

Mid-Atlantic Tidal Wetland Rapid Assessment Method

Version 4.0



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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. 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 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, 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. Since the first version of MidTRAM we have updated the metrics and scaling of metrics based on additional assessments in the Inland Bays, St. Jones River, and Murderkill River watersheds in Delaware.

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:

$$\begin{aligned}\text{Buffer} &= (((\sum(B1 \dots B5))/60)*100)-25)/75)*100 \\ \text{Hydrology} &= (((\sum(H1 \dots H4))/48)*100)-25)/75)*100 \\ \text{Habitat} &= (((\sum(HAB1 \dots HAB5))/60)*100)-25)/75)*100\end{aligned}$$

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 this version 4.0 changes were made to several metrics,

This is the third version (3.0) of MidTRAM. Changes made since version 2.0 were based on data from 150 sites in the Inland Bays, St. Jones River and Murderkill River watersheds. In version 3.0 the habitat metric Plant Fragments is removed due to high sample variability, low responsiveness and failed mean rank condition tests. Also, the test habitat metric Horizontal Vegetative Obstruction is now a scored metric based on strong correlations with above ground

biomass. Horizontal Vegetative Obstruction also replaces the metric Vertical Biotic Structure which had low precision among users. The habitat metric Bearing Capacity remains a scored metric as a result of strong correlations with biomass values even though it exhibited high site variability and poor responsiveness. To capture more site variability, version 3.0 requires that 8, bearing capacity readings are taken at each site (formerly 4). The attribute and final score formulas reflect these metric changes. Lastly, in cooperation with the Partnership for the Delaware Estuary, there are test metrics to measure 2 shoreline attributes: Erosion of shoreline and presence of shoreline alterations.

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 people requires approximately 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 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 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/default/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, 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 (1:3000)
- Wetlands and hydrology (1:24000)
- Tax Parcels (1:5000)
- Road Map (1:24000)
- Soils (1:5000)
- Old aerials 1937, 1954, 1961, 1968, 1992, 1997, 2002 (1:3000)

C. Equipment List

Printed protocol	Plastic folding ruler
GPS	Compass
Maps	Datasheets
Clipboard	Pencils
Guide to identifying tidal wetland plants	Sunscreen
Shovel	Slide Hammer
2 100m Tapes or 5 50m tapes	Profile Board
Waders	Refractometer
1m ² Quadrant	Water

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 – site 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 (top right) is Back barrier estuarine fringe, green outline (bottom left) is Fringing Estuarine Tidal Fringe, yellow outline (bottom middle) is Expansive Estuarine Tidal Fringe.

ESTABLISHING THE ASSESSMENT AREA

The Assessment Area (AA) is the area within a tidal wetland that will be sampled using MidTRAM. All measurements 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.

- Mark the center of the AA.
- Establish the AA as a 50-m radius circle centered on the sample point (0.8ha area). Using 2, 100m tapes, run one transect perpendicular from the open water edge to the upland edge, 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. This will prevent walking through and trampling areas that will become the AA subplots.

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 than above. The following circumstances are for adjustments during a probabilistic survey. The placement of the assessment area for reference sampling would allow moving from the original location by more than 100m. Please note: **If the location of the AA is moved or adjusted, make detailed notes on the datasheet explaining why the AA was moved, by how far, 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* <100m until the entire AA is within the wetland boundaries.
 - If >100m 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* <100m 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 $\leq 0.8\text{ha}$ (8000ft²):
 - The AA becomes the same size as the wetland. Detail this carefully in the site sketch.
4. If the wetland is $\geq 0.8\text{ha}$, but is oddly shaped and 50m radius will not fit without touching upland or without covering >10% natural open water (800m²; 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.

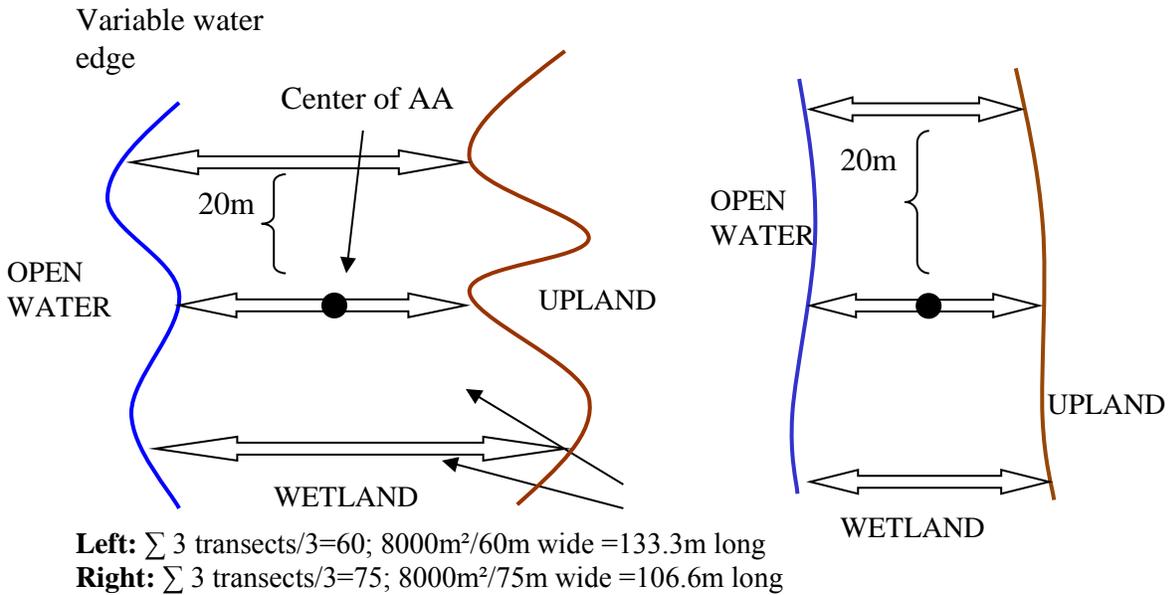


Figure 2. Illustration of how to determine the dimensions of a rectangular AA. Use the average distance between the channel edge and upland as determined from the 3 transects to calculate length and achieve a 0.8 ha rectangle.

B. Locating subplots within the AA

Subplots will all be located within the 0.8ha assessment area to perform 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 $\geq 10\%$ cover in the AA). If the given plot is not representative of a dominant vegetation type (makes up $\geq 10\%$ 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 $\geq 10\%$ 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 (makes up $\geq 10\%$ 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.

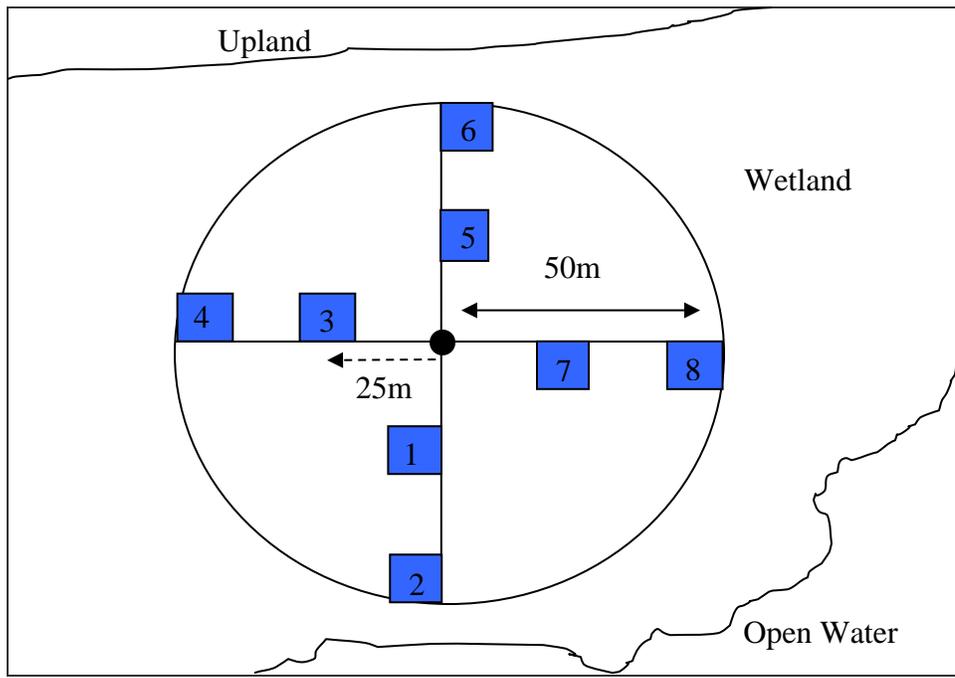


Figure 3: Location of Subplots in a circular assessment area.

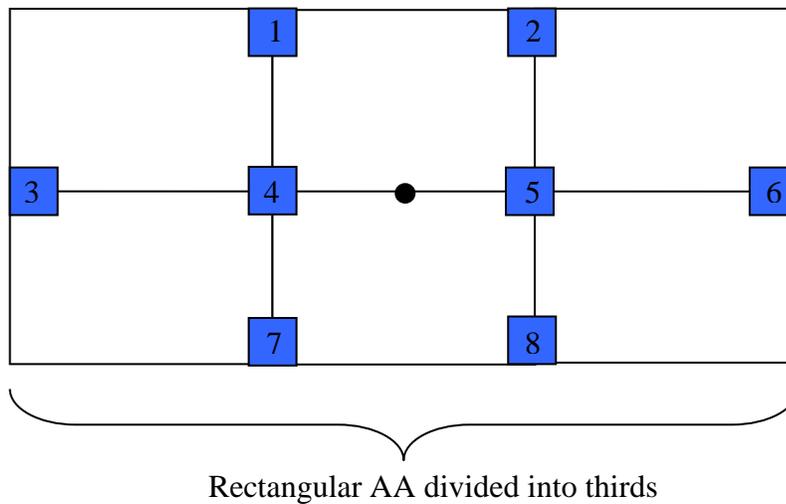


Figure 4. Location of Subplots in a rectangular assessment area.

METRIC OVERVIEW

<i>Attribute</i>	<i>Metric</i>	<i>Description</i>
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
Buffer 2	Average Buffer Width	The average buffer width surrounding the AA that is in natural or semi-natural condition
Buffer 3	Surrounding Development	Percent of developed land within 250m from the edge of the AA
Buffer 4	250m Landscape Condition	Landscape condition within 250m surrounding the AA based on the nativeness of vegetation, disturbance to substrate and extent of human visitation
Buffer 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	The presence of ditches in the AA
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
Hydrology 4	Docks and Duck Blinds	Area of AA and buffer covered by manmade structures
Habitat 1	Bearing Capacity	Soil resistance using a slide hammer
Habitat 2	Vegetative Obstruction	Visual obstruction by vegetation <1m measured with a cover board.
Habitat 3	Number of Plant Layers	Number of plant layers in the AA based on plant height
Habitat 4	Species Richness	Percent of co-dominant invasive species in the AA
Habitat 5	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

Select a unique name for the site.

Date and Time

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

Field crew

All members of the field crew

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

Based on wetland shape and location – see pages 4-5 of protocol for guidance on classification.

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.

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

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 distance from the original point to achieve a sampleable AA. See page 5 for more descriptions. Indicate '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 in each cardinal direction and of 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 is dominated by low marsh plants (*Spartina alterniflora*, *Spartina patens*) or high marsh species (*Iva frutescens*, *Baccharis halimifolia*, *Juncus gerardii*, *Schenoplectus*)

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, 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 from the center point area at least 18cm deep. Examine the core and determine the depth of the organic layer using the folding tape measurer. Note if organic layer appears to be shallow (<16cm deep) or deep (>16cm deep).

Salinity

Salinity of water in parts per thousand on the wetland surface using a refractometer.

Vegetation Communities and Features

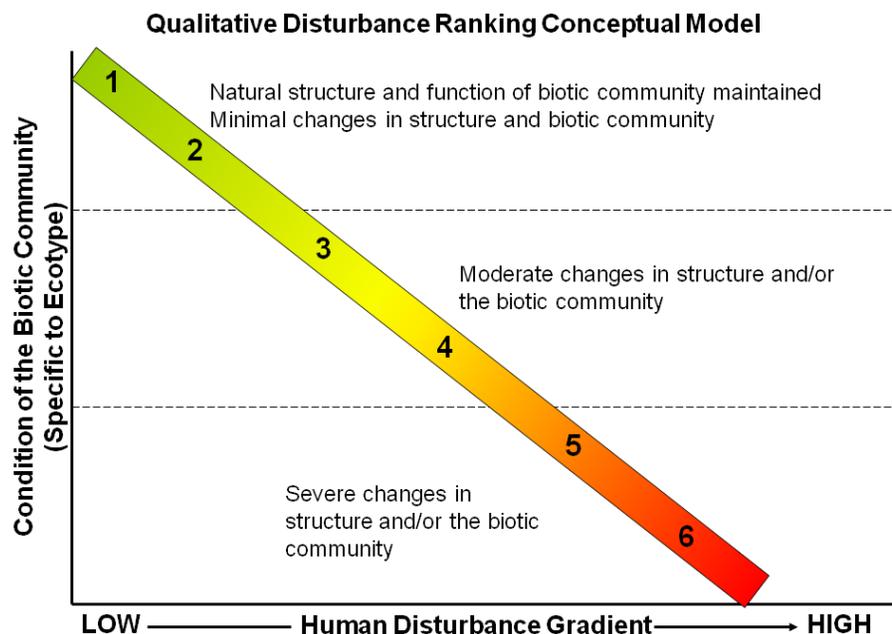
After completing the subplot measurements and walking the AA, estimate the percent cover of the plant community and wetland features present in the AA. Use the cover class and midpoint table for assistance. The values will not add up to 100% but should roughly describe the features in the AA. Common 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. 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’. Features such as a panne can overlap in both ‘pannes/pools/creeks’ and as ‘unvegetated/mud/sand’.

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.

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.

DATA COLLECTION - CONDITION METRICS

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. 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 in a natural state
2. Buffer area is used to characterize the landuses surrounding the AA (see below).
3. Landscape condition,
4. Land use impacts, and
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 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 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

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 and must be at least 10m wide and extend along the perimeter of the AA for at least 5 m.

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 1 for examples)
- Is present for at least 5m along the edge of AA
- Not Open Water- open water at least 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 it is natural and undeveloped but 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 nonbuffer.
- Consider the rest of the perimeter to be 100%.
- Determine the proportion of the perimeter that is buffer versus nonbuffer perimeter. Refer to Table 1 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 nonbuffer (road or developed).

Table 1: Guidelines for identifying wetland buffers and breaks in buffers.

Examples of Land Covers <i>Included</i> in Buffers	Examples of Land Covers <i>Excluded</i> 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: developed

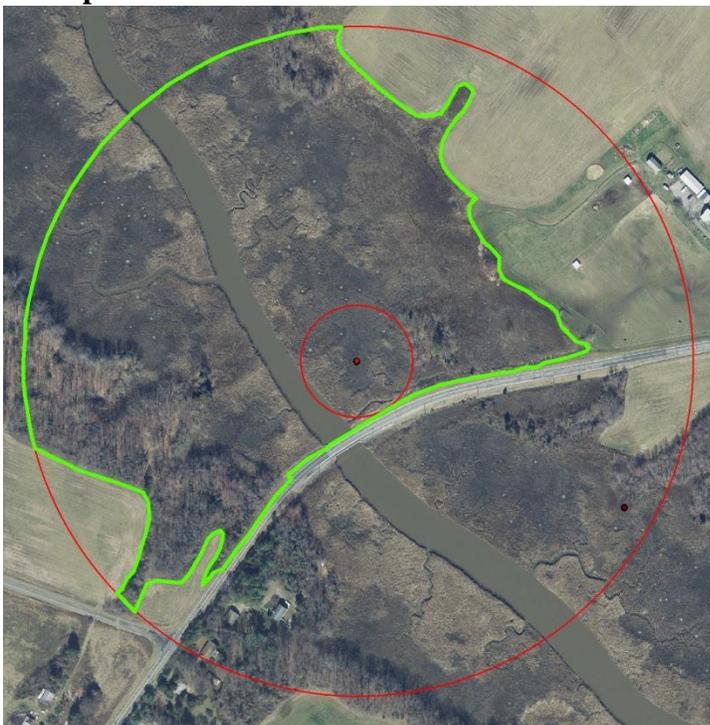
Extent: between AA edge and 250

Definition: This metric assesses the percent of the buffer area that is contiguous with the AA 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 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. 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 (274,500m²).
4. Assign a metric score based on the percent buffer area.

Example A:



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 132,076m² 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 $\geq 30\text{m}$ and across the river to the field edge where the river is $\leq 30\text{m}$ across. The area inside the green perimeter equals $87,823\text{m}^2$ which represents 32% and would be awarded a score of 3.

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. High Impact Land Uses in Buffer

Metric Source: DECAP modified

Extent: Buffer

Definition: Percent of the buffer area in unnatural or high impact land use

Assessment Protocol: Evaluate the surrounding land from the edge of the AA out to 250m. Use GIS analysis similar to B2 above and Table X below to separate high and low impact development and calculate the percent of area in each.

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 data available.

Examples of high impact land use	Examples of ag related land use	Examples of low impact land use

Golf course	Plowed fields	Park
Development (includes driveways, yards, houses, buildings)	Poultry or livestock	Fallow field
	Orchards	Timber harvest

B3: Scoring: Land Use Impacts

Area in Un-natural _____% Area in High Impact _____ %	
Alternative States	Rating (circle one)
No un-natural or high impact land uses	12
0-20% Un-Natural Land Use <i>and</i> <5% High Impact Land Use	9
20-50% Un-Natural Land Use <i>and/or</i> 5-20% High Impact Land Use	6
>50% Un-Natural Land Use <i>or</i> >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 confirmations. Use professional judgement and Table 3 to assign a metric score.

B4 Scoring: 250m Landscape Condition

Alternative States	Rating (circle one)
AA's surrounding landscape is comprised of <i>only</i> 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 are physical barriers along the shoreline that would prevent the wetland from migrating inland with increasing 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 that is obstructed from future marsh migration in the event of sea level rise.

6. Determine the direction of open water.
7. Draw a 90° 'pie wedge' behind the AA pointing away from the open water side of the AA directed landward (Figure 8, 9 and 10) to identify the area to evaluate. 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 verification and Quality Assurance checks.)
8. 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 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.

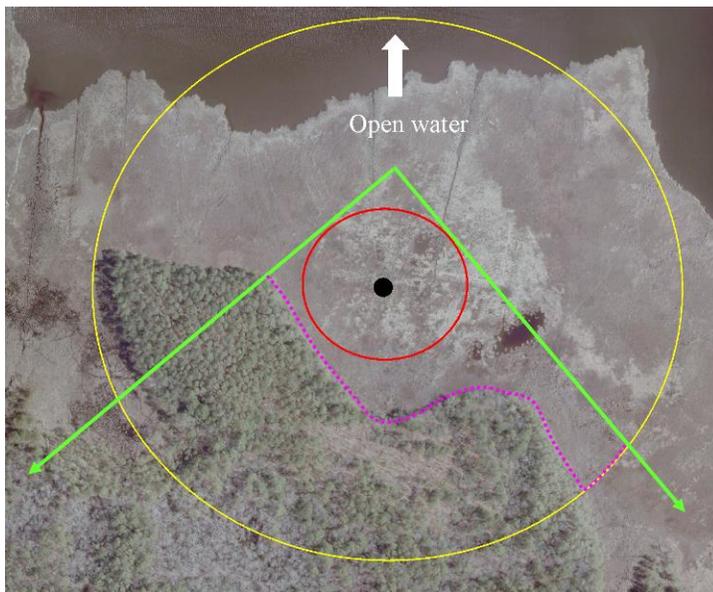


Figure 8. An example of BLM scoring. The black center point is surrounded by the red AA and yellow 250m buffer. The green arrows point landward to create the 'pie' area to be evaluated. The pink dashed line follows the wetland/upland perimeter along forest and is unobstructed. A small portion of the 250m perimeter is included in this perimeter. 0% of the landward perimeter is obstructed.

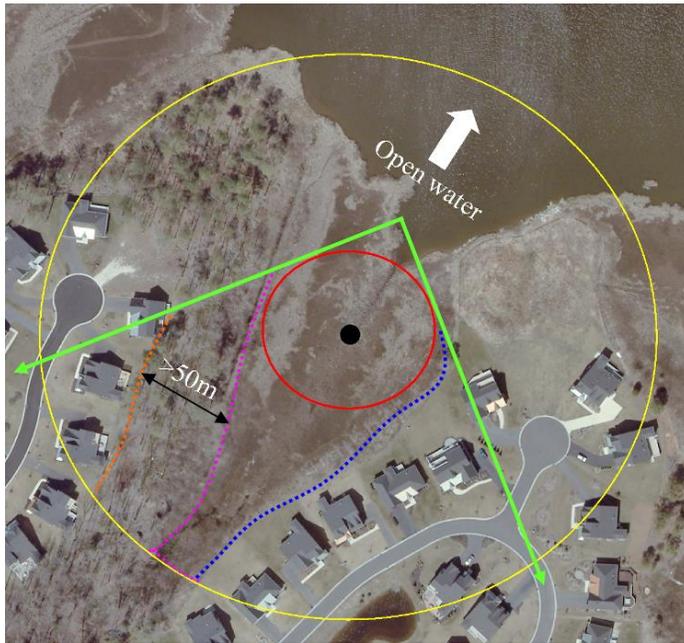


Figure 9. An example of BLM scoring. The green arrows create the ‘pie’ of area to be evaluated. The blue dashed line follows wetland/upland perimeter that is obstructed by development. The pink dashed line follows wetland/upland perimeter along forest and is unobstructed. A small portion of perimeter 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.



Figure 10. 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 road or yard. 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 & Draining and Fill & Fragmentation are measured within the assessment area; Diking & Tidal Restriction and Point Sources are measured in the AA and the surrounding 250m area.

H1. Ditching & Excavation (OMWM)

Metric Source: New England Rapid Assessment Method (NERAM; modified)
AA only

Extent: 50m AA

Definition: The extent of ditches and artificial excavation within the AA. Ditches increase or decrease the residency of water in the AA. 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 then a field visit to verify the presence and functionality of ditches. Examples below should be used as a reference for scoring. (Figures 11-14 show 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 looking for the number and size of ditches.
3. Confirm ditches in the field during the site visit as well.

Examples:

Scoring: Ditching & Excavation

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

H2. Fill

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

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. Examples below should be used as a reference for scoring. (Figures 12-13 show varying levels of fill).

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)
3. Validate observations in the field by walking the entire AA and recording the presence of fill in the AA
4. Estimate and record the dimensions of the surface area that fill is covering (e.g. 10 piles, each 1m²)
5. Determine appropriate score for site based on examples below

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 and <5%	9	
≥5% and <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

Scoring: Diking and Restriction

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

Habitat 4: Duck Blinds and Docks

Description: Measure area of AA and surrounding 250m buffer covered by manmade structures such as docks, piers, duck blinds

Extent: 250m buffer

Alternative States	Rating
Absent	12
Low:	9
Moderate	6
High	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 six metrics: bearing capacity, horizontal vegetative obstruction, number of plant layers, percent of co-dominant invasive 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. Bearing Capacity

Metric Source: New England Rapid Assessment Method (NERAM)

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. 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.



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

MidTRAM 4.0

bottom. The slide hammer is the top, weighs 7.4 pounds and is attached to a PVC ring with a 5/8th inch bolt. Measure bearing capacity in 8 sub-plots following the directions below:

1. Under Attribute 3 HAB 1, record the percent of the AA wetland in hummocks using the gray box in top left corner.
2. Measure and record the depth of surface water at each sub-plot in centimeters.
3. At sub-plot 1-8 toss a small ball (white or brightly colored golf balls work well) to determine a random sampling spot to place the flat cap bottom of the base. Push aside vegetation and place the instrument on bare ground.
4. Assemble the PVC tube and the slide hammer together first and then place gently on wetland surface at determined location.
5. Measure initial compaction by recording how deep the PVC penetrates into the ground without exerting any force, using the centimeter scale on the PVC pipe. Record this as 'Initial depth'.
6. Lift and extend the slide hammer fully; release and allow it to fall freely with gravity.
7. Without moving the slide hammer, measure compaction by reading where the marsh surface aligns with the centimeter scale on the PVC pipe. Record the depth as 'blow 1'.
8. Repeat steps 6-7 for blows 2-5. Record values in the space provided.
9. Subtract the initial depth from the final depth for subplot 1-8, average the 8 subplots and score using the options below.

****IF** unvegetated areas void of a root mat (hollows) make up >10% of the AA, bearing capacity readings should also be taken in exposed areas within the 8 sub-plots.

- Take the 'hummocks' readings as directed above.
- Record the percent hollows in the gray box under HAB1b on page 4. This reading and the recorded % hummocks should add up to 100%.
- While at each subplot, repeat the sampling procedure at the nearest spot void of vegetation and root mat (unvegetated hollow).
- Subtract the initial depth from the final depth for subplot 1-8, average the 8 subplots. Use the hummocks/hollows workspace on page 3 to calculate weighted bearing capacity for hummocks and hollows. Add the 2 weighted values.

$$X = (\text{hummock subplot average} * \text{hummock \%}) + (\text{hollow subplot average} * \text{hollow \%})$$
- To score, use the bearing capacity cutoffs listed and select the corresponding value.

Table 6: Bearing Capacity

% 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

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

HAB2. Horizontal Vegetative Obstruction

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

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

Definition: Measures the amount of visual obstruction through the subplot area due to vegetation at 5 levels in subplots 1-4 using a profile board. The profile board is 1m long and divided into 10 decimeter painted sections. Measurements are taken as the amount of board visible horizontally through vegetation from 4m away.

Assessment Protocol: Obtain profile board measurements in each of the 4 sub-plots.

- The recorder stands along the 100m tape at the subplot with a 1m dowel and the profile board.
- The observer stands 4m away from the recorder, perpendicular to the tape with the other 1m dowel.
- The profile board is held horizontally at 0.25m, 0.5m, 0.75m, 1.0m and 1.25m above the wetland surface (each height increment is measured from the top edge of board).
- The observer counts how many of the decimeter segments are visible at all through vegetation at each of the 5 heights.
- For each reading, the observer should be eye level to the height held by the recorder. The dowels are marked with the 5 height increments and used for accuracy.
- Record the value for each height and note the dominant vegetation found between the observer and the recorder.
- Sum the 5 height values for each subplot and average the 4 subplots. Use the table below to assign a score.

Table 1. Horizontal Vegetative Obstruction
Place a 0 in boxes where board is obstructed completely by vegetation.

Scoring: Horizontal Vegetative Obstruction

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

Average of 4 Subplot Totals	Rating
<7	12
<12 ≥7	9
<22 ≥12	6
≥22	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.

Assessment Protocol:

<i>Plant Height (covers ≥ 10% of AA)</i>	
<input type="checkbox"/>	Submerged or floating aquatic vegetation
<input type="checkbox"/>	Short <0.3m
<input type="checkbox"/>	Medium 0.3-0.75m
<input type="checkbox"/>	Tall 0.75-1.0m
<input type="checkbox"/>	Very Tall >1.0m

Scoring: Number of Plant Layers

4-5 layers	12
2-3 layers	9
1 layer	6
0 layer	3

HAB4. Plant Species Richness

Metric Source:

Definition:

Assessment Protocol:

<i>Amaranthus cannabinus</i>		<i>Polygonum ramosissimum</i>	
<i>Atriplex prostrata</i>		<i>Pontederia cordata</i>	
<i>Baccharis halimifolia</i>		<i>Salicornia virginica</i>	
<i>Bolboschoenus robustus</i>		<i>Schoenoplectus americanus</i>	
<i>Distichlis spicata</i>		<i>Solidago sempervirens</i>	
<i>Echinochloa walteri</i>		<i>Spartina alterniflora</i>	
<i>Hibiscus moscheutos</i>		<i>Spartina cynosuroides</i>	
<i>Iva frutescens</i>		<i>Spartina patens</i>	
<i>Juncus gerardii</i>		<i>Typha angustifolia</i>	
<i>Kosteletzkya pentacarpos</i>		<i>Typha latifolia</i>	
<i>Limonium carolinianum</i>		<i>Zizania aquatica</i>	
<i>Peltandra virginica</i>			
<i>Phragmites australis</i>			

<i>Pluchea odorata</i>		
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Scoring HAB4: Species Richness

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

HAB5. Percent Invasive Cover

Metric Source: Mid-Atlantic Tidal Wetland Rapid Assessment Method

Definition: Percent cover of invasive species in the AA.

Assessment Protocol: Survey the AA for live invasive species and estimate ~~their~~ total percent cover, 0-100%. For a complete list of Mid-Atlantic Invasive species refer to State Invasive Species Lists (Appendix A). Record the estimate. Use the cutoffs below to assign a metric score.

Scoring: Percent Invasive

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

APPENDIX A. State Invasive Species Lists

Delaware Invasive Species

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

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

Maryland Invasive Species

Acer platanoides
Ailanthus altissima
Ajuga reptans
Alliaria petiolata
Allium vineale
Ampelopsis brevipedunculata
Artemisia vulgaris
Arthraxon hispidus
Bidens polylepis
Bromus sterilis
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
Heracleum 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 spicatum
Myosoton aquaticum (Stellaria aquatica)

Ornithogalum nutans
Ornithogalum umbellatum
Paulownia tomentosa
Perilla frutescens
Phalaris arundinacea
Phragmites 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
Celastrum 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 compressa
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, Peterson & Soreng

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

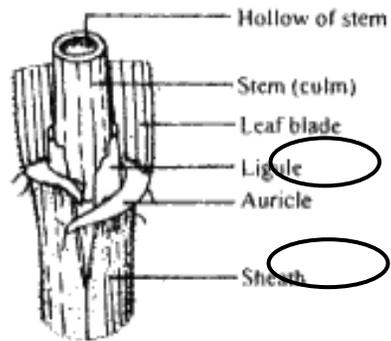
By Robert Meadows - Delaware Division of Fish & Wildlife, Newark, Delaware (robert.meadows@state.de.us)

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: <i>Remember to remove leaf sheath first!</i>			
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 Flower at nearly same time
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	
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	

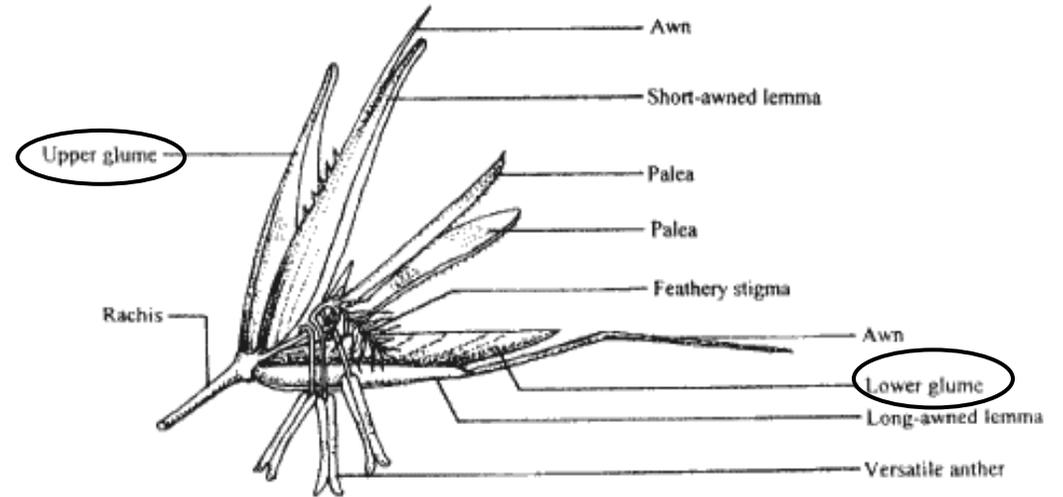
^a Characteristics 1, 4, 5, 7, and 9 are additional key field traits (the remaining traits are not required to make a positive ID).

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

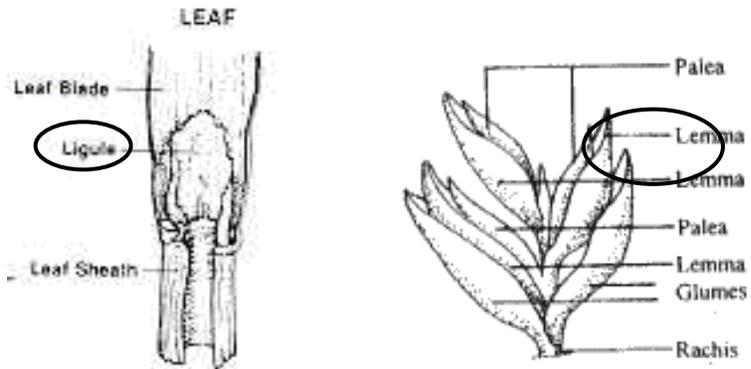
Leaf Sheath Parts



Flower Parts



Spikelet Parts (containing 3 Florets)



APPENDIX C: MidTRAM DATASHEETS

APPENDIX D: Shoreline Test Metrics

Proposed Shoreline Additions to MidTRAM v.2.0 DK, AP 6/4/10

Notes:

The MidTRAM has three core attributes, and this would add a fourth optional component. The goal is to assess the condition of the seaward edge, balancing the assessment of the landward buffer (already in MidTRAM). The shoreline component scores can be omitted from the overall RAM scoring in cases where results are to be directly compared to other MidTRAM results (i.e., the scoring is MidTRAM). If the shoreline component is included in the overall RAM scoring, the results will be presented as “modified MidTRAM” or some other name TBD.

A shoreline is defined as the area between the edge of the vegetated marsh and mean low water along the nearest adjacent water body to the assessment area. The water body must be a tidally influenced creek or open bay with a minimum width of 30 m. This criterion will ensure that the water body has sufficient surface area and fetch to be exposed to wave and erosion energies. If no suitable water body is within 250 m of the center of the assessment area, then shoreline condition will not be assessed for that point.

If >50% of the points do not meet these criteria and cannot be assessed for shoreline condition, and if additional funds allow for added fieldwork, then alternative points that satisfy these criteria can be selected from the overdraw field of random points for analysis of just the shoreline condition metrics.

The following is for potential modification of the Metric Overview table on pg 12 of MIDTRAM v. 2.0 pdf. For 2010, just test these metrics and later decide whether and how to add them to MidTRAM.

SHORELINE (S)

<u>Attribute</u>	<u>Metric</u>	<u>Description</u>
SHORELINE	S1: Shoreline Alterations	Presence of built structures or non-natural materials along the shoreline at transect points, such as bulkheads, old wharfs, rip rap, but not natural materials such as shell, debris and living shorelines.
	S2: Shoreline Erosion	Shoreline condition at shoreline transect points based on the erosion:accretion ratio.

Article I. Attribute: 4: Shoreline

While shorelines naturally change and move, their susceptibility to increased wave action due to human activities, as well as sea level rise, are not fully understood in the Delaware Estuary region. In marshes, the shoreline represents the “front-line” for either retreating or advancing marsh.

Shoreline condition is assessed with two metrics; erosion and alterations. Both of these metrics are assessed at the seaward termini for each of five transects that are oriented perpendicular to the shoreline as shown in Figure 1. These termini are referred to as “transect points.”

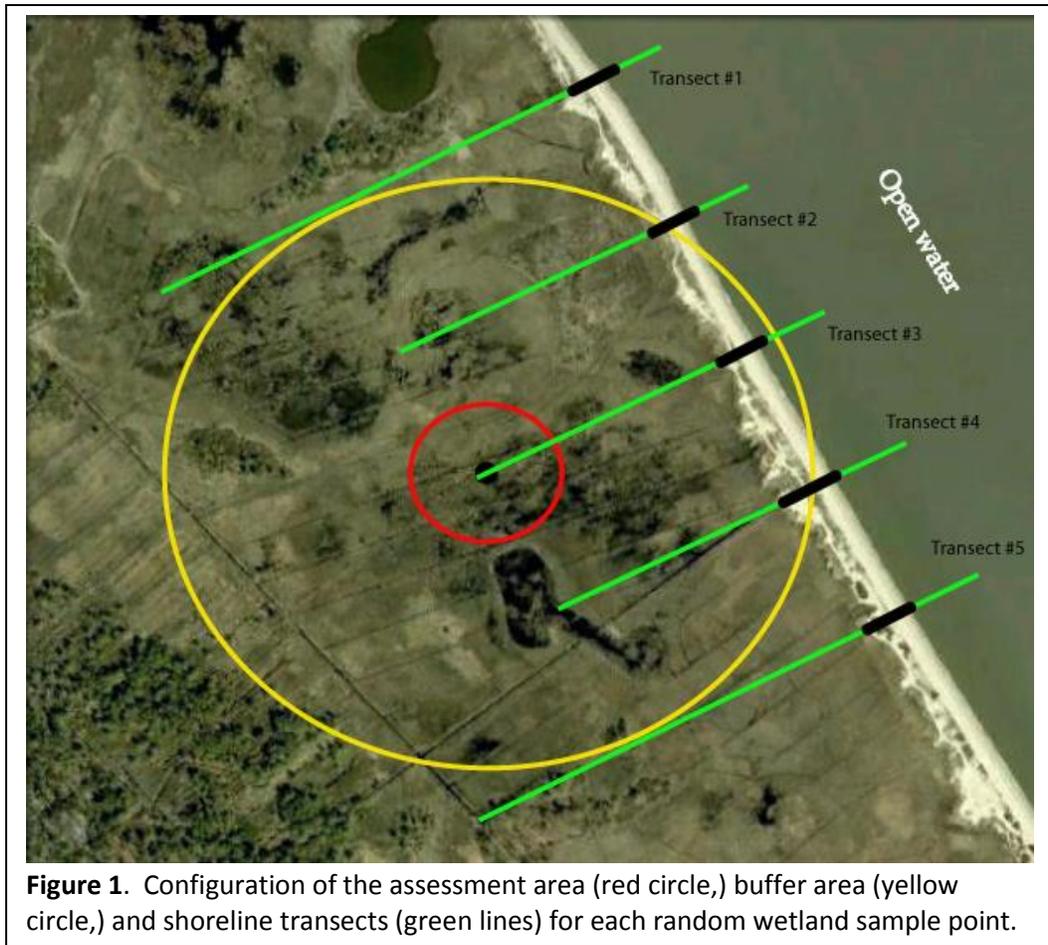


Figure 1. Configuration of the assessment area (red circle,) buffer area (yellow circle,) and shoreline transects (green lines) for each random wetland sample point.

Steps for determining transect point location (see Figure 1). Steps 1-3 should be completed using GIS prior to field work. The field crew will survey shoreline condition at five transect points using predetermined GPS coordinates. Once in the field, the field crew can adjust the location (or delete as a last resort) transect points that are found to be inaccessible or unsuitable. If a site is moved (in accordance with the MIDTRAM) then a transect will be drawn from the new point to the nearest tidal influenced, at least 30m wide, body of water. From this mid point (Point 3), the other 4 points can be determined by using GPS to pace out 150m in either direction from the midpoint then 300m from the midpoint in either direction. Shorelines are not considered if human built, ie levies, or a bay shoreline.

Identify the circular buffer area that extends 250m beyond the edge of the assessment area (AA.) Establish a linear transect from the center of the AA to the nearest tidal influenced, at least 30m wide, body of water.

In cases where the shoreline is curved, the linear transect will still be set as the shortest distance between the center of the AA and the shoreline. In cases where the AA is situated within an impoundment and there is a man-made levee or some other hydrological impediment between the AA and the shoreline, the transect will be kept as long as the body of water is tidally influenced and at least 30m wide. If this is not true the next nearest tidally influenced, at least 30m wide, body of water will be used.

In cases where transect is repositioned in the field, the location of the five transect points (see #1-5 below) will be set approximately 150m apart and actual GPS measurements will be recorded enabling calculation of exact distances later. A minimum of 3 transect points set at least 100 m apart are needed to constitute a valid shoreline assessment per point.

1. Find the nearest tidally influenced, at least 30m wide body of water.
2. Establish a transect from the center of the AA to this body of water. Where the transect intersects shoreline is Point #3.
3. Establish two transects that are parallel to the main center transect 300m on each side of the center of the AA, the outer boundary of the buffer area (see Figure 1.).
4. Establish two parallel transects that are 150m from the center of the AA. Facing the water from the AA, the transects are consistently numbered from 1-5 moving from North to South or East to West. The five transects are 150m apart.
5. The intersection of Transects #1-5 with the shoreline are the Transect Points #1-5. See above for the definition of the shoreline.
6. Two shoreline condition metrics will each be assessed at each of the five transect points preferably during the time between mid-ebb and mid-flood tides if possible for consistency. Therefore, during field assessments, the shoreline assessment portion should be completed near the beginning or end of the effort per point to ensure that at least half of the intertidal zone can be surveyed for shoreline condition. If this time frame cannot be accomplished, and the shoreline cannot be adequately viewed a score of "0", stable, will be assigned.
7. At each point, for shoreline alteration the area of focus will be a 50 m wide band through the intertidal zone, extending from the seaward edge of the contiguous vegetation to the middle of the intertidal zone (since the low intertidal zone might not always be visible). Shorelines with steep slopes will have a smaller area of focus than shorelines with gradual or terraced slopes (e.g. for examples, see Figure 2.) For the shoreline erosion metric a 20m area of focus will be considered.

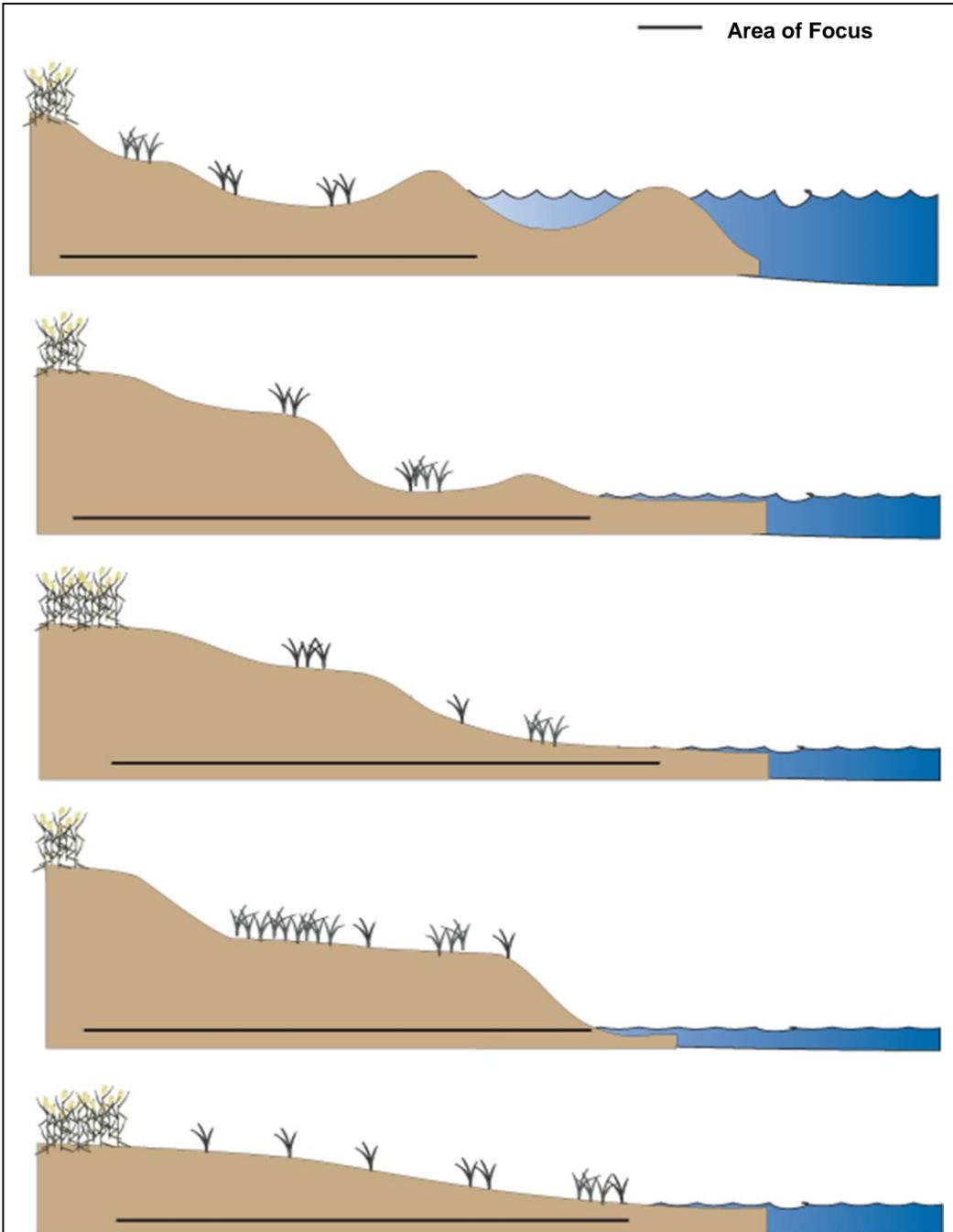


Figure 2. Area of focus (black line) for shoreline assessment for marsh edges having different slope configurations. In all examples, the dense clump of taller grasses to the left signifies the seaward margin of the contiguous vegetation, whereas small clusters of grasses within the area of focus signify clumps of vegetation or broken terraces.

Article II. **S1: Shoreline Alteration**

Definition:

Shoreline alterations are built structures that consist of hard surfaces or substrates that are not typically found along tidal wetland shorelines. Any structure that shades or disrupts the normal hydrology; examples include bulkheads, rip rap, wharfs and piers. These structures and alterations can be derelict or still maintained (for examples, see Figures 3 and 4.) Not to be included are restoration alterations that use soft or natural materials along the edge (e.g. some installed “living shorelines”, Figure 5), flotsam, or natural fill such as shell piles or woody debris.

Assessment Protocol:

Standing at the transect point where the transect exits the contiguous vegetated marsh and begins to drop in elevation through the non-vegetated intertidal zone (i.e., between the contiguous vegetated marsh edge and the mid-intertidal zone on the foreshore,) scan the immediate viewable upper intertidal zone along the shoreline for 25 m in either direction. Assess whether this 50 m section of shoreline is eroding, stable, or accreting, on average. If this is unclear, score it as stable.

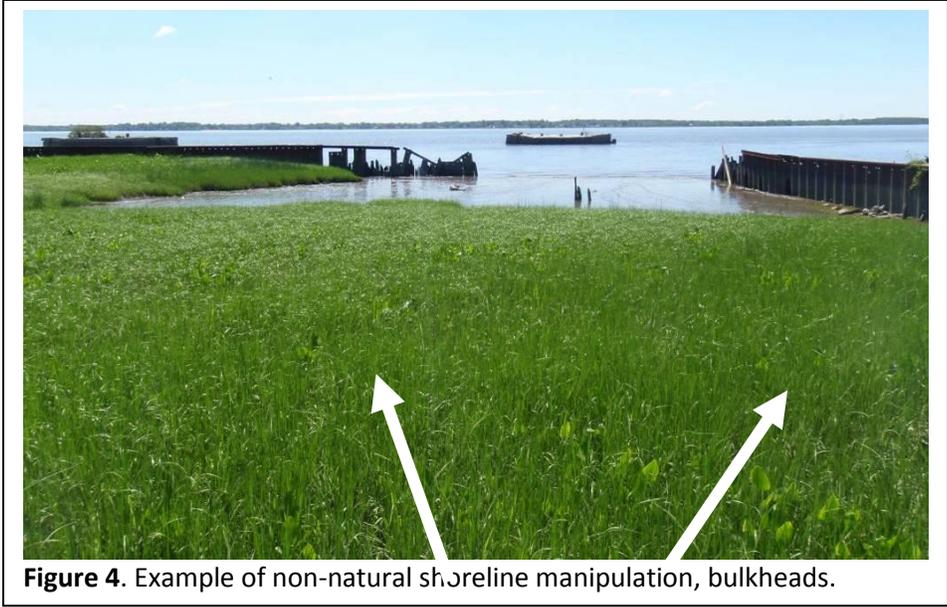
Standing at the transect points scan the immediate viewable upper intertidal zone along the linear shoreline for 25 m in either direction. Assess whether this 50 m section of shoreline contains any shoreline alterations, and if so, measure the total linear shoreline that is altered (occupied by structures or otherwise manipulated.)

Assessment Protocol:

At each transect point, measure the linear expanse of shoreline that is altered within the 50 m area of interest straddling the transect (25 m to either side.) Divide the altered shoreline length by 50 m to calculate a percentage of linear shoreline that is altered. Average this percentage among the (up to 5) transects.



Figure 3. Example of Shoreline Alteration of non-natural manipulation, a derelict pier.



Scoring: Shoreline Alterations

Percent Shoreline Altered	%
Transect 1	
Transect 2	
Transect 3	
Transect 4	
Transect 5	
Average	

Article III. **S2: Shoreline Erosion**

Definition:

Standing at the transect point where the transect exits the contiguous vegetated marsh and begins to drop in elevation through the non-vegetated intertidal zone (i.e., between the contiguous vegetated marsh edge and the mid-intertidal zone on the foreshore,) scan the immediate viewable upper intertidal zone along the shoreline for 25 m in either direction. Assess whether this 50 m section of shoreline is eroding, stable, or accreting, on average. If this is unclear, score it as stable.

See Figures 6 and 7 for examples of accretion and Figure 8 and 9 for examples of erosion. Typically, accretion is evidenced by accumulated soft sediments and seaward colonization of the foreshore by sprigs of vegetation. Erosion is typically indicated by a lack of accumulated soft sediments, exposure of non-vegetated peat, peat terraces, and sharp slopes with undercut vegetation and cusps. This metric requires that the observer estimate whether the shoreline is either generally eroding, generally accreting, or is generally stable, within a 20 m shoreline section bounded 10 m to either side of the transect point.

Assessment Protocol:

Scan the shoreline for 10 m in either direction of the transect point, focusing on the intertidal zone between the contiguous vegetated marsh and the mid-intertidal zone of the foreshore. In this 20 m of upper intertidal shoreline, estimate if the average condition is either generally eroding (-1), generally stable (0), or generally accreting (+1).

In cases where erosion or accretion is not evident, the area should be considered stable. If erosion and accretion are both evident, but balanced, then the shoreline is considered stable. Only score the area as eroding if >50% of the 20m is eroding, and only score it as accreting if >50% is accreting. If mixed patterns occur and it is unclear how to score the transect point, use a tape measure to dissect the 20 m into 10 m subsections (with the middle set on the transect point), score each subsection, average the scores, and round to the nearest whole number (-1, 0, 1).

After all transect points are surveyed (minimum of 3, ideally 5), average the scores. These will range between -1 to +1.

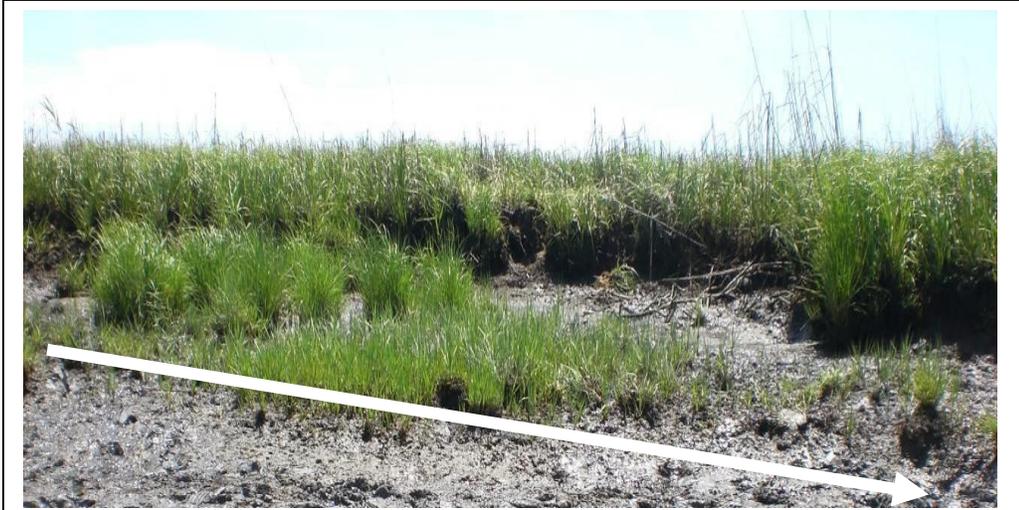


Figure 6. Accretion and Erosion; marsh plants expanding from marsh edge towards water line, but clearly previous erosion behind with an undercut bank.



Figure 7. Accretion; specifically of plants expanding onto foreshore.



Figure 8. Erosion; undercutting of banks leading to marsh slumping.



Figure 9. Erosion; specifically cusping.

Scoring: Shoreline Erosion

<p>Approximate Shoreline Erosion</p>	<p>Generally eroding (-1)/ Generally stable (0)/ Generally accreting (+1).</p>
<p>Transect 1</p>	

Transect 2	
Transect 3-Mid Point	
Transect 4	
Transect 5	
Average	



Figure 10. Erosion. Exposure of peat.



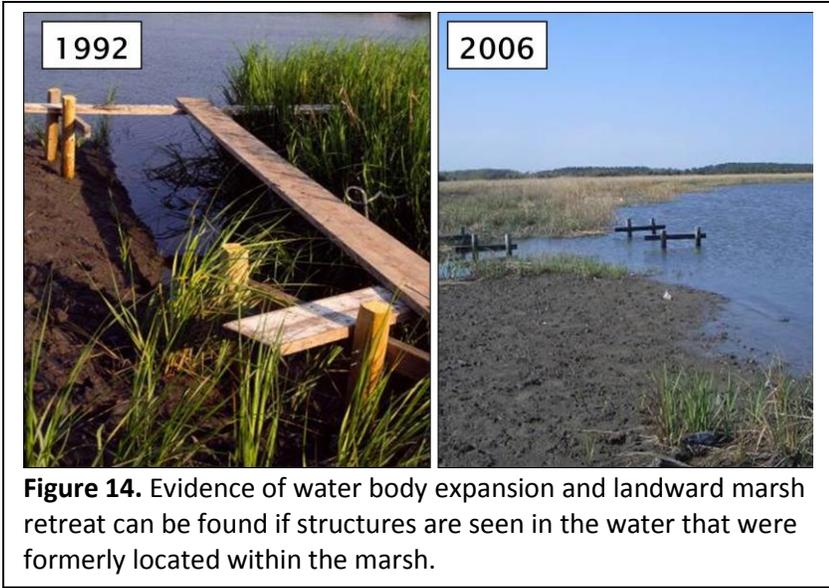
Figure 11. Exposure of erosion; peat and undercutting of banks.



Figure 12. Example of erosion; terracing.



Figure 13. Example of erosion, exposed roots.



Mid-Atlantic Tidal Wetland Rapid Assessment Method V4.0

Site # _____ Site Name _____ Date _____
 Time of Start& Finish _____:_____:_____ Crew Initials _____
 Watershed _____ Sub-Watershed _____
 lat/long _____ AA shape: circle or rectangle or entire wetland polygon (circle)
 AA moved from original location? Yes or No (circle one) If yes: distance, direction, reason _____

Classification: (circle one) Marine Tidal Fringe Fringing Estuarine Tidal Expansive Estuarine Tidal Back Barrier Estuarine Tidal	Reference or Assessment (circle one) Natural, Re-establishment, establishment Enhancement, Impoundment (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	Range of Photo Identification Numbers: Stressor Photo Description:
---	---

Assessment Area Sketch

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

Stability of AA (check one)	
<input type="checkbox"/>	Healthy & Stable
<input type="checkbox"/>	Beginning to deteriorate and/or some fragmentation
<input type="checkbox"/>	Severe deterioration and/or substantial fragmentation

Soils
 Depth of organic layer (cm): _____
 Comments on soil sample: _____

Salinity _____ ppt

Vegetation Communities and Features

Enter midpoint for each species/combination present using the cover class chart below

_____ Spartina alterniflora	_____ Phragmites australis	_____ root mat
_____ Spartina patens	_____ pannes, pools, creeks	_____ unvegetated, mud or sand
_____ Spart. alterniflora/Spart. cynosuroides	_____ open water	_____ unhealthy marsh-SWD, deterioration
_____ Spartina patens-Distichlis spicata	_____ ditches	_____ other 1 _____

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

Comments:

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

Mid-Atlantic Tidal Wetland Rapid Assessment Method V.4.0

Site # _____

Date ____/____/____

Attribute 1: Buffer/Landscape (All W/in 250m)

B1. Percent of Assessment Area Perimeter with 10m-Buffer

Percent _____%	Max: 3,456m ²
Alternative States(not including open-water areas)	Rating
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 Use Between AA Edge and 250m

% Natural Land Use _____	Max: 274,890m ²
Alternative States	Rating
100% natural land use buffer	12
75-99.9% natural land use buffer	9
55-74.9% natural land use buffer	6
<54.9% natural land use buffer	3

B3. Surrounding Un-Natural and High Impact Land Use Between AA Edge and 250m

Un-Natural Land Use _____% High Impact Land Use _____% (250m buffer = 274,890m²)

Alternative States	Rating
No Un-Natural Landuses	12
0-20% Un-Natural Land Use and <5% High Impact Land Use	9
20-50% Un-Natural Land Use and/or 5-20% High Impact Land Use	6
>50% Un-Natural Land Use or >20% High Impact Land Use	3

B4. 250m Landscape Condition

Alternative States	Rating
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 very intensive human visitation.	3

B5. Barriers to Landward Migration

	Alternative States	Rating
% Perimeter Obstructed _____% Dist. From Center of AA _____m	Absent: no barriers	12
	Low: <10% of perimeter obstructed	9
	Moderate: 10-25% of perimeter obstructed	6
	High: 26-100% of perimeter obstructed	3

Attribute 3: Habitat (All W/in AA)

HAB1a. Bearing Capacity (Hummocks) *

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

Hummocks average = _____

* if hummocks are present >10% use this workspace

_____ % of AA in hummocks x _____ hummocks avg (HAB1a) = _____
_____ % of AA in hollows x _____ hollows average (HAB1b) = _____
Sum of two weighted averages = _____

Tidal Salt

Av. of Final - Initial for the 8 Sub-plots	Rating (circle one)	Average Final-Initial=_____cm
≤ 1.8	12	
1.9-4.0	9	
4.1-6.2	6	
> 6.2	3	

HAB1b. Bearing Capacity (Unvegetated Hollows) if applicable*

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

Hollows average = _____

HAB2. Horizontal Vegetative Obstruction

Sub-plot	1	3	5	7
0.25m				
0.50m				
0.75m				
1.00m				
1.25m				
Sum				
Dominant Veg. Type				

Average of 4 Sub-plots _____

Average of 4 Sub-plots	Rating
<7	12
<12 ≥ 7	9
<22 ≥ 12	6
≥22	3

HAB3. # of Plant Layers (covers ≥ 10% of AA)

Floating/ Aquatic Species	_____
Short <0.3m	_____
Medium 0.3m- 0.75m	_____
Tall 0.75m- 1.5m	_____
Very Tall > 1.5m	_____

Number of Plant Layers: _____

Scoring Plant Layers	Rating
4-5 layers	12
2-3 layers	9
1 layer	6
0 layer	3

HAB4. Species Richness

<i>Amaranthus cannabinus</i>	_____	<i>Polygonum ramosissimum</i>	_____
<i>Atriplex prostrata</i>	_____	<i>Pontederia cordata</i>	_____
<i>Baccharis halimifolia</i>	_____	<i>Salicornia virginica</i>	_____
<i>Bolboschoenus robustus</i>	_____	<i>Schoenoplectus americanus</i>	_____
<i>Distichlis spicata</i>	_____	<i>Solidago sempervirens</i>	_____
<i>Echinochloa walteri</i>	_____	<i>Spartina alterniflora</i>	_____
<i>Hibiscus moscheutos</i>	_____	<i>Spartina cynosuroides</i>	_____
<i>Iva frutescens</i>	_____	<i>Spartina patens</i>	_____
<i>Juncus gerardii</i>	_____	<i>Typha angustifolia</i>	_____
<i>Kosteletzkya pentacarpos</i>	_____	<i>Typha latifolia</i>	_____
<i>Limonium carolinianum</i>	_____	<i>Zizania aquatica</i>	_____
<i>Peltandra virginica</i>	_____		_____
<i>Phragmites australis</i>	_____		_____
<i>Pluchea odorata</i>	_____		_____

HAB4. Species Richness

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

HAB5. % Invasive Cover in AA

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

Invasive Species Present: _____

Attribute 2: Hydrology

H1. Ditching/Excavation (OMWM) (AA only)

% of AA Ditched or Excavated	Rating
No Ditching	12
0-2.5%	9
2.6-5%	6
>5%	3

OR

H3. Diking & Tidal Restriction (250m)

Alternative States	Rating
Absent: no restriction, free flow	12
Elevated Path	9
Properly sized Dike, Levee, Bridge, Berm	6
Undersized Dike, Levee, Bridge, Berm	3

Description of Restriction: _____

	Ditch 1	Ditch 2	Ditch 3
Width 1			
Width 2			
Width 3			

H4. Docks and Duck Blinds (250m)

Description of Structure: _____

Alternative States	Rating
Absent	12
Low	9
Moderate	6
High	3

Area of Structure: _____

Distance from center of AA to Structure: _____

H2. Fill (AA only)

% of AA Filled	Rating
No Fill	12
0-5%	9
>5 <10%	6
≥10%	3

Estimate Amount of Fill: _____% of AA

Dimensions of Fill Pile: _____

	AA=7,854m ²	
1%	78m ²	9m x 9m
5%	393m ²	20m x 20m
10%	785m ²	28m x 28m

Mid-Atlantic Tidal Wetland Rapid Assessment Method V.4.0

Site Number:	Site Name:	Date: ___/___/___		
Attributes and Metrics	Raw Value	Scores	Comments	
Buffer/Landscape				
B1. % of AA Perimeter with 10m Buffer				
B2. Natural Land Use				
B3. Surrounding Land Use				
B4. 250 Landscape Condition				
B5. Barriers to Landward Migration				
(((Σ(B1,B2,B3,B4,B5))/60)*100)-25)/75)*100 = Buffer Attribute Score				
Hydrology				
H1 Ditching & Excavating (OMWM)				
H2. Fill				
H3. Diking/Restriction				
H4. Docks and Duck Blinds				
((((Σ(H1,H2,H3,H4))/48)*100)-25)/75)*100 = Hydrology Attribute Score				
Habitat				
HAB1. Bearing Capacity				
HAB2. Horizontal Vegetative Obstruction				
HAB3. Number of Plant Layers				
HAB4. Species Richness				
HAB5. Percent Invasives				
((((Σ(HAB1,HAB2,HAB3,HAB4,HAB5))/60)*100)-25)/75)*100 = Habitat Attribute Score				
((Buf/Land + Hydrology + Habitat Attribute Scores)/3)= Final Score		Final Score = _____		