

2016-2020

Delaware Wetland Program Plan

A vision for developing a comprehensive wetland program



Overview

The Delaware Wetland Program Plan was developed by the Delaware Department of Natural Resources and Environmental Control in cooperation with the Delaware Department of Agriculture's Forest Service. This effort was supported by a Region 3 Wetland Program Development Grant awarded by the U.S. Environmental Protection Agency.

This program plan would not have been completed without the advice, input, time, talents, and insight of wetland program staff and conservation partners throughout the state.

State Agency Participants

Department of Natural Resources and Environmental Control

Division of Watershed Stewardship
Division of Fish and Wildlife
Division of Parks and Recreation
Division of Waste and Hazardous Substances
Division of Energy and Climate
Delaware Coastal Programs



Department of Agriculture

Forest Service



Cover photo: Non-tidal depression wetland with spotted turtle (*Clemmys guttata*; WMAP)

Cover photo insets: Depression wetland (WMAP), Living shoreline restoration installation (WMAP), Mispillion salt marsh (WMAP), Field crew monitoring (WMAP), Depression wetland (WMAP), Wilmington Green Jobs outreach program for students aged 14-18 (WMAP)

Back Cover: Salt marsh landscape (WMAP)

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Office of the Secretary

SECRETARY
David Small

DEPUTY SECRETARY
Kara Coats

Contributions and Review Team

Chris Bennett
Mark Biddle
Brittany Haywood
Lyndie Hice-Dunton
Rob Hossler
Andy Howard
Gary Kreamer
Bill McAvoy
Maggie Pletta
Alison Rogerson
Amanda Santoni
Kenny Smith
Elena Stewart
Mike Valenti

Primary Author:

Alison Rogerson
Wetland Monitoring and Assessment
Program Leader

Designer:

Brittany Haywood

Photographers:

Chris Bason
Delaware National Estuarine Research
Reserve (DNERR)
Scott Figurski
Anthony Jackson
William A. McAvoy
Gene Shaner
Wetland Monitoring and Assessment
Program (WMAP)
John D. Willson



STATE OF DELAWARE
**DEPARTMENT OF NATURAL RESOURCES
AND ENVIRONMENTAL CONTROL**

OFFICE OF THE
SECRETARY

89 KINGS HIGHWAY
DOVER, DELAWARE 19901

PHONE: (302) 739-9000
FAX: (302) 739-6242

July 15, 2015

Dear Wetland Supporters,

Delaware's wooded and tidal wetlands are a significant part of what defines Delaware's natural heritage. Wetlands comprise a quarter of Delaware's land area and our residents and visitors are never more than a mile from one of these special areas. The wetlands of the Delaware River and Bay are internationally significant for their role as habitat for many species including horseshoe crabs, migratory shorebirds and waterfowl. These beautiful and unique habitats not only provide recreational opportunities, they are also important buffers to absorb stormwater and they remove harmful pollutants and excess nutrients from the water on which we depend for swimming, drinking and supporting fish and wildlife populations. Wetlands are also an integral part of our tourism and conservation economy.

We need to work together to develop new ways to collect meaningful biological and physical data that leads to a better understanding of wetland ecology and more effective management. DNREC is committed to efficient and effective protection and conservation of wetland resources that provide many benefits to the people of Delaware. Today, Delaware's wetlands face threats such as pollution, sea level rise, changing climates and landscapes. It is more important than ever to accurately assess our wetlands and identify changing trends. It is our responsibility to continue to raise awareness among Delaware's citizens about the value of wetlands. A majority of our freshwater wetlands are held in private property and we should reach landowners with important information to improve conservation through stewardship and volunteer actions.

This plan was developed as part of our Wetland Monitoring and Assessment Program and its partners and identifies activities we will be undertaking through 2020 and which will be funded in part through grants from the US Environmental Protection Agency. This document is the result of a collaborative effort to evaluate areas of need and identify a specific course of action to bring about a positive future for wetlands and the species they support. As Secretary, I recognize the need to build the capacity for a stronger wetland program in Delaware. I proudly support and endorse the effort by the contributing programs to prioritize wetland conservation needs in Delaware and work with partners to accomplish the objectives identified here.

I am confident that together we will succeed in protecting the valuable resources that make up our natural landscape and support a healthy economy and way of living. I hope that you will embrace and support our goal to protect the wetland resources that are so important to our great state.

Sincerely,

A handwritten signature in blue ink that reads "David S. Small".

David S. Small
Secretary

Delaware's Good Nature depends on you!

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INTRODUCTION



Figure 1. Tidal and non-tidal wetlands in Delaware (SWMP 2007).

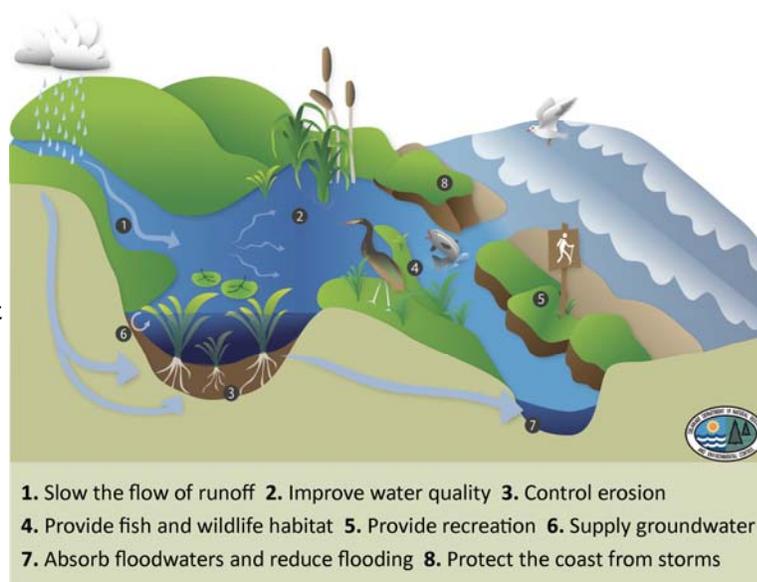
Delaware is host to roughly 320,000 acres of wetlands (Figure 1) that vary in salinity, soil type and vegetation based on geographic location and water source. With one quarter of the state's land area being wetlands, citizens and visitors to Delaware are surrounded by these hard-working natural features. Situated between water and land wetlands are highly adapted to particular conditions and provide many important services that support the state's economy (Figure 2). Wetlands are home to a myriad of plant and wildlife species, some rare and endemic species, as well as commercially harvested species. Delaware benefits from a strong tourism industry which includes birders, hunters and nature enthusiasts who visit Delaware and support local businesses. Wetlands also have the capacity to filter pollutants from our drinking, fishing and swimming waters and protect our shorelines and property from damaging winds and floods. Our bountiful wetland resources play an understated but vital role for our communities, economy and well-being.

However, Delaware's beautiful and valuable wetland resources are still vulnerable to the same threats they faced 10 years ago such as conversion to agriculture or development, a lack of awareness or appreciation, and prioritization differences between management levels. In addition, wetlands face new and growing challenges such as conversion to open water and salt water intrusion due to sea level rise and climate change. Wetlands in the Mid-Atlantic region, in particular, face severe impacts due to a heightened local rate of sea level rise and require the space and opportunity to migrate landward. The intention of this program plan is to outline how to address some or all of those threats in the next five years (2016-2020) in cooperation with partners through the goals and action items listed.

A healthy network of groups around the state are dedicated to studying, protecting and improving wetlands for today and future generations. This network ranges from state, county, federal, private, non-profit and academic groups, and often their work overlaps. In 2008, DNREC and the Forest Service collaborated to create a guiding document to identify and prioritize areas where information or action was needed. The result was the Delaware Wetland Conservation Strategy which listed 42 action items under 6 major goals. In 2011 the Conservation Strategy was expanded upon with the Delaware Wetland Monitoring Strategy and listed 3 goals and 31 tasks. Together these companion documents served as the Delaware Wetland Program Plan for 2011-2015. Over the past 5 years, progress has been made on 87% of the monitoring strategy action items, 27 of them were completed and another 8 are in progress. Today, updated goals and action items in the 2015 Delaware Wetland Program Plan address remaining gaps and needs to improve Delaware's capacity to monitor, restore, regulate and conserve its wetland resources.

In preparation for this program plan the following related documents were reviewed to identify overlapping objectives: 2015 Delaware Wildlife Action Plan, 2010 Delaware Statewide Forest Strategy, 2012 Coastal Training Program Strategy, Environmental Law Institute's 2010 Delaware Wetland Program Review, and the 2013 Recommendations for Adapting to Sea Level Rise in Delaware. The contents of this document are meant to give a brief summary of progress that has been made on past action items, identify remaining or recently developed areas of need and new action items that will help meet those goals.

The Wetland Monitoring and Assessment Program (WMAP) will use the goals and action items listed here to prioritize and select future projects to strengthen Delaware's capacity to conserve and improve wetlands.



1. Slow the flow of runoff
2. Improve water quality
3. Control erosion
4. Provide fish and wildlife habitat
5. Provide recreation
6. Supply groundwater
7. Absorb floodwaters and reduce flooding
8. Protect the coast from storms

Figure 2. Wetland Functions and Societal Values

Wetland Monitoring & Assessment Program

Vision: To achieve an annual net gain in wetland acreage and condition to support the wealth of services wetlands provide

The objectives of the WMAP which will achieve our vision are:

- ✧ **Objective 1: Monitoring & Assessment** —Obtain up-to-date scientifically valid information on the status and trends (quantity, quality, functions and services) of wetlands to make wise management decisions.
- ✧ **Objective 2: Voluntary Restoration & Protection** —Protect and restore wetlands through a variety of tools including voluntary incentive programs, and integration with watershed strategies and conservation plans.
- ✧ **Objective 3: Education & Collaboration** —Inform the citizens and visitors of Delaware about the functions and services of wetlands. Collaborate with State programs and conservation partners to improve project efficiency and effectiveness.
- ✧ **Objective 4: Regulation** — Inform regulatory decisions, mitigation processes and report to the Clean Water Act.

Objective 1 is a direct product of the ongoing efforts to monitor and assess the condition, function, and services of wetlands in the state. Objective 2 applies the information generated from Objective 1 to positively affect the decisions being made about the management, restoration, and protection of wetlands. Objective 3 transfers the knowledge and perspectives gained from Objective 1 and 2 to bring awareness and appreciation for wetlands. Objective 4 receives input from objectives 1, 2 and 3 to provide accurate and effective information to inform regulatory decisions and mitigation processes. The product of all four objectives will lead to the protection and restoration of wetlands and an increase in wetland acreage, function and services (Figure 2).

Wetland Monitoring & Assessment Program Objectives

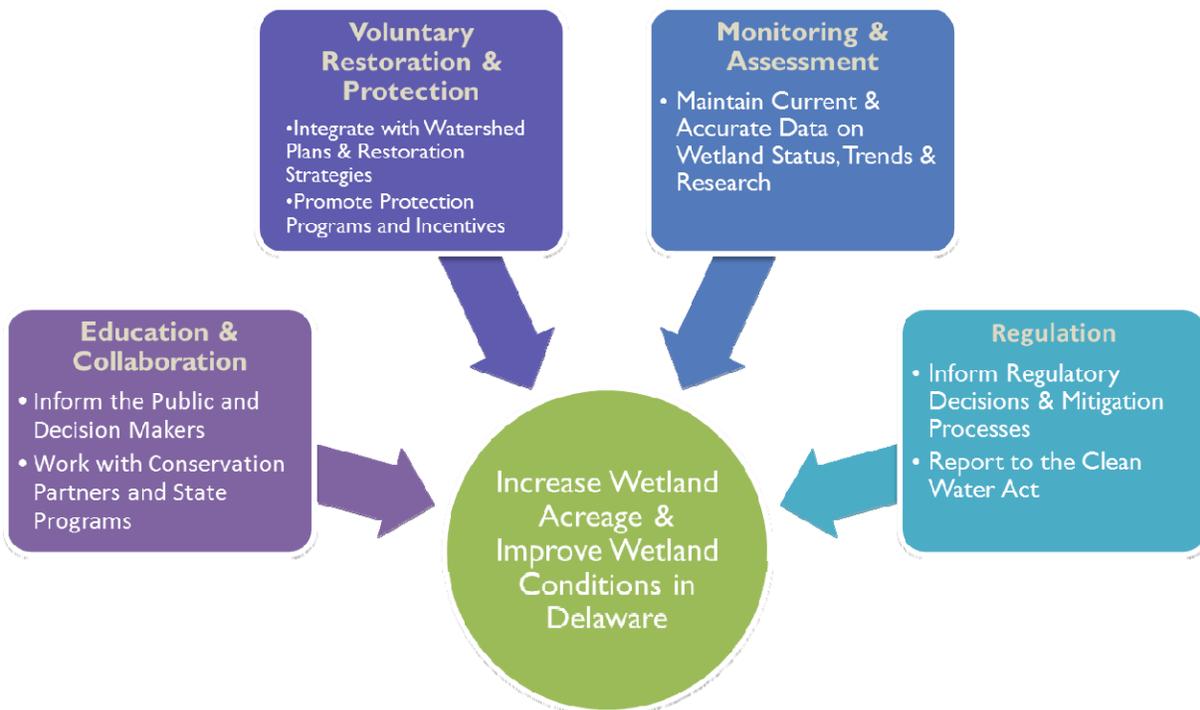


Figure 2. The four objectives of the program (shown in rectangles) needed to achieve the WMAP program vision (shown in circle).

The WMAP uses assessment protocols to determine the quality of Delaware’s wetlands and measure the functions and ecological services that they are providing. However, to develop a comprehensive strategy from site selection to data analysis and interpretation, various other factors must be considered. The following is an overview of the components of a wetland monitoring and assessment program as outlined in the EPA document “Application of Elements of State Water Monitoring and Assessment Program (2006).

Wetland Management Plan

The WMAP operates under the Delaware Wetland Management Plan (July 2015) which is an update of the 2008 Delaware Wetland Conservation Strategy. The Management Plan was produced using the input of a core team of 15 professionals representing six DNREC divisions and the Delaware Forest Service. Based on the accomplishments since 2008 and the existing gaps and needs of multiple wetland programs in the state, 7 major goals are identified accompanied by 39 related action items. This 5-year plan is intended to be a guiding document for DNREC and its partners to identify and prioritize wetland program needs, and to encourage collaboration and efficiency to improve Delaware’s capacity to conserve and improve its wetland resources.

Survey Design

The WMAP involves two levels of survey design. The first is to prioritize the order in which watersheds in the state will be monitored and the second is to define how we will select sampling locations within a watershed.

Prioritization of Watersheds

Prioritization of watershed monitoring efforts will be based largely on the TMDL implementation schedule. By following this schedule, comprehensive information about the surface waters and wetlands can be combined to develop the best restoration strategy for each watershed. Figure 3 depicts a tentative schedule for future wetland monitoring efforts. The dates will depend on the availability of resources at the State level and development of appropriate methods. The intent of the State is to monitor these watersheds using a rotating basin approach once an initial assessment of the wetlands within each watershed has been performed.

Watershed Sampling Design

The approach used to select sampling locations within a watershed will be a probabilistic sampling design. We currently rely on technical support from EPA’s Ecological Monitoring and Assessment Program (EMAP) to randomly select sampling sites within mapped wetlands in a watershed. The WMAP supplies the base map and any additional criteria such as excluding manmade ponds or only including tidal or non-tidal wetlands. Currently EPA is working on developing a program that would allow states to perform this operation independently. The base map that will be used for all watersheds will be the most up-to-date wetland layer available.

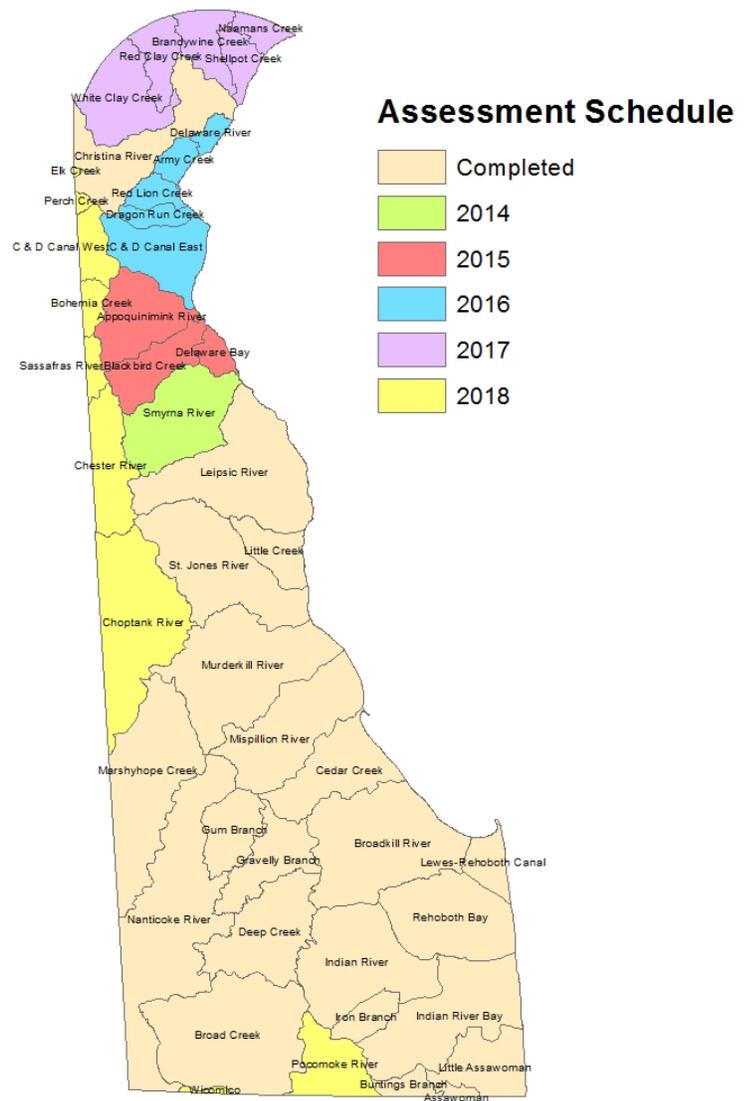


Figure 3. State of Delaware Wetland Monitoring Schedule

Assessment Indicators & Methods

The State of Delaware is developing multiple levels of assessment methods to evaluate wetland condition. These levels include a landscape level assessment, rapid field assessment, comprehensive field assessment, and intensive assessment (Figure 4) and are described in the Protocol Development section. Because the rapid assessment procedure has been calibrated to the comprehensive assessment procedure and we are achieving high correlations between the two methods, a combination of rapid and comprehensive assessments are used to evaluate the condition of the random sites. It was determined that the most efficient use of resources to collect the accurate data is to perform comprehensive assessments at approximately 20% of the sites where rapid assessments have been performed. The ability to fulfill this goal is dependent on time and resources. Assessment data from all levels will continue to be used to test for correlations between levels and refine protocols to improve the accuracy and the sensitivity to varying wetland condition.

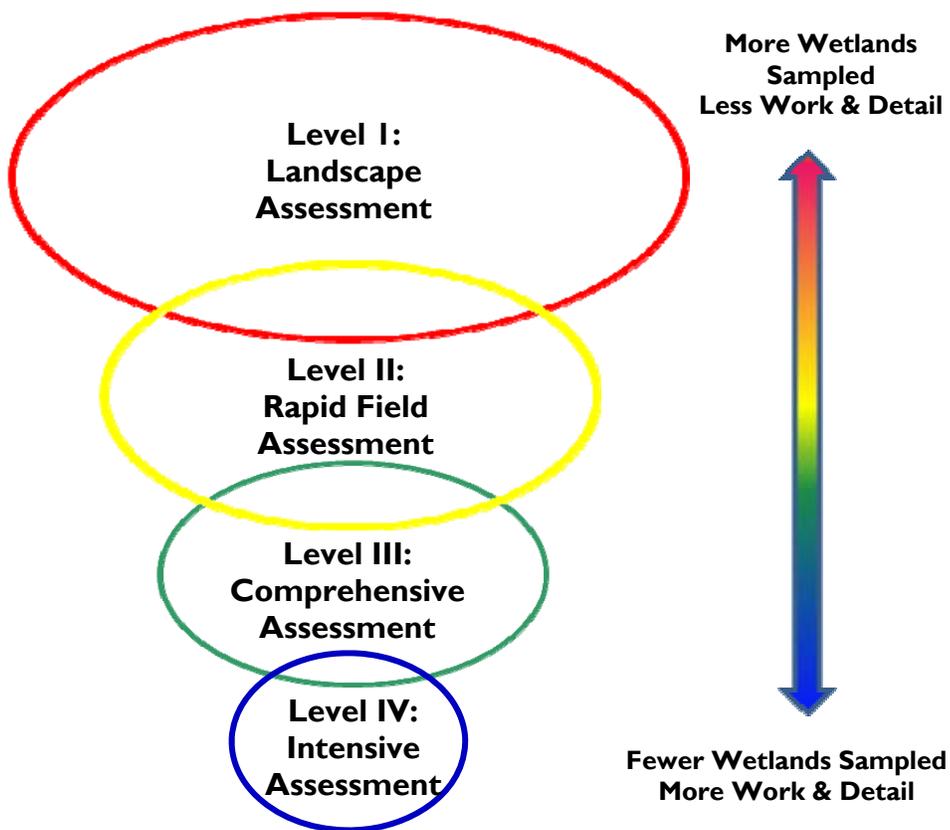


Figure 4. Four tiered approach to wetland assessment. The level of information and amount of effort increases from landscape assessment to intensive assessment. Each level overlaps with the next, allowing feedback, refinement and validation.

Field Data Collection

Based on past experience, it is essential to have a full time field coordinator who is responsible for implementing the monitoring in a watershed. This person should be dedicated full time to this task to effectively manage the large amount of information and oversee the multitude of tasks needed to accomplish the ambitious sampling goals in each watershed. This person will work directly under the Project Manager who is a DNREC employee.

Access to private property will be essential to the success of this program. Only sites on private property for which permission from the landowner has been granted will be sampled. In general, private landowners in Delaware are receptive to having field crews collect data on their property that will be used to improve the resources in their watershed. As part of every monitoring effort in a watershed, a public outreach component will aim to disseminate program goals as well as summaries of the data that are collected and related management implications.

Quality Assurance Program & Project Plans

The WMAP collects and manages all data under an EPA approved Quality Assurance Project Plan (QAPP). The QAPP covers project and task organization, training, data generation and acquisition, sampling design, sampling methods, quality control, equipment testing, data management, assessment and oversight, and data verification and validation. A copy of the QAPP can be obtained from Delaware DNREC's Watershed Assessment and Management Section.

Data Management

GIS Capabilities

The WMAP is equipped with up-to-date GIS software and will keep staff trained in using GIS programs to assist with: planning monitoring efforts, tracking collected data spatially and analyzing wetland data. Wetland monitoring data will be stored for future use and will be shared with DNREC for use in other related projects or decisions.

Training

All persons involved in the data collection process will be required to complete training to properly use the assessment protocols. One to two day training sessions will be offered by DNREC and will consist of lectures on how to properly use the protocols, high quality data collection practices, and field training to demonstrate the techniques. Field crew leaders will be required to have additional training consisting of participating on a field crew to collect data until the program manager is confident that they are proficient with the techniques. While collecting data, the current QAPP will be followed to ensure the highest quality of data.

Data Collection and Storage

All data collection will be performed using the standardized Delaware Comprehensive Assessment Procedure (DECAP) datasheets and Delaware Rapid Assessment Procedure (DERAP) datasheets on paper. DERAP will also be recorded using a tablet which has the current version of the DERAP datasheets. The current versions of both methods and the corresponding datasheets are available online from the Delaware wetlands website (<http://de.gov/delawarewetlands>) or by request. All data will be entered or transferred into an Access computer database that has been developed to consistently store wetland assessment data. Paper copies of the datasheets will be stored in the Watershed Assessment and Management Section. Additionally, if STORET (EPA's water monitoring data Storage and RETrieval repository) becomes compatible with entering this type of information we will contribute our data as appropriate.

Data Analysis

The WMAP follows documented procedures for collecting, processing and analyzing data. Methods for identifying random sites in each watershed are detailed in a Design Documentation report. Landowner success and sample profiles are provided in the technical wetland condition reports. Appropriate procedures for scoring data and ranking sites are specified in each protocol (tidal, nontidal, condition and value). For the Level III assessment, a Variable Scoring Protocol is in place for the three dominant types of freshwater wetlands (flat, riverine and depression wetlands; Appendix A) for calculating variable scores, functional scores and overall Index of Wetland Condition values. In addition, statistical and analysis procedures for comparing level 2 tidal data to tidal marsh bird survey data is documented in writing to be repeated in the future. Datasheets designed for each sampling method accompany the procedures and are always used.

Project Reporting

For each watershed assessed a technical report will be produced in a timely fashion that summarizes a watershed-specific wetland profile, recent trends for wetland acreage, the condition of wetlands by hydrogeomorphic (HGM) type, and appropriate management recommendations. Raw data will be included but site locations and ownership will not be disclosed. The condition of wetlands on the watershed scale will be included in Delaware's 305(b)/Integrated Report. Other documents for sharing project results will be produced as needed including information on becoming involved in protecting and restoring wetlands based on the suggested management recommendations.

Program Evaluation

A team of scientists and managers will be assembled to review the program's progress every 5 years. This team will consist of individuals from across DNREC and related partners with knowledge of sampling methods and techniques, survey design, as well as program that will be users of this information including planners and managers. The evaluation will include summarizing past accomplishments, identifying remaining gaps and needs and producing new objectives and action items.

Objective I:

Obtain up-to-date scientifically valid information on the status and trends (quantity, quality, functions and services) of wetlands to make wise management decisions.

Objective I: Monitoring & Assessment

Objective I includes the development of monitoring and assessment methods that are scientifically robust, the creation and use of up-to-date maps and spatial tools for evaluating wetland status and function, and the incorporation of wetland data into climate change and adaptation considerations.

The success in reaching these three goals will require using all available resources to create and support methods that determine wetland condition and function. The resulting information will support management and planning decisions. A research component will focus on using wetland data to answer specific questions that arise to support better wetland protection, management, and restoration.

Protocol Development

The assessment of wetland condition requires methods appropriate for the diversity of wetland types in Delaware which reflect current and changing conditions. The WMAP has been developing methods using a 4-tiered approach for assessment methods: landscape, rapid, comprehensive, and intensive assessments. The four tiers of assessment vary in the detail of data that are collected, the proportion of the population that they sample, and the resources that are needed to perform an assessment (Figure 4). The multi-tiered approach provides options depending on the specific goals and resources available for a project.

Delaware follows an HGM-based system for classifying wetlands that was developed for the Mid-Atlantic (Brooks et al. 2011). Appendix A provides a description of the major subclasses in Delaware including hydrology, major sources of variation, National Wetland Inventory (NWI) classification, and example communities. Wetland types can be differentiated using the wetland maps that have been improved with the HGM modifiers.

Landscape Assessment

Landscape assessment involves the prediction of wetland presence, condition and function based on wetland classification, landscape position, and surrounding land use features that can be remotely detected. The benefits of landscape level analysis are that access to private lands is not limiting, a complete census of all wetlands can be performed, and time and effort is greatly reduced because no field visits are required. The disadvantages to landscape level assessment are that predictions of wetland condition and function are based on documented relationships and may not always apply to specific wetlands. Also, detailed information is limited based on the type of indicators that can be assessed using remote information, and staffing with GIS capabilities are required.

The most recent wetland maps for Delaware are based on 2007 aerial photography. These maps updated prior NWI and State maps from 1981/2 and 1992, respectfully, using existing soil surveys, land use data, statewide natural heritage data, and color-infrared photointerpretation. Each wetland polygon was labeled using the Cowardin classification system (Cowardin et al. 1979) and the LLWW descriptor system (Tiner 2003) which uses Landscape position, Landform, Water flow path, and Waterbody type to describe a wetland, in addition to special state modifiers for exceptional ecological community types. The NWI Plus process also tagged each wetland polygon with eleven wetland functional estimates based on LLWW classification (Tiner 2003b).

Rapid Field Assessment

The Delaware Rapid Assessment Procedure (DERAP) is a rapid assessment method for determining the condition of a freshwater wetland based one site visit. The DERAP was developed to meet the needs of users that require a rapid assessment of the general condition of a wetland that is based on current site conditions. The DERAP uses a two-page checklist of stressors and other site features to produce an overall score of wetland condition. The DERAP is calibrated to the Delaware Comprehensive Assessment Procedure (DECAP) Index of Wetland Condition (DECAP IWC) using step-wise multiple regression analysis to select the stressors that best define differences in sites, and then multiple linear regression (MLR) to assign weights to the stressors.

Objective I: Monitoring & Assessment

Each wetland class is calibrated separately to produce weights for each wetland type. An overall score for a site is calculated by subtracting the sum of the weights for all the stressors that are present from the possible score if no stressors are present.

The Mid-Atlantic Rapid Assessment Method (MidTRAM) is a level II assessment for the condition of estuarine emergent tidal wetlands in Delaware, Maryland and Virginia. MidTRAM is validated with intensive biological data from vegetative biomass and marsh bird surveys. Optimal sampling for MidTRAM is during the local growing season (July-September in Delaware). This method yields a condition score for buffer, hydrology and buffer parameters as well as an overall condition score and condition category.

Value Assessment

A companion to the DERAP was created in 2013 to capture the non-condition related values that a wetland offers. The Value-Added Protocol is a rapid assessment that uses field observations and computer-based calculations to rate non-tidal wetlands on the opportunity to provide a function and the local significance of that function. A wetland site is scored for polygon size, being a rare or unique wetland type in Delaware, for hosting rare or endangered plants and animals, etc.

Comprehensive Field Assessment

The Delaware Comprehensive Assessment Procedure (DECAP) is a comprehensive assessment method for determining the condition of a wetland site relative to reference condition. The DECAP and associated assessment models have been developed and refined by both regional and national wetland scientists following standard HGM development guidelines. Protocols for the DECAP can be obtained online or by contacting DNREC Watershed Assessment Section.

The DECAP is used to collect detailed data on each site and encompasses a variety of parameters including vegetation, hydrology, soils, topography, structure and surrounding landuses. The goal is to collect data on a wide variety of parameters to determine which ones distinguish sites based on disturbance. These data are then used to scale variables and functions for each wetland subclass. Variables (for example the density of trees per hectare) are scaled based on the reference sites. The highest score of 1.0 indicates that the variable is equivalent to a Reference Standard site (or minimally impacted) ranging down to a score of 0.1 for a highly degraded site where restoration is possible, or 0.0 for a site where restoration is no longer possible for that variable. Variables are then combined into mathematical equations that were developed by a group of wetland scientists to depict functions including maintenance of characteristic hydrology, wildlife habitat integrity, plant community integrity, biogeochemical cycling, and buffer integrity. The final function score is not an absolute value of performance of a function but rather an index of how much that function is departing from a reference standard or minimally altered site.

Field protocols and models are in different stages of development for the various wetland types in Delaware (Table I). Once a method has been developed for a group of wetlands, it can be implemented for monitoring purposes.

Intensive Assessment

Intensive assessment involves the direct measure of specific wetland functions, processes or ecosystem services. Intensive assessments are performed to validate landscape, rapid, and comprehensive assessments and to determine long term changes in wetlands. Currently, the WMAP has permanent monitoring stations in tidal wetlands to collect baseline data on vegetation, sediment accretion and surface elevation, and to determine how they are responding to different stressors and changing overtime. Monitoring stations in non-tidal flat and river wetlands are being installed presently.



GOAL A: MAPPING

Update wetland mapping tools and improve access to wetland related spatial data



Freshwater Wetland: Peat-land Fen (William A. McAvoy)



*Plotting Shoreline Elevation Points
Via Real-Time Kinematic (RTK; WMAP)*

PROGRESS AND CURRENT STATUS

Since 2008 the ability to draw meaningful conclusions regarding recent changes in and the current status of our wetland resources have been fueled by the 2007 Statewide Wetland Mapping Project (SWMP) layers and accompanying 2011 Status and Changes report.

An assessment of overall wetland function was completed using data that highlighted the relationship between landscape level changes in wetlands and the impact to the services they provide. This information expanded our understanding of cumulative impacts to the wetland services that we all benefit from. Wetland trends for a fifteen year period from 1992 to 2007 were drawn using improved digital technology and incorporated a more conservative approach to mapping drier-end wetlands.

The findings of this mapping and reporting effort garnered significant attention due, in part, to a comprehensive webpage (<http://de.gov/dewetlandmapping>) that highlights the work of the Wetland Monitoring and Assessment Program as well as other programs and partners.

The Delaware Wetlands website (<http://de.gov/delawarewetlands>) also contains a library that shares technical reports, protocols, presentations and published articles. This webpage has been made possible through the allocation of a staff member to maintain and update the mapping web page, library and online communications.



GOAL A: MAPPING ACTION ITEMS



*Lingo Creek Marsh,
Lewes, Delaware (WMAP)*

VISION STATEMENT

DNREC uses statewide wetland maps created from 2007 aerial photos. The results from the 2011 Status and Changes report (Tiner et al. 2011) emphasized the importance for up-to-date tools and maps that show existing wetlands and highlight changes occurring across the state. State wetland maps and an accompanying Status and Changes report should be updated in 2017 and 2018, respectively, to maintain on a 10-year schedule. In addition, updated LIDAR (Light Detection and Ranging), Land Use Land Cover and EcoMap (formerly Delaware Ecological Network) mapping resources offer rich opportunities to draw new conclusions regarding wetlands, assist with planning for changing conditions and highlight priority areas for protection.

Mapping capabilities have improved greatly in the last eight years and offer more accurate and sophisticated information which should be shared widely. To be more useful, all spatial data layers should be accompanied by complete metadata and should be made accessible to a wide audience. The literature library should be kept current and promoted more to increase visitation and project sharing. Prioritization for conservation and restoration should consider the goals of the Delaware Bayshore Initiative. Lastly, there is a continued need for a streamlined database or web mapper that houses restoration project locations and information from multiple sources. In order to have in-house capabilities to complete projects requiring specialized mapping and analysis skills, staff positions must be supported.

ACTION ITEMS

- A-1 **COMPLETE UPDATE OF DELAWARE STATEWIDE WETLAND MAPPING PROJECT (SWMP) MAPS** and produce an updated wetlands “status and trends” report based on 2017 aerial photography and 2015 LIDAR
- A-2 **DEVELOP SPATIAL DATA LAYERS THAT COMBINE MAPPING RESOURCES** (e.g., SWMP layers, EcoMap, Wildlife Action Plan, sea level rise, ownership, protection status) to highlight overlapping areas prioritized for protection or restoration
- A-3 **ADOPT, MAINTAIN AND PROMOTE USE OF A RESTORATION TRACKING WEBMAPPER** such as the Watershed Resource Registry to report, map and track wetland projects and share project information with private and public professionals
- A-4 **INCREASE TRAFFIC TO 'LIBRARY' OF DOCUMENTS AND DATA LAYERS** that are up-to-date and provide complete metadata
- A-5 **HELP SUPPORT A GIS STAFF MEMBER TO MAINTAIN WETLAND RELATED DATA SETS AND LAYERS** and assist with spatial analysis needs
- A-6 **MAINTAIN AND PROMOTE A MAP-BASED DATABASE OF VOLUNTEER MONITORING PROJECTS AND INFORMATION**

Barking Treefrog (*Hyla gratiosa*; John D. Willson)



GOAL B: MONITORING

Increase monitoring efficiency and effort to provide insight into wetland function and health

PROGRESS AND CURRENT STATUS

On the ground monitoring of natural, restored or created wetlands have provided valuable insight into wetland health and function while enhancing opportunities to make in-person observations that could not be derived from a landscape census. Currently, wetland condition and local trends are reported on a watershed basis across the state. Since the inception of the previous Strategy comprehensive reports for the St. Jones, Murderkill, Broadkill and Christina River watersheds have been published for the public. Currently, science-based information is being incorporated into watershed specific management recommendations that drive restoration, protection and mitigation activities.

New sampling protocols are being developed to capture the condition and function of more wetland classifications (for example, tidal freshwater) in addition to refining existing methodologies to reflect a larger reference dataset and address changing concerns. Wetlands are also now being assessed to capture their value apart from condition; their potential to serve both society and the ecological community. Sampling protocols have been shared among DNREC colleagues and outside partners through trainings and presentations with the goal of adopting or utilizing the available data.

Volunteer monitoring has been very active through programs such as the shorebird volunteer program, Delaware Amphibian Monitoring Program (DAMP), marsh bird surveys and DNREC's Volunteer Coordinators Workgroup. Prior to its suspension in 2014 (due to funding challenges), the Adopt-a-Wetland program encompassed 120 wetland sites statewide, including many sites where volunteer adopters engaged in monitoring activities.

Installation of a Feldspar Plot to Monitor Sediment Accretion (WMAP)



Sunrise Marsh Bird Survey (WMAP)



GOAL B: MONITORING ACTION ITEMS



Lewes Wetland Monitoring (WMAP)

VISION STATEMENT

Increased sampling of natural, restored, created and mitigated wetlands provides a scientific basis for more effective planning and management. These data sets can be interpreted to track the short-term variability and long-term changes in wetland resources and can support ongoing initiatives such as Watershed Management Plans, the Delaware Wildlife Action Plan, and the National Estuarine Research Reserve (NERR) Research and Monitoring Plan. In addition to developing specialized sampling protocols, trainings for practitioners are necessary to increase the adoption and use of standardized methods. As operating procedures are developed for restoration techniques and other activities, advanced trainings will be needed to connect the Departments (Natural Resources and Agriculture) with professionals.

To make the most of available sampling methods and existing data, access to information online should be strengthened and clearly linked to other partner groups' work. The use of various levels of wetland information including maps, trends, methods and watershed condition reports should be promoted through online access and active sharing of available tools and information. Developing a web-based portal in lieu of paper submissions will encourage volunteers to contribute their collected data and improve the ease of reporting and tracking important volunteer hours.

A great way to engage citizens and supplement field observations is through volunteer and citizen science programs. Adopt-a-Wetland is an example of such a program where volunteers contribute their time and can be effectively trained to collect scientifically viable information. Through these programs, volunteers receive education about wetlands, and leave with a sense of accomplishment and ownership for natural resources, but overhead costs, staff time for training and oversight, as well as supplies must be covered in order for volunteer programs to succeed. A key priority for these programs will be to secure a long-term funding source to support and sustain the contributions that volunteers can make to monitoring efforts.

ACTION ITEMS

- B-1 DEVELOP STANDARDIZED SAMPLING PROTOCOLS FOR WETLAND ASSESSMENT AND MONITORING OF NATURAL, RESTORED AND CREATED WETLANDS.** Protocols should use a tiered approach to account for varying staff expertise, time commitment, and financial resources and should be revised periodically
- B-2 ENCOURAGE ADOPTION OF STANDARDIZED MONITORING PROTOCOLS AND REFERENCE DATA FOR WETLAND RESTORATION, MITIGATION, IMPACTS OR CREATION.** Post the most up-to-date versions on the Delaware Wetlands website for planning and permitting procedures
- B-3 HOLD TRAINING WORKSHOPS ON USE OF MONITORING AND ASSESSMENT PROTOCOLS, DATA COLLECTION METHODS AND QUALITY ASSURANCE TECHNIQUES** for environmental professionals, educators, and volunteer participants
- B-4 USE REFERENCE AND ASSESSMENT DATA TO UPDATE AND ADAPT DERAP, DECAP AND MIDTRAM** to evaluate beaver impoundments and tidal freshwater wetlands
- B-5 POST MONITORING AND ASSESSMENT INFORMATION ONLINE FOR ACCESS** in data form, as technical reports, as wetland report cards, in geospatial data form, and in public-friendly materials
- B-6 ASSESS THE CONDITION OF WETLANDS BASED ON THE SPECIFIED WATERSHED SCHEDULE** and the National Wetland Condition Assessment in 2016
- B-7 PROVIDE ORGANIZATIONAL AND FINANCIAL SUPPORT FOR CITIZEN SCIENCE AND VOLUNTEER PROGRAMS,** including wetland monitoring, science and stewardship



GOAL C: CLIMATE ADAPTATION

Use available science and research to better understand and plan for the effects of climate change and sea level rise on wetlands habitats



Nor'easter of May 2008, Line Represents Marsh Edge (WMAP)



Tidal Wetland Monitoring (WMAP)



Coastal Road Flooding and Overwash (WMAP)

PROGRESS AND CURRENT STATUS

Delaware has recognized the vulnerability of its properties, natural resources and infrastructure to inland and coastal flooding, intense precipitation events and droughts. Efforts began in 2000 with the Delaware Climate Change Impact Assessment followed by the Delaware Sea Level Rise Advisory Committee to assess possible impacts (including those affecting wetlands; 2012) and provide prioritized recommendations for adaptation to address those threats (2013). In addition, eleven state agencies are acting under Executive Order 41-Preparing Delaware for Emerging Climate Impacts and Seizing Economic Opportunities to Reducing Emissions (2013) to improve resiliency and develop strategies for adaptation and preparedness. Now the focus is on implementing high priority recommendations.

This new goal was developed in response to wetland-related questions and needs raised in the above mentioned documents. For example, are wetlands keeping pace with sea level rise? How are wetland plant communities adjusting to rising salinity lines? Are tidal freshwater wetlands being squeezed out between salt water intrusion and dams? How can coastal habitats be strengthened against increased storm energy?

Extensive loss of coastal habitat, including wetlands, will result in the loss of revenue from hunting, angling, boating, wildlife viewing and tourism. In addition, there will be impacts to farmland from increased salinity and salt water inundation. Fortunately, with federal support, several state, federal and academic programs, as well as non-profit organizations are already focused on investigating how wetlands are responding to changing conditions. maintaining safety and quality of living in Delaware for years to come.



GOAL C: CLIMATE ADAPTATION ACTION ITEMS



VISION STATEMENT

Coastal wetlands, although resilient to storm energy and environmental stresses, are threatened by an accelerated rate of sea level rise and are limited in their migration inland due to coastal development. Inland wetlands are threatened by erratic precipitation, warmer temperatures, rising tide lines and intruding salt water. Much remains unknown about how wetlands are being impacted by changing conditions, how they will respond and how DNREC can take action to ensure that Delaware's wetlands and their valuable services are sustained into the future.

In collaboration with DNREC's Coastal Programs, Division of Fish and Wildlife, University of Delaware, U.S. Geological Survey, Delaware Geological Survey and various non-governmental organizations (NGO's), the Division of Watershed Stewardship will expand research to investigate and model wetland responses to sea level rise in terms of elevation, subsidence rates, shifts in vegetation communities and conversion to open water. In particular, research will include determining how wetlands migrate and how habitat conversion is occurring as water levels rise. Areas that are identified as potential migration paths can be protected or acquired. In addition, the Division of Fish and Wildlife needs to address how flooding and salt water will affect wildlife impoundments and how to accommodate key species and habitats in the future. Another consideration to better understand is the potential loss of carbon storage if expansive tidal emergent wetlands are converted to open water. Research is needed to understand this wetland function, improve the methods to estimate the natural range of carbon storage and determine a value for this service. Additionally, as stronger coastal storms become more common, research will need to determine the impacts of marine debris on tidal wetlands.

In an effort to utilize research and mapping to its fullest, it is important to communicate key findings and implications with landowners, planners and municipalities to raise awareness regarding sea level rise, changing coastal conditions and the protection that wetlands provide. Delaware is a low lying state that relies on its coastal resources as part of its culture and economy. Numerous groups are interested in the effects of sea level rise and climate change in Delaware and every opportunity to collaborate and share information should be taken.

ACTION ITEMS

- C-1 **RESEARCH THE MECHANISMS AND POTENTIAL MIGRATION PATH OF WETLANDS AND HABITAT CONVERSION** as water levels rise and salt tolerance lines move
- C-2 **IDENTIFY COASTAL AREAS TO BE SECURED FOR POTENTIAL WETLAND MIGRATION** that will improve coastal protection and provide critical beach, marsh and forest habitat
- C-3 Develop an outreach strategy to **EDUCATE CITIZENS AND MUNICIPALITIES ON HOW WETLANDS ON THEIR PROPERTY WILL BE AFFECTED**
- C-4 **INVESTIGATE THE RISK OF FLOODING AND SALT WATER INTRUSION TO STATE WILDLIFE IMPOUNDMENTS AND PONDS** and consider how to support important wetland communities and related species
- C-5 Improve understanding of, and promote possible use of **BLUE CARBON VALUE SYSTEM FOR COASTAL WETLANDS AS IT RELATES TO CLIMATE CHANGE**
- C-6 **EXPAND ON STUDIES MONITORING SEDIMENT RATES, WETLAND ELEVATION AND SUSCEPTIBILITY OF WETLANDS TO CONVERSION**
- C-7 **FURTHER EVALUATE THE BENEFICIAL USE OF DREDGE MATERIAL TO RESTORE TIDAL WETLANDS**

Objective I: Monitoring & Assessment

Five Year Schedule

Action Items	'16	'17	'18	'19	'20
A-1 COMPLETE UPDATE OF DELAWARE STATEWIDE WETLAND MAPPING PROJECT (SWMP) MAPS and produce an updated wetlands “status and trends” report based on 2017 aerial photography and '15 LIDAR		X	X		
A-2 DEVELOP SPATIAL DATA LAYERS THAT COMBINE MAPPING RESOURCES (e.g., SWMP layers, EcoMap, Wildlife Action Plan, SLR, ownership, protection status) to highlight overlapping areas prioritized for protection or restoration				X	
A-3 ADOPT, MAINTAIN AND PROMOTE USE OF A RESTORATION TRACKING WEBMAPPER such as the Watershed Resource Registry to report, map and track wetland projects and share project information with private and public professionals		X			
A-4 INCREASE TRAFFIC TO 'LIBRARY' OF DOCUMENTS AND DATA LAYERS that are up-to-date and provide complete metadata	X	X	X	X	X
A-5 HELP SUPPORT A GIS STAFF MEMBER TO MAINTAIN WETLAND RELATED DATA SETS AND LAYERS and assist with spatial analysis needs			X	X	X
A-6 MAINTAIN AND PROMOTE A MAP-BASED DATABASE OF VOLUNTEER MONITORING PROJECTS AND INFORMATION		X	X		
B-1 DEVELOP STANDARDIZED SAMPLING PROTOCOLS FOR WETLAND ASSESSMENT AND MONITORING OF NATURAL, RESTORED AND CREATED WETLANDS. Protocols should use a tiered approach to account for varying staff expertise, time commitment, and financial resources and should be revised periodically	X		X	X	X
B-2 ENCOURAGE ADOPTION OF STANDARDIZED MONITORING PROTOCOLS AND REFERENCE DATA FOR WETLAND RESTORATION, MITIGATION, IMPACTS OR CREATION. Post the most up-to-date versions on the Delaware Wetlands website for planning and permitting procedures		X	X	X	X
B-3 HOLD TRAINING WORKSHOPS ON USE OF MONITORING AND ASSESSMENT PROTOCOLS, DATA COLLECTION METHODS AND QUALITY ASSURANCE TECHNIQUES for environmental professionals, educators, and volunteer participants	X	X	X	X	X
B-4 USE REFERENCE AND ASSESSMENT DATA TO UPDATE AND ADAPT DERAP, DECAP AND MIDTRAM to evaluate beaver impoundments and tidal freshwater wetlands	X			X	X
B-5 POST MONITORING AND ASSESSMENT INFORMATION ONLINE FOR ACCESS in data form, as technical reports, as wetland report cards, in geospatial data form, and in public-friendly materials	X	X	X	X	X
B-6 ASSESS THE CONDITION OF WETLANDS BASED ON THE SPECIFIED WATERSHED SCHEDULE and the National Wetland Condition Assessment in 2016	X	X	X	X	X
B-7 PROVIDE ORGANIZATIONAL AND FINANCIAL SUPPORT FOR CITIZEN SCIENCE AND VOLUNTEER PROGRAMS, including wetland monitoring, science and stewardship			X	X	X
C-1 RESEARCH THE MECHANISMS AND POTENTIAL MIGRATION PATH OF WETLANDS AND HABITAT CONVERSION as water levels rise and salt tolerance lines move	X	X			
C-2 IDENTIFY COASTAL AREAS TO BE SECURED FOR POTENTIAL WETLAND MIGRATION that will improve coastal protection and provide critical beach, marsh and forest habitat	X	X			
C-3 Develop an outreach strategy to EDUCATE CITIZENS AND MUNICIPALITIES ON HOW WETLANDS ON THEIR PROPERTY WILL BE AFFECTED		X	X		
C-4 INVESTIGATE THE RISK OF FLOODING AND SALT WATER INTRUSION TO STATE WILDLIFE IMPOUNDMENTS AND PONDS and consider how to support important wetland communities and related species		X			
C-5 Improve understanding of, and promote possible use of BLUE CARBON VALUE SYSTEM FOR COASTAL WETLANDS AS IT RELATES TO CLIMATE CHANGE				X	X
C-6 EXPAND ON STUDIES MONITORING SEDIMENT RATES, WETLAND ELEVATION AND SUSCEPTIBILITY OF WETLANDS TO CONVERSION	X	X	X	X	X
C-7 FURTHER EVALUATE THE BENEFICIAL USE OF DREDGE MATERIAL TO RESTORE TIDAL WETLANDS	X	X			

Objective 2:

Protect and restore wetlands through a variety of tools including voluntary incentive programs, and integration with watershed strategies and conservation plans.

Objective 2: Voluntary Restoration & Protection

Objective 2 involves using the results generated from monitoring efforts to enhance voluntary wetland restoration, management, and protection programs in the state. The data obtained during monitoring efforts will serve to inform State programs and restoration partners regarding the type of wetlands most in need of restoration and protection, which will be shared in watershed reports generated by the WMAP.

The WMAP can use wetland mapping resources and condition information to reach out to property owners of unique or rare wetland communities to provide information and encourage voluntary protection. In addition, results from status and trends reports will be used to message the need for greater voluntary wetland protection and restoration. The WMAP will use assessment results to encourage the financial support for voluntary protection and incentive programs in Delaware such as the Forestland Preservation Program.

Voluntary restoration will be promoted throughout the program's outreach efforts. Based on assessment results, restoration can focus on the dominant stressors that are impacting different wetland types. Watershed level restoration plans in watersheds with completed wetland assessments will be developed using wetland data and other relevant and available science-based information (e.g. rare species and communities, soils, hydrology, land use). These plans will provide direction and detail for restoration and protection project planning. Wetland health report cards will focus on communicating to landowners and managers how to improve wetlands based on the management recommendations. Through online and written resources, the WMAP will encourage landowners to become voluntary stewards to wetlands on their property and will connect eligible citizens with incentive or assistance programs.



Restoring Tax Ditch Connection to Forested Wetland Floodplain (WMAP)

Blackbird Reserve Living Shoreline Installation (W/MAP)



Beneficial Use of Dredge Material at Piney Point (W/MAP)



GOAL D: RESTORATION

Advance wetland restoration, creation and enhancement practices to increase wetland acreage, condition and function.

PROGRESS AND CURRENT STATUS

Wetland restoration has continued to evolve and advance by the work of multiple DNREC Divisions, the U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration and non-profit organizations such as the Delaware Center for the Inland Bays, Partnership for the Delaware Estuary, The Nature Conservancy, and Delaware Wild Lands.

DNREC has been supportive and actively involved in testing and developing restoration techniques in non-tidal and tidal wetlands. The goal of these projects is to improve restoration performance and increase the utilization of techniques that benefit wetland habitats.

Watershed condition assessments have been completed and reported, but using the assessment data to develop watershed level restoration plans has been limited. Revisions are expected to be made to allow for greater ease in developing watershed restoration plans while still providing polygon-specific restoration and protection priorities for freshwater wetlands.

As the effects of sea level rise and stronger coastal storms make noticeable changes to our coastlines and tidal wetlands, restoration techniques in estuarine systems have become more important. Demonstrations and training workshops for traditional restoration techniques, as well as for emerging practices, such as living shorelines, have been organized and held to educate wetland scientists and private sector practitioners.



GOAL D: RESTORATION ACTION ITEMS

VISION STATEMENT

The development and use of sound restoration techniques followed by thorough monitoring serves to increase wetland functions across Delaware. Connecting the development of new and refined practices to consultants, engineers and contractors is an important goal. As connections with more private practitioners are developed, targeted trainings should be continued and offered at more advanced levels.



Living Shoreline Contractor Training (WMAP)

Restoration efforts should dedicate more time and resources in planning for after-construction monitoring and the identification of possible adjustments to sites for improved performance and success. Above all it is imperative that wetland scientists, professionals and landowners communicate openly to share the best available techniques, work through adjustments and put research results to use when designing and implementing successful projects.

Creating clear Best Management Practices (BMPs) and mitigation requirements for restoration efforts will make reaching out to eligible landowners with restoration opportunities easier, more understandable and increase the likelihood of participation and compliance.

Plans to guide wetland restoration projects should be developed through collaboration, based on a refined process for prioritizing wetland polygons of greater ecological value and interest. Incorporation of existing information such as the EcoMap, wetland maps and Watershed Resource Registry will facilitate the creation of targeted areas and projects. During project design, the impacts of rising sea levels, changing precipitation patterns and salt tolerance should be incorporated.

ACTION ITEMS

- D-1 **HOST WORKSHOPS TO SHARE WETLAND RESTORATION TECHNIQUES AND PRACTICES** with consultants, engineers, planners, wetland professionals and interested stakeholders
- D-2 **EDUCATE ELIGIBLE LANDOWNERS ABOUT RESTORATION AND CONSERVATION OPTIONS** and promote enrollment or participation through workshops, online materials and targeted communications
- D-3 **SUPPORT COLLABORATION AND INFORMATION SHARING BETWEEN PRIVATE AND PUBLIC SECTORS** to more effectively advance and improve wetland restoration practices and rates of success
- D-4 **DEVELOP WATERSHED LEVEL RESTORATION PLANS** in watersheds with completed wetland assessments using GIS analysis and stakeholder input
- D-5 **SUPPORT THE WETLAND RESTORATION GOALS OUTLINED IN THE CHESAPEAKE BAY AGREEMENT**
- D-6 **EVALUATE THE PERFORMANCE OF WETLAND RESTORATION AND MITIGATION** in replacing wetland acreage and function
- D-7 **DEVELOP WETLAND RESTORATION BEST MANAGEMENT PRACTICES** for construction techniques, monitoring and reporting for a variety of wetland types and projects

Objective 2: Voluntary Restoration & Protection

Action Items		'16	'17	'18	'19	'20
D-1	HOST WORKSHOPS TO SHARE WETLAND RESTORATION TECHNIQUES AND PRACTICES with consultants, engineers, planners, wetland professionals and interested stakeholders	X	X			
D-2	EDUCATE ELIGIBLE LANDOWNERS ABOUT RESTORATION AND CONSERVATION OPTIONS and promote enrollment or participation through workshops, online materials, and targeted communications	X	X	X		
D-3	SUPPORT COLLABORATION AND INFORMATION SHARING BETWEEN PRIVATE AND PUBLIC SECTORS to more effectively advance and improve wetland restoration practices and rates of success	X	X	X	X	X
D-4	DEVELOP WATERSHED LEVEL RESTORATION PLANS in watersheds with completed wetland assessments using GIS analysis and stakeholder input	X	X	X	X	X
D-5	SUPPORT THE WETLAND RESTORATION GOALS OUTLINED IN THE CHESAPEAKE BAY AGREEMENT	X	X			
D-6	EVALUATE THE PERFORMANCE OF WETLAND RESTORATION AND MITIGATION in replacing wetland acreage and function		X			
D-7	DEVELOP WETLAND RESTORATION BEST MANAGEMENT PRACTICES for construction techniques, monitoring and reporting for a variety of wetland types and projects			X	X	

Objective 3:

Inform the citizens and visitors of Delaware about the functions and services of wetlands. Collaborate with State programs and conservation partners to improve project efficiency and effectiveness.

Objective 3: Education & Collaboration

Objective 3 is focused on linking information on the status of wetlands in Delaware to the decision making process and improving the condition of wetlands on the ground. Outreach and education efforts will focus on relaying information from the monitoring, assessment, and research efforts as well as the overall value and services of wetlands. By raising awareness of Delaware's rich wetland resources and the valuable services they provide, residents and visitors will appreciate wetlands and work towards a sustainable way of life that allows wetlands to persist for generations to come.

The WMAP will also focus on greater collaboration with state programs and conservations partners to share projects and improve efficiency. Through participation on work groups and by establishing lines of communication with related programs, data, methods and findings will be imparted, reducing redundancy and increasing the integration of wetland monitoring and assessment information. The WMAP will take a lead role in facilitating data sharing and the transfer of knowledge among professionals.

The assessment of wetland condition, including the identification of major stressors that are impacting wetlands as determined through the monitoring program, will be valuable for wetland education efforts. The goal is to

share wetland condition information and the implications of wetland impacts with conservation partners, decision makers and the public to gain their support in reducing wetland impacts through restoration, management and protection. Literature and online resources are being designed to share with the public in order to educate them in ways that they can work with their local land use decision makers to protect wetlands from encroaching development. The Delaware Wetlands website also serves the public by instructing homeowners on steps to minimize their footprint on their local watershed. Written and online materials as well as social media programs are designed to engage citizens and communities to connect with the resources around them.



Wetland invertebrate touch tanks at Ag Day 2014 (WMAP)



GOAL E: COLLABORATION

Facilitate collaboration and project sharing among wetland science programs, educators and regulators

PROGRESS AND CURRENT STATUS

DNREC and the Department of Agriculture have improved the level of collaboration and project sharing between related departments. This has in turn increased efficiency and strengthened relationships between some programs with similar goals to protect and conserve wetlands. There is still a need for more opportunities to stay connected to other groups.

In terms of reaching a large audience, the most successful effort to share wetland science and projects has been the biennial Delaware Wetlands Conference. In both 2012 and 2014 this event attracted over 250 attendees bringing together professionals and stakeholders from all sectors. These events informed participants about emerging topics, new technologies, current research endeavors, future needs for improving wetland protection and conservation and encouraged networking among colleagues.

DNREC has been successful in facilitating the completion of wetland-related projects with non-government organizations through technical advising or financial support. The formation of “work groups” such as the Delaware Living Shoreline Committee, Inland Bays Fringe Wetland Restoration Work Group, Delaware Sediment Elevation Table (SET) User Group, Chesapeake Bay Wetland Work Group, Mid-Atlantic Wetland Work Group ([MAWWG](#)), the Mid-Atlantic Coastal Wetland Assessment Working Group (MACWA) and the National Wetland Monitoring and Assessment Work Group (NWMAWG) have been critical for informing other states and organizations about Delaware’s projects and advances in wetland science. In addition, the Departments have benefited from the expertise and advice gained through shared insights, personal connections, and transferred technologies. Through these relationships Delaware’s wetland programs have become recognized and respected in the Mid-Atlantic region.

In an effort to connect wetland science with decision makers, biologists met with Kent County planners in a series of meetings regarding available wetland information and how to incorporate more wetland health findings into the review of proposed landuse projects. There was limited success in changing the current process. Also, Preliminary Land Use Service (PLUS) comments remain advisory only and do not require action. A need still exists to establish a process that engages end users and connects wetland data to decisions regarding wetland impacts and mitigation.



2014 Delaware Wetlands Conference (Gene Shaner)



Collaborative Living Shoreline Project Between Wetland Monitoring and Assessment Program, Partnership for the Delaware Estuary and Delaware Center for the Inland Bays (WMAP)



Wetland Assessment Method Workshop (2014; WMAP)



GOAL E: COLLABORATION ACTION ITEMS



*Inland Bays Fringe Wetland Restoration Group
Planning the Piney Point Restoration (WMAP)*

VISION STATEMENT

Collaboration has grown stronger between governmental and outside partners, but the Departments would like to find a consistent and convenient way for wetland groups to stay informed of developments and new projects. There is a need to open and maintain communication lines with outside experts and colleagues to maximize limited state funding and work efficiently. Local universities and colleges can strengthen wetland science research programs by offering wetland internships, networking and sharing wetland research experiences with other institutions via an academic work group, and incorporating wetland material into courses.

Continuing with the Delaware Wetlands Conference will engage and inform a wide audience in a short time, while also encouraging networking. Organizers will make an effort to have relevant topics represented, encourage networking and interactive discussions and place more focus on how to communicate wetland information with a wider audience. There should be a continued commitment to support and participate on the work groups previously mentioned that serve to bring state, federal, private and academic professionals together to share data and transfer knowledge. These wetland programs will expand opportunities for private sector entities to support projects through sponsorship and volunteering.

DNREC staff will pursue an avenue to insert more wetland-specific comments into landuse planning reviews that impact wetlands. County and municipal planners need to be educated to understand and value wetland-related remarks in order for them to generate project modifications.

ACTION ITEMS

- E-1 **HOST A BIENNIAL WETLANDS CONFERENCE** to share information relating to current wetland activities (e.g., monitoring, restoration, planning, education) among wetland professionals and interested public
- E-2 **PARTICIPATE IN AND LEAD PROFESSIONAL WORK GROUPS** to encourage data sharing and transfer of knowledge regarding wetland related issues in the state and the region
- E-3 **ENCOURAGE PROJECT SHARING WITHIN DNREC AND AMONG CONSERVATION PARTNERS AND ACADEMIA** through online and written communications or an organized cooperative to maximize impact and reduce redundancy
- E-4 **EXPAND PRIVATE SECTOR SUPPORT OF WETLAND CONSERVATION PROJECTS** to increase funding leverage and promote community stewardship
- E-5 **PRODUCE MORE DATA-DRIVEN WETLAND COMMENTS IN PLUS** review by coordinating among DNREC programs



GOAL F: EDUCATION

Enhance education and outreach efforts to broaden understanding and strengthen wetland stewardship among all wetland stakeholders

PROGRESS AND CURRENT STATUS

DNREC and the Forest Service have improved capabilities to reach a wider audience beyond one-on-one interactions through email marketing, interactive websites, printed materials and social media. A significant amount of materials and presentations were shared regarding changes in Delaware's wetland resources in the last few decades. Both the Adopt-a-Wetland program and the Delaware National Estuarine Research Reserve published a newsletter series to inform citizens about their work, educate readers and advertise upcoming events. Sophisticated guidebooks for wetland restoration and for public participation were printed, distributed widely and made available online. Wetland report cards by watershed share details about the health of wetlands by type, where the most severe impacts to function have occurred and offered recommendations for improvements. Recent reports conveying a message of wetland impacts and continued losses have reinvigorated the drive for strengthened freshwater wetland protection.

Despite increased use of electronic communication channels, the demand remains high for in-person events. Contact has been made with thousands of people of various ages and backgrounds to broaden their understanding of the wetland resources all around them. Citizen interest in wetland issues was reflected in growth of the Adopt-a-Wetland program to over 120 sites adopted across Delaware. This program has provided an outlet for school groups and interested citizens to voluntarily collect meaningful scientific information and become stewards for their adopted wetland. Their volunteer hours helped to support the Division of Fish and Wildlife and the Governor's No Child Left Inside Initiative but unfortunately this program was suspended due to funding challenges.

Not long after the state wetland maps were updated, DNREC met with county officials to improve the protection of freshwater wetlands. Planners were provided with more accurate maps to aid in the identification of areas in which development should be avoided. Information was also provided to planners about wetland health reports, wetland ecology and the value of wetlands to our state. Over the past few years DNREC has developed and executed a series of workshops for the public and local officials about the threats of sea level rise and how residents and municipalities can plan for changing conditions. Lastly, the Delaware National Estuarine Research Reserve's Coastal Training Program has coordinated dozens of learning opportunities across sectors and disciplines for the management of coastal resources in Delaware.



Filming for Outreach Video (WMAP)



Students Engaged in Hands-On Learning (WMAP)



Wetland Education and Outreach Display (WMAP)



GOAL F: EDUCATION ACTION ITEMS

VISION STATEMENT

Communication and education are crucial in reaching audiences and turning wetland science into better management and action. A goal for both Departments is the development of a common message for wetland conservation that sends a clear directive to audiences about what is needed and how they can help wetland conservation in Delaware. Priorities for wetland educators should include attending public events to attract new wetland enthusiasts, as well as outreach to schools to enlighten students on Delaware wetland issues. Where possible, tracking of numbers of individuals interacted with at events and programs should be maintained, with an eye to increasing the quality and quantity of such contacts on an annual basis. Also, there should be an effort to create or provide information and activities to educators that are aligned with public school science standards. This information should be easily accessible and organized clearly.

As the state moves forward with recommendations from the Delaware Wetland Advisory Committee, it is clear that more effort should be made to communicate with other county and municipal officials to improve planning decisions, especially after state wetland maps are updated. Targeting audiences on a watershed scale and reaching those decision-makers and landowners in their backyards with messages that are tailored to their priorities (e.g. business owner, landowner, forester, farmer) will move people to take action and make a difference in areas that are not protected or regulated.

Communicating the results of wetland studies, including wetland health report cards, is important and should focus on promoting how management can be improved and how citizens can become involved. Previously created guidebooks are in need of revisions and can be reprinted to include new landowner stories and emerging techniques, such as living shorelines. Increasing public participation in wetland programs through online and social media venues can expand the number of followers reached, leading to stronger connections with modern audiences. In addition, cross-posting of other wetland program updates (e.g. Partnership for the Delaware Estuary, Center for the Inland Bays, DNERR, Delaware Sea Grant, USFWS) on social media will boost exposure and awareness. Through online campaigns such as Wetlands Month, World Wetlands Day, National Estuaries Day, and Sea Level Rise Awareness Week, Delaware programs can bring local issues to the national level.



ACTION ITEMS

- F-1 **CREATE ELECTRONIC AND PRINTED EDUCATION MATERIALS FOR DISTRIBUTION** that represent a unified Department of Agriculture and DNREC message for wetland conservation, resonate with targeted audiences, reflect wetland condition findings, convey the monetary and biophysical value of wetlands and address misconceptions regarding wetland conservation and protection
- F-2 **IDENTIFY AND ADDRESS GAPS IN WETLAND EDUCATION PROGRAMS**, topics and audiences to improve wetland awareness, appreciation and prioritization
- F-3 **DEVELOP AND IMPLEMENT A SERIES OF WORKSHOPS AND COMMUNICATIONS TO EDUCATE COUNTY AND MUNICIPAL LEADERS** regarding the importance of wetland benefits, how wetland services support the economy, the threats posed to our state resources and the tools available to address those threats
- F-4 **EXPAND OR CREATE A SOCIAL MEDIA FOLLOWING FOR WETLAND PROGRAMS** to update constituents and conservation partners regarding wetland projects, facts and current events
- F-5 **REFINE AND MAINTAIN A WETLAND WEBPAGE** that shares scientific results, describes wetland types, services and values, informs audiences, and encourages wetland conservation
- F-6 **COMPILE, DEVELOP AS NEEDED AND PROMOTE WETLAND EDUCATION CURRICULUM AND MATERIALS** that align with science standards in public schools

Objective 3: Education & Collaboration

Action Items		'16	'17	'18	'19	'20
E-1	HOST A BIENNIAL WETLANDS CONFERENCE to share information relating to current wetland activities (e.g., monitoring, restoration, planning, education) among wetland professionals and interested public	X		X		X
E-2	PARTICIPATE IN AND LEAD PROFESSIONAL WORK GROUPS to encourage data sharing and transfer of knowledge regarding wetland related issues in the state and the region	X	X	X	X	X
E-3	ENCOURAGE PROJECT SHARING WITHIN DNREC AND AMONG CONSERVATION PARTNERS AND ACADEMIA through online and written communications or an organized cooperative to maximize impact and reduce redundancy	X	X	X	X	X
E-4	EXPAND PRIVATE SECTOR SUPPORT OF WETLAND CONSERVATION PROJECTS to increase funding leverage and promote community stewardship	X				
E-5	PRODUCE MORE DATA-DRIVEN WETLAND COMMENTS IN PLUS review by coordinating amongst DNREC programs		X	X		
F-1	CREATE ELECTRONIC AND PRINTED EDUCATION MATERIALS FOR DISTRIBUTION that represent a unified Department of Agriculture and DNREC message for wetland conservation, resonate with targeted audiences, reflect wetland condition findings, convey the monetary and biophysical value of wetlands, and address misconceptions regarding wetland conservation and protection	X	X	X	X	X
F-2	IDENTIFY AND ADDRESS GAPS IN WETLAND EDUCATION PROGRAMS , topics and audiences to improve wetland awareness, appreciation and prioritization			X	X	X
F-3	DEVELOP AND IMPLEMENT A SERIES OF WORKSHOPS AND COMMUNICATIONS TO EDUCATE COUNTY AND MUNICIPAL LEADERS regarding the importance of wetland benefits, how wetland services support the economy, the threats posed to our state resources and the tools available to address those threats		X	X	X	
F-4	EXPAND OR CREATE A SOCIAL MEDIA FOLLOWING FOR WETLAND PROGRAMS to update constituents and conservation partners regarding wetland projects, facts and current events	X	X	X	X	X
F-5	REFINE AND MAINTAIN A WETLAND WEBPAGE that shares scientific results, describes wetland types, services and values, informs audiences, and encourages wetland conservation	X	X	X	X	X
F-6	COMPILE, DEVELOP AS NEEDED AND PROMOTE WETLAND EDUCATION CURRICULUM AND MATERIALS that align with science standards in public schools			X	X	X

Objective 4: Regulation

Objective 4: Regulation

Inform regulatory decisions, mitigation processes and report to the Clean Water Act

Objective 4 takes the information and findings on wetland acreage, condition and function through customized educational materials to inform the regulatory process and support decisions. Integrating wetland monitoring data into considerations will enable Delaware to go beyond 'no net loss' to achieve a gain in functioning wetlands in Delaware. A portion of work will also be working to integrate the program's methods into the mitigation process. In addition, assessment data will be compiled and included in the State's 305(b)/Integrated Report as part of the Clean Water Act requirements.



A wet wooded lot for sale (Chris Bason)

The National Water Quality Inventory Report to Congress (305(b) report) is the primary vehicle for informing Congress and the public about general water quality conditions in the United States, including wetlands. This document characterizes our water quality, identifies widespread water quality problems of national significance, and describes various programs implemented to restore and protect our waters. The condition of wetlands on the watershed scale was included in Delaware's 305(b)/Integrated Report for the State beginning in 2008.

Assessment results will be used to enhance existing regulatory programs and evaluate the need for additional regulations. Based on the management recommendations from the wetland health reports for assessed watersheds, regulations that would address dominant stressors impacting wetlands can be evaluated to determine how to make them more effective (e.g. forested buffers). Additionally, mitigation provides an opportunity to incorporate the assessment methods (DERAP, DECAP, and MidTRAM) to improve restoration practices and focus future sites in areas identified as priorities in the watershed restoration plans.



Tidal wetland fill violations (Scott Figurski)



Fowler's Toad (Bufo fowleri; WMAP)



Coastal Plain Pond (William A. McAvoy)



Pink Orchid (Calopogon tuberosus; William A. McAvoy)



GOAL G: CONSERVATION

Work with partners to support and enhance wetland conservation programs that are not covered by state and federal regulations

PROGRESS AND CURRENT STATUS

DNREC has numerous programs related to wetlands, and a review of all of these programs was conducted by the Environmental Law Institute (ELI). The resulting report identified gaps and areas of need including consistent messaging, a freshwater wetland conservation program, and improved tracking of cumulative impacts due to permitted activities.

Forested headwater wetlands make up two-thirds of Delaware's freshwater wetlands and may appear dry during parts of the year, leaving them open to questionable delineations and susceptible to development. During a comparative review of mapped wetland losses versus permit records, it was discovered that cumulative impacts due to activities in wetlands and the investigation of possible illegal activities occurring in wetlands were not being tracked thoroughly. The review also highlighted a need for stronger state wetland conservation programs and greater attention on the enforcement of permits in Delaware's wetlands.

Delaware is an agriculturally rich state. In light of low land values and high crop prices, some Delaware farmers have, unfortunately, moved away from wetland preservation programs and returned wet fields to productive agricultural fields. Offering a higher wetland value per acre would incentivize participation in preservation programs. On the impacts side, Delaware does not have a mitigation bank for replacing wetlands impacted or an in-lieu fee program. Introducing such programs would provide incentives for landowners to commit to conserving their wetlands and thereby prevent further losses.

The ELI review in combination with the state's documented loss of wetlands prompted the creation of Senate Bill 78. This legislation established the Delaware Wetland Advisory Committee to contribute towards a statewide freshwater wetland strategic plan. The Committee met with the goal of delivering recommendations to improve freshwater wetland conservation and restoration to the DNREC Cabinet Secretary. The Committee recommended the promotion of tax incentive programs, such as the Forestland Preservation Act which would protect forested wetlands, and using outreach and education to encourage private landowner wetland stewardship.



GOAL G: CONSERVATION ACTION ITEMS



Coastal Plain Seasonal Pond (William A. McAvoy)

VISION STATEMENT

DNREC has the authority to regulate tidal wetlands as part of the Wetlands and Subaqueous Lands Section. This program has been successful in controlling and limiting tidal wetland impacts. The regulation of wetlands at the state level is limited, in part, by the hesitation of some stakeholder groups to additional regulations and general concern with state government. Using other states as an example will help to reach a compromise that benefits Delaware's resources and economy. Initiatives by both Departments will incorporate some of the recommendations by the Delaware Wetland Advisory Committee, such as pursuing a state conservation program for ecologically rare wetland habitat types. DNREC, DelDOT and the Department of Agriculture intend to set a strong example of resource conservation and the value of partnerships by forming a Memorandum of Understanding (MOU) to protect and conserve those rare and unique wetland communities occurring on their properties. DNREC will contribute wetland condition data towards the development of TMDLs and will seek the chance to establish wetland specific-water quality standards.

With the lack of a comprehensive state freshwater wetland program, DNREC, the Forest Service and related non-governmental organization's would like to increase voluntary preservation and conservation of privately owned wetlands by encouraging participation in incentive programs. In particular both groups would like to protect forested headwater wetlands and isolated wetlands. Forested headwater wetlands make up two-thirds of Delaware's freshwater wetlands and may appear dry during parts of the year, leaving them open to questionable delineations and susceptible to development. Isolated wetlands are home to dozens of endemic and endangered plant and animal species but lack regulation under the federal permitting system. Lastly, a review of local ordinances could identify areas that are not being used as intended or to their fullest capacity.

ACTION ITEMS

- G-1 **ESTABLISH A STATE WETLAND CONSERVATION PROGRAM** (maps included) that includes protecting rare and unique wetland communities and species, compliance monitoring and tracking impacts cumulatively
- G-2 **UPDATE STATE TIDAL WETLAND MAPS** to reflect changing coastal conditions, improve efficiency for permitting activities, and minimize wetland impacts in tidal wetlands
- G-3 **DEVELOP AN MOU BETWEEN STATE AGENCIES TO PROTECT AND CONSERVE RARE AND UNIQUE WETLANDS** on DelDOT, DNREC and Department of Agriculture property
- G-4 **ENCOURAGE COUNTY AND MUNICIPAL-LEVEL SUPPORT TO ESTABLISH FORESTED BUFFERS** around isolated and headwater forested wetlands and ecologically rare and unique wetland communities
- G-5 **PRIORITIZE FORESTLAND PROTECTION AND CONSERVATION** including forest buffers around streams and forested wetlands, isolated forested wetlands, headwater forests and large contiguous forest blocks
- G-6 **REVIEW EXISTING COUNTY MUNICIPAL CODES AND ORDINANCES** to consider their full intent, whether they are being used to their full extent, and to identify gaps in wetland protection including constructed wetland best management practices
- G-7 **REPORT ON THE CONDITION OF WETLANDS IN COMPLIANCE WITH THE CLEAN WATER ACT** (305b report) and explore opportunities to develop Water Quality Standards for Wetlands.

Objective 4: Regulation

Action Items		'16	'17	'18	'19	'20
G-1	ESTABLISH A STATE WETLAND CONSERVATION PROGRAM (maps included) that includes protecting rare and unique wetland communities and species, compliance monitoring and tracking impacts cumulatively	X	X	X		
G-2	UPDATE STATE TIDAL WETLAND MAPS to reflect changing coastal conditions, improve efficiency for permitting activities, and minimize wetland impacts in tidal wetlands	X	X			
G-3	DEVELOP AN MOU BETWEEN STATE AGENCIES TO PROTECT AND CONSERVE RARE AND UNIQUE WETLANDS on DelDOT, DNREC and Department of Agriculture property				X	X
G-4	ENCOURAGE COUNTY AND MUNICIPAL-LEVEL SUPPORT TO ESTABLISH FORESTED BUFFERS around isolated and headwater forested wetlands and ecologically rare and unique wetland communities		X	X	X	
G-5	PRIORITIZE FORESTLAND PROTECTION AND CONSERVATION including forest buffers around streams and forested wetlands, isolated forested wetlands, headwater forests and large contiguous forest blocks		X	X	X	
G-6	REVIEW EXISTING COUNTY MUNICIPAL CODES AND ORDINANCES to consider their full intent, whether they are being used to their full extent, and to identify gaps in wetland protection including constructed wetland best management practices			X	X	
G-7	REPORT ON THE CONDITION OF WETLANDS IN COMPLIANCE WITH THE CLEAN WATER ACT (305b report) and explore opportunities to develop Water Quality Standards for Wetlands.		X	X		

EVALUATING PROGRESS

Achievement of the goals presented in the preceding pages will lead to better protection and restoration of wetland resources in Delaware. We will evaluate progress toward meeting these goals and improving wetland protection in Delaware in five years (2020). The answers to the following questions will be used to evaluate areas where goals have been met, areas that require more work, and to determine if there is a need to develop new goals or action items.



GOAL A: Update wetland mapping tools and improve access to wetland related spatial data

- ◇ Have we improved the quality and availability of spatial layers?
- ◇ What spatial tools or layers have been created or made available?



GOAL B: Increase monitoring efficiency and effort to provide insight into wetland function and health

- ◇ Which standardized assessment protocols been developed for natural and restored wetlands?
- ◇ Have monitoring techniques been shared via workshops and trainings?



GOAL C: Use available science and research to better understand and plan for the effects of climate change and sea level rise on wetlands habitats

- ◇ Do we have an improved understanding of how and where wetlands are migrating?
- ◇ How are we using monitoring information to prevent loss of coastal wetlands?



GOAL D: Advance wetland restoration, creation, and enhancement practices to increase wetland acreage, condition and function

- ◇ What watersheds have strategic restoration and protection plans developed?
- ◇ Has there been an increase in enrollment in restoration and conservation programs?



GOAL E: Facilitate collaboration and project sharing between wetland science programs, educators, and regulators

- ◇ Has information sharing and transfer of knowledge been encouraged amongst wetland professionals?
- ◇ How has DNREC facilitated communication and collaboration of wetland projects, data, or findings?



GOAL F: Enhance education and outreach efforts to broaden understanding and strengthen wetland stewardship among all wetland stakeholders

- ◇ Have we increased the number of people reached with in person, online and written information sharing?
- ◇ Are educational materials aligned with public school programs and readily accessible?



GOAL G: Work with partners to support and enhance wetland conservation programs that are not covered by state and federal regulations

- ◇ Are wetlands in Delaware better protected by new or updated conservation programs?
- ◇ Has wetland protection been strengthened beyond the federal level?

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Appendix A: HGM subclasses found in Delaware (Brooks et al. 2011)

Proposed terminology for classifying Mid-Atlantic region wetlands using hydrogeomorphic attributes and descriptive examples

HYDROGEOMORPHIC CLASS ^{a,b} /Regional Subclasses	Dominant water sources of class and flow dynamics	Major source of variation within subclass	NWI vegetation classes ^c	Regional example	Citation
FLAT (FL)	Precipitation; Vertical fluctuation	Hydroperiod and fire frequency	FO, SS, EM	Wet pine flats/ wet pine savannas, wet hardwood flats; Broad areas with poor drainage on mineral soils	Walker and Peet (1983); Tiner (1985); Tiner and Burke (1995); Rheinhardt and Rheinhardt (2000), Havens et al. (2001), Rheinhardt et al. (2002)
Mineral soil (n)					Richardson (1981)
Organic soil (g)		Peat depths (from histis epipedons to histosols)	FO, SS, EM	Southern peat bogs such as pocosins; Broad areas with poor drainage that accrete organic matter	
SLOPE (SL)	Groundwater discharge and interflow; Unidirectional & horizontal				
Stratigraphic (s)	Derived from structural geologic discontinuities, discharging from distinct point(s)	Mineral(n) or organic(g)	FO, SS, EM	Spring seep	Cole et al. (1997); Wardrop et al. (2007)
Topographic (g)	Accumulates at toe-of-slope before discharging	Mineral(n) or organic(g)	FO, SS, EM	Forested fen	WPC (1998)
DEPRESSION (DP)	Precipitation or groundwater; vertical fluctuation				Tiner (1985); Tiner and Burke (1995)
Temporary (A)		No surface outlet; often has a perched water table	FO, SS, EM, AB	Vernal pools that dry during the growing season and often lack fish; Coastal Plain Seasonal Pond Complex (underlying calcium-rich shell marl)	Rawinski (1997); Havens et al. (2003a, b); Brooks (2004b, c)
Seasonal (C)		Infrequent surface connections to other waterbodies; normally in contact with groundwater	FO, SS, EM, AB	Deltarva bays; Interdunal swales	Phillips and Shedlock (1993); Rheinhardt and Faser (2001); Tiner (2003)
Perennial (H)		Frequent surface connections to other waterbodies with inlets and outlets conveying channel flow	FO, SS, EM, AB	Floodplain depressions isolated from overbank flow, vegetated marsh; riparian depressions with steady groundwater flow	Tiner (1985); Hull and Whigham (1987); Tiner and Burke (1995); Cole et al. 1997; Brooks and Hayashi (2002)
Human impounded (i) or excavated (x)		Size of catchment	SS, EM, AB	Borrow pits; some farm ponds; some created wetlands	Jordan et al. (1999); Whigham et al. (2002); Jordan et al. (2003)
LACUSTRINE FRINGE (LF)	Inundation from lake; Bi-directional and horizontal				
Permanently flooded (H)		Hydroperiod; minor fluctuations during year	FO, SS, EM, AB	Natural lake shore	Shafale and Weakley (1990)
Semipermanently flooded (F)		Hydroperiod; varies during growing season	FO, SS, EM, AB	Natural lake shore	Shafale and Weakley (1990)
Intermittently flooded ^d (J)		Hydroperiod; substrate exposed often	FO, SS, EM, AB	Natural lake shore	Shafale and Weakley (1990)
Artificially flooded ^e (K)		Reservoir dam release schedule creates fluctuations resulting in a strong vertical component depending on slope	FO, SS, EM, AB	Piedmont reservoirs	Mack (2004), Havens et al. (2003a, b)
RIVERINE (RV)	Overbank flow from channel and groundwater discharge; Unidirectional				
Headwater complex (3c)		Mosaic of low gradient small streams, depressions in the riparian zone, and toe of slope wetlands generally supported by groundwater; (usually < third order)	FO, SS, EM, AB	Forested	Farr 2003 Brooks and Wardrop unpublished data

Appendix A (cont'd): HGM subclasses found in Delaware (Brooks et al. 2011)

HYDROGEOMORPHIC CLASS ^{a,b} Regional Subclasses	Dominant water sources of class and flow dynamics	Major source of variation within subclass	NWI vegetation classes ^c	Regional example	Citation
Intermittent (4)		Range of hydroperiods within riparian zone (usually < third order), gradient high, water velocities fast.	FO, SS, EM, AB	Riparian forest, although not usually in the stream channel	Rheinhardt et al. (1998); Rheinhardt et al. (2000); Peterjohn and Correll (1984)
Lower perennial (2)		Range of hydroperiods within 100-y floodplain, including in-stream terraces and bars (usually > third order) Gradient is typically low; water velocities slow.	FO, SS, EM, AB	Bottomland or floodplain forest	NRC (2002)
Floodplain complex (2c)		Range of hydroperiods within 100-yr floodplain, including mosaic of depressions, remnant channels, and groundwater discharges; Gradient is typically low; water velocities slow.	FO, SS, EM, AB	Bottomland or floodplain forest with oxbow lakes, backwaters, toe-of-slope seeps	Brooks, Wardrop and Yetter, unpublished data
Beaver-impounded (b)		Dam more temporary than human-impounded; usually < third order	FO, SS, EM, AB	Beaver pond	Kloiz (1998); Correll et al. 2000 Bason and Brinson (in preparation)
Human-impounded ^d (h)		Range of water residence times based on impoundment volume and discharge	FO, SS, EM, AB	Mill ponds; large farm ponds not deemed to be Depressions	
ESTUARINE TIDAL FRINGE (EF)	Mixture of sea and fresh water; bi-directional and horizontal	Regularly flooded zone: Flooding by semidiurnal tides Irregularly flooded zone: Flooding by spring and storm tides and precipitation (Salinity ranges -0 to >30 ppt)	EM, AB	<i>Spartina alterniflora</i> -dominated zone <i>Juncus roemerianus</i> and <i>S. patens</i> dominated zone Freshwater tidal swamps	Stevenson et al. (1977); McCormick and Somes (1982); Simpson et al. (1983); Rheinhardt (1992); Havens et al. (2002); Paul (2001)
Estuarine wind Intertidal ^f (2w)		Tide induced by wind seiche (Salinity ranges - 0 to >30 ppt)	FO, EM, AB	Black needle-rush marshes	Brinson (1991)
Estuarine subtidal (1)		Low energy regime allows SAV establishment (Salinity ranges—0 to >30 ppt)	AB	Mud and sand flats, SAV beds; Oyster reefs	Rybicki et al. (2001) Southworth and Mann (2004)
Estuarine Impounded (h)		Flow is blocked by dike, gate, or dam; water source precipitation except for controlled delivery of estuarine water of varying salinity	EM, AB	Waterfowl impoundments	
MARINE TIDAL FRINGE (MF)	Marine source; Bi-directional and horizontal				
Marine intertidal (2)		N/A	US	High energy beach	
Marine subtidal (1)		N/A	UB	Shallow littoral	

^a Hydrogeomorphic (HGM) classes follow Brinson (1993a) and further refinements from other literature and field experiences of the authors

^b Upper case in bold are HGM classes; lower case in bold are regional subclasses, except for deepwater environments. Letters in parentheses are suggested mapping abbreviations, consistent with NWI wherever possible

^c NWI vegetation classes: forested (FO), scrub-shrub (SS), emergent (EM), aquatic bed (AB), unconsolidated shore (US), unconsolidated bottom (UB), riverine (R), Lacustrine (L), estuarine (E), marine (M)

^d The landward zones of Lacustrine Fringe may receive groundwater discharge and justify a Slope designation. Regardless, the hydraulic gradient is likely controlled by lake level. Does not include depths >2 m, which is Deepwater Habitat

^e Technically, reservoirs are an alteration of the Riverine class. However, large reservoirs are generally an irreversible social commitment not amenable to restoration. As a practical matter, their shorelines have strong Lacustrine Fringe characteristics, which justifies placing them in the Fringe category

^f Pamlico Sound, NC and tributary estuaries are little affected by astronomical tides because of their large volume and relatively small exchanges seawater during a tidal cycle

Appendix B: Acronym glossary

DECAP	Delaware Comprehensive Assessment Procedure
DelDOT	Delaware Department of Transportation
Departments	Natural Resources and Environmental Control & Agriculture
DERAP	Delaware Rapid Assessment Procedure
DNERR	Delaware National Estuarine Research Reserve
DNREC	Department of Natural Resources and Environmental Control
ELI	Environmental Law Institute
EPA	Environmental Protection Agency
HGM	Hydrogeomorphic
LLWW	Landscape Position, Landform, Water Flow Path and Waterbody Type
MidTRAM	Mid-Atlantic Tidal Rapid Assessment Method
NWI	National Wetland Inventory
PLUS	Preliminary Land Use Service
SET	Surface Elevation Table
SWMP	Statewide Wetland Mapping Project
TMDL	Total Maximum Daily Load
USFWS	U.S. Fish and Wildlife Service
WPP	Wetland Program Plan
WMAP	Wetland Monitoring and Assessment Program

“A true conservationist is a man who knows that the world is not given by his fathers, but borrowed from his children.”

— John James Audubon

