USA RAM MANUAL

Version 11
January 2011

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Basic Guidance

Purposes of USA-RAM

The primary purpose of USA-RAM is to assess the overall condition and stress for the nation's wetlands as part of the USEPA 2011 National Wetland Condition Assessment (NWCA). Secondary purposes include exploring relationships between stress and condition as mediated by buffers, and providing a RAM to US States and Tribes that they can further develop for their own purposes.

Assumptions of USA-RAM

- The overall condition of a wetland is its capacity or potential to provide its full suite of functions and services, relative to reference sites.
- The overall condition of a wetland can be assessed in terms of the complexity of its visible form and structure, relative to reference sites.
- The overall stress on a wetland is the sum total and extent of human-caused processes and events that are likely to degrade wetland form and structure.
- The overall stress on a wetland can be assessed as the number of evident stressors and their cumulative extent. As the number and extent of stressors accumulates, wetland overall condition declines, regardless of wetland type or vegetation community composition.
- Indicators are visible representations of wetland form, structure, or stress. Suitable indicators can be identified using conceptual models that relate wetland form and structure to wetland processes, functions, and stress.
- For any wetland type or class, larger wetlands with more intact structure and less stress tend to have greater levels of characteristic functions and services. This can be represented by Condition Profiles and Stress Profiles.

Structure of USA-RAM

USA-RAM is designed to assess overall condition and stress for a 0.5-ha Assessment Area (AA) and its buffer (defined here as the area within 100m distance from the perimeter of the AA). Each AA is assessed in terms of Attributes of condition and stress, based on Metrics of the Attributes and Field Indicators of the Metrics (Table 1).

USA-RAM recognizes four Attributes of condition and stress: Buffer, Hydrology, Physical Structure, and Biological Structure. However, for the following reasons, the Hydrology Attribute is only assessed in terms of its stressors.

- All aspects of wetland condition are affected by hydrology. Physical structure, biological structure, and buffer condition tend to be correlated to hydrology. The importance of the Hydrology Attribute is therefore adequately reflected by the assessment of these other Attributes of condition, without having to assess

hydrological conditions per se. An assessment of hydrological stressors is necessary, however, to understand the results for of the condition assessment.

- The hydrological conditions that account for the conditions of the other Attributes is not always evident during the assessment. The observed conditions might be affected by the hydrology of a previous season or year. In general, efforts to reconstruct previous hydrological conditions tend to incur substantial uncertainty.
- Hydrology varies more that the other Attributes of condition, both within and among wetland classes. Different metrics of hydrological condition are needed to assess different types of wetlands. Wetland hydrology is therefore not well assessed by a single set of hydrological metrics, as required for USA RAM.

Table 1: USA RAM Attributes and Metrics of wetland condition and stress.

Attributes	Condition Metrics	Stress Metrics
Buffer	Percent of AA Having Buffer	Stress to the Buffer Zone
	Buffer Width	
Hydrology	None	Alterations to Hydroperiod
		Stress to Water Quality
Physical Structure	Topographic Complexity	Habitat/Substrate Alterations
	Patch Mosaic Complexity	
Biological Structure	Vertical Complexity	Percent Cover of Invasive Plants
	Plant Community Complexity	Vegetation Disturbance

Joint Sampling for USA-RAM and the Field Operations Manual

During data collection for the NWCAA, field crews will be organized to simultaneously collect all data necessary to complete both the USA-RAM and the Field Operations Manual (FOM; USEPA 2010). The Vegetation Team and the AB Team will be tasked with completing different sections of USA-RAM. The AB Team will verify and collect data for the USA-RAM Buffer Metrics (Metrics 1 - 3), while the Vegetation Team will collect data for the Stressor and Condition Metrics (Metrics 4 - 12). This will streamline data collection efforts, making time spent in the field more efficient, while matching the Metrics to the different expertise of the Teams. Each Team will receive the appropriate Field Data Forms for its particular set of USA-RAM Metrics.

How to Use USA-RAM Version 11

- Learn USA-RAM in it entirety before applying it in the field. Many of the Metrics can be addressed more-or-less concurrently when all the Metrics are understood in detail. The time required to apply USA-RAM decreases as experience in its use is gained.
- Begin each application by inspecting the entire AA and its buffer zone. Many of the Metrics can be provisionally assessed during this initial inspection.

- Record all data on the appropriate Field Data Forms using the protocols described in the FOM.
- Use USA-RAM faithfully. Finalize all the Metrics while in the field at the AA. Do not alter any Metric. However, recommendations to improve the method should be recorded and provided to the USEPA NWCA team.

Scoring Plan

USA-RAM will provide separate scores for stress and condition for each AA and its associated buffer zone. Each AA score and each buffer zone score will be the sum of their respective Attribute scores. The Attribute scores will be sums of their respective Metric scores. The Metric scores will be derived from standardized "scoring tables." The scoring tables will be used to assign each Metric result to one of four categories of condition or stress. The categories will have unique numerical values that are scaled to help distinguish between similar AAs.

Separate scoring tables will be developed for each wetland class and NWCA region. This will help assure that the USA-RAM results reflect the natural variation in form and structure between wetland classes and regions, and that similar scores for like wetlands in different regions indicate similar condition or stress (i.e., scores for like wetlands will be comparable across the country).

A regional cumulative frequency distribution (regional CFD) will be calculated for the AA scores of each wetland class. It is likely that each AA score will be assigned to one of four categories of overall condition that correspond to the quartiles of the affiliated regional CFD. This will support regional and national reports on the distribution of wetlands among different categories of condition and stress.

A final stage in the analysis of USA-RAM results will be quantification of the effect of buffer condition on the correlation between AA condition and AA stress. The intent of this analysis is to explore how buffers might be used to mitigate stress.

Establishing the Assessment Area (AA) and Buffer Area

The rules for establishing an AA and its buffer zone are the same for USA-RAM and the NWCA Field Operations Manual (FOM; USEPA 2010). Highlights of the rules are described below. For a full description of the rules see Chapters 3 and 4 of the FOM

The FOM provides strict guidelines for establishing an AA. Once the sampling POINT has been identified, the AA can be been planned. After the plan has been verified in the field (see FOM Section 3.1.2), the AA can be established (see FOM Section 3.2). The guidelines for establishing an AA are summarized below.

- The "Standard Circular AA" is a 40m-radius circle centered on the POINT.
- The "Standard Circular AA–Shifted" is used when the center of the AA has to be shifted away from the POINT to fit within the wetland area that can be assessed.

- The "Polygon AA" is used for sites that are large enough for a full-sized (0.5 ha) AA, if the AA is not a circle. In this situation a 0.5 ha polygon is established with the center of the AA situated as close to the POINT as possible.
- The "Wetland Boundary AA" is used when the total area of the site is less than 0.5 ha but at least 0.1 ha. In this case, the AA boundary coincides with the wetland boundary.

The buffer zone for an AA will be established as follows (see Chapter 4 of the FOM for full details).

- For a Circular AA, the buffer zone is the area that lies within a 100m distance of the AA perimeter or 140m from the AA center. To mark the edge of the buffer zone, four (4) 140m transects are established in the four cardinal directions from the AA center, whether or not the center is the POINT (Figure 1A on page 7 below). The buffer zone is defined by the distance greater than 40m from the AA center.
- For a Polygon AA, the buffer zone is the area that lies within a 100m distance from the polygon boundary (Figure 1B on page 7 below).
- For a Wetland Boundary AA, the buffer extends 100m from the wetland boundary.

Integration of USA-RAM with the NWCA Site Evaluation Guidelines

Before fieldwork begins, a desktop evaluation of each sampling POINT will be done as described in the NWCA Site Evaluation Guidelines (USEPA 2010). The primary purpose of this evaluation is to determine if the selected POINT is, or likely will be, in the target population. Sources of information that will be used in the desktop evaluation include, but are not limited to, aerial photos, topographic maps, NWI data, NAIP imagery, and state, county or tribal wetland resource data.

As part of the data collection for the NWCA, several of the USA-RAM Metrics will be assessed using the NWCA imagery of the POINTS as described in the NWCA Site Evaluation Guidelines (USEPA 2010). The Metrics for which data will be derived in this way are:

Metric 1: Percent of the AA Having Buffer

Metric 2: Buffer Width

Metric 6: Patch Mosaic Complexity

The measurements needed for these Metrics will be determined by the Field Crews before the AA is assessed (i.e., during the desktop evaluation) using the site packet that contains information about site location and site access (e.g., maps and aerial images).

Section A: Assessment of the Buffer

The following three Metrics are designed to evaluate the form and condition of the buffer zone and the kind of stressors and amount of stress to which it is subject. Here we define the buffer as land adjacent to the AA that is comprised of natural vegetation and lacks evidence of intrusive human activity. As described above, the buffer has a maximum width of 100m. It is assumed that the buffer helps protect the AA by mitigating stress, including the deleterious effects of human land uses that adjoin the buffer zone.

Metrics 1 and 2 will be completed in two steps. Metric 1 consists of a desktop evaluation at the time of AA planning (USEPA 2010, Chapter 3, FOM) to determine the land use surrounding each sample POINT. Once the AA is established, the land area within 100m of the AA boundary will comprise the buffer zone (i.e., the area that has the potential to serve as buffer, depending on its land use). Examples of the buffer configuration to be used for the Standard Circular AA and the Polygon AA are shown in Figure 1. The second step for metric 1 is a field verification of the data derived from the aerial imagery.

Integrated Sampling of the Buffer

In order to streamline data collection for the NWCA, the AB Team will collect data for the Buffer Metrics that are included in USA-RAM, as well as complete the field protocol for sampling the buffer zone as described in the FOM. This will allow for efficient sampling of the buffer and enable field crews to use the information provided on aerial imagery to gather data and then perform a rigorous field verification of these data.

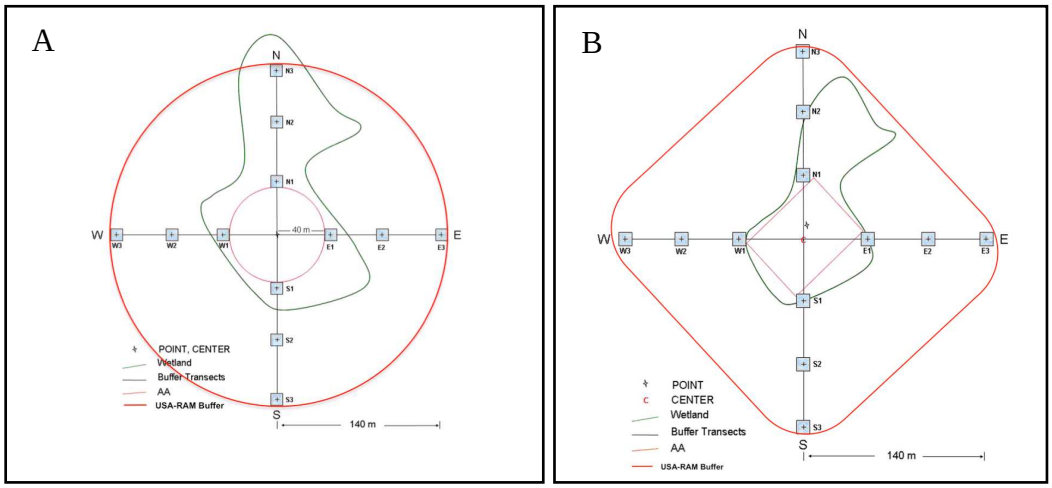


Figure 1. Establishment of the 100m buffer zone, defined as the 100m distance from the AA perimeter for a Circular AA (A) or the Polygon AA (B). Note the four transects laid out in the cardinal directions (North, South, East, West), along which are located the plots for assessing the buffer according to the FOM (original figure modified from the FOM; USEPA 2010). USA-RAM Buffer Metrics 1 and 2 will be verified when walking the four cardinal-direction transects.

Metric 1: Percent of AA having Buffer.

Land only counts as buffer if it consists of a land cover type that is capable of "buffering" the AA by protecting it from multiple kinds of stressors originating in the surrounding landscape outside. This Metric is based on the percent of the AA perimeter that adjoins a general type of "buffer land cover" as defined in Table 2. For the NWCA, land covers that might provide limited buffering under special circumstances, such as pasture land managed for ecological functions are not considered to be buffers because adequate knowledge of such localized circumstances cannot be assured throughout the survey.

General approach – The NWCA sample point imagery will be used to score this Metric, followed by ground verification of the imagery during the fieldwork. Site imagery plus field reconnaissance will be used to examine the entire perimeter of the AA and to estimate the percent of the perimeter that adjoins any type of Buffer Land Cover, based on Tables 2 and 3 below. Make estimates in increments of 5% of the distance of the perimeter of the AA. The AB Team) will implement USA-RAM protocol described here as well as the buffer sampling protocol described in the Field Operations Manual.

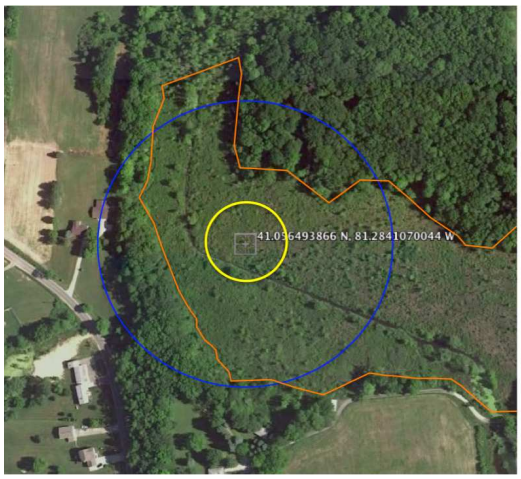
Table 2: Buffer Land Cover Criteria. To qualify as buffer, a land cover must meet all four of the listed criteria.

Buffer Land Cover Criteria
1. Is on the list of "buffer land covers" in Table 2
2. Is at least 5m wide
3. Extends at least 10m along the AA boundary as a contiguous cover **patch**
4. Is not separated from the AA by a non-buffer cover or open water that is ≥ 5m wide

Table 3: List of Buffer Land Covers based on the Anderson Land Cover Class system.

Buffer Land Covers	Non-buffer Land Covers
▪ Open water (surfaces of lakes, bays, ponds, rivers, etc. with <5% plant cover) ▪ Wetlands ▪ Permanent ice or snow (year round snow or ice surfaces with <5% plant cover) ▪ Natural, non-vegetated earth surfaces (natural rock outcrops, sand, gravel, etc. with <5% plant cover) ▪ Natural vegetation (areas with ≥ 5% cover of mostly non-impacted vegetation, including herbaceous, forest, or old fields undergoing succession; excludes lawns, playing fields, agricultural crops of any kind, recent **clear-cuts** or otherwise impacted forest lands, or recently burned lands) ▪ Trails (foot trails, equestrian trails, single-track bicycle trails, etc.)	▪ Built structures (houses, factories, schools, etc.) ▪ Artificial, non-vegetated land surfaces (parking lots, solar farms, feed lots, etc. that support <5% plant cover) ▪ Active mining areas (quarries, strip mines, gravel pits, etc.) ▪ Any active agriculture (orchards, vineyards, row crops, hay or grain fields, sod farms, feedlots, recently **clear-cut** or otherwise severely impacted forest lands, etc. Includes fallow agricultural fields) ▪ Any recently burned lands ▪ Urban and recreational lawns, sports fields, etc.) ▪ Any roadway dangerous to wildlife (railroads, busy streets, highways, etc.) ▪ ATV trails

Figure 2. Two examples of Buffer Metric 1, percent of AA perimeter having buffer.



Example 2A Worksheet

Percent of AA Perimeter Adjoining Buffer	
Land Use	**% of Perimeter**
Buffer	100
Non-buffer	0
Total % AA Perimeter with Buffer	**100**

Figure 2a: Example of buffer extent for a Standard Circular AA. Yellow indicates portions of the AA perimeter that adjoin a buffer land cover. In this case the buffer extent is 100% of the AA perimeter *(image from Google Earth)*.



Example 2B Worksheet

Percent of AA Perimeter Adjoining Buffer	
Land Use	**% of Perimeter**
Buffer	75
Non-buffer	25
Total % AA Perimeter with Buffer	**75**

Figure 2b. Example of buffer extent for a Standard Circular AA. Yellow indicates portions of the AA perimeter that adjoin a buffer land cover. In this case, about 75% of the AA perimeter is buffered *(image from Google Earth)*.

Table 4: Metric 1 data table.

Choose 1	Percent of AA Perimeter adjoining buffer
O	< 25 %
O	26 – 50%
O	51 – 75%
O	> 75%

Metric 2: Buffer Width.

The ability of an area to buffer a wetland from external stressors depends on the width of the buffer area. Minimum effective buffer widths can vary among stressors. However, it is assumed that buffers do not usually need to be wider than 100m. A width of 100m has become a commonly used definition of what constitutes a buffer for the sake of assessment in many programs, and land use in the 100m buffer has been found to be correlated with wetland condition.

For the NWCA, the AB Team will implement the USA-RAM protocol described here as well as the buffer sampling protocol described in the Field Operations Manual.

General approach - Four lines, each 100m long, are drawn from the AA perimeter on the site imagery in the cardinal directions (N, S, E, W); these are the transect lines along which the sampling plots for the FOM buffer protocol will be located. Another four lines are drawn in the ordinal directions (NE, SE, SW, NW), outward from the AA perimeter

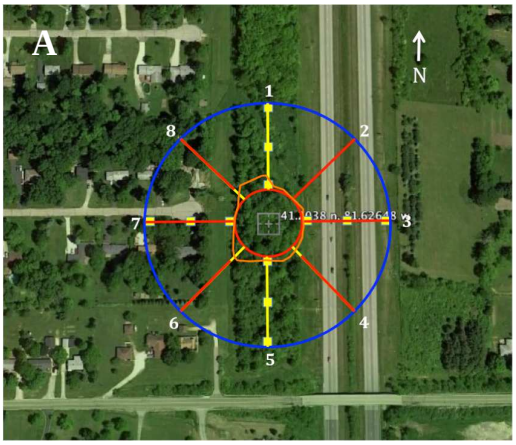
(see Figure 3 below). Lines are numbered clockwise with North as "1" as shown. Starting at the AA perimeter, the following procedure is followed.

- On each of the eight (8) transect lines, estimate the distance (meters) between the AA perimeter and the point at which the line first intercepts any type of non-buffer land cover (see Table 3 above). This distance equals the buffer width for each transect line.
- Make estimates of buffer width in increments of 5m.
- Ignore any non-buffer areas that do not cover at least 5m of a line.
- Enter the buffer width for each line in the Metric 2 Worksheet.
- See Tables 2 and 3 above for examples of buffer and non-buffer land covers.

There is potential that landuse changes may have occurred since the aerial imagery used in this Metric was developed. To ensure the best possible estimate of buffer width, the AB Team will need to ground-check the accuracy of the aerial imagery in the field. If there has been substantial change to the landscape in the 100m buffer zone, the data to indicate buffer width that are based on the imagery will have to be corrected, based on the following procedure.

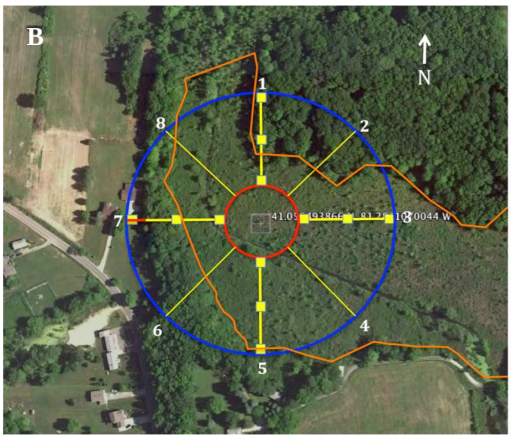
- As the AB Team walks the cardinal-direction transects to assess the buffer according to the FOM, it will also assess the usability of the aerial imagery.
- The buffer zone may also be observed from a nearby high vantage point.
- Any needed corrections should be noted by drawing on the aerial imagery.
- If the AB Team estimates that more than 10% of the buffer zone has changed (e.g., from forest to subdivision, or grassland to row crops) then the buffer width estimates along the eight transect lines must be corrected, based on the revised imagery, and the new estimates recorded on the Metric 2 Worksheet.

Figure 3. Example calculations of Metric 2: buffer width.



Example 3A Worksheet

Line	Buffer Width (m)
1	100
2	100
3	100
4	100
5	100
6	100
7	90
8	100
Average Width	**99**



Example 3B Worksheet

E

Line	Buffer Width (m)
1	100
2	0
3	0
4	10
5	100
6	20
7	0
8	15
Average Width	**31**

Figure 3A (top) and 3B (bottom). Example of buffer width calculation for Standard Circular AAs, showing AA perimeter (red), 100m area around AA (blue), and wetland boundary (orange). The eight transect lines are shown including the four cardinal-direction lines (yellow) with the buffer plots (yellow boxes) according to the FOM. Red portions of transect lines indicate non-buffer land use. The example worksheets show the buffer width along each line, and the average buffer width that is the Metric result.

Table 5: Metric 2 data Table.

Transect Line	Buffer Width (m)
1	
2	
3	
4	
5	
6	
7	
8	
Average Width	

Metric 3: Stress to the Buffer Zone.

Buffer areas can provide some protection to wetlands from human activities and the stressors they can generate. This metric is designed to tabulate and characterize the types and severity of stressors that can act to reduce the effectiveness of the buffer in protecting the AA from activity in the surrounding landscape.

For the sake of this Metric, the buffer zone is considered to be the entire 100m area around the AA, regardless of land use. Stressors that occur in land use covers, whether or not they count as buffers (see Table 3), have the potential to directly impact the AA. Therefore, stressors that occur in any land use within 100m of the AA will be tallied using the provided checklist.

General approach - Buffer stress will be assessed by the AB Team as it walks the four cardinal-direction transects (N, S, E, W) established in the buffer zone to assess the buffer according to the FOM. The AB Team will thoroughly examine the buffer zone along these transects and the visible adjoining buffer zone for evidence of stressors. It is particularly important to investigate any evidence of stressors noted in the buffer zone on the aerial imagery or maps, even if such evidence occurs away from the four cardinal-direct transect lines.

Observations will be made using site imagery, direct field observations, maps, and any other useful sources of information. Only stressors that are observed at the time of the field assessment should be counted. Indicators of past disturbance tend be less reliable and should not be considered.

This Metric is assessed based on the number of stressors that are evident (i.e., their presence – absence), as well as their severity. The severity of a stressor is characterized based on the portion of the entire buffer zone that the stressor apparently influences, using the guidelines shown in Table 6. The field indicators of stress are provided in Table 5, and are organized by Stressor Category (i.e., Hydrology, Habitat/Vegetation, Residential/Urban/Commercial Land Use, and Agriculture). All stressor indicators that are observed in the buffer zone should be checked, and the severity of that stressor must be indicated. After the checklist has been completed for a Stressor category, the overall severity of stress for the Categories is estimated on the field form.

Table 6: Guidelines for assessing stressor severity.

Portion of Buffer Zone Influenced by Stressor	Severity Code
less than one-third	1
between one-third and two-thirds	2
at least two-thirds	3

Table 7: Indicators of stress in the buffer zone. Rank each observed indicator based on Table 6 above. Rank the overall severity of stress for any Stressor Category with observed stress indicators. **Do not include these overall rankings for Stressor Categories in the final tally of stressors.**

If stressor is present, mark its severity			**Field Indicators by Stressor Category**
1	***2***	***3***	**Hydrological Stressors**
1	**2**	**3**	**Ditches**/ drains/ channelization
1	**2**	**3**	**Dikes**/dams/**levees**/ railroad or road beds
1	**2**	**3**	Culverts, pipes (point source discharge except stormwater) in buffer zone
1	**2**	**3**	Water level control structure
1	**2**	**3**	Obvious spills, discharges or odors; unusual water color or foam
1	**2**	**3**	Moderate to heavy formation of filamentous algae
1	**2**	**3**	Excavation, dredging
1	**2**	**3**	Fill / spoil banks
1	**2**	**3**	Wall/riprap
1	**2**	**3**	Inlets and outlets
1	**2**	**3**	Input from impervious surfaces (stormwater culvert)
1	***2***	***3***	**Habitat/Vegetation Stressors**
1	**2**	**3**	**Soil subsidence**, scour or surface erosion (root exposure)
1	**2**	**3**	Substrate disturbance (ATVs off-road vehicles, mountain biking)
1	**2**	**3**	Sediment input (construction, erosion, agricultural runoff)
1	**2**	**3**	Forest - **selective cut**
1	**2**	**3**	Forest - clear cut
1	**2**	**3**	Removal of **large woody debris**
1	**2**	**3**	Tree plantation present
1	**2**	**3**	Heavily grazed grasses, excessive grazing
1	**2**	**3**	**Tree** canopy herbivory
1	**2**	**3**	**Shrub** layer browsed
1	**2**	**3**	**Fire lines** (fire breaks)
1	**2**	**3**	Recently burned forest canopy
1	**2**	**3**	Recently burned grassland
1	**2**	**3**	Mowing/shrub cutting (brush hogging)
1	**2**	**3**	Other mechanical plant removal
1	**2**	**3**	Chemical vegetation control (herbicide application)
1	**2**	**3**	Cover of non-native or **invasive species**
1	**2**	**3**	Presence of power lines or utility corridors (continual maintenance)
1	**2**	**3**	Oil/gas wells
1	**2**	**3**	Logging roads
1	**2**	**3**	Trails
1	***2***	***3***	**Residential/Urban/Commercial Stressors**
1	**2**	**3**	Suburban residential land use
1	**2**	**3**	Urban multifamily land use
1	**2**	**3**	Urban/commercial buildings

Table 7 (continued).

1	**2**	**3**	Road – gravel
1	**2**	**3**	Road – 1 or 2 lane paved
1	**2**	**3**	Road- 4 lane
1	**2**	**3**	Parking lot/ pavement
1	**2**	**3**	Lawn/ park
1	**2**	**3**	Golf course
1	**2**	**3**	Landfill
1	**2**	**3**	Gravel pit/mining
1	**2**	**3**	Surface mine
1	**2**	**3**	Military land
1	**2**	**3**	Trash/ dumping
1	***2***	***3***	**Agricultural Stressors**
1	**2**	**3**	Pasture / rangeland
1	**2**	**3**	Row crops
1	**2**	**3**	Small grains
1	**2**	**3**	Nursery
1	**2**	**3**	Orchard
1	**2**	**3**	Dairy
1	**2**	**3**	Confined animal feeding operations
1	**2**	**3**	Irrigation (irrigated land)
1	**2**	**3**	Fallow field – recent
1	**2**	**3**	Fallow field – old
1	**2**	**3**	Rural residential
			A. Note the total number of marks in each column (not including marks for Stressor Category)
1 x **__**	***2 x*** **__**	***3 x*** **__**	**B. Multiply "A" above by its corresponding severity score**
			C. Add together the numbers from "B" above.

Section B: Assessment of Wetland Form and Structure

Physical Structure Attribute

Metric 4: Topographic Complexity.

Natural wetlands develop topographic relief due to variations in sediment production or deposition, erosion or oxidation of sediments, variations in hydroperiod, wildlife activities, etc. The resulting relief can be evident at multiple spatial scales. Increases in **micro-relief** represent increases in the surface area of a wetland and therefore can lead to increased bio- and geo-chemical processes at the sediment-water or sediment-air interface. It can also represent an increase in habitat quantity and diversity for diminutive forms of plants and animals, including plant propagules, insects, and amphibian larvae. Increases in **macro-relief** can lead to increases in the diversity of larger species or larger colonies of diminutive species, and plant community zonation.

General approach – the number of standard indicators of macro- and micro-topographic relief evident in the AA is used to assess its overall topographic complexity. To aid in the assessment, the likely influence of the indicators on the topographic cross-section of AA should be considered (Figure 4).

Macro-relief refers to the overall shape of the profile, including major changes in its steepness and the locations and sizes of persistent topographic features such as **benches**, plains, **berms,** furrows, **channels,** etc. **Micro-relief** refers to less persistent relief that occurs as details or elements of the macro-relief, such as animal burrows, **soil cracks**, surface objects (e.g., woody debris, cobbles or boulders), etc.

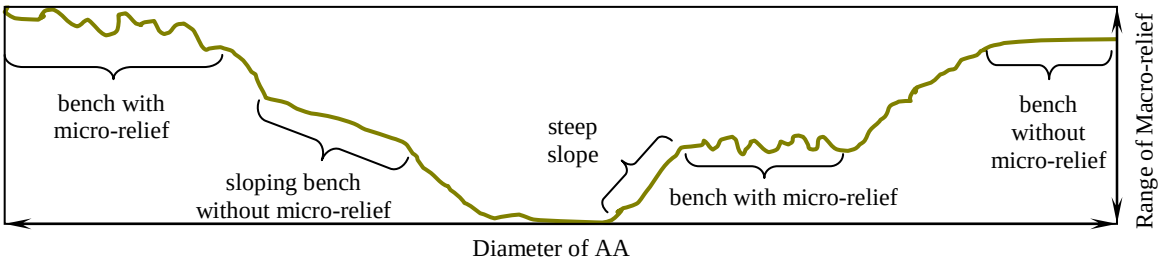


Figure 4: Example topographic cross-section of an AA showing the effect of macro- and micro-relief on overall topographic complexity. In this example, there are two **benches** and intervening slopes that account for the **macro-relief** of each half of the AA. Some of the **benches** and slopes have **micro-relief**, which might result from **woody debris**, **tussocks**, cobbles, animal burrows, etc. The vertical scale, which spans the total range of **macro-relief**, is exaggerated relative to the horizontal scale, which spans the AA.

Table 8: Checklist of field indicators of topographic complexity observed in the AA. Bold terms are in the glossary. An indicator should not be checked unless it covers at least $2m^2$ of the AA. For example, animal burrows should not be checked unless, *in aggregate*, they cover at least $2m^2$ of the AA.

Indicators	Check if observed
Multiple horizontal plains, **benches**, t**erraces**, or **flats** at different elevations	
Multiple slopes of varying steepness	
Natural or artificial **levee** or **berm**	
Bank slumps or undercut banks	
Undercut banks	
Multiple high water marks etched in substrate	
Potholes, sink holes or similar depressions not caused by animals	
Natural or artificial **channels**	
Natural or artificial **swales**	
Animal burrows or spoil piles from burrows (including ant or termite mounds)	
Animal tracks deep enough to hold water (e.g., cattle or elk tracks)	
Wallows, pig damage, or similar scale excavations by animals	
Inorganic **sediment mounds** not made by animals	
Natural or artificial debris or **wrack** along high water lines	
Natural or artificial debris in topographic low areas	
Natural or artificial debris dispersed across AA (**tree** limbs, lumber, etc)	
Plant hummocks or **tussocks**	
Soil cracks or fissures	
Cobbles or boulders	
Bare ground	
Total Number of Indicators Observed	

Metric 5: Patch Mosaic Complexity.

This metric addresses the structural complexity of the AA in plan-view (i.e., as viewed from above), based on the number of structural **patches** and their zonation or interspersion. When viewed from above, most wetlands are **mosaics** of different **patches** of substrate or plant cover. The complexity of the **mosaic** has two basic aspects: the diversity of the component **patches** and the degree to which they are interspersed (i.e., the amount of interface between multiple p**atches**). Within a given wetland class, the diversity and levels of ecological function of a wetland **mosaic** are expected to increase

with its overall complexity. The basic assumption is that more **patches** and more interface between them translates into more kinds of habitat and broader ranges in habitat condition, as well as more kinds and higher levels of material and energy transformation per unit area of the **mosaic**.

General approach – This metric is assessed based on visual comparisons between the AA, as viewed in NAIP imagery or imagined in plan-view, and schematic diagrams of the full range of possible **patch mosaic** complexity. The scale at which the AA is viewed must be standardized. The AA should be viewed or envisioned in its entirety. The 1m-pixel NAIP imagery supports this view. However, expert field personnel can also imagine a detailed orthogonal view of the entire AA based on their on-the-ground reconnaissance.

Table 9: Suggested **patch** types. The following surfaces or land covers should be considered possible **patches,** if they are *obviously visibly distinct* when the entire AA is viewed or envisioned from above. Each **patch** must cover a contiguous area of at least $10m^2$ to be considered for this metric. Inert constructed covers, such as pavement, roofs, etc., are ignored.

Mono-specific **patches**, including **patches** of one **tree** or **shrub** species, etc.
Visibly distinct assemblages of plant species; p**atches** may have species in common.
Surface water visible in lakes, lagoons, **channels**, wetlands, etc.
Bare substrate (i.e., < 5% plant cover), such as bedrock outcrops, river bars, etc.
Natural organic debris, including tree fall, flood deposits, etc.

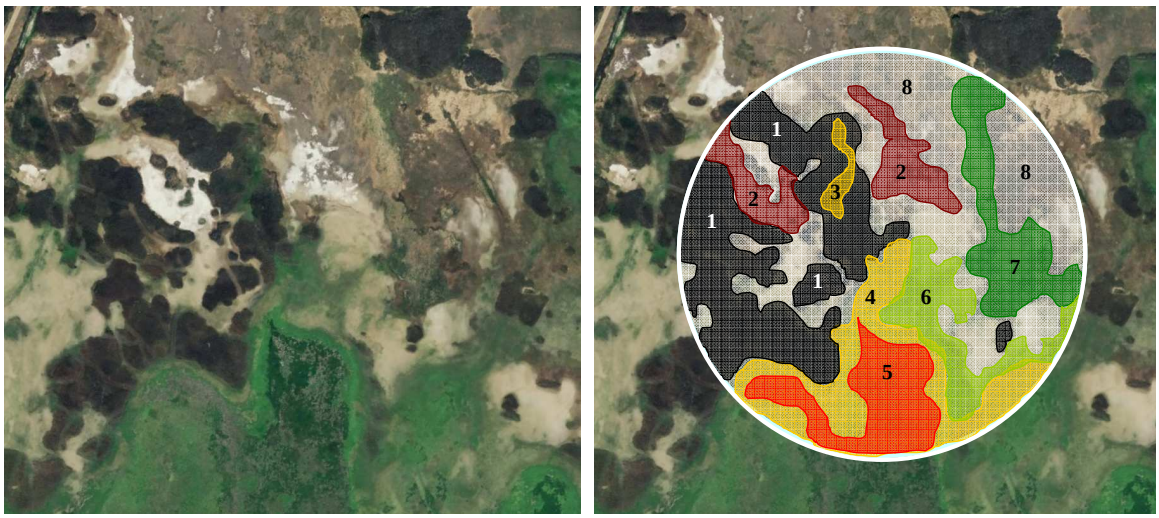
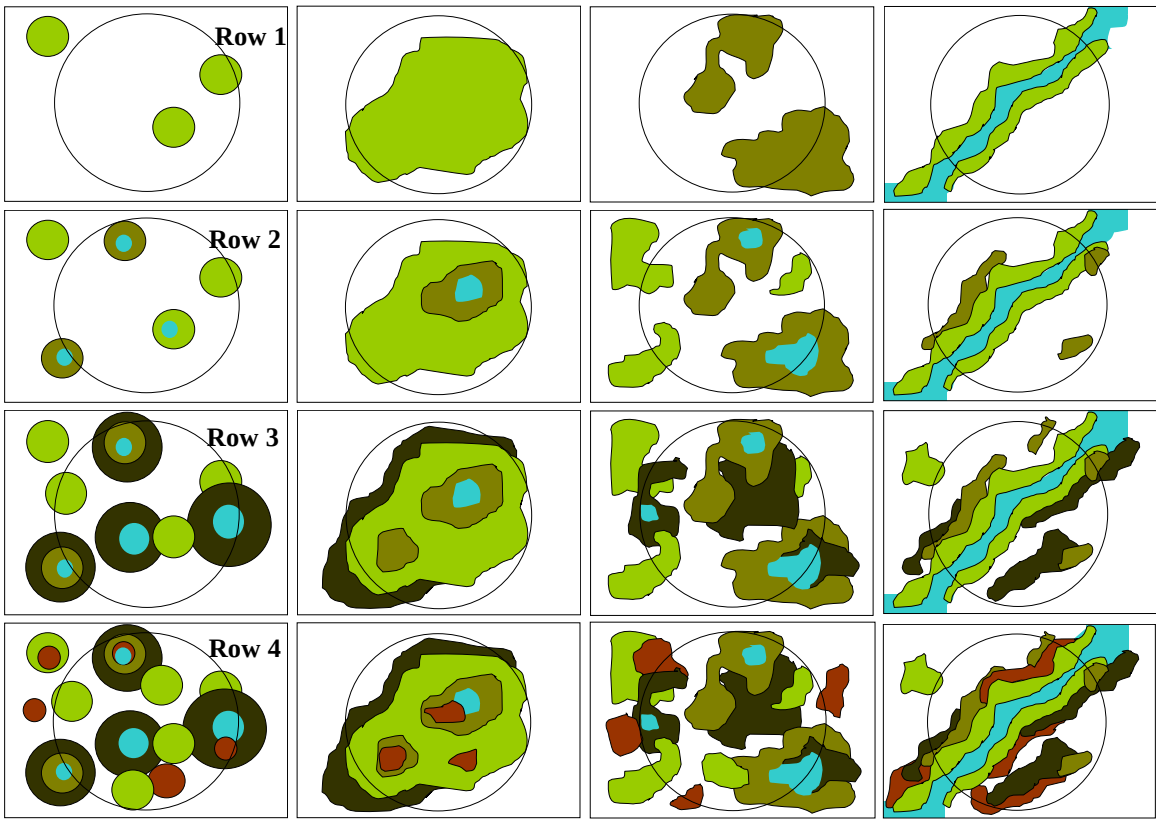


Figure 5: Example sketch of a **patch mosaic** (right-side image) based on NAIP imagery (left-side image). The white area in the **mosaic** is the matrix or background **patch** type. The other colors represent **patches** of different plant species, distinct assemblages of plant species, or bare ground. This **mosaic** has eight **patch** types, including the matrix.

Figure 6: Schematic diagrams of alternative **patch mosaics**. Each column of sketches represents a different **patch** pattern or template, ranging from separate circular **patches** (far left column) to parallel linear **patches** (far right column). For each column, **mosaic** complexity increases from Row 1 to Row 4. The large circle in each case represents the AA. The non-colored (white) area represents the matrix of the AA, or its background **patch** type. It could be upland. Blue represents standing water. Other colors represent **patch** types based on Table 9 above.



Select the diagram that most closely resembles the actual AA. The **mosaic** within the AA might appear to consist of replications of one of these diagrams. Any AA with a simpler **mosaic** than indicated in Row 1 should be assumed to belong to Row 1. Any AA with a more complex **mosaic** than indicated in Row 4 should be assumed to belong to Row 4.

Table 10: Metric 5 data table.

Selected the Row Number of the Mosaic That Most Resembles the AA
1
2
3
4

Biological Structure Attribute

Metric 6: Vertical Complexity.

This metric addresses the vertical structure of the plant community in terms of its component number of **plant strata**. Different strata provide different physical and ecological services. Tall vegetation tends to be more efficient at intercepting and holding rainwater, providing shade, serving as sources of allochthonous inputs, and moderating air temperature. Low-growing vegetation can shield soils from intense rainfall while serving as forage for herbivorous game. Transpiration by wetland plants can cause diel fluctuations in groundwater height or surface water depth. Perennial wetland plants tend to produce abundant below-ground biomass that influences substrate elevation and chemistry. Animal species tend to partition themselves vertically among wetland and riparian **plant strata**. The basic assumption is that more strata translates into more kinds of habitat and broader ranges in habitat condition, as well as more kinds and higher levels of material and energy transformation for the wetland as a whole.

General approach –The following worksheet is used to identify the dominant **plant strata** of the AA. USA-RAM recognizes seven (7) strata: **Submerged Plants, Floating** or **Floating-Leaved Plants, Tall Emergent Plants, Short Emergent Plants, Short Woody Plants, Tall Woody Plants,** and **Vines.** The absolute percent cover of each plant stratum is estimated in increments of 10%, based on a reconnaissance of the AA and site imagery. Each stratum is then assigned to one of five cover classes based on Table11 below. Dominant strata cover at least 10% of the AA. Cover estimates should include vegetation covering the AA but rooted outside the AA. Data can include standing stock from previous seasons, but all data must represent observed conditions rather that hindcasts or forecasts.

Table 11: Absolute cover of **plant strata**. Mark the category of absolute percent coverage of the AA that best fits each plant stratum. Since strata can overlap, their combined coverage can exceed 100%. See Glossary for definitions.

Plant Strata (see glossary)	**Percent Coverage**				
	< 10%	**10-15%**	**16-25%**	**26-50%**	**>50%**
Submerged Plants (any depth)					
Floating or Floating-leaved Plants					
Short Emergent Plants (< 0.5 m)					
Tall Emergent Plants (≥ 0.5 m)					
Short Woody Plants (shrubs and trees <5.0m)					
Vines					
Tall Woody Plants (shrubs and trees ≥ 5.0m)					
Total Number of Plant Strata Covering at Least 10% of the AA					

Metric 7: Plant Community Complexity.

Metric 7 addresses the diversity of plant species that dominate the **plant strata**. Since different species tend to have different growth patterns and morphometry, an increase in species diversity within a stratum tends to increase its internal architectural complexity. Different species are hosts to different parasites and diseases, may support and depend on different pollinators, can serve as cover or forage for different animal species, and may play very different roles in pollutant uptake and nutrient cycling. Within a wetland class, the diversity and levels of ecological function of a wetland are expected to increase with the number and abundance of different plant species. The basic assumption is that within a wetland class, greater diversity of co-dominant species translates into more kinds and higher levels of wetland functions.

General approach – In Table 12 below, mark the dominant plant strata (those that cover at least 10% of the AA), based on Table 11 of Metric 6. For each of these dominant strata, list the plant species that comprises at least 10% relative cover. Estimates of relative cover should be made in 10% increments. The listed species are the co-dominant species for each dominant stratum. The invasive status of each co-dominant species should also be determined. Users of this method may refer to local invasive plant species lists or resource agencies to determine which species are to be considered invasive. For a

list of targeted species defined for the NWCA, consult the **NWCA FOM Appendix B - Targeted Invasive Alien Plant** Species. This information will be useful in the assessment of stress due to invasive species in Metric 11.

Table 12: The invasive status and relative percent cover of co-dominant plant species of the dominant plant strata. Disregard strata with less than 10% absolute cover of AA (see Metric 6). Information about invasive status is used in Metric 11.

Plant Strata disregard strata with less than 10%cover (see Metric 6)	**For each Plant Stratum List All Plant Species Comprising at least 10% Relative Cover**					
	Species Name	**mark if Invasive**	**% Cover**	**Species Name**	**mark if Invasive**	**% Cover**
Submerged (any depth)						
	Total Percent Coverage for All Invasive Species in Stratum					
Floating or Floating-leaved						
	Total Percent Coverage for All Invasive Species in Stratum					
Short Emergent (herbaceous, < 0.5m)						
	Total Percent Coverage for All Invasive Species in Stratum					
Tall Emergent (herbaceous, ≥ 0.5 m)						
	Total Percent Coverage for All Invasive Species in Stratum					
Short Woody (shrubs, trees <5.0m)						
	Total Percent Coverage for All Invasive Species in Stratum					

Table 12 (continued).

Vines (any present)						
	Total Percent Coverage for All Invasive Species in Stratum					
Tall Woody (shrubs, trees ≥ 5.0m)						
	Total Percent Coverage for All Invasive Species in Stratum					
Total number of listed species for all plant strata combined (Do not count any species more than once).						

Section C: Assessment of Stressors in the AA

The following Metrics are used to assess stressors within the AA. Stress to the buffer is considered in the preceding Section A.

The primary purpose of the Stressor Metrics is to assess the distribution and severity of stressors within and among regions of the US. Information on stressors is valuable for diagnosing the causes of impairment and for determining what remediation or rehabilitation measures are warranted. A secondary purpose is to gain insight into possible causes for low condition scores. To meet this purpose, each Stressor Metric is designed to provide information relevant to one or both Metrics of an Attribute of condition. As explained in Section B, the Hydrology Attribute is assessed only in terms of its stressors.

The effects of stressors on wetland condition tend to increase with the number of different kinds of stressors and their severity, regardless of wetland type or vegetation community. The severity of a stressor depends on its duration, intensity, frequency, and proximity. The field indicators of stress tend to integrate across these parameters, such that they are not assessed independently.

However, by observing whether the stressor indicators are obvious and pervasive, subtle and highly restricted, or characterized as more moderate, the users should be able to judge whether each stressor has a high, medium, or low degree of severity. Additional evidence of stressors that is provided by maps, aerial imagery, and local reports can also be used. Each observed indicator will be ranked according to Table 13 below.

Table 13: Descriptions of stressor severity ranks.

Severity	Rank
Not severe - the stressor is present, but does not appear to negatively impact any Attribute of condition in the AA.	**1**
Moderately severe - the stressor is present and appears to have moderately negative impacts on one or more Attributes of condition in the AA.	**2**
Severe - the stressor is present and appears to have major negative impacts on one or more Attributes of condition in the AA.	**3**

The stressors in the following Metrics will be assessed based on these integrated rankings of stressor duration, intensity and frequency, and not based on aerial extent as was done for Metric 3. Walking the AA to make observations will be necessary, but care must be taken not to damage or trample the vegetation or other habitat features within the AA.

Hydrology Attribute

Metric 8: Stress to Water Quality.

Hydrology has been called the "master variable" that determines the structure, function and ecosystem services provided by wetlands. It includes measures of both water quality (Metric 8) and quantity (Metric 9). Human activities that degrade water quality include discharge from **point sources**, watershed activities that result in high sediment loads, nutrient runoff, mine drainage, or excess salts. As stressors accumulate at a site, services such as biodiversity support and biogeochemical cycling are compromised and downstream aquatic systems become altered. Water quality impacts can reduce vegetation diversity and lead to the establishment of **invasive species**. The water quality purification function of a wetland is typically reduced as water contaminants accumulate.

General approach – This Metric accounts for activities that affect or degrade water quality in the AA. It is assessed based on a checklist of field indicators of water quality stressors (Table 14 below). The indicators are listed in Stressor Categories.

All indicators of water quality stressors that are observed in the AA should be noted, and the severity of the indicated stressors should be ranked based on Table 13 above. After completing the checklist for a Stressor Category, the overall severity of stress for the Stressor Category as a whole should be estimated, unless none of the indicators in the category were observed. To complete the assessment for this Metric, the noted severity ranks should be tallied (added together) and recorded on the field form. Ranks for the Stressor Categories are not included in the tally of the indicator ranks.

Table 14: Indicators of water quality stress observed in the AA. Each observed indicator is ranked as (1) not severe; (2) moderately severe; or (3) severe, based on Table 13. Each indicator can have only one severity rank. Tally all the marked ranks to complete the metric, excluding the ranks for the Stressor Categories. Bold terms are in the glossary.

If stressor is present, mark its severity			**Field Indicators by Stressor Category**
1	***2***	***3***	**Point Sources**
1	**2**	**3**	**Point source** inputs (discharge from wastewater plants, factories, etc)
1	**2**	**3**	Stormwater inputs (discharge pipes, culverts, sewer outfalls)
1	***2***	***3***	**Sedimentation/Pollutants**
1	**2**	**3**	Debris lines on plants, **trees** or silt-laden vegetation
1	**2**	**3**	Sedimentation (e.g., the presence of sediment fans, deposits or plumes)
1	**2**	**3**	Industrial or domestic spills or discharges (odors; foam, oil sheen*)
1	**2**	**3**	**Turbidity** in the water column

Table 14 (continued).

1	*2*	*3*	**Eutrophication**
1	**2**	**3**	Direct discharges from feedlot manure pits, etc.
1	**2**	**3**	Direct discharges from septic or sewage systems
1	**2**	**3**	Direct application of fertilizer
1	**2**	**3**	Agricultural runoff (drain tiles, etc. discharging to site)
1	**2**	**3**	Formation of heavy algal or *Lemna* sp. surface mats or heavy benthic algal growth
1	***2***	***3***	**Mining Impacts**
1	**2**	**3**	**Acid mine drainage** discharge (excessively clear water (low pH) or presence/accumulation of "yellow-boy" orange precipitate)
1	***2***	***3***	**Salinity**
1	**2**	**3**	Obvious increases in the concentration of dissolved salts (dead or stressed plants; salt encrustations, etc)
Tally of all Ranks (excluding ranks for Stressor Categories)			

* Oil sheen should not be confused with surface iron films (normal in many wetlands); iron films can be broken while oil films cannot.

Metric 9: Alterations to Hydroperiod.

The hydroperiod (pattern of water level change over time) affects wetland vegetation community composition and productivity, the provision of spawning and nursery grounds for fish and amphibians, migratory waterfowl habitat, and biogeochemical processes. Functions such as floodwater storage and flood peak reduction are reflected in the hydroperiods of wetlands.

General approach - This Metric is assessed using a checklist of field indicators of hydroperiod alterations in the AA (Table 15 below). While many hydroperiod alterations will occur outside of the AA, only those that occur within the AA are considered in the Metric. Hydrologic alterations that are outside of the AA are assessed in Metric 3 or using other assessment methods.

The occurrence of any stressor indicator in the AA should be noted in the checklist, and its severity should be estimated, based on Table 13 above. To assess this Metric, the severity ranks (1, 2, and 3) noted for each observed indicator should be tallied (added together) and the sum should be recorded on the field form.

Table 15: Indicators of altered hydroperiod observed in AA. Each observed indicator is ranked as (1) not severe; (2) moderately severe; or (3) severe based on Table 13. Each indicator can have only one severity rank. Tally all the marked ranks to complete the Metric. Bold terms are in the glossary.

If stressor is present, mark its severity			**Field Indicators**
1	**2**	**3**	**Ditches**/channelization within AA
1	**2**	**3**	**Dikes**/dams/**levees**/**berms** at AA margin or within AA or roadbed or railroad (acting as block to water flows into or through AA)
1	**2**	**3**	**Channels** have deeply undercut banks and/or bank slumps or slides
1	**2**	**3**	**Culverts**, pipes (**point sources**) into AA *(change in water quantity)*
1	**2**	**3**	Water level control structure that impound water in all or part of the AA
1	**2**	**3**	Upland plant species encroaching into AA (due to drying of wetland)
1	**2**	**3**	**Die-off** of trees within AA due to increased ponding (exempting beaver impounded sites)
1	**2**	**3**	**Tidal restriction** in tidal wetlands (restricts flows to and from AA)
1	**2**	**3**	Presence of agricultural tiles or culverts at AA margin or within AA
1	**2**	**3**	Siphons, pumps moving water in or out of AA
1	**2**	**3**	Stormwater inputs from impervious surfaces/**flashy flows** into AA
			Tally of all Ranks

Physical Structure Attribute

Metric 10: Habitat /Substrate Alterations.

There is a range of anthropogenic events and activities that alter wetland habitats by disturbing their substrates. Off-site events and activities are usually hydrological. For example, floods caused by excessive runoff or major releases of water from dams can cause scouring of substrates or large deposits of sediment and debris. Onsite events and activities that alter substrates include grading, mining, off-road vehicle use, and vegetation control. Some urban wetlands are severely impacted by dumping of yard debris and other trash. Substrate alterations can cause changes in drainage and soil productivity that subsequently alter wetland plant communities. Severe alterations of wetland substrates often lead to plant invasions.

General approach - This Metric is assessed using a checklist of field indicators of stressors that affect or degrade the substrate observed in the AA (Table 16).

Table 16. Indicators of altered substrate observed in AA. Each observed indicator is ranked as (1) not severe, (2) moderately severe, or (3) severe based on Table 13. Each indicator can have only one severity rank. Tally all the marked ranks to complete the metric. Bold terms are in the glossary.

If stressor is present, mark its severity			Field Indicators	
1	**2**	**3**	**Soil subsidence**, scour or surface erosion (root exposure, etc)	
1	**2**	**3**	Off-road vehicles, mountain biking, trails cut, etc.	
1	**2**	**3**	Inorganic sedimentation inflow (sediment accumulation around vegetation, deep **sediment splay**s, recent vegetation burial, etc)	
1	**2**	**3**	**Dredging** or other prominent excavation at AA margin or in AA	
1	**2**	**3**	Grazing by domesticated or feral animals in AA (includes trampling, digging, wallowing, etc)	
1	**2**	**3**	Grazing by native ungulates.	
1	**2**	**3**	Recent farming activity (plowing, **disking**, etc.)	
1	**2**	**3**	Soil compaction by human activity (parking by cars, heavy machinery, etc)	
1	**2**	**3**	Filling, grading, or other prominent deposition of sediment	
1	**2**	**3**	Dumping of garbage or other debris	
1	**2**	**3**	Mechanical plant removal that disturbs substrate (rutting, grubbing by heavy machinery, etc.)	
1	**2**	**3**	**Fire lines** (fire breaks) dug in AA or at AA margin	
			Tally of all Ranks	

Biological Structure Attribute

Metric 11: Percent Cover of Invasive Plant Species.

Wetland plants are particularly useful as indicators because they are an easily observed, universal component of wetland ecosystems. Plant community composition, including the occurrence of invasive species, provides clear and robust signals of human disturbance.

This Metric is assessed based on field observations of the percent cover of **invasive species** in each of the **plant strata** within the AA. The observations made to assess Metric 7 will be useful, although in this metric the presence of any invasive species (i.e., any cover) is tallied using four broad cover classes (<5%, 5–25%, 26-75%, >75%). Users of this method may refer to local invasive plant species lists or resource agencies to determine which species are to be considered invasive. For a list of targeted species defined for the NWCA, consult the **NWCA FOM Appendix B – Targeted Invasive Alien Plant Species**. Some common invasive species are listed below (Table 17). This is not an exhaustive list.

Table 17: List of invasive plant species common to wetlands in many regions of the US. This is not an exhaustive list.

Invasive Plant Species That Commonly Invade Wetlands	
European milfoil (*Myriophyllum spicatum*)	Purple loosestrife (*Lythrum salicaria*)
Garlic mustard (*Alliaria petiolata*)	Reed canarygrass (*Phalaris arundinacea*)
Giant reed (*Phragmites australis)*	Russian olive (*Elaeagnus angustifolia)*
Giant salvinia *(Salvinia molesta)*	Salt cedar (*Tamarix spp*)
Poison hemlock (*Conium maculatum*)	Water hyacinth (*Eichhornia crassipes*).

General approach – A visual survey of the AA and its plant species composition will be used to note the percent cover of invasive species in each of the plant strata listed below. The information gathered to complete Metric 7 will be useful for this metric but will not be enough to complete it. For this Metric, all invasive species will be noted and recorded in one of the four cover classes, regardless of their cover. Strata that have no cover (zero) of any invasive species should be assigned a rank of "0".

Table 18: Metric 11 data table. Numbers indicate the rank score for each cover class in each strata. Circle one choice for each plant layer and tally all ranks for the final score.

Plant Strata (see glossary)	**Percent Cover of Invasive Species**				
	None	< 5%	5-25%	26-75%	>75%
Submerged (any depth)	**0**	**1**	**2**	**3**	**4**
Floating or Floating-leaved	**0**	**1**	**2**	**3**	**4**
Short Emergent (herbaceous, < 0.5m)	**0**	**1**	**2**	**3**	**4**
Tall Emergent (herbaceous, ≥ 0.5m)	**0**	**1**	**2**	**3**	**4**
Short Woody Plants (shrubs and trees < 5m)	**0**	**1**	**2**	**3**	**4**
Vines (any present)	**0**	**1**	**2**	**3**	**4**
Tall Woody Plants (shrubs and trees ≤ 5m)	**0**	**1**	**2**	**3**	**4**
				Tally of all Ranks	

Metric 12: Vegetation Disturbance.

This metric accounts for human activities that directly alter the plant community in the AA. Vegetation is an easily observed component of wetlands that responds predictably to disturbance. As vegetation communities shift in response to stress, important wetland services, such as biodiversity support and water quality improvement, may be affected.

General approach - This Metric is assessed based on a checklist of field indicators of anthropogenic disturbance to the plant community (Table 19 below). The indicators are listed in Stressor Categories. All stressors observed in the AA are noted, and the severity of the indicated stressors is ranked based on Table 13. Only on-going or recent disturbances that are clearly impacting the vegetation are considered. After completing the checklist for a Stressor Category, the overall severity of stress for the category as a whole should be estimated, unless none of the indicators in the category were observed. To complete this Metric, the noted severity ranks should be tallied (added together) and recorded on the field form. Exclude the ranks for the Stressor Categories from the tally.

Table 19. Indicators of vegetation disturbance observed in AA. Each observed indicator is ranked as (1) not severe, (2) moderately severe, or (3) severe based on Table 13. Each indicator can have only one severity rank. Bold terms are in the glossary.

If stressor is present, rank its severity			**Field Indicators by Stressor Category**
1	***2***	***3***	**Human Use and/or Management**
1	**2**	**3**	Mowing within AA (or at AA margin)
1	**2**	**3**	Forest - **selective cut**
1	**2**	**3**	Forest - **clear cut**
1	**2**	**3**	Prominent removal of **large woody debris**
1	**2**	**3**	Mechanical plant removal besides **tree** cutting or woody debris removal
1	**2**	**3**	Evidence of planting of non-native vegetation
1	**2**	**3**	Chemical vegetation control (herbicide application, defoliant use)
1	**2**	**3**	Farming (recent plowing, **disking**, etc)
1	***2***	***3***	**Excessive Grazing or Herbivory**
1	**2**	**3**	Grazing by domestic or feral animals (cows, sheep, pigs, etc)
1	**2**	**3**	Excessive wildlife herbivory (deer, muskrat, geese, carp, beaver, etc.)
1	**2**	**3**	Excessive insect herbivory of **tree** canopy, **shrub** stratum
1	***2***	***3***	**Fire**
1	**2**	**3**	Evidence of intentional burning at AA margin or in AA
1	**2**	**3**	**Fire lines** (fire breaks)
Tally of all Ranks (excluding ranks for Stressor Categories)			

USA RAM
Glossary

Acid mine drainage – acidic water typically with high metal concentrations that results from water flowing over sulfur bearing materials. Acid mine drainage often results from the process of mining, particularly coal mining.

Bank slumps – sediment or soil collapse from the face of a riverbank.

Bench - A flat, horizontal area of land that is longer than wide, with the long axis general parallel to a nearby shoreline or bank, one long side bounded by land sloping steeply upward, and the other side bounded by land sloping steeply downward.

Berm - A narrow bench of land typically along the top or bottom of a slope that separates two areas, also termed "ledge" and "shelf" (see "bench").

Channel - A landscape feature with well-defined bed and banks that has been formed by water and which under normal circumstances is maintained by the flow of water, or that is purposefully constructed and maintained to convey water.

Clear cut – a logging practice in which most or all of the trees in an area of forest are cut and removed.

Die-off - The relatively sudden, severe, and cotemporaneous deaths of most of the plants and/or animals of a kind in one area or habitat type, such as a lake or wetland.

Dike – An embankment or wall, typically of earth and stone, built to prevent flooding.

Disking – in farming, turning and loosening the soil with a series of discs (as in plowing)

Ditch – A small channel dug for the purposes of moving water, often used to speed drainage of an area.

Emergent (herbaceous) – Plants rooted in the soil with basal portions often in the water and whose leaves, stems, and reproductive structures are aerial. Examples include cattails (*Typha* spp.) and reed canary grass (*Phalaris arundinacea*).

Fire line – A gap in vegetation cut by fire crews in advance of a wildfire to stop its spread buy depriving the fire of fuel. Also known as fire breaks.

Flashy flows – Stream flows characterized by rapid rises and falls in water levels in response to rainfall. This includes higher peak flows (discharge) and lower base flows and is the result of impervious surfaces in the watershed. High water flows can lead to bank erosion and associated water quality issues.

Flat - A non-vegetated, horizontal area of land of any shape with at least one side bounded by water.

Invasive species - Plant species that are 1) non-native (alien) to the AA, and 2) whose introduction is likely to cause economic or environmental harm.

Large woody debris – Trees or portions of trees (limbs, rootwads, etc) typically with a diameter of 10 cm or more that have fallen into aquatic sites. These provide substantial habitat benefits.

Levee – An embankment that runs along the bank of a river or channel. It can be natural (due to flooding and sediment deposition) or human-made.

Macro-relief – Variations in ground surface elevation due to such factors as ground subsidence, erosion by waves, differential weathering rates of geologic strata, land slides, etc.

Micro-relief – Small scale variations in ground surface elevation due to such factors as animal burrowing, spatial differences in sediment accumulation, buried debris, etc.

Mosaic - An arrangement or array of patches of a landscape (see "patch").

Patch - An area assigned to a single land cover type or class that differs from its surroundings.

Pig damage - A wallow caused by wild or feral pigs digging into the ground (see "wallows").

Plant hummock or tussock – a compact tuft especially of grass or sedge, or an area of raised solid ground that is bound by roots of low-growing vegetation.

Plant Stratum (strata) – A class of plant height. Plants are classified based on their maximum height above the substrate, including aquatic plants rooted in benthic substrates and floating plants.

Point Source - any discernible confined and discrete conveyance including a pipe, ditch, channel, or conduit from which pollutants may be discharged.

Pothole - Any depression or hole in the land surface that is caused by physical processes other than subterranean erosion by groundwater, and that has a maximum width less than 3m.

Sediment mound - Any mound of sediment of any shape having a maximum height less that 2m and a maximum width or diameter less than 5m.

Sediment splay - A small fan of sediment deposited at the margin of a sudden and temporary inundation of the land surface by flood waters. Sediment splays are common on active riverine floodplains and interfluves.

Selective cut – Forestry practice in which certain desirable trees are cut and the remainder is left standing.

Shrub – Shrubs are woody species that have a relatively low height (typically 1.5 m or

less). This group includes true shrubs (woody species that lack a single trunk), and young or stunted trees. Common examples include blackberries (*Rubus* spp.).

Soil cracks - Cracks less than 1m deep in the permeable ground surface caused by its shrinking and swelling, or by freezing and thawing.

Soil subsidence – The downward movement of a soil surface. In wetlands this is often due to dewatering and peat oxidation or to sediment starvation when floodplains are cut off from the river and sediment deposition is reduced.

Submerged – Plants that spend their entire life cycle below the surface of the water except for flowers, which are typically borne about the water. Most are rooted although there are rootless species that float free in the water column.

Floating-leaved, and floating plants – Plants having leaves that float on the water surface. Floating-leaved species are rooted and included members of the water lily family, and some pondweeds (*Potamogeton sp.).* Floating plants are not rooted and so float on the water surface. They include some of the most troublesome invasive species such as water hyacinth (*Eichhornia crassipes*).

Swale - A channel with gently sloping banks that is as wide or wider than the channel bed (see "channel").

Terrace - A terrace is a former floodplain that is no longer inundated frequently enough to be termed active (ser "riverine floodplain" and "lacustrine floodplain").

Tidal restriction – Restrictions of tidal flows caused by water control structures such as floodgates that prevent the free movement of tidal inflows and outflows.

Tree - Woody plants that dominate the canopy of forested wetlands with a height greater than 6m. Young and small stature individuals can also be seen in the sub canopy, typically ranging from 1.5 to 5m in height. Common species include *Melaleuca* sp.

Turbidity – A measure of substances in the water column that interfere with the passage of light, such as suspended sediments, algae.

Vine – Weak-stemmed, climbing plants that gain support by growing on other, more robust plant species or substrates. Common species include grapevines (*Vitis* spp.)

Wallow - Any depression in the land surface that is wider than deep and is caused by animals sitting, lying, or rolling on the ground surface or digging into it.

Woody debris – tree limbs, branches, lumber, and other large pieces of wood**.**

Wrack - Debris, including plant material and trash that is transported and deposited on the land surface by water.