Comparative Analysis of Coastal Wetland Health in the Delaware Estuary Assessed Using Rapid Methods

Angela T Padeletti[1], Danielle Kreeger[1], Kelly Somers[1], Andrew Howard[2] and Allison Rogerson[2]

1. Partnership for the Delaware Estuary, Wilmington, DE; 2. Delaware Department of Natural Resources and Environmental Control, Dover, DE

Overview

Tidal wetlands are a hallmark feature of the Delaware Estuary, yet we know little about their health. The Partnership for the Delaware Estuary launched the Mid-Atlantic Coastal Wetlands Assessment to fill in these data gaps using various rapid assessment methods and intensive site monitoring throughout representative areas of the estuary.

The Mid-Atlantic Tidal Rapid Assessment Methodology, originally developed by the Delaware Department of Natural Resources and Environmental Control, was used to examine wetland stressors and health in; Maurice, NJ, Christina, DE, and Pennsylvania tidal wetlands. These watersheds span a broad stressor gradient, extending from urban, low salinity areas (Philadelphia, Wilmington) to rural, agricultural areas with salt marshes and a long history of salt hay farming.

Thirty randomly selected sites were visited at each of the three watersheds. Hydrology, habitat, and landscape condition were evaluated with on-the-ground and landscape GIS analyses to identify likely stressor-response relationships and yielding an overall wetland health score for site. Urban wetlands were higher in diversity than might be expected, but they appeared significantly impaired by smothering from floatable debris (trash) and their landward migration potential was severely restricted. Moreover, approximately 60 Pennsylvania sites designated as coastal wetlands in National Wetlands Inventory maps needed to be visited to find 30 sites that were still wetlands, suggesting that significant losses of wetlands (to development) occurred since the maps were produced, despite state and federal protection.

Taken together, these results indicate that the nationally rare freshwater tidal wetlands of the upper Delaware Estuary continue to be threatened by direct destruction as well as indirect stressors. In contrast, coastal wetlands in rural watersheds appear to be impaired by diverse local stressors. Watershed-specific report cards on wetland health are being developed to inform and engage the public , and attribute-specific data are being summarized for coastal managers so they can more strategically address specific sources of wetland impairment during these lean budget times.

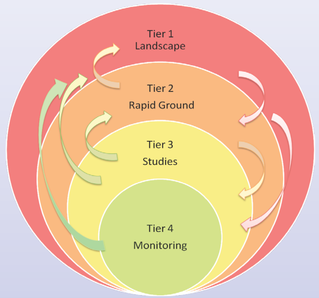

Figure 1

Figure 1. Following US EPA guidance, a four-tiered wetland assessment strategy was developed. Data from each level can be integrated, providing an approach to extrapolate local to regional conditions. An example of Tier 1 is the National Wetlands Inventory dataset. Tier 2 consists of efficient ground-truthing of Tier 1 data at numerous sites. Our rapid assessment method was developed with the unique diversity of tidal wetlands in the Mid-Atlantic region in mind. Tier 3 consists of intensive scientific studies that examine the links between condition, function and stressors. Tier 4 tracks condition and function at representative fixed stations where water quality, sediment flux, plant community, fauna integrity, and other metrics are monitored.

Figure 2. The Barnegat Bay (right) is a shallow lagoonal estuary that has experienced mosquito ditching, bulk-heading, and loss of buffer zones. Development has lead to the loss of 28% of the wetlands in the estuary. The Delaware Estuary (left) is unique in that it has a near contiguous band of salt, brackish and freshwater tidal marshes from near Cape May, NJ and Cape Henlopen, DE to the head of tide in Trenton. Despite their extent and diversity, wetlands are one of the most degraded habitats due to past land use practices and anthropogenic inputs, and are under increasing threats due to sea level rise and climate change.

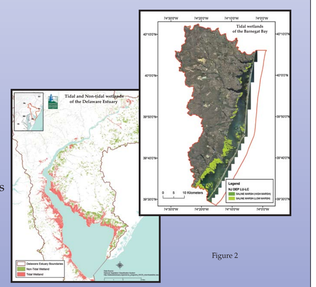

Figure 2

Attribute	Metric	Description
Buffer/Landscape	Percent of AA Perimeter with 5m Buffer	Percent of AA perimeter that has at least 5m of natural or semi-natural condition land cover
Buffer/Landscape	Average Buffer Width	The average buffer width surrounding the AA that is in natural or semi-natural condition
Buffer/Landscape	Surrounding Development	Percent of developed land within 250m from the edge of the AA
Buffer/Landscape	250m Landscape Condition	Landscape condition within 250m surrounding the AA based on the nativeness of vegetation, disturbance to substrate and extent of human visitation
Buffer/Landscape	Barriers to Landward Migration	Percent of landward perimeter of wetland within 250m that has physical barriers preventing wetland migration inland
Hydrology	Ditching & Draining	The presence of ditches in the AA
Hydrology	Fill & Fragmentation	The presence of fill or wetland fragmentation from anthropogenic sources in the AA
Hydrology	Wetland Diking / Tidal Restriction	The presence of dikes or other tidal flow restrictions
Hydrology	Point Sources	The presence of localized sources of pollution
Habitat	Bearing Capacity	Soil resistance using a slide-hammer
Habitat	Vegetative Obstruction	Visual obstruction by vegetation <1m measured with a coverboard
Habitat	Number of Plant Layers	Number of plant layers in the AA based on plant height
Habitat	Percent Co-dominant Invasive Species	Percent of co-dominant invasive species in the AA
Habitat	Percent Invasive	Percent cover of invasive species in the AA
Shoreline	Shoreline Erosion	Shoreline condition at shoreline transect points based on the erosion accretion ratio
Shoreline	Shoreline Alteration	Presence of built structures or non-natural materials along the shoreline at transect points

Table 1. The Partnership for the Delaware Estuary (PDE) adopted and developed by the State of Delaware and modified a rapid assessment protocol referred to as the Mid-Atlantic Tidal Rapid Assessment (MidTRAM). The MidTRAM is a rapid condition assessment of emergent tidal wetlands that two people can typically complete in 2 hours. The method is suitable for a variety of coastal wetlands and stressor conditions, ranging from freshwater tidal marshes in urban areas to salt marshes in rural reaches. Data for twenty metrics are collected which are grouped into three attributes; hyrdrology, habitat and buffer quality. The MidTRAM provides an overall condition score compared to reference sites within the region.

Sites

The Christina watershed, DE (Figure 4), the Maurice watershed, NJ (Figure 5) and the Pennsylvania tidal fresh (Figure 6) are three very different watersheds within the Delaware Estuary (Figure 3).

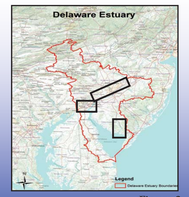

Figure 3

Figure 4

Figure 5

Figure 6

History

The Christina is an urban/suburban watershed with over 400 years of anthropogenic impacts to it's system. Diking to create towns and farmlands, and widespread pollution from toxic chemicals are among its history. Figure 7 shows a map of state listed contaminated sites along the Christina River, not including 3 federally listed sites.

The Maurice watershed lies in a rural area with habitat throughout the watershed providing home to 53% of the state's endangered species, excluding marine mammals.Yet anthropogenic impacts also from as early as the 17th century residents have been diking the shorelines for agricultural use. It is estimated that most of the Maurice river was at one time diked. Figure 8, circa 1950, areal shows the last of the last remaining diked farm in southern NJ, the Burchams farm.

In Pennsylvania when the city of Philadelphia was established in 1682 tens of thousands of acres of wetlands surrounded the area. A map from 1777 of the city and it's wetlands is found in Figure 9. Yet by the 1800's those "lowlands" were being filled with millions of cubic yards of fill from city refuse, dredge spoils and eventually excavated material from the subway system. Land was also diked and farmed for the ever increasing population.

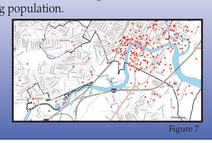

Figure 7

Figure 8

Figure 9

Figure 10

Figure 11

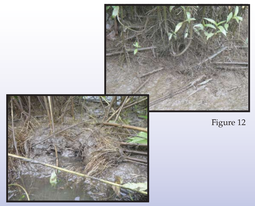

Figure 12

Figure 13

Figure 14

Figure 15

Recent Threats

In more recent history, the Christina marsh was impacted by the building of highways (Figure 10) and railroads (Figure 11) that caused fragmentation of the last remaining large tracts of marsh. During these construction projects the marshes were used as landfills for surplus sediments increasing the elevation of the marsh and altering the hydrology of the wetlands. Currently shorelines are bordered with abandoned warehouses and rundown factories.

While most of the Maurice River is rural, there are large urban areas at it's headwaters, causing sizable nutrient inputs. Figure 12 & 13 show flora in a marsh just down river of a waste water treatment plant on the river. This marsh showed large amounts of above ground biomass but virtually no below ground, as evident in these pictures of roots that are literally growing into the air.

In Pennsylvania, by the 1950's just over 1,000 acres of the once vast freshwater tidal wetlands survived, the largest remaining tract (200 acres) lies within an national refuge . Today the region continues to lose what little nationally important habitat is left, with the expansion of businesses (airport expansion, Figure 14) as well as continued urban sprawl (Figure 15) where wetlands naturally once were. Unfortunately National Wetlands Inventory data for this area are forty years old, causing 60 sites to be sampled before 30 could be found that were indeed tidal freshwater wetlands.

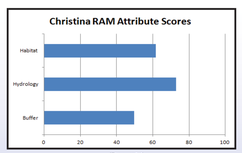

Figure16

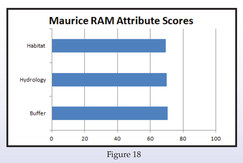

Figure 18

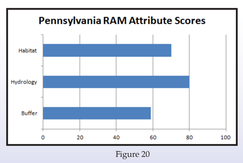

Figure 20

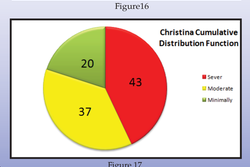

Figure 17

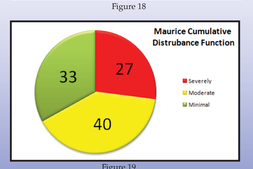

Figure 19

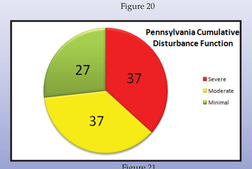

Figure 21

Health

MidTRAM results for all three watersheds (Figure 16, 18 &20) are normalized to a 0-100 scale, and broken into 3 attributes; habitat, hyrdology and buffer. The Christina's and Pennsylvania's most impacted attribute is the buffer at 49.8% and 59% respectively, while the Maurice has acceptable ranking of all 3 attributes.

A cumulative distribution function (Figure 17, 19 & 21) was used to extrapolate the results of the 30 sites to all wetlands within the watershed compared to reference sites. The Christina shows more stressed wetland conditions than in the Maurice and Pennsylvania which is split approximately 1/3 each into the severely, moderately and minimally stressed distinctions. While the stressors are different between the Maurice (rural) and Pennsylvania (urban), overall the CDF reveals similar results. We hope to verify these findings by comparing Tier 4 intensive study site data to these results, after another year of Tier 4 data is collected.

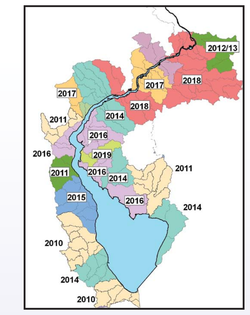

Figure 22

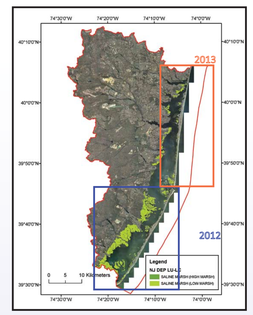

Figure 23

Next Steps and Expected Outcomes

MACWA plans to perform Tier 3 rapid assessment throughout the Delaware and Barnegat Bay estuaries, contingent on funding. Barnegat will be completed by 2013 and the Delaware by 2019 (Figures 22,23). By instituting and sustaining the multi-tiered MACWA framework, the following outcomes are expected:

- **Consistent interstate data** will strengthen and allow for status and trends reporting (e.g. State of the Estuary reports)
- **Identify critical stressor-response** relationships in specific sub-watersheds will facilitate best management practices to strategically address causes of impairment
- GIS data showing spatial variation in accretion rates and other factors (extrapolated from Tiers 1 and 4) will lead to **maps of "elevation capital"** that predict the fate of various coastal wetlands in the landscape. These findings will guide strategic prioritization of projects, such as how, where and when to preserve or enhance (e.g., for mitigation).
- **Facilitate ecosystem management** within target watersheds. For example, excess nutrients and insufficient sediments might be impairing wetlands, and in turn nutrient criteria establishment and regional sediment management could be affected by projected losses of sizeable tracts of tidal wetlands in the Delaware Estuary.

Figure 25. Photo of pile of trash that accumulates in Pennsylvania marshes. Trash can include TV's, tires, shower stalls, shopping carts, and thousands of plastic bottles. Large swaths of trash seem to be smothering parts of the wetlands.

Summary

Results from MidTRAM in three watersheds within the Delaware Estuary provide interesting conclusions about the health of the estuary's wetlands. In the urban corridor, wetlands scored higher than expected; what limited wetlands are left are in generally good condition, but are constrianed by limited migration possibility when sea levels rise. Large populations of invasive species decreased the score of the Christina watershed along with suburban squeeze of the wetlands. While the Maurice was diked and ditched for most of it's history, currently it is wetlands appear healthy, though true elevation-capital data should be obtained to quantify predictions.

The Mid-Atlantic Coastal Wetland Assessment is a new multilevel regional program designed to fill vital data gaps and provide new management tools for guiding coastal decision-making regarding the tidal wetlands. In the Delaware Estuary we have found flaws in the landscape condition scale data (Tier 1) with insufficient, outdated and erroneous data being used. Tier 4 intensive monitoring data is preliminary, but is revealing that watersheds throughout the estuary have their own unique set of stressors, making broad scale assessments limited in their effectiveness. If fully supported, the wetland strategy would allow cross-linking among of data products from different levels, helping us track important changes, understand and address impairments, and make the best possible decisions about management and restoration investments. PDE is currently revising its wetland strategy for the Delaware Estuary, including an updated technical plan for multi-level monitoring and assessment and a new operational plan to sustain the effort with help from diverse sectors .

For more information on MACWA, please see www.DelawareEstuary.org

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