Southern Coastal Plain Seepage Swamp and Baygall Ecological System

December 15, 2005

Ecological Integrity Assessment

Prepared by: Carl Nordman

NatureServe

Ecology Department, Southeast
6114 Fayetteville Road, Suite 109
Durham, NC 27713-6284

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A. INTRODUCTION

A.1 ECOLOGICAL SYSTEM DESCRIPTION

A.1.1. Classification Summary

CES203.505 Southern Coastal Plain Seepage Swamp and Baygall

Primary Division: Gulf and Atlantic Coastal Plain (203)
Land Cover Class: Woody Wetland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Forest and Woodland (Treed); Seepage-Fed Sloping; Broad-Leaved Evergreen Tree; East Gulf Coastal Plain
Concept Summary: This wetland system consists of forested wetlands in acidic, seepage-influenced habitats of the East Gulf Coastal Plain, extending into central Florida. These are mostly evergreen forests generally found at the base of slopes or other habitats where seepage flow is concentrated. Resulting moisture conditions are saturated or even inundated. The vegetation is characterized by *Magnolia virginiana* and *Nyssa biflora*. Examples occur in the outer portions of the Coastal Plain within the range of *Persea palustris*, and where *Magnolia virginiana* is an important or even dominant species. To the north this system grades into East Gulf Coastal Plain Northern Seepage Swamp (CES203.554), where evergreen species are largely replaced by deciduous species in the canopy. Due to excessive wetness, these habitats are normally protected from fire except those which occur during extreme droughty periods. These environments are prone to long-duration standing water, and tend to occur on highly acidic, nutrient-poor soils.

DISTRIBUTION

Range: This system occurs in the East Gulf Coastal Plain, extending into central Florida, and includes the southern parts of Alabama and Mississippi.
USFS Divisions (Bailey): 203:C
TNC Ecoregions: 43:C, 53:C, 55:C
Subnations: AL, FL, GA, LA, MS

A.1.2. Environment

Climate, Hydrology and Geomorphology
This system occurs in Florida and adjacent states on the Southern Coastal Plain. It extends south to central Florida. The entire range of this system has a warm humid climate, with mild winters, hot summers, and rainfall well distributed through the year. The system occurs in areas of low topographic relief, in swales in ridge and swale topography, and other low areas generally within flatwoods.

Seepage Swamp and Baygall wetlands occur in poorly developed drainages, toe-slopes, and the headwaters of small stream bottoms located within an upland matrix of highly permeable coarse textured surficial geologic strata underlain by impervious strata. They also occur in large poorly drained low areas, with poorly defined drainage patterns. Soils are typically saturated loamy fine sands or fine sandy loams and are strongly acidic, with high organic matter content. When these communities are associated with streams, they tend to be low gradient, with narrow, often braided channels and diffuse drainage patterns. Hydrologically, West Gulf Coastal Plain Seepage Swamp and Baygalls are soligenous wetlands since the primary water source is groundwater. They are classified in the Hydrogeomorphic classification of Brinson (1993) as "slope wetlands." While groundwater may be drained away as streamflow, often in anastomosing rivulets, there is very little or no streamflow into this habitat.

Though the primary source of water is groundwater discharge, which might lead one to expect a nutrient rich habitat, this system is nutrient poor due to the localized recharge zones comprised of sandy, acidic, nutrient poor soils. Decomposition is low due to waterlogged conditions and acidic conditions. Increasing nutrients or periods of drought could affect decomposition

Ecosystem development
The development of the Southern Coastal Plain Seepage Swamp and Baygall is site related, occurring in areas where the water table is high and nutrient status is low. These wetlands may occur in poorly developed upland drainages, narrow ravine bottoms, bases of steep heads, and small headwaters stream bottoms. In most cases, these wetlands are embedded in uplands with deep sandy soils. When this system is associated with streams, they tend to be low gradient, with narrow, often braided channels and diffuse drainage patterns. (NatureServe, 2005)

Biogeochemistry
These are wet acidic habitats, characterized by organic soils. They occur where peat can build up due to lack of oxygen in the usually wet, saturated soils.

A.1.3. Vegetation & Ecosystem

These are mostly evergreen forests generally found at the base of slopes or other habitats where seepage flow is concentrated. Resulting moisture conditions are saturated or even inundated. The vegetation is characterized by Sweet Bay (*Magnolia virginiana)* and Swamp Black Gum (*Nyssa biflora)*. Examples occur in the outer portions of the Coastal Plain within the range of Swamp Red Bay (*Persea palustris)*, and where Sweet Bay (*Magnolia virginiana)* is an important or even dominant species.

A.1.4. Dynamics

Due to excessive wetness, these habitats are normally protected from fire except those which occur during extreme droughty periods. The presence of Pond Pine (*Pinus serotina)* in many examples of Southern Coastal Plain Seepage Swamp and Baygall is probably related in part to the occurrence of infrequent (for example every 50-80 years), high intensity wildfire. These environments are prone to long-duration standing water and tend to occur on highly acidic, nutrient-poor soils.

Productivity is limited due to acidic conditions and saturation of the organic soils, especially during wetter times of the year.

A.1.5. Landscape

Because of the low relief, organic soils, and substantial role of rainfall and inhibited drainage, this system is less susceptible to hydrologic alteration from the surrounding landscape than many wetlands. However, intensive regional drainage will affect its hydrology.

A.1.6. Size

Most ecological function is proportional to size of occurrences, and some is disproportionately related to large occurrences. Some ecological functions occur only, or at much greater levels, in areas in good condition, while other ecological functions may occur even in relatively poor or degraded areas. Some species are specific to habitat in the best condition while others are more tolerant of degraded examples. Other ecological functions may occur in poorer quality areas, but only at a much reduced frequency/intensity, and some species may occur there but only at low density. Poorer quality areas thus contribute to the ecological significance of occurrences, but need to be considered separately from areas in better condition.

Examples larger than 30 acres are considered good; those larger than 100 acres, excellent.

A.2 ECOLOGICAL INTEGRITY

A.2.1 Threats

Hydrological Alteration

Hydrologic alteration is an important stressor of the Southern Coastal Plain Seepage Swamp and Baygall. This can be from drainage of the riparian zone, through stream channelization or ditching of the wetlands, so that water flows quickly into the stream. An additional form of hydrological alteration is the hydrological alteration of the watershed of this system. Watershed hydrological alteration can be associated with agriculture or forestry, or urban and suburban development. Bedding and ditching of the surrounding flatwoods has been a widespread practice associated with slash and loblolly pine forestry. In general these alterations can increase surface flow or increase the variation in seepage into this system. Hydrological alteration, which causes the organic horizons of the soil to dry out, can contribute to increased fire severity, in which organic material is consumed by ground fires, leading to further changes in the hydrology and species composition of the community. Organic matter may also be lost due to increased aerobic decomposition under these drier conditions.

Nutrient enrichment

Southern Coastal Plain Seepage Swamp and Baygall is a nutrient poor ecological system, characterized by saturated hydric soils high in organic matter (Carlisle, 1995). Adjacent and upstream land uses all have the potential to contribute excess nutrients into riparian areas. Increased nutrients can alter species composition by allowing aggressive, invasive species to displace native species. Altered hydrology can disrupt nutrient cycles, especially through increased aerobic decomposition under drier conditions.

Exotics

Non-native plants or animals can have wide-ranging impacts. Non-native plants can increase dramatically under the right conditions and essentially dominate a previously natural area (e.g., scraped roadsides). This can generate secondary effects on animals (particularly invertebrates) that depend on native plant species for forage, cover, or propagation. Non-native plants which can be problems in the Southern Coastal Plain Seepage Swamp and Baygall include Japanese Climbing Fern (*Lygodium japonicum)*, Chinaberry (*Melia azerderach*), Japanese Honeysuckle (*Lonicera japonica*), Ardisia (*Ardisia crenata*), Chinese Privet (*Ligustrum sinense),* Popcorn Tree *(Tradiaca sebifera)* and other Category I invasive plants (FLEPPC, 2005). Non-native animals could include feral hogs (*Sus scrufa)*, Imported fire ants *(Solenopsis invicta*), and Armadillo (*Dasypus novemcinctus*). These animals are important predators of native amphibians and invertebrates. Feral hogs also disturb the ground/herb/seedling layer and can promote both weedy native plants and invasive exotic plants.

Fragmentation

Human land uses both within the wetland area as well as in adjacent and upland areas can fragment the landscape and thereby reduce connectivity between depressional patches and between the depressional and upland areas. This can adversely affect the movement of surface/groundwater, nutrients, and dispersal of plants and animals. Roads, bridges, and development can also fragment these areas.

A.2.2 Justification of Metrics

Measures include:

- Landscape condition, given the role of the contributing watershed.
- Biotic condition, as measured by the species composition and diversity
- Impacts on nutrient status could have effects on species diversity.
- Invasion of exotics could alter species composition and dynamics.
- Degree of fragmentation in the riparian as well as upland areas.

A.2.3. Ecological Integrity Metrics

A synopsis of the ecological metrics and ratings is presented in Tables 1 and 2. The three tiers refer to levels of intensity of sampling required to document a metric. Tier 1 metrics are able to be assessed using remote sensing imagery, such as satellite or aerial photos. Tier 2 typically require some kind of ground sampling, but may require only qualitative or semi-quantitative data. Tier 3 metrics typically require a more intensive plot sampling or other intensive sampling approach. A given measure could be assessed at multiple tiers, though some tiers are not doable at Tier 1 (i.e., they require a ground visit). A given metric could be assessed at multiple tiers, though some metrics cannot be measured at Tier 1 (i.e., they require some kind of ground visit). The focus for this System is primarily on metrics using both Tier 1 and Tier 2 metrics.

The Scorecard (see Tables 1 and 2) contains two types of metrics: Core and Supplementary. Separating the metrics into these two categories allows the user to adjust the Scorecard to available resources, such as time and funding, as well as providing a mechanism to tailor the Scorecard to specific information needs of the user.

Core metrics are shaded gray in Tables 1 and 2 and represent the minimal metrics that should be applied to assess ecological integrity. Sometimes, a Tier 3 Core metric might be used to replace Tier 2 Core Metrics. For example, if a Vegetation Index of Biotic Integrity is used, then it would not be necessary to use similar Tier 2 Core metrics such as Percentage of Native Graminoids, Percentage of Native Plants, etc.

Supplementary metrics are those which should be applied if available resources allow a more in depth assessment or if these metrics add desired information to the assessment. Supplementary metrics are those which are not shaded in Tables 1 and 2.

For each metric, a rating is developed, scored as A – (Excellent) to D – (Poor). The background, methods, and rationale for each metric are provided in section B.   Each metric is rated, and then various metrics are rolled together into one of four categories: Landscape Context, Biotic Condition, Abiotic Condition, and Size.

Table 1. Overall Set of Metrics for the West Gulf Coastal Plain Seepage Swamp and Baygall System. Tier: 1 = Remote Sensing, 2 = Rapid, 3 =Intensive. Shaded metrics are core metrics. Unshaded are supplementary metrics.

CATEGORY	Key Ecological Attribute	Indicators/Metrics	Tier
LANDSCAPE CONTEXT	Landscape Composition	Landscape Development Intensity	1
		Buffer Width	1
	Landscape Pattern	Percentage of unfragmented landscape within 1 km.	1
BIOTIC CONDITION	Community Composition	Percent of Cover of Native Trees and Shrubs	2,3
		Percent Cover of Weedy Native Herbaceous Plant Species	2, 3
		Invasive Exotic Species – Plants	2, 3
ABIOTIC CONDITION	Energy/ Material Flow	Land Use Within the Wetland	1, 2, 3
	Hydrologic Alterations	Upstream Surface Water Retention	1
		Upstream/Onsite Water Diversions	1, 2, 3
		Water Table Depth	2, 3
		Evidence of hydrological alteration	(1), 2
		Index of Hydrological Alteration NOTE: this metric should be used in lieu of above metrics when data are available.	3
	Chemical/ Physical Characteristics	Litter Cover	2
		Nitrogen Enrichment (C:N)	3
		Phosphorous Enrichment (C:P)	3
		Organic Soil Horizons	2
		Soil Organic Matter Decomposition	2
	Organic matter	Soil Organic Carbon	3
SIZE	Absolute Size	Total area of ecological system occurrence	1, 2, 3

Table 2. Overall Set of Metrics Key Factors and Metrics for the West Gulf Coastal Plain Seepage Swamp and Baygall System. Tier: 1 = Remote Sensing, 2 = Rapid, 3 =Intensive. Shaded metrics are core metrics. Unshaded are supplementary metrics.

CATEGORY	Key Ecological Attribute	Indicators/Metrics	Tier	Metric Rating Criteria			
				A - Excellent	**B - Good**	**C - Fair**	**D - Poor**
LANDSCAPE CONTEXT	Landscape Composition	Adjacent Land Use (Landscape Development Intensity)	1	LDI =1.0-2.5	LDI =2.5-5.0	LDI =5.0-7.5	LDI =7.5-10.0
		Buffer Width	1	>50 m	33 – 50 m	33-15 m	<15 m
	Landscape Pattern	Percentage of unfragmented landscape within 1 km.	1	Wetland in 90-100% unfragmented natural landscape	Wetland in 60-90% unfragmented natural landscape	Wetland in 20-60% unfragmented natural landscape	Wetland in <20% unfragmented natural landscape
BIOTIC CONDITION	Community Composition	Percent of Cover of Native Trees and Shrubs	2,3	>95%	75-95%	75-50%	<50%
		Percent Cover of Weedy Native Herbaceous Plant Species	2, 3	<2% cover of weedy native herbaceous plants (i.e. *Andropogon* spp. or *Dichanthelium* spp.)	2-5% cover of weedy native herbaceous plants	5-10% cover of weedy native herbaceous plants	>10% cover of weedy native herbaceous plants
		Invasive Exotic Species – Plants	2, 3	<1%	1-2%	2-5%	>5%
ABIOTIC CONDITION	Energy/ Material Flow	Land Use Within the Wetland	1, 2, 3	>95% natural ecological systems	75-95% natural ecological systems	50-75% natural ecological systems and 25-50% industrial forestry	<50% natural ecological systems and forestry
	Hydrologic Alterations	Upstream Surface Water Retention	1	< 5% of drainage basin drains to surface water storage facilities (e.g. reservoirs)	>5 - 20% of drainage basin drains to surface water storage facilities (e.g. reservoirs)	>20 - 50% of drainage basin drains to surface water storage facilities (e.g. reservoirs)	> 50% of drainage basin drains to surface water storage facilities (e.g reservoirs)

CATEGORY	Key Ecological Attribute	Indicators/Metrics	Tier	Metric Rating Criteria			
				A - Excellent	**B - Good**	**C - Fair**	**D - Poor**
		Upstream/Onsite Water Diversions	1, 2, 3	subindex of 0.95-1.00	subindex of 0.90-0.95	subindex of 0.50-0.90	subindex of 0-0.50
		Water Table Depth	2, 3				
		Evidence of Hydrological Alteration	(1), 2	No evidence of effective artificial alteration of hydrology: ditches are absent, old, or not tied in to effective drainage; ground surface is not substantially altered.	Evidence of mild alteration of hydrology: ditches that are tied in to drainage networks are present at low density BUT ground surface is not substantially altered (as by bedding or pervasive fire plow lines).	Evidence of moderate alteration of hydrology: site is bedded or pervaded by numerous fire plow lines BUT ditches are absent or present only at low density.	Site is intensively altered by a dense network of ditches or by bedding combined with ditches.
		Index of Hydrological Alteration NOTE: this metric should be used in lieu of above metrics when data are available.	3	No significant change from Reference Hydrographs	Slight change from Reference Hydrographs	Moderate change from Reference Hydrographs	Large change from Reference Hydrographs
	Chemical/ Physical Characteristics	Litter Cover	2	Litter cover >90%	Litter cover 75-90%	Litter cover 60-75%	Litter cover <60%
		Nitrogen Enrichment (C:N)	3	Leaf tissue C:N is equivalent to natural range of variability	Leaf tissue C:N is slightly less and outside of natural range of variability	Leaf tissue C:N is significantly lower than natural range of variability	Leaf tissue C:N is significantly lower than natural range of variability
		Phosphorous Enrichment (C:P)	3	Leaf tissue C:P is equivalent to natural range of variability	Leaf tissue C:P is slightly less and outside of natural range of variability	Leaf tissue C:P is significantly lower than natural range of variability	Leaf tissue C:P is significantly lower than natural range of variability
		Organic Soil Horizons	2	Von Post index is within natural range of variability	Von Post index is within natural range of variability	Von Post index is lower (2 categories) than natural range of variability	Von Post index is lower (2 categories) than natural range of variability

CATEGORY	Key Ecological Attribute	Indicators/Metrics	Tier	Metric Rating Criteria			
				A - Excellent	B - Good	C - Fair	D - Poor
		Soil Organic Matter Decomposition	2	OMDF > 1.8 (rework for SCP Seepage Swamp and Baygall)	OMDF 1.25 - 1.8 (rework for SCP Seepage Swamp and Baygall)	OMDF 0.6 - 1.25 (rework for SCP Seepage Swamp and Baygall)	OMDF < 0.6 (rework for SCP Seepage Swamp and Baygall)
	Organic matter	Soil Organic Carbon	3	Soil C is equivalent to natural range of variability	Soil C is nearly equivalent to natural range of variability	Soil C is significantly lower than natural range of variability	Soil C is significantly lower than natural range of variability
SIZE	Absolute Size	Total area of ecological system occurrence	1, 2, 3	100 acres or more	30-100 acres	2- 30 acres	Less than 2 acres

A.3 SCORECARD PROTOCOLS

A point-based approach is used to roll up the metrics into Category scores. Points are assigned for each rating level (A, B, C, D) within a measure. The default set of points are A = 5.0, B = 4.0, C = 3.0, D = 1.0. Sometimes, within a category, one measure is judged to be more important than the other(s). For such cases, each metric will be weighted according to its perceived importance. Points for the various measures are then added up and divided by the total number of metrics. The resulting score is used to assign an A-D rating for the category. After adjusting for importance, the Category scores could then be averaged to arrive at an Overall Ecological Integrity Score, but this approach has not yet been developed for this system.

It is not always possible to develop a four grade rating system for each metric, because we lack sufficient detail on how the metric changes or what the thresholds might be. In some cases, the ratings may combine A and B. The point scoring approach is A/B = 5, C=3, D = 1.

At this time, roll-ups are provided for each of the four categories, but they are not rolled up into an overall Ecological Integrity Index.

Supplementary metrics are not included in the Rating Protocol. However, they could be incorporated if the user desired.

A.3.1. Landscape Context

Rate the Landscape Context metrics according to their associated protocols (see Table 2 and details in Section B). Use the scoring table below (Table 3) to roll up the metrics into an overall Landscape Context Rating.

<u>Rationale for scoring table:</u> Adjacent land use, buffer width, and distance to nearest road are judged to be more important than the amount of fragmentation within 1 km of the wetland since a wetland with no other natural communities bordering it is very unlikely to have a strong biological connection to other natural lands at a further distance.

Table 3. Landscape Context Metrics and Ratings for this System. Scores for the ratings are show in each cell.

Measure	**Tier**	**A**	**B**	**C**	**D**	**Weight**	**Score** (weight x rating)
Landscape Development Index	1	5	4	3	1	0.3	
Buffer Width	1	5	4	3	1	0.3	

Measure	Tier	A	B	C	D	Weight	Score (weight x rating)
Percentage of unfragmented landscape within 1 km.	1	5	4	3	1	0.1	
Landscape Context Rating A=4.5 - 5.0 B=3.5 - 4.4 C=2.5 - 3.4 D=1.0 – 2.4							**Total = sum of N scores**

A.3.2. Biotic Condition

Rate the Biotic Condition metrics according to their associated protocols (see Table 2 and details in Section B). Use the scoring table below (Table 4) to roll up the metrics into an overall Biotic Condition rating.

Rationale for Scoring: The three measures for Biotic Condition are complementary and measure different aspects of the vegetation. The A rated examples would have very low or no cover of invasive exotic plants, very low or no cover of weedy native herbaceous plant species (*Andropogon* spp. or *Dichanthelium* spp.), and generally will be dominated by native trees and shrubs. The measures are all derived from information collected with a single data collection protocol.

In other regions the Floristic Quality Assessment (FQA), or a Vegetation Index of Biotic Integrity can be used for rating Biotic Condition. These measures have not been developed in the Southern Coastal Plain, and perhaps will not be developed. If a formal Vegetation Index of Biotic Integrity is developed across the range of this System based on rigorous Tier 3 indicators (e.g., DeKeyser et al. 2003, Mack et al. 2004), then this table will be upgraded, and the rating of Biotic Condition = the VIBI rating.

Table 4. Biotic Condition Rating Calculations. Scores for the ratings are shown in each cell.

Measure	Tier	A	B	C	D	Weight	Score
Percent of Cover of Native Trees and Shrubs	2,3	5	4	3	1	0.33	
Percent Cover of Weedy Native Herbaceous Plant Species	2,3	5	4	3	1	0.33	
Invasive Exotic Species – Plants	2,3	5	4	3	1	0.33	

Measure	Tier	A	B	C	D	Weight	Score
Biotic Condition Rating A=4.5 - 5.0 B=3.5 - 4.4 C=2.5 - 3.4 D=1.0 – 2.4							**Total = sum of N scores**

A.3.3. Abiotic Condition

Rate the Abiotic Condition metrics according to their associated protocols (see Table 2 and details in Section B). Use the scoring table below (Table 5) to roll up the metrics into an overall Abiotic Condition rating.

Rationale for Scoring: Quantitative water table data are judged to more reliable than the other metrics for indicating Abiotic Condition (shaded metric in Table 5). However, if such data are lacking then stressor related metrics (Land Use & Hydrological Alterations) are perceived to provide more dependable information concerning Abiotic Condition.

Scoring for Abiotic Condition is a based on two scenarios: (1) one with a Tier 2 Water Table metric or (2) one with a Tier 3 Water Table metric. The Tier 3 metric is shaded to show that only one should be used in the Scorecard. The weights for the former scenario (Tier 2 Water Table Depth included) are shown without parentheses whereas weights for the latter (Tier 3 Water Table Depth included) are in parentheses.

Table 5. Abiotic Condition Rating Calculations. Scores for the ratings are shown in each cell. The Index of Hydrologic Alteration is shaded because, when available, it could replace all of the other metrics. However, the ability to implement this metric and its relative importance needs further review.

Measure	Tier	A	B	C	D	Weight*	Score (weight x rating)
Land Use Within the Wetland	1,2,3	5	4	3	1	0.20	
Upstream Surface Water Retention	1					0.20	
Upstream/Onsite Water Diversions	1,2,3	5	4	3	1	0.20	
Water Table Depth	2,3	5	4	3	1	0.20	
Evidence of hydrological alteration	(1),2	5	4	3	1	0.20	
Index of Hydrological Alteration NOTE: this metric should be used in lieu of above metrics when data are available.	3	5	4	3	1	?	

Measure	Tier	A	B	C	D	Weight*	Score (weight x rating)
Abiotic Condition Rating A=4.5 - 5.0 B=3.5 - 4.4 C=2.5 - 3.4 D=1.0 – 2.4							**Total = sum of N scores**

A.3.4. Size Rating

Rate the size metric according to the metrics protocols (see Table 2 and details in Section B). Use the scoring table below (Table 6) to roll up the metrics into an overall Size rating.

Table 6. Size Rating Calculations.

Measure	Definition	Tier	A	B	C	D	Weight	Score (weight x rating)
Absolute Size	The current size of the wetland	1	5	4	3	1	1.0	
Size Rating	A = 4.5 - 5.0 B = 3.5 – 4.4 C = 2.5 – 3.4 D = 1.0 – 2.4							**Total = sum of N scores**

B. DOCUMENTATION FOR METRICS

B.1 LANDSCAPE CONTEXT METRICS

B.1.1. Adjacent Land Use (Landscape Development Intensity)

Definition: Using land use data and a development intensity measure derived from energy use per unit area, an index of Landscape Development Intensity (LDI) is calculated for watersheds of varying sizes to estimate the potential impacts from human-dominated activities that are experienced by ecological systems within those watersheds. The intended use of the LDI is as an index of the human disturbance gradient, that is the the level of human induced impacts on the biological, chemical, and physical processes of surrounding lands or waters.

Background: http://www.dep.state.fl.us/water/wqssp/nutrients/docs/TAC/tac4_brown-vivas.pdf
Rationale for Selection of the Variable: The Landscape Development Intensity Index (LDI) has already been developed in Florida. To test the LDI, the site scores of the LDI for 100m and 200m buffers around isolated wetlands, were shown to be correlated with the results of the

Wetland Rapid Assessment Procedure (WRAP; Miller & Gunsalus 1997). The WRAP is a South Florida Water Management District regulatory tool used to evaluate wetland sites. Buffers wider than 200m around isolated wetlands resulted in less of a correlation between LDI and WRAP (Brown and Vivas, 2003).

Measurement Protocol: An "area of influence" needs to be selected for the wetland buffer. This should be between 100m and 200 m wide, for an isolated wetland. For connected (not isolated) wetlands, the "area of influence" can be the drainage basin of the wetland, or a well justified part of that drainage basin. The same "area of influence" should then be used for the duration of the wetland monitoring effort. Land uses within the "area of influence" are assigned an LDI coefficient from the table below. Then an overall LDI ranking is calculated as an area weighted average. Using the GIS, total area and percent of total area occupied by each of the land uses are determined and then the LDI is calculated as follows:

$LDI_{total} = \sum \%LU_i * LDI_i$

where:

LDI_{total} = LDI ranking for landscape unit
$\%LU_i$ = percent of the total area of influence in land use i
LDI_i = landscape development intensity coefficient for land use i

Land use classification, Non-Renewable Empower Density, and Resulting LDI Coefficients
(Brown and Vivas, 2003)

	Non-Renewable	Ln	LDI
Land Use	Empower Density	Non-Renewable	Coefficients
	(E14 sej/ha/yr)	Empower Density	
--	-----------------------	------------------------	------------------
Natural System	0	1	
Natural Open water	0	1	
Pine Plantation	5.1	1.63	1.58
Recreational / Open Space (Low-intensity)	6.55	1.88	1.83
Woodland Pasture (with livestock)	8	2.08	2.02
Pasture (without livestock)	17.2	2.84	2.77
Low Intensity Pasture (with livestock)	33.31	3.51	3.41
Citrus	44	3.78	3.68
High Intensity Pasture (with livestock)	46.74	3.84	3.74
Row crops	107.13	4.67	4.54
Single Family Residential (Low-density)	1,077.00	6.98	6.79
Recreational / Open Space (High-intensity)	1,230.00	7.11	6.92
High Intensity Agriculture (Dairy farm)	1,349.20	7.21	7
Single Family Residential (Med-density)	2,175.00	7.68	7.47
Single Family Residential (High-density)	2,371.80	7.77	7.55
Mobile Home (Medium density)	2,748.00	7.92	7.7
Highway (2 lane)	3,080.00	8.03	7.81
Low Intensity Commercial	3,758.00	8.23	8
Institutional	4,042.20	8.3	8.07
Highway (4 lane)	5,020.00	8.52	8.28
Mobile Home (High density)	5,087.00	8.53	8.29
Industrial	5,210.60	8.56	8.32
Multi-family Residential (Low rise)	7,391.50	8.91	8.66
High Intensity Commercial	12,661.00	9.45	9.18
Multi-family Residential (High rise)	12,825.00	9.46	9.19
Central Business District (Average 2 stories)	16,150.30	9.69	9.42
Central Business District (Average 4 stories)	29,401.30	10.29	10

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard according to the LDI $_{total}$ or LDI ranking for landscape unit.

Measure (Metric) Rating

Excellent	Good	Fair	Poor
1.0-2.5	2.5-5.0	5.0-7.5	7.5-10.0

B.1.2. Buffer Width

Definition: Wetland buffers are vegetated, natural (non-anthropogenic) areas that

surround a wetland. This includes forests, grasslands, shrublands, lakes, ponds, streams, or another wetland. Some land uses such as light grazing and recreation may occur in the buffer, but other land uses should be considered the buffer boundary. Irrigated meadows may be considered a buffer if the area appears to function as a buffer between the wetland and nearby, more intensive land uses such as agricultural row cropping, fenced or unfenced pastures, paved areas, housing developments, golf courses, mowed or highly managed parkland, mining or construction sites, etc. (Mack 2001).
Background: This metric is one aspect of the landscape context of specific occurrences of wetland or terrestrial ecological systems.
Rationale for Selection of the Variable: The intensity of human activity in the landscape often has a proportionate impact on the ecological processes of natural systems. Buffers reduce potential impacts to wetlands by alleviating the effects of adjacent human activities (Castelle et al. 1992). For example, buffers can moderate stormwater runoff, reduce loading of sediments, nutrients, and pollutants into a wetland as well as provide habitat for wetland-associated species for use in feeding, roosting, breeding and cover (Castelle et al. 1992).
Measurement Protocol: This metric is measured by estimating the width of the buffer surrounding the wetland. This should be completed in the field then verified in the office using aerial photographs or GIS. Measure or estimate buffer width on four or more sides of the wetland then take the average of those readings (Mack 2001). This may be difficult for large wetlands or those with complex boundaries. For such cases, the overall buffer width should be estimated using best scientific judgment.
Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Metric Rating			
Excellent	**Good**	**Fair**	**Poor**
Wide > 50 m	Medium 33m to 50 m	Narrow 15 m to 33 m	Very narrow < 15 m

Data: N/A
Scaling Rationale: Increases in buffer width improve the effectiveness of the buffer in moderating excess inputs of sediments, nutrients, and other pollutants from surface water runoff and provides more potential habitat for wetland dependent species (Castelle et al. 1992). The categorical ratings are based on data from Castelle et al. (1992), Keate (2005), Mack (2001), Wenger (1999), and best scientific judgment regarding buffer widths and their effectiveness.
Confidence that reasonable logic and/or data support the index: Medium/High.

B.1.3. Percentage of Unfragmented Landscape Within One Kilometer

Definition: An unfragmented landscape is one in which human activity has not destroyed or severely altered the landscape. In other words, an unfragmented landscape has no barriers to the movement and connectivity of species, water, nutrients, etc. between natural ecological systems. Fragmentation results from human activities such as timber

clearcuts, roads, residential and commercial development, agriculture, etc.
Background: This metric is one aspect of the landscape context of specific occurrences of wetland or terrestrial ecological systems. Habitat fragmentation is defined as "the division of large areas of natural habitat into smaller sections through conversion of the natural habitat to other uses (e.g., roads, development), resulting in populations of plants and animals becoming isolated from each others and potentially threatening their survival" (EPA 2003). Habitat loss and habitat fragmentation are closely related. As habitat is lost, the remaining fragments have a new size and edge to them, represent a subset of the original habitat diversity, and may be isolated. This metric assesses the degree to which fragmentation effects are likely to be present based on the percent of what is called the "local neighborhood" (0.656 km^2) (Heinz Center 2002). The metric could be applied to a series of increasingly larger neighborhood areas (e.g., from 2.2 ha to 5310 ha). It assesses the percentage of the area that is in non-forest and non-natural habitat cover (Heinz Center 2002, Riitters et al. 2002). Excluding natural non-forest cover helps to focus the metric on the fragmenting features that are of most concern in the definition.
Rationale for Selection of the Variable: The intensity of human activity in the landscape often has a proportionate impact on the ecological processes of natural systems. The percentage of fragmentation (e.g., anthropogenic patches) provides an estimate of connectivity among natural ecological systems. Although related to metric B.1.1 and B.1.2, this metric differs by assessing the spatial interspersion of human land use as well as considering a much larger area.
Measurement Protocol: Calculate from imagery the percent of non-forest cover found in a 1 km radius around each forest point. If data from remote sensing imagery is based on pixels, a square frame may be preferable (Heinz Center 2002). Within the non-forest cover, separate the natural from the non-natural cover, and add the natural cover back to the forest cover. For example, if non forest cover is open wetlands, open woodlands or rock outcrops, add that cover back to total forest cover. Summarize the total non-forest - non-natural cover remaining. Adding the natural non-forest cover back allows this metric to focus on fragmentation caused by human activity (development, agriculture) from that of natural patchworks of forest and non-forest cover (Heinz 2002, pg. 121).
Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
Embedded in 90-100% unfragmented, roadless natural landscape; internal fragmentation absent	Embedded in 60-90% unfragmented natural landscape; internal fragmentation minimal	Embedded in 20-60%% unfragmented natural landscape; Internal fragmentation moderate	Embedded in < 20% unfragmented natural landscape. Internal fragmentation high

Data: The Heinz Center (2002) used >90% forest as a measure of unfragmented (core = 100%, interior=90-99%) forest, and between 60-90% as "connected forested. The data on which these breakpoints were established needs to be investigated. The Heinz Center is also investigating the use of a fragmentation index that takes into account roads that occur within the neighborhood area. (Cavender-Bares pers. comm. 2005).
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 Heinz Center (2002), Riitters et al. 200X, and Rondeau (2001). The Heinz center (2002) used 100% forest as a measure of "core" forest, and 90-99% as "Interior" forest. Those values could be used to separate an "Excellent rating from a "Good" rating; rather than the 90 and 60% breaks used here.

Confidence that reasonable logic and/or data support the index: Medium.

B.2 BIOTIC CONDITION METRICS

B.2.1. Percent of Cover of Native Trees and Shrubs

Definition: Percent of the plant species which are native to the Southeastern Coastal Plain.

Background: This metric is one aspect of the condition of specific occurrences of wetland ecological systems.

Rationale for Selection of the Variable: Native species dominate Southern Coastal Plain Seepage Swamps and Baygalls which have excellent ecological integrity. This metric is a measure of the degree to which native plant communities have been altered by human disturbance including the introductions of non-native, invasive species. With increasing human disturbance, non-native species invade and can dominate the wetland. In some examples, sites which are otherwise in good ecological condition may have invasive exotic species (i.e. bird dispersed exotic plants).

Measurement Protocol: Although, quantitative measurements are preferred, depending on time and financial constraints, this metric can be measured with qualitative or quantitative data. The two methods are described as follows: (1) Site Survey (semi-quantitative): walk the entire occurrence of the wetland system and make a qualitative ocular estimate of the total cover of each species growing in the wetland. The cover classes identified in Peet et al. (1998) are recommended (solitary/few, 0-1%, 1-2.5%, 2.5-5%, 5-10%, 10-25%, 25-50%, 50-75%, 75-90%, 90-95%, 95-99%) but any cover class system can be used as long as they same system remains consistent when comparing data with time or different site. (2) Quantitative Plot Data: The plot method described by Peet et al. (1998) is recommended for collecting quantitative data for this metric. This method uses a 20 x 50 m plot which is typically established in a 2 x 5 arrangement of 10 x 10 m modules. However, the array of modules can be rearranged or reduced to meet site conditions (e.g. 1 x 5 for linear areas or 2 x 2 for small, circular sites). The method is suitable for most types of vegetation, provides information on species composition across spatial scales, is flexible in intensity and effort, and compatible with data from other sampling methods (Mack 2004; Peet et al. 1998).

The metric is calculated by dividing the total cover of native species by the total cover of all species and multiplying by 100.

Once qualitative or quantitative cover data are collected, these values are then used to determine the metric status in the scorecard.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Metric Rating			
Excellent	**Good**	**Fair**	**Poor**
100% cover of native plant species	85-< 100% cover of native plant species	50-85% cover of native plant species	<50% cover of native plant species

Data: N/A

Scaling Rationale: This needs work for the Seepage Swamp and Baygall, these metric ratings might be made more stringent. The criteria are based on extrapolated thresholds from ecological site descriptions from Utah, Wyoming, and Montana (NRCS 2005), data and descriptions in Cooper (1990), Windell et al. (1996), CNHP (2005), and best scientific judgment. These are tentative hypotheses, as they have not been validated with quantitative data.

Confidence that reasonable logic and/or data support the index: High

B.2.2. Percent Cover of Weedy Native Herbaceous Plant Species

Definition: Weedy native herbaceous plant species are disturbance indicators. The metric measures percent cover of all native grasses in the genera *Andropogon* (Broomsedges) and *Dichanthelium* (Low Panic Grasses).

Background: Weedy native herbaceous plant species are disturbance indicators. The metric measures percent cover of all native grasses in the genera *Andropogon* (Broomsedges) and *Dichanthelium* (Low Panic Grasses).

Rationale for Selection of the Variable: Weedy native herbaceous plant species can increase dramatically under the right conditions and essentially dominate a previously high quality natural area. The percent cover of weedy native herbaceous plant species can be estimated using ocular estimation in plots and cover classes assigned to these plots. From these an overall average can be obtained. In order for a site to stay in the excellent category, invasive plant species will need to be detected and may need to be managed for suppression where present..

Measurement Protocol: Although, quantitative measurements are preferred, depending on time and financial constraints, this metric can be measured with qualitative or quantitative data. The two methods are described as follows: (1) Site Survey (semi-quantitative): walk the entire occurrent of the wetland system, making sure that each microhabitat is surveyed, and make a comprehensive species list, make ocular estimates of percent cover for each weedy native herbaceous plant species in the genera *Andropogon* (Broomsedges) and *Dichanthelium* (Low Panic Grasses). (2) Quantitative Plot Data: The plot method described by Peet et al. (1998) is recommended for collecting quantitative data for this metric. This method uses a 20 x 50 m plot which is typically established in a 2 x 5 arrangement of 10 x 10 m modules. However, the array of modules can be rearranged or reduced to meet site conditions (e.g. 1 x 5 for linear areas or 2 x 2 for small, circular sites). The method is suitable for most types of vegetation, provides information on species composition across spatial scales, is flexible in intensity and effort, and compatible with data from other sampling methods (Mack 2004; Peet et al. 1998).

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Metric Rating			
Excellent	**Good**	**Fair**	**Poor**
<2% cover of weedy native herbaceous plants	2-5% cover of weedy native herbaceous plants	5-10% cover of weedy native herbaceous plants	>10% cover of weedy native herbaceous plants

B.2.3. Invasive Exotic Species – Plants

Definition: Percent cover of invasive exotic plant species.

Background: Non-native plants or animals can have wide-ranging impacts. Non-native plants can increase dramatically under the right conditions and essentially dominate a previously natural area (e.g., scraped roadsides). This can generate secondary effects on animals (particularly invertebrates) that depend on native plant species for forage, cover, or propagation. Non-native plants which can be problems in the Southern Coastal Plain Seepage Swamp and Baygall include Japanese Climbing Fern (*Lygodium japonicum)*, Chinaberry (*Melia azerderach*), Japanese Honeysuckle (*Lonicera japonica*), Ardisia (*Ardisia crenata*), Chinese Privet (*Ligustrum sinense),* and Popcorn Tree *(Tradiaca sebifera)* and other species listed as Category I in Florida (FLEPPC, 2005). Non-native animals could include feral hogs (*Sus scrufa)*, Imported fire ants *(Solenopsis invicta*), and Armadillo (*Dasypus novemcinctus*).

Rationale for Selection of the Variable: Non-native plants or animals can have wide-ranging impacts. Non-native plants can increase dramatically under the right conditions and essentially dominate a previously natural area. The percent cover of invasive exotic plant species can be estimated using ocular estimation in plots and cover classes assigned to these plots. From these an overall average can be obtained. In order for a site to stay in the excellent category, invasive plant species will need to be detected and may need to be managed for suppression where present..

Measurement Protocol: Although, quantitative measurements are preferred, depending on time and financial constraints, this metric can be measured with qualitative or quantitative data. The two methods are described as follows: (1) Site Survey (semi-quantitative): walk the entire occurrence of the wetland system, making sure that each microhabitat is surveyed, and make a comprehensive species list, make ocular estimates of percent cover for each Category I (FLEPPC, 2005) invasive exotic plant. (2) Quantitative Plot Data: The plot method described by Peet et al. (1998) is recommended for collecting quantitative data for this metric. This method uses a 20 x 50 m plot which is typically established in a 2 x 5 arrangement of 10 x 10 m modules. However, the array of modules can be rearranged or reduced to meet site conditions (e.g. 1 x 5 for linear areas or 2 x 2 for small, circular sites). The method is suitable for most types of vegetation, provides information on species composition across spatial scales, is flexible in intensity and effort, and compatible with data from other sampling methods (Mack 2004; Peet et al. 1998).

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Metric Rating			
Excellent	**Good**	**Fair**	**Poor**
<1% cover of invasive exotic plant species	1-2% cover of invasive exotic plant species	2-5% cover of invasive exotic plant species	>5% cover of invasive exotic plant species

B.3 ABIOTIC CONDITION METRICS

B.3.1. Land Use Within the Wetland

Definition: This metric addresses the intensity of human dominated land uses within the wetland. Each land use type is assigned a coefficient ranging from 0.0 to 1.0 indicating its relative impact to the wetland (Hauer et al. 2002).

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: The intensity of human activity in the wetland often has a proportionate impact on the ecological processes occurring onsite.

Measurement Protocol: This metric is measured by documenting land use(s) within the wetland. This should be completed in the field then verified in the office using aerial photographs or GIS. However with access to current aerial photography and/or GIS data a rough calculation of Land Use can be made in the office. Ideally, both field data as well as remote sensing tools are used to identify an accurate % of each land use within 100 m of the wetland edge. To calculate a Total Land Use Score estimate the % of the wetland area under each Land Use type and then plug the corresponding coefficient (Table 6; the coefficients in this table are derived from Hauer et al. (2002)) with some manipulation to account for regional application) into the following equation:

$$\textit{Sub-land use score} = \sum LU \times PC/100$$

where: LU = Land Use Score for Land Use Type; PC = % of adjacent area in Land Use Type.

Do this for each land use, then sum Sub-Land Use Score to arrive at a Total Land Score. For example, if 30% of the wetland was under moderate grazing (0.3 * 0.6 = 0.18), 10% composed of unpaved roads (0.1 * 0.1 = 0.01), and 40% was a natural area (e.g. no human land use) (1.0 * 0.4 = 0.4), the Total Land Use Score would = 0.59 (0.18 + 0.01 + 0.40).

Based on the Total Land Use Score, assign the Metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
Average Land Use Score = 1.0-0.95	Average Land Use Score = 0.80-0.95	Average Land Use Score = 0.4-0.80	Average Land Use Score = < 0.4

Data:

Table 1. Current Land Use and Corresponding Land Use Coefficients (based on Table 21 in Hauer et al. (2002)).

Current Land Use	Coefficient
Paved roads/parking lots/domestic or commercially developed buildings/gravel pit operation	0.0
Unpaved Roads (e.g., driveway, tractor trail) / Mining	0.1
Agriculture (tilled crop production)	0.2
Heavy grazing by livestock / intense recreation (ATV use/camping/popular fishing spot, etc.)	0.3
Logging or tree removal with 50-75% of trees >50 cm dbh removed	0.4
Hayed	0.5
Moderate grazing	0.6
Moderate recreation (high-use trail)	0.7
Selective logging or tree removal with <50% of trees >50 cm dbh removed	0.8
Light grazing / light recreation (low-use trail)	0.9
Fallow with no history of grazing or other human use in past 10 yrs	0.95
Natural area / land managed for native vegetation	1.0

Scaling Rationale: Coefficent for pine plantations with site preparation (i.e. bedding) is 0.4. Coefficents for other land uses typical of the SE Coastal Plain need to be assigned. The coefficients were assigned according to best scientific judgment regarding each land use's potential impact (Hauer et al. 2002). Land uses have differing degrees of potential impact. Some land uses have minimal impact, such as simply altering the integrity of native vegetation (e.g., recreation and grazing), while other activities (e.g., hay production and agriculture) may replace native vegetation with nonnative or cultural vegetation yet still provide potential cover for species movement. Intensive land uses (i.e., urban development, roads, mining, etc.) may completely destroy vegetation and drastically alter hydrological processes.

Confidence that reasonable logic and/or data support the index: Medium.

B.3.2. Upstream Surface Water Retention

Definition: This metric measures the percentage of the contributing watershed which drains into water storage facilities (e.g., reservoirs, sediment basins, retention ponds, etc.) that are capable of storing surface water from several days to months (Smith 2000).

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: Ecological processes of riparian areas are driven to a large degree by the magnitude and frequency of peak flows and the duration and volume of base flows (Poff et al. 1997). The biotic and physical integrity of riparian areas are dependent on the natural variation associated with these flow characteristics (Gregory et al. 1991; Poff et al. 1997). The amount of water retained in upstream facilities has a direct effect on these flows and subsequent effects on the continued biotic and physical integrity of the riparian area (Poff et al. 1997). For example, retention of surface water can decrease or eliminate episodic, high intensity flooding, decrease seasonal high flows (e.g., spring snowmelt) and increase base flows during seasonal dry periods causing a shift in channel morphology and altering the dispersal capabilities, germination, and survival of many plant species dependent on those flows (Poff et al. 1997; Patten 1998).

Measurement Protocol: This metric is measured as the percent of the contributing watershed to the riparian area that occurs upstream of a surface water retention facility. First the total area of the contributing watershed needs to be determined. Next, the area of the contributing which is upstream of the surface water retention facility furthest downstream is calculated for each stream reach (e.g., main channel and/or tributaries) then summed, divided by the total area of the contributing watershed, then multiplied by 100 to arrive at the metric value. This value is then compared to the scorecard to determine the rating.
For example if a dam occurs on the main channel, then the entire watershed upstream of that dam is calculated whereas if only small dams occur on tributaries then the contributing watershed upstream of each dam on each of the tributaries would be calculated then summed.
These calculations can be conducted using GIS themes of surface water retention facilities, USGS 7.5 minute topographic maps, and/or Digital Elevation Models. The contributing watershed can be calculated or digitized using Digital Elevation Models in a GIS. The percentage of the contributing watershed upstream of surface water retention facilities is simply "cut" from the original contributing watershed layer and its area is then calculated then compared to the total area.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
< 5% of drainage basin drains to surface water storage facilities (e.g. reservoirs)	>5 - 20% of drainage basin drains to surface water storage facilities (e.g. reservoirs)	>20 - 50% of drainage basin drains to surface water storage facilities (e.g. reservoirs)	> 50% of drainage basin drains to surface water storage facilities (e.g reservoirs)

Data: A GIS layer of surface water retention facilities can be downloaded from the Colorado Division of Water Resource's Decision Support Systems website: http://cdss.state.co.us/

Scaling Rationale: The scaling is based on Smith (2000) and best scientific judgment. The reference condition was defined as <5% of the percentage of the contributing watershed drains into water storage facilities that are capable of storing surface water from several days to months. Additional research may suggest changes to the scaling criteria.

Confidence that reasonable logic and/or data support the index: Low/medium.

B.3.3. Upstream/Onsite Water Diversions

Measurement Protocol: Surface Outlet (*VSUROUT*). This variable is defined as the effectiveness of a drainage ditch at removing surface water from the wetland. Measure this variable using the following procedure (from Noble, et al. 2004):

a. Using recent aerial photographs and verifying during field reconnaissance, determine if any drainage ditches occur within the catchment or 100 m (330 ft) from it, whichever is less. If no drainage ditches occur within or 100 m from the catchment, then the subindex score for this variable would be 1.0.

b. If one or more ditches occur within or 100 m from the wetland, examine the ditch(es) to determine if they are maintained and free of obstructions. If the ditch is overgrown with trees or brush, has a water control structure within the ditch, is not connected to an outlet (i.e., stream or larger canal system), or is otherwise not maintained, the variable subindex would be 1.0. If the ditch is maintained and free of obstructions, measure the depth of the ditch and record on the field data sheet.

c. If the elevation of the bottom of the ditch is above the lowest point in the wetland, then the variable subindex would be 1.0 (Figure 10 in Noble, et al., 2004).

d. If the elevation of the bottom of the ditch is lower than the lowest point in the wetland, determine the difference in elevation between the bottom of the ditch and the lowest point in the wetland.

e. Using the local NRCS County Soil Survey determine the dominant soil series between the wetland and the ditch and record on the field data sheet.

f. Using Table 7 (in Noble, et al., 2004) select a profile characteristics category for the soil series between the ditch and the wetland. Determine the effective depth of the ditch in centimeters, which is the difference in elevation between the bottom of the ditch and the lowest point or elevation in the wetland.

g. Determine the percent of the wetland that is within the impact distance of the ditch using Figure 11. Determine the variable subindex score for Surface Outlet using Figure 12 and enter on the field data sheet.

In peninsular Florida reference depressional wetlands, the impact of ditches on surface water storage ranged from zero to 85 percent. Based on data from reference standard sites, a variable subindex of 1.0 is assigned to sites outside the impact zone. As the percent of the wetland within the zone of impact increases above zero, the subindex score decreases linearly to zero when 100 percent of the wetland is within the zone of impact. This is based on the assumption that the relationship between surface water storage and impact by a drainage ditch is linear. This assumption could be validated using the independent, quantitative measures of function in the definition of the function.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
subindex of 0.95-1.00	subindex of 0.90-0.95	subindex of 0.50-0.90	subindex of 0-0.50

Data:

B.3.4. Evidence of Hydrological Alteration

Definition: This metric assesses the degree of alteration to natural hydrology.

Background: This metric is one aspect of the abiotic condition of the system. Southern Coastal Plain Seepage Swamp and Baygall are naturally seasonally saturated, but hydrology is one of the most frequently altered abiotic factors.

Rationale for Selection of the Variable: Hydrologic alteration has important effects on ecological system integrity. Hydrology is hard and costly to measure directly, and the natural range of variability is not well known. Therefore, this variable focuses on the presence of stressors that typically alter hydrology. Accurate assessment of hydrologic condition requires field examination and professional judgment. The effectiveness of alterations such as ditches varies depending on the age, what they are tied in to, and whether they are cleared and maintained. No simple relationship exists between number of ditches and degree of hydrologic alteration. Bedding also varies with height of beds and how they are oriented relative to the water table and the direction of natural water flow.

Measurement Protocol: The measure is evaluated by examining the occurrence for ditches, bedding, and other artificial alterations of hydrology and estimating their effectiveness. The surrounding area may also need to be examined for the presence of ditches that would affect the occurrence.

Metric Rating:

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
No evidence of effective artificial alteration of hydrology: ditches are absent, old, or not tied in to effective drainage; ground surface is not substantially altered.	Evidence of mild alteration of hydrology: ditches that are tied in to drainage networks are present at low density BUT ground surface is not substantially altered (as by bedding or pervasive fire plow lines).	Evidence of moderate alteration of hydrology: site is bedded or pervaded by numerous fire plow lines BUT ditches are absent or present only at low density.	Site is intensively altered by a dense network of ditches or by bedding combined with ditches.

Data: Ground water well data may exist for several individual Southern Coastal Plain Seepage Swamp and Baygall sites. Sufficient data to define the range of natural variation in water tables do not exist. No simple quantitative measure of the degree of alteration caused by ditches or bedding is known.

Scaling Rationale: In the absence of quantitative data, the scale is based on guidelines for professional judgment.

Confidence that reasonable logic and/or data support the index: High confidence for logic, but data are lacking.

B.3.5. Index of Hydrological Alteration

Definition: This metric uses daily streamflow data to determine trends at one site or determine differences between pre- and post-impacts of sites.

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: The Index of Hydrological Alteration (IHA) is an easy to use tool for calculating the characteristics of natural and altered hydrologic regimes using any type of daily hydrologic data, such as streamflows, river stages, ground water levels, etc. Rather that review the entire method here, please refer to http://www.freshwaters.org/tools to download the IHA software as well as supporting documentation, including numerous published papers.

Measurement Protocol: Long-term daily streamflow data are required for this metric. If those are not available daily flow data may be generated using a hydrologic model or other simulation method (see Richter et al. 1997). The IHA statistics will be meaningful only when calculated for a sufficiently long hydrologic record. The length of record necessary to obtain reliable comparisons is currently being researched, however it is recommended that at least twenty years of daily records be used (see Richter et al. 1997).

Some lake level and ground water well data are also available from the USGS, but much of this type of data is collected and managed by other local governmental entities. Usually, a few phone calls to local water departments or natural resource departments will lead you to the appropriate source of the data you are seeking, if it exists.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
No signficant change from Reference Hydrographs	Slight change from Reference Hydrographs	Moderate change from Reference Hydrographs	Large change from Reference Hydrographs

Data:
Index of Hydrologic Alteration Software and Supporting Documentation:
http://www.freshwaters.org/tools

U.S. Geological Survey Streamflow Data: http://water.usgs.gov/usa/nwis. (data can be imported directly in the IHA)

The U.S. Forest Service, U.S. Bureau of Land Management, and local government agencies may have streamflow data for some of the streams located on the lands they manage.

Scaling Rationale: The scaling is based on best scientific judgment of deviation from the reference standard. Additional research may suggest changes to the scaling criteria.

Confidence that reasonable logic and/or data support the index: Medium.

B.3.6. Litter Cover

Definition: Litter cover is the percent cover of leaf litter and small woody litter on the forest floor.

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: Litter cover is the percent cover of leaf litter and small woody litter on the forest floor. It is a measure of nutrient flows in the ecological system, and is related to decomposition.

Measurement Protocol: Although, quantitative measurements are preferred, depending on time and financial constraints, this metric can be measured with qualitative or quantitative data. The two methods are described as follows: (1) Site Survey (semi-quantitative): walk the entire wetland and make a qualitative ocular estimate of the total cover of litter cover in the wetland. The cover classes identified in Peet et al. (1998) are recommended (solitary/few, 0-1%, 1-2.5%, 2.5-5%, 5-10%, 10-25%, 25-50%, 50-75%, 75-90%, 90-95%, 95-99%) but any cover class system can be used as long as they same system remains consistent when comparing data with time or different site. (2) Quantitative Plot Data: The plot method described by Peet et al. (1998) is recommended for collecting quantitative data for this metric. This method uses a 20 x 50 m plot which is typically established in a 2 x 5 arrangement of 10 x 10 m modules. However, the array of modules can be rearranged or reduced to meet site conditions (e.g. 1 x 5 for linear areas or 2 x 2 for small, circular sites). The method is suitable for most types of vegetation, provides information on species composition across spatial scales, is flexible in intensity and effort, and compatible with data from other sampling methods (Mack 2004; Peet et al. 1998). See section A.2.2 for further information regarding plot establishment.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
Litter cover >95%	Litter cover 75-95%	Litter cover 50-75%	Litter cover <50%

B.3.7. Nutrient/Pollutant Loading Index

Definition: The nutrient/pollutant loading index is a measure of the varying degrees to which different land uses contributed excess nutrients and pollutants via surface water runoff and overland flow into a wetland.

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: The type and amount of each land use in the wetland and contributing watershed affects the amounts and types of nutrients and pollutants that enter into a wetland. Excess nutrients can result in degradation of biotic integrity, change nutrient cycling, and potentially affect peat integrity.

Measurement Protocol: Identify and estimate the percentage of each land use within the wetland and the contributing watershed (within 100 m of the wetland). This is best completed in the field, however with access to current aerial photography a rough calculation of Land Use can be made in the office. Ideally, both field data as well as remote sensing tools are used to identify an accurate % of each land use. Once the percentage of each land use is identified, multiply it by the corresponding Nutrient/Pollutant Loading coefficient found for each land use in Appendix B, then sum for the Nutrient/Pollutant Loading Index Score.

For example, if 50% of the wetland and contributing watershed (within 100 m of the wetland) was under heaving grazing, 10% had a dirt road, and 40% natural vegetation the calculation would be (0.5 * 0.87) + (0.1 * 0.92) + (0.4* 1.0) = 0.93 (Surface Water Index Score). Referring to the scorecard, this would give the metric a "Good" rating.

The contributing watershed can be calculated or digitized using Digital Elevation Models in a GIS. Surface water divides are determined using topography and although groundwater divides do not always coincide with these same hydrological divides, groundwater movement is assumed to do so, unless other data for the site is available

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
Average Score = 0.9 – 1.0	Average Score = 0.8 – 0.89	Average Score = 0.75 – 0.79	Average Score = < 0.7

Data: Appendix B.

Scaling Rationale: The scaling is based on best scientific judgment. Scores below 0.7 are assumed to have crossed a threshold in which loading impacts were considered to not be restoreable (based on the land uses that have coefficients below 0.7). Additional research may suggest changes to the scaling criteria.

Confidence that reasonable logic and/or data support the index: Low/medium.

B.3.8. Nutrient Enrichment (C:N)

Definition: The carbon to nitrogen (C:N) ratio in the aboveground biomass or leaves of plants is used to determine whether there is excess N in the system (compared to reference standard). Increasing leaf N decreases the C:N ratio and indicates nitrogen enrichment.

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: Nitrogen enrichment causes vegetation to increase uptake and storage of nitrogen in plant tissue and generally results in increased productivity (Craft et al. 1995, Bridgham et al. 1996 *in* U.S. EPA 2002). These changes affect ecosystem processes including decomposition (Valiela et al. 1982, Davis 1991, Rybczyk et al. 1996 *in* U.S. EPA 2002) and accumulation of soil organic matter (Craft and Richardson 1993, 1998, Morris and Bradley 1999 *in* U.S. EPA 2002). Floristic composition may change as well as aggressive, competitive species take advantage of increased nutrients and displace less competitive species. All of these changes degrade the ecological integrity of the wetland by altering energy flow, nutrient cycling, and potential habitat for fauna assemblages (U.S. EPA 2002).

Measurement Protocol: Herbaceous plants are preferentially sampled because they respond to nutrient enrichment quicker than woody species (U.S. EPA 2002). Two or three dominant species should be selected for sampling. Samples should be collected from plants of a similar age and clipped from nodes a similar distance below the terminal bud (U.S. EPA 2002). The plants should be growing in similar habitats. If habitat is heterogeneous, then it is best to sample from each dominant habitat type. Multiple samples should be collected from several individual plants (5-10) to capture variability within the population. It is important to make collections from the same species at each site so that variation in leaf tissue nutrient concentrations is minimized (U.S. EPA 2002). See U.S. EPA (2002) document for additional information.

Nitrogen is typically measured by dry combustion using a CHN analyzer. Each clipped sample should be placed in their own individual paper bag and sent to a laboratory, such as CSU's Soil, Water, and Plant Testing Laboratory, for analysis of soil organic carbon (e.g., CHN Analyzer). Do not put the sample in a plastic bag as this could induce decomposition of the sample.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
Leaf tissue C:N is equivalent to natural range of variability	Leaf tissue C:N is slightly less and outside of natural range of variability	Leaf tissue C:N is significantly lower than natural range of variability	Leaf tissue C:N is significantly lower than natural range of variability

Data: N/A

Scaling Rationale: Reference C:N ratios need to be established in undisturbed Southern Coastal Plain Seepage Swamp and Baygall. Thereafter, the scaling is based on best scientific judgment and an assumed linear relationship of the amount of deviation from the reference standard to level of nutrient enrichment. If data are collected from wetlands across a disturbance gradient, quantitative criteria could be established.

Confidence that reasonable logic and/or data support the index: Medium.

B.3.9. Nutrient (Phosphorus) Enrichment (C:P)

Definition: The carbon to phosphorous (C:P) ratio in the aboveground biomass or leaves of plants is used to determine whether there is excess P in the system (compared to reference standard). Increasing leaf P decreases the C:P ratio and indicates phosphorous enrichment.

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: Phosphorous enrichment causes vegetation to increase uptake and storage of phosphorous in plant tissue and generally results in increased productivity (Craft et al. 1995, Bridgham et al. 1996 *in* U.S. EPA 2002). These changes affect ecosystem processes including decomposition (Valiela et al. 1982, Davis 1991, Rybczyk et al. 1996 *in* U.S. EPA 2002) and accumulation of soil organic matter (Craft and Richardson 1993, 1998, Morris and Bradley 1999 *in* U.S. EPA 2002). Floristic composition may change as well as aggressive, competitive species take advantage of increased nutrients and displace less competitive species. All of these changes degrade the ecological integrity of the wetland by altering energy flow, nutrient cycling, and potential habitat for fauna assemblages (U.S. EPA 2002).

Measurement Protocol: Herbaceous plants are preferentially sampled because they respond to nutrient enrichment quicker than woody species (U.S. EPA 2002). Two or three dominant species should be selected for sampling. Samples should be collected from plants of a similar age and clipped from nodes a similar distance below the terminal bud (U.S. EPA 2002). The plants should be growing in similar habitats. If habitat is heterogeneous, then it is best to sample from each dominant habitat type. Multiple samples should be collected from several individual plants (5-10) to capture variability within the population. It is important to make collections from the same species at each site so that variation in leaf tissue nutrient concentrations is minimized (U.S. EPA 2002). See U.S. EPA (2002) document for additional information.

Phosphorous is typically measured by spectrophotometry in acid (H_2SO_4-H_2O_2) digests. Each clipped sample should be placed in their own individual paper bag and sent to a laboratory, such as CSU's Soil, Water, and Plant Testing Laboratory, for analysis of soil organic carbon (e.g., CHN Analyzer). Do not put the sample in a plastic bag as this could induce decomposition of the sample.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
Leaf tissue C:P is equivalent to natural range of variability	Leaf tissue C:P is slightly less and outside of natural range of variability	Leaf tissue C:P is significantly lower than natural range of variability	Leaf tissue C:P is significantly lower than natural range of variability

Data: N/A

Scaling Rationale: Reference C:P ratios need to be established in undisturbed Southern Coastal Plain Seepage Swamp and Baygall . Thereafter, the scaling is based on best scientific judgment and an assumed linear relationship of the amount of deviation from the reference standard to level of nutrient enrichment. If data are collected from wetlands across a disturbance gradient, quantitative criteria could be established.

Confidence that reasonable logic and/or data support the index: Medium/High.

B.3.10. Organic Soil Horizons

Definition: This metric estimates the thickness and integrity of the surface organic soil horizons (e.g., peat; Oi, Oe, and Oa horizons) in the Southern Coastal Plain Seepage Swamp and Baygall.

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: The presence of organic soils separate Southern Coastal Plain Seepage Swamp and Baygall from other wetlands. Surface organic horizons contribute to critical hydrologic, biogeochemical, and physical processes such as surface/sub-surface water storage, elemental cycling, carbon storage, and maintenance of plant communities (Hall et al. 2003). The amount of decomposition of organic matter relative to reference standards is an indication of disturbance or oxidation of the organic soils (Chimner and Cooper 2003).

Measurement Protocol: Multiple soil pits should be dug in the wetland to a depth of at least 40 cm. If quantitative vegetation data are being collected, soil pits should be located within these plots to allow correlations with vegetation data. For example, if using the 20 x 50 m plots described by Peet et al. (1998), soil pits would be located within each of the intensive modules.

The reduction in soil organic horizons is determined by comparing the assessment area with adjacent unaltered areas or by visually estimating reduction (i.e., organic soil horizons near a drainage ditch may be a few inches lower than surrounding, unimpacted peat).

The von Post index measures the amount of decomposition of organic soils in the field by assessing the distinctness of the structure of plant remains and color of soil water, determined by squeezing wet peat in the hand. A small handful of peat is squeezed in the hand. Three characteristics are then observed: the color of the solution extracted from the peat, the distinctness of the remaining peat fibers, and the proportion of the original sample that remains in the hand (MacKenzie 1999). The amount of peat water can have a significant effect on the results. For example, a dry and dense peat may only result in a 4 or 5 on the scale, whereas a wet mesic peat may be easily squeezed out of the hand (MacKenzie 1999). Thus, it is important that residue fibers be closely examined (by rubbing between fingers) to assist in concluding on the final von Post index score (MacKenzie 1999).

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Metric Rating			
Excellent	**Good**	**Fair**	**Poor**
Within the project assessment area, surface organic horizons are present and undisturbed. Von Post index is within natural range of variability	Within the project assessment area, surface organic horizons are present and undisturbed. Von Post index is within natural range of variability	Surface organic horizons are present. The thickness of the organic horizon has been reduced by > 25 %. The moss layer (when present) has been removed or partially removed. Von Post index is lower (2 categories) than natural range of variability	Surface organic horizons are present. The thickness of the organic horizon has been reduced by > 25 %. The moss layer (when present) has been removed or partially removed. Von Post index is lower (2 categories) than natural range of variability

Data:

Table 2. von Post Index

Index Value	Description
1	**Undecomposed:** Plant structure unaltered. Yields only clear colorless water.
2	**Almost undecomposed:** Plant structure distinct. Yields only clear water colored light yellow-brown.
3	**Very weakly decomposed:** Plant structure distinct. Yields distinctly turbid brown water; no peat substance passes between fingers, residue not mushy.
4	**Weakly decomposed:** plant structure distinct. Yields strongly turbid water; no peat substance passes between fingers, residue rather mushy
5	**Moderately decomposed:** Plant structure still clear but becoming indistinct. Yields much turbid brown water; some peat escapes between the fingers; residue very mushy.
6	**Strongly decomposed**: Plant structure somewhat indistinct but clearer in the squeezed residue than in the undisturbed peat. About half the peat escapes between the fingers; residue strongly mushy.
7	**Strongly decomposed:** Plant structure indistinct but still recognizable. About half the peat escapes between the fingers.
8	**Very strongly decomposed:** Plant structures very

Index Value	Description
	indistinct. About two-thirds of the peat escapes between the fingers; residue consists almost entirely of resistant remnants such as root fibers and wood.

B.3.11. Soil Organic Matter Decomposition

Definition: This metric indicates the amount of decomposition of soil organic matter present in the soil and thus is an indicator measure of nutrient cycling.

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: Soil organic matter generally refers to the organic fraction of the soil, including plant and animal residues at various stages of decomposition, as well as substances synthesized by the soil organisms (Neue 1984). Organic matter plays an extremely important role in the soil environment, including increases water holding capacity, encouraging soil structure, has a high cation exchange capacity, and supplies essential nutrients (Brady 1990).

Soil organic matter is accumulated in both the O and surface soil (either A or E) horizons in the soil profile. In some riparian areas, soils can be poorly developed, thus the A and E horizons are lumped into a "surface mineral soil horizon" (SMS-horizons) category for this metric (Hauer et al. 2002). The O horizon is found on the soil surface and is composed of various stages of decomposition. The SMS-horizons accumulate highly decomposed organic matter (e.g., humus), which gives the horizon a dark, black color and high amount of colloids (Brady 1990).

Deviation of the depth of the O horizon from reference conditions indicate under- or over-abundance or too fast or slow rate of decomposition (Hauer et al. 2002). The depth and color of the SMS-horizons is used in this metric as an index of the ability of the soil to store nutrients and thus changes from reference conditions are assumed to be indicators of changes in the input of organic matter as well in nutrient cycling (Hauer et al. 2002). For example, human disturbance may cause lower productivity resulting in thinner and lighter colored SMS-horizons (Hauer et al. 2002). Alternatively, thicker SMS-horizons than the reference standard may result from increased sedimentation (Hauer et al. 2002).

Measurement Protocol: The metric is calculated as an Organic Matter Decomposition Factor (OMDF) based on the depth of the O-horizon, the depth of the SMS-horizon, and the soil color value (from Munsell Soil Chart) of the SMS-horizon (Hauer et al. 2002).

Multiple soil pits should be dug in the wetland to a depth where the lower boundary of the SMS-horizon is detected. If quantitative vegetation data are being collected, soil pits should be located within these plots to allow correlations with vegetation data. For example, if using the 20 x 50 m plots described by Peet et al. (1998), soil pits would be located within each of the intensive modules (See section A.2.2 for further information regarding plot establishment). The thickness of the O and SMS-horizons should be measured and the soil color estimated using a Munsell Soil Color Chart.

The OMDF is calculated as: $\text{OMDF} = \left[(DepthOhorizon) + \left(\frac{DepthSMShorizon}{SoilColorValue} \right) \right]$

The OMDF value is then compared to the scorecard to assign a rating.

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
OMDF > 1.8 (rework for SCP Seepage Swamp and Baygall when needed data is available)	OMDF 1.25 - 1.8 (rework for SCP Seepage Swamp and Baygall when needed data is available)	OMDF 0.6 - 1.25 (rework for SCP Seepage Swamp and Baygall when needed data is available)	OMDF < 0.6 (rework for SCP Seepage Swamp and Baygall when needed data is available)

Data: N/A

Scaling Rationale: The Scaling Rationale needs to be reworked for the Southern Coastal Plain Seepage Swamp and Baygall. These figures are based on the Rocky Mountains. When the needed data is available, then the OMDF numbers will need to be developed for SCP Seepage Swamp and Baygall. The reference OMDF values are based on the work of Hauer et al. (2002) who found that riparian shrublands (e.g., willows and alders) and wet meadows in riverine floodplains in the Northern Rockies had OMDF value > 1.8. This reference value is tentatively used for Southern Rocky Mountain riparian shrublands, but additional data collection may suggest alternative values.

The scaling is based on best scientific judgment and an assumed linear relationship of the amount of deviation from the reference standard to level of disturbance. If data are collected from wetlands across a disturbance gradient, quantitative criteria could be established. Alternatively if “baseline” OMDF levels are known (from “pre-impact” conditions or from adjacent unaltered sites) then this metric can be used to determine change of OMDF with time.

Confidence that reasonable logic and/or data support the index: Low/Medium.

B.3.12. Soil Organic Carbon

Definition: This metric measures the amount of soil organic carbon present in the soil.

Background: This metric is one aspect of the condition of specific occurrences of wetland or terrestrial ecological systems.

Rationale for Selection of the Variable: Soil organic matter or carbon generally refers to the organic fraction of the soil, including plant and animal residues at various stages of decomposition, as well as substances synthesized by the soil organisms (Neue 1984). Organic matter plays an extremely important role in the soil environment, including increases water holding capacity, encouraging soil structure, has a high cation exchange capacity, and supplies essential nutrients (Brady 1990).

Soil organic carbon is strong metric of soil quality due to its sensitivity to environmental disturbance (NRC 2000 *in* Fennessy et al. 2004). Given that soil organic carbon contributes to critical hydrologic, biogeochemical, and physical processes (Hall et al. 2003), a reduction in soil organic carbon from reference conditions serves as a strong metric of loss of soil quality.

Measurement Protocol: Multiple soil pits should be dug in the wetland to a depth of at least 40 cm (deeper pits are suggested…up to 120 cm). If quantitative vegetation data are being collected, soil pits should be located within these plots to allow correlations with vegetation data. For example, if using the 20 x 50 m plots described by Peet et al. (1998), soil pits would be located within each of the intensive modules (See section A.2.2 for further information regarding plot establishment). At least five replicate soil samples should be taken within the top 10 cm of the soil surface in each pit. The replicates are mixed together as "one" sample from the site. Each soil sample should be placed in their own individual plastic bag, packed on ice, and sent to a laboratory, such as CSU's Soil, Water, and Plant Testing Laboratory, for analysis of soil organic carbon (e.g., CHN Analyzer).

Metric Rating: Assign the metric an Excellent, Good, Fair, or Poor rating on the scorecard.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
Soil C is equivalent to natural range of variability	Soil C is nearly equivalent to natural range of variability	Soil C is significantly lower than natural range of variability	Soil C is significantly lower than natural range of variability

Data: N/A

Scaling Rationale: Reference soil organic carbon levels need to be established in undisturbed fens. Thereafter, the scaling is based on best scientific judgment and an assumed linear relationship of the amount of deviation from the reference standard to level of disturbance. If data are collected from wetlands across a disturbance gradient, quantitative criteria could be established. Alternatively if "baseline" soil organic carbon levels are known (from "pre-impact" conditions or from adjacent unaltered sites) then this metric can be used to determine change of soil organic carbon with time.

Confidence that reasonable logic and/or data support the index: Medium/High.

B.4 SIZE METRICS

B.4.1. Absolute Size

Definition: This metric assesses the total size of all areas included in the occurrence or stand, i.e., all stands or patches that are close enough together to fall within the same occurrence.

Background: Size (area) of the occurrence has a large effect on the internal heterogeneity and diversity of an occurrence. To define the area, rules are needed to specify when two or more patches or stands are close enough together to belong to the same occurrence.

Rationale for Selection of the Variable: Most ecological function is proportional to size of occurrences, and some is disproportionately related to large occurrences. Some ecological functions occur only, or at much greater levels, in areas in good condition, while other ecological functions may occur even in relatively poor or degraded areas. Some species are specific to habitat in the best condition while others are more tolerant of degraded examples. Other ecological functions may occur in poorer quality areas, but only at a much reduced frequency/intensity, and some species may occur there but only at low density. Poorer quality areas thus contribute to the ecological significance of occurrences, but need to be considered separately from areas in better condition.

Measurement Protocol: This metric is evaluated by measuring or estimating the total area of the occurrence.

A Excellent	B Good	C Fair	D Poor
100 acres or more	30-100 acres	2- 30 acres	Less than 2 acres

Data: Plot data could potentially be analyzed to check the scaling of this measure by comparing plant species occurrence to size of occurrence. The number of different sites represented may not be sufficient to provide meaningful correlations. More limited data on animal occurrences may be used for similar analysis of the effect of size on animal species richness. Likely no data exist that would address the effect of size on other ecological functions.

Scaling Rationale: The scale is based at present on professional judgment about thresholds. The range of sizes is expected to apply throughout the range of the system. The scale could be improved by basing it on the correlation of species presence/richness with size values.

Confidence that reasonable logic and/or data support the index: High. Existing data may be appropriate for testing and refining the index, but this analysis has not been done.

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APPENIDX A: FIELD FORM REQUIREMENTS

To be developed

APPENDIX B: SUPPLEMENTARY DATA:

Coefficient Table (coefficients were calculated from numerous studies throughout the U.S. (Keate (2005)

Land Use	Surface Water Runoff	Nutrient/ Pollutant Loading	Suspended Solids
Natural area	1.00	1.00	1.00
Dirt Road (dirt or crushed or loose gravel, unpaved roads, local traffic)	0.71	0.92	0.90*
Field Crop (actively plowed field)	0.95	0.94	0.85**
Clearcut forest	0.83	0.93	0.98
Golf Course (area manipulated for golf, manicured grass)	0.75	0.86	0.94
High Intensity Commercial (area is entirely of commercial use and paved - shopping malls, construction yards)	0.13	0	0
High Traffic Highway (4 lanes or larger, railroads)	0.26	0.43	0.48
Industrial (intense production activity occurs on a daily basis - oil refineries, auto body and mechanic shops, welding yards, airports)	0.25	0.54	0
Feedlot, Dairy	0.62	0	0.81
Heavy grazing - Non-rotational grazing (year-round or mostly year-round grazing, vegetation is sparse and area trampled)	0.76	0.87	0.85***
Rotational Grazing (grazing is for short periods during the year, vegetation is allowed to recover)	0.96	0.95	0.98
Light Intensity Commercial (businesses have large warehouses and showrooms - large patches of vegetation occur between buildings)	0.19	0.64	0.02
Low Density Rural Development (areas of small structures in a farm or ranch setting - silos, barns)	0.87	0.92	0.98
Low Traffic Highway (2-3 lane paved highways)	0.26	0.69	0.16
Multi-family Residential (subdivisions with lots ½ acre or less)	0.38	0.55	0.61
Nursery (business where the production of nursery grade vegetation occurs including greenhouses, outbuildings and sales lots)	0.86	0.94	1.00
Orchards	0.86	0.93	0.99
Waterfowl Management Areas	0.86	0.91	0.98
Single Family Residential (residential lots are greater than ½ acre with vegetation between houses)	0.75	0.86	0.94
Surface Solid Waste (landfills and waste collection facilities)	0.71	0.87	0.61
Sewage Treatment Plants and Lagoons	0.60	0.61	0.71
Mining	0.76	0.94	0.80

* changeed value from 0.97; ** changed value from 1.00; *** changed value from 0.98