
PROJECT TITLE: A MULTI-METRIC SITE EVALUATION TOOL FOR RESTORATION OF NEW JERSEY'S TIDALLY INFLUENCED WETLANDS

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Abstract:

Wetland restoration is a complex science that attempts to facilitate positive changes in ecologic function via changes in integrated physical and biologic structure. Although wetland ecology is driven by a suite of interactive factors, frequently, a single parameter or metric is used to determine the restoration goals and measures of a project. Additionally, restoration and/or mitigation targets may be set and evaluated without a complete understanding of appropriate reference conditions the project is proposing to duplicate. As interest in adaptive restoration (focusing on resilience to sea level rise and storm impacts) grows, it is vital to provide information to correctly characterize baseline and changing conditions of the wetland being manipulated relative to a natural or reference condition for greater resilience. Precise evaluation of condition, function, and structure will allow for greater refinement in project design, effective monitoring plan development, and adaptive management strategies to achieve the target goals and objectives. The goals of this effort were to: 1) fill gaps in tidal wetland reference data in New Jersey, and 2) increase the accessibility of monitoring data to the public. This was accomplished by: 1) developing the NJ Reference Wetland Tool database; 2) filling data gaps on tidal wetland hydrology and water quality; 3) adding a long-term monitoring site in the Raritan River; and 4) developing tools that will assist standardized data collection in the future.

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Overview of Need

New Jersey has led the nation in the protection of wetlands through identification, acquisition, and regulation. Examples include the delineation of tidal wetlands in the 1970s, coastal wetland regulations (1970), freshwater wetland regulations (1986), and the acquisition of wetlands through federal, state, and local programs. More recently, additional effort has been applied to long-term monitoring and the collection of data and information on reference conditions. In 2007 New Jersey released its report *Valuing New Jersey's Natural Capital: An Assessment of the Economic Value of the State's Natural Resources* which brought further attention to the ecosystem value of wetlands from a monetary perspective. While New Jersey has invested in wetlands restoration it has been through a relatively small number of projects and usually where there was an egregious environmental assault. While New Jersey's coastal wetlands are protected from outright destruction through regulation, they are not immune to the impacts of sea level rise, subsidence, and human impacts (ditching, dredging, diking, OMWM, erosion). Hurricane Sandy was momentous in focusing attention on a) the value of wetlands in protecting coastal development and b) the declining condition of wetlands. These realizations prompted greater attention on restoration opportunities in addition to protection (through acquisition and regulation). Protected wetlands were now being looked at as the staging area for restoration activities rather than being left in their 'natural condition'. Hurricane Sandy also ushered in federal funding and the opportunity to explore new restoration techniques focused on climate adaptation. While the federal funds and interest were a boon for restoration, there was limited timing to fully characterize the wetlands being restored and the techniques applied. The work being conducted by the state, federal and NGO partners in collecting data on various wetland parameters/metrics were not readily accessible to be used in determining the right approach (technique) or target for the restoration project. This project looked to provide a multi-metric tool (The NJ Reference Wetland Tool) that allows restoration practitioners the ability to identify the appropriate reference conditions (based on reference data), and targets on which to base their restoration project.

Project Goals & Tasks

This project's focus was on filling reference data gaps from tidal wetlands in New Jersey and making monitoring data more accessible to the public. This was accomplished by: 1) developing the NJ Reference Wetland Tool; 2) filling data gaps on tidal wetland hydrology and water quality; 3) adding a long-term monitoring site in the Raritan River; and 4) developing tools that will assist standardized data collection in the future.

Task 1: Adding New Jersey Reference Wetlands to a Regional Interactive Data Base

Reference Wetland Tool

NJDEP partnered with Riparia and the Center for Environmental Informatics (CEI) at Penn State to develop a multi-metric Reference Wetland Tool for tidal wetlands in New Jersey. The use of reference sites has become

increasingly more common as scientists and resource managers search for reasonable and scientifically based methods to measure and describe the inherent variability in natural aquatic systems (e.g., Hughes et al. 1986¹; Brooks and Hughes 1988², Kentula et al. 1992³, Brooks et al. 2002⁴). The term reference wetlands is used to connote naturally occurring sites composed of wetland, stream, and riparian components that span a gradient of anthropogenic/human disturbance. The primary reasons to include reference sites in regional assessments and restoration efforts are the need to compare impacted or degraded sites to a least-impaired set of attributes or benchmarks, and to provide appropriate design and to inform the development of performance criteria for mitigation and restoration projects. The primary criterion for selecting reference sites involves identifying locations that represent ideal, relatively natural conditions (i.e., least disturbed), which is common for stream assessments (Karr and Chu 1999⁵). Sites can be chosen to represent the best attainable conditions for a particular region even though they may not be pristine (Smith et al. 1995⁶).

The Center for Environmental Informatics (CEI) at Penn State has pioneered advanced web approaches for a wide range of environmental and agricultural decision support tools. The tools combine interactive, feature-rich user interfaces with the underlying geospatial capability of web map server technology.

For this project, reference wetland data (biological and chemical) specific to New Jersey and collected through the NWCA, MACWA, and other initiatives were integrated into this Regional Interactive Tool.

- a. Link to Tool: <https://tools.cei.psu.edu/wetlands/njdep/>
- b. Link to User Guide:
<https://storymaps.arcgis.com/stories/caae4374e6ef48fe965efabec299c47e>

The full report on the project developed by Penn State can be found in Appendix 1.

Evaluating Wetland Condition Using the Ecological Integrity Assessment (EIA) Method

Supplemental Funding was provided for a two-day training course, “Evaluating Wetland Condition Using the Ecological Integrity Assessment (EIA) Method.” The field portion was not conducted due to complications arising from the COVID-19 pandemic restricting in-person attendance. Content for the EIA training was compiled in a “Field Manual for Applying Rapid Ecological Integrity Assessments in Wetlands and Riparian

¹ Hughes RM, Larsen DP, Omernik JM (1986) Regional reference sites: a method for assessing stream potentials. *Environ Manage* 10(5):629–635.

² Brooks, RP and RM Hughes. 1988. Guidelines for assessing the biotic communities of freshwater wetlands. Pages 276-282 in *Proc. Nat. Wetland Mitigation Symp.: Mitigation of Impacts and Losses*. Assoc. State Wetland Managers Tech. Rep. 3. 460pp.

³ Kentula ME, Brooks RP, Gwin SE, Holland CC, Sherman AD, Sifneos JC (1992) *Wetlands. An approach to improving decision making in wetland restoration and creation*. Island Press, Washington, DC, 151pp.

⁴ Brooks, RP, DH Wardrop, CA Cole, and KR Reisinger. 2002. Using reference wetlands for integrating wetland inventory, assessment, and restoration for watersheds. Pages 9-15 in RW Tiner (compiler). *Watershed-based wetland planning and evaluation. A collection of papers from the Wetland Millennium Event, 6-12 August 2000, Quebec City, Quebec, Canada*. Distrib. by Assoc. State Wetland Managers, Inc., Berne, NY. 141pp.

⁵ Karr JR, Chu EW (1999) *Restoring life in running waters. Better biological monitoring*. Island Press, Washington, DC, 149pp.

⁶ Smith RD, Ammann A, Bartoldus C, Brinson MM (1995) *An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices*. Wetlands research program technical report WRP-DE-9. U.S. Army Corps of Engineers, Waterways Experiment Station, Washington, DC, 79pp.

Areas in New Jersey”, including field forms and a “New Jersey Wetland Ecological Integrity Assessment Calculator.” Both products were adopted from the Washington Department of Natural Resources, Natural Heritage Program with permission from the authors. Kathleen Walz (NJ) and Joe Rocchio (WA) co-authored the 2016 EIA protocol (Faber-Langendoen et al. 2016 v2.08), and both developed EIA field forms and instructions for their respective states. Of note, the WA manual included updates to metrics and ratings that were more accurate to the most recent version of the EIA protocol. Upon review of the excellent WA field manual, and discussion with NatureServe and the WA Natural Heritage Program, a decision was made to simply modify the WA version for New Jersey. The EIA field manual, field forms, metric rating descriptions, and calculator – all of which form the basis for EIA training – are now available for use by practitioners conducting ecological integrity assessments of wetlands in New Jersey.

Citation for EIA Field Manual:

Rocchio, F. Joseph, Rex C. Crawford, Tynan Ramm-Granberg, and Kathleen S. Walz. 2022. Field Manual for Applying Rapid Ecological Integrity Assessments in Wetlands and Riparian Areas in New Jersey. “This manual is adopted from the Washington Department of Natural Resources, Natural Heritage Program EIA manual Version 1.2. Only minor changes were made to make the manual geographically relevant.” New Jersey Department of Environmental Protection, Office of Natural Lands Management, New Jersey Natural Heritage Program, Trenton, NJ. 92 p.

<https://hdl.handle.net/10929/106999>

Citation for EIA Calculator:

Rocchio, F. J., T. Ramm-Granberg, I. J. Weber, K.S. Walz and J. Hafstad. 2022. New Jersey Wetland Ecological Integrity Assessment Calculator [Adapted from Ecological Integrity Assessment Calculator (Macro-Enabled Excel Spreadsheet). Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.], New Jersey Natural Heritage Program, NJ Department of Environmental Protection, Trenton, NJ.

<https://hdl.handle.net/10929/107449>

Citation for NatureServe EIA Protocol:

Faber-Langendoen, D., W. Nichols, K. Walz, J. Rocchio, J. Lemly, and L. Gilligan, 2016. NatureServe Ecological Integrity Assessment: Protocols for Rapid Field Assessment of Wetlands. v2.08. NatureServe, Arlington, VA.

<https://hdl.handle.net/10929/107450>

Task 2: New Jersey Reference Wetland Network

Reference Standard Site Monitoring

The original grant application indicated that 50 additional wetland reference standard sites would be monitored to augment existing reference gradient wetland sites identified and sampled during the statewide wetland condition assessment probabilistic study (EPA-R2-WPDG-CD97225809-0). Because data gaps that are critical for setting appropriate goals and developing designs for restoration projects were identified during a meeting with experts, monitoring reference standard wetland sites using EIA protocols was replaced with a

GIS-based assessment of hydrogeomorphology at NJ Tidal Wetland Monitoring Network sites across the state. **These data were incorporated in the Reference Wetland Tool. The final report on this work entitled, “New Jersey Tidal Marsh Morphology Study,” can be found Appendix 2.**

In addition, supplemental funding was provided to conduct hydrologic monitoring at a select set of reference standard sites. Due to travel restrictions during the pandemic and supply chain issues, we were not able to install the tide gauges during the grant. However, three permanent tide gauges were purchased toward the end of the grant. These will be installed as part of the New Jersey Tidal Wetland Monitoring Network.

Collect algae/diatom specimens from coastal wetland reference standard sites

Tidal wetland characteristics were compared in natural and sediment-enhanced tidal wetlands using diatom inferences. **The final report, entitled “Cape May peninsula and Delaware Bay wetland characteristics based on diatom inferences: a comparison of TLP (thin layer placement) and control sites located in Fortescue, Avalon, and Ring Island salt marshes,” can be found in the appendix 3.** Samples collected by the National Wetland Conditions Assessment were not recounted because combined samples from across a wetland could not be used to calculate inferences.

Additional funding was received from EPA to create the “Diatom Flora of the New Jersey Coastal Wetlands”. In 2012-2017 the New Jersey Department of Environmental Protection sponsored several research projects aimed at evaluating the potential use of diatoms for characterizing present and inferring past environmental conditions in New Jersey coastal wetlands. The goal of this report was to document the most common diatom taxa from studied wetlands, with high-resolution light and electron microscopy images. The images of 499 taxa found in the sub-, inter-, and supratidal habitats and sediment core samples are presented. Genera with the most species are Navicula (148), Fallacia (34), Nitzschia (21), and Parlibellus (16). Some taxa could not be identified to species level and are listed under provisional names. Voucher slides are deposited in the Diatom Herbarium of the Academy of Natural Sciences of Drexel University.

This report is publicly available at <https://hdl.handle.net/10929/68423>

Task 3: Installation and Monitoring of a Site-Specific Intensive Monitoring Station – Urban Raritan Bay

The Mid-Atlantic Coastal Wetland Assessment (MACWA) led by Partnership for the Delaware Estuary and the Barnegat Bay Partnership, evaluates coastal wetland health states and trajectories in two estuaries in the Mid-Atlantic US through the implementation of Site-Specific Intensive Monitoring (SSIM) protocols. At the time the proposal for this grant was written, there were 14 SSIM stations (each with three Surface Elevation Tables (SETs)) in New Jersey and two in Pennsylvania (within the Delaware Watershed). The northernmost

SSIM in New Jersey is located in the Barnegat Bay Watershed. This task filled the geographic gap between the monitoring stations in the Meadowlands and the MACWA SSIM sites in Ocean County south by extending the SSIM network to the Raritan Bay wetland system. A new SSIM station was installed and monitored for two years by Rutgers University. The site and associated data have been incorporated into MACWA and the New Jersey Tidal Wetlands Monitoring Network.

The final report from Rutgers University can be found in Appendix 4.

Task 4: Developing additional tools that will assist standardized data collection in the future.

Task 4a: Statistical Analyses of Biological and Chemical Parameters included in Restoration Metrics

The Statistical Analyses of Biological and Chemical Parameters included in Restoration Metrics were accomplished through task 1 and task 4c. Task 1, the development of the Reference Wetland Tool, statistically analyzed reference data, comparing reference standard sites to reference sites across an alteration gradient. Task 4c compared data collected at restored tidal wetlands to data in the Reference Wetland Tool. It was determined that many of the parameters that are frequently collected as part of wetland conditions are too qualitative and based on disturbance to be used to assess restoration projects, at least in the short term. **See Appendices 1 and 5 for more information.**

Task 4b: Convene Panel of Restoration Scientists (Peer Review Team) – Recommendation for Multi-Metric Matrix

A panel of restoration scientists and monitoring practitioners with representatives from academic, non-profit, consulting, and federal sectors were convened several times to aid in the development of the Reference Wetland Tool (Task 1). **See the Penn State report in Appendix 1 for more information.**

Task 4c: Application of Reference Wetland Tool to 3 to 5 ongoing restoration projects in NJ's tidally influenced (coastal specific) wetlands

The Reference Wetland Tool (Task 1) was applied to three restoration projects in New Jersey's coastal wetlands. The purpose of this exercise was to pilot the Interactive Tool on restoration projects, provide data for adaptive management of ongoing projects, and inform future projects in the same geographic region and/or utilizing the same restoration techniques. Lessons learned from testing the Reference Wetland Tool on restoration sites were used to improve the Tool.

The report on Task 6, entitled “Applicability of a Rapid Assessment Method for Evaluating Restoration Sites Using the New Jersey Reference Wetland Tool,” can be found in Appendix 5.

Project-wide Summary and Conclusions and Future Work

The New Jersey Reference Wetland Tool provides easy public access to ecological condition assessment metrics and site scores for a broad cross-section of coastal wetlands in New Jersey. This tool provides stakeholders with valuable information about the condition of wetland resources and emphasizes the potential for improved ecological conditions by highlighting Reference Standard Wetlands along the coastline and across varied tidal and salinity ranges.

Throughout the project, stakeholder feedback was collected and incorporated in the Tool and User Guide. Not all suggestions received by the project team during agency and stakeholder workshops could be incorporated in the 2021 version of the Web Tool, but these additions can potentially be included in future updates. The feedback received during stakeholder workshops points to several potential opportunities. Of potential value to stakeholders interested in tidal wetland restoration is an addition to the site type drop-down menu to expand the user-defined choices to include restored wetlands. This option could provide users with data-driven ecological condition goals for wetland restoration efforts based on similar locations in the same watershed or landscape position. Another potential future addition is a suite of outputs dedicated to a specific program or decision support tool/model. This output could curate metrics necessary for a specific program or tool and provide output options readymade for use in these other management tools.

Currently, the Web Tool includes data from tidal wetlands, but we anticipate data from non-tidal wetlands in future updates. Data gaps can be easily identified through specific combinations of drop-down menu selections, so we anticipate targeted efforts to fill these gaps during future field seasons. Groups interested in partnering with the current data providers can request information from Riparia at Penn State. Existing data partner organizations should submit ecological condition assessment data to Riparia at Penn State after the completion of field seasons and after internal data quality assurance checks have been completed.

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Please see individual reports for a full list of acknowledgments.

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