Mid-Atlantic Tidal Wetland Rapid Assessment Method Version 1.0

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METHOD DEVELOPMENT

This 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 aimed at assessing 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. This method and protocol is a living document and will be updated 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.

This version (1.0) is the first version that was 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, macro invertebrate 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. We also added several new metrics.

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 metrics are summed by subcategory. Each subcategory is then averaged to produce the final score.

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 and could be used to assess different size areas, however, this should be field-tested to determine that all the metrics will still be applicable. Alternatively, to assess a larger wetland area, several assessment areas could be evaluated to represent the larger unit. **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 the MidTRAM will vary depending on the number of field crewmembers, the familiarity with MidTRAM , and the site conditions. A trained crew of 2 people should be able to complete the method within 2 hours 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 wetlands including 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 and landowner information can be found using the following websites:

Delaware Counties

Sussex County: **http://www.sussexcounty.net**

- Scroll to Tax Information
- Scroll to Map Search
- **Parcel ID from ArcMap:** The parcel ID that you recorded in ArcMap should resemble
  532-4.00-53.

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

- scroll to Pride Access (Property Information)
- search Outside unless you are at the R and R building
- search by Map Number
- **Parcel ID from ArcMap:** The parcel ID that you recorded in ArcMap should resemble (MN00-83.00-01-30.01).
- The parcel ID information is entered into the corresponding boxes on the website.

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

- Click on "look up property information" (under online services)
- Enter the tax parcel number (taken from the GIS tax parcel layer)
- Use the PARCELID number found in the attributes table
- Tax parcel number should resemble: 0600200008

Maryland Counties

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

- Select the appropriate county
- Select Map/Parcel Reference (under search method)
- Enter the Map and parcel numbers found in the attribute table
- Map number should resemble: 19
- Parcel number should resemble: 163

Virginia Counties

http://www.leaseown.org/Resources/VA_maps_data.html#county

- Under "local parcel information" select the appropriate county
- Select "web page" (under assessment data)
- Enter the map number or the property address

After parcel information is gained use a combination of phone books, postcards mailings, home visits, and letters to gain access to sites and contact landowners.

B. Field Map Production

Field maps should be produced before the initial site visit. They should contain 50m AA's, 250m buffer/landscape area, wetland polygons, and roads including names if applicable. Maps should illustrate the site at three levels:

- Overview- 1:20,000
- Buffer/landscape- 1:3,500
- Assessment Area- 1:1,000

C. Equipment List

- GPS
- Compass
- Maps
- Datasheets
- Clipboard
- Pencils
- Guide to identifying tidal wetland plants
- Shovel
- 60cc Syringe
- Nalgene Bottle
- 2mm Sieve
- Large Water Bottle/Bucket
- Shears
- 2 100m Tapes
- Compaction Hammer
- Waders

CLASSIFICATION OF TIDAL WETLANDS

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?

No – sites is nontidal please refer to the Delaware Rapid Assessment Protocol or Virginia Rapid Assessment Method for alternate assessment methods for nontidal wetlands.

Yes – go to step II

II. Is the wetland bordered by the ocean on at least one side?

A. Yes – Marine Tidal Fringe subclass

B. No – Estuarine Tidal Fringe subclass

1. Wetland located on the estuary side of a barrier island
   a) Yes – Back barrier Estuarine Tidal Fringe
   b) No – go to 2.
2. Wetland is a narrow fringing marsh along the estuary, bay, or tidal river
   a) Yes – Fringing Estuarine Tidal Fringe
   b) No – Expansive Estuarine Tidal Fringe

Further classify estuarine tidal fringe subclass by salinity

a) Polyhaline – 18 to 30 ppt
b) Mesohaline – 5 to 18 ppt
c) Oligohaline – 0.5 to 5 ppt
d) Freshwater - <0.5 ppt

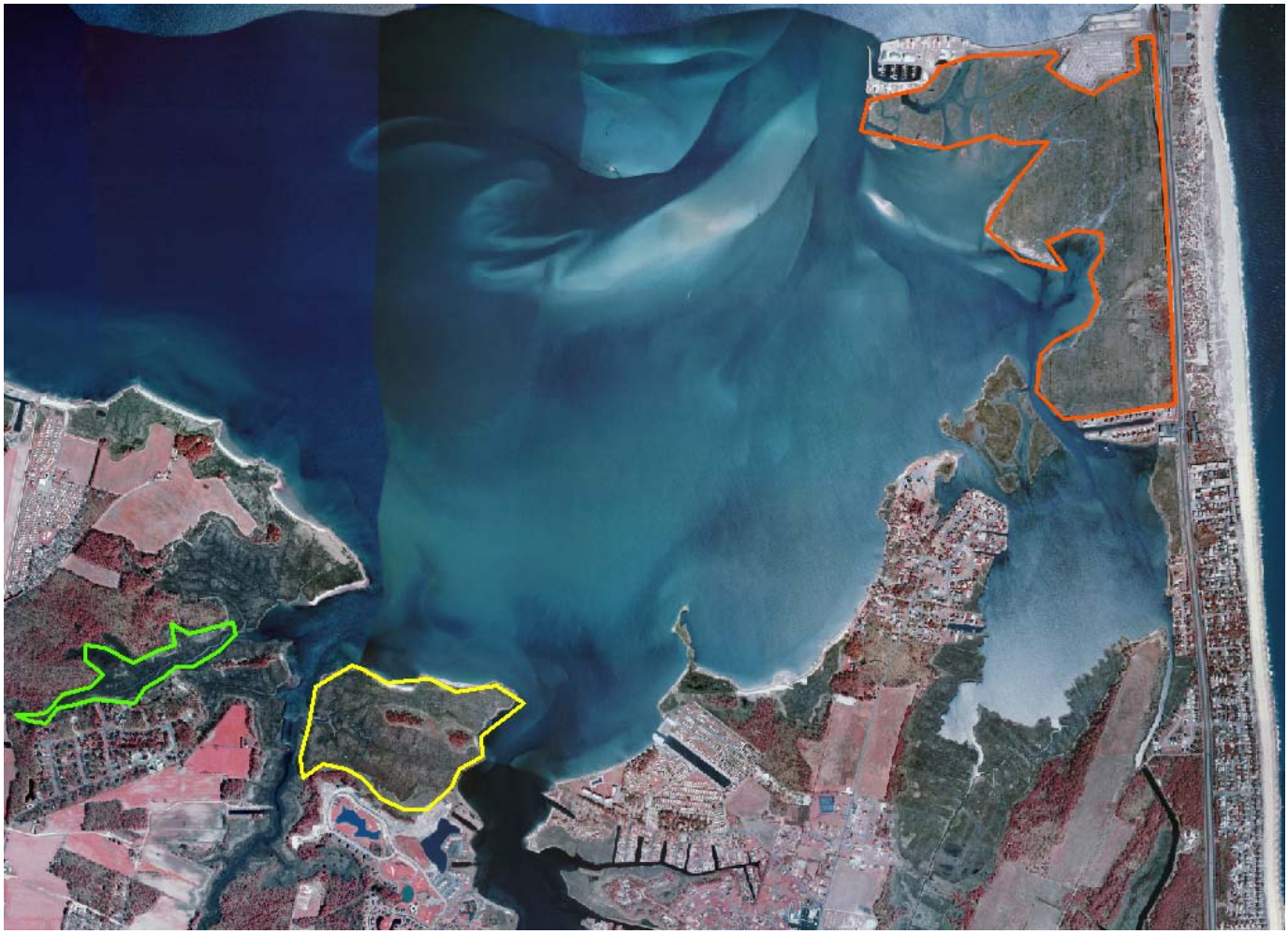


Figure 1. Examples of tidal wetland classification. Orange outline is Back barrier estuarine fringe, green outline is Fringing Estuarine Tidal Fringe, yellow outline is Expansive Estuarine Tidal Fringe.

ESTABLISHING THE ASSESSMENT AREA

The Assessment Area (AA) is the area within a wetland that will be sampled using MidTRAM. The majority of measurements will be performed in the AA or in relation to the AA. The center 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.

- Mark the center of the AA.
- Establish the AA as a 50-m radius circle centered on the AA (0.8ha area). Using 2, 100m tapes, locate one transect perpendicular from the open water edge to the upland edge, locate the 2nd transect perpendicular to the first.

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

Several situations may occur that would require that the AA be positioned differently that 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 new lat/long.**

1. Wetland does not extend 50m in all directions or part of the AA goes into an adjacent upland.
    - Move the center of the AA so that the entire AA is with in the wetland boundaries

2. AA is within a naturally occurring upland inclusion in the wetland.
    - If the upland inclusion is due to a disturbance i.e. a pile of fill, do not move the center of the AA.
    - If the location of the original point is determined to be upland, examine the entire 50m radius circle around the original point for a wetland.
        - If a wetland is found within this area, move the AA the least distance necessary to locate the AA entirely in the wetland
        - If no wetland is found with the bounds of the original AA, the site should be dropped and recorded as upland
3. Wetland is ≤ 0.8ha
    - The AA is the same size as the wetland
4. Wetland is ≥0.8ha, but oddly shaped and 50m radius will not fit
    - Adjust shape of AA to create 0.8ha AA without upland inclusions. Note the new dimensions and shape of the AA on the datasheet.

B. Locating subplots within the AA

Sub-plots will all be located within the 50m radius circle assessment area to perform vegetation structure and the belowground sampling protocols. Four, $1m^2$ plots will be placed along two 100m transects, dissecting the AA, within the dominant vegetation zone ideally at meters 30 and 75 on the perpendicular transect and meters 30 and 70 on the parallel transect (see figure 1). If the given plot is not representative of the dominant community cover (ie mud flat, ditch) move the sub-plot to the next representative meter along the transect and note the new location.

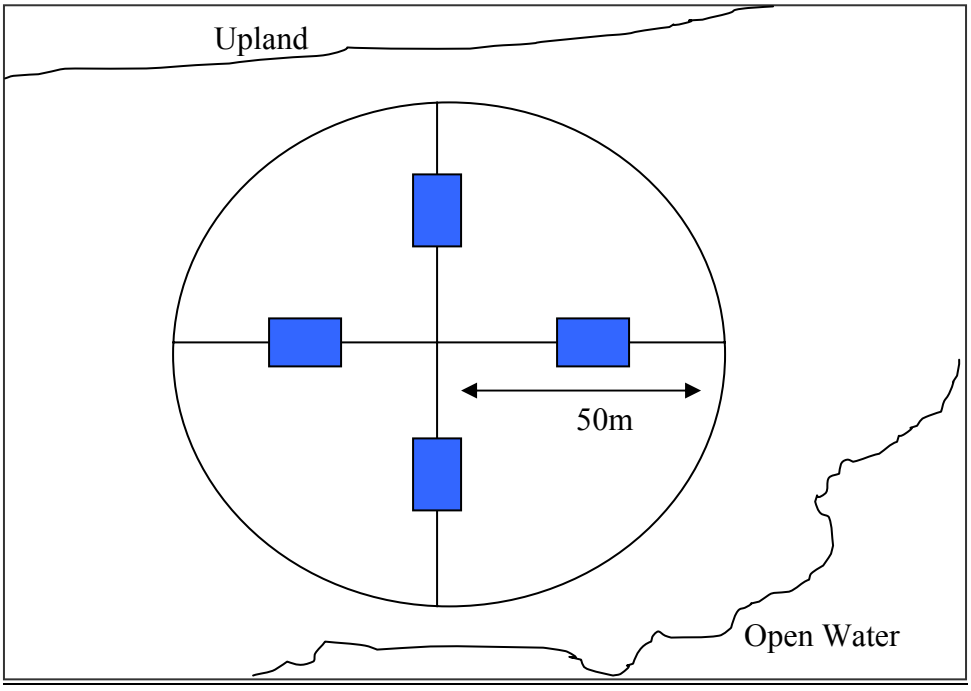


Figure 2: Location of Sub-plots.

METRIC OVERVIEW

Attribute	*Metric*	*Description*
Buffer/Landscape	Percent of AA Perimeter with 5m-Buffer	Percent of perimeter that has at least 5m of natural or semi-natural condition land cover
Buffer/Landscape	Average Buffer Width	The average buffer width surrounding the AA that is in natural or semi-natural condition
Buffer/Landscape	250m Landscape Condition	Landscape condition within 250m surrounding the AA based on the quality of vegetation, substrate and extent of human visitation
Buffer/Landscape	Surrounding Development	Percent of developed land within 250m from the edge of the AA
Buffer/Landscape	Marsh Habitat Richness	Number of different habitats found within 250m of the AA
Buffer/Landscape	Barriers to Landward Migration	Percent of AA perimeter that has physical barriers preventing marsh migration inland
Hydrology	Ditching & Draining	The presence and functionality of ditches in the AA
Hydrology	Fill & Fragmentation	The presence of fill or marsh fragmentation from anthropogenic sources in the AA
Hydrology	Diking/Restriction	The presence of dikes or other restrictions altering the natural hydrology of the wetland
Hydrology	Point Sources	The presence of localized sources of pollution
Habitat	Structural Patch Richness	Number of different physical habitat surfaces or features
Habitat	Bearing Capacity	Soils resistance
Habitat	Plant Fragments	Volume of plant fragments in the upper soil horizon
Habitat	Vertical Biotic Structure	The interspersion and complexity of the vegetation community
Habitat	Number of Plant Layers	Number of plant layers in the AA based on plant height
Habitat	Percent Co-dominant Non-Native Species	Percent of co-dominant non-native species in the AA
Habitat	Percent Invasive	Percent cover of invasive species in the AA

DATA COLLECTION – CHARACTERIZATION METRICS

SITE INFORMATION DATASHEET

Site #
Unique number for site (provided by EMAP if a random sample point)

Site Name
Names are given to each site

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

Tide
Direction during sampling

Field crew
All members of the field crew that participated in sampling the site

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. Assessment sites are sites that have been randomly selected using a probabilistic sampling design.

Marine tidal fringe, back barrier estuarine tidal fringe, fringing estuarine tidal fringe, expansive estuarine tidal fringe
Circle the appropriate choice based on marsh shape and location.

Natural, re-establishment, establishment, rehabilitation, enhancement
Select the appropriate choice based on the definitions below:

- **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.
- **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.
- **Rehabilitation**- the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions of a degraded wetland.
- **Enhancement**- the manipulation of the physical, chemical, 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.

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

Lat/Long
Latitude and longitude coordinates in digital degrees

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 a random located AA. If the center was moved record the reason that the AA was moved.

Tidal stage
Record the tidal stage that best represents the AA during the site visit. Circle the number that best describes the tidal stage, high= 5, mid-high= 4, mean= 3, mid-low= 2, and low= 1.

Amount of water on surface
Measure the amount of water on the wetland surface in an average area within the AA, note if highly variable. Record measurement in centimeters.

Photos
The photos should be taken in each cardinal direction and of prominent stressors. Record the photo id number, time, and relevant comments.

Assessment area sketch
Sketch the assessment area and adjacent land and note stressors and approximate distances.

Comments
Record information that would otherwise be undocumented.

Qualitative Condition Rating: The Qualitative Condition Rating assumes that condition declines with increased human disturbance. Through observation of vegetation, soils, hydrology and disturbance wetland assessors determine the degree of impact a disturbance has on a site. This is based on the Tier Aquatic Life Use Conceptual Model.

Rate the condition of the wetland (and surrounding buffer) from least disturbed (1) to highly disturbed (6) relative to other sites in the region based on best professional judgment (BPJ) (Figure 4). General description of the minimal disturbance, moderate disturbance and high disturbance categories are provided below. Observers should then use BPJ to assign a numerical Qualitative Condition Rating (QCR) within each disturbance category.

- **Minimal Disturbance Category (QCR 1 or 2):** Natural structure and biotic community maintained with only minimal alterations. *High condition sites have a characteristic native vegetative community, intact wetland soils and a natural hydrologic regime. These sites have natural 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 small ditches that convey small amounts of water, low occurrence of non native species, 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 QCR of 1 or 2.

- **Moderate Disturbance Category (QCR 3 or 4):** Moderate changes in structure and/or the biotic community. *Medium condition sites maintain some components of high condition sites such as intact hydrology, undisturbed soils and microtopography, intact landscape, or characteristic native biotic community despite some structural or biotic alterations.* Structural alterations include large ditches or a dam either increasing or decreasing flooding, grazing, moderate presence of invasives, high impact landuses in the buffer, and minimal hardened surfaces along the wetland/upland interface . Use BPJ to assign a QCR of 3 or 4.

- **High Disturbance Category (QCR 5 or 6):** Severe changes in structure and/or the biotic community. *Low condition sites have severe alterations to the vegetative community, hydrology and soils. This can be a result of one severe alteration or multiple 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 which is suppressing surrounding vegetation growth, hardened wetland upland interfaces along most of the site, conversion to a non-native vegetative community, and roads, excessive fill, excavation or farming in the wetland. Use BPJ to assign a QCR of 5 or 6.

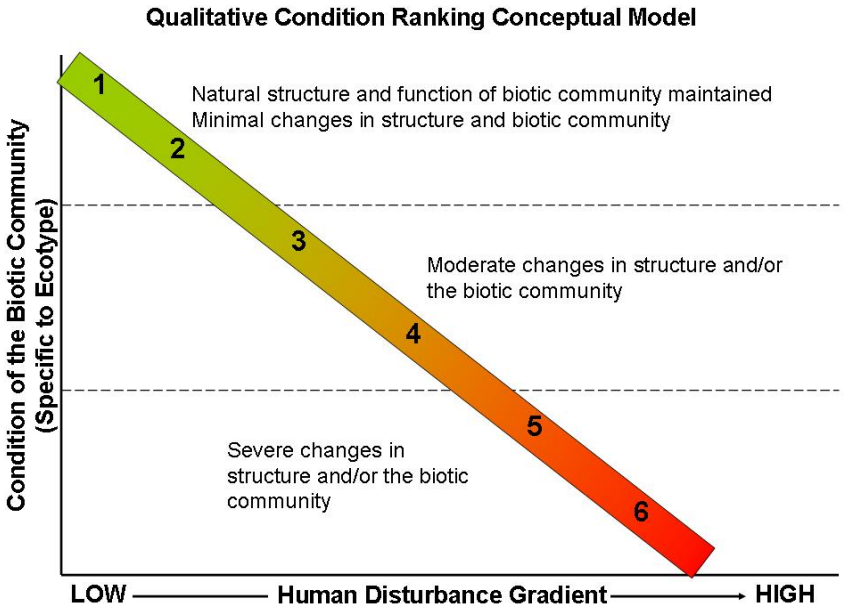


Figure 3. Diagram of narrative criteria for qualitative ranking of condition

Vegetation Communities and Features
Circle the dominant wetland vegetation zone (low marsh or high marsh) on the space provided on the top of the box. Estimate the percent cover of each vegetation community and wetland features present in the AA. If a vegetation community or wetland feature is present that is not listed, use the other box and write in a description of the community/feature. If a community or feature is not present record a "0".

Distance to Upland
Estimate the distance to the closest upland from the edge of the AA.

Distance Across
Estimate the distance across the wetland polygon from open water to upland. Estimate should be made by extending the open water/upland transect within the AA.

Distance to Open Water
Estimate the distance to the closest open water from the edge of the AA.

Stability of Assessment Area

Estimate the likelihood of the AA withstanding environmental stressors and continuing to function at normal levels. Circle the appropriate choice healthy & stable, beginning to deteriorate and/or some fragmentation, severe deterioration and/or severe fragmentation.

Soil Profile

Record a detailed description of the soil profile from the surface to as deep as a core can be extruded. The factor limiting the depth of the profile description will be that either there is an unconsolidated layer that can not be extruded, a compact layer, or a maximum depth of 1meter. For each layer or change in soil properties, record the soil type (mineral or organic), texture (i.e. for organic soils (hemic, fibric, or sapric) or mineral soils (sandy loam, silt loam etc.)), and root abundance (absent, rare, common). Note: this is currently being refined to establish if we need to do this at every site.

DATA COLLECTION - CONDITION METRICS

Attribute 1: Buffer/Landscape

Points to include in overview paragraph on the importance of this Attribute

- **Transition zone**
- **Protection from adjacent anthropogenic stressors**
- **Increase water quality by processing pollutants from upland areas**
- **Protect against outside human activities**
- **Habitat corridors**

Six metrics are used to assess the buffer and landscape attribute of wetlands. The percent of assessment area perimeter with buffer and average buffer width are used to characterize the buffer, which focuses strictly on natural and semi-natural landuses surrounding the AA. The landscape metrics characterize the condition of the surrounding landscape which includes both natural and anthropogenic land uses (250m landscape condition, surrounding development, marsh habitat richness, and 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 currently not dedicated to anthropogenic uses. To be considered as buffer, a suitable land cover type as defined in Table 1 must be at least 5m 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 and those dedicated to anthropogenic uses within 250m of the edge of the AA. The area surrounding the assessment area is critical to the overall health and continued existence of the wetland. The surrounding landscape dictates the amount of runoff and the concentration of pollutants within that runoff that the AA will receive. The surrounding landscape will also determine if the AA has the ability to migrate inland with increasing sea-levels.

B1. Percent of Assessment Area Perimeter with 5m-Buffer

Metric Source: California Rapid Assessment Method (CRAM), modified

Definition: The buffer is the area adjoining the AA that is in a natural or semi-natural state and currently not dedicated to anthropogenic uses. To be considered as buffer, a suitable land cover type as defined below must be at least 5m wide and extend along the perimeter of the AA for at least 5 m.

Assessment Protocol: Evaluate the landuse within 5m of the edge of the AA and and determine the percent of the AA perimeter that has a buffer meeting the following criteria:

- Adjacent to the AA
- Natural or semi-natural landuse (see Table 1 for examples)
- 5m wide from the edge of AA
- Not Open Water- open water at least 30m wide that is in or adjacent to the AA (ex. lake, bay, large river, or large slough) is considered to be neutral, neither part of wetland nor part of the buffer because it protects the wetland from some stresses (i.e. preventing development) but can also be a source of stress (i.e. boat wakes, conveyance of trash).

Table 1: Guidelines for indentifying 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
foot trails	fences that interfere with the movement of wildlife
horse trails	agriculture
natural upland habitats	roads
nature or wildland parks	lawns
	parking lots
	residential areas
	sports fields
	golf courses
	urbanized parks with active recreation
	pedestrian/bike trails with nearly constant traffic

Example: In Figure 4, the area surrounding the AA consists of buffer and nonbuffer land cover types. The AA adjoins additional wetland buffer, nonbuffer road, and open water which is excluded from the calculation. Follow guidelines below:

- Exclude open water (in this example 20% or .20)
- Determine the amount of buffer and nonbuffer perimeter (in this example 55% or .55 is buffered and 25% or .25 is nonbuffer)
- Subtract the entire perimeter (100% or 1.0) by the open water portion to get the site perimeter (in this example open water is 20% or .20, so 1.0 - .20 = .80 the site perimeter)
- Divide the buffered portion by the site perimeter to get the percent buffer (in this example .55/.80= .69 or 69% buffer)
- Record the estimated percent and circle the correct score based on the alternative states listed

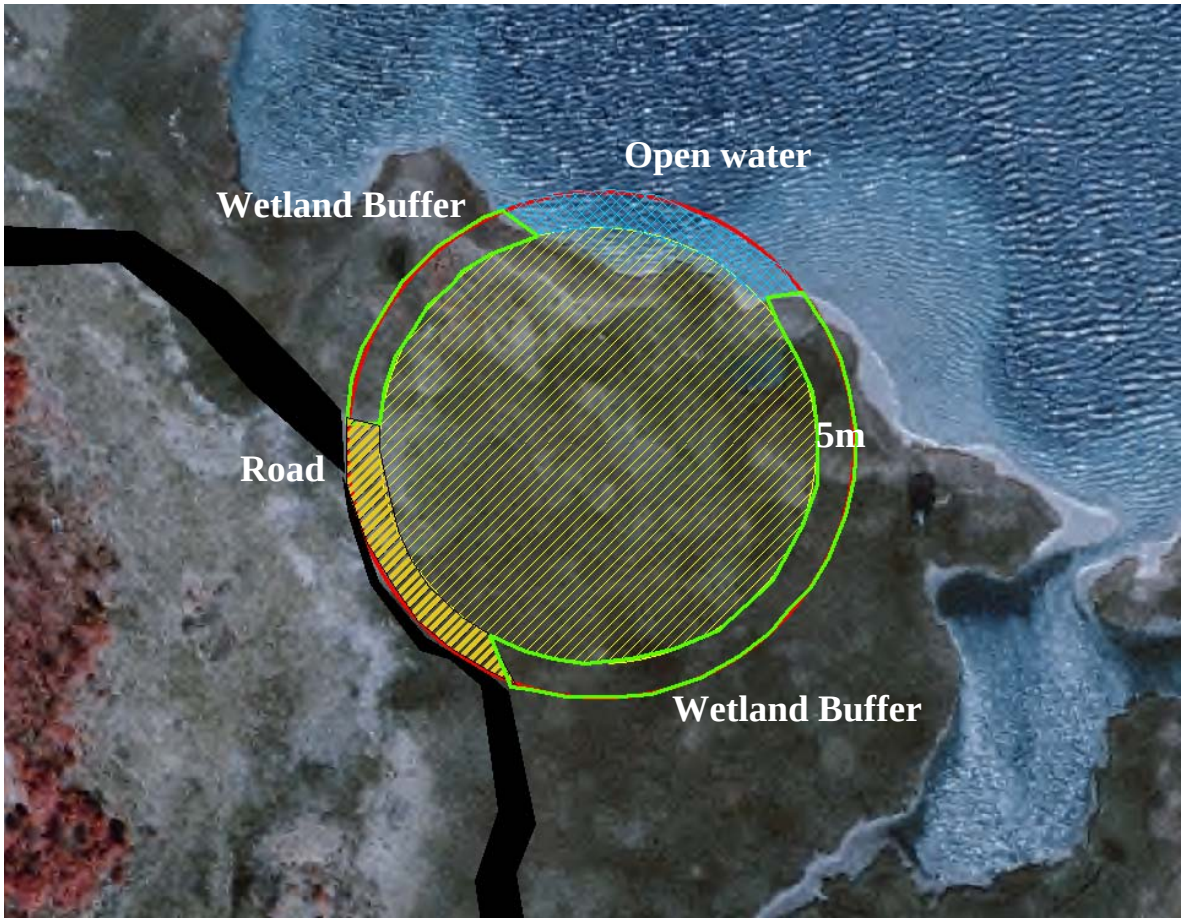


Figure 4: Diagram of buffer and non-buffer land cover types.

Scoring: Percent of Assessment Area Perimeter with 5m-Buffer

Record Estimated Percent _____%	
Alternative States (not including open-water areas)	**Rating (circle one)**
Buffer is 100% of AA perimeter.	**12**
Buffer is 75-99% of AA perimeter.	**9**
Buffer is 50-74% of AA perimeter.	**6**
Buffer is <50% of AA perimeter.	**3**

B2. Average Buffer Width

Metric Source: California Rapid Assessment Method (CRAM)

Definition: The average width of the buffer adjoining the AA is estimated by averaging the lengths of eight straight lines drawn at regular intervals around the AA from its perimeter outward to the nearest non-buffer land cover or 250m, which ever is first encountered. It is assumed that the functions of the buffer do not increase significantly beyond an average width of about 250m. The maximum buffer width is therefore 250m. The minimum buffer width is 5m (areas <5m are not considered buffer based on the definition above), and the minimum length of

buffer along the perimeter of the AA is also 5 m. Any area that is less than 5m wide and 5m is not considered as buffer.

Assessment Protocol:

1. Use aerial photo of sites with AA and a 250m circle from the edge of the AA.
2. Identify areas in which open water is directly adjacent to the AA. These areas are excluded from buffer calculations.
3. Draw eight straight lines 250m in length perpendicular to the edge of the AA through the buffer area at regular intervals along the portion of perimeter of the AA that has a buffer (see Figure 5).
4. Estimate the buffer width of each of the lines as they extend away from the AA (Open water should not be included in the total possible transect length).

Example A: Figure 5A details a scenario where buffer is limited by adjacent non-buffer landuse practices. Lines A-H are evenly spaced in the buffer area. The average buffer width for this site would be 147meters.

Line	Buffer Width (m)
A	75
B	180
C	225
D	240
E	175
F	150
G	70
H	60
Average Buffer Width	**147**

Max length 250m

Example B: Figure 5B explains a scenario in which the maximum buffer width of 250m is reached in all directions. Here the average buffer width is equal to the maximum, 250meters.

Line	Buffer Width (m)
A	250
B	250
C	250
D	250
E	250
F	250
G	250
H	250
Average Buffer Width	**250**

Max length 250m

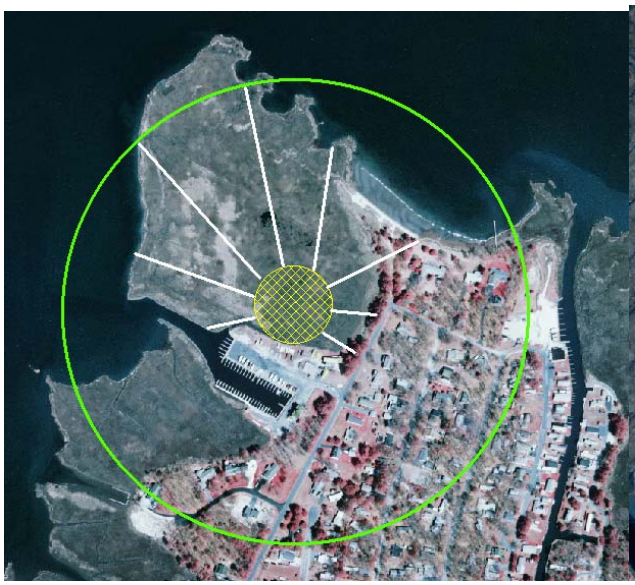


Figure 5A

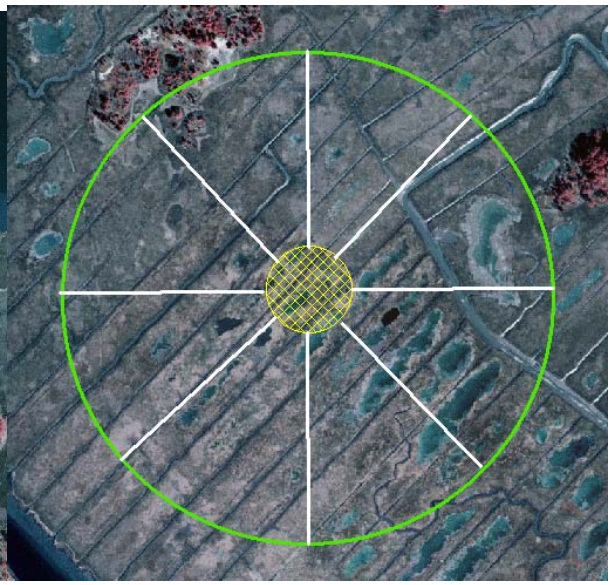


Figure 5B

Figure 5 A&B: Examples of how to estimate Buffer Width. Note that the width is based on the lengths of eight lines A-H that extend at regular intervals through the buffer areas, whether only a small portion of the 250m zone around the AA is buffer or the entire zone around the AA is buffer.

Table 2: Calculating average buffer width

Line	Buffer Width (m)
A	
B	
C	
D	
E	
F	
G	
H	
Average Buffer Width	

Max length 250m

Scoring: Average buffer width

Alternative States	Rating (circle one)
Average buffer width 190-250m.	**12**
Average buffer width 130-189m.	**9**
Average buffer width 65-129m.	**6**
Average buffer width 0-64m.	**3**

B3. 250m Landscape Condition

Metric Source: California Rapid Assessment Method (CRAM), modified

Definition: The present condition of the surrounding landscape based on landuse practices surrounding the AA including the extent and quality of its vegetation cover, condition of the substrate, and human visitation. The surrounding landscape is assessed in a 250m radius from the edge of the AA.

Assessment Protocol: Evaluate the landscape condition within 250m of the edge of the AA and use Table 6 to assign a metric score.

Table 3: 250m Landscape Condition

Alternative States	Rating (circle one)
AA's surrounding landscape is comprised of only native vegetation, has undisturbed soils, and is apparently subject to no human disturbance.	**12**
AA's surrounding landscape is dominated by native vegetation, has undisturbed soils, and is apparently subject to little or no 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 there is evidence of moderate human visitation.	**6**
AA's surrounding landscape is characterized by barren ground and/or highly compacted or otherwise disturbed soils, and/or there is evidence of very intensive human visitation.	**3**

B4. Surrounding Development

Metric Source: California Rapid Assessment Method (CRAM), modified

Definition: Developed land within 250m of the edge of the AA.

Assessment Protocol: Evaluate the surrounding land from the edge of the AA to 250m and determine the percent of the areas that is developed.

1. Use aerial photo of sites with AA and a 250m circle 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 landuse data available.

Scoring: Surrounding Development

Estimate Development _____%	
Alternative States	**Rating (circle one)**
250m ring has 0% development	**12**
250m ring has >0-5% development	**9**
250m ring has >5-15% development	**6**
250m ring has >15% development	**3**

B5. Marsh Habitat Richness

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

Definition: Marsh habitat richness is the amount of different habitats found within the 250m surrounding the AA. To be considered as a marsh habitat, it must cover a minimum of a 5m x 5m area.
Assessment Protocol: Evaluate the surrounding land from the edge of the AA and determine which of the following are present, if present record relative percent cover of invasive species. An aerial photo of the site and the area within 250m of the edge of the AA is helpful for locating habitats and estimating their distribution:

- Low marsh - typically dominated by *Spartina alterniflora*
- High marsh - typically dominated by *Distichlis spicata* and *Spartina patens*
- Saltmarsh terrestrial border - typically dominated by *Iva frutescens* and *Bacharis halmifolia*
- Brackish border - typically dominated by *Typha augustifolia* and *Schoenoplectus americanus*
- Pannes or pools - unvegetated or sparsely vegetated areas, may be dominated by *Salicornia europea*
- Natural channel creeks - small tidal water channel that has not been manipulated
- Openwater - areas of water greater than 30m in size
- Upland - non-wetland areas

Table 4: Marsh Habitat Richness

Communities and Habitats	**Check for presence**
Low Marsh	
High Marsh	
Saltmarsh Terrestrial Border	
Brackish Border	
Pannes or Pools	
Natural Channel Creeks	
Openwater	
Upland	
Number of Communities and Habitats	
Total Possible	**8**

Scoring: Marsh Habitat Richness

Alternative States	**Rating (circle one)**
Number of communities ≥3	**12**
Number of communities =2	**8**
Number of communities =1	**4**

B6. Barriers to Landward Migration

Metric Source: New England Rapid Assessment Method (NERAM)

Definition: Barriers to landward migration are physical barriers that prevent the marsh from migrating inland with increasing sea levels. Barriers can include hardened surfaces on the landward perimeter of the marsh such as sea walls, rip rap, debris or rock stabilization, and house or other development within 50m of wetland/ upland edge.

Assessment Protocol: Visually estimate the percentage of barriers to landward migration along the upland edge of the wetland system, within the 250m of the edge of the AA. If the upland edge is >than 250 from the edge of the AA then record no barriers present. Estimate the average distance to the barrier from the center of the AA.

Scoring: Barriers to Landward Migration

% Perimeter Obstructed _____%	**Estimated Dist. From center of AA _____m**
Alternative States	**Rating (circle one)**
Absent: no barriers	**12**
Low: <10% of perimeter obstructed	**9**
Moderate: 10-25% of perimeter obstructed	**6**
High: 25-100% 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 & draining and fill & fragmentation are measured within the assessment area. The other two metrics are diking & restriction and point sources which are measured in the AA and the surrounding 250m area.

H1. Ditching & Draining

Metric Source: New England Rapid Assessment Method (NERAM)

Definition: The quantity and functionality of ditches within the AA.

Assessment Protocol:
Preliminary evaluation of this variable is performed using recent aerial photographs of the sites and then a field visit to verify the presence and functionality of ditches. Examples below should be used as a reference for scoring. (Figures 6-9 of varying levels of ditching).

1. Use an aerial photo of the site that is zoomed to the extent of the AA.
2. Identify ditches within the AA.
3. When conducting field survey examine ditches for functional capacity.

Examples:

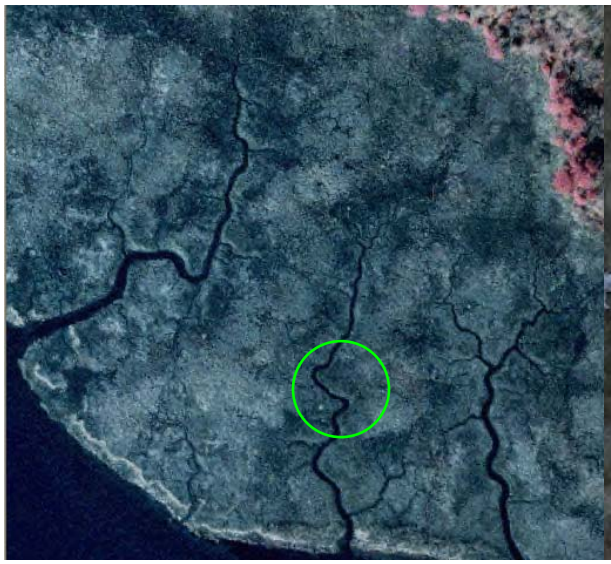


Figure 6: No Ditching- No ditches present within the AA.

Figure 7: Low Ditching- One small ditch that has very low function within the AA.

Figure 8: Moderate Ditching- One to two ditches present in the AA that transport small amounts of water.

Figure 9: Severe Ditching- At least two ditches present that significantly alter flow patterns with the AA. Ditches increase or decrease the residency of water on the AA's surface. i.e. grid ditches

Scoring: Ditching & Draining

Alternative States	Rating (circle one)
No Ditching	**12**
Low Ditching	**9**
Moderate Ditching	**6**
Severe Ditching	**3**

H2. Fill & Fragmentation

Metric Source: New England Rapid Assessment Method (NERAM)

Definition: The presence and extent of fill within the AA and the amount of fragmentation of the marsh due to anthropogenic alterations (i.e. roads, berms, walkways, docks).

Assessment Protocol:
Preliminary evaluation of this variable is performed using recent aerial photographs of the site and then a field visit to verify the presence of fill and barriers causing fragmentation of the AA. Examples below should be used as a reference for scoring. (Figures 10-11 of varying levels of fill and fragmentation).

1. Use an aerial photo of the site that is zoomed to the extent of the AA.
2. Identify areas of fragmentation within the AA.
3. Validate field observations in the field by walking the entire AA and recording the presence of fill and barriers causing fragmentation of the AA
4. Estimate and record the surface area that fill is covering
5. Using examples and scoring table determine appropriate score for site

Note: Ditches should not be included in the evaluation of fragmentation since they are evaluated under a separate metric.

Low – Small amounts of fill that do not interfere with water migration through the marsh
Moderate – Elevated walkways or docks that minimally interfere with water moving in or out of the site
Severe – Extreme structural obstructions on the marsh surface that restrict large amounts of water

Examples: Refer to figures 10-11 for depictions of various degrees of fragmentation.

Figure 10: Moderate fragmentation

Figure 11: Severe fragmentation

Scoring: Fill and Fragmentation

Estimate amount of fill _____% of AA		**Comments**
Dimensions of Fill Pile _____		
Alternative States	**Rating (circle one)**	
No fill or fragmentation	**12**	
Low fill or fragmentation	**9**	
Moderate fill or fragmentation	**6**	
Severe fill or fragmentation	**3**	

Note: the lower rating of fill and fragmentation should be used to score the metric.

H3. Diking/ Restriction

Metric Source: New England Rapid Assessment Method (NERAM)

Definition: The presence of diking and/ or other 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 any of the following restrictions, if a significant restriction is detected outside of the buffer a description and the distance to the restriction should be noted:

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

Scoring: Diking and Restriction

Description of restriction: _____	
Alternative States	**Rating (circle one)**
Absent: no restriction, free flow, normal range	**12**
Low: restriction presumed (<10% of normal range)	**9**
Moderate restriction (10-25% normal range)	**6**
High (25-100 of normal range)	**3**

H4. Point Sources

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

Definition: Localized sources of pollution that are entering the wetland through a confined pathway i.e. pipe, culvert, ditch. They can contribute significant amounts of polluted waters from adjacent impacted land practices.

Assessment Protocol: Survey for point sources such as outfalls and drains entering the AA or 250m surrounding area from adjacent landuses.

Scoring: Point Sources

Alternative States	**Rating (circle one)**
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: >2 discharges	**3**

Attribute 3: Habitat

Wetlands provide habitat for a diverse array of 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 economical benefits to society through hunting and non-consumptive activities (e.g. bird watching).

The habitat attribute is composed of seven metrics, structural patch richness, bearing capacity, plant fragments, vertical biotic structure, number of plant layers, percent of co-dominant non-native species, and percent invasive. These metrics characterize the biotic and abiotic shelter and structure components of the wetland. All measurements for habitat are taken within the assessment area.

HAB1. Structural Patch Richness

Metric Source: California Rapid Assessment Method (CRAM), modified

Definition: Patch richness is the number of different types of physical surfaces or features that may provide habitat for wetland species. Physical patches must be natural occurrences and at least $3m^2$ in size.

Assessment Protocol: Walk the entire AA and record the presence of patch types meeting the definitions below (modified from CRAM):

Secondary channels. A channel consists of a bed and its opposing banks, plus its floodplain. Estuarine wetlands can have a primary channel that conveys most flow, and one or more secondary channels of varying sizes that convey flood flows. Tributary channels that originate in the wetland and that only convey flow between the wetland and the primary channel are also regarded as secondary channels.

Pannes or pools. A panne is a shallow topographic basin lacking vegetation but existing on a well-vegetated wetland plain. Pannes fill with water at least seasonally due to overland flow. They commonly serve as foraging sites for waterbirds and as breeding sites for amphibians.

Non-vegetated flats (sandflats, mudflats, gravel flats, etc.). A flat is a non-vegetated area of silt, clay, sand, shell hash, gravel, or cobble at least 10 m wide and at least 30 m long that adjoins the wetland foreshore and is a potential resting and feeding area for fishes, shorebirds, wading birds, and other waterbirds.

Abundant wrackline or organic debris. Wrack is an accumulation of natural or unnatural floating debris along the high water line of a wetland.

Plant hummocks or sediment mounds. Hummocks are mounds created by plants and are typically less than 1m high. Sediment mounds are similar to hummocks but lack plant cover. This category does not include artificial fill piles.

Standing snags. Tall, woody vegetation, such as trees and tall shrubs, can take many years to fall to the ground after dying. These standing "snags" provide habitat for many species of birds and small mammals. Any standing, dead woody vegetation that is at least 2m tall is considered a snag.

Filamentous, macroalgae, or algal mats. Macroalgae occurs on benthic sediments and on the water surface of all types of wetlands. Macroalgae are important primary producers, representing the base of the food web in some wetlands. Algal mats and filamentous algae can provide abundant habitat for macro-invertebrates, amphibians, and small fishes.

Shellfish beds. Oysters, clams and mussels are common bivalves that create beds on the banks and bottoms of wetland systems. Shellfish beds influence the condition of their environment by affecting flow velocities, providing substrates for plant and animal life, and playing particularly important roles in the uptake and cycling of nutrients and other water-borne materials.

Animal mounds and burrows. Many vertebrates make mounds or holes as a consequence of their foraging, denning, predation, or other behaviors. The resulting soil disturbance helps to redistribute soil nutrients and influences plant species composition and abundance. To be

considered a patch type there should be evidence that a population of burrowing animals has occupied the Assessment Area. A single burrow or mound does not constitute a patch.

Submerged vegetation. Submerged vegetation consists of aquatic macrophytes such as *Elodea canadensis* (common elodea), and *Zostera marina* (eelgrass) that are rooted in the sub-aqueous substrate but do not usually grow high enough in the overlying water column to intercept the water surface. Submerged vegetation can strongly influence nutrient cycling while providing food and shelter for fish and other organisms.

Table 5: Structural patch type

Structural Patch Type	**Check for presence**
Minimum Patch Size	**3m^2**
Secondary channels (ditches not included)	
Pannes or pools	
Non-vegetated flats (mudflat or sandflat)	
Abundant wrackline or organic debris	
Plant hummocks and/or sediment mounds (not fill)	
Standing snags	
Filamentous, macroalgae, or algal mats	
Shellfish beds	
Animal mounds and burrows	
Submerged vegetation	
Total Possible	**10**
# **of Observed Patch Types**	

Scoring: Structural Patch Richness

Alternative States	**Rating**
High ≥ 7 patch types	**12**
Moderate 5-6 patch types	**9**
Low 3-4 patch types	**6**
Minimal 1-2 patch types	**3**

HAB2. Bearing Capacity

Metric Source: New England Rapid Assessment Method (NERAM)

Definition: Bearing capacity is the capacity of soil to support the loads applied to the ground as measured by the penetration of a capped 2" pvc tube into the marshes soil surface by applying a standard force with a slide hammer. Bearing capacity assesses the stability of the marsh with the assumption that as marshes deteriorate due to natural and anthropogenic influences the bearing capacity will decrease.

Assessment Protocol: The instrument is a 2inch capped pvc tube with a millimeter scale marked on its side. The slide hammer weights eight pounds and is attached to the pvc pipe with

a 5/8th inch bolt. The pvc pipe is one meter long and has a flat cap on the bottom. Measure bearing capacity in all 4 sub-plots following the directions below:

1. Within each sub-plot randomly throw small ball (white or brightly colored golf balls work well) to determine where to place the bottom of the pvc pipe. Measurements should be taken directly where the ball landed unless it is on a hummock of vegetation in which case it should be moved just to the side of the stems
2. Attach PVC tube to slide hammer and place gently on marsh surface at determined location.
3. Measure initial compaction by recording how deep the pvc penetrates into the marsh surface, using the millimeter scale on the pvc pipe.
4. Lift slide hammer and allow to fall freely with gravity.
5. Measure compaction by recording how deep the pvc penetrates into the marsh surface, using the millimeter scale on the pvc pipe.
6. Repeat steps 4-5 for blows 2-5.

Table 6: Bearing Capacity

	Mark Depth (cm)			
	Sub-plot 1	Sub-plot 2	Sub-plot 3	Sub-plot 4
Initial capacity				
Blow 1				
Blow 2				
Blow 3				
Blow 4				
Blow 5				
Final - Initial				

Scoring: Bearing Capacity

Average of Final – Initial Over the Four Sub-plots	**Rating**
>6.2	**12**
6.2-4.1	**9**
4.0-1.9	**6**
≤1.8	**3**

HAB3. Plant Fragments

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

Definition: the volume of root biomass 2-4cm below the marsh surface. This metric is an indicator on the below ground biomass of the site which contributes to marsh development and stability.

Assessment Protocol: Measure plant fragments in all 4 sub-plots following the directions below:

1. Within each subplot directly adjacent to bearing capacity measurements a soil core approximately 10cm x 10cm x 10cm should be extruded from the marsh.
2. Using shears, cut a 2cm x 2cm x 5cm piece of soil from the core at 2-4cm below the surface. Take care to keep the soil intact including any roots.

3. Break the chunk into small pieces and place in nalgene bottle with a small amount of water from the local water body.
4. Shake the bottle vigorously to loosen sediments attached to plant material.
5. Pour contents onto a 2mm sieve, allowing the sediment inlaid water to flow through.
6. If sediments remain on root fragments repeat steps 4-5 until clean.
7. Apply gentle pressure to the roots and sieve to remove the majority of water.
8. Place root fragments in 60cc syringe, cutting large roots if necessary to fit into the syringe.
9. Apply firm pressure to syringe stopper to remove remaining water and record volume.

Table 7: Plant Fragments

	Record Measurement (cc)			
	Point 1	Point 2	Point 3	Point 4
2-4cm deep				

Scoring: Plant Fragments

Average of Four Sub-plots	**Rating**
>29.8	**12**
29.8-22.3	**9**
22.2-14.6	**6**
<14.5	**3**

HAB4. Vertical Biotic Structure

Metric Source: California Rapid Assessment Method (CRAM), modified

Definition: Vertical biotic structure measures the interspersion and complexity of the vegetation community within the AA.

Assessment Protocol: Evaluate the vegetation within the AA based on descriptions below:

- Walk the AA and evaluate the vegetation community
- Determine the percent of the AA that has a canopy (See Figure 12)
- Measure the average height above the surface at several representative locations
- Refer to the table below for scoring

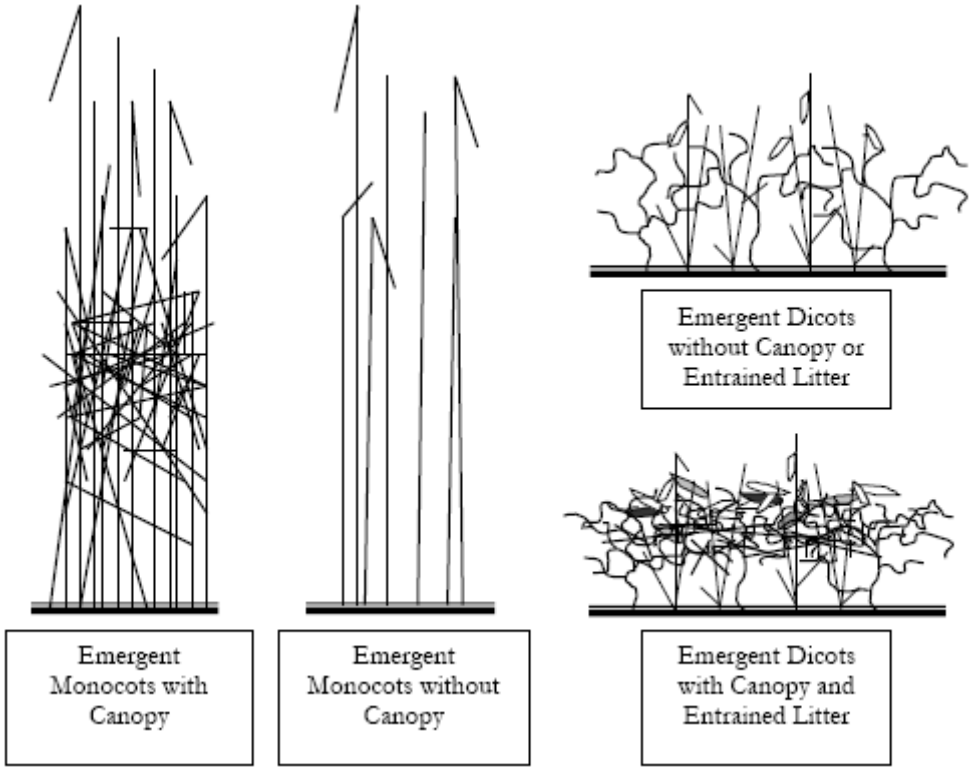


Figure 12. Schematic diagrams of plant canopies and entrained litter used to assess Vertical Biotic Structure.

Scoring: Vertical Biotic Structure

Alternative States	Rating
Most of the vegetated plain of the AA has a dense canopy of living vegetation or entrained litter or detritus forming a "ceiling" of cover 10-20cm above the wetland surface that shades the surface and can provide abundant cover for wildlife.	**12**
Less than half of the vegetated plain of the AA has a dense canopy of vegetation or entrained litter as described above OR Most of the vegetated plain has a dense canopy but the ceiling it forms is much less than 10-20cm above the ground surface.	**9**
Less than half of the vegetated plain of the AA has a dense canopy of vegetation or entrained litter and the ceiling it forms is much less than 10-20cm above the ground surface.	**6**
Most of the AA lacks a dense canopy of living vegetation or entrained litter or detritus.	**3**

HAB5. Number of Plant Layers

Metric Source: California Rapid Assessment Method (CRAM), modified

Definition: The number of plant layers of varying heights in the AA.

Assessment Protocol: Survey the AA for the number of plant layers as defined below. Record each species that comprises the layer and its invasive status. Layers must cover > 5% of the AA and are identified by actual plant heights within the AA, not the potential growth of the plant. Heights are measured as the vegetation stands and should not be held upright for measurement. All plant species are included and species may represent multiple layers.

- Floating Layer- rooted and non-rooted aquatic plants that form floating canopies
- Short Vegetation- plant heights < 30cm tall
- Medium Vegetation- plant heights are between 30-75cm tall
- Tall Vegetation- plant heights are between 75cm-1.5m tall
- Very Tall Vegetation- plant heights are ≥ 1.5m tall

Table 8: Plant Community Worksheet

Floating or Canopy-forming	**Invasive?**	**Short <0.3m**	**Invasive?**
Medium 0.3-0.75m	**Invasive?**	**Tall 0.75-1.5m**	**Invasive?**
Very Tall >1.5m	**Invasive?**		
		# of Plant Layers (max=5)	
		Total # of Native co-dominant species for all layers combined	
		Total # of Non-native co-dominant species for all layers combined	
		% of Non-native co-dominant species for all layers combined	
		Percent Invasive	

Scoring: Number of Plant Layers

Alternative States	**Rating**
4-5 Layers	**12**
2-3 Layers	**9**
1 Layer	**6**
0 Layer	**3**

HAB6. Percent Co-dominant Non-Native Species

Metric Source: California Rapid Assessment Method (CRAM), modified

Definition: Percent of co-dominant species in the AA that are non-native. To be considered a co-dominant each species must represent 10% relative cover within that layer.

Assessment Protocol: Using the Plant Community Worksheet identify all co-dominants species by estimating which make up 10% relative cover within each layer. Only species that contribute at least 10% relative cover will be used to compare the amount of native co-dominants to those that are invasive according to state invasive species lists (Appendix A). Divide the number of native co-dominant species by the number of non-native co-dominant species.

Scoring: Percent Co-Dominant Non-Native Species

Alternative States	Rating
0-15%	**12**
16-30%	**9**
31-45%	**6**
46-100%	**3**

.

HAB7. Percent Invasive

Metric Source: Mid-Atlantic Tidal Wetland Rapid Assessment Method

Definition: Percent cover of invasive species in the AA

Assessment Protocol: Survey the AA for invasive species and estimate their percent cover. For a complete list of Mid-Atlantic Invasive species refer to State Invasive Species Lists (Appendix A).

Scoring: Percent Invasive

Alternative States	Rating
0%	**12**
1-25%	**9**
26-50%	**6**
>50%	**3**

Appendix A. State Invasive Species Lists

Delaware Invasive Species

Ailanthus altissima (tree of heaven)
Alliaria petiolata (garlic mustard)
Arthraxon hispidus (small carpgrass)
Berberis thunbergii (japanese barberry)
Bidens polylepis (tickseed sunflower)
Cabomba caroliniana (carolina fanwort)
Carex kobomugi (Japanese sedge)
Celastrus orbiculata (asian bittersweet)
Cirsium arvense (canadian thistle)
Clematis terniflora (sweet autumn virginsbower)
Commelina communis (asiatic dayflower)
Conium maculatum (poison hemlock)
Convolvulus arvensis (field bindweed)
Duchesnea indica (indian strawberry)
Egeria densa (brazilian waterweed)
Eichhornia crassipes (water hyacinth)
Eragrostis curvula (weeping lovegrass)
Galanthus nivalis (snowdrop)
Hedera helix (english ivy)
Hemerocallis fulva (daylily)
Humulus japonicus (japanese hop)
Humulus lupulus (common hop)
Hydrilla verticillata (waterthyme)
Iris pseudacorus (yellow iris)
Ligustrum vulgare (european pivet)
Lonicera japonica (japanese honeysuckle)
Lonicera morrowii (morrow's honeysuckle)
Lonicera tatarica (tartarian honeysuckle)
Ludwigia peploides Raven spp. Glabrescens (floating primrose-willow)
Lysimachia nummularia (creeping jenny)
Lythrum salicaria (purple loosestrife)
Microstegium vimineum (japanese silt grass)
Murdannia keisak (marsh dewflower)
Myriophyllum aquaticum (parrot feather)
Myriophyllum Spicatum (eurasian milfoil)
Phalaris arundinacea (reed canarygrass)
Phragmites australis (common reed)
Pinus thunbergiana (Japanese black pine)
Pistia stratiotes (water lettuce)
Polygonum cespitosum (oriental lady's thumb)
Polygonum Cuspidatum (japanese knotweed)
Polygonum perfoliatum (Asiatic tear thumb)
Pseudosasa japonica (arrow bamboo)
Rosa multiflora (multiflora rose)
Rubus phoenicolasius (wineberry)
Sorghum halepense (johnsongrass)
Trapa natans (water chestnut)
Urtica dioica (stinging nettle)
Vinca minor (common periwinkle)

Maryland Invasive Species

Acer platanoides
Ailanthus altissima
Ajuga repans
Alliaria petiolata
Allium vineale
Ampelopsis brevipedunculata
Artemisia vulgaris
Arthraxon hispidus
Bidens polylepis
Bromus sterillis
Carduus acanthoides
Carduus natans
Catalpa spp.
Caulerpa taxifolia
Celastrus orbiculatus
Centaurea maculosa
Cirsium arvense
Cirsium vulgare
Clematis terniflora
Coronilla varia
Dioscorea oppositifolia
Dipsacus sylvestris
Duchesnea indica
Eichhornia azurea crassipes
Elodea densa
Euonymus fortunei
Festuca elatior
Glechoma herderacea
Hedera helix
Heraceleum mantegazzianum
Hermerocallis fulva
Humulus japonicus
Hydrilla verticillata
Iris pseudacorus
Laminum amplexicaule
Lamium purpureum
Lespedeza cuneata
Liriope spicata
Lonicera japonica
Lysimachia nummularia
Lythrum salicaria
Microstegium vimineum (Eulalia viminea)
Miscanthus sinensis
Morus albus
Myiophyllum brasiliense
Myiophyllum spictatum
Myosoton aquaticum (Stellaria aquatica)
Ornithogalum nutans
Ornithogalum umbellatum
Paulownia tomentosa
Perilla frutescens
Phalaris arundinacea
Pharagmites australis
Picea glauca
Pinellia ternata
Polygonum cuspidatum
Polygonum perfoliatum
Polygonum sachalinense
Populus alba
Potamogeton crispus
Prunus avium
Pueraria loboata
Ranunculus ficaria
Salvinia molesta
Solanum dulcamara
Sorghum bicolor
Sorghum halepense
Trapa natans
Vinca minor
Wisteria floribunda

Virginia Invasive Species

Acer platanoides
Agropyron repens
Agrostis tenuis
Ailanthus altissima
Ajuga reptans
Akebia quinata
Albizia julibrissin
Alliaria petiolata
Allium vineale
Alternanthera philoxeroides
Ampelopsis brevipedunculata
Arostis gigantea
Arrhenatherum elatius
Artemisia vulgaris
Arthraxon hispidus
Arundo donax
Berberis thunbergii
Carduus nutans
Carex kobomugi
Cassia obtusifolia
Celatrus orbiculata
Centaurea biebersteinii
Centaurea jacea
Cirsium arvense
Cirsium vulgare
Commelina communis
Conium maculatum
Conron varia
Convolvulus arvensis
Dactylis glomerata
Dioscorea oppositifolia
Dipsacus laciniatus
Dipsacus sylvestris
Egeria densa
Elaeagnus angustifolia
Elaeagnus pungens
Elaeagnus umbellata
Eragrostis curvula
Euonymus alata
Euonymus fortunei
Euphorbia esula
Festuca elatior (F. pratensis)
Foeniculum vulgare
Glechoma hederacea
Hedera helix
Holcus lanatus
Humulus japonicus
Hydrilla verticillata
Imperata cylindrica
Ipomoea coccinea
Ipomoea hederacea
Ipomoea purpurea
Iris pseudacorus
Lapsana communis
Lespedeza bicolor
Lespedeza cuneata
Ligustrum obtusifolium
Ligustrum sinense
Lonicera fragrantissima
Lonicera japonica
Lonicera maackii
Lonicera morrowii
Lonicera standishii
Lonicera tatarica
Lonicera x bella
Lotus corniculatus
Lysimachia nummularia
Lythrum salicaria
Melia azedarach
Melilotus alba
Melilotus officinalis
Microstegium vimineum
Miscanthus sinensis
Morus alba
Murdannia keisak
Myriophyllum aquaticum
Myriophyllum spicatum
Pastinaca sativa
Paulownia tomentosa
Perilla frutescens
Phleum pratense
Phragmites australis
Phyllostachys aurea
Poa comressa
Poa trivialis
Polygonum cespitosum
Polygonum cuspidatum
Polygonum perfoliatum
Populus alba
Pueraria montana
Ranunculus ficaria
Rosa multiflora
Rubus phoenicolasius
Rumex acetosella
Rumex crispus
Setaria faberi
Sorghum halepense
Spriaea japonica
Stellaria media
Trapa natans
Ulmus pumila
Veronica hederifolia
Viburnum dilatatum
Vinca minor (V. major)
Wisteria floribunda
Wisteria sinensis
Xanthium strumarium

Appendix B. Identifying Native *Phragmites*

Phragmites australis subsp. *americanus* - Saltonstall, P.M. Anderson & Soreng

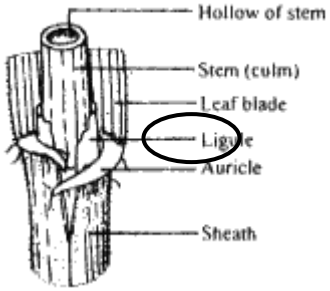
Overview of Key Field Characteristics in the Tidal Mid-Atlantic Region.

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

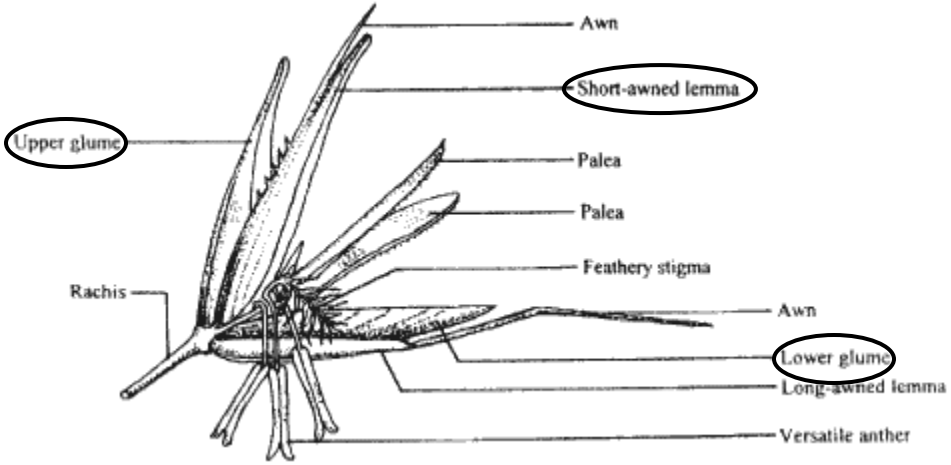
No.	Characteristic	Native	Introduced	Remarks
1	**Leaf** : Color	**Lighter Green**	**Darker Blue Green**	Summer
2		Smoother	Coarse (midrib apparent)	Late Summer
	Leaf Sheath:			
4	Clasping Stem	Very loosely wrapped	Very tightly wrapped	Late Summer, Fall, & Winter
5	Texture **Retention on stem***	Caducous: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

Leaf Sheath Retention (5) & Ligule width (13a) are universal traits; always check these on dead stems to confirm a presumptive ID. Characteristic 1, 4, 5, 7, and 9 are additional key field traits (the remaining traits are not required to make a positive ID).

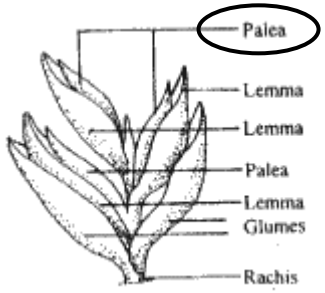
Leaf Sheath Parts



Flower Parts



Spikelet Parts (containing 3 Florets)



Appendix C. MidTRAM Datasheets

Mid-Atlantic Tidal Wetland Rapid Assessment Method V.1.0

Site # _____ Site Name _____ Date _____

Time of Start& Finish____:____ ____:____ Crew _____

Watershed _____ Sub-Watershed_____

lat/long _____

AA moved from original location? Yes or No (circle one) If yes, reason _____

Classification (circle one) Marine Tidal Fringe Fringing Estuarine Tidal Fringe Expansive Estuarine Tidal Fringe Back Barrier Estuarine Tidal Fringe	Reference or Assessment (circle one) Natural, Re-establishment, establishment, enhancement (circle one)

What best describes the tidal stage over the course of the time spent in the field? (circle one)
Note: It is recommended that the assessment be conducted at low tide.

Tide Stage

H <----------M----------> L

5 4 3 2 1

Amount of water on surface _____cm

Photo Identification Numbers and Description:					
	Photo ID #	Description	Time		Comments
1		North			
2		West			
3		South			
4		East			
5		Stressor			
6		Stressor			

Assessment Area Sketch

Qualitative Condition Rating						
1	**2**	**3**	**4**	**5**	**6**	(circle one)
Low <----------Disturbace----------> High						

Assessment Complete: Yes No (circle one)

Mid-Atlantic Tidal Wetland Rapid Assessment Method V.1.0

Vegetation Communities and Features

low marsh or high marsh (circle one)
Distance to Upland _____meters
Distance to Open Water _____meters

enter midpoint for each zone present - see chart below

_____ unvegetated/mud or sand flat
_____ Spartina alterniflora
_____ Juncus roemerianus
_____ Schoenoplectus americanus-Spartina patens
_____ Spartina patens-Distichlis spicata
_____ Phragmites australis
_____ pannes, pools, creeks
_____ open water
_____ ditches
_____ unhealthy marsh- SWD, deterioration
_____ other 1_____
_____ other 2_____

Cover Classes	MidPt		Cover Classes	MidPt
0	0		26-50%	38
<1%	0.5		51-75%	63
1-5%	2.5		76-99%	88.5
6-25%	15.5		100%	100

Soil Profile

Depth	Type	Organic Texture	Mineral Texture	Comments		
range	mineral or organic	hemic, fibric, sapric	sandy loam, silt loam, etc.			

Stability of AA	Check One
Healthy & Stable	
Beginning to deteriorate and/or some fragmentation	
Severe deterioration and/or substantial fragmentation	

Comments:

Mid-Atlantic Tidal Wetland Rapid Assessment Method V.1.0

Site # _____ Date ____/_____/_____

Attribute 1: Buffer/Landscape

B1. Percent of Assessment Area Perimeter with 5m-Buffer

Record Estimated Percent _____%	
Alternative States(not including open-water areas)	**Rating (circle one)**
Buffer is 100% of AA perimeter.	**12**
Buffer is 75-99% of AA perimeter.	**9**
Buffer is 50-74% of AA perimeter.	**6**
Buffer is <50% of AA perimeter.	**3**

B2. Average Buffer Width (max 250m)

Line	Buffer Width (m)
A	
B	
C	
D	
E	
F	
G	
H	

Average Buffer Width _____

Alternative States	Rating (circle one)
Average buffer width 190-250m	**12**
Average buffer width 130-189m	**9**
Average buffer width 65-129m	**6**
Average buffer width 0-64m	**3**

B4. Surrounding Development

Estimate Development _____%	
Alternative States	**Rating (circle one)**
250m ring has 0% development	**12**
250m ring has >0-5% development	**9**
250m ring has >5-15% development	**6**
250m ring has >15% development	**3**

B3. 250m Landscape Condition

Alternative States	Rating (circle one)
AA's surrounding landscape is comprised of only native vegetation, has undisturbed soils, and is apparently subject to no human disturbance.	**12**
AA's surrounding landscape is dominated by native vegetation, has undisturbed soils, and is apparently subject to littler or no 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 there is evidence of moderate human visitation.	**6**
AA's surrounding landscape is characterized by barren ground and/or highly compacted or otherwise disturbed soils, and/or there is evidence of very intensive human visitation.	**3**

B5. Marsh Habitat Richness

Communities and Habitats	check if present
Low Marsh	
High Marsh	
Saltmarsh Terrestrial Border	
Brackish Border	
Pannes or Pools	
Natural Channel Creeks	
Openwater	
Upland	
Number of Communities and Habitats	
Total Possible	**8**

Alternative States	Rating (circle one)
Number of Communities ≥3	**12**
Number of Communities =2	**8**
Number of Communities =1	**4**

B6. Barriers to Landward Migration

% Perimeter Obstructed _____%

Dist. From Center of AA _____m

Alternative States	Rating (circle one)
Absent: no barriers	**12**
Low: <10% of perimeter obstructed	**9**
Moderate: 10-25% of perimeter obstructed	**6**
High: 25-100% of perimeter obstructed	**3**

Attribute 2: Hydrology

H1. Ditching/Draining

Alternative States	Rating (circle one)
No Ditching	12
Low Ditching	9
Moderate Ditching	6
Severe Ditching	3

H2. Fill & Fragmentation

Estimate amount of fill _____**% of AA**

Dimensions of Fill Pile _____

Alternative States	Rating (circle one)
No fill or fragmentation	12
Low fill or fragmentation	9
Moderate fill or fragmentation	6
Severe fill or fragmentation	3

H3. Diking & Restriction

Description of restriction: _____

Alternative States	Rating (circle one)
Absent: no restriction, free flow, normal range	12
Low: restriction presumed (<10% of normal range)	9
Moderate restriction (10-25% normal range)	6
High (25-100 of normal range)	3

H4. Point Sources

Alternative States	Rating (circle one)
Absent: no discharge	12
Low: one small discharge from a natural area	9
Moderate: one discharge from a developed area or two discharges from a natural area	6
High: >2 discharges	3

Comments:

Attribute 3: Habitat

HAB1. Structural Patch Type (Minimum Patch Size 3m^2)

Structural Patch Type	Check if present
Secondary channels (ditches not included)	
Pannes or pools	
Non-vegetated flats (mudflat or sandflat)	
Abundant wrackline or organic debris	
Plant hummocks and/or sediment mounds (not fill)	
Standing snags	
Filamentous, macroalgae, or algal mats	
Shellfish beds	
Animal mounds and burrows	
Submerged vegetation	
Total Possible	**10**
# of Observed Patch Types	

Alternative States	Rating (circle one)
High ≥ 7 patch types	12
Moderate 5-6 patch types	9
Low 3-4 patch types	6
Minimal 1-2 patch types	3

HAB2. Bearing Capacity

	Mark Depth (cm)			
	Point 1	Point 2	Point 3	Point 4
Initial capacity				
Blow 1				
Blow 2				
Blow 3				
Blow 4				
Blow 5				
Final - Initial				

Average of Final - Initial for the Four Sub-	Rating (circle one)
>6.2	12
6.2-4.1	9
4.0-1.9	6
≤1.8	3

HAB3. Plant Fragments

	Record Measurement (cc)			
	Point 1	Point 2	Point 3	Point 4
2-4cm deep				

Average of Four Sub-plots	Rating (circle one)
>29.8	12
29.8-22.3	9
22.2-14.6	6
<14.5	3

HAB4. Vertical Biotic Structure

Alternative States	Rating (circle one)
Most of the vegetated plain of the AA has a dense canopy of living vegetation or entrained litter or detritus forming a "ceiling" of cover 10-20cm above the wetland surface that shades the surface and can provide abundant cover for wildlife.	12
Less than half of the vegetated plain of the AA has a dense canopy of vegetation or entrained litter as described above OR Most of the vegetated plain has a dense canopy but the ceiling it forms is much less than 10-20cm above the ground surface.	9
Less than half of the vegetated plain of the AA has a dense canopy of vegetation or entrained litter and the ceiling it forms is much less than 10-20cm above the ground surface.	6
Most of the AA lacks a dense canopy of living vegetation or entrained litter or detritus.	3

HAB5-7. Plant Community Worksheet

Floating or Canopy-forming		Invasive?	Short <0.3m	Invasive?
Medium 0.3-0.75m		**Invasive?**	**Tall 0.75-1.5m**	**Invasive?**
Very Tall >1.5m		**Invasive?**		
			# of Plant Layers	
			Total # of Native co-dominant species for all layers combined	
			Total # of Non-native co-dominant species for all layers combined	
			% of Non-native co-dominant species for all layers combined	
			Percent Invasive	

HAB5. # of Plant Layers

Alternative States	Rating (circle one)
4-5 layers	12
2-3 layers	9
1 layer	6
0 layer	3

HAB6. % Co-Dominant Non-Native Species

Alternative States	Rating (circle one)
0-15%	12
16-30%	9
31-45%	6
46-100%	3

HAB7. % Invasive

Alternative States	Rating (circle one)
0%	12
1-25%	9
26-50%	6
>50%	3

Comments

Mid-Atlantic Tidal Wetland Rapid Assessment Method V.1.0

Site Number:

Attributes and Metrics		Scores	Comments
Buffer/Landscape			
B1.			
B2.			
B3.			
B4. % of AA Perimeter with 5m Buffer			
B5.			
B6. Average Buffer Width			
250 Landscape Condition Surrounded Developed (∑(B1,B2,B3,B4,B5,B6))/72 = **Buf/Land Attribute Score** Barriers to Landward Migration Marsh Habitat Richness	**Site Name:**	Score	**Date:** ____/____/____
Hydrology	**Raw #**		
H1.			
H2.	**Raw #**		
H3.			
H4.			
(∑(H1,H2,H3,H4))/48 = **Hydrology Attribute Score** Ditching & Draining Fill & Fragmentation Diking/Restriction		Score	
Habitat			
HAB1. Point Sources			
HAB2.			
HAB3. Structural Patch Richness			
HAB4.			
HAB5. Bearing Capacity			
HAB6. Vertical Biotic Structure Plant Dominants Number of Plant Layers			
HAB7. Percent Invasives			
(∑(HAB1,HAB2,HAB3,HAB4,HAB5,HAB6,HAB7))/84 **= Habitat Attribute Score**		Score	
(Buf/Land + Hydrology + Habitat Attribute Scores) x 100 = Final Score		**Final Score =_____**	

Raw #