September 2021

UMBRELLA MITIGATION BANKING INSTRUMENT PROSPECTUS

Submitted to:
Delaware Interagency Review Team

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Delaware Department of Transportation Umbrella Mitigation Banking Instrument Prospectus

I. Introduction

Delaware Department of Transportation (DelDOT) as Bank Sponsor, proposes to prepare and submit an Umbrella Mitigation Banking Instrument (UMBI) in accordance with 33 CFR 332, Compensatory Mitigation for Losses of Aquatic Resources ("Mitigation Rule"). The purpose of this prospectus is to outline the development of an UMBI, which will govern the establishment, use, operation, maintenance, and closure of the umbrella bank by establishing guidelines and responsibilities for use.

The Bank Sponsor proposes to use a combination of restoration, creation, enhancement and preservation of a wide variety of aquatic resources and uplands for the purpose of generating compensatory mitigation credits under the proposed UMBI. The Bank Sponsor proposes to manage the development, release, and use of mitigation credits under the proposed UMBI with approval by the Interagency Review Team (IRT). Mitigation credits generated and approved by the IRT, on a site-specific basis, may be used for future DelDOT projects requiring compensatory mitigation within the mitigation site-specific service area. Mitigation site-specific details including service area, mitigation type, release schedule, etc. for each site under the proposed UMBI will be provided in Site-Specific Mitigation Plans included as addenda to the Final UMBI. Addenda for newly proposed mitigation bank sites will be prepared as new proposed mitigation bank sites are identified for review and approval by the IRT.

The UMBI will set the framework by which future individual mitigation sites will be added as addenda to the UMBI as they are identified. The roles and responsibilities of the IRT will be outlined, including responsibilities related to review of future site-specific mitigation plans within the UMBI. The intent of the UMBI will be to establish a framework and eliminate future redundancy in administration and focus review and resources on technical issues related to the development, implementation, and success of future site-specific mitigation plans as individual bank sites are identified.

II. Justification

The Council on Environmental Quality (CEQ) issued guidance, Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact (January 14, 2011). The intent of the guidance is to support the integrity of the NEPA process by encouraging identification of mitigation and monitoring measures earlier in the planning process to incorporate into the NEPA environmental review documents. Earlier planning and identification of mitigation and monitoring measures adds predictability to project planning and development, streamlining implementation of transportation projects and reducing costs.

Given the emphasis on early planning, wetland and stream banks are becoming increasingly desirable. Transportation Authorization Acts both current and in the past have a history of stating that preference shall be given, to the maximum extent practicable, to the use of mitigation banks. Banking as a mitigation strategy is also supported by the Compensatory Mitigation for Losses of Aquatic Resources; 2008 Final Rule.

The creation of wetland and stream banks in priority watersheds gives project planners, DelDOT and regulatory personnel tangible compensatory mitigation to consider and approve when transportation improvements will result in permanent wetland and stream impacts.

DelDOT has significant anticipated future needs for mitigation. DelDOT has completed a needs assessment for New Castle County and is working towards completing a state-wide assessment for each County. For the 2020-2024 period, a total of 54 projects are anticipated for New Castle County alone:

Table 1: 2020-2024 Anticipated Projects in New Castle County

Project Type	Number of Projects
Bike/Pedestrian	6
Bridge	15
DTC Facility	1
Maintenance and Operations	2
Planning Studies	1
Roads	23
Transportation Alternative Program	2
Transportation Enhancement-DelDOT Administered	3
Other	1

Of these projects, 42 are anticipated to have wetland impacts, including 27 projects which are not related to bridge construction. Exact impact totals are not yet tabulated as many are still being planned. It is anticipated that as other needs assessments are tabulated, these wetland mitigation needs will grow.

As part of the analysis, projects were classified as having no predicted wetlands or having potential wetlands. Those projects with potential wetlands had hydric soils, water features adjacent to the project, or NWI mapped wetlands. These are the projects that have the highest potential for wetland mitigation. Projects with no projected wetlands lacked hydric soils, water features, or NWI mapped wetlands adjacent to the project. The following tables provide impact estimates per watershed:

Table 2: Projects Per Watershed

Chester-Sassafras	Lower Delaware	Brandywine-Christina	Broadkill-Smyrna
2	0	52	0

Table 3: Projects in Chester-Sassafras Watershed

No Predicted Wetland Impacts	Potential Wetland Impacts
0	2

Table 4: Projects in Brandywine-Christina Watershed.

No Predicted	Potential Wetlands	Potential Wetlands

Wetland Impacts	Impacts	Excluding Bridge Projects
10	42	27

III. Goals / Objectives of the UMBI

The goal of the UMBI is to establish the framework for restoring, enhancing, creating and/or preserving tidal and non-tidal wetlands, riparian systems, streams, and contiguous buffer corridors, as well as uplands and/or other aquatic resources as may be approved by the IRT, and their functions and values to compensate for unavoidable and permitted wetland and stream impacts, or other purposes as may be approved by the IRT, for proposed DelDOT projects. The Bank Sponsor's goals in establishing the UMBI include:

- Streamline Section 404/401 and Section 10 permit evaluation processes by providing a means of compensating in advance for unavoidable wetland, stream, etc., impacts resulting from DelDOT projects.
- Provide high function and value, advanced compensatory mitigation based on a watershed approach.
- Restore and preserve resources based on environmental priorities and relative probability of successfully achieving self-maintaining ecological uplift.
- Support mitigation priorities established in the US Army Corps of Engineers (Corps) /Environmental Protection Agency (EPA) Mitigation Rule (33 CFR Part 332 and 40 CFR Part 230), the and the Delaware Department of Natural Resources (DNREC).
- Achieve efficiencies for DelDOT and the entire IRT review process by eliminating repetitive practices and redundant review processes thereby reducing costs and addressing permitting priorities in a more expedient time frame.

IV. Establishment and Operation of the Umbrella Mitigation Bank Instrument

The UMBI will be developed by the Bank Sponsor in coordination with the Corps and the IRT, and will contain detailed information governing the establishment, use, operation, and maintenance of the umbrella mitigation bank. The umbrella mitigation bank will include all mitigation sites that fall (or will fall) under the UMBI, including future proposed bank sites. The UMBI and the development and operation of individual bank sites documented in future UMBI addenda will be in accordance with the Mitigation Rule requirements.

The Bank Sponsor will develop wetland and stream mitigation projects throughout the State of Delaware, to comply with Section 404/401 and Section 10 permit requirements and related state laws and regulations. Mitigation sites/projects that will be included as part of the UMBI will be referred to as "bank sites." Bank sites may be comprised of one or more land parcels and may include one or more mitigation types (wetland or stream and either restoration, creation, enhancement, or preservation, for example) and a variety of mitigation functions/values. Each bank site will be subject to the terms of the UMBI as well as site-specific final mitigation plans.

Once mitigation credits are available through ratification of the UMBI and approval of future mitigation sites in accordance with this UMBI and the Mitigation Rule, compensatory mitigation can be accomplished through the withdrawal of credits. Requests for credit releases (credits available from a bank) require final approval from the IRT.

A. Establishment of the Umbrella Bank and Bank Sites

1. **Establishment of the Umbrella Bank:** The Bank Sponsor will obtain all appropriate environmental documentation, permits, or other authorizations needed to establish and maintain the umbrella bank. The UMBI will not fulfill or substitute for such authorization, but would rather fulfill authorization for establishment, use, operation, and maintenance of an umbrella bank to be administered by the Bank Sponsor.

2. **Establishment of Future Individual Bank Sites and UMBI Addenda:** The Bank Sponsor will obtain all appropriate environmental documentation, permits, or other authorizations needed to establish and maintain future individual bank sites. The UMBI would not fulfill or substitute for such authorizations. The UMBI and site-specific addenda or mitigation plans would fulfill authorization for the establishment, use, operation, and maintenance of bank sites to be administered via the UMBI.

3. **Perpetual Protection/Real Estate Provisions:** Property subject to the UMBI and authorized by the IRT as a mitigation bank site will be perpetually protected and preserved through management agreements, plat and restrictive covenants with third party enforcement or conservation easements and/or Declaration of Restrictive Covenants on a project-by-project basis, unless otherwise approved by the IRT. These provisions will conform to the Mitigation Rule with the language modified on a case-by-case basis to allow for existing elements such as road easements, road/bridge crossings, hike/bike trails and other activities that are pertinent to each site proposed for bank use.

4. **Financial Assurances:** As a source of mitigation for State projects, which are supported with Federal, State and/or local funding, financial assurances for the development, establishment, monitoring, and maintenance of the primary bank site by the IRT may not be required. Financial assurances can thereafter be addressed during the review of each addendum covering any new site and project proposed under this UMBI. If required, financial assurances will then be addressed during bank site-specific review, permitting and approvals.

B. Operation of Umbrella Bank and Bank Sites

1. **Umbrella Bank Geographic Service Area:** The Geographical Service Area (GSA) is the designated area wherein a bank can reasonably be expected to provide appropriate compensation for impacts to streams and wetlands. The Bank Sponsor will establish separate geo-political GSA's for each individual bank site as they are identified. Bank sites will be identified as needed to compensate for future DelDOT projects planned within the various Hydrologic Unit Codes (HUC), or as otherwise defined by the IRT. Each bank site will have a primary service area, and may also have a larger secondary service area as proposed and approved by the IRT. Primary and secondary service areas will be based on USGS 8-Digit HUCs, but may also consider physiographic (**Figure 1**). For individual bank sites, the GSA will be presented to the Corps, , in coordination with the IRT, for final approval. Use of a bank site to compensate for impacts beyond the geographic service area may be considered by the Corps, in coordination with the IRT, on a case-by-case basis.

2. **Site Specific Mitigation Plans/UMBI Addenda:** Site Specific Mitigation Plans/UMBI Technical Addenda will be developed by the Bank Sponsor and submitted to the Corps for distribution to the IRT, for each proposed bank site. Information required within this addendum is outlined in the CFR 332.4(c)(2)-(14) as well as specific requirements as required by USACE and the IRT.

   The addendum will contain basic information in the introduction which includes the bank name and location, property ownership and title report for the parcel(s), sponsor contact information and qualifications, consultant point of contact, and a list of adjacent property owners.

   A detailed bank need and technical feasibility for the proposed mitigation site will be included. Baseline site conditions and information including functional or condition assessments, wetland delineation (including stream order and wetland Cowardin type), historical hydrology, soils maps, aerial photography, adjacent land uses, previous site uses, and any existing credit types located on the property will be provided. Reference conditions used to inform the assessment and design of the proposed mitigation site will be discussed, as well as departure analysis in relation to reference conditions. The addendum will include basic site surface and groundwater hydrology, hydroperiod, drainage area maps, and relationship with adjacent water resources and management rights will be provided to develop a water budge and other information to provide basic assurance of sufficient water rights for the site for the amount of wetland credit proposed.

   Agency coordination will be provided in the addendum. This includes but is not limited to: Jurisdictional Determination (JD), Joint Permit Application (JPA), meetings, meeting minutes, and other agency communications to date.

   The UMBI addendum will include the following additional detailed information on each bank site as required per CFR 332.4(c)(2)-(14):

   a) **Objectives:** The bank purpose and type will be outlined for the addendum. A description of the resource type(s) and amount(s) that will be provided, the site-specific service area, the method of compensation (i.e., restoration, establishment, enhancement, and/or preservation), and the way in which the resource functions of the compensatory mitigation project will address the needs of the watershed, ecoregion, physiographic province, or other geographic area of interest.

   b) **Vicinity and location maps**: A map detailing where the mitigation bank is to be located, as well as maps showing the location relative to the primary and secondary service areas.

   c) **Property Assessment & Warranty Checklist and Bank Sponsor Certification of Property Rights & Agreement to Provide Access**: A completed checklist and signed agreements certifying and warranting the sponsors rights and access to the property. The sponsor shall provide an

Option or proof of ownership, title insurance, and document zoning for the site.

d) **Site selection factors considered (criteria):** A description of the factors considered during the site selection process, including consideration of watershed needs, on-site alternatives where applicable, and the practicality of accomplishing ecologically self-sustaining aquatic resource restoration, establishment, enhancement, and/or preservation at the compensatory mitigation project site. Existing impairments and threats to the site (including, but not limited to, conflicting adjacent land uses or adjacent development, and hydrological disturbance both on and off the site outside of the Sponsor's control) must be identified.

e) **Service Area**: A description and map of the service areas and justification for its extent. The types of functional loses of the watershed and anticipated or typical impacts in the watershed will be included in this rational for the service area and any proposed secondary service areas. Regional benefits of the bank must be identified in the context of the justification for the service area.

f) **Mitigation work plan:** A detailed written specification and work descriptions for the mitigation bank site, including, but not limited to, the geographic boundaries of the project; construction methods, timing, and sequence; source(s) of water, including connections to existing waters and uplands; methods for establishing the desired plant community; plans to control invasive plant species; the proposed grading plan, including elevations and slopes of the substrate; soil management; and erosion control measures. For stream compensatory mitigation projects, the mitigation work plan may also include other relevant information, such as planform geometry, channel form (e.g., typical channel cross-sections), watershed size, design discharge, and riparian area plantings. The mitigation work plan should contain any information relative to the remedy and/or management of existing site impairments in relation to the success of the mitigation work.

g) **Performance Standards:** Ecologically based, measurable and repeatable standards used to determine whether the project is achieving its objectives as established or approved by the IRT.

h) **Crediting and Debiting Procedures:** Description of the number of credits to be provided, including a brief explanation of the rationale for this determination and details on where, when and how these credits can be used.

i) **Credit release schedule:** The credit release schedule should reserve a share of total credits for release only after full achievement of ecological performance standards. All credit releases must be approved by the Corps ,in consultation with the IRT, based on a determination that required milestones have been achieved.

j) **Credit sale statements (if applicable):** Statement that details the project for which the credits are being used to offset, including specific project information and signed below by the bank sponsor.

k) **Monitoring & Reporting requirements:** Monitoring and reporting requirements are established in the Mitigation Work Plan. A description of the parameters to be monitored is included in the Mitigation Work Plan, along with metrics and milestones to determine if the compensatory mitigation project is on track to meet performance standards or if adaptive management is needed to meet goals. A schedule for monitoring and reporting on monitoring results must be included.

l) **Bank operations maintenance plan**: A description and schedule of maintenance requirements to ensure the continued viability of the resource once initial construction is completed.

m) **Long-term management plan:** A description of mitigation site management after meeting all performance standards to ensure long-term sustainability of the site, including long-term financing mechanisms if appropriate and the party responsible for long-term management. Long-term ownership and stewardship partners of the site must be identified. The site protection instrument and its holder must be identified, along with any accompanying funds or endowments.

n) **Adaptive management plan:** A management strategy to address unforeseen changes in site conditions or other components of the mitigation project, including the party or parties responsible for implementing adaptive management measures. The plan will guide decisions for revising compensatory mitigation plans and implementing measures to address both foreseeable and unforeseeable circumstances that adversely affect compensatory mitigation success.

o) **Financial assurances:** A description of financial assurances, if any, that will be provided and how they are sufficient to ensure a high level of confidence that the mitigation project will be completed in accordance with its performance standards.

p) **Notice:** A description of where documents and notices should be sent.

3. **Mitigation Ratios and Establishment and Use of Credits:** The UMBI will outline mitigation ratio agreements between the Bank Sponsor and the IRT. The UMBI will outline compensation ratios based on anticipated ecological uplift for specific wetland classifications and stream uses. This will be based on coordination and approval by the Corps, in consultation with the IRT.

   The UMBI will also outline the Bank Sponsor's responsibility for accounting of credits and debits in the UMBI. A ledger will be developed for each mitigation site and will be coordinated through the IRT. Accounting procedures for the site will be in accordance with the Federal Mitigation Rule. Each credit for mitigation will be comprised of an appropriate accounting metric determined in consultation with the IRT consistent with the terms of the UMBI and/or site-specific addenda.

Use of credits from the umbrella bank to offset wetland and stream impacts authorized by Corps and DNREC wetland/waterway permits must be in compliance with the Federal and State regulations, including:

- Sections 401 and 404 of the Clean Water Act (33 U.S.C 1344)
- Sections 9 and 10 of the Rivers and Harbors Act of 1899 (33 U.S.C 401 and 403)
- National Environmental Policy Act (NEPA) and all other applicable Federal and State legislation, rules and regulations.
- Delaware Wetlands Regulations (7 Del. C. § 7502)

a) **Credit Determination:** Credits for all proposed wetland mitigation bank sites will be determined based on mitigation type employed (creation of wetlands from uplands, restoration of wetlands, enhancement, preservation, etc.), and enumerated by acres (or fractions thereof) by mitigation type of wetlands created (open water, emergent, scrub- shrub, forested, tidal freshwater, tidal saltwater/brackish, etc.). The measure of aquatic functions will be based on resources restored, established/created, enhanced or preserved. The Bank Sponsor proposes a minimum 1:1 ratio for wetland creation, with anticipated higher rations for restoration, enhancement, and preservation to be determined on a case-by-case basis. Additionally, the Bank Sponsor may also propose wetland mitigation credits for terrestrial resources that provide important support functions to the aquatic mitigation habitat elements and/or the watershed as a whole (e.g., buffers, preservation or enhancement). Non-tidal wetland ratios will be determined by a wetland condition assessment using DNREC's Delaware Rapid Assessment Procedure (DERAP) (**Appendix A**) or another IRT - approved method for calculating functional uplift. Tidal wetland ratios will be determined by a wetland condition assessment using DNREC's MidAtlantic Tidal Rapid Assessment Method (MidTRAM) (**Appendix B**) or another IRT - approved method for calculating functional uplift. The number of stream mitigation credits created by development of mitigation banks will be determined by anticipated functional uplift, by linear feet of each activity and/or on the basis of an IRT - approved method of calculating functional uplift, and corresponding credit ratios for those activities, such as the Function-Based Framework for Stream Assessment and Restoration Projects (Harman & Starr, 2012).

b) **Credit Release Schedule:** The Bank Sponsor will recommend withdrawal of credits for permitted impacts within the defined GSA of a specific bank site based on agreed-upon bank site-specific credit release schedules. Final approval from the permitting agencies, the Corps, in consultation with the IRT, will be required regarding use and withdrawal of mitigation credit from the UMBI.

For bank sites under the UMBI, the Bank Sponsor proposes the following credit release schedule as a guideline schedule for all mitigation bank sites established under the UMBI, unless otherwise approved as part of a Final Mitigation Plan:

Wetland and Stream Mitigation Bank Site Milestones	Credits Release Range
Final Mitigation Plan approval by Corps and IRT	10%
Successful Post-Construction submittal (implementation of physical & biological improvements per approved plans)	30%
After year 1 and success criteria met	10%
After year 2 and success criteria met	10%
After year 3 and success criteria met	10%
After year 4 and success criteria met	10%
After year 5 and success criteria met	20%

Incremental release of credits during the construction milestone is permitted, rather than the lump sum 30%. The incremental release should accompany completion of major construction milestones, such as those relating to significant completion of grading, hydrology, or planting work. The release of credits incrementally shall not exceed the 30% lump sum release for all construction activities.

The release of credits may also be governed by the credit type. Preservation credits, for example, may be released immediately upon approval of the Final Mitigation Plan. Enhancement credits may be approved upon completion of enhancements as approved by the IRT.

c) **Use of Credits:** Any credits generated under this Umbrella Mitigation Banking Instrument are for DelDOT use only from projects under their jurisdiction and control, where DelDOT is the named permittee, or public-private partnerships as awarded through DelDOT where DelDOT or an entity as sanctioned by DelDOT is the permittee. For multi-year projects, credits to be generated under this Umbrella Mitigation Banking Instrument may be allocated in full to permits prior to final release as approved by the Corps and the IRT and as recorded appropriately through the credit ledger.

V. Maintenance/Monitoring of Bank Sites

The Bank Sponsor agrees to establish and maintain the mitigation sites and ownership until the bank has had all credits released and a third-party organization adopts the long-term site management/maintenance responsibilities. The Bank Sponsor will propose future, ecologically sustainable mitigation bank sites, and will avoid establishing banks that require regular or intensive maintenance. The Bank Sponsor accepts full responsibility for any required maintenance activities that may be necessary related to achievement of performance standards, such as addressing invasive species control or tree/vegetation replacement. Any required maintenance activities proposed by the Bank Sponsor will be coordinated through Corps, in consultation with the IRT, prior to execution.

The Bank Sponsor understands that banking activity can only be terminated through coordination and approval by the Corps, in consultation with the IRT. As part of the Bank Sponsor's required maintenance, the Bank Sponsor will monitor all bank sites over a minimum of 5 year period, and

recommend maintenance activities related to performance standards, or other possible maintenance activities such as repairing broken fences, cleaning up trash or vandalized areas, among others. The Bank Sponsor will continue to submit regular Mitigation Monitoring Reports to the Corps and the IRT describing site conditions in relation to the performance standards outlined in the UMBI and/or Site-Specific Final Mitigation Plans. Additionally, the Bank Sponsor will be responsible for developing an adaptive management plan, in coordination with the IRT, if the site fails to achieve the goals and objectives laid out in the Final Mitigation Plan.

The UMBI will define site "close-out" procedures, sponsor/Corps/IRT responsibilities related to close- out, and will define a timeline for acceptable termination of maintenance activities.

A. **Monitoring:** The UMBI will outline the Bank Sponsor's requirements for performing all necessary work to monitor the bank sites and to demonstrate compliance with the established success criteria. Success criteria will be based on Corps guidance, IRT input and those outlined in the Site-Specific Mitigation Plans. Monitoring goals and schedules will be developed and submitted for each bank site as documented in site specific final mitigation work plans. Monitoring procedures, duration and reporting criteria, and scope will also be outlined in the UMBI.

B. **Long-term Management:** The UMBI will outline the Bank Sponsor's commitment to implementing long-term management measures towards maintaining the ecological integrity of their mitigation bank sites, and managing and maintaining these sites in perpetuity as functioning wetlands or other aquatic systems after meeting all performance standards. On completion of all phases of mitigation construction, the Bank Sponsor will either continue to ensure long-term sustainability or may transfer the conservation easement to a third party approved by the IRT (e.g., nonprofit entity, state conservation agency or a land trust), who would be responsible for the long-term conservation goals and managing the lands in perpetuity.

   The Bank Sponsor anticipates typical long term management provisions for bank sites may include invasive species control, upkeep of physical barriers such as fences and gates, collection/removal of excessive trash, repair of vandalized structures and rectification of trespass impacts, for example. Fence and gate maintenance and repair frequency will be dependent on trespass and access control issues, as well as whether grazing is utilized as a vegetation management technique and to what extent. Grazing may also be discouraged by use of fencing based on its incompatibility with the goal of achieving mitigation objectives. Case-by-case long-term management opportunities will be determined through coordination with the Corps, in consultation with the IRT.

   The Bank Sponsor's approach to the long-term management of the bank site(s) will be to conduct periodic site examinations after the five-year monitoring period and achievement of performance standards to determine stability and ongoing trends of the created, restored, enhanced or preserved resources. The Bank Sponsor, or as may be assigned to the Long Term Steward, will observe/assess the bank's condition, degree of erosion, invasion of exotic species, fire hazard, and/or other aspects that may warrant management actions. The objective of the long-term management plan will be to conduct periodic site investigations to identify any issues that arise, and implement adaptive management strategies to determine what actions will be most appropriate for individual bank sites, if required.

C. **Assurance of Success:** The UMBI will outline the Bank Sponsor's responsibility for assuring the success of the restoration, creation, enhancement and preservation activities at the bank sites, and for the overall operation, maintenance and management of the umbrella bank. If a bank site is assigned to a third party, that third party will be required to assure the success of the bank site per the UMBI agreement with the mechanism of assurance to be determined by the Corps, in consultation with the IRT.

D. **Accounting Procedures:** The UMBI will outline all mitigation tracking requirements /responsibilities of the Bank Sponsor. The monitoring section of the UMBI will outline requirements related to tracking debits related to permitted projects and any mitigation accrued when success criteria are met as specified in the UMBI. The cumulative total area of impacts to wetlands permitted to use credits from the mitigation bank shall not exceed the total area of wetlands created by the mitigation bank. If the mitigation bank is constructed in phases, the accounting credits shall duly reflect this phasing of work. A ledger for tracking debits, available credits, and permitted projects will be submitted to the Corps and the IRT. The Bank Sponsor will submit the ledger annually.

E. **Default, Contingency/Adaptive Management/Remedial Action Plan:** The Bank Sponsor will develop necessary contingency/adaptive management plans and implement appropriate remedial actions in coordination with the Corps and IRT if the site is not on a trajectory to meet performance criteria or permit requirements. A general contingency/remedial action plan will be developed for the UMBI, and if necessary, for individual bank sites addressing site specific existing or proposed conditions. The adaptive management plan will establish the framework by which the Bank Sponsor will proceed to correct deficiencies identified on a given bank site. Before considering any adaptive management changes, the Bank Sponsor, in coordination with the IRT, will consider whether such actions will help ensure the continued viability of bank's biological resources. In that remedial actions, cannot be fully determined at this time or at the time of the preparation of the site-specific mitigation plan, the Bank Sponsor retains the right to adaptively manage required amendments to the remedial action plans, as appropriate, upon identification of remedial needs in the future, and with approval from the IRT.

   If the Bank Sponsor or the IRT determines that the bank site is operating at a deficit, or has failed to meet the success criteria, the Corps, in consultation with the IRT and the Bank Sponsor, will determine what remedial actions are necessary to correct the situation. In the event the Bank Sponsor fails to implement necessary remedial actions within one growing season (by November 1 of the following year) after notification by the Corps and IRT of necessary remedial action to address any failure in meeting the success criteria, the IRT will notify the Bank Sponsor and the appropriate authorizing agencies and direct appropriate remedial actions. As determined by the Corps, in coordination with the IRT and the Bank Sponsor, if conditions at the bank site do not improve or continue to deteriorate within one growing season from the date that the need for remedial action was first identified in writing to the Bank Sponsor by the Corps the IRT may suspend credit transactions until the deficiencies are corrected.

   Following implementation of remedial measures and at the written request of the Bank Sponsor, the IRT will perform a compliance visit to determine whether identified remedial actions have been implemented successfully and, if necessary, lift the suspension on

credit transactions.

VI. Responsibility of the IRT

The IRT will be Chaired by a representative of the U.S. Army Corps of Engineers, Philadelphia District. The IRT shall facilitate establishment of the UMBI and facilitate reaching consensus on future individual bank sites. It is anticipated that members of this Umbrella Bank's IRT team will include participants from:

- Army Corps of Engineers, Philadelphia District
- US Environmental Protection Agency
- US Fish and Wildlife Service
- Delaware Department of Natural Resources and Environmental Conservation
- National Marine Fisheries Service
- National Park Service

In coordination with the Corps, the IRT will be responsible for providing appropriate oversight in carrying out the provisions of the UMBI. The IRT agency representatives agree to use their best efforts to review and provide comments on the UMBI, and subsequent site-specific mitigation prospectuses, draft and final mitigation plans/UMBI addendum, monitoring reports, success criteria, credit review reports, accounting ledgers and remedial action plans for individual bank sites. The Corps retain final authority for approval of the UMBI and site-specific mitigation bank instruments. The IRT will also be responsible for adhering to time frames defined in the Mitigation Rule.

The UMBI will outline and define the Corps role, as chair of the IRT, regarding their responsibility for initiating IRT conflict resolution regarding UMBI development or use of a mitigation bank for purposes of Section 404, Section 10 and other related state permit compliance when consensus cannot be reached. The UMBI will also establish timeframes for IRT comment periods and Corps final decisions.

VII. Sponsor Qualifications

DelDOT is qualified and has extensive experience locating, developing, and managing mitigation sites either directly or indirectly through contractors. DelDOT understands the importance of delivering successful, ecologically productive and self-maintaining cost-effective mitigation and is accountable for the functional replacement of unavoidable wetland impacts served by its mitigation banks. Current and past successful mitigation projects include, but are not limited to,

- I-95 Peterson Mitigation Sites – Monitoring in Progress
- New U.S. Route 301 Wetland Mitigation Sites – Monitoring Complete
- Glenville Wetland Mitigation Site – Monitoring Complete
- Eskridge Wetland Mitigation Site – Monitoring Complete
- State Route 1 Phase 1 and Phase 2 Mitigation Sites – Monitoring Complete

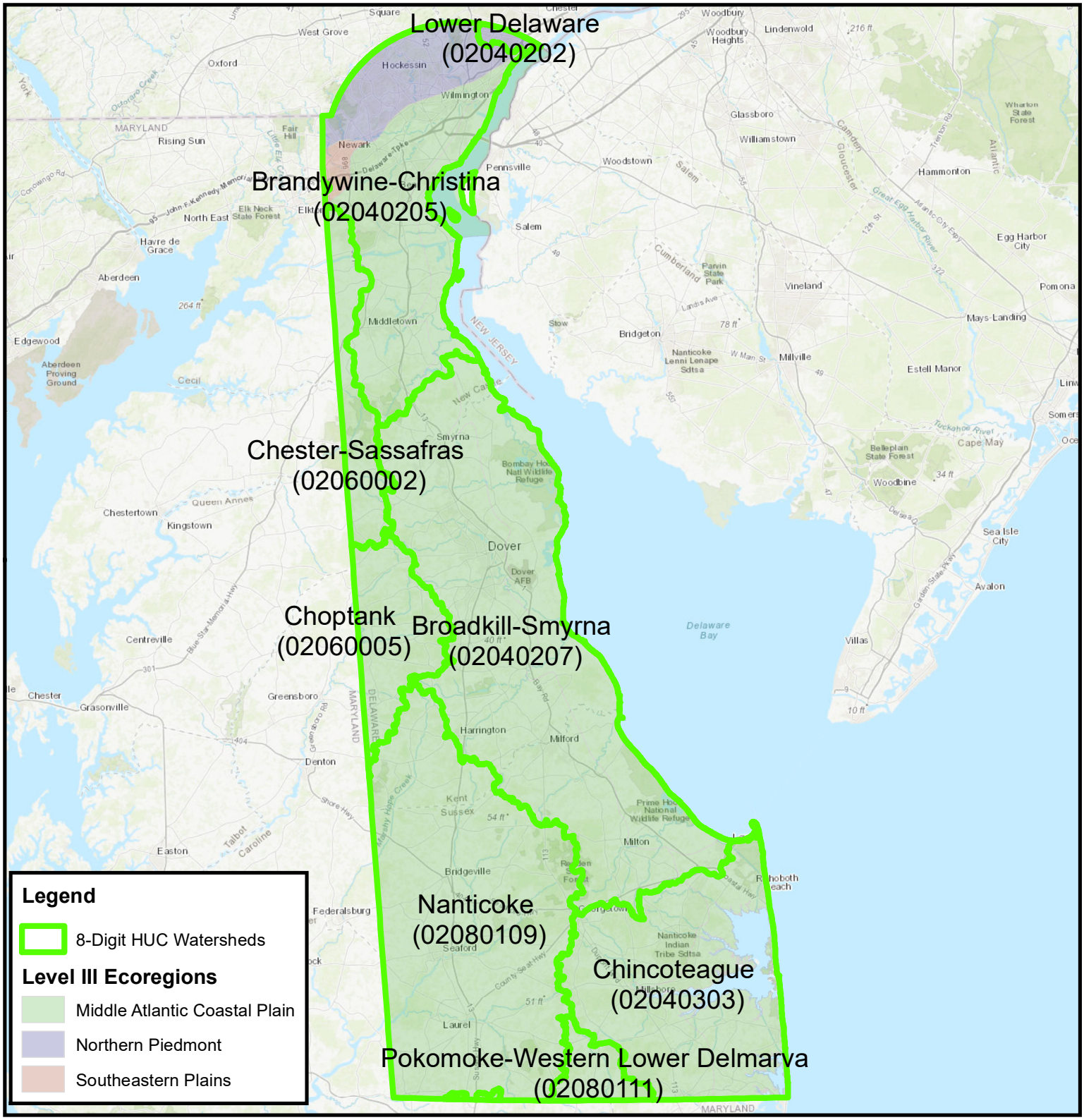
VIII. Miscellaneous

The UMBI will address other administrative or technical elements related to the umbrella mitigation bank establishment, use, operation and maintenance through coordination with the IRT.

Other potential elements that will be addressed in the UMBI that are not part of this prospectus may include, but is not limited to:

- Effective Date of UMBI and amendment/modification process/approval requirements
- Dispute resolution process
- Authorities
- Process for IRT participation termination
- Delays/Defaults
- Force Majeure
- Eminent Domain
- Counterparts
- Binding nature of agreement
- Third Party Beneficiaries
- Governing Laws
- UMBI Amendments
- IRT Contacts
- Responsibility for Compensatory Mitigation

Figure 1



0 12 24 Miles

1 in = 12 miles

N

Figure 1: USGS 8-Digit HUC Map with Physiographic Regions

Delaware

Date: December, 2020

Source: ESRI, NHD, EPA, DGS

Appendix A

Report # ##-##-##/##/##/##

Delaware Rapid Assessment Procedure

Version 6.0

User's Manual and Data Sheets

2010

Last updated August 2010

Delaware Department of Natural Resources and Environmental Control
820 Silver Lake Blvd., Ste 220
Dover, DE 19904

Program Contact: Alison Rogerson
302-739-9939
Alison.Rogerson@state.de.us

Delaware Wetlands

Purify Provide Protect

www.dnrec.delaware.gov/admin/delawarewetlands

This report should be cited as:
Jacobs, A.D. 2010. Delaware Rapid Assessment Procedure Version 6.0. Delaware Department of Natural Resources and Environmental Control, Dover, DE. 36pp.

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GENERAL GUIDANCE

Use of Method

The intended use of the Delaware Rapid Assessment Procedure (DERAP) is to assess the general condition of wetland based on the presence and intensity of stressors related to habitat, hydrology, and buffer features at a site. Stressors are correlated to intensive tier 3 condition data (DECAP) to assign a condition score. The State of Delaware uses DERAP in conjunction with DECAP to assess and report on the condition of wetlands by watershed and to assess status and trends over time. DERAP stressor data is also used to identify the types of impacts to wetlands which is then applied to develop wetland restoration and protection priorities.

Development and Validation of DERAP

DERAP was developed to meet the needs of users that require a rapid assessment of the general condition of a wetland site. Our goal was to develop a method that could be used in any type of wetland in Delaware, was relatively quick to perform in the field, resulted in a single score of condition, and could be validated with the DECAP. Scoring for the DERAP to produce one overall score of condition was developed through a process to calibrate the presence of stressors at a site to comprehensive wetland condition data using the DECAP Index of Wetland Condition (IWC). We developed the DECAP IWC using a process to screen hydrogeomorphic (HGM) variables specific to wetland subclass to select the strongest variables that would represent the condition of the primary wetland attributes (plant community, hydrology, and buffer) (Jacobs et al. 2010). The DERAP was then calibrated to the DECAP IWC using a data set of over 250 sites from the Nanticoke, Inland Bays, and Delaware Bay watersheds in Delaware (Sifneos et al. 2010). We selected stressors using step-wise multiple regression and Akaike's information criteria (AIC) to develop the best model that correlated with the DECAP IWC without over-fitting the model to this specific dataset. Coefficients or weights associated with each stressor were assigned using multiple linear regression. We calculated the DERAP IWC score by summing the stressor coefficients for each of the selected stressors that were present and subtracting the sum from the linear regression intercept.

We feel confident that the rapid assessment is providing a relative measure of condition compared to reference standard (minimally disturbed) sites. The weighted DERAP score is significantly correlated with the DECAP IWC scores with r^2 values of 0.83 for flats, 0.87 for riverine and 0.67 for depressions with $P<0.001$ for all wetland types.

Related Delaware Comprehensive Assessment Procedure

The Delaware Comprehensive Assessment Procedure (DECAP) is a detailed method that can be used to determine the condition of a wetland site relative to reference condition. Data are collected on the plant community composition and structure, hydrology, soils, topography, and surrounding land use. Data collection typically takes a field crew of 3-4 people about 4 hours.

DECAP is an HGM-based method that uses reference data to develop variables that are responsive to disturbance and are scaled from least disturbed to most disturbed. These variables are then combined into functions and an Index of Wetland Condition (IWC). The IWC is a single composite score that represents the overall condition of the site. Comprehensive variables were screened and scored in a manner analogous to that used in developing macroinvertebrate and fish indicators of biotic integrity (IBI) in EMAP stream surveys. This included screening for signal:noise ratio, range test, responsiveness and redundancy. Variables that passed each of these

tests were used in the final IWC, and variables that did not were dropped (Jacobs et al. 2010). Variables within the IWC were weighted based on their contribution to three categories: hydrology, plant community, and buffer/ landscape. The IWC is used to calibrate the condition score of the DERAP. Protocols for the DECAP are available at: **http://www.wr.dnrec.delaware.gov/Information/OtherInfo/Pages/WetlandMonitoringandAssessment.aspx** or contacting the DNREC Watershed Assessment Section.

Geographic and Hydrogeomorphic scope

DERAP has been calibrated with data from the Nanticoke, Inland Bays and Delaware Estuary watersheds and continues to be updated as more data are collected as part of the Delaware Wetland Monitoring and Assessment Program. DERAP is applicable to all non-tidal wetlands in the Outer Coastal Plain regions of Maryland and Delaware, however, we suggest checking for updated weights frequently, since we continue to refine the stressor weights as more sites are sampled with both the DECAP and DERAP. Additional testing is planned to continue to validate the DERAP with the Delaware Comprehensive Assessment Procedure (DECAP) and to test DERAP in tidal freshwater systems and the Piedmont. To assess tidal estuarine emergent wetlands refer to the MidAtlantic Tidal Rapid Assessment Method (MidTRAM) available at: **http://www.wr.dnrec.delaware.gov/Information/OtherInfo/Pages/WetlandMonitoringandAssessment.aspx**

Training and User Precision

The DERAP should only be performed by individuals who have completed a training course on how to properly use this method. Users of DERAP should have experience and/or education in the identification of wetlands including an understanding of the various stressors that impact different wetland types, native flora of the region and soil properties. A study of user precision has showed that users that received training on how the use the method had significantly higher precision in identifying stressors and assigning a condition score than users that did not have training (Herlihy et al. 2009).

Landowner Permission

Permission should be obtained before accessing private property. Our experience is that if contact can be made with the landowner there is a high probability that they will allow access to their property. Georeferenced parcel data can be obtained through the State intranet and landowner information can be found using the following websites:
Sussex County: **http://www.sussexcountyde.gov/.**

Kent County: **http://www.co.kent.de.us**

New Castle County**:** **http://www.nccde.org/defaulthome/home/webpage1.asp**

Time and Effort Involved

The time to complete the DERAP will vary by site depending on the distance to the site from the nearest access point, the density of the vegetation and level of difficultly navigating through the site, the complexity of the site in determining the presence of stressors, and the experience of the person performing the assessment. On average this method should take 2 people no more than 1 hour once at the site.

Equipment Needed

- Clipboards
- Pencils
- Auger
- Munsell Color Chart
- Mid-Atlantic Hydric Soil Indicators
- Compass
- Waders
- Field Protocol
- GPS
- Pruners
- Increment borer
- Angle gauge

TASKS TO BE COMPLETED BEFORE GOING INTO THE FIELD

1) Determine stream order (riverine sites only)
2) Landowner contact information and permission for access
3) Print and review maps
   a) Wetlands and hydrology (1:3000)
   b) Wetlands and hydrology (1:24000)
   c) Tax Parcels (1:5000)
   d) Road Map (1:24000)
   e) Soils (1:5000)
   f) Old aerials 1937, 1954, 1961, 1968, 1992, 1997, 2002 (1:3000)

WETLAND CLASSIFICATION

Although DERAP can be used on any type of nontidal wetland in Delaware's Coastal Plain Region[1], it is important to identify the type of wetland to properly assess the site and to compute a final condition score. If the wetland type is unknown, perform the methods and consult additional resources to determine the wetland subclass. There are six wetland classes in the Coastal Plain of Delaware (modified from Whited and Ainslie (2000)). Several of these classes also include distinguishing subclasses such as intermittent low order and perennial under riverine. A table of all wetland subclasses and types with descriptions is provided in Appendix A. Identification of wetlands should be performed to the lowest possible level.

Depression

Wetlands located in low points in the landscape characterized by closed elevation contours that allow the accumulation of surface water. Potential water sources are precipitation, overland flow and groundwater. Depressional wetlands may have any combination of inlets and outlets or lack them completely. The predominant direction of flow is from the higher elevations toward the center of the depression. The predominant hydrodynamics are vertical fluctuations that range from

[1] Currently the DERAP has only been tested and verified on Flat, Riverine, and Depressional wetlands

diurnal to seasonal. Depression wetlands may lose water through evapotranspiration, intermittent or perennial outlets, or recharge to groundwater.

Mineral – mineral soils, most common in Delaware

Organic – organic soils, most common in Great Cypress Swamp

Sea Level Fen - Herbaceous/graminoid peatlands that occur at the upland edges of ocean tidal marshes; uncommon in Delaware.

Flat

Wetlands that are most common on interfluves, in the headwaters of watersheds, or large floodplain terraces. The dominant water source is generally precipitation; however, groundwater has some contribution to these systems. During late winter/ early spring saturation of upper soil horizons meets with saturation of lower soil horizons caused by rising ground water tables to a continuous saturated soil from the surface to the groundwater table. These zones then separate when the groundwater lowers and the surface wide subsides due to evapotranspiration. Flats lose water by evapotranspiration, overland flow, and seepage to underlying groundwater. They are distinguished from flat upland areas by their poor vertical drainage, slow lateral drainage, and low hydraulic gradients.

Mineral – mineral soils, most common in Delaware
Organic – organic soils, most common in Great Cypress Swamp

Riverine

Wetlands that occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow from channel or subsurface hydraulic connections between the stream channels and wetlands. Additional sources may be interflow, overland flow from adjacent uplands, tributary inflow, and precipitation. When overbank flow occurs, surface flow down the floodplain may dominate hydrodynamics. In headwaters, riverine wetlands often intergrade with slope, depressional, poorly drained flat wetlands, or uplands as the channel and bank disappear. Perennial flow is not required. Riverine wetlands lose surface water via the return of floodwater to the channel after flooding and through surface water flow to the channel during rainfall events. They lose subsurface water by discharge to the channel, movement to deeper groundwater, and evapotranspiration. Associated slope wetlands which are typically located at the toe-slope of the floodplain in the coastal plain physiographic region and are dominated by ground water inputs are included in this subclass. They are not identified as a separate subclass because they are typically very small and are always located within a riverine wetland. There are 4 subclasses of riverine wetlands:

Intermittent – Upper perennial – Typically first and second order streams that serve as headwaters to the watershed. These systems may or may not have a defined channel. Floodplains associated with these systems are fairly narrow and flow may be intermittent or perennial.

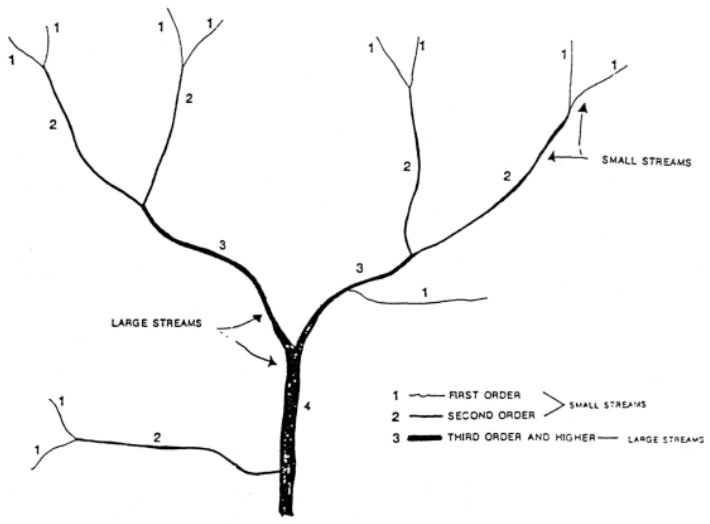
Lower Perennial- Typically third order and higher along the mid-reach or mainstem of the system. Floodplains are wide with a defined channel and surface water is perennial.

Beaver Impounded – wetlands that are or have been impounded by beaver. Floodplains are generally dominated by herbs and emergent vegetation. Snags and dead trees may be present. Canopy tends to be open. Signs of beaver activity such as dams, lodges, chewed stumps and feeding platforms are generally present.

Human Impounded – Typically associated with wetlands along the edge of mill ponds or other manmade bodies of water.

Stream Order (for riverine sites only): Assign the Strahler stream order to the stream associated with the riverine wetland. Using topo maps and NHD GIS data, start at the headwaters of the watershed upstream of the assessment site. Headwater streams that do not have any tributaries entering them (they may not be shown as blue-line streams or ditches) are considered first-order streams. When two **first-order** streams come together, they form a **second-order** stream. When two second-order streams come together, they form a **third-order** stream. Streams of lower order joining a higher order stream do not change the order of the higher stream. Thus, if a first-order stream joins a second-order stream, it remains a second-order stream. It is not until a second-order stream combines with another second-order stream that it becomes a third-order stream.

FIGURE 1
STREAM ORDER HIERARCHY



Slope

Wetlands normally found where there is discharge of groundwater to the land surface, either on sloping land or flat areas at the base of a slope (i.e. toe slope). The dominant hydrologic source is

groundwater and flows downslope in a unidirectional flow. Slope wetland may not have a channel but if a channel is present, it carries water away from the wetland

Estuarine Tidal Fringe

Wetlands that occur along estuaries and rivers and are under the influence of sea level. They intergrade landward with riverine wetlands where tidal current diminishes and river flow becomes the dominant water source. Additional water sources may be groundwater discharge and precipitation. The interface between the tidal fringe and riverine classes is where bidirectional flows from tides dominate over unidirectional ones controlled by floodplain slope of riverine wetlands. Because tidal fringe wetlands frequently flood and water table elevations are controlled mainly by sea surface elevation, tidal fringe wetlands seldom dry for significant periods. Tidal fringe wetlands lose water by tidal exchange, by overland flow to tidal creek channels, and by evapotranspiration. Two subclasses are distinguished in Delaware, freshwater tidal fringe and saltwater tidal fringe.

Marine Tidal Fringe

Wetlands that occur along the Atlantic Coast in Delaware and are under the influence of sea level. Because tidal fringe wetlands frequently flood and water table elevations are controlled mainly by sea surface elevation, tidal fringe wetlands seldom dry for significant periods. Tidal fringe wetlands lose water by tidal exchange, by overland flow to tidal creek channels, and by evapotranspiration.

Key to Determining Wetland Class in the Coastal Plain

1. Is the wetland influenced by tidal cycles from a Bay or Ocean?
   No – go to step 3
   Yes – go to step 2
2. Is the wetland influenced by tidal cycles from the Ocean?
   Yes – Marine Tidal Fringe subclass (refer to MidTRAM for assessment)
   No – go to step 3
3. Is the wetland brackish or salt water?
   Yes ~~- Estuarine Tidal Fringe subclass (refer to MidTRAM for assessment)~~go to step 4
   No – go to step 5
4. Is the wetland emergent?
   Yes - Estuarine Tidal Fringe subclass (refer to MidTRAM for assessment)
   No – Estuarine Tidal Fringe (tidal Riverine – DERAP being tested for this type)

5. Is the wetland in a valley or stream channel where it gets inundated by overbank flooding from that stream or river in an unaltered condition (i.e. if a stream has been channelized and no longer receives overbank flooding it could still be a riverine wetland in an altered condition)?
   No – go to step 6
   Yes – Riverine subclass
6. Is the wetland in a topographic depression, outside areas that are inundated by overbank flooding, in which water ponds during at least part of the year?
   No – go to step 7
   Yes – Depressional subclass
7. Is the wetland at the bottom of a topographic slope?
   No – Flat Subclass
   Yes – Slope subclass

Classification of Created and/or manipulated Wetlands

The State of Delaware, in an effort to track and report progress in the State that is comparable with other on-going tracking efforts is using the definitions as defined by the Federal Geographic Data Committee, Wetlands Subcommittee. This subcommittee developed definitions for restoration and related activities designed to aid agencies in accurately reporting wetland increases due to their program activities. The definitions, below, provide standard terminology for the more than 15 agencies involved in wetland restoration, related activities, and/or mitigation.

Restoration: the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to former or degraded wetlands. For the purpose of tracking net gains in wetland acres, restoration is divided into:

- *Re-establishment:* the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland. Re-establishment results in rebuilding a former wetland and results in a gain in wetland acres. Restore acreage and function

- *Rehabilitation:* the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions of degraded wetland. Rehabilitation results in a gain in wetland function, but does not result in a gain in wetland acres. Restores only function, but not acreage

Establishment: the manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist on an upland or deepwater site. Establishment results in a gain in wetland acres. Create a new wetland from a different ecosystem type.

Enhancement: the manipulation of the physical, chemical, or biological characteristics of a wetland (undisturbed or degraded) site to heighten, intensify, or improve specific function(s) or for a purpose such as water quality improvement, flood water retention or wildlife habitat. Enhancement results in a change in wetland function(s) and can lead to a decline in other wetland function, but does not result in a gain in wetland acres. This term includes activities commonly associated with the terms enhancement, management, manipulation, directed alteration. Improves a specific function of a site not necessarily to reference condition

Protection/Maintenance: the removal of a threat to or preventing decline of, wetland conditions by an action in or near a wetland. This includes purchase of land or easement, repairing water control structures or fences, or structural protection such as repairing a barrier island. This term also includes activities commonly associated with the term preservation. Protection/Maintenance does not result in a gain of wetland acres or function

LOCATING ASSESSMENT AREA

The Assessment Area (AA) is the area within a wetland that will be sampled using the DERAP. Most measurements will be performed in the AA, however, some measurements will assess conditions surrounding the AA. The center of the AA is a random point located in a mapped wetland that has been selected using a probabilistic sampling design for a watershed scale study. If the method is being used for a site assessment more than one AA may need to be placed on the site for a complete assessment if the project site is >0.5ha. AAs should be placed to cover any changes in vegetation types, hydrology, topography, and disturbance history throughout the site.

Note: If this method is being used to sample a subjectively selected reference site, a center point for the AA should be located such that it is representative of the wetland and the ecological condition that it is representing (i.e. clear cut flat, channelized low-order riverine).

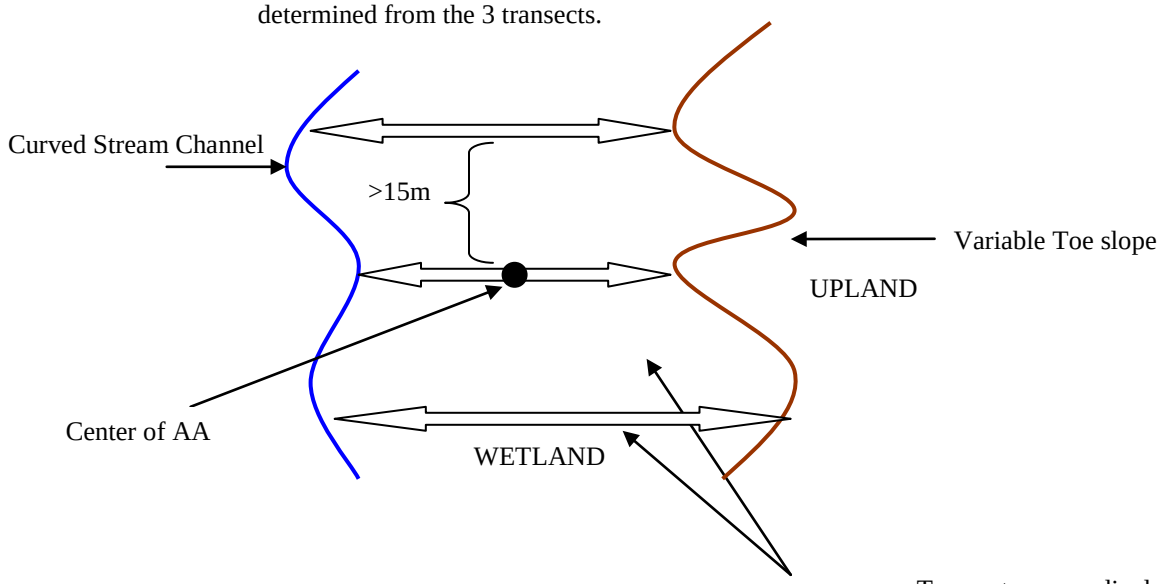
- Mark the center of the AA with a large piece of flagging.
- Establish the AA as a 0.5 ha area around the point (40-m radius circle centered on the point)

Several situations may occur that would require that the AA to be positioned differently than above. Each of these circumstances is detailed below. Please note: **If the location of the AA is moved make detailed notes on the datasheet explaining why the AA was moved and record the lat/long of the new center:**

1) If the mapped wetland does not extend 40m from the point in all directions, move the center of the AA so that the entire AA is within the wetland boundaries.
2) If the assessment area is within a naturally occurring upland inclusion in the wetland, move the center of the AA so that the uplands are excluded from the AA. If the upland inclusion is due to a disturbance i.e. a pile of fill, do not move the center of the AA.
    a) If the location of the original point is determined to be upland, examine the entire 40m radius circle around the original point for a wetland.
        i) If a wetland is found within this area, move the AA the least distance necessary to locate the AA in the wetland.
        ii) If no wetland if found, the site should be dropped and recorded as upland
3) If the AA is within a wetland that is smaller than 1.0 ha, the AA is the same size as the wetland (see below rules for riverine wetlands).
4) If the center of the AA is located in a riverine wetland:
    i. that is >80m wide on the side of the stream where the point falls, the stream channel should not be included in the AA and the AA should be located on the side of the channel where the original point fell
    ii. that is <80m wide
        1. The channel should be included in the AA if the stream is wadable and permission to access both sides of the channel is granted. A stream is wadable if the deepest part of the stream is <1 m deep.

2. If the stream is not wadable or permission is only received to access one side of the channel, make the AA a 0.5ha rectangle with the width being from the edge of the channel to the toe slope (i.e. upland). If the distance varies between the edge of the channel and the toe slope, measure 3 transects, at least 15 m apart perpendicular from the stream to the upland. Locate transects over the approximate length of the AA. Average the lengths of these 3 transects and use this as the average width of the AA. Use the calculated average width to determine the length of your rectangle (see figure below).

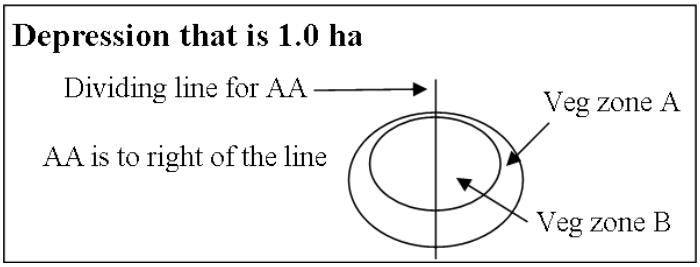
To determine the rectangle length, use the average distance between the channel edge and toe slope as determined from the 3 transects.

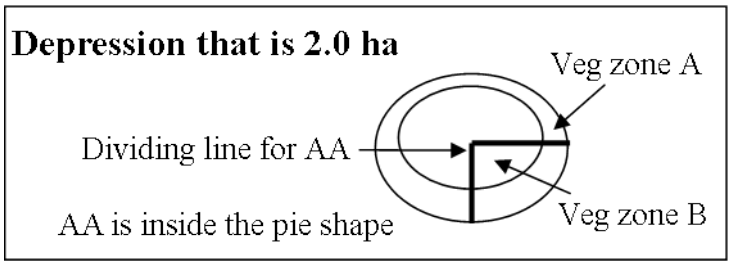


Transects perpendicular to stream channel and upland.

3. Adjust the shape of the AA to a rectangle that is 5,000 sq.meters with the width being the average width of the transects (ex. If the average transect length is 50 meters, the AA would be 100m in length). If the average transect length is less than 50m in width use a maximum length for the AA of 100m and note this on the datasheet. The resulting rectangular AA should be variable in width (i.e. following the contours of the stream and upland) but a determined length.

5) If the AA is located in a depression ≤ 1,0 ha assess the entire wetland .
6) If the depressional wetland is >1.0 ha the AA should be placed as to encompass all vegetation zones present in the site, this will typically involve sampling half of the site or a pie-shaped section to include all vegetation zones. Even when depressional sites are split in half, you should still walk the entire site because some stressors may occur outside of the AA (see stressor scoring).





DATASHEET

Header Information

Site #: Unique EMAP number for site including a watershed abbreviation and 4 digit site number (ex: MU0023)

Site Name: Unique names are given to each site

Date: Month, day and year of sampling

Observer: All members of the field crew that participated in sampling the site

HGM Class and Subclass: HGM wetland class and subclass according to definitions and key above

Stream Order (for riverine sites only): Assign the Strahler stream order to the stream associated with the riverine wetland as described above.

Natural, re-establishment, establishment, rehabilitation, enhancement (circle one): Select the appropriate choice based on the definitions provided above. If the wetland is any category other than natural a DE Restoration Info sheet should also be filled out in addition to all of the standard dataforms with this method.

Reference or Assessment Site: circle which applies. Reference sites are subjectively selected because they represent a specific condition such as minimally disturbed or impacted by a specific stressor or represent an ecological variation of a wetland class. Reference sites can span the range of condition. Reference Standard sites represent the least disturbed condition of a wetland class within a watershed. Assessment sites are sites that have been randomly selected using a probabilistic sampling design.

Watershed and subwatershed: record the watershed that the site is located in and can be determined by overlaying the DE watershed layer of the lat/long that is taken on site. Record subwatershed in areas where appropriate.

Year Restored: Only for restoration sites.

Photos: The frames that are shot should be marked on the data sheet. Photos can point in cardinal directions from center point or to depict a major stressor. If more than two are taken, the range can be given

Lat/Long: Latitude and longitude coordinates in digital degrees

AA size and shape: In most cases the AA will be 0.5ha and circular. Note if adjusted to a rectangle or smaller due to wetland size.

AA moved from original location? Circle yes or no to indicate if the center of the AA was moved from its original location. This only applies to assessment sites that are based on randomly located AA. If the center was moved record reason that the AA was moved.

Qualitative Disturbance Rating: To be agreed upon by entire field crew upon the assessment completion. Through observation of stressors and alterations to the vegetation, soils, hydrology in the wetland site, and the landuse surrounding the site, assessors determine the level of disturbance. Observers should use best professional judgment (BPJ) to assign the site a numerical Qualitative Disturbance Rating (QDR) from least disturbed (1) to highly disturbed (6) relative to other sites in the watershed based on BPJ. General description of the minimal disturbance, moderate disturbance and high disturbance categories are provided below.

Minimal Disturbance Category (QDR 1 or 2): Natural structure and biotic community maintained with only minimal alterations. Minimal disturbance sites have a characteristic native vegetative community unmodified water flow into and out of the site, undisturbed microtopographic relief, and are located in a landscape of natural vegetation (250m buffer). Examples of minimal alterations include a small ditch that is not conveying water, low occurrence of non native species, individual tree harvesting, and small areas of altered habitat in the surrounding landscape, which does not include hardened surfaces along the wetland/upland interface. Use BPJ to assign a QDR of 1 or 2.

Moderate Disturbance Category (QDR 3 or 4): Moderate changes in structure and/or the biotic community. Moderate disturbance sites maintain some components of minimal disturbance sites such as unaltered hydrology, undisturbed soils and microtopography, intact landscape, or characteristic native biotic community despite some structural or biotic alterations. Alterations in moderate disturbance sites may include one or two of the following: a large ditch or a dam either increasing or decreasing flooding, mowing, grazing, moderate stream channelization, moderate presence of invasives, forest harvesting, high impact landuses in the buffer, and minimal hardened surfaces along the wetland/upland interface. Use BPJ to assign a QDR of 3 or 4.

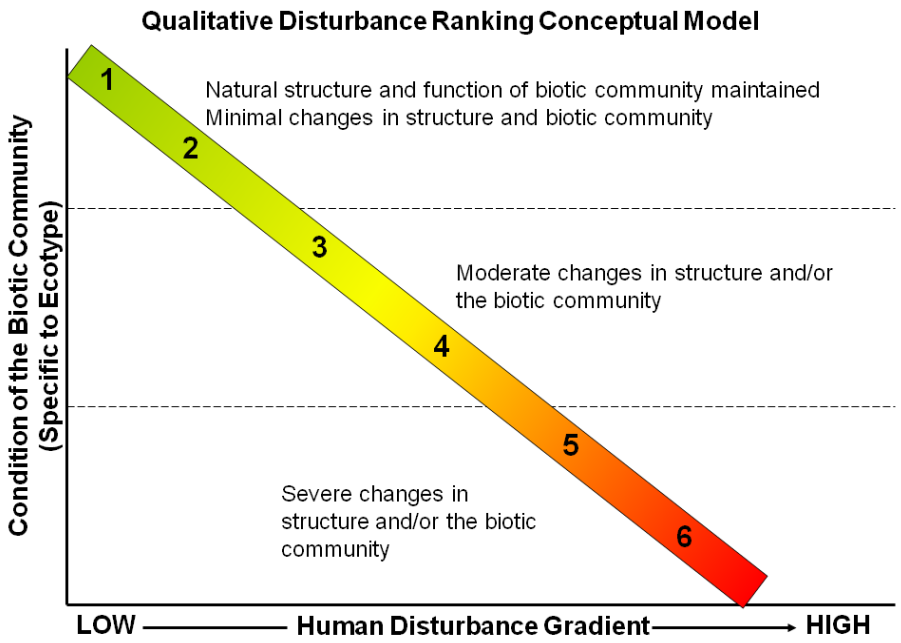


Figure 4. Diagram of narrative criteria for qualitative ranking of disturbance

High Disturbance Category (QDR 5 or 6): Severe changes in structure and/or the biotic community. High

disturbance sites have severe alterations to the vegetative community, hydrology and/or soils. This can be a result of one or several severe alterations or more than two moderate alterations. These disturbances lead to a decline in the wetland's ability to effectively function in the landscape. Examples of severe alterations include extensive ditching or stream channelization, recent clear cutting or conversion to a non-native vegetative community, hardened surfaces along the wetland/upland interfaces for most of the site, and roads, excessive fill, excavation or farming in the wetland. Use PBJ to assign a QDR of 5 or 6.

General Guidance

Once the Assessment Area is defined and flagged each field crew member must walk the entire AA. All members should meet at the center of the assessment area to complete the rapid worksheet. First, sketch the AA identifying the location of major stressors, the major overstory habitat and location of forestry activities- if any. Complete the Rapid Worksheet as a group. Once complete discuss and assign QDR.

When completing the DERAP minimize double counting the same impact. Only the most intense stressor of the impact should be recorded. Several examples are provided below:

i) If a site is farmed – under Habitat Category record Farmed;
   (1) DO NOT record Forest Harvesting land not recovering
   (2) DO NOT record mowing if there is a grass filter strip associated with the farm because this is encompassed in the farming practice
ii) If a road goes through the AA, record the presence of a road
   (1) DO NOT record mowing if the edge of the road is mowed as well
iii) If there is a golf course in the buffer record golf course in the Buffer Category
   (1) DO NOT record mowing for areas within the golf course
iv) In Hydrology Category, roads should be recorded either in the Weir/Dam/Road Stressor if they are affecting the flow of water in the site, or in the Fill Stressor if they are not affecting flow.
   (1) DO NOT include roads in the Microtopography Stressor.
v) In Habitat or Buffer Category only record the most intense road type present
   (1) DO NOT record mowing that is general maintenance for roads

One exception to this rule is the use of windrows as an indicator of microtopography alteration and fill. If windrows are present, they are used to indicate that the site has been mechanically cleared. The entire area inclusive of windrows (area in and between the windrows) should be included in the area estimation for microtopography alteration. Only the footprint of the windrows should be used under the fill stressor.

ANALYZING OLD AERIAL PHOTOS CAN PROVIDE INSIGHT INTO PAST LAND USE PRACTICES, FORESTRY OPERATIONS AND SITE HISTORY.

Habitat Stressors

Stressors that have the potential to impact the habitat and plant community of the wetland. Only consider the presence of these stressors if they are within the assessment area.

Dominant Forest Age and Harvesting within 50 years

Utilize aerial photographs to assist in determining forestry activities that occurred within the past 50 years Harvesting includes all forestry activities where trees were harvested and/or removed from the site. Indicators of clear cutting include an even aged stand of regenerating trees and/or site preparations such as bedding and wind rows.

- Selective cutting indicators include a mixed age stand with patches of trees that are much younger and the presence of tree stumps with older aged trees. Thinning operations should be included under selective cuts.

Dominant Forest Age
Determine the age of the dominant forest (the majority of the forested area within in the AA) through aerial photography and/or increment boring of pine, ash or poplar. If area was selective cut forest age is based on the remaining trees.

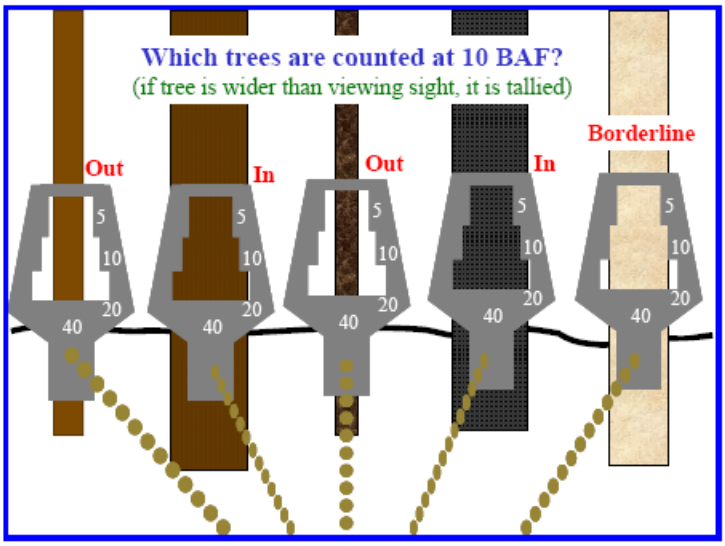
Dominant trees are ≤ 50 and >30 years old
Dominant trees are ≤30 and >15 years old
Dominant trees are ≤15 and >2 years old
Dominant trees are ≤2 years old

Harvesting within 50 years
If the dominant forest age is ≤ 50 years, the appropriate box should be checked to indicate the type of harvesting that occurred (clearcutting or selective cut). The percent of the AA affected by clear cutting should be determined (<10%, 11-50% or >50%).

% of AA Forested
Record the percent of the AA that is in a forested vegetative cover type. Cover types that should not be included as forested include emergent or shrub wetland with no forested canopy or a cleared or disturbed area with natural regeneration of a forest not occurring. Young forests that are regenerating are considered forested.

BAF(10) of Dominant Forest Cover

This is a test metric this is being assessed for its correlation with basal areas determined using DECAP. ***Only complete if a comprehensive assessment is also being performed at the site.*** Assess the basal area of the dominant forest (that for which the age was estimated in the stand age section above) using a 10 factor angle gauge. This is a plotless sampling procedure where the inclusion of a tree depends on the basal area (cross sectional area of a tree at breast height) of the tree and its proximity (distance) to the sample point. The basal area factor (BAF) is the number of units of basal area per acre.



Standing at the center of the AA, hold the end of the chain on the angle gauge against your chin and extend the gauge perpendicular from your body until the chain is fully extended. Rotate in a 360 degree circle keeping your eye over the center of the AA and count each tree **≥ 15cm DBH** that is larger than the angle gauge opening using the 10BAF opening. (see figure). If a tree is behind another tree, carefully step to the side of your point center while keeping the same distance from the tree. You should then be able to see if it's in, out or borderline.

Borderline trees: For borderline trees, measure the dbh and the distance to the tree. The distance should be measured to the "center" of the tree, NOT THE FACE of the tree. If the tree is equal to or closer than the

limiting distance for its dbh, then it is tallied. Limiting distances for 10 BAF prisms and gauges are listed in Appendix D. The table goes to 10ths of a cm. For an example, the limiting distance for a 39.1cm dbh tree is 12.9 m. Any 39.1cm dbh tree 12.9m or closer to the sample point is counted.

Forest Management

Pine Plantation- the AA is managed or converted to pine. The AA is either converted to a loblolly pine plantation by planting pines after harvest, or is being managed to encourage the growth of pines and discourage the growth of other species that are naturally regenerating. This is typically evidenced by an even-aged stand of pine. If a site is a mix of pine and hardwood and the management intent is unclear, additional information may be gained from the landowner.

Chemical Defoliation - A broad leaf chemical herbicide was applied to the site, which defoliated all herbaceous and broadleaved woody plants. This is a common practice in areas that have been recently harvested and are naturally regenerating to kill the broad-leaf species to release the pines to grow.

Vegetation Alteration

Determine if any of the following are present in your Assessment Area (check all present):

Mowed – any re-occurring activity that inhibits the natural succession of vegetation through mechanical means, i.e. mowing of grass or brush adjacent to development, on ditch spoil banks, and powerline right-of-ways

Farmed – part or all of the assessment area is cultivated as part of a farming operation to grow crops

Grazed – grazing activity as part of an animal rearing operation such as goats, pigs, sheep, cows, etc. Do not include browsing by wildlife which should be considered under excessive herbivory.

Cleared Not Recovering – area that has been affected by a disturbance such as land clearing, excavation etc. where natural regeneration of the natural vegetation is not occurring.

Other - The cleared not recovering category applies to areas that were cut and are being maintained in an early successional habitat. Examples include sites maintained as emergent wetlands or borrow pits that were cut and then flooded and therefore cannot recover.

Presence of Invasive Species

Invasive species as identified by the DE Natural Area Program (see Appendix B) are identified within the AA. Percent cover of invasive species within the AA should be estimated in the following categories: Not Dominating (<1% of AA, 1-5% of AA, 6-50% of AA) or Dominating (>50% of AA).

Excessive Herbivory (Pine Beetle/Gypsy Moth/Nutria)

Assessment area has been impacted by intense herbivory or infestation by southern pine beetle or gypsy moth. Herbivory by deer or nutria is evidenced by browse lines on the vegetation due to deer activity or large mud flats exposed due to nutria activity. Pine beetle and gypsy moth damage is evidenced by high densities of either dead or downed pine trees for the southern pine beetle or oaks for the gypsy moth.

Areas affected by southern pine beetles are characterized by a central host tree with a large radius of dead trees, similar to a bulls eye. Affected trees can be wiped out in a week's time. Almost exclusively occurs in over-mature tree stands or stressed trees (drought, flooding, fire, poor nutrition).



Left: Gypsy moth tent; *Middle*: Southern Pine Bark larvae; *Right*: Nutria damage in tidal marsh

Increased nutrients

Dense algal mats – the presence of algae over a portion of the wetland surface or growing in dense mats beneath the surface. Do not include algae that are naturally occurring on the surface of large downed wood or vegetation.

Depressional Wetlands Only: Presence of Nutrient Indicator Species– nutrient indicator species as identified by the DE Natural Heritage Program (see Appendix C) are identified within the AA. Indicator species are considered to dominate the site if all the indicator species combined comprise >50 of the vegetative cover in the site. These species have been found to be associated with depressions that have sustained nutrient enrichment. This indicator can only be used for wetlands in the depression subclass.

Roads

Note the presence of roads in the assessment area. Check most intensive type present and record others under comments. The degree of impact the road is categorized by amount of impervious, amount of fill and the type of use of the road. Use the following definitions:

Non-Elevated Road (logging, dirt road or ATV trail)- roads that cut through an area, but were not filled to elevate the surface of the road higher than the surrounding area, includes ATV trails. Does not include walking or deer trails.

Elevated Road (Dirt or Gravel): Permeable roads created by filling the wetland and used by either motorized vehicles for non-motorized recreation. (i.e. hiking/horse trail maintained in a park)

Paved Road: Impervious roads where fill was brought on site or excavated from ditches to elevate the surface of the road higher than the surrounding area.

Other - Record any other stressors that are observed in the site that could potentially be affecting the habitat and/or plant community of the assessment area.

Hydrologic Stressors

Record stressors that have the potential to impact the hydrology of the assessment area. This may include stressors that are physically outside of the assessment area if their presence is impacting the hydrology inside the assessment area. For Riverine wetlands the stream channel will always affect the hydrology of the AA.

Ditches (flats and depressions only)

Presence of man-made ditches within the assessment area, constructed in areas that were not former streams for the purpose of conveying water into or out of the site.

Slight - Presence of 1-3 shallow (≤0.3mdeep) ditches within the AA.

Moderate - Presence of many (>3) shallow ditches within the AA **or** presence of a moderate depth ditch (0.3 – 0.6m deep) within the AA **or** presence of 1 deep ditch (>0.6m deep) within 25m of the AA.

Severe - Presence of >1 moderate ditch within the AA **or** presence of a deep ditch in the AA (>0.6m deep)

Stream Alteration (Riverine Only)

A stream that has been altered by mechanical or hand excavation or is incised. Streams that have been channelized typically have less meanders than natural streams and often have an elevated area next to one or both sides of the stream where the dredge spoil was disposed (spoil bank/spoil pile).

Not maintained, reverted to natural morphology - historic channelization detected from presence of spoil piles on one or both sides of stream that are typically small mounds directly adjacent to the stream. Natural morphology (meanders and bottom substrates) have returned over time. Usually only found in low order streams that were channelized by hand. If a meandering stream is forming inside of a ditch or channelized stream this should not be considered reverting to natural morphology, rather the entire channel is developing meanders through the floodplain.

Spoil bank - spoil pile (deposition of materials that were dredged from the channel) located on one or both sides of the channel. Check box to indicate if the spoil bank is located on the same side of the stream as the AA.

Natural Stream Channel incision - in riverine wetlands, the stream channel that is associated with the riverine channel has been excessively incised creating an abnormally deep channel. Incised channels often lower the water table and decrease the occurrence of overbank flooding to the riverine wetland. Stream Incision should not be checked if the stream has been channelized.

Weir/ Dam/ Road

Includes any man-made structure including dams, weirs, roads, railroads, culverts, etc. in a wetland that is impacting the flow of water through a site by either impounding water in the site and/ or inhibiting water getting to the site. The effect of the structure on the hydrology should be evaluated to determine if the structure is impeding flow to the site or is impounding flow in the site. If the structure is impounding water in the site, the percent of the assessment areas that is impacted should be estimated. If the structure is within the assessment area and is impeding flow on one side and inhibiting flow on the other side then points for both categories should be deducted.

Flooding

This is a test metric that is currently not scored. The information is being used to characterize the hydrology at wetland types in various condition classes and will be analyzed to determine if this can be used as a rapid indicator of hydrologic disturbance to a site. Determine the percent of the AA that is permanently flooded and inundated using the following definitions.

Permanently flooded – percent of the AA that is covered with standing water continually throughout the entire year.

Inundated – percent of the AA that is covered with standing water sometime during the year but not the entire year. This can be determined by indicators that standing water was present previously such as blackened leaves, water marks on trees or other hydrologic indicators. The percent inundated should be equal or greater than the percent permanently flooded.

If standing water is present indicators such as the presence of vegetation and depth of water should be used to determine if the water is likely to be permanent throughout the year (included with permanently flooded percent) or transient and likely to dry up during the drier part of the year (included with inundated percent)

Stormwater and Point Sources

Stormwater inputs - Evidence of rain and snow runoff from the urban/suburban landscape, primarily runoff from impervious surfaces. To determine if stormwater is affecting the AA a stormwater pipe must be present in the AA or **two** of the following indicators must be present:
-Impervious surfaces adjacent to the wetland and in immediate drainage of the wetland
-Flashy water table fluctuations in AA (evidenced from water marks and wrack lines) and/or large amounts of water impounding in the AA for short periods
-Racks of debris and trash that have moved into the AA via transport from high water
-Storm water pipes directly entering the wetland within 100m of AA

Point source (non-stormwater) - a source of pollutants which may be traced to a discrete point of emission. The pollutant discharge is from a discrete conveyance and must be effluent from the end of a pipe or ditch.

Excessive sedimentation - sedimentation is observed on the soil surface that is not attributed to normal accretion processes. Sources of sedimentation may include adjacent construction or agricultural activities. Sedimentation can often be detected because it is usually a subsurface soil material that is deposited on top of an A or O horizon.

Filling and/or Excavation

Evaluate the assessment area and determine the percent of the area that is being impacted by fill or excavation according to the below definitions

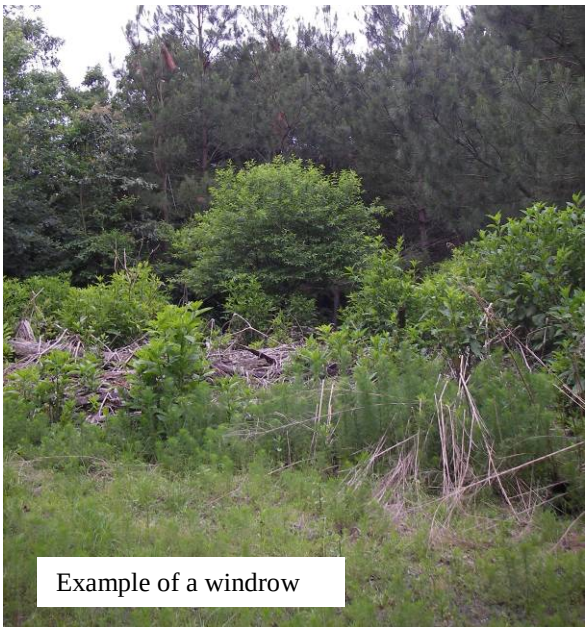
Fill – man-made deposits of soil material, rock products, waste materials including organic materials such as brush and lawn clippings, etc. added to the wetland not due to a natural process. Garbage, trash and yard waste should be considered as fill if they are in amounts large enough to cover an area and raise the surface of the wetland.

- Isolated pieces of trash should be recorded under the habitat category.
- Windrows that are associated with logging activities should be considered as fill because they typically develop into upland "ridges" through the sites and usually have upland vegetation

associated with them. Only the "footprint" of the windrows should be used to estimate the % of the AA covered by fill.

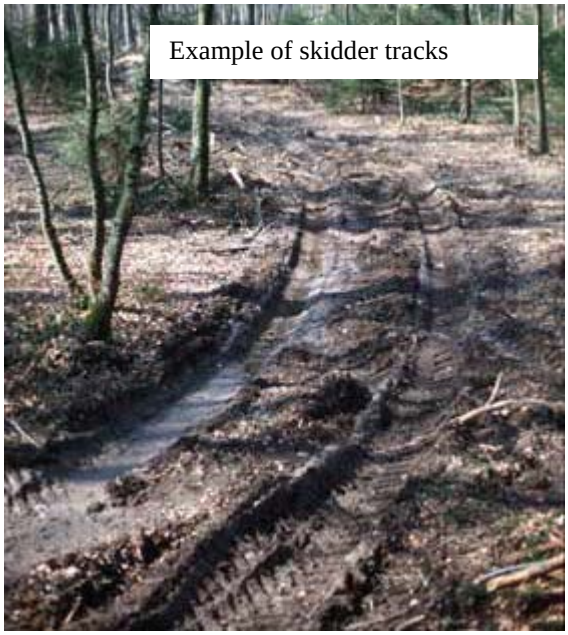
- Spoil excavated from a ditch and deposited in the AA
- Road or railroads within a site that ARE NOT IMPEDING flow of water through the site should be considered as fill
- Excessive sedimentation due to alterations in the surrounding land use should not be included as fill, but recorded under the Excessive Sedimentation stressor

Excavation - the process of digging, cutting or scooping, and removing of material


Example of a windrow

Check the box indicating what percent of the AA that has been filled or excavated.

Microtopographic Alterations


Example of skidder tracks

Any alteration to the natural soil surface such as plowing, bedding for forestry operations, skidder or ATV ruts, etc. Bedding is a planting preparation that forms small mounds to elevate seedling root zones above water. Established roads should be recorded under roads on the habitat/plant community box. Estimate the area of the assessment area where the natural microtopography has been altered by human disturbance. If windrows are present, they are used to indicate that the site has been mechanically cleared. All of the area in and between the windrows should be included in the area estimation for microtopography alteration (i.e. if the entire site has been windrowed then the area of impact would be 100%). Roads should not be included in microtopography alteration, but recorded under either the Weir/dam/road Stressor if they are affecting the flow of water through the site, or in the Fill Stressor if they are not impacting flow. Check the box indicating the percent of the AA that has human altered microtopography.

Soil Subsidence/ Root Exposure

The settling or sinking of the ground as a result of the collapse of porous formations, lack of support from underlying soils or strata, decrease in ground water or the oxidation of organic materials on the surface. This stressor is typically associated with riverine wetlands that have been channelized and the soils are subsiding due to the altered hydrology. However, other types of wetlands including flats and depression may also have subsidence where the hydrology has been altered. Associated with soil subsidence is the exposure of tree roots to the surface that would typically be covered with soil.

Example of soil subsidence/ root exposure in a flat in the Inland Bays watershed. Photo from Chris Bason

Other – record any other stressors that are observed in the site that could potentially be affecting the hydrology of the assessment area.

Buffer Stressors

Stressors that are present in the buffer area surrounding the assessment area and that may affect the condition of the assessment area. This category is an indicator of how well the wetland is protected from disturbances that are present in the surrounding landscape. The buffer area is a 100m radius circle from the edge of the assessment area or approximately 140m from the center of the assessment area, assuming a circular 0.5ha assessment area. Recent aerial photographs are useful to determine if stressors are present in addition to the on-site observations.

Development

Includes any type of human development in the buffer such as commercial/ industrial including any businesses, stores, plants, factories, etc. and residential including single family houses and apartments.

Roads

Presence of constructed roads in the buffer area. If more than one type of road is present in the buffer area, score the category based on the highest intensity type. Active and maintained logging roads for vehicle use should be scored as a dirt or gravel road. Railroads should be scored as a dirt or gravel road. Roads encompassed within a residential development are accounted for under Development stressor (i.e. residential). Do not double count residential roads. Trails and old logging roads are not considered stressors in the buffer. .

Landfill/ Waste Disposal

Presence of anthropogenically derived materials that were deposited over an extended period of time (i.e. not an isolated incident). Includes both municipal landfills as well as areas on private property

Channelized Streams or Ditches
Evidence of channelized streams or ditches > 0.6m deep in the buffer

Row crops, nursery plants, orchards
Includes soybeans, corn, wheat, truck crops (i.e. tomatoes, potatoes, bean, watermelons), nursery plants (i.e. shrubs and trees for landscaping), and orchards. Excludes forestry and pine plantations

Poultry or livestock operation
Includes chicken houses, pigs, cows or other livestock rearing operations

Forest harvesting in past 15 years
Forest harvesting activities including selective cutting, clearcutting, thinning etc. have occurred in the buffer within the last 15 years. Refer to aerial photos for additional insight

Golf Course
The presence of a golf course in the buffer

Mowed area
Any re-occurring activity that inhibits the natural succession of vegetation through mechanical means, i.e. mowing of grass or brush adjacent to development, on ditch spoil banks, and powerline right-of-ways, etc. **This does not** include mowing that is associated with a more intensive stressor such as residential lawns, golf courses, roads and agriculture.

Sand/gravel operation
The presence of a sand and gravel operation in the buffer

Other - record any other stressors that are observed in the site that could potentially be affecting the buffer of the assessment area.

Computing Total Score

The total score for the DERAP is computed using the following steps:

(1) Assign weights to the habitat and hydrology stressors that are present according to the scoring sheet in Appendix E. Stressor weights vary by HGM class so it is important to correctly identify the HGM subclass of the site.
(2) Tally the number of buffer stressors present and determine the weight by subclass.
(3) Sum all of the weights for the stressors that were present at the site.*
(4) Subtract the total stressor weight from the intercept of the wetland subclass.
(5) If no stressors are present the score for the site equals the intercept score.

* Stressors that are recorded in the "Other" category should be assigned a weight using best professional judgment and considering the effect of the stressor relative to other stressor weights in the same category. In the Buffer category, an "Other" stressor in included in the final tally of stressors to determine the weight.

Determining Condition Class

For reporting purposes, we established condition breakpoints using the Total Score based on the upper 25th percentile and lower 75th percentile of sites as compared to QDR ratings based on data from over 200 sites in the Coastal Plain. We report the condition of wetlands in three categories:

Minimally or Not Stressed – 25th percentile of sites with QDR of 1 or 2. Exhibiting soil and/or vegetative structure and function similar to natural communities of the same wetland type; no or incidental anomalies; ecosystem level functions are highly maintained.
Moderately Stressed – Sites between minimally and severely stressed. Evident changes in soil and/or vegetative structure including shifts in size, relative abundance and/ or presence of more tolerant taxa and/ or absence of characteristic taxa; some ecosystem level functions maintained.
Severely Stressed – 75th percentile of sites with QDR of 5 or 6. Large changes in soil and/or vegetative structure including changes in dominant taxa; ecosystem functions are altered and exhibit reduced complexity and redundancy.

The percent agreement of assigning sites using the DECAP versus the DERAP was 76% for flats, 76% for riverine, and 65% for depressions. Almost all of the sites that were classified differently using the two methods were due to the DERAP scoring sites "Minimally or Not Stressed" or as "Severely Stressed" and the DECAP scoring sites "Moderately Stressed". No sites were classified as Minimally or Not Stressed by one method and Severely Stressed by the other method. This illustrates that the DERAP is producing a similar assessment of condition but it is a coarser measure of the condition and in some situations is unable to detect condition based solely on the presence of stressors that are easily observable. Some sites are found to be in lower or higher condition when the DECAP is used because this method is using more detailed indicators to determine condition.

A condition class for each assessment site can be determined using the subclass and Total Score in the table below. The root mean square error (root MSE) was used to create "grey zones" on the upper end of the severely stressed and moderately stressed condition classes. Sites that score within the grey zone are within the margin of error of being in the next higher condition class. The root MSE was 7.5 for flats, 9.5 for riverine, and 16 for depressions. To best protect the resource in higher condition classes, sites that score within the grey zone can either be categorized in the higher condition class or a comprehensive assessment can be performed using the DECAP to more accurately determine the condition class.

Condition Class based on DERAP Total Score

Subclass	Minimally or Not Stressed	Moderately Stressed		Severely stressed	
Flats	**≥ 88**	**< 88 and ≥ 80.5**	**<80.5 and ≥ 65**	**<65 and ≥57.5**	**< 57.5**
Riverine	**≥ 85**	**< 85 and ≥ 75.5**	**<75.5 and ≥ 47**	**<47and ≥ 37.5**	**< 37.5**
Depression	**≥ 73**	**< 73 and ≥ 57**	**<57 and ≥ 53**	**<53 and ≥ 37**	**< 37**

Glossary

Assessment Area (AA) – area within the wetland that is sampled using the Delaware Rapid Assessment Procedure. All stressors are evaluated based on their potential effect on the AA with the exception of the buffer category. To locate the assessment area in the wetland, refer to instructions in the Locating Assessment Area section.

Channelized Stream– a natural stream channel that has been straightened, widened, deepened or otherwise modified to provide improved drainage of surrounding areas.

Constructed Road – road where fill was either brought on site or excavated from ditches on either side of the road to elevate the surface of the road higher than the surrounding area

Ditch - A man-made, open drainage-way in or into which excess surface water or groundwater drained from land, stormwater runoff, or floodwaters flow either continuously or intermittently

Fill – man-made deposits of soil material, rock products, waste materials etc. added to the wetland not due to a natural process.

Invasive Species – a non-native or introduced species that has developed a tremendous capacity for reproduction and distribution throughout its new home and that also has a negative impact on environmental, economic, or public welfare priorities. Appendix B. is a list of invasive species found in Delaware.

Logging road - roads that are cut through an area but that were not filled excessively to elevate the surface of the road higher than the surrounding area

Microtopography – the natural configuration of the surface of the land on a small scale including changes in elevation due to the presence of hummocks, mounds and depressions.

Random Site – a randomly generated site produced by the EPA's Environmental Monitoring and Assessment Program (EMAP). The site was selected from a group of wetlands that fit a specific Hydrogeomorphic subclass (HGM). The classification of the wetland group was derived from a modified version of the National Wetlands Inventory Map (NWI).

Reference Standard Site - a site that has minimal man induced alterations or disturbance is in a least altered state compared to other wetlands in Delaware.

Spoil pile – pile of soil material that was excavated or dredged from an adjacent ditch or stream.

Storm water - Stormwater is water that accumulates on land as a result of storms, and can include runoff from urban areas such as roads and roofs.

Weir - a dam in a stream or river to raise the water level or divert its flow

APPENDIX A - Classification of Delaware's wetlands using hydrogeomorphic attributes and descriptive examples

HYDROGEOMORPHIC CLASS[2] Subclass	Dominant water sources of class and flow dynamics	Major source of variation within subclass	NWI vegetation classes[3]	Regional example	Citation
FLAT	Precipitation; Vertical fluctuation				
Mineral soil		Hydroperiod and fire frequency	FO, SS, EM	Wet pine flatwoods/ pine savannas: Broad areas with poor drainage on mineral soils	Walker and Peet (1983); Rheinhardt et al. (2002)' Rheinhardt and Rheinhardt (2000)
Organic soil		Peat depths (from histic epipedons to histosols)	FO, SS, EM	Southern peat bogs such as pocosins: Broad areas with poor drainage that accrete organic matter	Richardson (1981)
SLOPE	Groundwater discharge and interflow; Unidirectional & horizontal				
Mineral soil		None available	FO, SS, EM	Spring seep	Cole et al. 1997
Organic soil		None available	FO, SS, EM	Forested fen	WPC 1998
Sea-level fen	Groundwater seepage, oligotrophic, acidic freshwater		EM		

[2]Upper case in bold are HGM classes; lower case in bold are regional subclasses, except for deepwater environments.

[3] 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).

DEPRESSION	Precipitation or groundwater; vertical fluctuation				
Inland	With our without inlet and outlets		FO, SS, EM,	Coastal plain ponds, forested depressions	
Interdunal Swale	Groundwater driven	Groundwater withdrawal causing intrusion of salt water, ditching, dune crossings, OMWM, invasive species	PEM	Along Atlantic coastal strand and barrier islands, shallow depressions behind primary dune ridges	DENHP (1994)
Human impounded or excavated		Size of catchment	SS, EM, AB	Borrow pits; some farm ponds; some created wetlands	xxxx

RIVERINE – non-tidal	Overbank flow from channel and groundwater discharge; Unidirectional				
Intermittent-Upper perennial	Non-tidal	Range of hydroperiods within riparian zone (usually < third order), gradient high, water velocities fast.	FO, SS, EM, AB	Riparian forest	Rheinhardt et al. (1998); Rheinhardt et al. (2000)
Lower Perennial	Non-tidal	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)
Beaver-impounded		Dam more temporary than human-impounded; usually < third order	FO, SS, EM, AB	Beaver pond	Klotz (1998) Bason and Brinson (in preparation)
Human-impounded[4]		Range of water residence times based on impoundment volume and discharge	FO, SS, EM, AB	Mill ponds; large farm ponds not deemed to be Depression	xxxx

ESTUARINE TIDAL FRINGE	Mixture of sea and fresh water; bi-directional and horizontal				
Estuarine lunar intertidal					
	Freshwater tidal		FO, EM, AB	Freshwater tidal swamps	
	Brackish tidal	**Regularly flooded zone:** Flooding by semidiurnal tides **Irregularly flooded zone:** Flooding by spring and storm tides and precipitation	EM, AB	*Spartina alterniflora*-dominated zone *Juncus roemerianus* and *S. patens* dominated zone	Stevenson et al. (1977) Simpson et al. (1983); Rheihnhardt (1992)
Estuarine subtidal		Low energy regime allows SAV establishment (Salinity ranges - 0 to >30ppt)	FO	Mud and sand flats; SAV beds; Oyster reefs	Rybicki et al. (2001) Southrworth and Mann (2004)
Estuarine impounded		Flow is blocked by dike, gate, or dam; water source precipitation except for controlled delivery of estuarine water of varying salinity	FO, EM, AB	Waterfowl impoundments?	xxxx
MARINE TIDAL FRINGE	Marine source; bi-directional and horizontal				
Marine intertidal		N/A	US	High energy beach	
Marine subtidal		N/A	UB	Shallow littoral	

APPENDIX B - DELAWARE INVASIVE SPECIES LIST

Draft from W.A. McAvoy, 6-08-2010

Acer platanoides Norway maple
Acorus calamus European sweetflag
Ailanthus altissima tree-of-Heaven
Akebia quinata five-leaf akebia
Alliaria petiolata garlic mustard
Ampelopsis brevipedunculata porcelain-berry
Aralia elata Japanese angelica-tree
Arthraxon hispidus joint-head arthraxon
Berberis thunbergii Japanese barberry
Bromus inermis awnless brome
Bidens polylepis awnless beggar-ticks
Cabomba caroliniana Carolina fanwort
Carex kobomugi Japanese sand sedge
Celastrus orbiculata Oriental bittersweet knotweed
Centaurea stoebe subsp. micranthos spotted knapweed
Cirsium arvense Canada thistle
Clematis terniflora Japanese virgin's-bower
Conium maculatum poison-hemlock
Echinochloa crus-galli barnyard grass
Egeria densa Brazilian waterweed
Elaeagnus umbellata autumn olive
Euonymus alatus winged euonymus
Euonymus fortunei winter creeper
Ficaria verna/Ranunculus ficaria lesser celandine
Galanthus nivalis snowdrops
Gleditsia triacanthos honey-locust
Hedera helix English ivy
Hemerocallis fulva orange daylily
Humulus japonicus Japanese hops
Hydrilla verticillata hydrilla
Iris pseudacorus yellow iris
Leucojum aestivum summer snowflake
Ligustrum obtusifolium border privet
Lisustrum sinense Chinese privet
Ligustrum vulgare European privet
Lonicera japonica Japanese honeysuckle
Lonicera maackii Amur honeysuckle
Lonicera morrowii Morrow's honeysuckle
Ludwigia leptocarpa water-willow
Ludwigia peploides subsp. glabrescens floating seedbox
Lysimachia nummularia creeping loosestrife
Lythrum salicaria purple loosestrife
Magnolia kobus Kobus magnolia
Microstegium vimineum Japanese stilt grass
Miscanthus sinensis Chinese silver grass
Murdannia keisak marsh dewflower
Myriophyllum aquaticum parrot's-feather
Ornithogalum umbellatum Star-of-Bethlehem
Pachysandra terminalis pachysandra
Persicaria longiseta/Polygonum cespitosum longbristle
Persicaria perfoliata/Polygonum perfoliatum mile-a-minute
Phalaris arundinacea reed canary grass
Photinia villosa oriental redtip
Phragmites australis subsp. australis common reed
Phyllostachys aurea bamboo
Pinus thunbergiana Japanese black pine
Poa trivialis rough bluegrass
Pyrus calleryana Callery pear
Quercus acutissima sawtooth oak
Reynoutria japonica/ Polygonum cuspidatum Japanese knotweed
Rhodotypos scandens jetbead
Rosa multiflora multiflora rose
Rubus phoenicolasius wineberry
Rubus triphyllus three-leaf blackberry
Schoenoplectus mucronatus/Scirpus mucronatus alien bulrush
Sorghum halepense Johnson grass
Thlaspi alliaceum roadside penny-cress
Typha angustifolia narrowleaf cattail
Urtica dioica subsp. dioica stinging nettle
Viburnum dilatatum exotic arrow-wood
Viburnum setigerum tea viburnum
Vinca minor lesser periwinkle
Wisteria sinensis Chinese wisteria

APPENDIX C – Nutrient Enrichment Indicator Species List

Scientific Name	Common Name
Amaranthus spp.	pigweed's
Ambrosia spp.	ragweed's
Arctium spp.	burdock's
Artemisia spp.	wormwood's
Azolla caroliniana	eastern mosquito-fern
Barbarea spp.	mustard's
Betula nigra	river birch
Bidens spp.	tickseed sunflowers
Brassica spp.	mustard's
Carex annectens	yellow-fruited sedge
Carex frankii	Frank's sedge
Carex vulpinoidea	fox sedge
Chenopodium spp.	goosefoot's
Conyza canadensis	mare's tail
Cornus amomum	silky dogwood
Cyperus spp.	flatsedges and nutsedges
Decodon verticillatus	hairy swamp loosestrife
Echinochloa spp.	barnyard grasses
Eleocharis obtusa	blunt spike-rush
Eupatorium capillifolium	small dog-fennel thoroughwort
Hibiscus moscheutos	swamp rosemallow
Iris pseudacorus	yellow iris
Juncus effusus	smooth rush
Leersia oryzoides	rice cutgrass
Ludwigia spp.	seedboxes
Microstegium vimineum	Japanese stilt grass
Murdannia keisak	marsh dewflower
Nuphar advena	spatterdock
Panicum dichotomiflorum	spreading panic grass
Phalaris arundinacea	reed canary grass
Phragmites australis	alien common reed
Phytolacca americana	common pokeweed
Poa trivialis	rough bluegrass
Polygonum spp.	smartweed and knotweeds
Populus heterophylla	swamp cottonwood
Rumex verticillatus	swamp dock
Salix nigra	black willow
Saururus cernuus	lizard's tail
Solanum dulcamara	climbing nightshade
Sonchus spp.	sowthistle's
Sparganium spp.	bur-reeds
Typha angustifolia	narrow-leaf cattail
Typha latifolia	broadleaf cattail
Utricularia macrorhiza	large bladderwort
Xanthium spp.	cockleburs

APPENDIX D – Horizontal Limiting Distance for BAF

Table 1: Horizontal limiting distance in feet for BAF 10 point-sampling instruments

DBH, cm	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
12	3.96	3.99	4.03	4.06	4.09	4.13	4.16	4.19	4.22	4.26
13	4.29	4.32	4.36	4.39	4.42	4.46	4.49	4.52	4.55	4.59
14	4.62	4.65	4.69	4.72	4.75	4.79	4.82	4.85	4.88	4.92
15	4.95	4.98	5.02	5.05	5.08	5.12	5.15	5.18	5.21	5.25
16	5.28	5.31	5.35	5.38	5.41	5.45	5.48	5.51	5.54	5.58
17	5.61	5.64	5.68	5.71	5.74	5.78	5.81	5.84	5.87	5.91
18	5.94	5.97	6.01	6.04	6.07	6.11	6.14	6.17	6.20	6.24
19	6.27	6.30	6.34	6.37	6.40	6.44	6.47	6.50	6.53	6.57
20	6.60	6.63	6.67	6.70	6.73	6.77	6.80	6.83	6.86	6.90
21	6.93	6.96	7.00	7.03	7.06	7.10	7.13	7.16	7.19	7.23
22	7.26	7.29	7.33	7.36	7.39	7.43	7.46	7.49	7.52	7.56
23	7.59	7.62	7.66	7.69	7.72	7.76	7.79	7.82	7.85	7.89
24	7.92	7.95	7.99	8.02	8.05	8.09	8.12	8.15	8.18	8.22
25	8.25	8.28	8.32	8.35	8.38	8.42	8.45	8.48	8.51	8.55
26	8.58	8.61	8.65	8.68	8.71	8.75	8.78	8.81	8.84	8.88
27	8.91	8.94	8.98	9.01	9.04	9.08	9.11	9.14	9.17	9.21
28	9.24	9.27	9.31	9.34	9.37	9.41	9.44	9.47	9.50	9.54
29	9.57	9.60	9.64	9.67	9.70	9.74	9.77	9.80	9.83	9.87
30	9.90	9.93	9.97	10.00	10.03	10.07	10.10	10.13	10.16	10.20
31	10.23	10.26	10.30	10.33	10.36	10.40	10.43	10.46	10.49	10.53
32	10.56	10.59	10.63	10.66	10.69	10.73	10.76	10.79	10.82	10.86
33	10.89	10.92	10.96	10.99	11.02	11.06	11.09	11.12	11.15	11.19
34	11.22	11.25	11.29	11.32	11.35	11.39	11.42	11.45	11.48	11.52
35	11.55	11.58	11.62	11.65	11.68	11.72	11.75	11.78	11.81	11.85
36	11.88	11.91	11.95	11.98	12.01	12.05	12.08	12.11	12.14	12.18
37	12.21	12.24	12.28	12.31	12.34	12.38	12.41	12.44	12.47	12.51
38	12.54	12.57	12.61	12.64	12.67	12.71	12.74	12.77	12.80	12.84
39	12.87	12.90	12.94	12.97	13.00	13.04	13.07	13.10	13.13	13.17
40	13.20	13.23	13.27	13.30	13.33	13.37	13.40	13.43	13.46	13.50
41	13.53	13.56	13.60	13.63	13.66	13.70	13.73	13.76	13.79	13.83
42	13.86	13.89	13.93	13.96	13.99	14.03	14.06	14.09	14.12	14.16
43	14.19	14.22	14.26	14.29	14.32	14.36	14.39	14.42	14.45	14.49
44	14.52	14.55	14.59	14.62	14.65	14.69	14.72	14.75	14.78	14.82
45	14.85	14.88	14.92	14.95	14.98	15.02	15.05	15.08	15.11	15.15
46	15.18	15.21	15.25	15.28	15.31	15.35	15.38	15.41	15.44	15.48
47	15.51	15.54	15.58	15.61	15.64	15.68	15.71	15.74	15.77	15.81
48	15.84	15.87	15.91	15.94	15.97	16.01	16.04	16.07	16.10	16.14
49	16.17	16.20	16.24	16.27	16.30	16.34	16.37	16.40	16.43	16.47
50	16.50	16.53	16.57	16.60	16.63	16.67	16.70	16.73	16.76	16.80
51	16.83	16.86	16.90	16.93	16.96	17.00	17.03	17.06	17.09	17.13
52	17.16	17.19	17.23	17.26	17.29	17.33	17.36	17.39	17.42	17.46
53	17.49	17.52	17.56	17.59	17.62	17.66	17.69	17.72	17.75	17.79
54	17.82	17.85	17.89	17.92	17.95	17.99	18.02	18.05	18.08	18.12
55	18.15	18.18	18.22	18.25	18.28	18.32	18.35	18.38	18.41	18.45
56	18.48	18.51	18.55	18.58	18.61	18.65	18.68	18.71	18.74	18.78
57	18.81	18.84	18.88	18.91	18.94	18.98	19.01	19.04	19.07	19.11
58	19.14	19.17	19.21	19.24	19.27	19.31	19.34	19.37	19.40	19.44
59	19.47	19.50	19.54	19.57	19.60	19.64	19.67	19.70	19.73	19.77
60	19.80	19.83	19.87	19.90	19.93	19.97	20.00	20.03	20.06	20.10
61	20.13	20.16	20.20	20.23	20.26	20.30	20.33	20.36	20.39	20.43
62	20.46	20.49	20.53	20.56	20.59	20.63	20.66	20.69	20.72	20.76
63	20.79	20.82	20.86	20.89	20.92	20.96	20.99	21.02	21.05	21.09

64	21.12	21.15	21.19	21.22	21.25	21.29	21.32	21.35	21.38	21.42
65	21.45	21.48	21.52	21.55	21.58	21.62	21.65	21.68	21.71	21.75
66	21.78	21.81	21.85	21.88	21.91	21.95	21.98	22.01	22.04	22.08
67	22.11	22.14	22.18	22.21	22.24	22.28	22.31	22.34	22.37	22.41
68	22.44	22.47	22.51	22.54	22.57	22.61	22.64	22.67	22.70	22.74
69	22.77	22.80	22.84	22.87	22.90	22.94	22.97	23.00	23.03	23.07
70	23.10	23.13	23.17	23.20	23.23	23.27	23.30	23.33	23.36	23.40
71	23.43	23.46	23.50	23.53	23.56	23.60	23.63	23.66	23.69	23.73
72	23.76	23.79	23.83	23.86	23.89	23.93	23.96	23.99	24.02	24.06
73	24.09	24.12	24.16	24.19	24.22	24.26	24.29	24.32	24.35	24.39
74	24.42	24.45	24.49	24.52	24.55	24.59	24.62	24.65	24.68	24.72
75	24.75	24.78	24.82	24.85	24.88	24.92	24.95	24.98	25.01	25.05
76	25.08	25.11	25.15	25.18	25.21	25.25	25.28	25.31	25.34	25.38
77	25.41	25.44	25.48	25.51	25.54	25.58	25.61	25.64	25.67	25.71

APPENDIX E – Stressor Weights for Delaware's Coastal Plain

Updated June 2010	Weights		
Description	**Flats**	**River**	**Dep**
Habitat Category			
Forest Age and Harvest History			
Forest age 31-50 years	0	0	0
Forest age 16-30 years and/ or <10% clear cut	5	4	2
Forest age < 15 years and /or > 10% clear cut	19	7	12
Forest Management (managed or converted to pine and/ or chemical defoliation)	5	9	1
Vegetation Alteration (mowing, farming, grazing, cleared not recovering, other clearing)	15	3	24
Excessive Herbivory/ Pinebark Beetle/Gypsy	4	2**	2**
Invasive Species			
Dominating site (>50%)	2**	20	7
NOT dominating (<50%)	0*	5	7
Nutrients (algal mats or dominated by indicator species)	10	12	10
Road within AA (non-elevated, elevated, paved)	2	2**	2**
Hydrology Category			
Ditching (Flats and Depressions only)			
Slight or moderate	10		5
Severe	17		5**
Stream Channel Condition (Riverine Only)			
Channelized stream not maintained		13	
Channelized with spoil banks on one or both sides		31	
Natural channel incised		21	
Flooding weir/dam/road decreasing or increasing flooding of site	2**	17	2**
Stormwater Inputs (stormwater, point source, sedimentation)	2**	2**	2**
Filling, Excavation			
<10%	2	0*	8
10-75% or >75%	2	12	19
Microtopography alterations and subsidence			
Microtopography alterations <10% and/ or subsidence	7	0*	0*
Microtopography alteration >10% (10-75%, >75%)	16	11	2**
Buffer Category			
1 Buffer Stressor	3	1	4
2 Buffer Stressors	6	2	8
>3 Buffer Stressors	9	3	12
Intercept	95	91	82
R-square	0.83	0.87	0.67

Note: stressors weights that are hashed out are not used for that wetland type.

**Stressor did not show correlation with condition based on existing data set and receives a zero weight. We will continue to collect information to further evaluate.*

*** Sample size of the occurrence of this stressor was too low to determine a correlation with wetland condition. Currently given the minimum weight of a lesser stressor until more data are collected. These stressors were not included in the final regression. .*

Appendix B

Mid-Atlantic Tidal Wetland Rapid Assessment Method

Version 4.1

June 2017

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METHOD DEVELOPMENT

The Mid-Atlantic Tidal Wetland Rapid Assessment Method was developed as part of a collaborative effort among the Delaware Department of Natural Resources and Environmental Control, Maryland Department of Natural Resources, and the Virginia Institute of Marine Sciences to assess the condition of tidal wetlands in the Mid-Atlantic region. We are very grateful to the developers of the New England Rapid Assessment Method (NERAM) and the California Rapid Assessment Method (CRAM) from which we borrowed metrics, indicators, and index development. We would like to thank Erin McLaughlin from the Maryland Department of Natural Resources Riparian and Wetland Restoration Services and Kirk Havens from the Virginia Institute of Marine Sciences Center for Coastal Resources Management for helping with the development of these metrics.

This protocol was originally developed based on data collected in the Indian River watershed (DE), Nanticoke watershed (MD), and York River watershed (VA) in 2006 and 2007. We collected a range of data including vegetation composition and structure, soil attributes, above and below ground biomass, soil stability, macroinvertebrate composition, bird community composition, hydrology, surrounding land use, and stressors. Additionally, we used both the NERAM and CRAM on the same sites. Based on our data analysis we selected metrics from both NERAM and CRAM that were suitable to the Mid-Atlantic region and were able to discriminate sites along a disturbance gradient. The scaling of individual metrics was then adjusted to fit the range of conditions found in Mid-Atlantic tidal wetlands. In 2010, we updated the metric content and scaling based on additional assessments in the Inland Bays, St. Jones River, and Murderkill River watersheds in Delaware. **This protocol is a living document and will continue to be updated periodically as we collect more information and continue to learn more about tidal wetland processes and stressors and how these impact the ecological integrity or condition of wetlands.**

The overall formatting follows that of CRAM to depict the major wetland attributes including Plant Community (biotic and physical structure), Hydrology, and Buffer. Each metric is given a score between 3 and 12 and then combined into attribute scores by summing the metric scores and dividing by the total possible value, depending on the number of metrics in that group. That value is adjusted to be on a 0-100 scale since each metric can only score a minimum of 3:

$$\text{Buffer} = ((((\sum(B1 \ldots B5))/60)*100)-25)/75)*100$$
$$\text{Hydrology} = ((((\sum(H1 \ldots H3))/36)*100)-25)/75)*100$$
$$\text{Habitat} = ((((\sum(HAB1 \ldots HAB5))/60)*100)-25)/75)*100$$

Final MidTRAM condition scores range from 0-100 and are calculated by averaging the 3 attribute group scores:

$$\text{MidTRAM} = ((\text{Buffer} + \text{Hydrology} + \text{Habitat})/3)$$

CHANGES IN THIS VERSION

In Version 4.1 changes were made to several metrics to reflect a growing reference data set. Some metrics were removed and replaced with metrics that better reflect wetland conditions.

Also the method was updated to represent natural conditions in tidal freshwater wetland sites. Data and scores from 341 sites in 10 watersheds throughout Delaware, New Jersey, and Pennsylvania were used to evaluate metric performance and scoring variation. Version 4.1 attempts to minimize user subjectivity and clarify instructions on how metrics should be performed. Metric scoring has been updated to represent the range of conditions in all watersheds to date.

There were changes made to several buffer metrics. B1, Percent of Assessment Area Perimeter with 10m Buffer, increased from 5m to 10m because using 5m captured very little scoring variation. Increasing to 10m separated sites more effectively. B2 changed from Buffer Width measured by averaging 8 'spokes' around the AA to Natural Land Uses in the 250m Buffer, which measures the proportion of the buffer area that is in a natural state. This change better represents land use in the entire buffer area and removes user variation related to placing the measured 'spokes'. Metric B3, High Impact Land Uses in the Buffer, changed from estimating the percent of surrounding development from an aerial image to a calculation completed by using the most recent Land Use Land Cover (LULC) data and clipping it to the 250m buffer in GIS. Although this adds to office time, it removes user variability. In the 250m Landscape Condition metric (B4), the scoring descriptions were updated to add mention of point source inputs such as agricultural ditches, storm water ponds, and polluted sources.

For Hydrology metrics, Point Sources (H1) was removed as a tidal saltwater wetland metric due to low occurrences in the reference data set. Point Sources remains a metric for tidal freshwater sites only. Ditching and Excavation (H1) and Fill (H2) now include more detailed scoring descriptions with an added emphasis on measuring the width and length of the ditches and the area of any fill piles. Ditching and Excavation is scored for saltwater sites only; it is not scored as a metric for tidal freshwater sites because of extremely low occurrence in the reference dataset. The updated Wetland Diking and Tidal restriction (H3) metric now includes field examples for the scoring descriptions instead of an estimation of the effect of the stress.

Several changes were made to the Habitat metrics as well. Scoring for Bearing Capacity (HAB1) was updated to include separate scoring scales for tidal saltwater sites and tidal freshwater sites, as analysis of reference data showed a significant difference in bearing capacity between these habitat types. For Horizontal Vegetative Obstruction (HAB2), measurements at heights 1.0m and 1.25m were added to capture conditions in very tall vegetation. The scoring was updated to incorporate the 8 additional measurements per site when necessary. A scoring table for tidal saltwater sites is provided, but scoring for tidal freshwater sites is still under development. The Plant Community Worksheet was redone to reduce both user confusion and repetition. The Number of Plant Layers (HAB3) was simplified into a checklist. Percent Co-dominant Invasive Species (HAB4) was removed and replaced with a Plant Species Richness checklist. Percent Invasive Cover (HAB5) remains unchanged.

USE OF METHOD

This method was developed for the primary purpose of assessing the condition of tidal wetlands at the watershed scale using a probabilistic survey. Therefore, the assessment is based on the evaluation of a fixed area of tidal wetland (50m radius circle). We believe that the method also has wider applicability for other uses. Multiple assessment areas may be required to assess larger areas to accurately depict the condition of the site.

***The development team would appreciate any feedback from users on how they are using the method, the applicability in different areas, and suggestions for improvement.**

A. Time and Effort Involved

The time to sample a site with MidTRAM will vary depending on the number of field crewmembers, the familiarity with MidTRAM, and site conditions. Based on our experience, a trained crew of 2-3 people requires approximately 1-2 hours to complete the method once on site.

B. Experience and Qualifications Needed

MidTRAM should only be performed by individuals who have completed a training course on how to properly perform this method. Users of this method should have experience in the identification of tidal wetlands, an understanding of the various stressors that impact different wetland types, native flora of the region, and soil properties. For information on training opportunities contact one of the program contacts listed above.

FIELD PREPARATION

A. Landowner Permission

Permission should be obtained before accessing private property. Our experience is that if contact can be made with the landowner there is a high probability that they will allow access to their property. Georeferenced parcel data can be obtained through the state intranet for Delaware and landowner information can be found using the following websites:

Delaware Counties

Sussex County: **http://www.sussexcountyde.gov**

Kent County: **http://www.co.kent.de.us**

New Castle County**:** **http://www.nccde.org/defaulthome/home/webpage1.asp**

Maryland Counties

http://sdatcert3.resiusa.org/rp_rewrite/

Virginia Counties

http://www.dof.virginia.gov/gis/parcel-data.shtml

B. Field Map Production

Field maps should be produced before the initial site visit. They should include the outline of the 50m assessment area(AA), the outline of the 250m buffer area, NWI or state wetland boundaries, and roads including names if applicable. If an unusual feature exists in the AA or 250m buffer, review and print older maps to convey site history and disturbance considerations. Maps should illustrate the site at multiple levels and dates:

- Wetlands and hydrology (1:2,000)
- Wetlands and hydrology (1:24,000)
- Tax parcels (1:5,000)
- Road map (1:24,000)
- Soils (1:5,000)
- Old aerial photos as available dating back several decades (1:3,000)

C. Equipment List

Printed protocol	Plastic folding ruler
GPS	Compass
Printed Maps	Datasheets
Clipboard	Pencils
Guide to identifying tidal wetland plants	Sunscreen
Shovel	Slide Hammer & PVC
Two 100m Tapes	Vegetation Profile Board
Waders	YSI
Two 1.25m marked PVC veg height poles	Water
Camera	

CLASSIFICATION OF TIDAL WETLANDS

Because this assessment method is only appropriate for tidal wetlands, it is first important to determine whether a site is tidal or non-tidal. Tidal wetlands can then be further broken down into subclasses. See the key below to determine which subclass a wetland site belongs to.

Key to determining tidal wetland subclass in the Mid-Atlantic region (see Figure 1)

I. Is the wetland influenced by tidal cycles from a bay or ocean?
   A. No—site is non-tidal; please refer to the Delaware Rapid Assessment Protocol (DERAP) for assessment methods for non-tidal wetlands
   B. Yes—go to step II

II. Is the wetland bordered by ocean on at least one side?
   A. Yes—Marine Tidal
   B. No—go to step III

III. Is the wetland located on the estuary side of a barrier island?
   A. Yes—Back Barrier Estuarine Tidal
   B. No—go to step IV

IV. Is the wetland a narrow fringing marsh along the estuary, bay, or tidal river?
   A. Yes—Fringing Tidal
   B. No—Expansive Tidal

Figure 1. Examples of tidal wetland classification (L to R): tidal freshwater, fringing, expansive, and back barrier.

Table 1. Factors to consider when classifying fringing tidal and expansive tidal wetlands as tidal freshwater or brackish/saltwater.

	Tidal Fresh	Tidal Salt/Brackish
Salinity	≤2.0 ppt	> 2.0 ppt
Plant community	Dominated by tidal fresh plant species (see Table 2a)	Dominated by tidal salt/brackish species (see Table 2b)
Cowardin Maps	Palustrine wetlands with tidal modifiers (S, Q, R, T, V=freshwater tidal)	Estuarine wetlands
LLWW Maps	Palustrine wetlands with tidal waterbody type modifier ("5"=tidal) and tidal water flowpath modifier ("BT"=bidirectional-tidal)	Estuarine wetlands
Final subclass classification	**Expansive Palustrine Tidal** or **Fringing Palusrine Tidal**	**Expansive Estuarine Tidal** or **Fringing Estuarine Tidal**

Once a tidal wetland is classified as fringing tidal or expansive tidal, the next step is to determine whether the site is tidal freshwater (i.e. palustrine tidal) or brackish/saltwater (i.e. estuarine). **This determination can be made using best professional judgement by examining three factors (Table 1): salinity, dominant plant community (Tables 2a, b, c), and wetland maps. Once these factors are considered, wetlands can be classified as expansive palustrine tidal, fringing palustrine tidal, expansive estuarine tidal, or fringing estuarine tidal (Table 1).**

The first factor that should be considered is the salinity of the surface or creek water. For the purpose of this protocol, anything 2.0 ppt or below is considered tidal freshwater, and anything greater than 2.0 ppt is considered brackish/saltwater. This cutoff point was chosen using field data collected from tidal freshwater wetlands in Delaware, Pennsylvania, and New Jersey. These data showed that a salinity of 2.0 ppt was a breaking point, at or below which tidal freshwater plant communities dominated, and above which brackish/saltwater plant communities dominated. Surface water salinity, however, can be variable because of influences such as tides, droughts, or storm events. As such, other factors should be considered in combination with salinity to make the most accurate determination possible.

The second factor to consider is the dominant plant community in the wetland (Table 1). Many plant species are sensitive to salinity and only exist in lower salinity environments. Because you are only taking one reading, and salinity can be variable, plant communities are likely to provide a better idea of the salinity regime in an area. Below are lists of plants that are commonly found in tidal freshwater environments (Table 2a), brackish/saltwater environments (Table 2b), and plants that are more versatile and can exist in both tidal fresh and brackish/saltwater environments (Table 2c). Note that this is not an all-inclusive list, and that this list can be supplemented with a wetland plant field guide. If a combination of freshwater tidal and brackish/saltwater plants is present in a wetland, determine which community type is dominant (i.e. >50% cover). Note in particular the presence or absence of smooth cordgrass (*Spartina alterniflora*)*;* this plant tends to dominate brackish/saltwater wetlands, whereas it is absent from most tidal freshwater wetlands (although it can be present in tidal freshwater wetlands, it is not likely dominant).

The third factor to consider is how the site is classified on a wetland map. Take note to see if wetlands are mapped as freshwater (palustrine) or brackish/saltwater (estuarine) environments, and see if freshwater habitats have tidal modifiers (Table 1). It may also be useful to map the salt line (i.e. the boundary between freshwater and saltwater) if data are available to see what salinity regime the site is likely to have. Maps should only be used as a supplement to salinity readings and plant community observations in the field, however, as sometimes wetlands are incorrectly classified on wetland maps.

Table 2a. Common Mid-Atlantic plant species of tidal freshwater wetlands.

Common Plants of Tidal Freshwater Wetlands	
Common name	**Scientific name**
Swamp milkweed	*Asclepias incarnata*
Smooth beggartick	*Bidens laevis*
River bulrush	*Bolboschoenus fluviatilis*
Jewelweed	*Impatiens capensis*
Common rush	*Juncus effusus*
Rice cutgrass	*Leersia oryzoides*
Spatterdock	*Nuphar luteum*
Arrow arum	*Peltandra virginica*
Halberdleaf tearthumb	*Polygonum arifolium*
Dotted smartweed	*Polygonum punctatum*
Pickerelweed	*Pontederia cordata*
Broadleaf arrowhead	*Sagittaria latifolia*
Softstem bulrush	*Scirpus tabernaemontani*
Narrowleaf cattail	*Typha angustifolia*
Broadleaf cattail	*Typha latifolia*
Annual wild rice	*Zizania aquatica*

Table 2b. Common Mid-Atlantic plant species of brackish/saltwater wetlands.

Common Plants of Tidal Saltwater/Brackish Wetlands	
Common name	**Scientific name**
Triangle orache	*Atriplex prostrata*
Saltmarsh bulrush	*Bolboschoenus robustus*
Spikegrass	*Distichlis spicata*
Dwarf spike-rush	*Eleocharis parvula*
Marsh elder	*Iva frutescens*
Black grass	*Juncus gerardii*
Seashore mallow	*Kosteletzkya virginica*
Northern sea lavendar	*Limonium carolinianum*
Sweetscent	*Pluchea odorata*
Virginia glasswort	*Salicornia virginica*
Seaside goldenrod	*Solidago sempirvirens*
Smooth cordgrass	*Spartina alterniflora*
Salt meadow hay	*Spartina patens*

Table 2c. Common Mid-Atlantic plant species that can be found in tidal fresh, brackish, and saltwater wetlands.

Common Plants of Tidal Fresh, Brackish, and Saltwater Wetlands	
Common name	**Scientific name**
Water hemp	*Amaranthus cannabinus*
Sea myrtle	*Baccharis halimifolia*
Rose mallow	*Hibiscus moscheutos*
Switchgrass	*Panicum virgatum*
Common reed	*Phragmites australis*
Big cordgrass	*Spartina cynosuroides*

ESTABLISHING THE ASSESSMENT AREA

The Assessment Area (AA) is the area within a tidal wetland that will be sampled using MidTRAM. Data collection will be performed in the AA or in the adjacent buffer to the AA. The center point of the AA is either randomly located when using a probabilistic sampling design or can be subjectively selected based on the goals of the assessment.

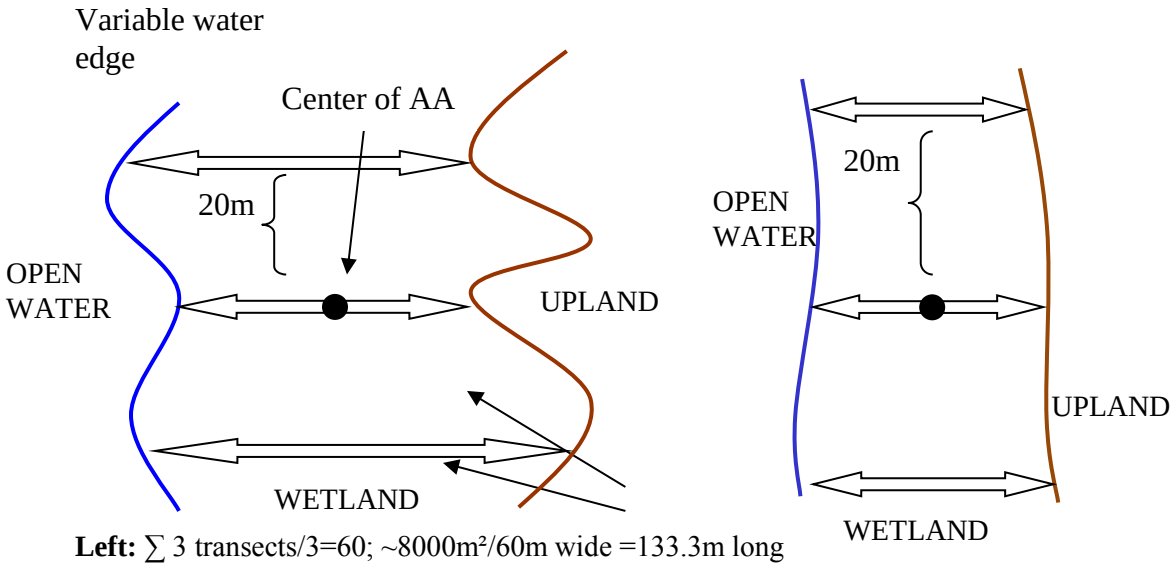
- Establish the center of the AA by marking a map, creating a point on the GPS and writing the coordinates on the datasheet.
- Establish the AA as a 50-m radius circle centered on the sample point (0.8ha=8,000m^2 area). Using two 100m tapes, run one transect perpendicular from the open water edge to the upland edge, and locate the 2nd transect perpendicular to the first. Walk the tapes out from the center with the tapes on the right side. Look ahead to an approximate destination and try not to trample the wetland surface on the right. Walk back to the center point keeping the tapes on the left.

Helpful tips: Walk away from center with tapes on the right, walk towards center with tapes on the left. This will prevent walking through and trampling areas that will become the AA subplots. Leave the tape reel in the direction you will exit the wetland to save walking time and energy.

A. Moving or adjusting the location and/or dimensions of the AA

Several situations may occur that would require that the AA to be positioned differently than above. The following circumstances are for adjustments during a probabilistic survey site. **If the location of the AA is moved or adjusted, be sure to make detailed notes on the datasheet explaining why the AA was moved, by how far, in what direction, and record the new lat/long.**

1. If the wetland does not extend 50m in all directions without touching upland or if >10% of the AA would include a natural open water feature (water >30m wide):
   - Move the center point *the least necessary distance* <50m until the entire AA is within the wetland boundaries.
   - If >50m is needed the site should be rejected for a probabilistic survey.
   - If moving the AA away from upland or open water on one side results in a conflict on the other side see item 4 below.
2. If the AA is within or contains a naturally occurring upland inclusion in the wetland:
   - If the upland inclusion is due to a disturbance (e.g. a pile of fill) do not move the center of the AA because you want to include the disturbance in the assessment.
   - If the original point is determined to be natural upland, examine the entire 50m radius circle around the original point for a wetland.
     - If a wetland is found within this area, move the center point *the least distance necessary* <50m to establish an AA entirely in the wetland.
     - If no wetland is found within the bounds of the original AA, the site should be dropped and recorded as upland for a probabilistic survey.
3. If the wetland is ≤ 0.8ha (8,000m²):
   - The AA becomes the same size as the wetland. Detail this carefully in the site sketch.
4. If the wetland is ≥0.8ha, but is oddly shaped and 50m radius will not fit without touching upland or without covering >10% natural open water (800m^2; Figure 2):
   - Configure the AA as a 0.8ha rectangle positioned long ways across the wetland with the width being from the edge of the open water to the upland. Find the average wetland width by measuring 3 transects, at least 20m apart, perpendicular from the open water to the upland. This average will be the width of the AA. Use the calculated average width to determine the length of your rectangle to equal 0.8ha.
   - Rectangle should be no longer than 150m long due to habitat variability and may be curved to fit along upland and open water edges. Note the new dimensions and shape of the AA on the datasheet.



Left: ∑ 3 transects/3=60; ~8000m²/60m wide =133.3m long
Right: ∑ 3 transects/3=75; ~8000m²/75m wide =106.6m long

Figure 2. Illustration of how to determine the dimensions of a rectangular AA. Use the average distance between the channel edge and upland as determined from the 3transects to calculate length and achieve a 0.8 ha rectangle.

B. Locating subplots within the AA

Subplots will all be located within the 0.8ha assessment area to assess vegetation structure and bearing capacity.

1. Circle plot (Figure 3)
   - Eight 1m^2 subplots will be placed along two 100m transects, dissecting the AA perpendicularly.
   - Subplots should be placed 25m and 50m from the center of the AA along each transect.
   - Subplots should be located in a dominant vegetation type of the AA (makes up ≥10% cover in the AA). If the given plot is *not* representative of a dominant vegetation type (< 10% cover in the AA; e.g., on a small mud flat or in a ditch), move the sub-plot 1 meter along the transect and note the new location.
2. Rectangle plot (Figure 4)
   - Eight 1m^2 subplots will be placed along three transects within the AA, within a dominant vegetation type (covering ≥10% of AA).
   - Divide the AA in half length-wise, and into thirds width-wise.
   - Spread the 8 subplots out along the transects depending on the size of the rectangular AA, with 6 subplots along the outside edges and 2 subplots where the transects cross.
   - If the given plot is *not* representative of a dominant vegetation type (< 10% cover in the AA; e.g., on a small mud flat or in a ditch), move the subplot 1 meter along the transect and note the new location.

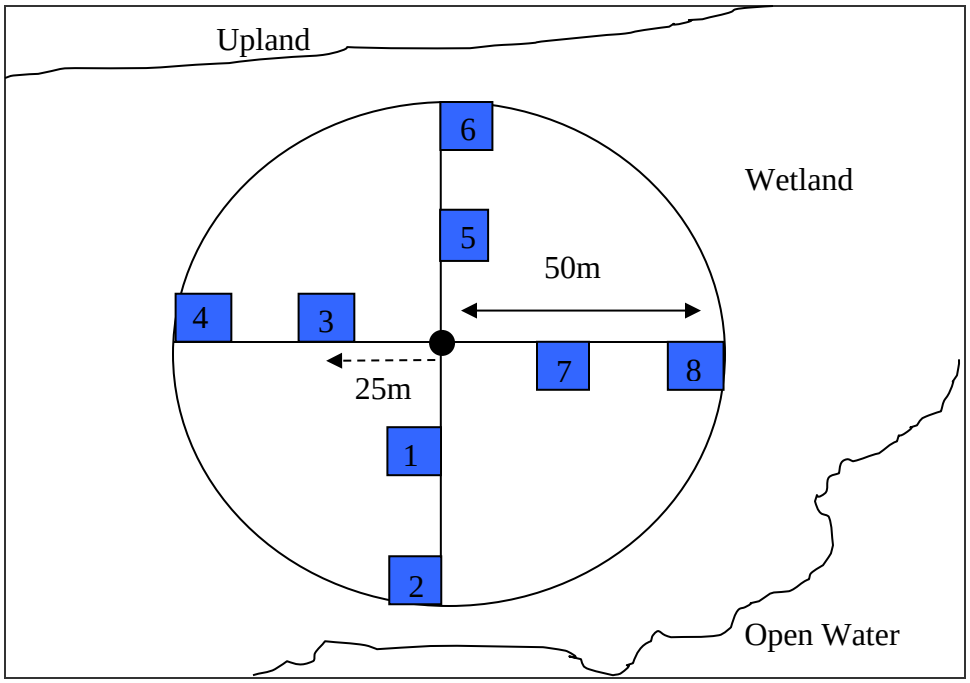


Figure 3: Location of Subplots in a circular assessment area.

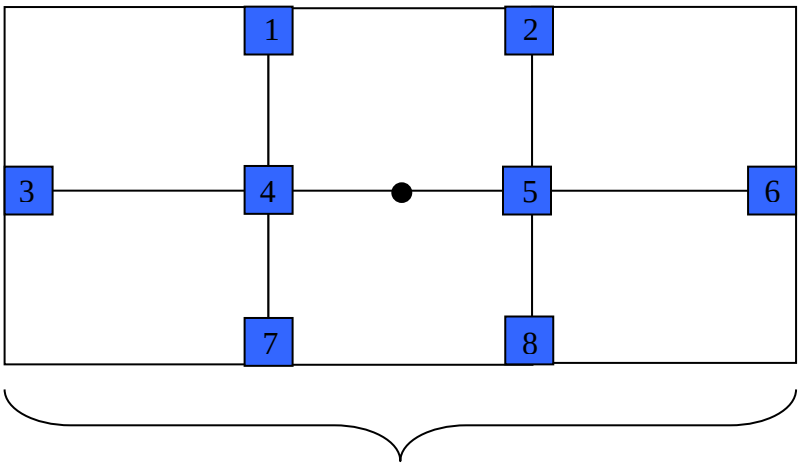


Figure 4. Location of Subplots in a rectangular assessment area.

METRIC DEFINITIONS

Table 3. Overview of metrics in the buffer/landscape, hydrology, and habitat attribute categories.

Attribute	***Metric***	***Description***
Buffer 1	Percent of AA Perimeter with 10m-Buffer	Percent of AA perimeter that has at least 5m of natural or semi-natural condition land cover that is at least 10m in width
Buffer 2	Natural Land Use in Buffer	Percent of the buffer area that is contiguous between the AA and 250m buffer edge and in a natural or semi-natural state
Buffer 3	Altered and High Impact Land Use	Percent of the buffer area that is an altered or high impact land use
Buffer 4	250m Landscape Condition	Landscape condition within 250m surrounding the AA center point based on the nativeness of vegetation, disturbance to substrate and extent of human visitation
Buffer 5	Barriers to Landward Migration	Percent of landward perimeter of wetland within 250m that has physical barriers preventing wetland migration inland
Hydrology 1	Ditching and Excavation (a) **or** Point Sources (b)	The presence of excavated ditches or OMWM pools in the AA for tidal saltwater sites (a), **or** The presence of point source inputs in tidal freshwater sites (b)
Hydrology 2	Fill	The presence of fill or wetland fragmentation from anthropogenic sources in the AA
Hydrology 3	Diking and Tidal Restriction	The presence of dikes or other tidal flow restrictions
Habitat 1	Bearing Capacity	Soil resistance measured using a slide hammer and veg height poles
Habitat 2	Horizontal Vegetative Obstruction	Visual horizontal obstruction by vegetation at 0.25-1.25m heights measured in 0.25 intervals with a cover board
Habitat 3	Number of Plant Layers	The presence of up to 5 distinct vertical plant zones
Habitat 4	Species Richness	Count of plant species found in the AA
Habitat 5	Percent Invasive Cover	Percent cover of invasive species in the AA

DATA COLLECTION – CHARACTERIZATION METRICS

SITE INFORMATION DATASHEET

Site #
Unique number for the site

Site Name
Select a unique name for the site

Date and Time
Month, day, year, and hour and minutes of start and finish of sampling

Field Crew
All names of the members of the field crew

Reference or Assessment Site
Circle which applies. Reference sites are subjectively selected to provide baseline condition values for a particular geographic area or watershed and are selected to represent the highest and lowest condition for comparison prior to assessing randomly selected sites. Assessment sites can be project related or are randomly selected using a probabilistic sampling design for a watershed study.

Marine Tidal, Back Barrier Estuarine Tidal, Fringing Estuarine Tidal, Expansive Estuarine Tidal, Fringing Palustrine Tidal, Expansive Palustrine Tidal
Based on wetland shape and location – see pages 4-7 for guidance and examples.

Natural, Re-Establishment, Establishment, Rehabilitation, Enhancement
Select appropriate classification based on the below definitions.

Natural- wetland that is un-manipulated

Re-establishment- the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former wetland. Example: re-establishing a previously farmed wetland.

Establishment- the manipulation of the physical, chemical, or biological characteristics present to develop a wetland that did not previously exist on an upland or deepwater site.

Restoration- the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing a degraded wetland to natural condition and historic functions.

Enhancement- the manipulation of the physical, chemical, biological characteristics of a wetland site to heighten, intensify, or improve specific function(s) or for a purpose such as water quality improvement, flood water retention or wildlife habitat. Example: Water control structure impoundments for migratory waterfowl habitat.

Watershed/Sub-Watershed
Watershed and sub-watershed in which the site is located.

Lat/Long
Latitude and longitude coordinates in digital degrees.

AA Moved From Original Location?

The AA should only be shifted the minimum necessary distance from the original point in order to be able to assess the AA. See page 5 for more descriptions. Circle 'yes' or 'no' to indicate if the center of the AA was moved from its original location. If the center was moved, record the reason and the distance that the AA was moved. This only applies to assessment sites that are based on a randomly located point.

Tidal Stage
Tidal stage that best represents the AA during the site visit. Estimate tidal stage based on wrack lines and water marks.

high= 5, mid-high= 4, mean= 3, mid-low= 2, and low= 1

Photos
The photos should be taken from the center point out each transect. Also document prominent stressors. Record the photo id number, time, and relevant comments.

Assessment Area Sketch
Sketch the AA and surrounding area. Include the assessment area, transect orientation, subplots, direction to open water, major habitat features, adjacent land types and note stressors and approximate distances.

Low Marsh/High Marsh
Indicate if the AA in a saltwater/brackish wetland is dominated by low marsh plants (e.g. *Spartina alterniflora,*) or high marsh species (e.g. *Spartina patens, Iva frutescens, Baccharis halmifolia, Juncus gerardii, Distichlis spicata*)

or

Indicate if the AA in a tidal freshwater wetland is dominated by low marsh plant species (e.g. *Nuphar luteum, Pontedaria cordata*) or high marsh species (e.g. *Impatiens capensis, Typha spp., Hibiscus moscheutos, Polygonum arifolium, Leersia oryzoides*)

**Note that marsh zonation tends to be much less distinct in freshwater tidal marshes compared with salt marshes. Many plant species tend to occur in both high marsh and low marsh zones (e.g. *Peltandra virginica, Spartina cynosuroides, Zizania aquatica*). Make a note on the datasheet if low/high marsh cannot be distinguished at a particular tidal freshwater site and describe the plant species distribution in your site sketch.

Distance to Upland
Estimate the distance from the edge of the AA to the closest major upland body (not an island).

Distance to Open Water
Estimate the distance from the edge of the AA to the closest source of open water (>30m wide).

Stability of Assessment Area
Estimate the current physical stability of the wetland within the AA based on the below descriptions.

Healthy & stable- wetland surface is mostly covered by vegetation mats, and vegetation is healthy (green and robust).

Beginning to deteriorate and/or some fragmentation- wetland surface is moderately covered by vegetation root mats with moderate amounts (~25%) unvegetated

unconsolidated muck or open water. Vegetation is showing some signs of stress as indicated by yellowing tips of the vegetation or stunted plants.
Severe deterioration and/or severe fragmentation- wetland surface covered by sparse vegetation root mats with large areas of unvegetated unconsolidated muck or open water. Vegetation is severely stressed as indicated by yellowing or browning of leaves and stems, severely stunted plants, or early senescence of plants in the growing season.

Soil Profile
Extract a soil sample with shovel from the center point area at least 18cm deep. Examine the core and determine the depth of the organic layer using the folding tape measure. Note if organic layer appears to be shallow (<16cm deep) or deep (>16cm deep).

Salinity
Salinity in parts per thousand (ppt) of the surface or creek water using a YSI or other digital water quality instrument. Digital meters are preferred over refractometers because refractometers are generally not as accurate at very low salinities.

Vegetation Communities and Features
After completing the subplot measurements and walking the AA, estimate the percent cover of plant communities and wetland features present in the AA. Use the cover class and midpoint table for assistance. The values will not add up to 100% but should roughly describe the features in the AA. Common species/features are listed; if a vegetation type or wetland feature is present that is not listed, use the "other" box and write in a description of the type/feature. If a vegetation type or feature is not present record a "0". These responses will help guide the plant layer worksheet in the Habitat group for future revisions. The amount of root mat can be affected by deep ditches, hummocks, or mucky ponds. Dead vegetation (e.g. sprayed Phragmites) can be accounted for in 'unhealthy marsh'.

Qualitative Disturbance Rating: To be agreed upon by the entire field crew once the assessment is complete. Through observation of stressors and alterations to the vegetation, soils, and hydrology in the wetland site, and the land use surrounding the site (Table 3), the field crew determines the overall level of disturbance. Observers should use best professional judgment (BPJ) to assign the site a numerical Qualitative Disturbance Rating (QDR) from least disturbed (1) to highly disturbed (6) relative to other sites in the watershed. General description of the minimal disturbance, moderate disturbance, and high disturbance categories are provided below.

Minimal Disturbance Category (QDR 1 or 2): Natural structure and biotic community maintained with only minimal alterations. Minimal disturbance sites have a characteristic native vegetative community unmodified water flow into and out of the site, undisturbed microtopographic relief, and are located in a landscape of natural vegetation (250m buffer). Examples of minimal alterations include a small ditch that is not conveying water, low occurrence of non-native species, individual tree harvesting, and small areas of altered habitat in the surrounding landscape, which does not include hardened surfaces along the wetland/upland interface. Use BPJ to assign a QDR of 1 or 2.

Moderate Disturbance Category (QDR 3 or 4): Moderate changes in structure and/or the biotic community. Moderate disturbance sites maintain some components of minimal disturbance sites such as unaltered hydrology, undisturbed soils and microtopography, intact landscape, or characteristic native biotic community despite some structural or

biotic alterations. Alterations in moderate disturbance sites may include one or two of the following: a large ditch or a dam either increasing or decreasing flooding, mowing, grazing, moderate stream channelization, moderate presence of invasives, forest harvesting, high impact landuses in the buffer, and minimal hardened surfaces along the wetland/upland interface. Use BPJ to assign a QDR of 3 or 4.

High Disturbance Category (QDR 5 or 6): Severe changes in structure and/or the biotic community. High disturbance sites have severe alterations to the vegetative community, hydrology, and/or soils. This can be a result of one or several severe alterations, or more than two moderate alterations. These disturbances lead to a decline in the wetland's ability to effectively function in the landscape. Examples of severe alterations include extensive ditching or stream channelization, recent clear cutting or conversion to a non-native vegetative community, hardened surfaces along the wetland/upland interfaces for most of the site, and roads, excessive fill, excavation, or farming in the wetland. Use PBJ to assign a QDR of 5 or 6.

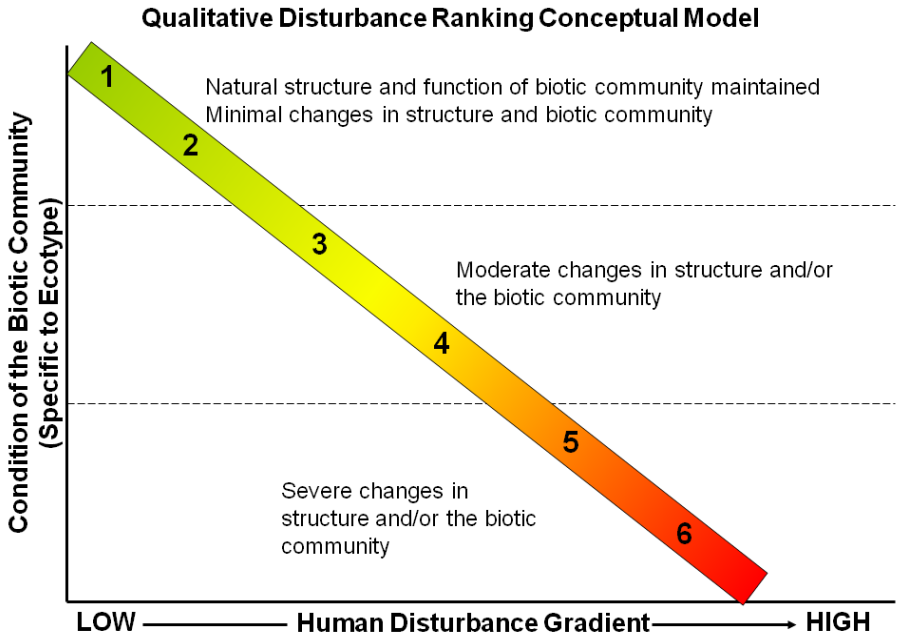


Figure 5. Diagram of narrative criteria for qualitative ranking of disturbance.

Comments

Information that would otherwise be undocumented, such as notations about observed wildlife or local features

Attribute 1: Buffer/Landscape

The area surrounding a wetland is a critical transition zone that is important to the overall health and continued existence of a wetland. The surrounding landscape can control runoff and improve water quality by processing pollutants from upland areas before it enters the wetland. The surrounding landscape will also determine if a wetland has the ability to migrate inland with increasing sea-levels. Wetland buffers can provide protection from adjacent anthropogenic stressors (e.g. development), protect against outside human activities (e.g. farming), and can serve as habitat corridors for movement and recolonization of plants and wildlife.

Five metrics are used to characterize and rate the buffer and surrounding landscape of the assessment area:

1. Percent of assessment area perimeter with a 10m buffer in a natural or semi-natural state
2. Natural land uses surrounding the AA
3. Altered and high impact land uses surrounding the AA
4. Landscape condition surrounding the AA
5. Barriers to landward migration

The following definitions should be used when evaluating metrics in the Buffer/ Landscape Attribute:

Buffer – The buffer is the area adjoining the AA that is in a natural or semi-natural state and is not currently dedicated to anthropogenic uses. To be considered as buffer, a suitable land cover type as defined in Table 4 must be at least 10m wide and extend along the perimeter of the AA for at least 5 m. The buffer width is evaluated out to 250m from the edge of the AA.

Landscape – The surrounding landscape is defined as matrix of land in a natural or semi-natural condition as well as those dedicated to anthropogenic uses within 250m from the edge of the AA.

B1. Percent of Assessment Area Perimeter with 10m Buffer

Metric Source: California Rapid Assessment Method (CRAM), modified
Extent: 10m band around AA edge (3,456 m²)
Definition: The buffer is the area adjoining the AA that is in a natural or semi-natural state and is not currently dedicated to anthropogenic uses. To be considered as buffer, a suitable land cover type as defined below and must be at least 10m wide and extend along the perimeter of the AA for at least 5m.

Assessment Protocol: Using aerial photos or GIS evaluate the land use within 10m of the edge of the AA and determine the percent of the AA perimeter that has a buffer meeting the following criteria:

- Adjacent to the AA
- Natural or semi-natural land use (see Table 4 for examples)
- Is present for at least 5m along the edge of AA

- Not Open Water- open water ≥ 30m wide that is in or adjacent to the AA (e.g. lake, bay, large river, or large slough) is considered to be neutral- neither part of the wetland nor part of the buffer, because although water is natural and undeveloped it can also be a source of stress (e.g. destructive wave energy, erosion).

Follow guidelines below:

- Draw a perimeter around the AA 10m wide.
- Exclude open water from the equation as neither buffer nor non-buffer.
- Consider the rest of the perimeter to be 100%.
- Determine the proportion of the perimeter that is buffer versus non-buffer perimeter. Refer to Table 4 for examples.
- Record the estimated percent and circle the correct score based on the alternative states listed.

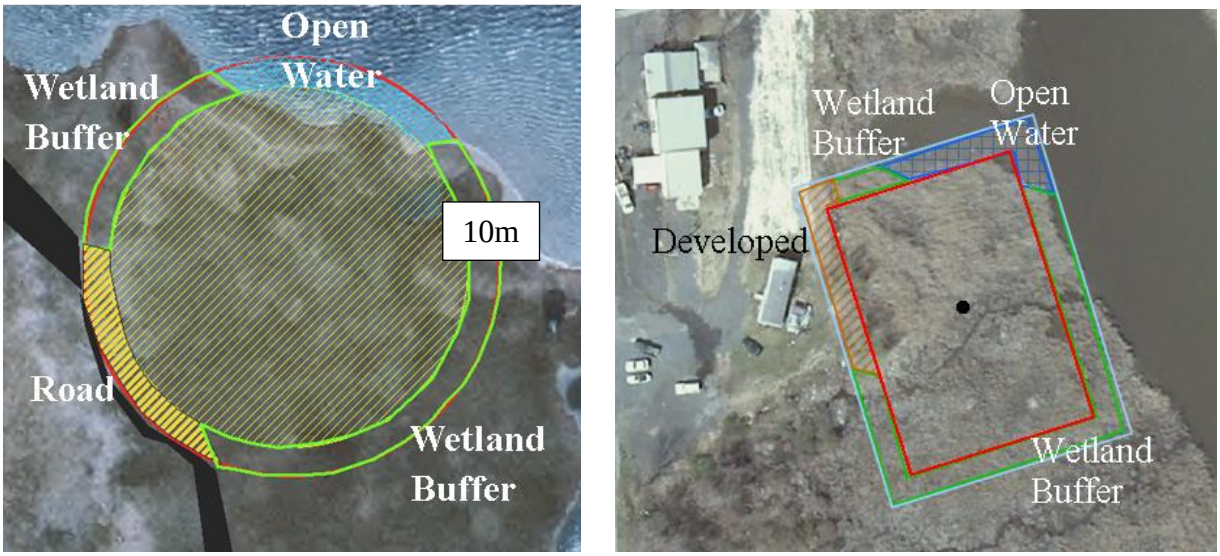


Figure 6: Examples of determining % of AA with 10m buffer. In both examples above, a portion of the perimeter is open water and is not counted. Of the remaining perimeter, 70% is natural wetland buffer, 30% is non-buffer (road or developed).

Table 4: Guidelines for identifying wetland buffers and breaks in buffers.

Examples of Land Covers *Included* in Buffers	**Examples of Land Covers *Excluded* from Buffers** Notes: buffers do not cross these land covers	
bike trails	commercial developments	residential areas
foot trails	fences that interfere with the movement of wildlife	sports fields
horse trails	agriculture	golf courses
natural upland habitats	roads	urbanized parks with active recreation
nature or wildland parks	lawns	pedestrian/bike trails with nearly constant traffic
Raised dock or walkway	parking lots	impoundments or berms

B1 Scoring: Percent of Assessment Area Perimeter with 10m-Buffer

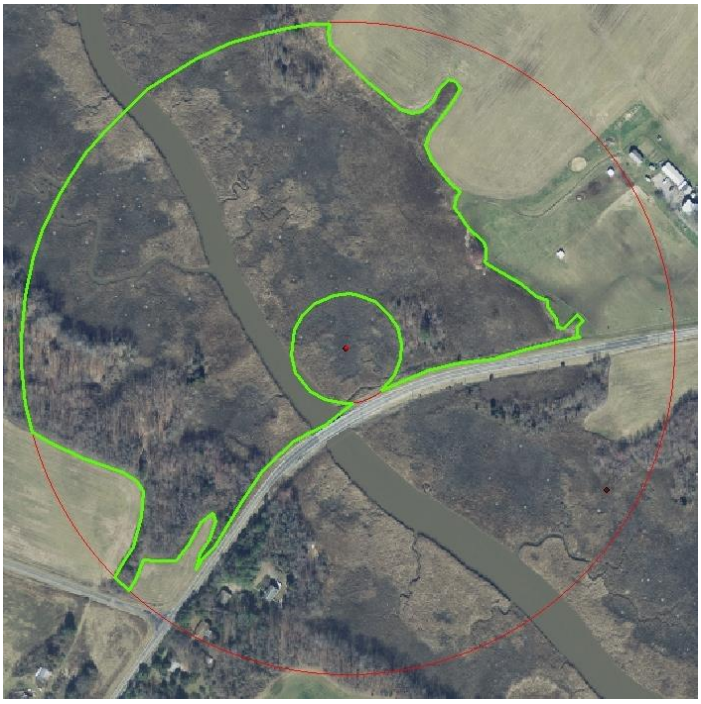
Record Raw Percent _____%	
Alternative States (not including open-water areas)	**Rating (circle one)**
Buffer is 100% of AA perimeter.	**12**
Buffer is 94-99.9% of AA perimeter.	**9**
Buffer is 80-93.9% of AA perimeter.	**6**
Buffer is <80% of AA perimeter.	**3**

B2. Natural Land Uses in Buffer

Metric Source: DNREC/PDE
Extent: 250m buffer (274,889m²)
Definition: This metric assesses the percent of the buffer area that is contiguous between the AA and 250m buffer edge and in a natural or semi-natural state (see Table 1). Desktop determinations should be confirmed in the field to detect recent disturbances, depending on the age of aerial imagery used.

Assessment Protocol:

1. Use the results of B1 and an aerial image of the AA and 250m buffer to determine the areas considered to be buffer. Be sure to exclude open water (≥ 30m wide) and non-buffer habitat.
2. Use the 'draw polygon' tool in ArcMap to create a polygon that includes any adjacent habitat in natural land use. Do not include the AA in your buffer polygon (if the AA falls in your created polygon, subtract 7,854m² from your polygon area). Multiple polygons are not permitted. Non-buffer features should not be crossed.
3. Right click on the polygon to determine the area (m²). Divide that area by total buffer area (274,889m²).
4. Assign a metric score based on the percent buffer area.



Example 1. The natural buffer area extends out to the edge of the ag. field and to the road/bridge. Area inside the green perimeter equals 130,857m² which represents 48% and would be awarded a score of 3.

Example 2. The natural buffer area extends out to the edge of the ag. field, to the river's edge where the distance across is ≥ 30m and across the river to the field edge where the river is < 30m across. The area inside the green perimeter equals 87,505m² which represents 32% and would be awarded a score of 3.

Example 3. The natural buffer area extends out to the edge of the ag field and around to the access road to the field. This polygon contained the AA so 7,854m² would be deleted from the total area. The area inside the green perimeter equals 237,606m² which represents 86% and would be awarded a score of 9.

B2 Scoring: Natural Land Uses in Buffer

Alternative States	Rating (circle one)
100%	**12**
75-99.9%	**9**
55-74.9%	**6**
≤ 54.9%	**3**

B3. Altered and High Impact Land Use between AA Edge and 250m

Metric Source: Delaware Comprehensive Assessment Protocol (DECAP) modified
Extent: 250m buffer (274,889m²)
Definition: Percent of the buffer area in altered or high impact land use
Assessment Protocol: Evaluate the surrounding land from the edge of the AA out to 250m. Use GIS analysis and Table 5 below to find any altered and high impact land uses and calculate the percent of area in each. All high impact land uses are considered altered land uses.

1. Use aerial photo of sites with AA and a 250m buffer from the edge of the AA.
2. Estimate the percent of developed area within 250m of the edge of the AA.
3. Confirm field estimates in office with ArcGIS and the latest land use Land Cover data available.

Table 5. Guidelines for determining altered and high impact land uses.

Examples of Altered Land Uses	Examples of High Impact Land Uses	
Cropland	Residential	Industrial/ Commercial
Fallow Fields	Golf Course	Utilities
Orchards/ Pine Plantation	Park	Railroad
Rangeland	Roads/ Parking Lots	Transitional Lands

B3: Scoring: Land Use Impacts

Area in Altered _____% Area in High Impact _____ %	
Alternative States	**Rating (circle one)**
No Altered or High Impact Land Uses	**12**
0-20% Altered Land Use *and* <5% High Impact Land Use	**9**
20-50% Altered Land Use *and/or* 5-20% High Impact Land Use	**6**
>50% Altered Land Use *or* >20% High Impact Land Use	**3**

B4. 250m Landscape Condition

Metric Source: California Rapid Assessment Method (CRAM), modified
Extent: 250m buffer
Definition: The presence and severity of alterations to the surrounding landscape based on the extent and nativeness of the plant community, disturbance to soil substrate, presence of point source pollution, and human visitation.

Assessment Protocol: Evaluate the landscape condition within 250m of the edge of the AA using aerial photos and field observations. Use professional judgement to assign a metric score.

B4 Scoring: 250m Landscape Condition

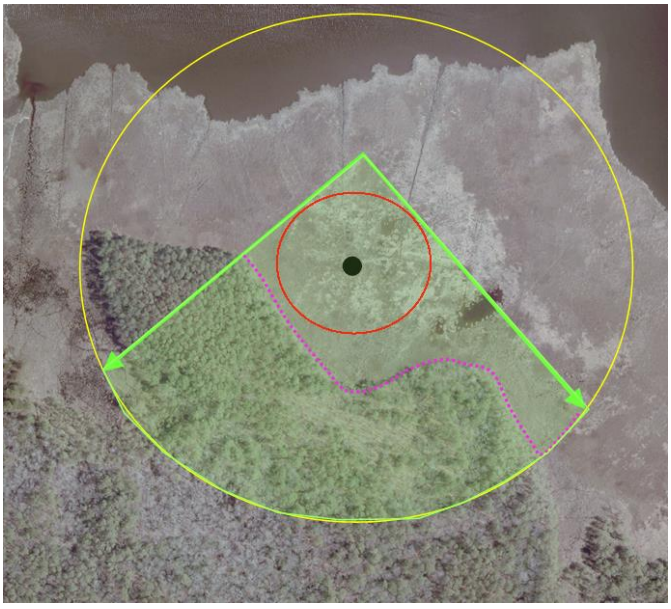
Alternative States	**Rating (circle one)**
AA's surrounding landscape is comprised of *only* native vegetation, has undisturbed soils, no point source discharges, and there is no evidence of human disturbance.	**12**
AA's surrounding landscape is dominated by native vegetation, has undisturbed soils, receives water from a stormwater pond drain, and there is little or no evidence of human visitation.	**9**
AA's surrounding landscape is characterized by an intermediate mix of native and non-native vegetation, and/or a moderate degree of soil disturbance/compaction, and/or receives water from one or more agricultural field ditch(es), and/or there is evidence of moderate human visitation.	**6**
AA's surrounding landscape is characterized by barren ground and/or dominated by invasive species, and/or highly compacted or otherwise disturbed soils, and/or receives discharge directly from a polluted source, and/or there is evidence of intensive human visitation.	**3**

B5. Barriers to Landward Migration

Metric Source: New England Rapid Assessment Method (NERAM)
Extent: 250m Buffer
Definition: Barriers to landward migration (BLM) are physical barriers along the shoreline that would prevent the wetland from migrating inland with rising sea levels. Barriers can include hardened surfaces on the landward perimeter of the wetland such as sea walls, rip rap, debris or rock stabilization, a road or driveway that would be maintained, or other development within 50m of wetland/ upland edge.

Assessment Protocol: Determine the proportion of wetland/upland shoreline within the 250m buffer that is obstructed from future marsh migration in the event of sea level rise.

1. Determine the nearest source of open water.
2. On a map, originating on the open water source side of the AA, draw a 90º wedge directed landward to the limit of the 250 buffer (see examples below) to identify the evaluation area. The wetland/upland shoreline or the 250m buffer line within the pie wedge is the perimeter to evaluate, whichever is encountered first. Do not include islands in this calculation. Draw this perimeter line on the map. (Drawing the pie and perimeter lines allow for verification and Quality Assurance checks.)
3. Visually estimate the percentage of that perimeter that is obstructed by a barrier to marsh landward migration. Use aerial photography to estimate barriers and use field visits for confirmation. Perimeter that is not hardened or maintained and would allow for marsh migration in the future is considered unobstructed. If there is a barrier present in the upland (e.g. yard, berm, raised road) but there are >50m of unobstructed land (e.g. forest, scrub shrub, ag field) between the upland edge and the barrier, do not include as a barrier. If the wetland/upland edge is >250m from the edge of the AA (the entire 250m buffer is marsh), record no barriers present and estimate the nearest distance to a barrier from the center of the AA.



Example 1. An example of BLM scoring. The black center point is surrounded by the red AA and yellow 250m buffer. The green arrows point landward to create the 'pie' area to be evaluated. The pink dashed line follows the wetland/upland perimeter along forest and is unobstructed. A small portion of the 250m perimeter is included in this perimeter. 0% of the landward perimeter is obstructed.

Example 2. An example of BLM scoring. The green arrows create the 'pie' of area to be evaluated. The blue dashed line follows wetland/upland perimeter that is obstructed by development. The pink dashed line follows wetland/upland perimeter along forest and is unobstructed. A small portion of perimeter line runs along the 250m buffer boundary and is not obstructed. A measurement verified that nearby houses on the left are >50m from the perimeter line and do not count as obstructed. About 45% of the perimeter is obstructed.

Example 3. An example of BLM for a rectangular AA. The black center point is surrounded by the red AA and yellow 250m buffer. The green arrows point landward to create the 'pie' area to be evaluated. The pink dashed line follows the wetland/upland perimeter along forest >50m wide and is unobstructed. The blue dashed line follows the wetland/upland perimeter that is obstructed by either adjacent. In this example, 60% of the perimeter is obstructed by road or yard.

Scoring: Barriers to Landward Migration

% Perimeter Obstructed _____%	**Estimated distance from center of AA _____m**
Alternative States	**Rating (circle one)**
Absent: no barriers, 0%	**12**
Low: <10% of perimeter obstructed	**9**
Moderate: 10-25% of perimeter obstructed	**6**
High: >25% of perimeter obstructed	**3**

Attribute 2: Hydrology

Hydrology is the driving force that maintains the unique characteristics of wetlands, including hydrophytic vegetation and hydric soils, which differentiate wetlands from uplands. Hydrology is integral to supporting numerous functions which define the wetland's plant and animal composition and richness, physical borders, and nutrient cycling.

The hydrology attribute is composed of four metrics. Ditching & Excavation or Point Sources, Fill, and Wetland Diking/Tidal Restrictions. Ditching is measured within the 50m assessment area; Wetland Diking/Tidal Restriction and Point Sources are measured in the AA and the surrounding 250m buffer.

H1a. Ditching & Excavation (OMWM)--*for saltwater/brackish sites only* **Metric Under Development

Metric Source: New England Rapid Assessment Method (NERAM; modified)
Extent: 50m AA (7,854m²)
Definition: The extent of ditches and artificial excavation (such as open marsh water management, or OMWM) within the AA. Ditches increase or decrease the residency of water in the AA. This metric does not include natural ponds or interior marsh opening.

Assessment Protocol: Evaluation of this variable is performed using recent aerial photographs of the site and a field visit to verify the presence and functionality of ditches. Three width measurements should be taken per ditch in the field; ditch width is difficult to measure using GIS because of variable overhanging vegetation on ditch banks. Length is less variable on aerial imagery, so a length measurement can be taken either in the field or using GIS. Examples below should be used as a reference for scoring.

1. Use an aerial photo of the site that is zoomed to the extent of the AA. Identify ditches within the AA, noting the number and size of ditches.
2. Confirm presence and functionality of ditches in the field during the site visit. Then, take 3 evenly-spaced width measurements along each ditch in the field to calculate average width for each ditch. Record these values on Page 4 of the datasheet.
3. Take one length measurement of each ditch either in the field or using GIS, and record on Page 4 of the datasheet.
4. Calculate ditch area for each ditch using length and average width. If there are multiple ditches in the AA, sum the areas of the ditches to get a total area of AA that is ditched.
5. Calculate the percent of the AA that is ditched by dividing the total area ditched by the area of the AA (7,854m²).

Examples: Refer to the 4 examples below for depictions of various degrees of ditching & excavation.

Example 1: Natural stream channels, no ditching or excavation. Score: 12

Example 2: Single ditch running through AA. 123.2 m²: 1.6% of AA is ditched: Score: 9

Example 3: Multiple narrow ditches throughout AA. 312.9 m²: 3.9% of AA is ditched: Score: 6

Example 4: Multiple ditches and created interior OMWM ponds. 808.5 m²: 10.3% of AA: Score: 3

Scoring: Ditching & Excavation

Alternative States	Rating (circle one)
No Ditching or Excavating	**12**
0-2.5%	**9**
2.6-5%	**6**
> 5%	**3**

H1b. Point Sources--*for freshwater tidal sites only*

Metric Source: New England Rapid Assessment Method (NERAM), modified

Definition: The presence of localized sources of pollution that are entering the wetland through a confined pathway (i.e. pipe, culvert, or ditch). Point sources can contribute significant amounts of polluted waters from adjacent land practices.

Assessment Protocol: Evaluate the AA and 250m buffer using aerial photography for point sources such as outfalls and drains entering the AA or 250m buffer. Field validate to confirm sources. Determine if the source of the input is from a 'developed' or 'natural' land use. Examples of inputs from a natural land use include those from a forest or through a fallow field. Inputs from developed land are those from lands that are dedicated to anthropogenic uses, such as urban, suburban, or industrial buildings, agriculture, lawns, yards, and golf courses. Man-made water bodies that drain from developed land (e.g. a storm water retention pond) and exit into a wetland should be considered as a developed source.

Scoring: Point Sources

Alternative States	Rating
Absent: No Discharge	**12**
Low: 1 small discharge from a natural area	**9**
Moderate: 1 discharge from a developed area or 2 discharges from a natural area	**6**
High: $\geq$ 2 discharges from a developed area or $\geq$ 3 from a natural area	**3**

H2. Fill

Metric Source: New England Rapid Assessment Method (NERAM; modified)
Extent: 50m AA (7,854m²)
Definition: To measure the presence and extent of fill within the AA that could be affecting the natural hydrology and plant community of the wetland.

Assessment Protocol:
Evaluation of this variable is performed using recent aerial photographs of the site and then a field visit to verify the presence of fill affecting hydrology in the AA.

1. Use an aerial photo of the site that is zoomed to the extent of the AA (1:2000) to identify possible sources of fill (e.g. row of small hummocks along a grid ditch)
2. Validate observations in the field by walking the entire AA and recording the presence of fill in the AA
3. Estimate and record the dimensions (length x width) of the surface area that fill is covering (e.g. 10 piles, each 1m x 3m)
4. Determine appropriate score for site based on percent of AA that contains fill.

Scoring: Fill and Fragmentation

Estimate amount of fill _____% of AA		**Comments**
Dimensions of Fill Pile _____		
Alternative States	**Rating (circle one)**	
0%, No Fill	**12**	
>0 - <5%	**9**	
≥5% - <10%	**6**	
≥10%	**3**	

H3. Wetland Diking/ Tidal Restriction

Metric Source: New England Rapid Assessment Method (NERAM)
Extent: 250m buffer
Definition: The presence of wetland diking and/or other tidal restrictions that interfere with the natural hydrology of the wetland. Knowledge of local tide regimes is critical in determining the severity of tidal restrictions.

Assessment Protocol: Observe the AA and the surrounding 250m for sources of restrictions. Look for wrack lines and water lines near structures as a sign that they cause restrictions. If a significant restriction is detected outside of the 250m buffer, it may also be scored down if it is known to cause restriction at the sampling location. Note the distance and provide a description. Examples of diking and tidal restriction:

- Under-sized culverts or bridge crossings
- Roads
- Man-made berms and dikes

Example 1. The scouring on the west side of the bridge and the size difference of the width of the river on each side of the bridge is evidence that this is an undersized bridge, and is therefore a tidal restriction. This site would score a 3.

Example 2. This is an example of a wetland with a dike surrounding it. If a point was found in this wetland it would score a 6.

Scoring: Diking and Restriction

Description of restriction: _____	
Alternative States	**Rating (circle one)**
no restrictions	**12**
Elevated path	**9**
dike, levee, bridge or berm	**6**
Undersized culvert or bridge	**3**

Attribute 3: Habitat

Wetlands provide habitat for a diverse array of plants and animals ranging from large mammals to invertebrates in the soil. These species are dependent on the availability of resources provided by the wetland, including vegetative structure and standing water. Additionally, the wildlife communities that are supported provide valuable social and economic benefits to society through hunting and non-consumptive activities (e.g. bird watching).

The habitat attribute is composed of five metrics: bearing capacity, horizontal vegetative obstruction, number of plant layers, plant species richness, and percent invasive cover. These metrics characterize the biotic and abiotic shelter and structure components of the wetland. All measurements for habitat are taken within the assessment area only.

HAB1. Bearing Capacity

Metric Source: New England Rapid Assessment Method (NERAM)
Extent: Measured at subplots 1-8 within the 50m AA
Definition: Bearing capacity is the ability of soil to support the loads applied to the ground, as measured by the penetration of a capped 2" PVC tube into the wetland soil surface by applying a standard force with a slide hammer. Bearing capacity assesses the below-ground stability of the wetland with the assumption that as a wetland deteriorates due to natural and anthropogenic influences, below-ground organic material and the soil bearing capacity will also decrease. Thus, the more the PVC tube penetrates the marsh surface after slide hammer blows, the lower the below-ground marsh stability is. Reduced below-ground organic material may precede above-ground changes in the plant community and other indicators of stress. Water depth is measured at each sub-plot to characterize the site, but is not used in any bearing capacity calculations.
****Note that the procedure is the same but the scoring is different for salt/brackish and tidal freshwater wetlands for this metric.**

Assessment Protocol: The base of the instrument is a 2-inch capped PVC tube with a centimeter scale marked on its side. The PVC pipe is one meter long and has a flat cap on the bottom. The slide hammer is placed on top; it weighs 7.4 pounds and is attached to a PVC ring with a 5/8th inch bolt. The percent cover of hummocks and hollows in the AA will determine how you proceed with this metric. If unvegetated areas void of root mat (i.e. hollows) make up < 10% of the AA, measure bearing capacity in 8 sub-plots following the directions below:

1. Record the percent of the AA wetland in hummocks.
2. At subplots 1-8, determine a sampling spot to place the flat cap bottom of the base. Push aside all vegetation (live and dead) to reveal bare ground.
3. Measure and record the depth of surface water (if any) at each subplot, in centimeters, in the location where the flat cap bottom of the PVC pipe will rest.
4. Assemble the PVC tube and the slide hammer together first, and then place gently on bare ground on the wetland surface at the determined location. Make sure the PVC is vertical and not tilted.
5. Measure initial compaction using the centimeter scale on the PVC pipe by recording how deep the PVC penetrates into the ground without exerting any force. Record this as 'Initial depth' to the nearest 0.25cm (e.g. if it is between 4cm and 5cm, record as 4.25cm, 4.5cm, or 4.75 cm, whichever it is nearest to).
6. Lift and extend the slide hammer fully while ensuring that the PVC tube is in a straight, upright position. Release the hammer and allow it to fall freely with gravity. Then, for the safety of your fellow field crew members, stabilize the slide hammer in place (without exerting any extra force on it) so that it does not fall off of the PVC pipe onto another field crew member.
7. Without moving the slide hammer, measure compaction by reading where the marsh surface aligns with the centimeter scale on the PVC pipe, again to the nearest 0.25cm. Record the depth as 'blow 1'.
8. Repeat steps 6-7 for blows 2-5. Record values in the space provided (see example table below).

9. Subtract the initial depth from the final depth for subplots 1-8. Average these values for the 8 subplots and use that average to score the site using the scoring table. In this case, because hollows make up < 10% of the AA, the table for hollows remains blank on the data sheet. We recommend waiting to do any sort of calculations until you are out of the field and back in the office to avoid errors.

If hollows make up >10% of the AA, bearing capacity readings should also be taken in hollows within the 8 subplots. If a hollow is not present within the subplot, take bearing capacity readings in the hollow closest to the subplot up to, but not more than, 3m away from subplot.

1. Take the 'hummocks' readings as directed above.
2. In addition, record the percent hollows in the AA. Percent hollows and percent hummocks should add up to 100%.
3. While at each subplot, repeat the sampling procedure at the nearest spot void of vegetation and root mat (unvegetated hollow) that falls ≤ 3m from the subplot. This means that at each subplot, both hummock *and* hollow bearing capacity readings should be recorded. Separate tables are provided on the data sheet for hummock readings and hollow readings.
4. Subtract the initial depth from the final depth for subplots 1-8, and then average the 8 subplots. Use the hummocks/hollows workspace on page 3 of the datasheet to calculate weighted bearing capacity for hummocks and hollows based on percentages of each in the AA. Add these 2 weighted values to get a final value (X) to use for scoring, as in the equation below:

   X= (hummock subplot average*hummock %) + (hollow subplot average*hollow %)

We recommend waiting to do any sort of calculations until you are out of the field and back in the office to avoid errors.

Bearing Capacity (Hummocks)

% Hummocks _____%	Mark Depth (cm)							
	Subplot 1	Subplot 2	Subplot 3	Subplot 4	Subplot 5	Subplot 6	Subplot 7	Subplot 8
Water Depth								
Initial depth								
Blow 1								
Blow 2								
Blow 3								
Blow 4								
Blow 5 (Final)								
Blow 5 - Initial								

Scoring: Bearing Capacity (saltwater/brackish only)

Average of Final – Initial Over the Eight Sub-plots	Rating
≤1.80	**12**
1.81-4.00	**9**
4.01-6.20	**6**
>6.21	**3**

Scoring: Bearing Capacity (tidal freshwater only)

Average of Final – Initial Over the Eight Sub-plots	Rating
≤4.40	**12**
4.41-6.70	**9**
6.71-11.40	**6**
>11.41	**3**

HAB2. Horizontal Vegetative Obstruction

Metric Source: This parameter was a test metric in 2008-09 and was added to the protocol as a scored metric in 2010.

Extent: Measured at subplots 1, 3, 5, and 7 within the 50m AA

Definition: A measure of vegetation thickness by determining the amount of visual obstruction through the subplot area due to vegetation at 5 height levels using a profile board. The profile board is 1m long, is divided into 10-decimeter painted sections that alternate between red and white, and has a rope 4m in length tied to one end. Measurements are taken as the amount of board visible horizontally through vegetation from 4m away.

**Note: scoring for tidal freshwater wetlands is still under development.

Assessment Protocol:

1. The recorder stands along the 100m tape at the subplot with a 1.25m-tall dowel or PVC pole and the profile board. Two dowels should be marked at heights 0.25m, 0.5m, 0.75m, 1.0m, and 1.25m.
2. The observer stands 4m away from the recorder (measured using the 4m rope attached to the board), perpendicular to the tape, with the other 1.25m dowel that is marked at the same 5 height intervals listed in Step 1. The observer should walk out and around the subplot when walking 4m away from the recorder to be sure not to trample the vegetation you will be measuring visual obstruction through.
3. The recorder holds the profile board horizontally at 0.25m above the wetland surface by using the premarked dowel or PVC, with the top edge of the profile board even with the 0.25m dowel mark.
4. The observer positions themselves so that they are eye level with the profile board at 0.25m above the wetland surface using the second premarked dowel or PVC. Then, the observer counts how many of the decimeter segments on the profile board are visible through vegetation (i.e. unobstructed). If *any* part of a decimeter segment is seen through the vegetation, it counts as being seen. Record the number of visible decimeter segments at 0.25m (see data table example below). (Helpful Hint: sometimes it helps to wiggle the profile board so the observer can get a better view.)
5. Repeat Steps 3-4 at 0.5m, 0.75m, 1.0m, and 1.25m. At minimum, readings should be done at.25m, .5m, and .75m heights for all subplots. If the vegetation community is not growing at all to 1.0m or 1.25m at a subplot, do not take a reading; instead, put an X at that height in the data table to note that vegetation is not growing that tall. Also note the dominant vegetation found between the observer and the recorder.
6. Back in the office, sum the values for each subplot. Then, find the total number of visible decimeter segments for the whole site by adding the four subplot totals together. Divide that by the total amount of decimeter segments (visible + invisible) for the site in order to calculate a percentage of decimeter segments that were unobstructed. Ex: If a site has vegetation growing to 1.25m in all subplots, divide the total visible by 200 (10 decimeter segments x 5 plant heights x 4 subplots= 200 total possible decimeter segments to see in a site). If a site has 4 X's in the data table denoting that vegetation does not grow to certain heights at certain subplots, then the total visible for the site would instead be divided by 160 (4 X's means 40 fewer possible decimeter segments because readings were not taken at those heights).
7. Subtract the percent unobstructed from 100 to get the percent obstructed. Use the percent obstructed to score the site using the scoring table on the data sheet (see example below).

Horizontal Vegetative Obstruction
Place a 0 in boxes where board is obstructed completely by vegetation and an X where vegetation does not grow that tall.

Sub-plot	1	2	3	4
0.25m				
0.50m				
0.75m				
1.0m				
1.25m				
SUM				
Dominant vegetation				

Scoring: Horizontal Vegetative Obstruction

Out of:_____

% unobstructed:_____

100-% unobstructed = % obstructed____

Average of 4 Subplot Totals	Rating
≥ 60%	**12**
45% - 59.9%	**9**
30% - 44.9%	**6**
≤ 29.9%	**3**

HAB3. Number of Plant Layers

Metric Source: California Rapid Assessment Method (CRAM), modified
Extent: 50m AA
Definition: The number of plant forms in the AA based on plant height. A plant layer must cover ≥ 10% of the AA to be counted.

Assessment Protocol:

Plant Height *(covers ≥ 10% of AA)*
☐ Submerged or floating aquatic vegetation
☐ Short <0.3m
☐ Medium 0.3-0.75m
☐ Tall 0.75-1.0m
☐ Very Tall >1.0m

Scoring: Number of Plant Layers

Alternative States	Rating
4-5 layers	**12**
2-3 layers	**9**
1 layer	**6**
0 layer	**3**

HAB4. Plant Species Richness

Metric Source: California Rapid Assessment Method (CRAM), modified
Extent: 50m AA
Definition: Walk your AA and mark presence of each species found in the AA at >10% coverage. Also record any species not listed in the provided blank spaces as long as they are found in >10% of the AA. This is best done towards the end of your assessment after you have had a chance to get a feel for the site.

Assessment Protocol:

Amaranthus cannabinus		*Polygonum arifolium*	
Asclepias incarnata		*Polygonum punctatum*	
Atriplex prostrata		*Polygonum ramosissimum*	
Baccharis halimifolia		*Pontederia cordata*	
Boehmeria cylindrica		*Sagittaria latifolia*	
Bolboschoenus robustus		*Salicornia virginica*	
Clethra alnifolia		*Saururus cernuus*	
Distichlis spicata		*Schoenoplectus americanus*	
Echinochloa walteri		*Solidago sempervirens*	
Hibiscus moscheutos		*Spartina alterniflora*	
Impatiens capensis		*Spartina cynosuroides*	
Iva frutescens		*Spartina patens*	
Juncus effusus		*Symplocarpus foetidus*	
Juncus gerardii		*Typha angustifolia*	
Kosteletzkya virginica (pentacarpos)		*Typha latifolia*	
Leersia oryzoides		*Zizania aquatica*	
Limonium carolinianum			
Nuphar luteum			
Panicum virgatum			
Peltandra virginica			
Phragmites australis			
Pluchea odorata			

Scoring: Species Richness

Alternative States	Rating
> 5 species	**12**
4 or 5 species	**9**
2 or 3 species	**6**
1 species	**3**

HAB5. Percent Invasive Cover

Metric Source: California Rapid Assessment Method (CRAM), modified
Extent: 50m AA
Definition: Percent cover of invasive species in the AA.

Assessment Protocol: Survey the AA for live invasive species and estimate total percent cover of all invasive species combined. For a complete list of Mid-Atlantic Invasive species, refer to your state's invasive species list (see links below). Use the cutoffs below to assign a metric score. You can also make note of any dead invasive species in the AA, such as sprayed *Phragmites*; however, dead invasive species are not included in the scoring of this metric.

Scoring: Percent Invasive

Alternative States	Rating
0%	**12**
>0-25%	**9**
26-50%	**6**
>50%	**3**

Invasive Species Present: _____ **%**

_____ **%**

_____ **%**

Please look for the current invasive species list for your state:

Delaware: http://www.wrc.udel.edu/de-flora/?l=3

Maryland: http://dnr.maryland.gov/Invasives/Pages/default.aspx

Virginia: http://www.dcr.virginia.gov/natural-heritage/invspinfo

New Jersey: http://www.njisst.org/fact-sheets.htm

Other Resources: https://plants.usda.gov/java/

https://www.invasive.org/maweeds.cfm

https://www.doi.gov/invasivespecies

APPENDIX A. Identifying Native *Phragmites*

Phragmites australis subsp. *americanus* Saltonstall, Peterson & Soreng

Adapted from Key Field Characteristics in the Tidal Mid-Atlantic Region

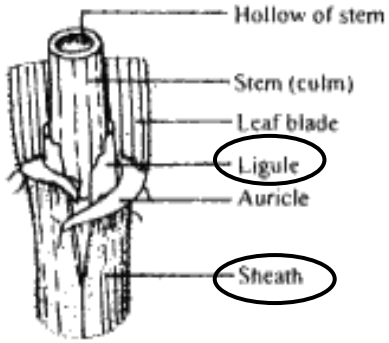
By Robert Meadows - Delaware Division of Fish & Wildlife, Newark, Delaware (robert.meadows@state.de.us)

No.	Characteristic	Native	Introduced	Remarks
1[a]	**Leaf Color**	Lighter Green	Darker Blue Green	Summer
2	**Leaf Texture**	Smoother	Coarse (midrib apparent)	Late Summer
	Leaf Sheath:			
4[a]	Clasping Stem	Very loosely wrapped	Very tightly wrapped	Late Summer, Fall and Winter
5[ab]	Retention on stem	Caducous: most fall off.	All are still tightly wrapped	If in doubt, look at dead reeds!
6[b]	Ligule width	Wider (1.0-1.7 mm)	Narrower (0.4-0.9 mm)	See Diagrams
	Culm: *Remember to remove leaf sheath first!*			
7[a]	Color in Summer	Maroon ("sunburnt")	Light Green	In exposed portions of stand
8	Color in Winter	Chestnut	Tan	
9[a]	Spots	Distinct Black Spots	None	On culm, not sheath (at node)
10	Height	Shorter, to ca. 12-ft	Taller, to ca. 15-ft	
12	Stem smoothness	Glossy (polished)	Ridged, can feel with fingernail	
b	**Flower**: Lower Glumes	Longer 3.0-6.5 mm	Shorter 2.5-5.0 mm	See Diagrams
c	Upper Glumes	5.5-11.0 mm	4.5-7.5 mm	
d	Lemmas	8.0-13.5 mm	7.5-12.0 mm	Flower at nearly same time
14	**Rhizome**	Less dense, softer/fewer root hairs	Denser, firmer/thicker root hairs	
15	**Senescence**	ca. mid to late September	ca. Late October- November	Best times to survey for native
	Habitat:			
16	Salinity	Fresh to Oligohaline (<8ppt)	Fresh to Mesohaline (≤18ppt)	Native historically occurred in mesohaline
17	Disturbance	Undisturbed wetlands	Highly disturbed to pristine	
18	Biodiversity	Other plant sp. common	Monotypic stands common	

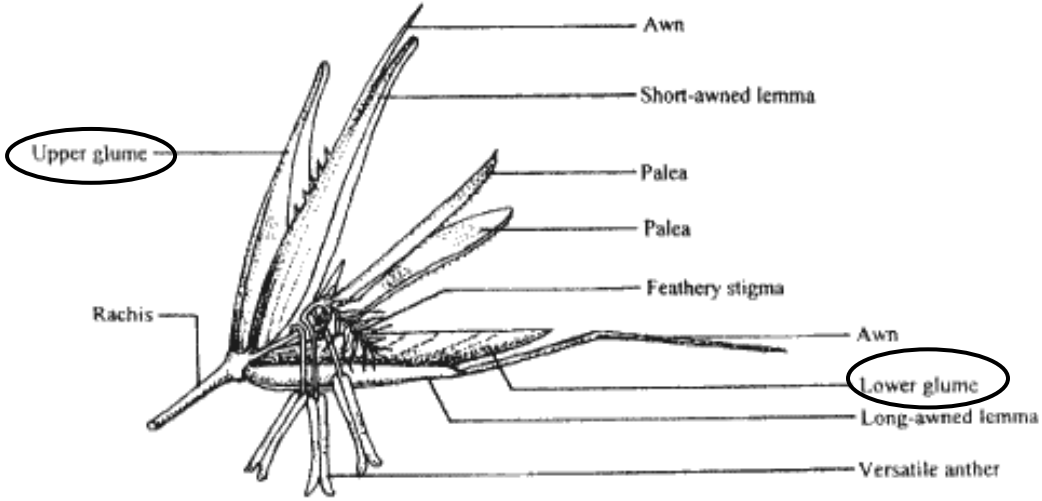
[a] Characteristics 1, 4, 5, 7, and 9 are additional key field traits (the remaining traits are not required to make a positive ID).

[b] Leaf Sheath Retention (5) and Ligule width (6) are universal traits; always check these on dead stems to confirm a presumptive ID.

Leaf Sheath Parts



Flower Parts



Spikelet Parts (containing 3 Florets)