/c	c	c
	Increasing Drought	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements	a/b	a/b/c	c	c
	Increasing Storminess	Rain events causing significant damage, flooded grounds, high winds could impede fieldwork	a	b	c	c
	Sea Level Rise	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements	a/b	a/b/c	c	c
	Salinity Change	Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements	a/b	a/b/c	c	c
	Seasonal Uncertainty	Frost damage; Could impact the results of baselines and long-term tracking through (abnormal) monitoring measurements	a/b	a/b/c	c	c

TABLE 10: GOAL H2: STEM FOREST LOSS - H2.2

Goal H2: Stem Forest Loss - H2.2						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H2.2 Promote the use of BMPs by local partners for the health and sustainability of forests	Warmer Summers	Implementation of BMPs (due to plantings, invasive species management, harvesting frequency/intensity, riparian corridor management) could change	b	c	c	c
	Warmer Winters	Implementation of BMPs could change	b	c	c	c
	Increasing Drought	Implementation of BMPs could change	b	c	c	c
	Increasing Storminess	Implementation of BMPs could change	b	c	c	c
	Sea Level Rise	Implementation of BMPs could change	b	c	c	c
	Salinity Change	Implementation of BMPs could change	b	c	c	c

TABLE 11: GOAL H2: STEM FOREST LOSS - H2.3

Goal H2: Stem Forest Loss - H2.3						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H2.3 Protect forests through land acquisition and stewardship, education and outreach, utilizing the regulatory framework	*Warmer Summers*	Could create changes in the land that is being acquired; land may no longer meet articulated priorities and risk is that you're protecting the wrong place	a	b/a	b	Uncertain
	Warmer Winters	Could create changes in the land that is being acquired; land may no longer meet articulated priorities and risk is that you're protecting the wrong place	a	b/a	b	Uncertain
	Increasing Drought	Could create changes in the land that is being acquired; land may no longer meet articulated priorities and risk is that you're protecting the wrong place	a	b/a	b	Uncertain
	Sea Level Rise	Could create changes in the land that is being acquired; land may no longer meet articulated priorities and risk is that you're protecting the wrong place	a	b/a	b	Uncertain
	Salinity Change	Could create changes in the land that is being acquired; land may no longer meet articulated priorities and risk is that you're protecting the wrong place	a	b/a	b	Uncertain

TABLE 12: GOAL H3: INCREASE AND IMPROVE FISH AND SHELLFISH HABITAT - H3.1

Goal H3: Increase and improve fish and shellfish habitat - H3.1						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H3.1 Inventory, map, and enhance habitat critical for fish and crabs	*Warmer Summers*	Lower dissolved oxygen will bias assessments and impact enhancement placement; more frequent assessments and inventories will be necessary (leading to greater costs); changes habitat baseline	a	c	c	c
	Warmer Winters	Lengthens fieldwork season; growing season may alter baseline	a	c	c	c
	Warmer Water	Lower dissolved oxygen; earlier spawn; restoration/enhancement season shortened (shifts the timing of species migration); shifts food; species range could shift; passage created in the past won't take fish where they need to go	b	c	c	c
	Increasing Drought	Higher salinity; spatial extent will change; will impact species especially in non-tidal environments	b	c	c	c
	Increasing Storminess	Changes habitat baseline; will determine whether or not SAV is present; creates flood risks; will impact fish and horseshoe crab spawning	b	c	c	c
	Sea Level Rise	Changes to baseline; new opportunities for benthic habitat; tide gates will be impacted; freshwater impoundments at risk	b	c	c	c
	Salinity Change	Will shift where species go; will create changes in spawning habitat; manmade salt barriers will impact fish passage	b	c	c	c

TABLE 13: GOAL H3: INCREASE AND IMPROVE FISH AND SHELLFISH HABITAT - H3.2

Goal H3: Increase and improve fish and shellfish habitat - H3.2						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H3.2 Restore oyster beds and productivity in and around Delaware Bay	*Warmer Summers*	Will change water temperature and flow, making oysters more susceptible to disease; a greater number of high heat days will impact fieldwork	a	c	b	c
	Warmer Winters	Higher flows may create salinity balance issues and shift range	a	c	b	c
	Warmer Water	May be impacts to food sources; counterproductive to commercial interests (shorter harvest, shrinking area); can make oysters more susceptible to disease	a	c	b	c
	Increasing Drought	May change flow (temperature and salinity), making oysters more susceptible to disease	a	c	b	c
	Increasing Storminess	Flooding from storms can impact oyster beds; Storms will impact days available for fieldwork; more difficult for aquaculture and to harvest commercially; would need to design hybrid living shorelines for greater energy	a	c	b	c
	Sea Level Rise	Will create a shift in geography; may have difficulty keeping pace and will fall deeper in the water column, creating food challenges; turbidity (as a result of SLR impact on marshes) will also impact food	a	c	b	c
	Ocean Acidification	Impacts to spat	a	b	b	b
	Salinity Change	Will reduce or shift range; increase susceptibility to disease; may create an opportunity in tributaries and intertidal areas	a	c	b	c

TABLE 14: GOAL H3: INCREASE AND IMPROVE FISH AND SHELLFISH HABITAT - H3.3

Goal H3: Increase and improve fish and shellfish Habitat - H3.3						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H3.3 Restore and manage mussel populations for water quality	*Warmer Summers*	Will shift timing for glochidia release; will impact food sources; will create species shifts	a	a	c	c
	Warmer Winters	Will likely be correlated with lower flows, impacting water temperature and creating a shift or loss in host fish species	a	a	c	c
	Warmer Water	Will reduce dissolved oxygen; will create a shift or loss in host fish species	b	b	b	c
	Increasing Drought	Will result in a loss of habitat and additional predation	b	b	c	c
	Increasing Storminess	May change where habitat is appropriate for restoration; limits fieldwork during and immediately after; increases erosion, reduces habitat, impacts restoration efforts	b	c	c	c
	Sea Level Rise	May create a species shift due to salinity change; will erode habitat for ribbed mussels	b	c	b	c
	Ocean Acidification	May impact ribbed mussel larvae	a	a	b	b
	Salinity Change	Fluctuations in salinity may create a barren zone; may otherwise alter geography	b	b	b	c

TABLE 15: GOAL H3: INCREASE AND IMPROVE FISH AND SHELLFISH HABITAT - H3.4

Goal H3: Increase and improve fish and shellfish habitat - H3.4						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H3.4 Protect and restore horseshoe crab habitat	*Warmer Water*	Will lead to earlier spawn; will impact food	b	a	b	c
	Increasing Storminess	Will erode horseshoe crab habitat; will impact days available for volunteer activity; will reduce spawning events	b	c	b	c
	Sea Level Rise	Will erode and submerge horseshoe crab spawning habitat	b	c	b	c
	Salinity Change	Spawning range may shift	a	a	b	c

TABLE 16: GOAL H3: INCREASE AND IMPROVE FISH AND SHELLFISH HABITAT - H3.5

Goal H3: Increase and improve fish and shellfish Habitat - H3.5						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
H3.5 Coordinate management of rare, endangered, and invasive species through species management plans	No risks for this strategy were identified; coordination will occur regardless of climate change impacts.					

TABLE 17: GOAL C1: INCREASE COMMUNITY RESILIENCE AND ACCESS - C1.1

Goal C1: Increase Community Resilience and Access - C1.1						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impac (a-c)**	**Time Horizon (a-c)**
C1.1 Restore working waterfronts	Warmer Summers	Increased risk of asthma for working in urban areas; increased risk of heat fatigue; fewer field work days	a	a	c	c
	Warmer Winters	Insects and invasives worsened; more opportunity for fieldwork days	a	a	c	c
	Warmer Water	Moving target if species composition changes due to habitat change; species shift could impact local industry; difficulties with algal blooms	a	a/b	c	c
	Increasing Drought	May create difficulties working on boats in channels that have not been dredged if flow is not as high as anticipated	b	b	c	c
	Increasing Storminess	May lose working days due to storms; waterfronts could sustain damage due to storm surge; erosion of tidal wetlands leads to diminished fish populations for harvest will impact local industry	b	c	c	c
	Sea Level Rise	May lose waterfronts over time; could create water supply impacts	b	c	c	c
	Ocean Acidification	Impact on oysters could have repercussions for local industry	a	?	b	c
	Salinity Change	Species shift could impact local industry; could impact restoration efforts; could impact water supply	b	b	b/c	c

TABLE 18: GOAL C1: INCREASE COMMUNITY RESILIENCE AND ACCESS - C1.2

Goal C1: Increase Community Resilience and Access - C1.2						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C1.2 Provide tools and technical assistance to waterfront communities & partners to improve economic and environmental resilience	Warmer Summers	Will impact the demand for technical assistance and the types of tools used. Warmer summers may impact on-site fieldwork.	a	b	a/b/c	c
	Warmer Winters	The number of field days may increase. Insects/invasives can impact fieldwork and species composition. If warmer winters lead to less snow, there could be access issues due to lower flows.	a	b	a/b/c	c
	Warmer Water	Could create access issues if there are algal blooms.	a	b	a/b/c	c
	Increasing Drought	Creates an opportunity if the issue is visible.	a	b	a/b/c	c
	Increasing Storminess	Could create access issues because of flooding. Water quality issues associated with flooding could impact water-based economies and fieldwork.	a/b	b	a/b/c	c
	Sea Level Rise	Could create access issues.	a/b	b	a/b/c	c
	Salinity Change	Will impact the types of tools used.	a	b	a/b/c	c

TABLE 19: GOAL C1: INCREASE COMMUNITY RESILIENCE AND ACCESS - C1.3

Goal C1: Increase Community Resilience and Access - C1.3						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C1.3 Protect and restore natural areas and public access, including (where appropriate) infrastructure like trails, boardwalks, piers, parking, restrooms, etc. for public access	Warmer Summers	May impact natural areas (shift in species composition; invasives); will impact days available for fieldwork; materials degrade faster	b	b	a/b/c	c
	Warmer Winters	May impact natural areas (shift in species composition; invasives); will impact days available for fieldwork	a	b	a/b/c	c
	Warmer Water	May impact natural areas	a	b	a/b/c	c
	Increasing Drought	May impact natural areas; may impact structural integrity (submerged vs. not submerged)	a	a	a/b/c	c
	Increasing Storminess	May damage infrastructure and access points over time; will impact days available for fieldwork	b	b	a/b/c	c
	Sea Level Rise	May damage/submerge infrastructure and access points over time; will impact fieldwork	b	b	a/b/c	c
	Ocean Acidification	May create a shift in species composition in natural areas	a	a	a/b/c	c
	Salinity Change	May create a shift in species composition in natural areas	b	b	a/b/c	c

TABLE 20: GOAL C1: INCREASE COMMUNITY RESILIENCE AND ACCESS - C1.4

Goal C1: Increase Community Resilience and Access - C1.4						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C1.4 Utilize natural areas and waterfronts as opportunities for connecting people to the Delaware Estuary	Warmer Summers	Could decrease opportunities due to increased number of high heat days	b	b	c	c
	Warmer Winters	May extend the season for recreational opportunities; more insects that may impact fieldwork	a	a	c	c
	Warmer Water	May increase the possibility of harmful algal blooms, impacting recreational use of water; could change the range of fish and crabs which impacts fishing	b	b	c	c
	Increasing Drought	May impact natural areas; not enough flow, boats get stuck	a	a	a	c
	Increasing Storminess	May damage waterfronts and natural areas; could reduce the number of days that the public has access to the water due to storm days and post-storm conditions; could damage signage and safety infrastructure	b	b	c	c
	Sea Level Rise	May lose waterfronts and coastal natural areas over time; may lose access to these points	b	c	b	c
	Salinity Change	May impact natural areas; fish and plant communities may change	a	a	c	c

TABLE 21: GOAL C2: IMPROVE PUBLIC AWARENESS AND STAKEHOLDER ENGAGEMENT - C2.1

Goal C2: Improve Public Awareness and Stakeholder Engagement - C2.1						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C2.1 Employ marketing & mass communications to build awareness and affinity, and provide access to information	No Risks					

TABLE 22: GOAL C2: IMPROVE PUBLIC AWARENESS AND STAKEHOLDER ENGAGEMENT - C2.2

Goal C2: Improve Public Awareness and Stakeholder Engagement - C2.2						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C2.2 Hold events to build awareness and affinity and engage new people	Warmer Summers	Increasing high heat days may limit days available for these experiences	a	a	a/b	c
	Increasing Storminess	Increasing storminess may limit days available for these experiences	a	a/b	c	c
	Sea Level Rise	Affects ability to access events	a	b	a	c
	Change in air quality	Could result in less people wanting to participate/attend events, limits days available for experiences	a	a/b	a	b/c

TABLE 23: GOAL C2: IMPROVE PUBLIC AWARENESS AND STAKEHOLDER ENGAGEMENT - C2.3

Goal C2: Improve Public Awareness and Stakeholder Engagement - C2.3						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C2.3 Develop and promote programs that engage teachers and schools in stewardship of the Estuary	Warmer Summers	Increasing high heat days may limit days available for these experiences	a	a	a	n/a
	Increasing Storminess	Increasing storminess may limit days available for these experiences	a	a	a	n/a
	Sea Level Rise	May impact areas that would be used for experiential learning	a	a	a	n/a

TABLE 24: GOAL C2: IMPROVE PUBLIC AWARENESS AND STAKEHOLDER ENGAGEMENT - C2.4

Goal C2: Improve Public Awareness and Stakeholder Engagement - C2.4						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C2.4 Develop and promote programs with local communities and partners that foster volunteer stewardship and experiential learning	Warmer Summers	Increasing high heat days may limit days available for these experiences	a	a	a	c
	Increasing Storminess	Increasing storminess may limit days available for these experiences	a	a	a	c
	Sea Level Rise	May impact areas that would be used for experiential learning	a	a	a	c

TABLE 25: GOAL C2: IMPROVE PUBLIC AWARENESS AND STAKEHOLDER ENGAGEMENT - C2.5

Goal C2: Improve Public Awareness and Stakeholder Engagement - C2.5						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C2.5 Publish and share outreach materials and scientific results	No Risks					

TABLE 26: GOAL C2: IMPROVE PUBLIC AWARENESS AND STAKEHOLDER ENGAGEMENT - C2.6

Goal C2: Improve Public Awareness and Stakeholder Engagement - C2.6						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C2.6 Engage key stakeholders to coordinate science and management of the Estuary through regular meetings and communication	No Risks					

TABLE 27: GOAL C2: IMPROVE PUBLIC AWARENESS AND STAKEHOLDER ENGAGEMENT - C2.7

Goal C2: Improve Public Awareness and Stakeholder Engagement - C2.7						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
C2.7 Assess impacts of outreach	No Risks					

TABLE 28: GOAL W1: REDUCE TOXIC POLLUTION AND ITS IMPACTS - W1.1

Goal W1: Reduce Toxic Pollution and Its Impacts - W1.1						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W1.1 Conduct outreach and technical assistance programs to reduce non-point source of toxins and other hazardous substances	Warmer Summers	Increased number of high heat days may impact the days available for activities like storm drain marking and river cleanups	a	a	c	c
	Increasing Storminess	May impact the days available for activities like storm drain marking and river cleanups	a	a	c	c

TABLE 29: GOAL W1: REDUCE TOXIC POLLUTION AND ITS IMPACTS - W1.2

Goal W1: Reduce Toxic Pollution and Its Impacts - W1.2						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W1.2 Accelerate the cleanup/stabilization of contaminated sites and sediments	Warmer Summers	May increase the risk of asthma for working in urban areas; increased number of high heat days will impact days available for work	a	c	c	c
	Increasing Storminess	May limit number of days for work at toxic sites; can make spills more difficult to contain	b	b	c	c
	Sea Level Rise	If a site becomes permanently inundated there is no opportunity to fulfill this strategy. Dredging would be conducted less frequently with more navigational depth	b/c	c	b	c

TABLE 30: GOAL W1: REDUCE TOXIC POLLUTION AND ITS IMPACTS - W1.3

Goal W1: Reduce Toxic Pollution and Its Impacts - W1.3						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W1.3 Coordinate regional management of toxins for reduction over time utilizing the regulatory framework	Increasing Storminess	Businesses and offices may close due to severe weather events and be unable to fulfill coordination initiatives	a	a	c	c

TABLE 31: GOAL W1: REDUCE TOXIC POLLUTION AND ITS IMPACTS - W1.4

Goal W1: Reduce Toxic Pollution and Its Impacts - W1.4						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W1.4 Prevent and reduce impacts from toxins and other hazardous substances by doing and utilizing research, development, and monitoring (including biological monitoring)	Warmer Summers	Increased number of high heat days may limit days available for monitoring	a	a	c	c
	Warmer Water	Change in resources/monitoring	a/b	b	c	b/c
	Increasing Drought	Change in resources/monitoring	a/b	b	c	b/c
	Increasing Storminess	May disturb installations and monitoring equipment, as well as limit times available for monitoring	a	a	c	c
	Sea Level Rise	Change in resources/monitoring	a/b	b	c	b/c

TABLE 32: GOAL W1: REDUCE TOXIC POLLUTION AND ITS IMPACTS - W1.5

Goal W1: Reduce Toxic Pollution and Its Impacts - W1.5						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W1.5 Prevent harmful impacts to people through continued monitoring and improved communication about fish and shellfish consumption	Warmer Summers	May limit times available for monitoring	a	a	c	c
	Increasing Storminess	May disturb installations and monitoring equipment, as well as limit times available for monitoring	a	a	c	c

TABLE 33: GOAL W1: REDUCE TOXIC POLLUTION AND ITS IMPACTS - W1.6

Goal W1: Reduce Toxic Pollution and Its Impacts - W1.6						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W1.6 Implement key recommendation of the DRBOSAC and sustain/enhance early warning systems	Group did not feel sufficiently knowledgeable to respond to the vulnerability of this strategy.					

TABLE 34: GOAL W2: REDUCE NUTRIENT POLLUTION AND ITS IMPACTS - W2.1

Goal W2: Reduce Nutrient Pollution and Its Impacts - W2.1						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W2.1 Promote the use of BMPs to reduce nutrients from stormwater and agricultural runoff (non-point source)	No Risks					

TABLE 35: GOAL W2: REDUCE NUTRIENT POLLUTION AND ITS IMPACTS - W2.2

Goal W2: Reduce Nutrient Pollution and Its Impacts - W2.2						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W2.2 Promote land use planning by local municipalities to prevent/reduce stormwater runoff (non-point source)	No Risks					

TABLE 36: GOAL W2: REDUCE NUTRIENT POLLUTION AND ITS IMPACTS - W2.3

Goal W2: Reduce Nutrient Pollution and Its Impacts - W2.3						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W2.3 Promote and incentivize traditional and green/innovative infrastructure improvements to reduce nutrients from wastewater discharges	No Risks					

TABLE 37: GOAL W2: REDUCE NUTRIENT POLLUTION AND ITS IMPACTS - W2.4

Goal W2: Reduce Nutrient Pollution and Its Impacts - W2.4						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W2.4 Provide outreach and information to homeowners for changing behavior to reduce non-point sources of nutrients	No Risks					

TABLE 38: GOAL W2: REDUCE NUTRIENT POLLUTION AND ITS IMPACTS - W2.5

Goal W2: Reduce Nutrient Pollution and Its Impacts - W2.5						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W2.5 Conduct research on nutrient impacts and DO needs for biological/ecological endpoints	Warmer Summers	Increased number of high heat days may limit days available for research in the field; what one would study could change	b	b	c	c
	Warmer Winters	What one would study could change	b	b	c	c
	Warmer Water	What one would study could change	b	b	c	c
	Increasing Drought	May disturb installations and monitoring equipment; as well as limit times available for monitoring or modify monitoring program duration and frequency	b	b	c	c
	Increasing Storminess	May disturb installations and monitoring equipment; as well as limit times available for monitoring or modify monitoring program duration and frequency	b	b	c	c
	Sea Level Rise	May disturb installations and monitoring equipment; as well as limit times available for monitoring or modify monitoring program duration and frequency	b	b	c	c

TABLE 39: GOAL W3: SUSTAIN FLOW FOR DRINKING WATER AND ECOSYSTEMS - W3.1

Goal W3: Sustain Flow for Drinking Water and Ecosystems - W3.1						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W3.1 Promote water conservation by utilities through the use of conservation rate structures, retrofitting, conjunctive use, integrated resources plans, and other conservation techniques	Warmer Summers	Easier to convey a water conservation message	a	a	c	c
	Increasing Drought	Easier to convey a water conservation message; need to promote water conservation for a longer season/over a longer period of time	a/b	b	a/b/c	c
	Wetter Conditions	More difficult to convey a water conservation message	b	a/b	c	c

TABLE 40: GOAL W3: SUSTAIN FLOW FOR DRINKING WATER AND ECOSYSTEMS - W3.2

Goal W3: Sustain Flow for Drinking Water and Ecosystems - W3.2						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W3.2 Promote water conservation and infiltration by residential and commercial users and communities through outreach and technical assistance on BMPs	Warmer Summers	Increased number of high heat days may limit days available for BMP installation and maintenance	a	b	a/c	c
	Warmer Winters	Species composition may shift, which would change some plans	a	c	a/c	b/c
	Increasing Drought	Challenging to maintain certain BMPs; easier to convey a water conservation message; water table height impacts BMP feasibility	b	b	a/c	a/b
	Increasing Storminess	May disturb installations as well as limit times available for installations and maintenance	b	c	a/c	c
	Sea Level Rise	Impacts the height of the water table, impacts BMP feasibility	b	b/c	b	c
	Seasonal Irregularity	Affects season for days available to work in the field; impacts planning	a	b	a/c	c
	Wetter Conditions	More difficult to convey water conservation messaging	a	b	c	c

TABLE 41: GOAL W3: SUSTAIN FLOW FOR DRINKING WATER AND ECOSYSTEMS - W3.3

Goal W3: Sustain Flow for Drinking Water and Ecosystems - W3.3						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W3.3 Work with states, DRBC, and decree party to adaptively manage mainstem Delaware River flows to meet needs in the Estuary	No Risks					

TABLE 42: GOAL W3: SUSTAIN FLOW FOR DRINKING WATER AND ECOSYSTEMS - W3.4

Goal W3: Sustain Flow for Drinking Water and Ecosystems - W3.4						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W3.4 Implement the Regional Sediment Management Plan	Group did not feel sufficiently knowledgeable to respond to the vulnerability of this strategy.					

TABLE 43: GOAL W3: SUSTAIN FLOW FOR DRINKING WATER AND ECOSYSTEMS - W3.5

Goal W3: Sustain Flow for Drinking Water and Ecosystems - W3.5						
Organizational Strategies	**Climate Stressor**	**Risk**	**Consequence (a-c)**	**Likelihood (a-c)**	**Spatial Extent of Impact (a-c)**	**Time Horizon (a-c)**
W3.5 Conduct research on salinity impacts and flow needs for biological/ecological endpoints	Warmer Summers	Increased number of high heat days may limit days available for research in the field	a/b	c	c	c
	Warmer Winters	Opportunities for field work; impacts length of monitoring (issue for funding); can create inconsistency in data	b	b/c	c	c
	Warmer Water	Risk of algal blooms, oyster disease, and both of these impact monitoring.	b	c	b	c
	Increasing Drought	Frequency of data collection would need to change	b	a/b	c	c
	Increasing Storminess	May disturb monitoring equipment and samples, as well as limit times available for research and monitoring in the field	b	b	c	c
	Sea Level Rise	Frequency of data collection would need to change	a	a/b	a/b	b
	Seasonal Irregularity	Frequency of data collection would need to change	a/b	b/c	c	c