Appendix B – EIA Metric Definitions and Scoring Criteria

From Faber-Lagendoen et al. 2012

Level-2 Condition Metrics (field based)

1. **Relative Cover of Native Plant Species**--A measure of the relative percent cover of all plant species that are native to the region. Typically measured by estimating total absolute cover and subtracting total exotic species cover. **Rationale:** Native species dominate this system when it has excellent ecological integrity. This metric is a measure of the degree to which native plant communities have been altered by human disturbance. With increasing human disturbance, non-native species invade and can dominate the wetland. **Scaling Rationale:** The criteria are based on extrapolated thresholds from ecological site descriptions from NRCS (2005), Cooper (1990), Windell et al. (1996), CNHP (2005), and best scientific judgment. These criteria need further validation.
    a. Excellent (A) --Relative Cover of native plants > 99%
    b. Good (B)--Relative Cover of native plants 97 to 99%.
    c. Fair(C)--Relative Cover of native plants 90 to 96%.
    d. Poor (D)--Relative Cover of native plants 50 to 89%.
    e. Outside Ref Cond (E)--Relative Cover of native plant spp. < 50%
2. **Cover of Non-Native Invasive Plant Species**--A measure of the percent cover of a set of exotic plant species that are considered invasive. **Rationale**: As viable populations of invasive plants become established in novel habitats, they inflict a suite of ecological damage to native species including loss of habitat, loss of biodiversity, decreased nutrition for herbivores, competitive dominance, overgrowth, struggling, and shading, resource depletion, alteration of biomass, energy cycling, productivity, and nutrient cycling (Dukes and Mooney 1999). Invasive plant species can also affect hydrologic function and balance, making water scarce for native species. **Scaling rational**: In progress. Invasive species can cause a substantial management effort to control and reduce condition.
    a. Excellent (A) Exotic invasive plant species absent (<1% absolute cover).
    b. Good (B) Exotic invasive plant species present, but sporadic (1-2% cover).
    c. Fair (C) Exotic invasive plant species prevalent (3–10% cover).
    d. Poor (D) Exotic invasive plant species abundant (>10% cover).
3. **Vegetation Composition**--An assessment of the overall species composition and diversity, including by layer, and evidence of specific species diseases or mortality. **Rationale**: Trees, shrubs, herbs, and alga play an important role in providing wildlife habitat, and they are the most readily surveyed aspect of wetland biodiversity. Vegetation is also the single, largest component of net primary productivity. The functions of ecosystems are optimized when a rich native flora dominates the plant community, and when the botanical structure is complex due to species diversity and recruitment, and resulting in suitable habitat for multiple animal species. Much of the natural microbial, invertebrate, and vertebrate communities are adjusted to the architectural forms, phenologies, detrital materials, and chemistry of the native vegetation. Furthermore, the physical form is partly the result of interactions between plants and physical processes, especially hydrology for wetlands and fire regime for uplands. A sudden change in plant-community dominance, such as that which results from plant invasions, can have cascading effects on system form, structure, and function (Collins et al. 2006). **Scaling Rationale:** The metric is scaled based on the similarity between the dominant species

composition of the vegetation and what is expected based on reference condition. Reference conditions reflect the accumulated experience of field ecologists, studies from sites where natural processes are intact, regional surveys and historic sources (Collins et al. 2006).

a. Excellent (A)--Vegetation composition minimally to not disturbed: i) Native species indicative of anthropogenic disturbance (increasers, weedy or ruderal species) absent to minor; AND ii) Typical range of diagnostic species present, including those native species sensitive to anthropogenic degradation.
b. Good (B)--Vegetation composition with minor disturbed conditions: i) Some native species indicative of anthropogenic disturbance (increasers, weedy or ruderal species) are present but minor in abundance, AND ii) Some diagnostic species absent or substantially reduced in abundance.
c. Fair (C)--Vegetation composition with moderately disturbed conditions: i) Species are still largely native and characteristic of the type, but they also include increasers, weedy or ruderal species, AND ii) Many diagnostic species absent or substantially reduced in abundance.
d. Poor (D)--Vegetation composition with severely disturbed conditions. i) Species from entire strata may be absent or species are dominated by ruderal ("weedy") species, or comprised of planted stands of non-characteristic species, or unnaturally dominated by single species, OR ii) Most or all diagnostic species absent, a few may remain in very low abundance.

4. **Native bunchgrass abundance** (for shrub steppe uplands)—Abundance of native bunchgrasses. **Rationa**l: High bunchgrass density increases infiltration by improving soil structure and slowing runoff, High cover of native bunchgrasses is related to community resistance to invasion of invasive species (Pellant et al. 2005)
   a. Excellent (A)-Perennial bunchgrasses > 80% relative cover or less if near site potential.
   b. Good (B) Perennial bunchgrasses 50-80% relative cover or reduced from site potential.
   c. Poor (C) Perennial bunchgrasses 30-50% relative cover or reduced from site potential.
   d. Fair (D) Perennial bunchgrass <30% relative cover and much reduced from site potential.

   Scaling Rational: Pellant et al. (2005) summarize how loss of functional bunch-grass groups increases potential for erosion. Scoring based on the degree of departure from reference conditions

5. **Biological soil crust** (for shrub steppe uplands)—Abundance of biological soil crust. **Rational:** Crust cover and diversity is greatest where not impacted by trampling, other soil surface disturbance and fragmentation (Tyler 2006; Rosentreter and Eldridge 2002; Belnap et al. 2001).
   a. Excellent (A) Largely intact biological soil crust that nearly matches the site capability where natural site characteristics are not limiting, i.e. steep unstable, south aspect, dense native grass
   b. Good (B) Biological soil crust is evident throughout the site but its continuity is broken
   c. Fair (C) Biological soil crust is present in protected areas and with a minor component elsewhere
   d. Poor (D) Biological soil crust, if present , is found only in protected areas

   Scaling Rational: Pellant et al. (2005) and Ponzetti et al (2007) summarize how intact soil crust increases non-vascular biological diversity and decreases potential for erosion. Scoring based on the degree of departure from reference conditions

6. **Fire Sensitive Shrub composition** (for shrub steppe uplands)—Composition of fire sensitive shrubs relative to references conditions. **Rationale**: Natural fire regime promotes patchy low cover big sagebrush or bitterbrush cover
    a. Excellent (A) Fire-sensitive shrubs mature and recovered from past fires; shrubs generally 3-10% cover
    b. Good (B) Fire-sensitive shrubs not recovered from past fires; represented mostly as seedlings less than height of bunchgrasses. shrubs generally <20% cover
    c. Fair (C) Shrub >20% cover beginning to affect bunchgrass layer
    d. Poor (D) Shrubs well >20% cover reducing bunchgrass layer or sagebrush or bitterbrush only scattered individuals or seedlings
7. **Soil Surface Condition--** An indirect measure of soil condition based on stressors that increase the potential for erosion or sedimentation of the soils, assessed by evaluating intensity of human impacts to soils on the site. **Rationale:** Soils are a key feature of wetlands, providing the medium in which plants grow and storing filtrate water. Assessment of soils is challenging for rapid assessments; surface condition is the most visible aspect that can be assessed. The attributes for this metric describe surface conditions that affect a site's biological and physical characteristics and functions (Page-Dumroese et al. 2000, 2009a). **Data for Metric Rating**: See Faber-Langendoen et al. (2011) for an evaluation of the discriminatory power of this metric based on an assessment of 277 wetlands in Michigan and Indiana. Also see Page-Dumroese et al. (2009b) for a summary of data for forests. **Scaling Rationale:** Page-Dumroese et al. (2009a) summarize how increasing levels of soil impacts in forests lead to changes in hydrology and other ecological processes.

Table 15.1. Soil Surface Metric Rating. Separate variants are provided by NVC Formation for all freshwater wetlands (non-tidal) including Flooded & Swamp Forest, Freshwater Marsh, Wet Meadow & Shrubland, Bog & Fen, Aquatic Vegetation versus estuarine wetlands (tidal) including Mangrove and Salt Marsh.

Metric Rating	***V1: Soil Surface Condition variant: ALL FRESHWATER NON-TIDAL WETLANDS*** (FLOODED & SWAMP FOREST, FRESHWATER MARSH, WET MEADOW & SHRUBLAND, BOG & FEN, AQUATIC VEGETATION)
EXCELLENT (A)	Bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails.
GOOD (B)	Small amounts of bare soil areas due to human causes are present but the extent and impact is minimal. The depth of disturbance is limited to only several centimeters (a few inches) and does not show evidence of ponding, channeling water, or effects of boat traffic. Any disturbance is likely to recover within a few years after the disturbance is removed.
FAIR (C)	Moderate amounts of bare soil areas due to human causes. Soil trampling by livestock can cause 5-10 centimeters (several inches) of soil disturbance. Off-road-vehicles or other machinery may have left some shallow ruts or erosion. Damage is not excessive and the site will recover to potential with the removal of degrading human influences and moderate recovery times.

POOR (D)	Bare soil areas substantial and contribute to altered hydrology or other long-lasting impacts. Deep ruts from Off-road-vehicles or machinery may be present, or livestock soil trampling and/or trails are widespread. Water will be channeled or ponded. The site will not recover without restoration and/or long recovery times.

Metric Rating	***V2: Soil Surface Condition variant: ESTUARINE WETLANDS*** (MANGROVE, SALT MARSH, and tidal variants of FRESHWATER MARSH, WET MEADOW & SHRUBLAND)
EXCELLENT (A)	Excluding mud flats, bare soils are limited to salt pannes.
GOOD (B)	Limited exposure of bare soils caused by erosion of marsh and channel banks due to excavation by marine traffic.
FAIR (C)	Frequent exposure of bare soils caused by erosion of marsh and channel banks due to excavation by marine traffic.
POOR (D)	Extensive bare soils caused by erosion of marsh and channel banks due to excavation by marine traffic.

8. **Physical Patch Types--** Definition: A checklist of the number of different physical surfaces or features that may provide habitat for species. Rationale: The rationale for this variable as used by Collins et al. (2006) emphasizes the connection between increasing physical complexity and increasing ecological functions, beneficial uses, as well as overall condition. Here we revise the metric to primarily emphasize condition. For each wetland class, there are visible patches of physical structure that typically occur at multiple points along the hydrologic gradient. But not all patch types will occur in all wetland types. Therefore, the rating is based on the percent of total expected patch types for a given wetland class at a site.

Table 14.1. Physical Patch Type Worksheet.

FLOODED & SWAMP FOREST		FRESHWATER MARSH, WET MEADOW & SHRUBLAND		BOG& FEN	
Open water - Oxbows / Backwater channels / Pools / Tributaries	FS1	Open water - ponds or lakes	M1	Open water margin - Moats / Laggs	BF1
Seeps / Springs - onsite or adjacent	FS2	Open water - pools	M2	Inlet / Outlet Stream (fens)	BF2
Depositional or erosional features, e.g., point bar, flats, bare ground, undercut banks	FS3	Open water - streams	M3	Rivulets	BF3
Debris jams / Woody debris on-site or in adjacent channel	FS4	Seeps / Springs: adjacent or onsite	M4	Springs / Seeps / Shallow open water (fen)	BF4
Tip up mounds / Pits	FS5	Non-vegetated areas (e.g., Bare ground / Mudflat / Sand)	M5	Moss / Aquatic hollows / Bog pools	BF5
Beaver dams / Canals	FS6	Beaver dams / Canals	M6	Floating mats	BF6
Terraces	FS7	Debris jams / Woody debris	M7	Beaver dams / Canals	BF7
Natural levees	FS8	Topographic gradient	M8	Peat flats (bog) / Marl flats (fens)	**BF8**
Upland pockets in floodplain or swamp	FS9	Swale topography	M9	Flarks / Strings	**BF9**
Plant hummocks and hollows	FS10	Plant hummocks / Hollows	M10	Plant hummocks / Hollows	BF10
Animal mounds and burrows	FS11	Animal mounds and burrows	M11	Animal mounds and burrows	BF11

MANGROVE		**SALT MARSH**		**AQUATIC VEGETATION**	
Open water (tidal)	M1	Natural tidal creeks/Creeklets	SM1	Shallow open water (<2 m deep)	AV1
Non-vegetated flats or bare ground	M2	Pannes or Pools	SM2	Non-vegetated flats or bare ground	AV2
Topographic gradient	M3	Mudflats / Sandflats	SM3	Woody debris	AV3
Marl levee	M4	Deposition or erosional features e.g., sand or mud fans, edge sloughing, intertidal rocky shore	SM4	Boulders, rocks, or bedrock	AV4
Prop roots, drop roots, pneumatophores, aerial rootlets, viviparous propagules	M5	Topographic and/or Salinity gradient	SM5	Topographic gradient	AV5
Intertidal barnacle or oyster colonies	M6	Detrital mats	SM6		
Fiddler crab burrows	M7	Intertidal mussel colonies	SM7		
		Fiddler crab burrows	SM8		
OTHER:					

Metric Rating:

Table 14.2. Physical Patch Type Metric Rating.

Metric Rating	***Physical Patch Types: ALL WETLAND TYPES***
EXCELLENT (A)	Expected physical patch types for a particular example of wetland type are present (see worksheet for examples).
GOOD (B)	One or two of the expected physical patch types are lacking (give evidence).
FAIR (C)	Several of the expected physical patch types are lacking (give evidence).
POOR (D)	Most or the entire expected physical patch types are lacking (give evidence).

Data for Metric Rating: See table from Collins et al. (2006, Physical Patch Type Worksheet). Refinement is ongoing as we apply this to a variety of wetlands. Also see Faber-Langendoen et al. (2011) for an evaluation of the discriminatory power of this metric based on an assessment of 277 wetlands in Michigan and Indiana. Lemly and Rocchio (2009) tested user variability and the performance of a variant of this metric in relation to a Level 3 EIA (e.g., vegetation index of biotic integrity).

Scaling Rationale: Scaling rationale focuses more on a characteristic set of physical patch types, appropriate to the site rather than a presumption that more physical patch types are better than fewer patch types. But assessing a characteristic set of patch types may not be a particularly sensitive metric (Faber-Langendoen et al. 2011). Further testing is needed.

Level-1 Metrics—Landscape Connectivity & Land Use, Buffer Metrics, Hydrology

1. **Landscape Connectivity** A measure of connectivity assessed using the percent of natural habitat in the surrounding landscape beyond the 100 m buffer, based on an additional 150 m width for the core landscape and an additional 250 m width for the supporting landscape. **Rationale**: The intensity of human activity in the landscape often has a proportionate impact on the ecological processes of natural systems. The percentage of cultural land use (e.g., agricultural and developed urban/suburban patches) within the surrounding landscape provides an indirect estimate of connectivity among natural ecological systems. Landscapes that retain more connectivity among patches of otherwise isolated wetlands, and therefore have higher levels of

connectivity, are assumed to be more likely to maintain populations of various species that inhabit the natural patch. Studies have shown that lack of landscape connectivity reduces pollination and seed dispersal, animal movements, ecological processes, and ultimately genetic diversity (Lindenmayer and Fischer 2006). In riverine habitats, the floodplain landscape typically comprises a continuous corridor of intact natural vegetation along the stream channel and floodplain. These corridors allow uninterrupted movement of animals to up- and down-stream portions of the riparian zone as well as access to adjacent uplands (Gregory et al. 1991). These corridors also allow for unimpeded movement of surface and overbank flow, which are critical for the distribution of sediments and nutrients as well as recharging local alluvial aquifers. Fragmentation of the riverine corridor can occur as a result of human alterations such as roads, power and pipeline corridors, agriculture activities, and urban/industrial development.

a. Excellent (A) Intact: Embedded in 90-100% natural habitat Connectivity is expected to be high; remaining natural habitat is in good condition (low modification); and a mosaic with gradients
b. Good (B) Variegated: Embedded in 60-90% natural habitat. Connectivity is generally high, but lower for species sensitive to habitat modification; remaining natural habitat with low to high modification and a mosaic that may have both gradients and abrupt boundaries
c. Fair (C) Fragmented: Embedded in 20-60% natural habitat. Connectivity is generally low, but varies with mobility of species and arrangement on landscape; remaining natural habitat with low to high modifications and gradients shortened.
d. Poor (D) Relictual: Embedded in <20% natural habitat. Connectivity is essentially absent; remaining natural habitat generally highly modified and generally uniform.

Scaling Rationale: Less fragmentation increases connectivity between natural ecological systems and thus allow for natural exchange of species, nutrients, and water. The categorical ratings are based on McIntyre and Hobbs (1999).

2. **Land Use Index-** This metric measures the intensity of human dominated land uses in the surrounding landscape beyond the 100 m buffer, based on an additional 150 m with for the core landscape and an additional 250 m width for the supporting landscape. **Rationale:** The intensity of human activity in the landscape has a proportionate impact on the ecological processes of natural ecosystems. Assessing land use incorporates both the aspect of "habitat destruction" and "habitat modification" (sensu McIntyre and Hobbs 1999), at least for the non-natural habitats. That is, in addition to the effect of converting natural habitat to agricultural, urban and other land use modifications, there is the additional aspect of the intensity of that land use. Human land uses often directly or indirectly alter many natural ecological processes. This is a GIS process by which the amount of area by land use category is calculated. Each land use is given a coefficient of land use intensity on a scale of 0-1. For example Parking lots and Industrial areas score 0.0, intensive till crop agriculture 0.2, tree plantations 0.5, logged forests 0.80, natural areas/ land managed for native vegetation 1.0. See Appendix for more land use coefficients.
    a. Excellent (a) average land use score = 1.0-0.95

b. Good (b) average land use score = 0.80-0.95
c. Fair (c) average land use score = 0.4-0.80
d. Poor (d) average land use score = <0.4

Scaling Rationale: Land uses have differing degrees of potential impact on ecological patterns and processes. Some land uses have minimal impact, such as simply altering the integrity of native vegetation (e.g., recreation and low intensity grazing), while other activities (e.g., hay production and agriculture) may replace native vegetation with non-native or cultural vegetation yet still provide potential cover for species movement. Intensive land uses (e.g., urban development, roads, and mining) may completely destroy vegetation and drastically alter ecological processes (Hauer et al. 2002, Mack 2006).

3. **Buffer Index**-- A measure of the overall area and condition of the buffer immediately surrounding the assessment area (100 m radius), using 3 sub-metrics: (a) Buffer Continuity - Percent of AA having buffer, (b) Average Buffer Width, and (c) Buffer Condition. Wetland buffers are defined as vegetated, natural areas that surround a wetland. **Rationale:** The Environmental Law Institute (2008) summarizes extensive data on the rationale for the role of buffers in maintaining ecological integrity of wetlands. Many studies have looked at specific effects of buffers on water quality, birds and other attributes of ecosystems. For example, Semlitsch (1998) monitored terrestrial migrations for six Ambystomid salamander species and found that buffers were critical to permitting their passage into uplands. They found that buffer areas 164 m from wetland edges were needed to encompass 95% of population forays.

   3a. <u>Buffer Continuity</u>--Percent of assessment area having a buffer-- length of the AA perimeter contiguous with a natural buffer of at least 5 m in width. See Appendix for list of appropriate buffer types.
   3b. <u>Buffer Width</u> – average width of appropriate buffer area—see Appendix for additional details such as slope modifiers.
   3c. <u>Buffer Condition</u> –applied only to areas designated as appropriate buffer, condition of buffer areas is based on cover of native vegetation, disruption to soils, signs of reduced water quality, amount of trash or refuse, and intensity of human visitation or recreation, including from foot or boat traffic.

   Each sub-metric is scored:

   a. Excellent (A) Buffer is 90 -100% continuous; Average buffer width is >95 m, adjusted for slope; Buffer is characterized by abundant (>95%) cover of native vegetation, with intact soils, no evidence of loss in water quality and little or no trash or refuse.
   b. Very good (A-) Buffer is >75 -89% continuous; Average buffer width is 75 -94 m, after adjusting for slope; Buffer is characterized by substantial (75-95%) cover of native vegetation, intact or moderately disrupted soils, minor evidence of loss in water quality, moderate or lesser amounts of trash or refuse, and minor intensity of human visitation or recreation.
   c. Good (B) Buffer is 50 -75% continuous; Average buffer width is 50 -74 m, after adjusting for slope; Buffer is characterized by a moderate (50-75%) cover of native

vegetation, and either moderate or extensive soil disruption, moderate to extensive evidence of loss in water quality, moderate or greater amounts of trash or refuse, and moderate intensity of human visitation or recreation.

d. Fair (C) Buffer is 25-49% continuous; Average buffer width is 25-49 m, after adjusting for slope; Buffer is characterized by a low (25- 50%) cover of native vegetation, barren ground and highly compacted or otherwise disrupted soils, strong evidence of loss in water quality, with moderate or greater amounts of trash or refuse, and moderate or greater intensity of human visitation or recreation.
e. Poor (D) Buffer is <25% continuous; Average buffer width is <25 m, after adjusting for slope; Very low (<25%) cover of native plants, dominant (>75%) cover of non-native plants, extensive barren ground and highly compacted or otherwise disrupted soils, moderate - great amounts of trash, moderate or greater intensity of human visitation or recreation, OR no buffer at all.

Overall Index Score integrates the three sub-metrics and the Buffer Condition is given half the weight of the Buffer Continuity and the Average Buffer Width, as its influence on overall on-site condition is not as strong as the other two. Letter scores are converted to numeric values (e.g., A = 4, A- = 3.5, B = 3, C = 2, D = 1). Buffer Index Score is calculated in 2 steps: 1) Buffer Continuity + Average Buffer Width / 2= Average Buffer Score, 2) Average Buffer Score + (Average Buffer Condition X 0.5) / 1.5 = Buffer Index.

Scaling Rationale: There is abundant evidence on the value of even narrow buffers between 5 and 25 m (Environmental Law Institute 2008); More generally, setting buffer widths is based on assessing edge effects. The edge effect width of 100 m is based in part on data from Kennedy et al. (2003), who reviewed edge effects for both plants and animals. They recommend a buffer up to 230–300 m as a precautionary threshold. A buffer width of 100 m is also a widely used minimum threshold (e.g., USA RAM).

4. **Water Source**--An assessment of the extent, duration, and frequency of saturated or ponded conditions within a wetland, as affected by the kinds of direct inputs of water into, or any diversions of water away from, the wetland. **Rationale:** Natural inflows of water to a wetland are important to its ability to persist as a wetland. The flow of water into a wetland also affects sediment processes and the physical structure/geometry of the wetland (Collins et al. 2006).
    a. Excellent (A) Water source is natural, site hydrology is dominated by precipitation, groundwater, and natural runoff from an adjacent freshwater body. System may naturally lack water at times, such as in the growing season. There is no indication of direct artificial water sources. Land use in the local drainage area of the site is primarily open space or low density, passive uses. Lacks point source discharges into or adjacent to the site.
    b. Good (B) Water source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources. Indications of anthropogenic input include developed land or agricultural land (<20%) in the immediate drainage area of the site, or the presence of small storm drains or other local discharges emptying into

the site, road runoff, or the presence of scattered homes along the wetland that probably have septic systems. No large point sources discharge into or adjacent to the site.

c. Fair (C) Water source contains a large component of urban runoff, direct irrigation, pumped water, artificially impounded water, or other artificial hydrology. Indications of substantial artificial hydrology include >20% developed or agricultural land adjacent to the site, and the presence of major point sources that discharge into or adjacent to the site.
d. Poor (D) Water flow exists but has been substantially diminished by known impoundments or diversions of water or other withdrawals directly from the site, its encompassing wetland, or from areas adjacent to the site or its wetland, OR water source has been severely altered to the point where it no longer supports much vegetation (e.g., flashy runoff from impervious surfaces).

Scaling Rationale: Metric ratings are adapted from Collins et al. (2006).

5. **Hydroperiod**. An assessment of the characteristic frequency and duration of inundation or saturation of a wetland during a typical year. **Rationale:** For all non-riverine wetlands, hydroperiod is the dominant aspect of hydrology. Hydroperiod, or the pattern and balance of inflows and outflows, is a major determinant of wetland functions. The patterns of import, storage, and export of sediment and other water-borne materials are functions of the hydroperiod. In most wetlands, plant recruitment and maintenance are dependent on hydroperiod. The interactions of hydroperiod and topography are major determinants of the distribution and abundance of native wetland plants and animals (Mitsch and Gosselink 2000). For riverine wetlands, hydroperiod is assessed through the patterns of water flow associated with rainfall, snowmelt, dams, and long term weather patterns, i.e. the flow regime (Poff et al. 1997). The natural flow regime of a river can be characterized in terms of the magnitude, frequency, duration, and timing of extreme high flows and low flows (Poff et al. 1997, 2007). Flow regime has an important impact on sediment movement and sinuosity of the stream and river. *Hydroperiod variant for HGM DEPRESSION, LACUSTRINE, or SLOPE*
   a. Excellent (A) Natural patterns associated with inundation – drawdown, saturation, and seepage discharge.
   b. Good (B) Some alteration to the natural patterns associated with inundation – drawdown, saturation, and seepage discharge.
   c. Fair (C) Moderate alteration to the natural patterns associated with inundation – drawdown, saturation, and seepage discharge.
   d. Poor (D) Significant alteration to the natural patterns associated with inundation – drawdown, saturation, and seepage discharge.

   Hydroperiod variant: RIVERINE (Non-tidal)
   a. Excellent (A) Most of the channel/riparian zone is characterized by equilibrium conditions, with no evidence of severe aggradation or degradation.

b. Good (B) Most of the channel/riparian zone is characterized by some aggradation or degradation, none of which is severe, and the channel seems to be approaching an equilibrium form.
c. Fair (C) Most of the channel/riparian zone is characterized by severe aggradation or degradation.
d. Poor (D) Most of the channel is concrete or artificially hardened.

Scaling Rationale: Metric ratings are adapted from Collins et al. (2006).

6. **Hydrologic Connectivity**-- An assessment of the ability of the water to flow into or out of the wetland, or to inundate adjacent areas. **Rationale**: Hydrologic connectivity between wetlands and adjacent uplands supports key ecologic processes, such as the exchange of water, sediment, nutrients, and organic carbon. Connectivity of both surface and subsurface hydrologic connections, including connections with shallow aquifers and hyporheic zones (zones beneath and alongside stream beds, where surface water and groundwater mix), is a challenging and often poorly understood aspect of connectivity. Many animal species, such as amphibians, depend on the connectivity between streams and their floodplains, or ponds and surrounding habitats (Poff et al. 1997, Amoros and Bornette 2002).

Hydrologic Connectivity variant HGM (DEPRESSION, LACUSTRINE, SLOPE)

a. Excellent (A) No unnatural obstructions to lateral or vertical movement of ground or surface water, or if perched water table then impermeable soil layer (fragipan or duripan) intact. Rising water in the site has unrestricted access to adjacent upland, without levees, excessively high banks, artificial barriers, or other obstructions to the lateral movement of flood flows.
b. Good (B) Minor restrictions to the lateral or vertical movement of ground or surface waters by unnatural features, such as levees or excessively high banks. Less than 25% of the site is restricted by barriers to drainage. If perched then impermeable soil layer partly disturbed (e.g., from drilling or blasting). Restrictions may be intermittent along the site, or the restrictions may occur only along one bank or shore. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.
c. Fair (C) Moderate restrictions to the lateral or vertical movement of ground or surface waters by unnatural features, such as levees or excessively high banks. Between 25-75% of the site is restricted by barriers to drainage. If perched then impermeable soil layer moderately disturbed (e.g., by drilling or blasting). Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.
d. Poor (D) Essentially no hydrologic connection to adjacent wetlands or uplands. Most or all water stages are contained within artificial banks, levees, sea walls, or comparable features. Greater than 75% of wetland is restricted by barriers to drainage. If perched then impermeable soil layer strongly disturbed.

Hydrologic Connectivity variant: RIVERINE (Non-tidal)

a. Excellent (A) Completely connected to floodplain (backwater sloughs and channels). No geomorphic modifications made to contemporary floodplain.
b. Good (B) Minimally disconnected from floodplain. Up to 25% of stream banks are affected.
c. Fair (C) Moderately disconnected from floodplain due to multiple geomorphic modifications (e.g., dikes, tide gates, and elevated culverts); 25-75% of stream banks are affected.
d. Poor (D) Extensively disconnected from floodplain; >75% of stream banks are affected.

Scaling Rationale: Metric ratings are adapted from Collins et al. (2006).

7. Absolute Patch Size[1]

Definition: A measure of the current absolute size (ha) of the entire wetland type polygon or patch. The metric is assessed with respect to expected patch sizes for the type across its range. **Rationale:** The role of absolute size in assessing integrity is complex. First, higher ratings for size may not always indicate increased integrity. For some types absolute size can vary widely for entirely natural reasons (e.g., a forest type may have very large occurrences on rolling landscapes, and be restricted in other landscapes to small occurrences on north slopes or ravines).

Second, size overlaps with landscape context as a metric, depending on the scale of the wetland type. Size and landscape context both address spatial aspects of an occurrence. Very large sized, matrix occurrences essentially define the landscape context. Standards for establishing the size metric ratings sometimes can be confounded with criteria for Landscape Context. For example, the use of Minimum Dynamic Area (MDA) as the basis for the Size criteria is misleading, at least at the system or natural community level, because MDA is really assessing the landscape area within which an occurrence is embedded and on which it depends for its persistence (Leroux et al. 2007). MDA is typically applied to types at very broad classification scales (e.g., northern hardwood and boreal forest landscapes).

Nonetheless, size can be an important aspect of integrity. For some types, diversity of animals or plants may be higher in larger occurrences than in small occurrences that are otherwise similar. For occurrences in mosaics, the larger occurrences often have more micro-habitat features. Larger wetlands are more resistant to hydrologic stressors; larger uplands more resistant to invasion by exotics, since they buffer their own interior portions. Thus size can serve as a readily measured proxy for some ecological processes and the diversity of interdependent assemblages of plants and animals.

[1]Note that NatureServe's methodology for evaluation patches or polygons (the "Element Occurrence Rank") integrates integrity and conservation values, so with respect to size, larger occurrences are generally presumed to be more value for conservation purposes, as they provide a better representation of the type being conserved. We keep the Size metrics separate within a Primary "Size Rank Factor" so that users can readily determine the role of these metrics in the overall EIA scores. Some consideration had been given to combining size metrics with a broader "landscape context and size rank factor," so that interactions between size and landscape context could be dealt with first, before considering their joint interaction with condition. Users focused strictly on ecological integrity may find this an appealing option.

Table 4.1. Definitions of various patch types that characterize the spatial patterning of ecosystems (ecological community and system types) (Comer et al. 2003).

PATCH TYPE	***DEFINITION***
Matrix	*Ecosystems that form extensive and contiguous cover, occur on the most extensive landforms, and typically have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g., <5%) of the total occurrence. In undisturbed conditions,* ***typical occurrences range in size from 2,000-10,000 ha (100 km^2) or more.***
Large Patch	*Ecosystems that form large areas of interrupted cover and typically have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large proportion of the overall occurrence (e.g., >20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions,* ***typical occurrences range from 50-2,000 ha.***
Small Patch	*Ecosystems that form small, discrete areas of vegetation cover, typically limited in distribution by localized environmental features. In undisturbed conditions,* ***typical occurrences range from 1-50 ha.***
Linear	*Ecosystems that occur as linear strips. They are often ecotonal between terrestrial and aquatic ecosystems. In undisturbed conditions,* ***typical occurrences range in linear distance from 0.5-100 km.***

Absolute Size can be measured in GIS using aerial photographs, orthophoto quads, National Wetland Inventory maps, or other data layers. Size can also be estimated in the field using 7.5 minute topographic quads, NPS Vegetation Mapping maps, National Wetland Inventory maps, or a global positioning system. Wetland boundaries are not delineated using jurisdictional methods (U.S. Army Corps of Engineers 1987); rather, they are delineated by ecological guidelines for delineating the boundaries of the wetland type, based on the International Vegetation Classification, equivalent National Vegetation Classifications, National Wetland Inventory, or other wetland classifications.

Metric Rating: Two metric ratings may be used. One is based on an absolute patch size rating, in the context of the typical patch type of the wetland (Table 4.2). The other is a comparative rating, based on the known distribution of wetland sizes for a wetland type (Table 4.3). If information on both ratings is available, then the rating that generates the higher rating is used.

Table 4.2. Absolute Patch Size Metric Rating: Area by Patch Type. General guidelines for assessing patch size of wetlands. A determination first needs to be made as to the typical spatial pattern type of the wetland type in the ecoregions or across its entire range.

Metric Rating	***Absolute Size Metric (hectares): ALL WETLANDS, BY PATTERN TYPE***						
	MATRIX	***LARGE PATCH***		***SMALL PATCH***			***LINEAR***
	Matrix (ha)	**Very Large Patch (ha)**	**Large Patch (ha)**	**Medium-Small Patch (ha)**	**Small Patch (ha)**	**Very Small Patch (ha)**	**Linear (length in km)**
EXCELLENT (A)	>25,000	>500	>125	>50	>10	>2	>5 km
GOOD (B)	500-25,000	100-500	25-125	10 - 50	2 - 10	0.5 - 2	1-5 km
FAIR (C)	50-500	20 -100	5 -25	2 -10	0.5-2	0.1-0.5	0.1-1 km
POOR (D)	<50	<20	<5	<2	0.5	0.1	<0.1 km

OR

Metric Rating	***Absolute Size Metric (acres): ALL WETLANDS, BY PATTERN TYPE***						
	MATRIX	***LARGE PATCH***		***SMALL PATCH***			***LINEAR***
Spatial Pattern Type	**Matrix (ac)**	**Very Large Patch (ac)**	**Large Patch (ac)**	**Medium-Small Patch (ac)**	**Small patch (ac)**	**Very Small Patch (ac)**	**Linear (mi)**
EXCELLENT (A)	>6,000	>1,250	>300	>125	>25	>5	>3 mi
GOOD (B)	1,250-6,000	250 - 1,250	60-300	25 - 125	5 - 25	1 -5	0.6 - 3 mi
FAIR (C)	125 - 1,250	50 - 250	12 -60	5 -25	1 - 5	0.25 - 1.25	0.06 - 0.6 mi
POOR (D)	<125	<50	<12	<5	1	0.25	<0.06 mi

Table 4.3. Absolute Patch Size Metric Rating: Comparative.

Metric Rating	***Absolute Patch Size: ALL WETLANDS***
EXCELLENT (A)	Patch size is very large compared to other examples of the same type (i.e., top 10% based on known and historic occurrences; most area-sensitive indicator species very abundant within occurrence).
GOOD (B)	Patch size is large compared to other examples of the same type (i.e., within 10-30% based on known and historic occurrences; many area-sensitive indicator species moderately abundant within occurrence).
FAIR (C)	Patch size is medium to small compared to other examples of the same type, (i.e., within 30-70% of known or historic sizes; some area-sensitive indicator species are able to sustain a minimally viable population; many characteristic species are of low abundance but present).
POOR (D)	Patch size is small to very small; occurrence too small to sustain full diversity and function of the type (e.g., smallest 30% of known or historic occurrences; both key area-sensitive indicator species and characteristic species are sparse to absent).

Data for Metric Rating: See Faber-Langendoen et al. (2011) for an evaluation of the discriminatory power of this metric based on an assessment of 277 wetlands in Michigan and Indiana. Lemly and Rocchio (2009) tested user variability and the performance of this metric in relation to a Level 3 EIA (e.g., vegetation index of biotic integrity).

8. Relative Patch Size

Definition: A measure of the current size of the wetland (in hectares) divided by the historic wetland size (within most recent period of intensive settlement or 200 years), multiplied by 100. **Rationale:** Relative size is an indication of the amount of the wetland change caused by human-induced disturbances. It provides information that allows the user to calibrate the current size to the historic area of the wetland. For example, if a wetland has a current size of 1 hectare but the historic size was 2 hectares, this indicates that half (50%) of the original wetland was lost or severely degraded. Complicating the use of this metric is that in some cases, wetland size increases due to human disturbances.

The definition of the "historic" timeframe will vary by region, but generally refers to the intensive Euro-American settlement that began in the 1600s in the eastern United States and extended westward into the 1800s. If the historic time frame is unclear, use a minimum of a 50 year time period, long enough to ensure that the effects of wetland loss are well-established, and the wetland has essentially adjusted to the changes in size.

Metric Rating:

Table 5.1. Relative Patch Size Metric Rating:

Metric Rating	***Relative Patch Size: ALL WETLANDS***
EXCELLENT (A)	Occurrence is at, or only minimally reduced (<5%) from its full original, natural extent, and has not been artificially reduced in size. See note below for interpretation of "reduction."
GOOD (B)	Occurrence is only modestly reduced (5-20%) from its original natural extent. See note below for interpretation of "reduction."
FAIR (C)	Occurrence is substantially reduced (20-50%) from its original, natural extent. See note below for interpretation of "reduction."
POOR (D)	Occurrence is heavily reduced (>50%) from its original, natural extent See note below for interpretation of "reduction." .

***Note**: Reduction in size for metric ratings A-D can include conversion or disturbance (e.g., changes in hydrology due to roads, impoundments, development, human-induced drainage; or changes caused by recent cutting). Assigning a metric rating depends on the degree of reduction.

For Literature Cited please see

Faber-Langendoen, D., J. Rocchio, S. Thomas, M. Kost, C. Hedge, B. Nichols, K. Walz, G. Kittel, S. Menard, J. Drake, and E. Muldavin. 2012b. *Assessment of wetland ecosystem condition across landscape regions: A multi-metric approach. Part B. Ecological Integrity Assessment protocols for rapid field methods (L2).* EPA/600/R-12/021b. U.S. Environmental Protection Agency Office of Research and Development, Washington, DC.