PREPARING FOR SEA LEVEL RISE
DEVELOPMENT OF AN ADAPTATION STRATEGY FOR THE STATE OF DELAWARE

Issue Characterization Workshop March 12, 2009

Tony Pratt

A summary, including completed issue characterizations, of the Sea Level Rise Issue Characterization Workshop held March 12, 2009.

Delaware Document Number 40-07-01/09/05/01

Workshop Purpose

The Sea Level Rise Issue Characterization Workshop, held on March 12, was the first step towards the development of a Sea Level Rise Adaptation Strategy for the State of Delaware. The purpose of the Sea Level Rise Issue Characterization Workshop was to raise awareness regarding potential sea level rise impacts in Delaware and to initiate dialogue about sea level rise with an initial group of stakeholders. The workshop was also designed to develop a list of sea level rise issues of concern and to have participants develop an initial set of issue descriptions in a standard written format.

About this Document

The Sea Level Rise Issue Characterization Workshop Summary presents a synopsis of workshop results and specific outcomes from each of four break-out group sessions:

- Economy and Community
- Habitat and Natural Resources
- Human Health and Public Welfare
- Infrastructure

It also contains the full text of Issue Characterization worksheets that were drafted by workshop participants. This information will provide a foundation for determining the priority issues for the sea level rise adaptation strategy.

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Preparing for Sea Level Rise: Development of an Adaptation Strategy for the State of Delaware

Issue Characterization Workshop

Sheraton Dover Hotel – Dover, Delaware

March 12th, 2009

Summary Document

May 2009

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Production of this document funded by Delaware's Experimental Program to Stimulate Competitive Research Delaware Department of Natural Resources and Environmental Control, Delaware Coastal Programs, pursuant to National Oceanic and Atmospheric Administration Award Number NA08NOA4190464

State of Delaware Document No. 40-07-01/09/05/01

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Introduction

Delaware's coast has played a significant role in the history, culture, and economy of the state. No part of the state is more than 8 miles from tidal waters and the state's geography is predominantly low-lying coastal plains. As a result, Delaware is highly susceptible to rising sea levels.

Any acceleration of sea level rise in Delaware may have significant impacts for our coastal communities. Potential impacts include: inundation of low lying coastal areas; increased extent and severity of flooding during storm events; increased coastal erosion during storm events; saltwater intrusion into groundwater supplies; and increased salinity in rivers and streams. Secondary impacts may include loss of recreational and economic resources; changes to habitat; and operation problems for wells, septic systems and sewage treatment facilities.

A Sea Level Rise Adaptation Plan is being developed to better evaluate and, when necessary, address these impacts. This statewide plan will include an analysis of the issues affecting Delaware and will provide recommendations to ensure that Delaware pro-actively plans for these effects. To initiate the development of this plan, a workshop was held to engage a focused group of likely sea level rise adaptation stakeholders in an issue identification process.

This document summarizes the results of the one-day workshop "Preparing for Sea Level Rise: Development of an Adaptation Strategy" held on March 12, 2009. It contains a description of the process used, summaries of breakout group discussions and full text of 46 Issue Characterization Worksheets completed by workshop participants.

This workshop represented the first time a focus group of stakeholders came together to discuss potential impacts of sea level rise statewide. Results from this workshop will be used as the basis for the formation of a coordination committee, technical working groups and research and monitoring projects. Many more opportunities for stakeholder engagement will be provided during the development of the Sea Level Rise Adaptation Plan.

Background

A wide array of scientific research and information indicates that there are many likely impacts of changing global climate, one of which is sea level rise. For centuries, sea level rise has affected and will continue to affect all coastal regions of the United States.

Increasing sea levels are caused by "thermal expansion" and the melting of polar ice caps. As temperatures rise, water occupies more space; this is known as thermal expansion. In addition to the volume of the ocean increasing, land in the Mid-Atlantic is actually sinking as a result of geologic changes. This is known as "subsidence." Thermal expansion, melting of the polar ice caps and subsidence all combine to contribute to relative sea level rise.

Observations in the history of the Earth's climate, geography, geology and evolution have lead to theories that sea level has been highly variable over time. Approximately 130,000 years ago when global temperatures were much higher than present average, global sea level was about 5 meters higher than it is today. About 20,000 years ago, global temperatures were apparently much lower than present. At this time sea level was about 120 meters lower than present. Particularly along the Atlantic (e.g. Delaware Coast) and Gulf coasts, regional and local

subsidences are likely contributors to the sea level rise phenomenon.

A historic rate of sea level rise in Lewes, Delaware has shown a 1.05 foot rise between the years 1919 and 2006. The mean sea level trend is 3.20 millimeters per year. Other gauges in the region have show similar rates of sea level rise; 3.44 millimeters per year in Annapolis, Maryland and 3.90 millimeters per year in Sandy Hook, New Jersey. This rate is expected to increase due to climate change and accompanying melting of the Greenland and West Antarctic ice sheets.

To address issues pertaining to climate change, several committees have been convened within the past 2 decades, to study the causes and effects of climate change and sea level rise and to study potential adaptation and mitigation measures. The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental organization that was established for the purpose of providing decision-makers and other interested parties with an objective source of information about climate change. The IPCC aims to assess scientific information obtained from experts from all regions of the world and their relevant disciplines. The IPCC has the ability to provide scientific technical and socio-economic information on climate change, along with options for adaptation and mitigation, in a policy-relevant yet policy neutral way to decision makers. Similarly, Climate Change Science Program (CCSP), sponsored by thirteen federal agencies in the U.S., integrates federal research on climate and global change.

In 2007, the IPCC projected that global sea level will likely rise between 19 and 59 centimeters (7 and 23 inches) by the end of the century. Recent research that is taking into account the rapid melting of Antarctic ice sheets put these numbers notably higher. An assessment report conducted by the U.S. Geological Survey (2009) estimates sea level rise with these melting ice sheets at 50 – 140 centimeters (1.64 – 4.59 feet) by 2100.

The above IPCC projection is also reported in the most recent CCSP report on global climate change: Synthesis and Assessment Product 4.1, Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region. The lead agency on this product was the U.S. Environmental Protection Agency (EPA), while other key participating agencies include U.S. Geological Survey (USGS) and National Oceanic and Atmospheric Administration (NOAA). This assessment report was based on three relative sea level rise scenarios using the twentieth century rate as the basis of these scenarios. These scenarios are: Scenario 1 – the twentieth century rate, which is generally 3 to 4 millimeters per year in the mid-Atlantic region (30 to 40 centimeters total by the year 2100); Scenario 2 – the twentieth century rate plus 2 millimeters per year acceleration (up to 50 centimeters total by 2100); Scenario 3 – the twentieth century rate plus 7 millimeters per year acceleration (up to 100 centimeters by 2100).

With the large amount of available scientific data, emerging technology and modeling capabilities of the scientific technical experts, there is no better time than now to start assessment of potential vulnerability to sea level rise and preparation for these effects in the long term.

Purpose of Workshop

The goal of this workshop was to the raise the awareness regarding potential sea level rise impacts in Delaware and to initiate dialogue about sea level rise with an initial group of stakeholders. The workshop was also designed to develop a list of sea level rise issues of concern and to have participants develop an initial set of issue descriptions in a standard written format. These issue

identifications and descriptions provide a foundation for determining the priority issues for the sea level rise adaptation strategy.

The Adaptation Plan Process

Developing a statewide strategy for adapting to sea level rise involves a comprehensive process for identifying environmental and socio-economic problems, compiling sound scientific data, identifying data gaps associated with these problems, developing management strategies, and crafting action plans to resolve these problems and implement the necessary strategies. This requires input and involvement from multiple stakeholders: local and regional experts; local, state, and federal government agencies; businesses; nonprofit organizations; and members of the public. It is critical that the adaptation strategy uses the best and most current data and information resources available to resolve issues that pertain to sea level rise, as well as developing an effective plan that will be implemented through collaboration with stakeholders.

This collaborative process will be carried out in four phases: Issue characterization; issue prioritization; strategy development; and implementation. This workshop is the initial part of the Issue Identification phase.

Issue Characterization. This process entails identifying data needs and reviewing existing research. Directed communication on the topic of sea level rise in the state will be stimulated amongst a wide array of decision-makers and experts. New information on the issues, modifications and refinements will be incorporated into the strategy development process based on the best available science and technology. In addition, the Delaware Experimental Program to Stimulate Competitive Research (EPSCoR) has committed to support research that will help address information needs for characterizing sea level rise impacts in Delaware.

Issue Prioritization. To ensure a pragmatic and effective approach to sea level rise, it is necessary to prioritize these issues and focus our efforts on developing strategies for the most important issues. Technical and policy experts will review the data and make any necessary adjustments. The prioritized issues will then provide the information necessary to begin the strategy development process.

Strategy Development. Stakeholders will identify possible "solutions" to the prioritized issues. Workshops and small focus groups will be held for this purpose. These strategies will provide an action plan for sea level rise adaptation.

Implementation. A long term mechanism for ensuring the implementation of the adaptation plan will be identified. Strategies included in the adaptation plan will be prioritized and initiated. Evaluation of the efficiency of implemented strategies is a critical part of this process as it provides a basis for discontinuing ineffective strategies and developing new strategies to meet new needs.

For more information on the adaptation plan please visit the website: http://www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

The Workshop Process

To efficiently develop management strategies, it is extremely important that stakeholders and decision makers share a common knowledge and understanding of the issues of concern and the scientific data to support or refute these concerns. To fulfill

this requirement, this workshop was designed to bring a diverse group of decision-makers together to learn about sea level rise, to determine areas that may be potentially vulnerable to its impacts, and to characterize these identified impacts. Scientists, technical experts, state, local and county government officials, not-for-profit organizations, business representatives, academia and others were invited to attend. Please see Appendix A for a list of workshop attendees and the workshop agenda.

The approach taken at this workshop used a structured process to capture information on potential issues and risks faced in certain areas, organizations that should be involved and additional knowledge needed to further characterize the issues identified throughout the workshop. This provided food for thought as it stimulated critical thinking about the details needed to fully evaluate each issue or problem identified.

During a morning plenary, workshop participants heard presentations about sea level rise and sea level rise adaptation from national experts and local project managers:

- *Sea Level Rise and Storm Effects on Coasts*, by S. Jeffress Williams, Senior Coastal Marine Geologist of the U.S. Geological Survey and Woods Hole Science Center;

- *Sea Level Rise Adaptation in Mid-Atlantic States, by* Jim Titus of the U.S. Environmental Protection Agency;

- *National and Regional Planning for Sea Level Rise*, by Kristen Fletcher, Executive Director of the Coastal States Organization; and

- *Developing a Sea Level Rise Strategy for Delaware*, by Susan Love, Planner IV with the Delaware Coastal Programs (Department of Natural Resources and Environmental Control) and Steve Borleske, Director of the Delaware EPSCoR.

These presentations can be found online: http://www.swc.dnrec.delaware.gov/coastal/Pages/SeaLevelRiseAdaptation.aspx

Participants were pre-assigned to break-out groups based on their area of expertise or their prioritized type of concern. The breakout groups were: Economy and Community; Habitat and Natural Resources; Human Health and Public Welfare; and Infrastructure. In each group, facilitators lead discussions on the ideas and concerns pertinent to participants regarding sea level rise. Participants in each group were asked to consolidate and group the ideas and concerns identified in the group discussion into specific issues or categories of issues. These issues were then described in greater detail using the Issue Identification and Characterization Form (see Appendices B through E). The form covered the geographic extent to which these issues pose threat; stakeholder groups that these issues may affect; who should be involved in developing action plans to deal with these issues; and what information may be needed to further address these issues. Lastly, participants were asked to place a measure of priority (high, medium, low) on each issue, while considering the feasibility and perceived economic, social, and environmental benefits and costs of proactively addressing these issues.

The workshop ended with a plenary review of the issues identified and their priorities. Any themes that may have been recognized and data resources or needs observed were also discussed. Finally, participants were encouraged to become involved in future strategy development activities.

Workshop Results

The participants at the workshop identified and provided an initial characterization of 61 sea level rise related issues, 9 of which were categorized as "Economic/Community" issues, 13 as "Habitat and Natural Resources" issues, 20 as "Human Health and Public Welfare" issues, and 19 as "Infrastructure" related issues. Issue Characterizations developed by participants can be found in Appendices B – E.

One of the primary concerns raised was the lack of a diverse representation. Some breakout groups were well attended by a specific group of stakeholders while other key stakeholders were absent. This may have limited the scope of issues considered.

Issues that appeared in more than one breakout group indicate the cross-cutting nature of the potential problems we are facing. These included topics such as the need for more education on the issue, as well as the need for better data and political will. The details of these breakout group proceedings are included in the following sections of this document.

Session Summaries

Participants were divided into four groups based upon their area of expertise to discuss and characterize the potential impacts of sea level rise and potential impacts to Delaware's economy, environment, and quality of life. Because of the cross-cutting nature of most issues related to sea level rise, several groups discussed similar issues, but from different viewpoints.

Each break-out session was led by a facilitator responsible for guiding the discussion; a co-facilitator responsible for capturing participants input; and a note-taker responsible for recording a transcript of the discussion. Before discussions began, ground rules were established and participants introduced themselves, including name, organization, and specific interest or outstanding concern regarding sea level rise.

Each group breakout began by "brainstorming" ideas and concerns pertinent to sea level rise. These ideas were captured by the co-facilitator on flip-chart paper and posted on the wall. As expected, many ideas were duplicative or of similar theme. When the brainstorming session ended, facilitators and note-takers reviewed the ideas captured on the flip charts and grouped similar items into specific issues or categories of issues (if necessary). Participants were then assigned, either singly or in small groups, to complete Issue Characterization Worksheets for each issue of category of issues. Full text of the brainstorming session can be found in Appendix F.

Economy and Community Session Summary

The Economy and Community break out session closely followed the process above. There were 15 participants in this session representing local governments and county governments, State government, University researchers, and non-profit organizations.

The majority of ideas brainstormed by participants fit into the following nine categories:

1. *Maintaining & Growing Delaware Tourism*
   How do we maintain and grow Delaware's tourism industry and what is the magnitude of potential revenue loss if

coastal areas are no longer a target destination?

2. *Personal Responsibility vs. Regulation*
   What level of government involvement is appropriate in "protecting citizens" from SLR and to what extent should citizens assume personal risk for living in coastal areas?

3. *Classifying Coastal Areas: Different Situations, Different Solutions*
   There is no "one size fits all" strategy to adapt to SLR - each geographic segment of Delaware must have different strategy to adapt.

4. *Social Justice*
   How will the State assist vulnerable (elderly, disabled, low income) populations?

5. *Identifying Key Stakeholders & Getting Them To Work Together*
   How do we ensure adequate representation for all interest groups/agencies/population segments and coordinate efforts?

6. *Safety Concerns & Evacuation*
   What are the public health risks and how do we improve evacuation strategies?

7. *Understanding & Managing Risk*
   How do we identify and calculate the impact of data uncertainties?

8. *Water Quality & Economic Impact*
   What are the economic ramifications of impaired water quality to commercial fisheries, drinking water supplies, and wetland loss?

9. *Education & Outreach As A Crosscut*
   How do we disseminate key information to ensure the public is aware of SLR impacts and importance?

Participants were assigned to each of the nine categories (based on area of expertise) and tasked with completing the Issue Characterization Worksheet. Worksheets were completed in the afternoon session and briefly discussed with the group upon completion. Of the nine categories, eight characterization worksheets were completed. One issue, Safety Concerns and Evacuation, was not addressed as participants assigned to that category did not attend the afternoon session; however, safety and evacuation issues were discussed at length within the Public Health and Welfare breakout session.

There was a consensus within the group that multiple key stakeholders were absent which resulted in a narrowly focused discussion. Because this breakout session was well attended by municipal officials from coastal resort towns, a significant portion of the brainstorming session centered on Atlantic coastal resort communities and the role of the National Flood Insurance Program in encouraging residential homes in vulnerable high hazard areas. The group dynamic and discussion may have been broader had there been more representation from urban coastal areas, minority and low-income population advocates, and agricultural and industrial interests.

Another key issue the group identified was the high variability of predicted sea level rise scenarios and challenges associated with preparing an adaptation strategy for such a wide range of possible outcomes. There was a general feeling that planning for the "worst case scenario" may be exorbitantly expensive and unnecessary. However, the group conceded the difficultly of achieving a relative consensus on what level of sea level rise the State should target the adaptation strategy.

Habitat and Natural Resources Session Summary

The Habitat and Natural Resources break out session closely followed the process outlined above. There were 21 participants in this breakout session representing town governments, county governments, State and Federal land and resource managers and not for profit organizations.

Twenty issues were identified; these were further combined into the following 13 categories.

1. *Wetland Impacts*
   How will we adapt and/or mitigate for wetland loss, wetland degradation, and wetland migration as sea level rises? What are alterations or losses in wetland functions and values?

2. *Critical Habitat/Species*
   How will loss and alteration of habitat affect species (especially endangered and or threatened species)? We need to complete risk assessments in order to adequately evaluate species vulnerability. We need to be aware of species migration shifts and shifts in species ranges as climate changes. There is also a concern regarding species interactions and timing of those (horseshoe crabs/shorebirds). As climate changes and sea level rises, will the interaction between horseshoe crabs and shorebirds (for example) be significantly impacted?

3. *Saltwater Intrusion/Water Quality/Groundwater*
   How will saltwater intrusion impact drinking water wells, agricultural practices, and public health?

4. *Waterfowl Management/Impoundments*
   Do we maintain existing freshwater impoundments or do we allow natural changes to occur? What are the thresholds for retreat? Where will the migratory waterfowl go? How will this impact Delaware's hunting/recreation?

5. *Beach Management*
   How will the loss of beaches impact beach and interdunal species as well as those species who utilize the beach (horseshoe crabs/shorebirds)? How would the loss of beaches impact the littoral conveyor belt? How will the economy be impacted by loss of beaches for tourism and recreation?

6. *Salinity Changes in Surface Water*
   How will salinity changes affect fisheries and oyster habitat? What are the likely changes?

7. *Agriculture*
   How do we maintain or adapt our agricultural practices to address sea level rise (salt tolerant crops, run-off, and irrigation issues)? This could also impact the agricultural economy.

8. *Political Barriers*
   How do we address the lack of political will? Who pays for implementing solutions?

9. *Economic Benefits and Losses*
   Loss of habitat will affect the economy, specifically tourism associated with hunting, fishing, etc. Who will eventually pay?

10. *Education and Outreach*
    How do we engage the general public as well as coastal decision makers? It is important to tailor the information dissemination to the audience.

11. *Scientific Data Needs*

There is a suite of global, national, and local knowledge. What data do we need to support or refute the national consensus?

12. *Benthic Habitats*
    There could possibly be positive implications with increasing the amount of benthic habitat. Will there be species shifts or loss in the benthic community as well? We are still in the process of understanding what currently exists in our benthic communities.

13. *Human Responses to Natural Environment*
    How do we address the conflicts between human needs and natural processes and dynamics? Do you protect or remove human structures? How do you protect shorelines from erosion?

Participants were assigned to each of the original twenty categories based on area of expertise and tasked with completing the Issue Characterization Worksheet. Worksheets were completed in the afternoon session and briefly discussed with the group upon completion. Characterization worksheets were completed for all of the original 20 categories.

A significant portion of the brainstorming session was focused on the broad topics and adaptation planning process questions. The group began to identify more specific issues towards the end of the brainstorming session. It was pointed out that we need to know which scenario of sea level rise we are planning to address. Members of the group also noted that risk assessments need to be conducted to adequately identify more specific issues (especially as it relates to critical habitats and species). The group also understood that additional issues may be identified by technical working groups.

Human Health and Public Welfare Session Summary

The Human Health and Public Welfare break out session closely followed the process above, with minor modifications due to the number of issues discussed. There were 19 participants in this session representing State and Federal environmental and planning agencies, not for profit organizations and University researchers.

Over 60 different issues were identified by participants during a round-robin brainstorming session. Issues were grouped under the following four categories: Saltwater Intrusion & Contamination; Inundation & Shoreline Erosion; Elevated Water Tables; and General Concerns. Due to the number of issues identified, participants prioritized the issues identified in the morning session through "sticky-dot voting." Each break-out group participant received 5 dots that they placed on the issues they felt most important. Twenty issues received votes. Participants were assigned to small groups and tasked with completing the Issue Characterization Worksheet for the highest priority issues. Of the twenty issues prioritized, twelve characterization worksheets were completed.

Prioritized Issues

1. *Waste water systems disposal*
   Septic systems and sewers could fail with elevated water tables; spray irrigation would not be feasible.

2. *Educating Public and Homeowners*
   Education on where to go and what to do – identifying shelters, dissemination of information. Educating public on what they can do ahead of time to help themselves – mitigation measures.

3. *Drinking water, wells and water systems*

The location of the water supply intakes could be affected by saltwater intrusion. How to ensure potable drinking water? Effect of people who have wells that won't be good anymore and they will lose the value of their land – loss of real-estate value, subsidy issue.

4. *Financing Public Works (cooling intakes, roads, buildings…)*
   How would we fund public works projects that would need to take place? Would federal funding pay for support or relocation of public infrastructure?

5. *Agriculture and Food Production*
   How do we maintain or adapt our agricultural practices to address sea level rise (salt tolerant crops, run-off, and irrigation issues)? This could also impact the agricultural economy and the ability to grow food for ourselves and feed for livestock.

6. *Land Use Planning*
   Where are populations concentrating? Where are community service facilities being sited? Long-term planning for public transportation and placement of electrical transmission lines is needed. Building practices may require modification (slabs, crawl spaces, insurance).

7. *Stormwater*
   Will stormwater management facilities continue to be adequate? Stormwater and combined sewer outfalls may need upgrades. Potential for increased flooding during storm events.

8. *Biodiversity Impacts & Ecosystem Modification*
   Ecosystem modifications including loss of habitat, domino effect and systemic change in the environment will cause many yet to be identified issues.

9. *Water Borne Diseases*
   There could be a possible increase in water borne diseases including diseases arising from improperly controlled/treated sewage.

10. *Emergency Evacuation Response (Flooding)*
    What are the specialized equipment and training needs for responders? Are emergency facilities in a flood prone area? Educating populations about where to go and what to do in emergencies is very important.

11. *Location of Community Services*
    How will the location and access to community services be affected by the reduction in usable land for the facilities?

12. *Access to Medical Facilities*
    How can we ensure access to medical care? What are potential impacts to the facilities? Are the roads to them accessible in storms?

13. *Willingness of people to leave*
    Is the population willing to evacuate during flooding events, or relocate after storm damage?

14. *Drainage Issues*
    What areas could be prone to flooding under sea level rise scenarios? How will sea level rise and increased flooding impact business operations, farming and the economy?

15. *Landfill/Contaminated Lands*
    How will the migration of toxic sediments from brownfields, liner failures, dredge spoil sites, underground storage tanks, cemeteries, coal ash, and jet fuel at airports be affected as these areas are inundated or have elevated water tables?

16. *Social Justice*
    Can vulnerable and low income communities evacuate or relocate? What about the housing needs, health programs, emergency services and health

in general of low income or elderly populations?

17. *Impact/Damage Private Property*
    What would be the damage to the homes and social impacts to the owners? Concern for the availability of insurance – coastal insurance is difficult to get and is still expensive even with subsidized.

18. *Recreation Infrastructure (mental health)*
    What are the potential impacts to recreation infrastructure? Limited access to recreation activities could impact quality of life and mental health of citizens.

19. *Impacts to Aquifers*
    Where could impacts to aquifers occur? Can populations afford to adapt? Will there be options for clean drinking and irrigation water?

20. *Drinking water for wildlife*
    What potential conflicts will arise between human and wildlife populations as drinking water for wildlife becomes contaminated?

During this breakout group sessions, much discussion focused on existing storm response and storm preparation and the difficulty of separating issues of sea level rise from issues of storm preparedness. Participants were encouraged to discuss any aspect of storm preparedness and response if it was felt that rising sea levels could impact how response could occur or future planning.

Infrastructure Session Summary

The Infrastructure break out session closely followed the process above, with minor modifications due to the number of issues discussed. There were 25 participants in this session representing Federal, State, county and local government entities responsible for research, planning and maintenance of waterways, water supply and transportation.

Approximately 50 specific issues or questions were brought up during the brainstorming session in four categories: Saltwater Intrusion & Contamination; Inundation & Shoreline Erosion; Elevated Water Tables; and General Concerns. There was some overlap between issues discussed in each category. The concerns were grouped into the following 19 categories:

1. *Built features*
   Roads, pipelines, sewer, drinking water, firehouses, waste water treatment facilities (e.g., in Wilmington, which is surround by dykes), landfills, power infrastructure, flood mitigation structures (e.g. tide gates), rails, trail, airports, seaports, all weather stations (ex. stream and tide gauges) at risk.

2. *Land Development Patterns*
   Roads running parallel vs. perpendicular to ocean, maintaining beaches.

3. *Domino effects*
   Connectivity of issues – how one issue affects another.

4. *Coastal Evacuation*
   Access to location and people; ability to provide services; evacuation for emergencies.

5. *Salt water contamination of drinking water*
   How will saltwater intrusion impact drinking water wells, agricultural practices, and public health?

6. *Segmented planning*
   More integrated planning for multiple types of infrastructure.

7. *Shore dependent uses*
   Impacts to Port of Wilmington and industries, leading to large economic consequences.

8. *Agricultural irrigation*

9. *What policies will be used*
   Need to decide on what policies/approaches we will use (retreat, dyke, elevate).

10. *Buried infrastructure*
    Impacts, including corrosion of drainage and drinking water lines; gas lines; sewer lines.

11. *Water related infrastructure*
    Bridges; seaports; storm water infrastructure not designed to handle increased storm intensity.

12. *Changing boundaries*
    Changes to flood plain boundaries, development area boundaries

13. *Transportation infrastructure*
    Bridges (e.g., weakening and wash outs); roads; rails; trails; airports; seaports.

14. *Drinking water*
    Will quality/quantity of drinking water be compromised?

15. *Access to locations and people*
    Evacuation not only affects the people being evacuated but also the locations and residents to which they are being evacuated.

16. *Power infrastructure*

17. *Political will*

18. *Natural Features*
    Changes to these features (beaches, wetlands, others) may impact built features.

19. *Increased stress on existing infrastructure*

Participants were asked to place their initials next to the issue upon which they placed most priority; this served to provide focus for assigning groups to fill out Issue Characterization Forms. Participants were then grouped according to their top prioritized issue and filled out Issue Characterization Worksheets. Upon completion, there was brief discussion of the information written on each form as each group was allowed the chance to report out. A total of 9 forms were filled out for this group.

During discussions, participants felt that there was a need for "critical infrastructure" to be defined, while the question was raised whether or not there is need for distinction between and separation of private vs. public infrastructure issues. Also a part of the general consensus was the need to firmly decide on what policies or approaches will be used by the state (retreat, dykes, elevate) and federal government. Another hot topic was the issue of costs/budgets. Participants agreed that changing the infrastructure is expensive and that there is a need for benefit costs analyses for improvements for infrastructure.

Common Concerns and Comments

A common comment amongst attendees was that several key stakeholders were not at the workshop that would have important input and would be beneficial to the program. Participants agreed on the need for terminologies to be defined (e.g., "critical infrastructure"), as well as the sea level rise scenarios and scientific data that will be used

as focus for the adaptation planning, since there is currently a vast range of scenarios being discussed. The need for political will and firm decisions on what policies or strategies will be used by the state (retreat, dykes, elevate) was a general consensus.

Costs or budgets were a common concern amongst groups recognizing that change may be expensive and benefit cost analyses for improvements and adaptation strategies should be considered. A significant portion of attendees felt it was difficult to separate sea level rise issues from issues of storm preparedness, and to distinguish between private vs. public infrastructure issues. Many participants also noted that risk assessments need to be conducted to efficiently identify more specific sea level rise issues; long or short term planning needed to be decided upon; environmental justice needed to be addressed and saltwater intrusion and its impacts on water quality should be a major concern.

Next Steps

Over the next several months, the Delaware Coastal Programs, with the assistance of research, technical and political experts will use the results of this workshop to form the basis for determining data gaps, issues and strategies for management and adapting to sea level rise. A coordination committee and technical working groups will be tasked with the evaluation and refinement of issues identified to date, as well as identification of other issues relevant to sea level rise that were not identified at this initial workshop.

In addition, a broader range of stakeholders will be identified and a public outreach plan will be developed to ensure participation from a wide audience.

Appendix A:

Participants List and Agenda

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Preparing for Sea Level Rise:
Development of an Adaptation Strategy for Delaware
March 12, 2009 · 8:45-4:30
Sheraton Hotel and Conference Center
1570 North DuPont Highway · Dover, Delaware 19901

8:00 – 8:45 Registration (pre-registration is required)

Morning Plenary Session (Champagne Room)

8:45 *Welcome*
David Carter, Program Manager
DNREC Delaware Coastal Programs

9:00 *Sea-level Rise and Storm Effects on Coasts*
S. Jeffress Williams, Senior Coastal Marine Geologist
U. S. Geological Survey, Woods Hole Science Center

9:40 *Sea Level Rise Adaptation in Mid-Atlantic States*
Jim Titus, Sea Level Rise Project Manager
U.S. Environmental Protection Agency

10:10 *National and Regional Planning for Sea Level Rise*
Kristen Fletcher, Executive Director
Coastal States Organization

10:35 *Developing a Sea Level Rise Adaptation Strategy for Delaware*
Susan Love, Planner
DNREC Delaware Coastal Programs

Stephen Borleske, Director
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Working Group Breakout Session

11:00 Break into pre-assigned Working Groups to draft list of potential issues

- Economy and Community (Corporate Room West)
- Habitat and Natural Resources (Sienna Room)
- Human Health and Public Welfare (Corporate Room East)
- Infrastructure (Venetian Room)

12:30 Lunch (Champagne Room)

1:15 Working Groups reconvene to:

- Finalize list of issues
- Draft issue characterizations
- Select priority issues

3:20 Break

<u>Afternoon Plenary Session (Champagne Room)</u>

3:30 Working groups present results of breakout sessions

4:15 Questions and Next Steps

4:30 Adjourn

Appendix B:

Issue Characterizations

Economy and Community Breakout Group

Classifying Coastal Areas

***Breakout Group*:** Economy & Community

Author(s):

Richard Kautz - Sussex County Planner

***Description of Issue*:**

- Land Use
  - urban – developed
  - rural – vacant
  - in-between - mixed
  - resident vs. nonresident
- Demographics
  - Elderly, handicapped, poor
- Environment
  - Beach
  - Wetland
  - Developed
  - Agriculture
- Public Service
  - Hospital
  - School
  - Prison

Very broad topic – East Wilmington vs. Slaughter Beach.

Need to produce a matrix that has community type (urban to rural) on one axis and the issue (land use, demographic, environment) on the other. Inside each cell would be a sea level rise strategy (protect, retreat, elevate).

***Geographic Extent of Issue Impact*:**

X	**Statewide**		**New Castle County**		**Kent County**		**Sussex County**
	Specific Community		**1-5 Communities**		**More than 5 Communities**		

***Additional information provided for the above question*:**

- Depending on SLR assumptions, most of the state could be impacted.

***Who does this issue affect*?**

Depends on approach:

- Retreat – property owners, environmental community
- Elevate – property owners, utility/PW
- Protect – property owners

***When will these effects be felt*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***When should managers begin to address this issue*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Mayor/Admin/Clerk – local government for planning and implementation.
- Public – taxpayers, impacted property owners, interest groups.

***What information is already available to further characterize this issue*?**

- Evacuation Plans
- Comprehensive Plans
- Community Services

***What additional data or information may be necessary to fully understand this issue*?**

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

***Provide additional Information of clarification (if any)*:**

- FEMA regulations and programs.

Education & Outreach

***Breakout Group*:** Economy & Community

Author(s):

Kate Barba – NOAA/OCRM

***Description of Issue*:**

- Discussion across groups related to increasing understanding vulnerability, risk, and basic science impacts relating to climate impacts.
- In order to build consensus, ownership for solutions, strong and urgent need to identify key audiences and general public with education campaign to increase knowledge/understanding of science, uncertainties and impacts relevant to their lives.
- An informed public equals informed decisions.
- Ensure education for a diverse cross section of audiences – age, income, ethnicity, geography.
- Target materials for relevancy (what climate impacts are relevant).

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- All citizens are potential targets, w/ limited resources, target decision makers first with credible and lay-understandable materials – accurate/science-based. Second, educators/extension agents, e.g. train the trainers. Third, community and religious leaders.

***When will these effects be felt*?**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***When should managers begin to address this issue*?**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Sea Grant – trainers/extension agents
- Industries – materials development – test/pilot
- Citizen groups/networks
- Business community / professional associations
- DNREC/DNERR – education
- Environmental nonprofit educators (CIB)
- Reach out to national/regional groups for materials/products

***What information is already available to further characterize this issue*?**

***What additional data or information may be necessary to fully understand this issue*?**

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

***Provide additional Information of clarification (if any)*:**

Identifying Key Stakeholders & Getting Them To Work Together

***Breakout Group*:** Economy & Community

Author(s):

David Edgell – Office of State Planning Coordination

Barb Dehaven - DEDO

***Description of Issue*:**

- Need to make sure key stakeholders are part of the process of providing and receiving information as well as decision making.
- Regional as well as statewide
- Regional – multistate collaboration – high level

***Geographic Extent of Issue Impact*:**

[X]	**Statewide**	[ ]	**New Castle County**	[ ]	**Kent County**	[ ]	**Sussex County**
[ ]	**Specific Community**	[ ]	**1-5 Communities**	[ ]	**More than 5 Communities**		

***Additional information provided for the above question*:**

- Plus Region

***Who does this issue affect*?**

- Government
- State agencies
- 3 counties
- 57 municipalities
- Community Groups
- Business
- Citizens

***When will these effects be felt*:**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***When should managers begin to address this issue*:**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*:**

- State Chamber
- County Chamber
- Each county administrator
- Municipal mayors
- Key legislators
- City of Wilmington
- DEDO – Jeff Stone
- Various Interest groups

***What information is already available to further characterize this issue*:**

- Mapping resources

***What additional data or information may be necessary to fully understand this issue*:**

- Areas of focus – physical boundaries
- After mapping, what jurisdictions does it affect

***What are the economic, social and/or environmental benefits to proactively addressing this issue*:**

- Helps maintain a unified message. Buy-in from stakeholders is critical for implementation of any plans/actions.
- Regional alliance allows sharing of info.

***Provide additional Information of clarification (if any)*:**

Maintaining & Growing Delaware Tourism

***Breakout Group*:** Economy & Community

Author(s):

Dell Tush – Dewey Beach / Mayor

Pat Schuchman – Fenwick Island

***Description of Issue*:**

- Maintenance – town maintains but owned by states
- Public beaches – town provides public safety (lifeguards), trash clean-up, and maintain beach and dune.
- Beaches are promoted thru local chamber of commerce and business and realtors.
- 1% of hotel tax goes to beach re-nourishment
- 3% of hotel tax goes to southern Delaware tourism
- Town maintains streets, sidewalks, storm drains, and street lights
- Town maintains police dept.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**

- Tourism - worldwide

***Who does this issue affect*?**

- The state, the county, property owners, business owners, visitors i.e. tourists.

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Federal Government – funding
- State government – funding and construction
- The county – funding
- The municipality – implementation of project in conjunction with federal and state.

***What information is already available to further characterize this issue*?**

- FEMA
- DNREC – Tony Pratt
- CIB – Ed Lewindowsky

***What additional data or information may be necessary to fully understand this issue*?**

- Accurate Information

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Economic benefit is billions of dollars in lost tourism.
- We want healthy bays and rivers.
- Social value is lost if the beaches and bays are impacted and public safety can't be provided due to lost revenue.

***Provide additional Information of clarification (if any)*:**

Personal Responsibility vs. Regulation

***Breakout Group*:** Economy & Community

Author(s):

Rich Collins - Positive Growth Alliance

***Description of Issue*:**

- There is a tendency for government regulation to have great faith in top down regulation. This ignores experiences with human nature. For example, colleges have constructed buildings without sidewalks and then after a year they build the sidewalks in the path created by users. To do otherwise would mean sidewalks might be ignored.
- Regulation can not anticipate the infinite numbers of variables that influence the human behavior. Effects of sea level rise will be gradual. People can adjust their behavior to match. In the meantime, all Delawareans can enjoy the many financial and recreational benefits provided by our coastal areas. People must be allowed to make their own decisions as to how close they want to live near the coast. Over 50% of the US population wants to live nearby.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Everyone in Delaware

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

When should managers begin to address this issue**?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

What organizations/individuals should be involved in finding solutions to this issue**?**

- As long as the focus is providing accurate information (not political) to the public, and responding to problems after the facts, government agencies can handle most of the responsibility. If mandated changes in human behavior are proposed, decision should be made by elected officials. All public meetings should reach out to landowners, business people, and private citizens.

What information is already available to further characterize this issue**?**

- 233 years of history since July 4, 1776

What additional data or information may be necessary to fully understand this issue**?**

- A study of the American economy vs. all others.

What are the economic, social and/or environmental benefits to proactively addressing this issue**?**

- People can live the life they choose without excessive government interference. Consider our approach to crime. Police come after the crime has been committed. They don't move everyone out of the neighborhood because crime might occur.

Provide additional Information of clarification (if any)**:**

- Coastal communities are among our largest drivers of the economy. Regulatory restrictions might have far more economic consequences than we know.

Social/Environmental Justice towards those most vulnerable

***Breakout Group*:** Economy & Community

Author(s):

Yda Schreuder - UD/CEEP.

CEEP has concentrated its effort on issues related to climate change for over a decade. In addressing sea level rise and climate change it is important that we address the needs and concerns of the most vulnerable segment of the population (i.e. poor communities in urban floodplains).

***Description of Issue*:**

- In the case of the state of Delaware it is important for that reason that we distinguish between the coastal areas/beach communities and urban areas in northern Delaware (i.e. East & South Wilmington). The response to sea level rise (retreat/elevation/protection) would likely dictate a different approach (protection vs. retreat/elevation) as poor residents typically have no choice. As tenants, instead of property owners, their residence is defined and in situ in older low cost housing, historically determined, and dating back to Wilmington's industrial past. This different situation therefore requires different solutions as compared to tourist/coastal communities. "Personal responsibility" has little relevance. Safety concerns and evacuation plans are very different as compared to coastal/tourist communities and managing risks at an individual level may not be possible. Instead, large scale evacuation will be needed. Also note that water quality impacts will differ from coastal communities.

***Geographic Extent of Issue Impact*:**

☐	**Statewide**	X	**New Castle County**	☐	**Kent County**	☐	**Sussex County**
☐	**Specific Community**	X	**1-5 Communities**	☐	**More than 5 Communities**		

***Additional information provided for the above question*:**

- Claymont. South & East Wilmington. New Castle.

***Who does this issue affect*?**

- City neighborhood associations.
- African-American & various immigrant community organizations.
- Cities of Claymont, Wilmington and New Castle
- New Castle County

***When will these effects be felt*?**

☐	**Immediately**	☒	**Within 10 years**	☒	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***When should managers begin to address this issue*?**

☒	**Immediately**	☒	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

- Please note if protection in the form of sea-walls/barriers, dikes, and drainage systems has to be constructed, it will take 10 years to plan and construct. Evacuation planning will have to be studied and implemented in coordination with DEMA.

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Corps of Engineers – Engineering
- City of New Orleans – Recent experience
- Netherlands – 4 century long experience
- FEMA/DEMA – evacuation plans

Note: I suggest that you contact us (CEEP) to do further research on the relevant issues. I will be happy to be the contact person.

***What information is already available to further characterize this issue*?**

- Contact New Orleans city government and FEMA.

***What additional data or information may be necessary to fully understand this issue*?**

Mapping flood plains under threat:

- Under different scenarios of sea level rise
- Under different scenarios of water runoff during severe weather events (i.e. Brandywine and Christina river watersheds.)
- Research of groundwater infiltration & water supply as affected under different scenarios.
- Research towards anticipated health conditions that may occur
- Projected traffic congestions and research towards anticipated road capacity and public transportation.

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Saving lives and urban infrastructure.
- Preventing deterioration of water supply for urban areas.

***Provide additional Information of clarification (if any)*:**

- Just about any aspect of adaptation relative to sea level rise and flooding and inundation and the effect of severe weather events differ with respect to the nature of the community affected.
- Poor urban neighborhoods require a very different approach and response as compared to wealthy coastal tourist oriented communities.
- For the sake of doing justice for all Delawareans, it is important that stakeholders from poor urban neighborhoods are at the table in the planning process for sea level rise.
- Poor residents are the most vulnerable. They do not live in floodplains by choice and are not in a position to assume risks and do not have the means to rebuild.
- All the more reason that public funding be designated to plan for sea level rise in this case.

Understanding and Managing Risk

***Breakout Group*:** Economy & Community

Author(s):

Kate Barba – NOAA/OCRM

***Description of Issue*:**

- Understand/map what is vulnerable: green and built infrastructure. Assess risk given vulnerability. What is anticipated risk? Develop inundation scenarios. Articulate uncertainty. Map major infrastructure / built environment impacts. Engage key stakeholders for each impacted area.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- All sectors

***When will these effects be felt*?**

[X] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [X] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Management and planning agencies.
- Technical assistance from state and federal agencies.
- Risk assessment based on vulnerability.
- ID/classify area appropriate for specific strategies (retreat, elevation, protection).
- Engage cross section to develop solution scenarios of stakeholders by geography.
- There is a science and available tools around vulnerability and risk assessments.

***What information is already available to further characterize this issue*?**

***What additional data or information may be necessary to fully understand this issue*?**

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

***Provide additional Information of clarification (if any)*:**

Water Quality & Economic Impact

***Breakout Group*:** Economy & Community

Author(s):

Priscilla Cole. Partnership for the Delaware Estuary.

Karl Kalbacher. New Castle County / Director of Redevelopment.

***Description of Issue*:**

- Water quality degradation
  - Oysters
    - Stress on populations
    - Collapse of seafood industry
  - Drinking Water
    - Surface water and groundwater
    - Contamination of aquifer system
    - Saltwater upstream migration into intakes
  - Wetlands
    - Losing habitat
    - Impact to fisheries
    - Reduces buffers and flooding
    - Reduce filtering contaminants and sediment

***Geographic Extent of Issue Impact*:**

☐ **Statewide** ☐ **New Castle County** ☐ **Kent County** ☐ **Sussex County**

☐ **Specific Community** ☐ **1-5 Communities** ☐ **More than 5 Communities**

***Additional information provided for the above question*:**

- Coastline communities

***Who does this issue affect*?**

- Federal, State, Local governments.
- Utilities
- NGO Conservation & Restoration
- Commercial Fisherman
- Property Owners
- Private Industry

***When will these effects be felt*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***When should managers begin to address this issue*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Federal, State, Local governments.
- Utilities
- NGO Conservation & Restoration
- Commercial Fisherman
- Property Owners
- Private Industry

***What information is already available to further characterize this issue*?**

- John Talley. Delaware Geological Survey.
- Chris Coons. New Castle County.
- Jon Hudbaun. New Castle County.
- Syd Sharma. City of Wilmington.
- Gerry Kaufman. Water Resources Agency.
- Priscilla Cole. Partnership for the Delaware Estuary.

- Laura Herr. DNREC – Wetlands.
- Diane Taylor. Artesian Water.
- Dave Velinsky. Academy of Natural Sciences.
- George Parsons University of Delaware – Env. Economics
- Bob Tudor. Delaware River Basin commission.
- Lorraine Fleming. Delaware Nature society.
- Sam Cooper. City of Rehoboth Beach.
- Dell Tush. Mayor of Dewey Beach.
- Roy Miller. DNREC - Fish & Wildlife.

***What additional data or information may be necessary to fully understand this issue*?**

- Further quantification of sea level rise.
- Reliable model for saltwater intrusion.
- Robust analysis of SLR and salinity increase on habitat and species
- Impacts of SLR on stormwater and wastewater infrastructure.
- Sediment budgets to estuary and wetlands
- Info on future land use planning in coastal areas.
- Upstream community impacts on DE.

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Lost savings.
- Quality of life.
- Public understanding and acceptance.

***Provide additional Information of clarification (if any)*:**

Appendix C:

Issue Characterizations

Habitat and Natural Resources Breakout Session

Agricultural (Salt Tolerant Species/Management)

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Michael Stroeh – US Fish and Wildlife Service

***Description of Issue*:**

- Drainage/Tax Ditches
- Biofuels - what is the implication? Switchgrass, other semi-salt tolerant species suitable for use in biofuels?
- Programs (USDA) to help landowners adjacent to migrating wetlands ex. WRP

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Landowners
- Agricultural Communities

***When will these effects be felt*:**

☐	**Immediately**	☒	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***When should managers begin to address this issue*:**

☒	**Immediately**	☐	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*:**

- USDA
- USFWS
- DNREC

***What information is already available to further characterize this issue*:**

-

***What additional data or information may be necessary to fully understand this issue*:**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*:**

- Economic – Agriculture is #1 business in the state

***Provide additional Information of clarification (if any)*:**

Beach Management (Nourishment, Sources, Erosion)

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

John Talley – DGS

Bill Meredith – DE Mosquito Control

Anthony Pratt – DNREC/DSW

***Description of Issue*:**

- SLR can inundate beaches and dunes (overwhelm the sedimentary system)
- Loss of natural buffer between wetlands and open water
- Loss of ecological base – (horseshoe crab, shorebird habitat, interdunal communities, beach fauna and wetland/estuary protection
- Reduction in littoral conveyor belt due to beaches and inlets that could result in threshold failure
- Economic impact is broad and severe
- There is not a good understanding of the role beach dunes play in the protection of estuarine habitat
- Beach access/Management

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**
Towns, counties, state, and beach users

***Who does this issue affect*?**

- Towns
- Counties
- State
- Beach users
- Bird watchers
- Hunters
- Fishers

***When will these effects be felt*?**

☐	**Immediately**	☒	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***When should managers begin to address this issue*?**

☒	**Immediately**	☐	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Federal – Corps projects, US F+W, NOAA
- State – Projects, planning, funding
- Scientific/Engineering communities – research, modeling

***What information is already available to further characterize this issue*?**

- Shore processes data and modeling – UD, private contractor, corps

***What additional data or information may be necessary to fully understand this issue*?**

- Improved data
- Improved model verification
- System understanding

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Protection of tourism
- Job creation and protection
- Biodiversity and productivity protected
- Reduction of coastal damage from storms

***Provide additional Information of clarification (if any)*:**

- Improved communication/outreach on the role good beaches and dune systems play on providing and protecting diverse biological populations
- Viable sand sources (economies)
- User friendliness – grain size, beach slope

Benthic Habitat/Management

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Bartholomew Wilson – DNREC/DSW

Maria Sadler – DNREC/DSW

Chad Tolman – DE Chapter of Sierra Club

Danielle Kreeger – Partnership for the DE Estuary

***Description of Issue*:**

- Need to understand what we can and can't do, use triage and careful analysis to focus realistic management where protection is warranted.
- Benthics = all bottom habitats and communities including open estuary waters
- Oyster Reefs, Sabellaria, SAV, mudflats, all under water bottoms
- ISSUES:
    - With sea level rise, we could see increase in benthic habitat
    - Lag in fisheries management related to shifts in benthic communities. Issue is that fisheries depend on bottom communities which may move.
    - Oysters, HABS other bio will respond to changes in salinity e.g. Dermo virulence and prevalence (time and space) impacting oysters; blooms of harmful algae
    - Baseline understanding needed on how pelagic organisms will respond to shifting bottom communities
    - Invasive species coming or from the south or other areas due to disturbance
    - ? Ocean acidification and shell budgets and vertical relief for reefs

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**
See front page

***Who does this issue affect*?**

- Fish and Wildlife Agencies and groups
- Commercial and recreational fisheries
- Shell fisheries
- Interstate challenges (e.g. HSC fishery regulation)
- Water quality (filtration by oyster reefs)
- Regional Ocean Governance Council

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Academia e.g. UD – Doug Miller, Benthic ecologist
- State (DNREC)
- Federal

    - NMFS
    - USFWS
    - Shellfish SAW
    - ACFHP
    - ASMFC
- Non-profits
    - PDE
    - TNC
    - Global Marine
    - Sierra Club
    - ALS
    - NWF

***What information is already available to further characterize this issue*?**

- Local:
    - DEBI
    - DNREC – Benthic Mapping
    - NCA – benthics
    - Oyster SAW
    - DE Fisheries Trawl Surveys
    - HSC spawning surveys
- Global/National
    - TNC – Global Shellfish Reefs at Risk
    - Ocean Acidification studies

***What additional data or information may be necessary to fully understand this issue*?**

- See white paper 2006 – benthic needs
- Benthic indicators for 2008 State of the Estuary Report
- See DNREC Fish and Wildlife profiles
- UD?
- Need more data at every level on benthic characterization and associated ecosystem service
- Where are benthic communities most important for fisheries and shell fisheries, functional importance e.g. Ecosystem model and fisheries model
- Vulnerability Assessment for key benthic areas and manage them more carefully to offset climate change

What are the economic, social and/or environmental benefits to proactively addressing this issue**?**

- See above
- Lives and livelihoods
- Fisheries, Shell fisheries = jobs, recreation
- Water quality benefits
- Shoreline protection

Provide additional Information of clarification (if any)**:**

Critical Habitats (Endangered/Threatened Species)

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Mark Nardi – USGS

Karen Bennett – DNREC/DFW

***Description of Issue*:**

- (See "Species Range/Migration Shifts" worksheet)

***Geographic Extent of Issue Impact*:**

☐ **Statewide** ☐ **New Castle County** ☐ **Kent County** ☐ **Sussex County**

☐ **Specific Community** ☐ **1-5 Communities** ☐ **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

-

***When will these effects be felt*?**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***When should managers begin to address this issue*?**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

-

***What information is already available to further characterize this issue*?**

-

***What additional data or information may be necessary to fully understand this issue*?**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

-

***Provide additional Information of clarification (if any)*:**

Economic Benefits/Loss of Habitat

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Michael Stroeh - USFWS

***Description of Issue*:**

- Tourism, hunting, fishing and bird watching, etc. provide valuable revenues to local, state and federal agencies not to mention all of the small businesses affected by these activities. The loss of habitat may result in loss of revenues from wildlife dependent recreation
- Who is it valuable to? Who pays?
- Needs more information. After describing the issue well there is little to expand.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Local, State and Federal Agencies
- Recreational Users

***When will these effects be felt*?**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☒ **Within 26-50 years** ☐ **Longer than 50 years**

OR SOONER!

***When should managers begin to address this issue*?**

☒ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DNREC
- US Fish and Wildlife Service

***What information is already available to further characterize this issue*?**

-

***What additional data or information may be necessary to fully understand this issue*?**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Maintaining/increasing funding
- Planning – redirecting current resources

***Provide additional Information of clarification (if any)*:**

Education/Outreach – Capacity Building

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Ken Reynolds – DNREC/DFW

Julia Wyman – CSO

Dan Brower – DNREC/DSW

***Description of Issue*:**

- Public must be educated on subject in order to inform voters and influence political decisions in a positive way – educated politicians
- Multiple layers of education to reach difficult population segments
- New tools and techniques needed for this multi-faceted education

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Public and private schools
- Community leaders, mayors, city councils, county executives
- Planning and zoning groups
- Civic groups
- Business community

***When will these effects be felt*:**

[X] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*:**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*:**

- DOE
- School teachers/school district superintendents
- NGOs – DNS
- State Agencies
- Federal Government

***What information is already available to further characterize this issue*:**

-

***What additional data or information may be necessary to fully understand this issue*:**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*:**

- Education of public and politicians will have positive effects on all aspects ultimately

***Provide additional Information of clarification (if any)*:**

Forestry/Riparian Buffers

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Mark Nardi – USGS

Karen Bennett – DNREC/DFW

***Description of Issue*:**

- Maritime forests/Riparian will likely move inland
- Riparian Buffers will likely move towards uplands, composition of species may change
- Forest stressors will change
- (See Species Range/Migration shifts)

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

-

***When will these effects be felt*?**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***When should managers begin to address this issue*?**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- (See Species Range/Migration)

***What information is already available to further characterize this issue*?**

- (See Species Range/Migration)

***What additional data or information may be necessary to fully understand this issue*?**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

-

***Provide additional Information of clarification (if any)*:**

Groundwater (Recharge; Saltwater Intrusion)

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

John Talley – DGS

Bill Meredith – DE Mosquito Control

Anthony Pratt – DNREC/DSW

***Description of Issue*:**

- Saltwater intrusion resulting in possible loss of potable water in coastal areas and communities that rely exclusively on water for public, commercial, industrial, domestic or agriculture

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**

-

***Who does this issue affect*?**

- Atlantic ocean, Delaware Bay and River and Inland Bay communities
- Public municipal and private water surveyors
- Citizens, especially coastal homeowners and transients/visitors
- Agriculture
- Public Health
- Emergency management

- DNREC Water Supply
- Ground water discharges
- Watershed assessment
- Soil and water conservation, etc.
- Development and real estate communities

***When will these effects be felt*?**

[X] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Delaware Geological Survey – groundwater monitoring, subsurface geological mapping, groundwater modeling
- DNREC – water supply
- Public health
- Pertinent water surveyors
- Coastal communities

***What information is already available to further characterize this issue*?**

- Existing maps and reports
- Continuous water level and water quality monitoring in coastal areas – Scott Andres, Kelvin Ramsey, John Talley

***What additional data or information may be necessary to fully understand this issue*?**

- Water levels
- Well construction
- Water quality
- Subsurface mapping (historic and current)
- Water use
- Hydrologic characteristics of coastal aquifers
- Observation and monitoring of wells
- Projected demands for additional water resources in specific areas
- More thorough understanding of groundwater recharge and discharge

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Water resources in coastal areas subject to saltwater intrusion are required to support economic development, agriculture, land use planning, allocation of water resources, tourism, etc.

***Provide additional Information of clarification (if any)*:**

- In some areas the issues of groundwater recharge and saltwater intrusion already exists
- There have been evaluations of potential for saltwater intrusion, recharge, discharge for the past 50 years. Additional modeling and evaluating of subsurface ecology and hydrology in areas where saltwater intrusion has occurred or could potentially occur should be addressed

Horseshoe Crab/Shorebirds

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Roy Miller – DNREC/DFW

Michael Rhode – DNREC/DSW

Lorraine Fleming – DE Nature Society (Scribe)

***Description of Issue*:**

- Decrease on horseshoe crab spawning habitat
- Cascade effect on shorebirds dependent on horseshoe crab eggs
- Timing issues relative to climate change – SLR
- Roosting/resting areas for migrant shorebirds impacted
- Decline in harvestable crabs – loss of waterman income, biomedical industry critical needs, ecotourism impacts (crab and shorebird declines)
- Crab declines result in food source loss for many other organisms
- Shoreline migration landward incompatible with horseshoe crab – shorebird connection

***Geographic Extent of Issue Impact*:**

☐ **Statewide**	☐ **New Castle County**	☒ **Kent County**	☒ **Sussex County**
☐ **Specific Community**	☐ **1-5 Communities**	☒ **More than 5 Communities**	

A good case could be made for "statewide"

***Additional information provided for the above question*:**

- Fish-invertebrate complex impacted
- Avian Communities impacted
- Marine resources impacted

***Who does this issue affect*?**

- Watermen
- Individuals
- Coalitions
- Multitude of conservation organizations birders and ecotourists
- Biomedical industries
- Seafood wholesalers and distributors
- Tourism agencies
- Chambers of Commerce
- Beach goers
- ASMFC

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DNREC – primary regulatory and management agency
- ASMFC – regional regulatory and management agency
- UD – monitoring
- Ornithological organizations – DNS, DOS, DAS, TNC – advocacy

- Waterman associations including wholesalers and retailers – professional livelihood
- USFWS (Dave Smith et al) – research and monitoring

***What information is already available to further characterize this issue*?**

- Voluminous scientific papers – Amanda Day
- Databases, monitoring – Karen Bennett
- Landing and tagging studies – Nigel Clark
- Stock Assessments – ASMFC/DNREC/USFWS
- Breeding bird surveys
- Breeding grounds surveys
- Over-wintering area surveys – Larry Niles

***What additional data or information may be necessary to fully understand this issue*?**

- Continued research and monitoring to better understand the interdependence
- Beach creation (appropriate to horseshoe crab spawning)
- Precise quantity of horseshoe crab eggs needed to sustain specific shorebirds (species specific)

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Sustain a fishery
- Sustain an ecotourism attraction
- Retain species (prevent extirpations or extinctions)
- Sustain a biomedical industry
- Keeps coastal communities viable

***Provide additional Information of clarification (if any)*:**

Human Responses to the Natural Environment (dykes, shoreline armoring)

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Kelvin Ramsey - DGS

***Description of Issue*:**

- Conflict between human-based needs, projects, construction vs. natural processes and dynamics
- Management of environment or let if adjust naturally
- Protection for sea level rise – retreat, protect, or build upwards
- What actually will happen to the shoreline with sea level rise?
- Marsh – upland boundary migration – what policies regarding loss of farmland, community frontage
- Sand and other natural resources for beach nourishment. Where does it come from and what cost
- Effects of dyke abandonment
- All comes down to policy decision: retreat or something else

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Resource management (wildlife, shorelines, etc.)
- Shoreline property owners
- Recreational users (birders, beach users, surfers)

***When will these effects be felt*?**

☐ **Immediately** ☒ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***When should managers begin to address this issue*?**

☒ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DNREC – permitting/policy
- DGS – geology/science/sand resources
- NOAA – science/climate - sea level monitoring
- USGS – science/geology/biology
- ACOE - engineering

***What information is already available to further characterize this issue*?**

- Not sure specifically
- Wealth of data on shoreline construction (armoring, dykes, etc.) and the results of such projects

***What additional data or information may be necessary to fully understand this issue*?**

- Once policy is decided:
  - Models of shoreline inundation and habitat migration
  - Geology of coastline

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- $ - Policy will drive a lot if it is approached?

***Provide additional Information of clarification (if any)*:**

- Ultimately a policy decision or retreat of doing something else – before solutions can be determined

Impoundment Management

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Michael Stroeh – US Fish and Wildlife Service

***Description of Issue*:**

- With SLR, freshwater and brackish impoundments will be lost. Many Public Land Agencies manage impoundments for migratory and resident wildlife. In many cases wildlife dependent recreation is also associated with these impoundment systems. With increasing sea levels and storm events, what are the thresholds for retreat? Where will these wildlife resources associated with these impoundments go?
- Freshwater vs. Saltwater

***Geographic Extent of Issue Impact*:**

X	**Statewide**		**New Castle County**		**Kent County**		**Sussex County**
	Specific Community		**1-5 Communities**		**More than 5 Communities**		

***Additional information provided for the above question*:**

Federal and State Wildlife areas

***Who does this issue affect*?**

- DNREC
- US Fish and Wildlife Service
- Bird watchers and Hunters
- DelDOT

***When will these effects be felt*:**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*:**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*:**

- DNREC
- US Fish and Wildlife Service
- DelDOT

***What information is already available to further characterize this issue*:**

-

***What additional data or information may be necessary to fully understand this issue*:**

- Shift in the wildlife resources
- Habitat shift
- Are there areas inland for the wildlife resources?
- Are there areas available for the wildlife dependent recreation?

***What are the economic, social and/or environmental benefits to proactively addressing this issue*:**

- Economic – Hunting, bird watching, tourism
- Environmental – these areas provide habitat for a wide range of species

***Provide additional Information of clarification (if any)*:**

Loss of Wetlands

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Ken Reynolds – DNREC/DFW

Julia Wyman – CSO

Dan Brower – DNREC/DSW

***Description of Issue*:**

- As sea level rises, we would have an expected net loss. Many species lost or displaced – plant and animal
- Certain recreational aspects lost = hunting, bird watching, crabbing, fishing.
- Ecosystem imbalance
- Increase in invasive species
- Loss of farmland
- Forest land losses

***Geographic Extent of Issue Impact*:**

X	**Statewide**		**New Castle County**		**Kent County**		**Sussex County**
	Specific Community		**1-5 Communities**		**More than 5 Communities**		

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Hunters, landowners, bird watchers, economic losses to communities from reduced tourism, environmental groups, flooding, issues due to loss of buffering effect of wetlands, watermen affected, community infrastructure damage

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- State Government
- Federal Government
- NGOs
- Landowners
- Political subdivisions

***What information is already available to further characterize this issue*?**

-

***What additional data or information may be necessary to fully understand this issue*?**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Avoid losses or mitigate losses and therefore protect tourism, avoid or mitigate impacts to hunting economy, fishing industry, avoid losses in outdoor recreational pursuits

***Provide additional Information of clarification (if any)*:**

Migration of Wetlands

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Kurt Philipp – Wetlands Research Services

Wayne Baker – Town of Dagsboro

Andrew Manus – TNC

Holly Michael - UD

***Description of Issue*:**

- Best described in terms of the question. How best to accommodate and/or utilize mechanisms to allow for the landward migrations of wetlands given "x" rate of sea level rise. Major geographies that will be impacted will include coastal agricultures; private hunt clubs; state wildlife areas/parks; and federal wildlife refuges in Delaware
- Marsh landward transgression will create new salt marsh mosquito breeding habitat as the "high" marsh (marsh/wetland ecotones) moves landward – may or may not be "offset" by changes or losses of wetlands more seaward

***Geographic Extent of Issue Impact*:**

[X] **Statewide**	[ ] **New Castle County**	[ ] **Kent County**	[ ] **Sussex County**
[ ] **Specific Community**	[ ] **1-5 Communities**	[ ] **More than 5 Communities**	

***Additional information provided for the above question*:**
See question 1

***Who does this issue affect*?**

- Private property owners (farmers), hunt club, NGO, Delaware Wild Lands, TNC, Little Creek, Leipsic, Milford Neck, Woodland Beach, NWR, duck hunters, bird watchers, trappers, Natural Resource Agencies, residential

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- NGOs – lead by example in managing lands
- Federal WRs – lead by example in managing lands
- State FW – lead by example in managing lands
- Town's Government Agencies – work with citizens
- Farm Bureau – help members understand impacts and work to develop strategies to help them adapt
- State Planning Office – anticipating planning and outreach, permits/policy development
- County
- Academics – research understanding effects

***What information is already available to further characterize this issue*?**

- Wetlands Vulnerability Index – EPA
- Managed retreat in Great Britain – Kurt Philipp
- Policy Information – FEMA Flood Response

***What additional data or information may be necessary to fully understand this issue*?**

- Ground ± with wetland vulnerability index
- Understand wetland accretion rates
- LiDAR fact set for wetlands
- Property owners (landward)
- What incentives work to allow for migration
- DO Rolling Conservation Easements work
- Transformational Farming
- Explore use of halophyte based crops

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Helps protect wetland and habitat
- Retains recreational values of marshes
- Acknowledges the ecological services of marshes
- Helps protect economic stability of agricultures
- Flood protection benefits
- Safety in protecting against flood damage

***Provide additional Information of clarification (if any)*:**

Wetland migration is already being experienced (Bombay Hook/Prime hook). This will be exacerbated as storm frequency and severity increases along with sea level rise ratio

Migratory Waterfowl Management/Diversity

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Holly Michael – UD

Andrew Manus – TNC

Wayne Baker – Town of Dagsboro

Kurt Philipp – Wetlands Research Services

***Description of Issue*:**

- Whether to maintain freshwater habitats in the face of natural changes in the wetlands in order to maintain recreation/hunting. In our view, this is more of a value-driven issue than an ecological one. The birds have alternative habitat. The issue is whether to keep specific birds in a particular are for human use.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**
Suisun Marsh in California is an example

***Who does this issue affect*?**

- Ducks Unlimited
- Delmarva Water fowlers
- Bombay Hook
- Fish and Wildlife Advisory Council, Atlantic Coast Joint Venture
- State Fish and Wildlife Agencies

***When will these effects be felt*?**

[X] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- State and Federal Wildlife area managers – Management decisions on local refuge
- Academics – research on ecological effects
- Private hunt clubs – Cost benefit ratios: maintain or abandon?
- Ducks Unlimited – Cost benefit ratios: maintain or abandon?

***What information is already available to further characterize this issue*?**

- Ducks Unlimited may have info
- Matt Dibona – State Waterfowl biologist

***What additional data or information may be necessary to fully understand this issue*?**

- Up to date relative sea level rise forecasts
- Permitting and regulatory programs
- Adjacent land use – can areas migrate inland? Permitting issues?
- Current practices in other areas of the country (Gulf? Coastal Louisiana)

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Social benefits primarily to maintaining freshwater habitats. Mainly on hunting and waterfowling public
- Ecological benefits likely secondary

***Provide additional Information of clarification (if any)*:**

Managers should decide <u>whether</u> to address the issue

Political Barriers

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

John Talley – DGS

Bill Meredith – DE Mosquito Control

Anthony Pratt – DNREC/DSW

***Description of Issue*:**

- LACK OF "POLITICAL WILL"
- Very difficult for elected or appointed officials to ask the public to make sacrifices or experience "pain" today for benefit of citizens tomorrow
- Taking actions that will involve "pain" for the public can almost always be delayed for at least 4 years, especially if any issue needs "more study"
- Who "pays" the most for implementing any solutions that may be found? The Feds? The State? Counties of local municipalities? How would this be determined?

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Everybody

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Activists
- NGOs
- Agency professionals
- Whoever might be able to get the Governor's office and the General Assembly to act in responsible manner, despite the political costs to the Governor or General Assembly members if they thus act this way
- Conversely, you might ask the Governor or General Assembly to actually take the lead, but this might be asking too much

***What information is already available to further characterize this issue*?**

- What you can see in the daily newspapers in a hundred and one different ways

***What additional data or information may be necessary to fully understand this issue*?**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- If you could get the Governor of General Assembly to “do the right thing” about sea level rise issues, almost anything else could be successfully addressed too!

***Provide additional Information of clarification (if any)*:**

REALISTIC VIEW

- We probably need to start to experience some real hardships that are widespread before enough “political will” will finally surface to start to do whatever is needed. We’re not there yet.

Saltwater Intrusion (Into freshwater sources/Habitats)

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Roy Miller – DNREC/DFW

Michael Rhode – DNREC/DSW

Lorraine Fleming – DE Nature Society (Scribe)

***Description of Issue*:**

- Fast shift in flora and fauna in coastal freshwater impoundments and flooding water
- Salt lines will advance in all tidal waters affecting anadromous fish species
- Affect commercial and recreational fishing and recreational hunting (both positively and negatively)
- Affecting drinking water supplies
- Other water/chemistry effects
- Affects land cultivation/Ag Community
- Ultimately limits land development

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**
Widespread impacts

***Who does this issue affect*?**

- DNREC

- ASMFC
- USFWS
- Local governments
- Hunter organizations
- Commercial and recreational fishing organizations
- Water resource agencies
- Conservation organizations
- Farmers
- Homebuilders
- Realtors
- DHSS (Division of Public Health)
- DGS
- USGS
- WSCC

***When will these effects be felt*?**

[X] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DNREC – monitoring/management/regulatory
- ASMFC/USFWS – monitoring/management/regulatory
- Local Governments – management/regulations
- Hunting/fisheries organizations – anecdotal info/advocacy
- Water resources agencies – monitoring/research/regulations
- DGS – monitoring/research/advocacy
- DHSS - monitoring/research/regulations
- Conservation organizations - monitoring/research/advocacy

***What information is already available to further characterize this issue*?**

- Geologic info – DGS/USGS
- Water quality info – DGS/USGS/Water Resource Agency/Water Utilities
- Info on life histories/tolerances/preferences of aquatic organisms – scientific literature
- Human water chemistry, tolerances – medical literature

***What additional data or information may be necessary to fully understand this issue*?**

- Refinement/expansion of above
- More hard data needed

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Water supply protection
- Preservation of recreation
- Preservation of floral and faunal species and ecological communities

***Provide additional Information of clarification (if any)*:**

Scientific Data Needs

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Kurt Philipp – Wetlands Research Services

Wayne Baker – Town of Dagsboro

Andrew Manus – TNC

Holly Michael - UD

***Description of Issue*:**

- Data required to describe climate change and sea level rise as they affect Delaware. Real world specific applications of global, national, regional science to Delaware environments

***Geographic Extent of Issue Impact*:**

[X]	**Statewide**	[ ]	**New Castle County**	[ ]	**Kent County**	[ ]	**Sussex County**
[ ]	**Specific Community**	[ ]	**1-5 Communities**	[ ]	**More than 5 Communities**		

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Academic entities, State, County, Federal Research groups

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Academic entities – interpretation of global science to Delaware conditions
- Federal Research – Delaware based research to support or refute global data
- State
- County

***What information is already available to further characterize this issue*?**

- Information presented at morning technical session of this workshop

***What additional data or information may be necessary to fully understand this issue*?**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

-

***Provide additional Information of clarification (if any)*:**

Species Range/Migration Shifts

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Mark Nardi – USGS

Karen Bennett – DNREC/DFW

***Description of Issue*:**

- Species may be displaced
- Invasive/nuisance species and disease may increase
- Species composition will most likely change
- Value? → Economical/social – What will be impacted? What are priorities? What do we do? Allow others (state) to take over? Shorebirds stopover. What baseline are we going to manage for…e.g. "restoration": what would that look like?
- We do not know what the change will "look like"
- Cannot engineer a response to species by species management
- Need a baseline risk assessment for species and habitats
- Species values and ecosystem services – Value
- We don't know what will be impacted – not identified yet
- Impossible to separate. Ultimate Climate Change – Sea level rise and policy/management response!
- Edge of range species – southern species here now, but rare – will we be center of range for those species?

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Everyone
- Public
- Conservation organizations/NGO
- Regulators and local economies/tourism
- Hunters
- Fishermen
- Bird watchers

***When will these effects be felt*?**

☐	**Immediately**	☒	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***When should managers begin to address this issue*?**

☒	**Immediately**	☐	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Partnership for DE – analysis, funding
- NOAA – commerce
- DOI – USGS, FWS
- EPA
- DNREC/DFW – field assessment

- DDA – Forest services and plant Ind. – invasives and nuisance
- USDA – NRCS – Implementation
- TNC – analysis, funding
- DNS – analysis, funding
- Private land owners – implementation/practices

***What information is already available to further characterize this issue*?**

- Sea level rise models
- Elevation data
- Vegetative community data/Habitats – Natural Heritage/DPW/DNREC
- Rare and uncommon species locations - Natural Heritage/DPW/DNREC
- Water Quality data
- Stream flow data
- Waterfowl concentration – DNREC/DFW
- Shorebird concentration – DNREC/DFW
- Fisheries data e.g. oysters, horseshoe crabs, etc.
- Species → plants and animals

***What additional data or information may be necessary to fully understand this issue*?**

- Social/economic priorities
- Regional and national opportunities to replace lost resources in DE → regulatory level assessment of risk and impacts
- Tracking ranges, especially invasive/diseases

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Unknown → Need to know what would be affected first

- Can predict economic/social effects of losing individual or groups of species? For recreational/community harvest could be done – has been done for some
- Disease/insect-borne or other invasive

***Provide additional Information of clarification (if any)*:**

Water Quality (Effects of SLR)

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Ken Reynolds – DNREC/DFW

Julia Wyman – CSO

Dan Brower – DNREC/DSW

***Description of Issue*:**

- Ground water impacts
- Saltwater intrusion in wells affecting drinking water
- Saltwater effects on some septic systems
- Implications on public health

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Individual home owners – private wells
- Municipalities – water supplies
- Groups/advocates involved in public health issues
- Development companies – restricted opportunities if poor water quality
- Real estate companies

***When will these effects be felt*:**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*:**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*:**

- State, federal, local governments
- Non-governmental groups

***What information is already available to further characterize this issue*:**

-

***What additional data or information may be necessary to fully understand this issue*:**

-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*:**

- Population health
- Agriculture benefits
- Developers/real estate economic benefits

***Provide additional Information of clarification (if any)*:**

Wetland Degradation/Ecosystem Replenishment

***Breakout Group*: Habitat and Natural Resources**

***Authors*:**

Bartholomew Wilson – DNREC/DSW

Maria Sadler – DNREC/DSW

Chad Tolman – DE Chapter of Sierra Club

Danielle Kreeger – Partnership of the DE Estuary

***Description of Issue*:**

- Current evidence indicates 2/3 of the existing Tidal marshes are already degrading in condition and function
- Need monitoring and assessment standards and resources to assess future needs
- Degraded conditions → reduced flood protection
- Heightened vulnerability to major storm blow out
- Habitat loss – shellfish, migratory birds
- Sea Level Rise threatens these habitats for many reasons. E.g. salinity, increased energy from storms, shoreline erosion, increased or decreased nutrients

***Geographic Extent of Issue Impact*:**

[X]	**Statewide**	[ ]	**New Castle County**	[ ]	**Kent County**	[ ]	**Sussex County**
[ ]	**Specific Community**	[ ]	**1-5 Communities**	[X]	**More than 5 Communities**		

***Additional information provided for the above question*:**
There is a diversity of wetland types that are affected differently. Sea level rise impacts need to be studied along with other impacts for example, nutrient studies, freshwater inputs

***Who does this issue affect*?**

- Everyone → wildlife and fish, water quality managers
- Ducks Unlimited, commercial crabbers and fishermen, development that benefits from flood protection by wetlands
- Wetland restoration stakeholders

***When will these effects be felt*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- State – Division of Water Resources
  - Division of Soil and Water Conservation
- Federal – Corps – Fish and Wildlife Service
- MAWWG
- Non-Profits – Delaware Nature Society
- Towns and Communities
- Need a regional approach – Counties
- Need to explore what other states have done and learn from their mistakes and accomplishments

***What information is already available to further characterize this issue*?**

- Info available on conditions is limited
- Estuary Program is monitoring (DEWMAP)
- National Wetland Inventory – State Survey – Division of Water Resources
- NVCS – from partnership with TNC – mapping with GIS

***What additional data or information may be necessary to fully understand this issue*?**

- DEWMAP – 1/10 funded – need resources for conditional assessments
- Need to know more about stressor conditions that are interacting with sea level rise – example fly ash storage at Indian River Power Plant
- Need unified plan so there is intercomparability among groups and agencies – include adjacent watersheds
- Beneficial use of dredge material
- Need regional sediment budget model that explains whether marsh condition is affected by sediment deficits associated with channel deepening

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- When proactive, can identify those environments that are most impacted and vulnerable and develop cost effective strategies to save marshes for tomorrow

***Provide additional Information of clarification (if any)*:**

- The need for more study, data and assessment should not be an excuse for inaction. There are certainly no-brainer, low-hanging fruit options that can be acted on quickly
- Plan for the future, not the past
- Encourage wetland condition in place (vertical accretion, lining shorelines, beneficial dredge spoil use) as well as allowing horizontal migration
- Focus these efforts where marsh condition is likely to be sustained (lack of other major stressors)

Appendix D:

Issue Characterizations

Human Health and Public Welfare Breakout Session

Access to Medical Facilities

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Lisa Pertzoff – LWV

Jack Klingmeyer - City of New Castle

Rick Perkins - Div. of Public Health

***Description of Issue*:**

- As sea level increase medical facilities may be impacted that are located near the coast
- Transportation may be impacted
- Increased response time
- Socioeconomic impact possible

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

- Those local within area of tidal rise

***Who does this issue affect*?**

- Public Health
- Area hospitals
- Citizens in the area
- Medical Responders

***When will these effects be felt*?**

☐	**Immediately**	☐	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☒	**Longer than 50 years**		

***When should managers begin to address this issue*?**

☐	**Immediately**	☒	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Hospitals - may need to be relocation
- EMS/Police - response route changes
- Transportation - loss of roadway
- Public Health - may result in decrease in health care

***What information is already available to further characterize this issue*?**

- Local Address - see yellow pages
- Need mapping so facilities in danger can be identified

***What additional data or information may be necessary to fully understand this issue*?**

- Mapping of all medical facilities with regard to sea level rise

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Identify facility that may be impacted
- Need to look @ transportation impacts

***Provide additional Information of clarification (if any)*:**

Agriculture & Food Production

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Greg Williams - DNREC

Jen Campagnini - DNREC (scribe)

Tom Moran - DNREC

Diana Olinger - NOAA

***Description of Issue*:**

- loss of productive agricultural land
- agriculture is DE's (one of) greatest economic drivers (poultry, cropland, vegetable production)
- transportation of goods
- impact on growing seasons and productivity
- types of crops that can be grown due to change in conditions/saltwater intrusion – content/soil conditions
- irrigation of crops due to saltwater issues
- potential contamination of available agricultural land by underground storage tanks, other pollutants from flooding, elevated water table impacts on polluted lands
- Aquatic/shellfish food industry lost – economic impacts
- Harvest of other aquatic species described b/c of lost habitat
- What to do with animal waste/pollution to WQ
    - increased / pollution water table
- availability of food products
- monetary value of land decreased/lost
- higher food prices due to decreased production

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**

- Primarily Kent and Sussex issue b/c where agricultural land is.

***Who does this issue affect*?**

- EVERYONE!
- Farmers
- Fisherman/waterman
- Tourist
- Property owners
- Consumers
- Municipal government
- Real estate industry

***When will these effects be felt*?**

☐	**Immediately**	☐	**Within 10 years**	☒	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***When should managers begin to address this issue*?**

☒	**Immediately**	☐	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Farmers - provide information/knowledge on how issue may affect them; how they are able to adapt
- Ecologists/Scientist (soil/wetlands) - provide research/data on potential impacts to spec. resources
- Local municipalities / decision makers - land use planning perspective
- DNREC/DDA/DelDOT - access, transportation, policy, and resource issues
- Conservation Districts/NRCS - technical assistance/financial assistance
- Poultry producers
- Economic development office
- Ag Researchers (UD, DSU) - understand and provide science

***What information is already available to further characterize this issue*?**

- Research/Data on soils/wq/ag production - UD-CANR/DSU/other academic sources
- Mapping/Modeling of coastal zone/wetland – Dave Carter / DNREC
- Production info / data for ag/food production – ag/food production industry groups; NRCS-USDA
- Alternative farming practices (hydroponic methods, etc)

***What additional data or information may be necessary to fully understand this issue*?**

- education/knowledge of farmers on issues
- better models/mapping to show more realistic impacts
- understanding types of ag/crops can be sustained under conditions
- availability of funding to subsidize ag/food production – what happens if that $$ goes away
- how much will cost be impacted

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Availability of food!
- Less subsides needed – availability of sufficient land for production
- Protection of habitat for aquatic ag resource
- Minimizing pollution sources for Water Quality

***Provide additional Information of clarification (if any)*:**

- All depends on approaches taken to deal with this…i.e. retreat vs. dike vs. elevate.

Biodiversity Impacts & Ecosystem Modification

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Lisa Pertzoff - LWV

Jack Klingmeyer - City of New Castle

Rick Perkins - Div. of Public Health

***Description of Issue*:**

- Biodiversity changes as a results of "saltwater"
- Potential impacts on agriculture and animal husbandry (?)
- Recreational changes – mental health
- Fisheries changes may be impacted
- Aquatic or terrestrial - we are not sure what to focus on??

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

- Coastal area will be impacted primarily

***Who does this issue affect*?**

- Local fisherman
- DNREC
- All citizens

***When will these effects be felt*?**

☐	**Immediately**	☐	**Within 10 years**	☐	**Within 11-25 years**
☒	**Within 26-50 years**	☐	**Longer than 50 years**		

***When should managers begin to address this issue*?**

☐	**Immediately**	☐	**Within 10 years**	☒	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DNREC
- US EPA

***What information is already available to further characterize this issue*?**

***What additional data or information may be necessary to fully understand this issue*?**

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

***Provide additional Information of clarification (if any)*:**

Drinking Water – Wells & Systems

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Lisa Pertzoff - LWV

Jack Klingmeyer - City of New Castle

Rick Perkins - Div. of Public Health

***Description of Issue*:**

- Long range planning to insure water quality to Delawareans as a result of sea-level rise.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Citizens (private and public water users)
- Municipalities; counties; water utilities
- Governmental regulatory agency (office of drinking water)

***When will these effects be felt*?**

[ ] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DNREC - take lead on climate change
- Div Public Health - water testing; monitoring
- US EPA - tougher regulation of climate change
- USGS - ?
- NOAA - ?
- Private Industry - treatment technology

***What information is already available to further characterize this issue*?**

- Water quality data - Div Public Health; office of Drinking Water
- Sea-level Rise Data - NOAA

***What additional data or information may be necessary to fully understand this issue*?**

- Accurate rate of sea level rise
- Intrusion rate data
- Better modeling of climate change and impact on
- Sea level Rise

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- potable water is a must
- prohibit the combustion of fossil fuels

***Provide additional Information of clarification (if any)*:**

Educating the Public & Homeowners

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Patricia Strombaugh - Town of Smyrna / Mayor

Mike Powell - DNREC/DSW

Don Knox - DEMA

Ed Durst - DEMA

***Description of Issue*:**

- The public/homeowners can't make informed or educated decisions without having the proper information or knowing what programs are available.
- The public needs to know the potential impacts of sea level rise to make informed decisions.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

- Will affect not just Delaware but the region.

***Who does this issue affect*?**

- Individual property owners
- Communities
- Insurance industry
- Realtors, builders, developers

***When will these effects be felt*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***When should managers begin to address this issue*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- State legislature – amend state real estate disclosure laws
- Government planners (state, local, county) – incorporate sea level rise planning into land use planning
- NOAA – develop maps to show vulnerability to sea level rise.

***What information is already available to further characterize this issue*?**

- LIDAR
- Long range sea level rise projections

***What additional data or information may be necessary to fully understand this issue*?**

- What will help property owners make informed decisions

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Provide guidance to prevent potentially risky land development
- Allow property owners to make informed decisions
- Head off potential litigation
- Set aside land for wetland migration
- Protect environment

***Provide additional Information of clarification (if any)*:**

Emergency Evacuation Response (Flooding)

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Ed Durst – DEMA

Mike Powell – DNREC

Pat Strombaugh - SMYRNA

***Description of Issue*:**

- Sea level rise causes increased flooding leading to emergency response needs.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

- Or adjacent regions in major events.

***Who does this issue affect*?**

- Fire
- Police
- EMS
- Red Cross
- Volunteers
- Guard
- Elected Officials
- County and Local Governments
- Schools
- Emergency Management

***When will these effects be felt*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***When should managers begin to address this issue*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Elected Officials – decision making
- County Emergency Ops. – coordinate evacuation decision making.
- DELDOT / Police – manage traffic
- First Responders – Finding solutions and reviewing local emergency ops plans.
- Health care facilities – evacuation plans

***What information is already available to further characterize this issue*?**

- Evacuation plans already exist – DELDOT – Gene
- DE emergency ops plan – DEMA – Donaldson
- Shelter plans – DEMA
- Local emergency ops plans – Local Governments

***What additional data or information may be necessary to fully understand this issue*?**

- How sea level rise affects emergency response
- Future growth patterns
-

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Public safety

***Provide additional Information of clarification (if any)*:**

Financing Public Works

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Greg Williams - DNREC

Jen Campagnini - DNREC (scribe)

Tom Moran - DNREC

Diana Olinger - NOAA

***Description of Issue*:**

- Identifying funding sources for roads, sewer, stormwater, water, electric, etc…including hospitals, emergency response, to prepare for sea level rise
- Cost of updating public works to adopt to sea level rise
- Interagency coordination to address this issue is a problem
- Ability to relocate and adapt public works cost effectively – availability of land for services

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [X] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- DelDOT
- Municipal units
- Hospitals
- Fire departments

- Emergency responders
- Railroads
- Water/sewer providers/users
- Public
- Police
- DEMA
- FEMA
- Banks/finance companies

***When will these effects be felt*?**

[X] **Immediately** [X] **Within 10 years** [X] **Within 11-25 years**

[X] **Within 26-50 years** [X] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Planners (all levels)
- DelDOT
- Emergency Response
- Municipal Governments
- Federal governments/elected officials
- DNREC
- Railroads
- Public works organizations
- All of the above for planning, coordination, investments, education

***What information is already available to further characterize this issue*?**

- Case studies – i.e. Glenville, Katrina - various
- NOAA/CSC - hazards, state events for case studies, vulnerability studies
- Coastal vulnerability studies - Dave Carter

***What additional data or information may be necessary to fully understand this issue*?**

- Build out level for counties/municipalities
- Land use plans
- Vulnerability analysis
- Cost/benefit of current infrastructure – money to maintain, retreat, fortify (?)
- Risk assessments

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Reduce cost to mitigate now vs. later
- Social-economic – prioritize infrastructure spending overtime
- Standard of living issues

***Provide additional Information of clarification (if any)*:**

Land Use Planning

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Patricia Strombaugh - Town of Smyrna / Mayor

Mike Powell - DNREC/DSW

Don Knox - DEMA

Ed Durst - DEMA

***Description of Issue*:**

- Land use planning affects everybody and generally does not account for increased risk to sea level rise.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Counties
- Towns
- Emergency responders
- Developers
- Landowners
- Utilities
- Schools/Districts

***When will these effects be felt*:**

	Immediately		**Within 10 years**		**Within 11-25 years**
X	**Within 26-50 years**		**Longer than 50 years**		

***When should managers begin to address this issue*:**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*:**

- Elected Officials – make informed laws and regulations
- Planners – planning decisions
- Scientists – create data that planners can use

***What information is already available to further characterize this issue*:**

- LIDAR
- Sea level rise projections

***What additional data or information may be necessary to fully understand this issue*:**

- Maps showing land impacted by sea level rise
- Future or projected sea level rise
- Historical data of storms, sea levels

***What are the economic, social and/or environmental benefits to proactively addressing this issue*:**

- Create open space in areas to allow wetland migration
- Prevent people from building in high risk areas
- Reduce property damage

***Provide additional Information of clarification (if any)*:**

Location of Community Services

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Don Knox - DEMA

Brian Hall - Office of State Planning

Valerie Grey - DNREC/AQM

***Description of Issue*:**

- The location of community services in the event of sea level rise will require the relocation of a local community.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[X] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

- This could affect a variety of coastal and river based communities.

***Who does this issue affect*?**

- Property Owners
- Federal – FEMA
- Local – Towns and Counties
- State – DNREC and DEMA

***When will these effects be felt*?**

[ ] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [X] **Longer than 50 years**

***When should managers begin to address this issue*?**

☐	**Immediately**	☐	**Within 10 years**	☐	**Within 11-25 years**
X	**Within 26-50 years**	☐	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Local – town and county
- State – anybody and everybody
- Federal
- NGO
- Hospital

***What information is already available to further characterize this issue*?**

- Land use plans
- Mitigation plans
- Historical plans

***What additional data or information may be necessary to fully understand this issue*?**

- Site specifics
- Historical data
- Community input

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

***Provide additional Information of clarification (if any)*:**

Stormwater

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Don Knox - DEMA

Brian Hall - Office of State Planning

Valerie Grey - DNREC/AQM

***Description of Issue*:**

- Stormwater management – drainage.
- Septic failure due to saturated soils – drinking water filtration.
- Increase in number of flooding locations
- Increase of duration of flooding
- Greater flooding effect and greater impact
- Cost of relocation of facilities

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Federal
- State
- Local
- Individual Homeowners

***When will these effects be felt*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***When should managers begin to address this issue*?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Federal: EPA, Corp, FEMA
- State: DNREC, DELDOT, DEMA, OMB, Conservation Districts, Farm Community (Ag)
- Local: Counties, Municipalities, Public Works, Planning and Zoning
- Individual homeowners
- NGO's and community groups
- Industries

***What information is already available to further characterize this issue*?**

- Flood Maps – DNREC
- Stormwater studies – DNREC
- Land use plans – OPC
- Mitigation Plans – DEMA
- Historical Data – DEMA
- Districts and local stormwater management/drainage districts

***What additional data or information may be necessary to fully understand this issue*?**

- Continued land use planning

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

***Provide additional Information of clarification (if any)*:**

Wastewater Systems Disposal

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Valerie Grey - DNREC/AQM

Brian Hall - Office of State Planning

Peder Hanson - DNREC/DWR

***Description of Issue*:**

- Ensure statewide wastewater system integrity for the next 50 years.

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Federal, state, local governments.
- Individuals
- Private utilities
- Private communities

***When will these effects be felt*?**

[ ] **Immediately** [ ] **Within 10 years** [X] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

When should managers begin to address this issue**?**

X	**Immediately**		**Within 10 years**		**Within 11-25 years**
	Within 26-50 years		**Longer than 50 years**		

What organizations/individuals should be involved in finding solutions to this issue**?**

- EPA
- DNREC
- Counties
- Municipalities
- NGO's

What information is already available to further characterize this issue**?**

- Current baseline data on existing facilities
- Land use planning data
- Population projections

What additional data or information may be necessary to fully understand this issue**?**

What are the economic, social and/or environmental benefits to proactively addressing this issue**?**

- "Being able to flush the hopper" and protect human health and the environment

Provide additional Information of clarification (if any)**:**

Waterborne Disease

***Breakout Group*: Human Health & Public Welfare**

Author(s):

Greg Williams - DNREC

Jen Campagnini - DNREC (scribe)

Tom Moran - DNREC

Diana Olinger - NOAA

***Description of Issue*:**

- Mosquitoes
- Biohazard – e. coli
- Loss of recreation areas, fishing, aquatic shellfish/seafood industry
- Pushing coast inland – potential for more interaction b/w breeding areas & population centers
- Higher incidence of waterborne disease in livestock, wildlife, etc.

***Geographic Extent of Issue Impact*:**

☐ **Statewide**	☐ **New Castle County**	☐ **Kent County**	☐ **Sussex County**
☐ **Specific Community**	☐ **1-5 Communities**	☒ **More than 5 Communities**	

***Additional information provided for the above question*:**

- i.e. bay communities area, tidal river areas as they move inland.

***Who does this issue affect*?**

- Public health, Parks & Recreation, Fish & Wildlife
- Agriculture industry, bay community residents
- Shellfish industry, tourist industry in affected areas

***When will these effects be felt*?**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

- Long duration, high intensity of effect.
- Depends on when disease appears

***When should managers begin to address this issue*?**

☒ **Immediately** ☒ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

- Research on for mitigation, vaccines, etc.

***What organizations/individuals should be involved in finding solutions to this issue*?**

- NIH - Research
- Universities - Research
- CDC - Research/Response
- Public Health (DE) - implementation
- Land use planners

***What information is already available to further characterize this issue*?**

- Existing research on disease impacts
- Environment that produces waterborne disease

***What additional data or information may be necessary to fully understand this issue*?**

- Preventive methods/measures to deal w/diseases
- Outreach/education
- Modeling/mapping of potential impacts & potential conditions to breed disease

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- reduction of risk of incidence of disease
    - reduced cost to treat/healthcare
    - less loss of life (human, livestock, aquatic, wildlife)
    - protection of aquatic/shellfish industries
    - protection of livestock

***Provide additional Information of clarification (if any)*:**

- This issue will only become important when an occurrence is imminent.
- Increased prevalence of water-borne disease would be indicative of future problems.

Appendix E:

Issue Characterizations

Infrastructure Break Out Session

Built Features

***Breakout Group*: Infrastructure**

***Authors*:**

Mary Neutz – City of Wilmington

John Lloyd – City of New Castle

***Description of Issue*:**

- Sewer/Drinking Water
- Wilmington → drinking water issues are water quality related → supply comes from PA
- Wilmington Port will lose infrastructure
- Pump Stations – South Wilmington – would affect ability to transport sewage to plants
- Wilmington tide gates
- Sewers – combined system
- NCC/New Castle → salt intrusion into water wells (aquifer contamination)
- Sewer (New Castle) – ability to get product to plant
  - backing up of product
- Aging
- Undersized system
- Breaks/leakages
- Roads – major highways 95/495 under water → erosion will undermine roads
- Landfills
- Bridges

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**
All water providers, sewage treatment facilities, DelDOT, Municipalities, counties

***When will these effects be felt*?**

[ ] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[X] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DNREC
- EPA
- POTWs
- Water Providers
- DE Water Resources Agency
- Counties
- Municipalities

***What information is already available to further characterize this issue*?**

***What additional data or information may be necessary to fully understand this issue*?**

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

***Provide additional Information of clarification (if any)*:**

Coastal Evacuation

***Breakout Group*: Infrastructure**

***Authors*:**

Mark Glaze – DelDOT

Maria Honeycutt – NOAA/CSC

***Description of Issue*:**

- Evacuation of 100 000 – 150 000 people from Delaware Atlantic Coastal beaches in summer (seasonal population)
- Evacuation of smaller population from same area because of winter storms/Nor'easters
- Similar evacuation needed for small Delaware Bay communities
- Evacuation routes for Sussex County currently below mapped 100-year coastal flood elevation (RT 1, RT 24, RT 54)
- With SLR ± increased storm intensity, roads will be even further submerged
- Population has little/no experience evacuating; poor understanding of current risks, let alone risks including SLR
- Main issues are: Access to roads is threatened by SLR and/or sheer number of people using roads (capacity)

***Geographic Extent of Issue Impact*:**

☐ **Statewide**	☐ **New Castle County**	☒ **Kent County**	☒ **Sussex County**
☐ **Specific Community**	☐ **1-5 Communities**	☒ **More than 5 Communities**	

***Additional information provided for the above question*:**
Complicating factor – evacuees from Maryland

***Who does this issue affect*?**

- Evacuees: Resident population, seasonal residents, business owners/employees, state/local employees – in harm's way
- Evacuation planners/managers: Need to develop plans, strategies to deal with evacuation routines with SLR

***When will these effects be felt*? NEXT STORM!!! (Worsening in future)**

☐ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***When should managers begin to address this issue*?**

☒ **Immediately** ☐ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DEMA
- DelDOT
- Responders (Police National Guard)
- State/Local Officers (Those who adopt evacuation plans, those who make evacuation decisions)
- Chambers of Commerce – business/tourism
- Science Community and Engineers – Academics (UD, DGS), Government (NOAA, USGS, USACE, State Agencies – DNREC, Sea Grant)
- Maryland Representative (Maybe VA too)

***What information is already available to further characterize this issue*?**

- Flooding info with Climate Change info estimates – Floodplain Managers, Flood Forecasts (news), Scientists (e.g. DGS) for historical flood info, SLR estimates
- Road network (including elevations!) – DelDOT
- Population numbers (year round and seasonal) – State Planning (MD and DE)
- Behavioral info (who evacuates, why, how many will go) – USACE (hurricane evacuation studies)
  *Would probably need more refined info that USACE work)

***What additional data or information may be necessary to fully understand this issue*?**

- Sea Level Rise estimates → How much in planning window, ± factor of safety
- Flooding estimates (storms) that include projected SLR and potentially increasing storm intensity/frequency info → Maybe range of flood scenarios for consideration in planning process

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Avoids loss of life!
- Minimize needless evacuation (focus efforts in most vulnerable areas)

***Provide additional Information of clarification (if any)*:**

- DelDOT presentation: "Global Warming Impacts to Delaware's Transportation Factor" – November, 2008
- Managers' efforts should be made now to incorporate in existing planning

Drinking Water

***Breakout Group*: Infrastructure**

***Authors*:**

Scott Andres – DGS

Andrew Homsey – UD – WRA

Holly Weyers - USGS

***Description of Issue*:**

- Saltwater intrusion, aquifer inundation, etc.
- High percentage of people live within self supply areas
- Public/Private issue
- United Water DE – lots of regulations
  - Permitting of their tidal control structure
  - Move intake?
- Lack of basic data to enable prediction
- Demographic shifts will exacerbate situation (and population)

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**
Complex system – Public/Private INIDIV, Utilities, Surface/Ground

***Who does this issue affect*?**

- Drinking water affects everyone

***When will these effects be felt*?**

☐ **Immediately** ☒ **Within 10 years** ☐ **Within 11-25 years**

☐ **Within 26-50 years** ☐ **Longer than 50 years**

***When should managers begin to address this issue*?**

Immediately **Within 10 years** **Within 11-25 years**

☒ **Within 26-50 years** ☐ **Longer than 50 years** ☐

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DNREC/DWR
- DHS
- DSU/UD/DGS – studies
- Investor owned utilities
- Municipal utilities
- DRBC
- USACE
- CGS

Overlapping Jurisdiction

Overlapping Jurisdiction

***What information is already available to further characterize this issue*?**

***What additional data or information may be necessary to fully understand this issue*?**

- Move groundwater monitoring wells
- Need to know where salt water is
  → Want to predict where issues will be

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Avoid major disruptions which would affect quality of life, human health and safety

***Provide additional Information of clarification (if any)*:**

Land Development Patterns

***Breakout Group*: Infrastructure**

***Authors*:**

Rob McCleary – DelDOT
Jeff Bergstrom – City of New Castle
Dwayne Day – DelDOT

***Description of Issue*:**

- Emergent land use planning that precludes economically and physically dangerous land development

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**

***Who does this issue affect*?**

- Everyone affected by or involved in coastal zones

***When will these effects be felt*?**

[ ] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X] **Immediately** [ ] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***What organizations/individuals should be involved in finding solutions to this issue*?**

- Local Government – adopt land use regulation
- County Government – adopt land use regulation
- State Agencies – provide expertise
- Universities – provide technical skills
- Developers themselves – provide the impetus

***What information is already available to further characterize this issue*?**

- Not so much except for anecdotal information about events

***What additional data or information may be necessary to fully understand this issue*?**

- Accurate hydrographic modeling
- Projection models – weather/development/sea level rise/demographic data

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Loss if inhabitation for coastal communities

***Provide additional Information of clarification (if any)*:**

Segmented Planning

***Breakout Group*: Infrastructure**

***Authors*:**

Mary Ellen Gray – Kent County Planning

Silvana Croope – DelDOT - TMC

***Description of Issue*:**

- Many types of infrastructure with some level of interconnection work if they were completely apart (own worlds), but impact usually ignores boundaries (geographic, budgetary, economic sectors…)

***Geographic Extent of Issue Impact*:**

[X] **Statewide** [ ] **New Castle County** [ ] **Kent County** [ ] **Sussex County**

[ ] **Specific Community** [ ] **1-5 Communities** [ ] **More than 5 Communities**

***Additional information provided for the above question*:**
Affect coastal communities first

***Who does this issue affect*?**

- A large group → cross-sector infrastructure e.g. people living along the coast and sharing protection responsibilities (e.g. elevated road, dykes…)
  → Can be responsible for domino effect even budget wise

***When will these effects be felt*?**

[X] **Immediately** [X] **Within 10 years** [ ] **Within 11-25 years**

[ ] **Within 26-50 years** [ ] **Longer than 50 years**

***When should managers begin to address this issue*?**

[X]	**Immediately**	[ ]	**Within 10 years**	[ ]	**Within 11-25 years**
[ ]	**Within 26-50 years**	[ ]	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DelDOT – Transportation (access and mobility), share/hold communication coordination
- DNREC – Environment (data resources)
- Private Water/Utility Company – sustainability
- Local Planning and Governments – Geographic distribution of activities and housing, policy "wish list" and locations of issues
- Neighborhood Organization
- Financial Planning and Government – allocation of present/future budget
- Research Centers – problem investigation and proposing solutions
- DEMA – overall impact, preparedness, response
- Agriculture – sustainability
- Developers – redefining projects in a proactive way with governmental planning

***What information is already available to further characterize this issue*?**

- LiDAR data for past/simulated events with real world data
- FEMA/DEMA damage assessment for recovery grant
- UD and Disaster Research Center (Sue McNeil – smcneil@udel.edu)
- TRB (Transport Research Board) – ongoing research and models → Committee ABE-40 critical infrastructure
- Asian Development Bank → reconstruction of disaster impacted communities
- U.S. Aid helps recovery of broadly impacted communities

- Local Land Use Plans
- TMC – DelDOT – coordination of events, incidents, emergencies, disasters (Gene Donaldson – DelDOT)
- U.N. and IPCC

***What additional data or information may be necessary to fully understand this issue*?**

- Capturing order of cascading issues impacting interdependent or interconnected infrastructure through time →know more vulnerable infrastructure and types of problems that may rise as time passes by

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Better local development
- Better comprehension of priority areas for investment
- Better chances to mitigate, respond and prepare for existing and coming problems with sea level rise
- Better exchange of information
- Teamwork
- Saving time and money for common ground activities

***Provide additional Information of clarification (if any)*:**

- To plan requires knowledge
- If knowledge is of parts, it may fail because infrastructure is not a closed system (living system)
- Big picture built by multidisciplinary group allows detecting problems that may not be visible when working with just a "project level"
- It is an exercise from a holistic (Big Picture) to a specific view and vice-versa

Transportation Infrastructure

***Breakout Group*: Infrastructure**

***Authors*:**

Bill Swiatek – WILMAPCO
Philip Wheeler – DNREC/AWM
Kristen Fletcher – CSO

***Description of Issue*:**

- SLR endangers many types of transportation infrastructure. These include: public highways and roads, railways, train stations, air and seaports, marinas and non-motorized facilities. These infrastructures are in danger of deterioration, destruction or frequent disruption due to flooding. This may result in isolation of thousands of people – which in turn would lead to increased use of other facilities and more incidents and will hamper economic activity and movement of people and goods.

***Geographic Extent of Issue Impact*:**

[X]	**Statewide**	[ ]	**New Castle County**	[ ]	**Kent County**	[ ]	**Sussex County**
[ ]	**Specific Community**	[ ]	**1-5 Communities**	[ ]	**More than 5 Communities**		

***Additional information provided for the above question*:**
Lower elevation communities are at a greater risk of SLR impacts

***Who does this issue affect*?**

- DelDOT, DEMA, DNREC, MPOs, State Police, Local law enforcement, Fire companies, FHWA, US Army Corps of Engineers, City of Wilmington Public Works, DMTA, Amtrak, Norfolk Southern, SEPTA, Port Authority (Wilmington), CSX, New Castle County Airport, Diamond State Corp, DRBA

***When will these effects be felt*?**

☐	**Immediately**	☒	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***When should managers begin to address this issue*?**

☒	**Immediately**	☐	**Within 10 years**	☐	**Within 11-25 years**
☐	**Within 26-50 years**	☐	**Longer than 50 years**		

***What organizations/individuals should be involved in finding solutions to this issue*?**

- DelDOT/Secretary Wicks – Planning and technical assistance
- WILMAPCO/Tigist Zegeye – Planning and technical assistance
- DNREC/Secretary – Data collection
- Governor's Office and DelDOT – Organization/Co-ordination
- Delmarva Passenger Rail Association – Planning assistance
- Dover Kent MPO – Planning and technical assistance
- Salisbury MPO – Planning and technical assistance
- Other State DOTs – Planning and technical assistance
- DEMA – Planning and technical assistance

***What information is already available to further characterize this issue*?**

- Evacuation routes – DelDOT
- Elevation maps – USGS
- Existing facilities – WILMAPCO/DelDOT
- 100 year Flood Plain maps – DNREC
- Vulnerable coastal map – EPA (unpublished)

- LiDAR Map – DNREC
- Population Data – Census Bureau/MPOs
- Road Condition – DelDOT/New Castle County

***What additional data or information may be necessary to fully understand this issue*?**

- Inventory of flood prone bridges and roads
- Monitoring of infrastructure for stress and weaknesses
- Standards for new roads and bridges

***What are the economic, social and/or environmental benefits to proactively addressing this issue*?**

- Improve long-term quality of life
- Economic benefits

***Provide additional Information of clarification (if any)*:**

Appendix F:

Complete List of Issues Compiled During Brainstorming Session

Appendix F contains a verbatim transcription of the initial issues and topics concerning sea level rise that participants listed during break-out sessions. In most cases, these lists were further refined or categorized by the groups, but are provided here for reference.

Economy and Community

- Impacts to Tourism
    - Beach loss in Dewey. Loss of tourism revenue. Beach tourism revenue sustains them and sustains the state, especially from hotels.
- Evacuation Concerns
    - Evacuation route of the beach towns is through Millville. Public Safety concerns.
- Flooding Concerns
    - SLR in Fenwick Island, observed increased rate of flooding
- Infrastructure / Roads
    - DEDO is looking at big picture road planning and redevelopment. Need to identify vulnerabilities, event potential, and evaluation of accurate data.
- Ensure Representation of ALL interested stakeholders. Bias of data distributed and accuracy long range forecasts. Personal Choice & Responsibility vs. government Regulation.
    - Personal Choice: Need to give citizens accurate, unbiased information and then let them make decisions.
        - Underestimated is the capability of individuals to adjust their lives to new circumstances.
        - Need to have faith in individuals to manage their own circumstances.
    - Stakeholder Representation: participant thinks statement of 'diverse stakeholders' is laughable (referring to workshop participant list).
        - Not just all stakeholders, but the correct ones too.
    - Bias of Information: Will there ever be a debate about global warming.
    - Accuracy of Data: Long term forecasts, ex. NOAA and weather forecasts, hurricane forecasts, are uncertain.
        - Make sure accurate information only is presented to communities.
- Creating Moral Hazard & Perverse Incentives
    - Reform existing institutions so that individuals and businesses bare full social costs.
        - People need to face the correct set of incentives
        - Ex. Flood insurance: Private sector should take care of that. Do not rush in with relief. Creates moral hazard incentive. Modify disaster response.
        - Ex. Internalize protective services provided in local areas. Beach nourishment should be borne locally and by tourists not by national taxpayers.
- What public policies to adopt for local governments.
    - Need to balance public interest, environmental issues, economic issues, and private property rights.
- Flood Insurance / Tourism:
    - Flood insurance premiums went up this year.
    - State owns the beach but Dewey maintains it and provides public safety for beach.
    - 50,000 people in Dewey in summertime.
    - FEMA said federal government does not supply funds into flood insurance and it is paid for by policy holders. FEMA is currently trying to change that.
    - Coastal areas are the 'cash cow'.

    - A lot of properties are owned by people in other states.
    - In some areas some have private policy holders.
- Social & Environmental Justice
    - Those with least control of their own destiny are most at risk. They are the most burdened. Historically people have settled in floodplain and do not have means to move. They are not fully being considered.
    - 50% live near coast. There is a reason for the population shift to the coast. People choose to live there.
- Coordination & Responsibility in Planning
    - State government is relied upon in Delaware, whereas in larger states county governments are relied upon. Delaware has 61 jurisdictions; 57 municipalities, 3 counties, & state government. Internalize social costs. Need to protect our existing investments, ex. Riverfront, because they are economic impacts. This could be an opportunity for sustainable economic development.
    - Must be regional efforts, some places are currently ignored. Regional transportation issues ignored.
- Water Quality & Economic Impacts
    - Saltwater intrusion and drinking water case studies.
        - Ex. New York is using up freshwater and decreasing Delaware's water supply.
        - Ex. Oysters. Increased diseases with increasing salinity. Large economic impact.
    - Dewey piggybacks off of Rehoboth for water supply.
    - Rehoboth gets their water inland near route 24, Lewes has well field near …
    - A lot of water is now brackish.
    - Referenced DNREC source water provision, which did not emphasize saltwater intrusion. Thinks there will be plenty of time to adjust to these incremental changes. Drinking water concerns are different in different parts of the state.
- Different Situations, Different Solutions:
    - Need different scenarios to illustrate range of effects.
    - Lay the facts out as strongly as you can. Focus on the facts and not hearsay information. Communicate to broad audience and define risk.
    - This issue is a risk management exercise. Plan for different scenarios.
    - We have to work from a common set of facts. Different people have different interpretations and applications of these facts.
    - Need to make a distinction in strategies of how to adapt in coastal areas versus in urban centers. No one size fits all.
    - Historical planning efforts tend to put in impediments to people not in favored areas. Top down management efforts are questionable. Planning delays of 2 or 3 years in some agencies. Too much forward planning can be unnecessary and counterproductive.
    - The best response is going to vary by community. First step is to classify different responses for different areas. After classification of these response policies can flow easier. Need for highly flexible institutions.
- Emergency Response & Public Education
    - Need to educate the people and get down to the nitty gritty and talk to the people who live there and get them ready for an event.

Habitat and Natural Resources

- Wetland Impacts/Loss of wetlands
    - Issue is that species will be lost or displaced. Loss of recreation. Result in ecosystem imbalance. Invasion of species (new and existing invasive species). Effects felt immediately, issue should be addressed immediately
    - Currently, satellite imagery show that our wetlands are already degraded. Fixing less carbon, growing less fish, etc. Conditions are depressed. Just starting to look at conditions of wetlands and losses. Emerging area. Needs to be more monitoring. Resources are a huge issue. Threats SLR salinity increase, alteration in nutrient budget. Fishery groups, natural resource management are affected. Time frame Urgent. Highly susceptible.
- Critical Habitat/Species Range/Migration shifts
    - Risk assessment of what gets lost first. What are we aiming for? May not be what we have now. Decide in terms of economic and social values. Restoration projects that we start today need to survive 50 years out. Time frame – now. Implementation 10-20 yrs.
- Saltwater Intrusion/Water Quality/Groundwater
    - Residential and Ag areas that rely on groundwater for all their water needs (coastal). Geographic extent is statewide. Current & immediate & within 10 years. Additional modeling must be done. Deal with projected demands for water supply. Area is growing rapidly.
- Waterfowl Management/Impoundment
    - Prime Hook has 4500 of freshwater impoundments, the storm last year breached and salt water got into the impoundment. Wildlife dependent recreation is associated with these impoundments. What are the thresholds for retreat? When we do retreat, where are wildlife resources going to go? Where are the duck going to go? Or have they already left the system? Needs to be addressed immediately. Doesn't feel he has enough information to determine thresholds.
- Beach Management
    - SLR can inundate beaches and dunes. Loss of natural buffer between open water and wetlands. Loss of ecological base (HSC/shorebirds), interdunal and beach organisms. Reduction in littoral conveyor belt. Embargo of sand can result in loss of beach. Economic impacts. Not a good understanding in role of beaches. Abandonment of easements and government help could result in loss of public beach. Current & continue to do look at immediately.
- Salinity Rise
    - SLR will cause saltwater to breach freshwater impoundments. Will reduce species and affect recreation. Will affect Ag and land cultivation. Need is immediate.
- Agriculture
    - Various issues dealing w/ development to movement of groundwater from Ag to wetlands. Ditches are going to redirect runoff etc. Needs to be addressed immediately or in the next 10 years.

- Political Barriers

    - Lack of political will. Do not want to ask citizens to make sacrifices. Who pays for implementing solutions? Time frame immediately through longer than 50 years (ongoing).
- Economic Benefits/Loss of Habitats
    - Economic benefit is tourism associated with hunting, fishing, etc. Loss will affect economy. Who will eventually pay?
- Education and Outreach
    - General public must be informed about SLR. Decision maker must be influenced. Education has to be tailored to its audience. Implement immediately.
- Scientific Data needs
    - Global National and Local suite of knowledge. Use to support or refute national consensus. Need is immediate.
- Benthic Habitats
    - SLR anything under the water, increases in bottom habitat, positive implications associated with that. Not a good understanding of what is out there. Need more information to understand it. Are we going to have a species shift under the water too? Species loss? Timing immediate.
- Human Responses to Natural Environment
    - Conflict between human needs and natural processes and dynamics. Do you protect or remove structures? Let them decay naturally? What happens to shoreline as a result of SLR? Edge of the marsh, will it migrate with SLR? What resources would be used for these projects? How will abandonment of hard structures affect erosion or be affected by SLR? Beach 2000 policy (1988) did work. Is nourishing beaches economically viable? 10-25 year range.

Human Health and Public Welfare

Saltwater Contamination /Intrusion

- Food production/Agriculture Impacts
    - Economics
    - Growing vegetables
    - Feeding livestock
- Municipal water supplies
- Drinking water
- Changes to biodiversity
- Slowing or stopping impacts to aquifers
- Freshwater for wildlife
- Location of water supply intakes
- Wells/septic/sewer failure
- Marine Fisheries impacts
    - Jobs
    - Increase in marine disease (dermo)
    - Distribution patterns
- Ecosystem changes
- Public/private water supply / waste water costs
    - What are the costs
    - Who pays

Inundation/Shoreline Erosion & Saltwater Contamination/Intrusion

- Storm Evacuation
- Weather related/Non-weather related emergency
- Social Justice
    - Impacts to low-income populations
    - Economically
    - Housing
    - Safety
    - Healthcare
- Water quality
    - Saltwater intrusion
    - Potable drinking water
- Shifting development inland
- Air quality impacts due to shifting populations
- Impact on Medical care
    - Access
    - Impacts to facilities
- Insurance availability (economically unavailable due to policy)
    - Issues related to municipalities
- Impacts on Septic systems
    - Rising water tables to spray irrigation

- Migration of toxic sediments
    - Brownfields
    - Dredge spoil
    - Coal ash
    - Jet fuel
- Educating realtors/public (buyers/sellers)
    - Current and future implications to purchasing selling in certain areas
- Food production/agriculture
- Emergency evacuation limitations/plans
    - Educating populations on here to go/what to do
    - Shelters/medications/important papers/emergency kits
- Private properties
    - Damage to homes
    - Impacts to owners
- Educating public on mitigation measures
- Disease control
    - Mosquitoes (yellow fever/west Nile)
    - Sewer treatment (e coli)
- Impact on recreation infrastructure
    - Limit access
    - Impacts on mental health
- Salinization
    - Impacts on agriculture
    - Destabilizing plant communities
- Animal control
    - abandoned pets
    - wildlife
- Remediation
    - Initial expense – coastal property owners
    - Future expense – total population
    - What is the future of distribution of costs
    - What about out of state property owners who don't pay their share of taxes
- Housing displace populations
- Ecosystem modifications
    - Domino effect
    - Future impacts
    - Systematic change
- Manure storage
- Crime due to
    - Rapid evacuation
    - Condemned properties
- Transportation
    - Moving people out
- availability of medicines
    - supply coming in
    - lost medical records
    - lost prescriptions

- subsidizing /mitigating impacts to wells
    - real estate values
- how to irrigate crops
    - moving water to/from
    - over using aquifers
- cooling systems/power plants/refineries
    - need freshwater to operate
- future research is required on crop modifications or to identify actual impacts as nature may work to correct itself
- movement of saltwater upstream
- drought exacerbating saltwater intrusion/climate change

<u>Elevated Water tables</u>

- Tree stability/survival (affecting root systems)
- Structural impacts (mold)
- Septic system (failure) / wastewater disposal (spray irrigation limitations)
- Building practices – require modification
    - Slabs
    - Crawl spaces
    - Insurance
- Location of community services (fire/hospitals)
    - Affected by reduction in usable land
- Stormwater/combined sewer overflows – infrastructure impacts
- Drainage issues causing increased icing
    - Impacts to commutes/travel
    - Drainage issues for agricultural land
- Increased flooding results in changes to habitat and therefore impacts wildlife
- Long term planning – consideration of life span development project
- Stormwater management planning
- Future financing of public works
    - Will federal funding pay for support or relocation of public infrastructure
- "Liner" failures – (landfill/contaminated lands)
- Educating owners to impacts on raised water tanks
- Underground storage tanks
- Cemeteries
- Land use planning
    - Concentrating populations
    - Facility placement
- Waterborne disease
    - Animal based
    - Contamination
- Emergency Response
    - Specialized equipment and training needs
    - Funding for necessary equipment resources
    - Location of facilities – facilities need to be placed OUT of flood plains

- Building practices
- Long-term planning for public transportation
- Placement of electrical transmission lines

General

- Plan should be carefully and specifically define intent
    - Define difference between sea level rise and storm surge
- There is a need for a Delaware specific Environmental Public Health Tracking (EPHT) system
    - EPHT describes concepts related to how the environment affects human health and has links to projects that use health and environmental data

Infrastructure

Inundation and shoreline erosion will impact:

- What is critical infrastructure?
    - Public vs. private
    - Built vs. natural
    - How do you distinguish and do you need to?
        - Cannot separate private and public infrastructure issues. Will need to develop policies that account for both
- Need to decided on what policies/approaches we will use (retreat, dyke, elevate)
- Costs/Budgets
    - Changing the infrastructure is expensive
    - Need to consider constituents
    - Benefit cost analysis for improvements for infrastructure
- Shore-dependent uses (e.g., Port of Wilmington), leading to large economic consequences
- Transportation infrastructure
    - Bridges (e.g., weakening and wash outs)
    - Roads
    - Rails
    - Trails
    - Airports
    - Seaports
- Access to locations and people
    - Ability to provide services
    - Evacuation for emergencies
- Land development patterns
    - Roads running parallel vs. perpendicular to ocean
    - Maintaining beaches
- Political will
- Natural features – changes to these may impact built features
    - Beaches
    - Wetlands
    - Others?
- Built features
    - Roads
    - Pipelines
    - Sewer
    - Drinking water
    - Firehouses
    - Waste water treatment facilities (e.g., in Wilmington, which is surround by dykes but at risk)
    - Landfills
    - Power infrastructure
    - Flood mitigation structures (e.g. tide gates)
    - Rails, Trail, airports, seaports
    - All weather stations (ex. Stream and tide gauges)

- Domino effects
- Cultural considerations
    - Challenges:
        - Access is already compromised and will be further compromised in the future
        - Interdependencies and compounding of infrastructures failures
        - Rising groundwater (ex. Failing septic systems)
        - Can current infrastructure withstand greater variability?
        - Aging infrastructure will be further stressed
        - What will be the role of government in addressing private property impacts (e.g., losses)
        - Revising public policies that encourage development in risky areas
        - Desires of constituents

Solutions:

- More integrated planning for multiple types of infrastructure

<u>Increased Storm Intensity & Occurrence</u>

- Storm water infrastructure
    - not designed to handle increased storm intensity
- Coastal storm evacuation
- Immediate threats to infrastructure is lost very fast, so need to plan before storm arrives or will be too late
- Drinking water quality compromised
- Increasing intensity of storms (e.g., winter storm events) having increased stress on structures
- Education process
- Locations of buildings and increasing risk
- Changing boundaries and definition for floodplains
- Acute/catastrophic events – blowouts of coastal areas (barrier islands)
    - Non-linear responses to events – geological tipping points, storm slightly stronger but that is just enough to greatly change infrastructure or land failure
- Impact of storms on quality of life
- Impacts of these events on society

<u>Saltwater Contamination/Inundation</u>

- Buried infrastructure (e.g., corrode pipes prematurely)
    - Drainage and drinking water
    - Gas lines
    - Sewer lines
- Increased salinity (e.g., affect piers, metal on bridges, Amtrak rails)
- Underground storage tanks
- Agriculture irrigation
- Poultry industry effects
- Salt line moving into fresh water supplies

Appendix G:

Acronyms

ACRONYMS

ACFHP – Atlantic Coastal Fish Habitat Partnership
ALS – American Littoral Society
ASMFC – Atlantic States Marine Fisheries Commission
CEEP – Center for Energy and Environmental Policy
CSO – Coastal States Organization
CSX – Seaboard Coastline Railroad
DEBI – Diffusion of Effective Behavioral Interventions
DelDOT – Delaware Department Of Transportation
DEMA – Delaware Emergency Management Agency
DGS – Delaware Geological Survey
DMTA – Delaware Metropolitan Transportation Authority
DNREC – Department of Natural Resources and Environmental Control
DNREC/AQW – Division of Air Quality and Waste Management
DNREC/DFW – DNREC Division of Fish and Wildlife
DNREC/DSW – DNREC Division of Soil and Water
DNS – Delaware Nature Society ???
DOE – Department of Education
DRBA – Delaware River and Bay Authority
FEMA – Federal Emergency Management Agency
FHWA – Federal Highway Administration
HSC – Horseshoe Crab
LiDAR – Light Detection And Ranging
LWV – League of Women Voters
MPO – Metropolitan Planning Organizations
NCA (benthics) – National Coastal Assessment
NCC – New Castle County
NGO – Non-governmental Organization
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NWF – National Wildlife Federation
OCRM (NOAA) – Office of Ocean and Coastal Resources Management
PDE – Partnership for the Delaware Estuary
SAV – Sub Aquatic Vegetation
SAW – Stock Assessment Workshop
SEPTA – Southeastern Pennsylvania Transportation Authority
TNC – The Nature Conservancy
UD – University of Delaware
USDA – United States Department of Agriculture
USFWS – US Fish and Wildlife Service
USGS – United States Geological Survey
WILMAPCO – Wilmington Area Planning Council
WRA – Water Resources Agency

May, 2009

State of Delaware Document No. 40-07-01/09/05/01