5 ECOLOGICAL INTEGRITY ASSESSMENTS[13] (Occurrence Ranks and Occurrence Rank Specifications)

5.1 Purpose of Ecological Integrity Assessments
5.2 Ecological Integrity Ranks
5.3 Ecological Integrity Rank Criteria
5.4 Ecological Integrity Rank Values
5.5 Establishing the Rank Scale
5.6 Developing Ranking Criteria
5.7 Developing a Rank Score
5.8 Templates for Writing Ecological Integrity Rank Assessments

5.1 PURPOSE OF ECOLOGICAL INTEGRITY ASSESSMENTS

Ecological integrity ranks provide a succinct assessment of **ESTIMATED VIABILITY (PROBABILITY OF PERSISTENCE)** or **ECOLOGICAL INTEGRITY** (integrity) of occurrences of a given Element. For community and system Elements, the "Ecological Integrity Rank" is a measure of the ecological integrity of an occurrence. Ecological integrity is generally defined as the maintenance of structure, species composition, and the rate of ecological processes and functions within a normal or natural range of variation. Parrish et al. (2003) define *ecological integrity* as "the ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region."[14] An occurrence of an ecological system or species has integrity or is viable when its dominant ecological characteristics (e.g., elements of composition, structure, function, and ecological processes) are present within their expected natural ranges of variation; and can withstand and recover from (or is resilient to) most perturbations imposed by natural environmental dynamics or human disruptions.

5.2 ECOLOGICAL INTEGRITY RANKS

An integrity rank represents the relative overall quality of an occurrence with respect to expected conditions in an undegraded state, based on criteria derived from specific integrity rank factors. Integrity ranks are assigned on the basis of data obtained from recent data collection from aerial reconnaissance and/or field surveys (except for historical, or in some cases extirpated, occurrences)

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[13] The Ecological Integrity Assessment Working Group included Don Faber-Langendoen and Pat Comer of NatureServe (co-chairs), David Braun (The Nature Conservancy), Andy Cutko (Maine NHP, now NatureServe), Tom Foti (Arkansas HP), Stephanie Neid (Colorado HP), Joe Rocchio (Colorado HP), Steve Rust (Idaho HP), Mike Schafale (North Carolina HP), Dan Salzer (The Nature Conservancy).

[14] Parrish, J.D., D. P. Braun, and R.S. Unnasch. 2003. Are we conserving what we say we are? Measuring ecological integrity within protected areas. BioScience 53: 851-860. See also, Lindenmayer, D.B., and J.F. Franklin. 2002. Conserving forest biodiversity: A comprehensive multiscaled approach. Island Press, Washington, DC. 351 p.

by knowledgeable individuals. (See definition of "recent" under the description of "H" rank below.) The ranks should be set in accordance with specifications for "A", "B", "C", and "D" ranks, or other guidelines, if these criteria cannot be applied.

5.2.1 Basic Ecological Integrity Ranks

Basic integrity ranks used in prioritizing occurrences for conservation planning purposes are shown in Table 5.1.

Table 5.1 - Basic Integrity Ranks

Rank	Description of Viability or Ecological Integrity
A	excellent
B	good
C	fair
D	poor
E	verified extant (viability or integrity not assessed)
H	Historical
F	failed to find
X	extirpated

Both one- and two-point spreads are acceptable ranges for integrity ranks. The "AC" range rank may be used to indicate that an occurrence is simply deemed to have at least a fair probability of being viable when further information indicating the degree of viability or integrity (*i.e.,* "A", "B", or "C" differentiation) is lacking. Occurrence range ranks with spreads greater than two points should not be used (*i.e.,* an "AD" rank is the same as, and should be recorded as, an "E" rank). Valid range ranks are summarized in Table 5.2.

Table 5.2 - Range Ranks

Spread	Range Rank	Estimated Viability or Integrity
1 - point	AB	excellent or good (A or B)
	BC	good or fair (B or C)
	CD	fair or poor (C or D)
2 - point	AC	excellent to fair (A, B, or C)
	BD	not excellent (B, C, or D)

In many situations (*e.g.,* due to insufficient field information), the uncertainty about an integrity rank may be distributed around an "A", "B", "C", or "D" rank. In these cases, a "?" qualifier may be used in conjunction with one of these basic ranks to indicate uncertainty about that rank.

5.2.2 Origin Status Subranks

The majority of occurrences represent naturally occurring native species populations, communities or systems. However, Elements may be found at locations where they are not native and/or not

naturally occurring[15]. In such cases, it may be desirable to track these occurrences if the Element is very rare, or if the occurrence is critical to the survival of the species.

Knowledge of the origin status of an occurrence may be useful in prioritizing occurrences for conservation purposes, since natural occurrences have inherently higher conservation value relative to both non-native occurrences and those which are not natural in origin. If an occurrence is not native or not natural in origin, its origin status can be indicated through the use of an origin status subrank (shown in Table 5.3) following the assigned basic integrity rank or range rank.

Table 5.3 – Origin Status Subranks

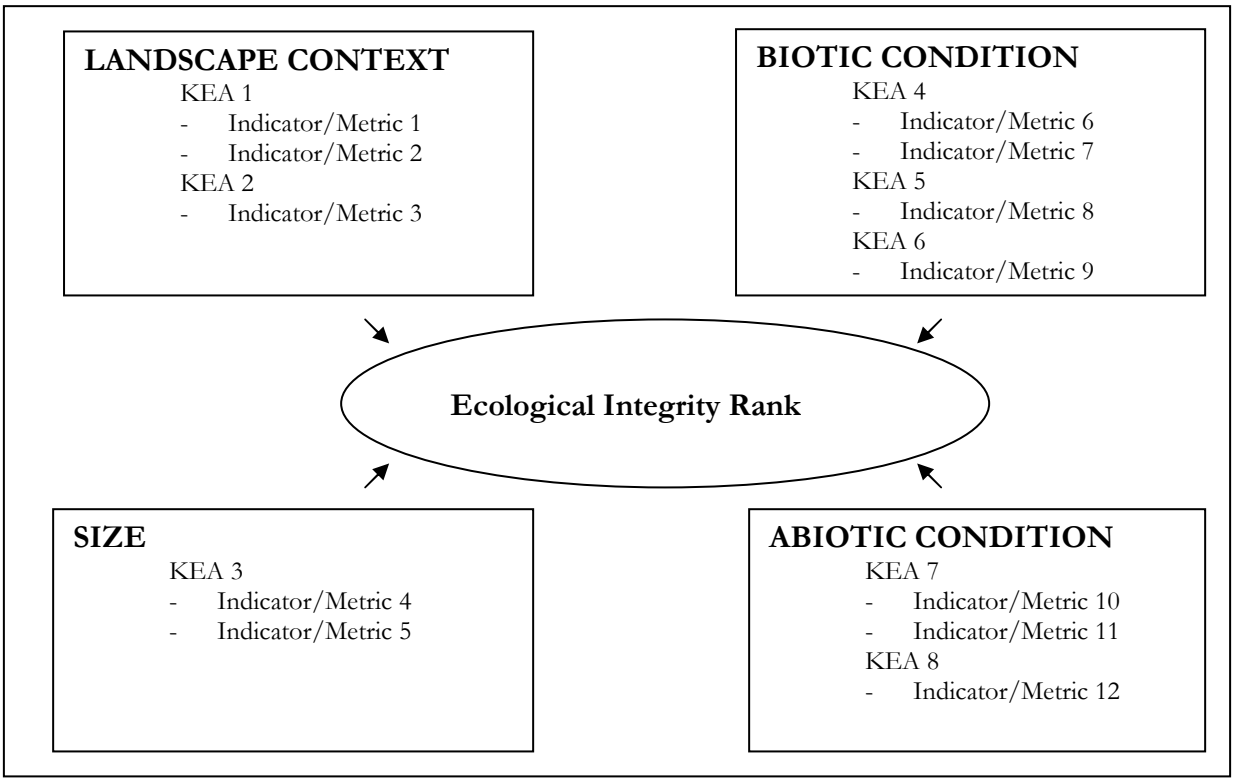
Origin Status Subrank	Description
R	reintroduced / restored
I	introduced

5.3 ECOLOGICAL INTEGRITY RANK CRITERIA

Because integrity ranks are used to represent the relative overall quality of an occurrence as it currently exists, integrity ranks are based solely on criteria that reflect the present status of that occurrence. Criteria can be broadly specified as **rank factors,** namely size, abiotic and biotic condition, and landscape context (Figure 5.2). Rank factors can also be broken down into key **ecological attributes** – those attributes that have an important (driving) function in the viability or integrity of the element, and **indicators** – the measurable features that reflect changes in the viability or integrity of the element (Figure 5.2). **Metrics** are the measurable expression of an indicator. For example, "coarse woody debris" is an indicator of the "community dynamics key ecological attribute," and the specific metric is "volume / ha of fallen stems over 10 cm diameter." For some purposes, such as identifying the broad set of best examples of occurrences for conservation planning, it may be sufficient to simply rate the element using one or more of the rank factors; for other purposes, such as monitoring the response of an occurrence to management actions, habitat mitigation, and ecological restoration, it may be desirable to develop specific indicators and metrics.

[15] Categorization of an occurrence as "natural" at a particular location is independent of whether the habitat at that location is natural or anthropogenic. For example, bats in a mine can be a natural occurrence (*i.e.,* not introduced or reintroduced), even though the mine is an anthropogenic habitat.

Figure 5.2 – Conceptual Model for Assessing Ecological Integrity Rank (EO RANK). The rank is assessed using one or more of the four Rank Factors, whose specifications can be detailed using Key Ecological Attributes (KEA) and Indicators/Metrics.



5.3.1 Integrity Rank Factors

Rank Factors provide the broad circumscription of relevant features of species and ecological elements that determine viability and integrity. There are four integrity rank factors, each reflecting what is currently known (in an ideal situation) about an occurrence: size, biotic condition, abiotic condition, and landscape context (Figure 5.2). These factors are used to organize various attributes and measurements for estimating the viability or ecological integrity of an occurrence, *i.e.,* its integrity rank. Thus:

$$\text{Size} + \text{Biotic Condition} + \text{Abiotic Condition} + \text{Landscape Context} \Rightarrow$$
$$\Rightarrow \text{Estimated Ecological Integrity}$$

More directly, integrity ranks reflect the degree of negative anthropogenic impact to the occurrence (*e.g.,* the degree to which people have directly or indirectly adversely impacted population viability or community composition, structure, and/or function, including alteration of natural disturbance processes). Occurrences with relatively less impacts would generally be ranked "A", "B", or "C" (at least "fair" viability or integrity), and those with significant degradation would be ranked "D" ("poor" viability or integrity).

5.3.2 Key Ecological Attributes

Among all characteristic ecological attributes, **key ecological attributes** may be viewed as the principal drivers of the health and function of each occurrence for a given element. That is, of the many ecological attributes that distinguish each element from others, key attributes have the most direct effect on shaping its natural variation over time and space, and strongly influence its long-term persistence. Our focus for element occurrence evaluation is on those attributes that are commonly influenced by human alteration. They can include biological characteristics, ecological processes, and biotic interactions with the physical environment, along with the critical causal links among them. The four integrity rank factors and typical key ecological attributes are summarized in Table 5.5 below and a comprehensive list is provided in Appendix 1. Generally, one to two key ecological attributes should be identified within each of the relevant Rank factors for each element (totaling between 1 and 8 key ecological attributes).

5.3.3 Indicators / Metrics

Indicators are the general and metrics the specific expression of each key ecological attribute within the various rank factors. Indicators/metrics should be carefully selected, emphasizing ecological relevance, ease of measurement, sensitivity to anticipate change, interpretability, scale-ability, and potential for repeating measurement over time. Indicators / metrics may be either qualitative or quantitative. For efficiency, one should aim to have the fewest number of metrics possible, preferably just one for each key ecological attribute identified for the element, and preferably no more than 10 per element. In most cases, the metric reflects a natural attribute, but there will be cases where it reflects a specific ecological stressor (or direct threat). For example, a common indicator of community composition (a key ecological attribute of biotic condition) is the relative proportion of invasive species present; native composition is the desired indicator, but an indicator focused on altered native composition may be most efficient way to assess biotic condition.

The combination of multiple metric ratings express the measurable differences along a continuum from full ecological integrity (or least impacted condition) to highly degraded (poor condition). For any give metric, establishing these condition classes (or regression-based trends) is a challenging aspect of a metrics-based Ranking methodology, and typically requires calibration of the metric based on reference conditions. In some cases, it may not be feasible or necessary to establish a full range of condition classes for each metric. However, it is important to at least establish the critera between the C/D class for each metric (essentially a pass/fail rating), because this class can help provide the minimum information needed to assess the overall integrity and/or restorability of a given occurrence. If criteria cannot be developed for even this break, then the metrics and criteria lack sufficient information to be useful for ranking occurrences.

Table 5.5 - Rank Factors and Key Ecological Attributes (see also Fig 5.2).

FACTOR	KEY ECOLOGICAL ATTRIBUTES	Ecological Elements
Size	absolute size; area of occupancy;	√
	relative size; relative to expected natural range, or historic extent	√
Biotic Condition	development/structure/maturity (stability, seral stage proportion, old growth)	√
	species composition and biological structure (species richness, dominance, observed vs. expected composition)	√
	animal composition	√
Abiotic Condition	ecological dynamics (e.g., measurable abiotic effects of disturbance by changes in hydrology or natural fire regime)	√
	abiotic physical/chemical factors (stability of substrate, physical structure, water quality)	√
Landscape Context	landscape structure and extent (pattern, connectivity, *e.g.*, measure of fragmentation/patchiness, measure of genetic connectivity)	√
	condition of the surrounding landscape (*i.e.,* development/maturity, species composition and biological structure, status of landscape-scale ecological dynamics, abiotic physical/chemical factors)	√

5.3.4 Rank Criteria Considerations

Integrity ranks should be based only on *current* measures of size, biotic condition, abiotic condition, and landscape context. Accordingly, integrity rank specifications should stipulate criteria for *current* measures only, and should consider components of those factors that provide the most reliable predictions of the future.

Other factors that have historically been considered as potential integrity rank factors are future stresses (direct threats), defensibility, manageability, and restorability. These factors relate to demonstrably uncertain predictions of the impacts of future actions, and do not represent the relative overall quality of an occurrence as it presently exists, based on known current and recent factors. As such, information related to these factors should not be considered in integrity ranking, but may be handled in comments fields, and should be incorporated in conservation planning.

5.4 ECOLOGICAL INTEGRITY RANK VALUES

Different integrity ranks reflect varying degrees of overall quality of an occurrence. For purposes of sorting, selecting, and reporting on occurrences, integrity ranks may be expressed in their original form, as rounded ranks, and/or as numerical rank sequence values.

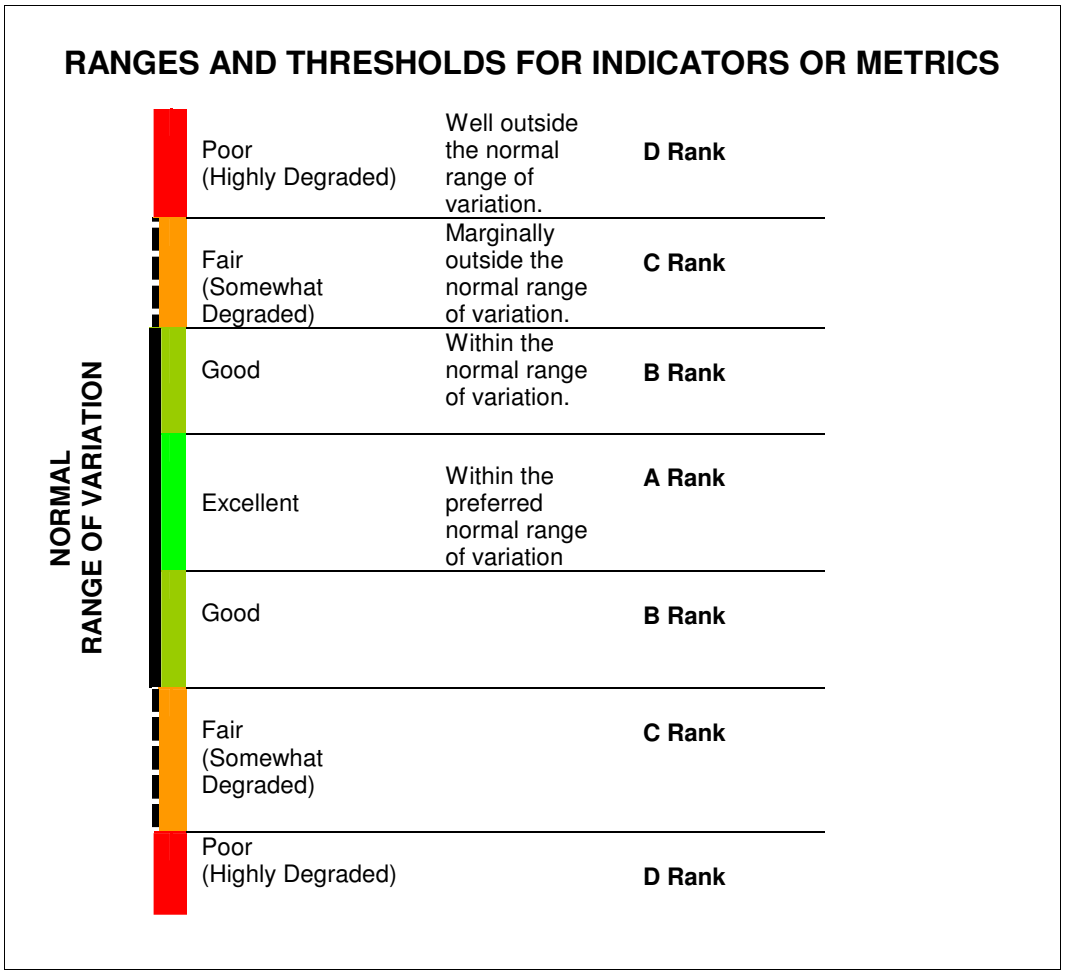
5.5 ESTABLISHING THE RANK SCALE

Wherever possible, integrity rank specifications should be developed that establish a scale for distinguishing between “A”, “B”, “C”, and “D” occurrences. This scale should usually spread from a lowermost limit (the “D” rank or minimum occurrence threshold) up through the threshold for an “A” rank. In addition, the threshold delineating occurrences with “fair” vs. “poor” viability or

integrity must be identified. Figure 5.3 illustrates the rank scale for "A", "B", "C", and "D"-ranked occurrences.

For ecological elements it is often possible to characterize this rank scale using the **natural range of variation** (or **historic range of variation)** concepts. The ecological response to stressors and negative disturbances can be measured as the degree to which variation in the rank factors and their ecological attributes and indicators are pushed beyond their natural range of variation. What is natural or historical may be difficult to define for many elements, given our inability to document this range of variation over sufficient spatial and temporal scales and the relative extent of human disturbance over time. For example, in an undocumented past, people may have used fire to clear patches of forest over several millennia, altering land/waterscapes and influencing species distributions. However, through careful scientific reference, reflections on historical data, and comparisons with the best-preserved occurrences, we can often distinguish the effects of intensive human uses and begin to describe a **normal range of variation** for ecological attributes that maintain the occurrence over the long-term. It is this practical concept that we apply to evaluating occurrences.

Figure 5.3– Expanded Model of the A, B, C, and D Rank Scale based on the Normal Range of Variation



Establishing the rank scale for viability or integrity may require developing multiple metrics for ecological structure, composition, and function as compared to reference or benchmark occurrences operating within (and outside) their normal or natural range of variation. The structure of ranking criteria can be nested, from overall Rank, to rank factors, to key ecological attributes, to their component metric(s). Ratings can be developed at these multiple levels, proceeding from ratings for specific metric or key ecological attributes, to rank factor ratings, and finally to an overall Rank. A good metric responds over a wide range of the disturbance gradient, declining more-or-less continuously with increasingly levels of disturbance. The use of multiple metrics (multi-metric approach) to help guide an overall rating is similar to the Index of Biotic Integrity (IBI) approach[16], particularly in that the metrics document degradation along a continuum from reference to degraded conditions. However, the overall Rank includes not just metrics that relate to biotic integrity (biotic

[16] See Karr, J.R. and E.W. Chu. 1999. Restoring life in running waters: better biological monitoring. Washington (DC). Island Press, 206 pp.

condition), but also abiotic condition, size, and landscape context metrics that define an index of ecological integrity.

5.5.1 The Rank Scale and Reference Condition

In choosing a rating scale for rank factors or metrics, it is important to understand the behavior of the rank factors and metrics over a wide range of field conditions using reference sites, ongoing monitoring, and available literature. The reference condition is at one end of a continuum from an "unimpacted" state to a totally altered state (perhaps leading to an alternative human-caused state). The natural reference condition represents the hypothesized unmodified condition of the element or can be the best condition that can be obtained. The reference conditions may be represented by actual reference sites, or it may be necessary to conceptualize a hypothetical reference condition by synthesizing what is known at the most intact sites, the effect of alteration, historical conditions, and other factors.

Depending on the availability of information, a useful approach to developing the integrity rank specifications is to establish thresholds between various levels of viability or integrity. **The concept of "threshold" is most relevant at the rank factor level, where a combination of metrics help define overall integrity or viability. At the level of individual metrics, the ratings more often reflect disturbance classes and may have somewhat more arbitrary break points**.

An "A" rank need not be strictly comparable to historical conditions. This may be especially true for some migratory species, and the predominant ecological system types, such as "matrix-forming" forest types of many river systems. For example, bison will not conceivably exist again in their historical herd sizes, numbering in the millions, but nevertheless a range of viable populations (*e.g.,* herds of differing sizes and conditions) might still be reasonably achievable. In other words, it is still necessary to conceive of an acceptable range of viable populations, although the range is truncated when compared to integrity rank specifications that would have been written 150 years ago.

A "C" Rank indicates that viability is expected to be low or that some or all key ecological attributes for the occurrence are outside of their normal or natural range of variation but only marginally, such that occurrence will continue to persist, at least in the short term, under current conditions. The distinction between occurrences with "fair" viability or integrity (*i.e.,* "C"-ranked) and occurrences with "poor" viability or integrity ("D"-ranked) is especially important for helping to prioritize occurrences for conservation planning. The context for developing minimum specifications for "C"-ranked occurrences (*i.e.,* the "C" rank threshold) is described below for species and ecological elements. Although lack of restorability per se is not an explicit criterion for determining a "D" rank, it is true that the relative degree of difficulty in restoring an occurrence may reflect the degree to which an occurrence is outside its normal range of variation. For example, the degree to which the current state of a fire-dependent element that has not been burned for a while is outside its natural range of variation may partly be determined by how quickly it responds to a prescribed burning program.

5.6 DEVELOPING RANKING CRITERIA

5.6.1 Ranking Criteria for Ecological Elements

Selection and development of metrics for integrity criteria can be quite challenging, given natural variability, the large number of ecological attributes that could be measured, and concerns over cost-effectiveness and scientific rigor. It is equally challenging to develop effective procedures that can summarize the overall Rank and help guide conservation action.

In order to develop ecological integrity criteria to rank occurrences of ecological elements, the following steps should be taken:

1) determine the level of detail (Level 1, 2 or 3) needed to rank the occurrence.
2) identify a limited set of key ecological attributes for the type, organized into categories of biotic condition, abiotic condition, landscape context, and size;
3) identify a limited set of practical metrics for each key ecological attribute, appropriate for the level of analysis;
4) divide metrics and rank factors into those that are most essential for evaluating viability or integrity (core) versus those that are less essential (supplementary).
5) establish metric or rank factor ratings based on best available information for normal or natural ranges of variation, and relevant disturbance classes for each metric (typically a 4 point scale, but can be more or less); and,
6) provide a roll-up scheme, where the metrics are combined and integrated into rank factor ratings, and the rank factors are aggregated into an overall ecological integrity score based on A to D scale. If more than one level of detail is included, provide roll-up schemes for each level.

5.6.2 Ranking using a Three-level Approach

Ecological integrity assessments can be completed using one or more levels of detail, depending on the objectives of the project[17] (see Table 5.8). All levels should provide a single rating or score that shows where a community falls on the continuum ranging from full ecological integrity (or least impacted condition) to highly degraded (poor condition). Level 1 (Remote Assessment) relies primarily on remotely sensed information and landscape metrics; Level 2 (Rapid Assessment) typically involves an evaluation of the condition of an occurrence based on relatively simple field indicators; and Level 3 (Intensive Assessment) typically requires a detailed field-based assessment, including quantifiable measurements and sampling design. Level 2 rapid assessments is the standard level of evaluation for most Natural Heritage work. Expert judgment may play a strong role in this level of assessment, but guidelines are given to help different experts reach comparable conclusions. Although these rapid assessments often use metrics, the metrics may be more qualitative.

[17] Brooks, Robert P., Denice Heller Wardrop, and Joseph A. Bishop. 2004. Assessing wetland condition on a watershed basis in the Mid-Atlantic region using synoptic land cover maps. Environmental Monitoring and Assessment 94(1):9-22

Table 5.8. A Three-level approach to assessing ecological integrity.

Level	Products & Applications
Level 1 – Remote Assessment Evaluate condition of individual areas (occurrences) using GIS and remote sensing. Assessment typically makes substantial use of landscape / watershed condition around the occurrences, in addition to indicators within the occurrence that are visible with remote sensing data. Typical assessment layers include land cover, land use, and other mapped layers of ecological types.	• Landscape condition assessment relevant to targeted occurrences (Level 1 Rank). • Identification of priority sites • Targeting restoration and monitoring. • Status and trends of acreages or condition of types across the landscape
Level 2 – Rapid Assessment Evaluate the condition of individual occurrences using relatively simple field indicators. Assessment can be based on both stressor (e.g., ditching, road crossings, and pollutant inputs) and condition metrics (e.g., hydrologic regime, species composition).	• Rapid site condition assessments relevant to targeted occurrences (Level 2 Rank) • General conservation and management planning • Integrated scorecard reporting • Landscape / watershed planning • Implementation monitoring of restoration or management projects
Level 3 – Intensive Assessment Evaluate the condition of individual occurrences using relatively detailed quantitative field indicators. Assessment can be based on indicators that have been calibrated to measure the responses of the system to various disturbances (e.g., indices of biotic or ecological integrity).	• Detailed site condition assessments relevant to targeted occurrences (Level 3 Rank) • Status and trends of specific occurrences or indicators • Integrated scorecard reporting • Restoration, mitigation, and management monitoring

Level 1 Remote assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape condition and the distribution and abundance of types in the landscape or watershed. Field-based assessments (Level 2 and 3) can be targeted within parts of the landscape and to specific occurrences in need of more rigorous assessment.

Level 2 Rapid assessments use relatively simple field metrics for collecting data at specific sites. This level will often require considerable professional judgment. Quantitative guidelines are encouraged to aid understanding of the metrics and thresholds, but no substantial quantitative sampling is expected during the assessment[18]. Level 2 assessments may also make use of remotely sensed

[18] For a recent example of a Level 2 approach using a rapid field protocol, see Mack, J. J. 2001. Ohio Rapid Assessment Method for Wetlands v. 5.0, User's Manual and Scoring Forms. Ohio EPA Technical Report WET/2001-1. Ohio Environmental Protection Agency, Division of Surface Water, 401/Wetland Ecology Unit, Columbus, Ohio.

metrics used in level 1, if these are the best way to measure a given ecological factor, but with the opportunity to do some ground verification. The rapid method is the main approach used by Network biologists, rarely taking more than four hours of field time, coupled with some office preparation and data analysis to reach a rank. Ranks can be verified with a Level 3 "Intensive" assessment, where desirable. The rapid assessment method can be used for conservation planning, prioritizing of sites for management or regulatory decision making, local land and water use planning.

Level 3 assessments are more rigorous, field-based method that provides higher resolution information on the condition of occurrences within an assessment area, often employing quantitative plot-based assessment procedures coupled with a sampling design. Calculations of calibrated indices, e.g., vegetation indices of biological integrity ("IBI"), HGM functional assessment methods, and others may also be used[19]. Some metrics based on remote sensing data or qualitative field assessment may also be used if there is no benefit in further quantification or intensity of effort for them.

The 3-level approach allows flexibility to develop data for many occurrences that cannot readily be visited or intensively studied, allows more widespread assessment, and allows more detailed monitoring of occurrences to be tied to integrity ranks. Table 5.9 provides an example structure for summarizing metrics for an ecological element. Table 5.10 includes an example for a particular metric. Appendix 2 includes a detailed example where information from all levels is included. Within Data fields, the type of assessment (Levels 1-3) may be documented, providing users with a good indication of the intensity of evaluation underlying the overall Rank.

5.6.3 Conceptual Models and Core versus Supplemental Metrics

Attribute selection is based on our knowledge of a type across its range of distribution. The attributes emphasize factors that both drive the function of the type, *and* are responsive to degrading effects of human activity. Conceptual "state-and-transition" models can also be helpful to articulate the major ecological "states," such as a structural/composition stage of succession, and the one-several "transitions" from one state to another, driven by natural dynamics, or human alterations. Often, key ecological attributes can be identified as the driving forces behind these conceptual transitions; e.g., fire regime in fire-adapted ecosystems, or hydrologic regime in aquatic and wetland systems, etc.

Review of the ecological characteristics of an ecological element or species may also lead to prioritization of the metrics. Some metrics or rank factors may be considered **core**; that is, they are most essential to characterizing viability or integrity, whereas others may be considered **supplemental**; that is, their measurement may not be required to provide an occurrence rank, but if they are relatively easy to measure, they can provide corroboration or calibration to core metrics, or are valuable in monitoring status and trends or restoration. For ecological elements all four rank

[19] For a recent example of a Level 3 approach using a vegetation-based IBI, see Miller, S.J., D.H. Wardrop, W.M Mahaney, and R.P. Brooks. 2006. A plant-based index of biological integrity (IBI) for headwater wetlands in central Pennsylvania. Ecological Indicators 6: 290-312.

factors are typically seen as core (though they can be weighted in importance), but individual metrics within a rank factor may be less important or only needed for special applications.

Table 5.9 Example structure of ecological integrity table for a wetland system at three Levels of Assessment. Core (C) metrics are in bold, supplementary (S) metrics are in italics.

Level 1 Assessment

Category	Key Ecological Attribute	Metric	Level 1 C/S
LANDSCAPE CONTEXT			
	Landscape Composition	**Landscape Development Index**	C
	Landscape Structure	**Buffer Width**	C
		Percentage unfragmented landscape within 1 km	C
BIOTIC CONDITION			
	Community Structure	Stand Structure	S
ABIOTIC CONDITION			
	Energy/ Material Flow	**Land Use Within the Wetland**	C
	Hydrology	Hydrological Alterations	S
SIZE			
	Area	**Absolute Size**	C

Level 2 Assessment

Category	Key Ecological Attribute	Metric	Level 2 C/S
LANDSCAPE CONTEXT			
	Landscape Composition	**Edge ratio of natural/non-natural habitat (buffer)**	C
	Landscape Structure	**Size /connectivity of compatible natural systems**	C
		Distance to nearest road	S
BIOTIC CONDITION			
	Community Structure	**Canopy Structure / Age**	C
	Community Composition	**Percent Cover of Native Plant Species**	C
		Presence of Exotics or Weedy Natives	C
ABIOTIC CONDITION			
	Energy/ Material Flow	**Land Use Within the Wetland**	C
	Hydrology	**Hydrological Alterations**	C
		Water Table Depth	S
SIZE			
	Area	**Absolute Size**	C
		Relative Size	C

Level 3 Assessment.

Category	Key Ecological Attribute	Metric	Level 3 C/S
LANDSCAPE CONTEXT			
	Landscape Composition	**Edge ratio of natural/non-natural habitat (buffer)**	C
	Landscape Structure	**Size /connectivity of compatible natural systems**	C
		Percentage unfragmented landscape within 1 km	S
BIOTIC CONDITION			
	Community Composition	**Vegetation Index of Biotic Integrity (IBI)**	C
	Community Structure	Stand Live Basal Area	S
		Coarse Woody Debris	S
ABIOTIC CONDITION			
	Soil (Chem/Physical)	**Soil Perturbation Index**	C
	Energy/ Material Flow	Land Use Within the Wetland	S
		Hydrologic Alterations	S
	Hydrology	Water Table Depth	S
SIZE			
	Area	**Absolute Size**	C
		Relative Size	C

Table 5.10. Example of some core (C) metrics for a Level 2 Rapid Assessment of a marsh type, showing definition of metric and metric ratings.

CATEGORY **Key Ecological Attribute** **Indicator & Metric**	**Level & C/S**	**Definition**	**Field Value**	*Metric Rating Criteria*			
				A Excellent	**B Good**	**C Fair**	**D Poor**
LANDSCAPE CONTEXT Landscape Composition **Buffer Width**	2,C	Wetland buffers are vegetated, natural (non-anthropogenic) areas that surround a wetland.		Wide > 100 m	Medium. 50 m to <100 m	Narrow. 25 m to 50 m	Very Narrow. < 25 m
BIOTIC CONDITION Community Composition **Percent Cover of Native Plant Species**	2,C	Percent cover of the plant species that are native, relative to total cover (sum by species)		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

5.7 DEVELOPING A RANK SCORE

For ecological elements, the size, biotic condition, abiotic condition, and/or landscape context factors will always be considered together in determining an integrity rank. Thus, specifications for "A", "B", "C", and "D" ranks for each of the four rank factors may be entered into corresponding **INTEGRITY RANK SPECIFICATIONS** fields. These specifications may consist of qualitative descriptive criteria, or may be based on more precise metrics, each of which could be rated individually, before assigning an integrity rank factor rating, and an overall integrity rank.

5.7.1 Aggregating Metrics and Rank Factors

A number of approaches for aggregating metrics or rank factors are available, each with a variety of strengths and weaknesses. Three may be noted here: 1) **preponderance of evidence** approach, where the various metrics and other supporting information are reviewed and a best judgment is made; 2) **point-based** approach, where individual metrics are scored and weighted to produce an overall rating for a rank factor, and the rank factors are in turn scored and weighted to produce an overall rank; and 3) **rule-based** (combination) approach, where specific combinations of metrics and rank factors are specified to produce the overall rank. The preponderance of evidence approach may work best where data sources are somewhat heterogeneous, field surveys may cover rather large areas, or where the responsiveness of metrics is still besting tested.

Experimentation with these different aggregation methods is encouraged in the process of developing specifications, to explore the implications of the rules used. An example of a point-base approach is provided in Appendix 3 and a rule-based, combination table Approach in Appendix 4 .

5.8 TEMPLATES FOR WRITING ECOLOGICAL INTEGRITY RANK ASSESSMENTS

Using a standard template when writing integrity rank specifications may help ensure that they are consistent with the guidelines described above (Section 5.7). Figure 5.6 provides a template that could be used when writing criteria for ranking occurrences for ecological elements. (For examples of integrity rank specifications developed using the templates, see Appendix D; see also Appendix 5 (chapter 5.) For species, rank specifications should be recorded in the "A" through "D" specifications fields. For ecological elements, a set specifications should be recorded in the "A = Excellent" through "D = Poor" fields for each metric of each key ecological attribute, organized within relevant integrity rank factors (*i.e.,* biotic condition, abiotic condition, size, and landscape context).

Figure 5.6 - Template for Ecological Integrity Assessments

Rank Specs

ASSESSMENT GROUP (Name of groups of elements, if applicable)

Level 2 Assessment

OVERVIEW

(Overview of **Threats** and **Justification of Metrics)**

ASSESSMENT CRITERIA

Summary Table

Rank Factor	**Key Ecological Attribute**	**Metric**	**Core / Supp. (C,S)**	**Metric Definition**	*Metric Rating Criteria*			
					A = Excel-lent	**B = Good**	**C = Fair**	**D = Poor**
LANDSCAPE CONTEXT								
		1						
		2						
BIOTIC CONDITION								
		3						
		4						
ABIOTIC CONDITION								
		5						
		6						
SIZE								
		7						
		etc.						

METRICS AGGREGATION

[1)Rationale and methods for weighting metrics by rank factor and 2) Aggregation summary table]

RANK FACTOR AGGREGATION

[Rationale and methods for prioritizing and weighting Rank Factors to determine overall integrity rank]

METRICS DOCUMENTATION

Metric Code: [we may want to assign a database code to these metrics to facilitate population of forms]
Definition:
Background:
Rationale for Selection of the Variable:
Measurement Protocol:
Metric Rating Scale (A – D classes, or other rating scale):
Data Sources:
Scaling Rationale:
Confidence that reasonable logic and/or data support the index:
References

Edition

RANK SPECS AUTHOR (significant contributors to integrity rank specifications)

RANK SPECS EDITION DATE (YYYY-MM-DD)

RANK SPEC NOTES (internal notes relating to development of integrity rank specifications

APPENDICES

APPENDIX 1. Summary Of Major Categories And Subcategories Of Key Ecological Attributes.

APPENDIX 2. Overall Set of Metrics for a Marsh Ecological System.

APPENDIX 3. Simple Point-Based Approach For Rating Metrics And Rank Factors

APPENDIX 4. Rule-Based Combination Table Approach For Rating Metrics And Rank Factors

APPENDIX 5. Extended Example Of Ecological Integrity Assessment Documentation For An Ecological Element, With Simple Point-Based Approach

APPENDIX 1. Summary Of Major Categories And Subcategories Of Key Ecological Attributes

Attributes are organized by the four rank factors (Landscape Context, Biotic Condition, Abiotic Condition, and Size). Key ecological attributes for the first 3 factors are subdivided into structure (pattern) and process (function) (adapted from Young and Sanzone 2002). Attributes may overlap among factors, e.g., natural disturbances may be tracked through vegetation structural or compositional changes within Biotic Condition.

LANDSCAPE CONTEXT

Structure

- Extent of Ecological System/Habitat Types
- Landscape Composition
- Landscape Pattern and Structure

Process

Natural Disturbance Regimes

- Frequency
- Intensity
- Extent
- Duration

BIOTIC CONDITION

Structure

- Ecosystems and Communities
  - Community Composition
  - Trophic Structure
  - Community Dynamics
  - Physical Structure
- Species and Populations
  - Genetic Diversity
  - Population Structure
  - Habitat Suitability
- Organism Condition
  - Physiological Status
  - Symptoms of Disease or Trauma
  - Signs of disease

Process

- Energy Flow
  - Primary Production
  - Net Ecosystem Production
  - Growth Efficiency
- Material Flow
  - Organic Carbon Cycling
  - Nitrogen and Phosphorus Cycling
  - Other Nutrient Cycling
- Natural Disturbance Processes

ABIOTIC CONDITION –

Structure:

Chemical, Physical Characteristics

- **Air Quality and Climate**
- **Soil Quality**
- **Water Quality**
  - Nutrient Concentrations
    - Nitrogen
    - Phosphorus
    - Other Nutrients
  - Trace Inorganic and Organic Chemicals
    - Metals
    - Other Trace Elements
    - Organic Compounds
  - Other Chemical Parameters
    - pH
    - Dissolved Oxygen
    - Salinity
    - Organic Matter
    - Other
  - Physical Parameters

Process

Hydrology and Geomorphology

- Surface and Groundwater flows
  - Pattern of Surface Flows
  - Hydrodynamics
  - Pattern of Groundwater Flows
  - Salinity Patterns
  - Water Storage
- Dynamic Structural Characteristics
  - Channel/Shoreline Morphology, Complexity
  - Extent/Distribution of Connected Floodplain
  - Aquatic Physical Habitat Complexity
- Sediment and Material Transport
  - Sediment Supply / Movement
  - Particle Size Distribution Patterns
  - Other Material Flux

SIZE

Ecosystem / Community Area

- Absolute size
- Relative size [is there a better term?]

Population Abundance

- Population Size
- Population Dynamics

APPENDIX 2. Overall Set of Metrics for a Level 2 Assessment of a marsh wetland type.

Table A2.1. Definition and Metric Rating are provided for each metric. Core metrics = C (and in bold), Supplementary metrics = S.

RANK FACTOR Key Ecological Attribute	**Indicator & Metric**	**(C,S)**	**Definition**	*Metric Rating Criteria*			
				A = Excellent	**B = Good**	**C = Fair**	**D = Poor**
LANDSCAPE CONTEXT							
Landscape Composition	**Adjacent Land Use**	**C**	Addresses the intensity of human dominated land uses within 100 m of the wetland.	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
	Buffer Width	**C**	Wetland buffers are vegetated, natural (non-anthropogenic) areas that surround a wetland.	Wide > 100 m	Medium. 50 m to <100 m	Narrow. 25 m to 50 m	Very Narrow. < 25 m
Landscape Pattern	**Percentage of unfragmented landscape within 1 km.**	**C**	An unfragmented landscape has no barriers to the movement and connectivity of species, water, nutrients, etc. between natural ecological systems.	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
	Distance to nearest road	S	Addresses the potential impacts to the site of roads or major trails, which are a specific type of altered habitat effect.	Very Far > 300 m	Far. 100 m to 300 m	Near. 50 m to 99 m	Very Near. < 50m
BIOTIC CONDITION							
Community Composition	**Percent of Cover of Native Plant Species**	**C**	Percent cover of the plant species that are native, relative to total cover (sum by species)	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
	Invasive Species – Plants	**C**	Percent of marsh dominated by invasive, aggressive plants.	Native species such as *Typha* and *Phragmites*, if present, do not dominate wetland	Native species such as *Typha* and *Phragmites* and/or other non-native invasive species present but occupy less < 25% of wetland;	Native species such as *Typha* and *Phragmites* and/or other non-native invasive species present and occupy 25-75% of wetland;	Native species such as *Typha* and *Phragmites* and/or other non-native invasive species present and occupy >75% of wetland;

RANK FACTOR Key Ecological Attribute	**Indicator & Metric**	**(C,S)**	**Definition**	*Metric Rating Criteria*			
				A = Excellent	**B = Good**	**C = Fair**	**D = Poor**
	Floristic Quality Assessment (Mean C) [	S	The mean conservatism of all the native species growing in the wetland.	Mean C > 4.5	Mean C = 3.5-4.5	Mean C = 3.0 – 3.5	Mean C < 3.0
ABIOTIC CONDITION							
Energy/ Material Flow	**Land Use Within the Wetland**	**C**	Addresses the intensity of human dominated land uses within the wetland.	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
Hydrology	**Flashiness Index**	**C**	Measures the variability of water table fluctuations and rates it compared to a reference standard	Flashiness Index = 1.0 - 2.0	Flashiness Index = 1.0 - 2.0	Flashiness Index = between 2.0 -3.0 if wetland is NOT associated with riverine	Flashiness Index = > 3.0 if wetland is NOT associated with riverine environment
	Hydrological Alterations	**C**	The degree to which onsite or adjacent land uses and human activities have altered hydrological processes.	No alterations. No dikes, diversions, ditches, flow additions, or fill present in wetland that restricts or redirects flow	Low intensity alteration such as roads at/near grade, small diversion or ditches (< 1 ft. deep) or small amount of flow additions	Moderate intensity alteration such as 2-lane road, low dikes, roads w/culverts adequate for stream flow, medium diversion or ditches (1-3 ft. deep) or moderate flow additions.	High intensity alteration such as 4-lane Hwy., large dikes, diversions, or ditches (>3 ft. deep) capable to lowering water table, large amount of fill, or artificial groundwater pumping or high amounts of flow additions
SIZE							
Absolute Size	**Absolute Size**	**C**	The current size of the wetland	> 25 acres (10 ha)	5 to 25 acres (2 to 10 ha)	1 to 5 acres (0.4 to 2 ha)	< 1 acre (<0.4 ha)
Relative Size	**Relative Size**	**C**	The current size of the wetland divided by the total potential size of the wetland multiplied by 100.	Wetland area = onsite Abiotic Potential	Wetland area < Abiotic Potential; Relative Size = 90 – 100% ; (< 10% of wetland has been reduced, destroyed or severely disturbed due to roads, impoundments, development, human-induced drainage, etc.	Wetland area < Abiotic Potential; Relative Size = 75 – 90%; 10-25% of wetland has been reduced, destroyed or severely disturbed due to roads, impoundments, development, human-induced drainage, etc	Wetland area < Abiotic Potential; Relative Size = < 75%; > 25% of wetland has been reduced, destroyed or severely disturbed due to roads, impoundments, development, human-induced drainage, etc

APPENDIX 3 . Simple Point-Based Approach For Rating Metrics And Rank Factors

In this approach, numerical values are assigned to the rating categories (A, B, C, and D) for each metric. Weighting factors are specified for each metric to control its contribution to the final score, and the values for the ratings are multiplied by them. Thresholds are specified for the summed point values, to assign them to A, B, C, or D categories. Numerical combinations can be done in multiple stages or in one large formula, but at least the four rank factors (biotic condition, abiotic condition, size, and landscape context) should be given specific ratings before being combined into the final integrity rank. The default set of points are A= 5, B = 4, C = 3, D = 1. The weights are derived from the basic weighting scheme used in Karr's IBI approach, where 5 (good), 3 (fair) and 1 (poor) points were used. Distinctions between Excellent (A) and Good (B) can be subtle, so only a single point separates them, whereas distinctions between fair (C) and Poor (D) should be strong; hence a low value of 1 is assigned to D.

An example of a point-based approach for aggregating metrics, without interactions, is shown in Table 5.10. The example assigns a weight to the three metrics, based on their perceived importance to overall Biotic Condition. The final score is the basis for the A – D rating for the Biotic Condition Rank Factor. In the example, all metrics have four categories of rating (A- D), but in some cases, a metric may only have 3 (A/B, C, D) or 2 ratings (A-C, D); less commonly it may have more than 4 (A, B+, B-, C, D).

Table A3.1. Example of Calculation of the Biotic Condition Rank Factor using a Point-based Rating System for each Metric (Level 2 Assessment).

Metric	Definition	Rating				Weight*	Score (weight x rating)
		A	B	C	D		
Percent of Cover of Native Plant Species	**Percent of the plant species which are native to the region**	5	4	3	1	0.30 (0.55)	
Invasive Species – Plants	**Percent of marsh which is dominated by invasive, aggressive plants.**	5	4	3	1	0.20 (0.45)	
Floristic Quality Assessment (FQA) (Mean C)	The mean conservatism of all the native species growing in the wetland.	5	4	3	1	0.50 (N/A)	
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**

* The weight in parentheses is used when FQA metric is not used.

APPENDIX 4. Rule-Based Combination Table Approach For Rating Metrics And Rank Factors

In this approach, the result for each combination of metrics is specified, allowing either simple or complex interactions. This example is from integrity rank specs for the Atlantic Coastal Plain Northern Wet Longleaf Pine Savanna and Flatwoods ecological system. Tables A4.1, A4.2, and A4.3 show the stepwise combination of metrics for biological condition into composite ratings herb layer condition and canopy condition, and then into a single biotic condition rating. Besides canopy condition and herb layer condition, another biotic condition metric pertaining to presence and abundance of exotic plants must be combined to determine the final biotic condition rating. This could have been indicated by using another three-way table for the final combination. However, because exotics are rarely a problem in this ecological system and will rarely affect the final rating this metric is indicated with asterisks and a footnote to the final combination table. This allows a simpler combination table. The final rating for biotic condition would then be combined in a similar way with those for abiotic condition, size, and landscape context.

Table A4.1. Example of a two-way combination table for two biotic condition metrics assessing the herb layer. Ratings for herb layer diversity are represented by the columns, ratings for abundance of characteristic grasses are represented by the rows, and the value of combinations is represented by letters in the cells and by the color of the cells. [The red letters of the "track changes" version don't show up in the red cells but will when the changes are accepted.]

		Herb layer diversity		
Abundance of characteristic grasses	**A**	**B**	**C**	**D**
A	**A**	**B**	**B**	**C**
B	**B**	**B**	**C**	**D**
C	**B**	**C**	**C**	**D**
D	**C***	**D**	**D**	**D**

Table A4.2. Example of a three-way combination table for three biotic condition metrics assessing the tree canopy. Ratings for tree size/age are represented by the columns, ratings for canopy patch structure are represented by the rows. Ratings for canopy composition are represented by the subdivisions within each cell. Combined ratings are given by the letters following the colon in each subdivision and also by the colors of the subdivisions. Note that one combination is not logically possible: there cannot be a good canopy patch structure if there are no trees or only very young trees.

		Tree size/age		
Canopy patch structure	**A**	**B**	**C**	**D**
	Canopy composition			
A	**A: A** **B: B** **C: B** **D: C**	**A: B** **B : B** **C: C** **D: D**	**A: B** **B: B** **C: C** **D: D**	**Will not occur.**
B	**A: A** **B: B** **C: C** **D: D**	**A: B** **B: C** **C: C** **D: D**	**A: C** **B: C** **C: D** **D: D**	**A: C** **B: C** **C: C** **D: D**
C	**A: B** **B: B** **C: C**	**A: B** **B: B** **C: C**	**A: C** **B: C** **C: D**	**A: C** **B: C** **C: C**

	D: D	**D: D**	**D: D**	**D: D**
D	**D**	**D**	**D**	**D**

Table A4.3. Example of two-way combination table with an additional rule (modifying footnote). This table combines the results of the previous two tables into a biotic condition rank factor score. The combined canopy rating is represented by the columns, the combined herb layer rating by the rows. The combined biotic condition score is given by letters within the cells and by the color of the cells; however the higher biotic condition rating will be reduced if there is poor condition due to exotics.

		Canopy score		
Herb layer score	**A**	**B**	**C**	**D**
A	**A ***	**B ***	**B ***	**C**
B	**B ***	**B ***	**B ***	**C**
C	**B ***	**C**	**C**	**D**
D	**C**	**D**	**D**	**D**

* If presence and abundance of exotics score = D, reduce the score from this table by one grade (e.g. from B to C).

APPENDIX 5. Extended Example Of Ecological Integrity Assessment Documentation For An Ecological Element, With Simple Point-Based Approach

Rank Specs

RANK SPECS GROUP:
Level 2 Assessment
Temperate and Boreal Wet Meadows
(based on CES306.812 Rocky Mountain Alpine-Montane Wet Meadow)

RANK SPECS OVERVIEW

Threats

[Text describing each of the threats may be provided.]
Hydrological Alteration
Land Use
Nutrient enrichment
Exotics
Fragmentation:

Justification of Metrics

As reviewed above, the literature suggests that the following attributes are important measures of the ecological integrity of Temperate and Boreal Wet Meadows:

- Landscape Context: Land use within the contributing watershed has important effects on the connectivity and sustainability of many ecological processes critical to this system.
- Biotic condition: Species composition and diversity, presence of conservative plants, and invasion of exotics are important measures of biological integrity.
- Abiotic Condition: Hydrological integrity is the most important variable to measure, however land use within the wetland can have detrimental impacts on other important abiotic processes such as nutrient cycling.
- Size: Absolute size is important for consideration of conservation values as well as ecosystem resilience. Relative size is also very important as it provides information regarding historical loss or degradation of wetland size.

METRICS SPECIFICATIONS

Table A5.1 Summary Table showing all metrics. Details of the ratings are not shown here (See Metrics Documentation below and Appendix 2 . Supplementary metrics are italicized.

RANK FACTOR **Key Ecological Attribute**	**Indicators/Metrics**	**Leve** **1** **2**	**Core?**	**Metric Ratings**			
				A	**B**	**C**	**D**
LANDSCAPE CONTEXT							
Landscape Context	Adjacent Land Use	2	C				
	Buffer Width	2	C				
	Percentage of unfragmented landscape within 1 km.	2	C				
BIOTIC CONDITION							
Composition	Percentage of Native Graminoids	2	C				
	Percent of Cover of Native Plant Species	2	C				
	Floristic Quality Index (Mean C)	2	S				
Patch Diversity	*Biotic Patch Richness*	2	*S*				
	Interspersion of Biotic Patches	2	*S*				
ABIOTIC CONDITION							
Energy/ Material Flow	Land Use Within the Wetland	2	C				
Hydrological Regime	Water Table Depth	2	C				
	Hydrological Alterations	2	C				
Chemical-Physical Processes	*Litter Cover*	2	*S*				
	Soil Organic Matter Decomposition	2	*S*				
SIZE							
Area	Absolute Size	2	C				
	Relative Size	2	C				

METRICS AGGREGATION

Rationale

Landscape Context Metrics: Adjacent land use and buffer width 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.

Biotic Condition Metrics: Percentage of native graminoids, which typically dominate the wet meadows, is judged to be more important than overall cover of native plant species.

Abiotic Condition Metrics: Stressor related metrics (Land Use & Hydrological Alterations) are perceived to provide more dependable information concerning Abiotic Condition that is a visual field assessment of Water Table Depth.

Size Metrics: Absolute size is judged to be most important, since wet meadows are relatively small in size (<<1,000 acres or 400 ha). However, for some calculations, only the weight of relative size should be used.

Metric Numeric Rating:
A = 5
B = 4
C = 3
D = 1

Metric Rating Summary

Table A5.2. Summary Table showing how to calculate point scores for metrics, for a Level 2 Rapid Assessment.

RANK FACTOR Metric	**Metric No.**	**Metric Field Value**	**Metric Rating (A-D, etc)**	**Numerical Rating**	**Weight**	**Score**
LANDSCAPE CONTEXT						
Adjacent Land Use	L1	0.98	A	5	0.40	2
Buffer Width	L2	75 m	B	4	0.40	1.6
Percentage of unfragmented landscape within 1 km.	L3	80%	B	4	0.20	0.8
					Landscape Context Rating/Score (L)	**4.4 (B)**
BIOTIC CONDITION						
Percentage of Native Graminoids	B1	45	C	3	0.55	1.7
Percent of Cover of Native Plant Species	B2	55	C	3	0.45	1.3
					Biotic Condition Rating/Score (B)	**3.0 (C)**
ABIOTIC CONDITION						
Land Use Within the Wetland	A1	0.5	C	3	0.25	0.8
Water Table Depth	A2	Hydric soils present	A/B	5	0.20	1.0
Hydrological Alterations	A3	Small dikes, shallw ditches	B	4	0.55	2.2
					Abiotic Condition Rating/Score (A)	**4.0 (B)**
SIZE						
Absolute Size	S1	50 acres	B	4	0.70	2.8
Relative Size	S2	95	B	4	0.30	1.2
					Size Rating/Score (S)	**4.0 (B)**

RANK FACTOR AGGREGATION

Rationale
This is a small patch community.

Primary Factor: Condition (Abiotic and Biotic): 60% (35% Abiotic, 25% Biotic)
Secondary: Landscape Context: 25%
Tertiary Factor: Size (15%)

Basic Equation:

Overall Ecological Integrity Rank =
[Abiotic Condition Score *(0.35)] + [Biotic Condition Score *(0.25)] + [Landscape Context Score * (0.25)] + [Relative Size Score * (0.15)]
Note: For this calculation ONLY consider Relative Size for Size Score]

Alternative Equation:

If Landscape Context is *C* or *D* AND Size = *A* or *B* then the Overall Ecological Integrity Rank = **[Abiotic Condition Score *(0.35)] + [Biotic Condition Score *(0.25)] + [Size Score * (0.25)] + [Landscape Context Score * (0.15)]**

Calculation:
Landscape Context = B; use Basic Equation
Ecological Integrity (occurrence) Rank = [4.0*(0.35)] + [3.0 *(0.25)] + [4.4 * (0.25)] + [4.0 * (0.15)]
= 1.4 + 0.8 + 1.1 + 0.6
= 3.9
= **B**

Table A5.3. Rank Scale for Ranking Ecological Element Occurrences

Rank	Numeric Values (Scores) (if metric numerical ratings range from 1(D) - 4 (A)	Numeric Values (Scores] (if metric numerical rating points range from 1 (D) – 5 (A)
A	>3.25 and ≤4.00	4.5. – 5.0
B	>2.50 and ≤3.25	3.5 – 4.4
C	>1.75 and ≤2.50	2.5 – 3.4
D	>1.00 and ≤1.75	1.0 – 2.4

METRICS DOCUMENTATION

[only one metric is shown]

Landscape Context

Metric LC 1: 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.

Background: This metric is one aspect of the landscape context of specific occurrences of wetland and riparian 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. Buffer boundaries extend from the wetland edge to intensive human land uses which result non-natural areas. Some land uses such as light grazing and recreation may occur in the buffer, but other more intense 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).

Measurement 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.

Measure (Metric) Rating			
Excellent	**Good**	**Fair**	**Poor**
Wide > 100 m	Medium. 50 m to <100 m	Narrow. 25 m to 50 m	Very Narrow. < 25m

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), and best scientific judgment regarding buffer widths and their effectiveness in the Southern Rocky Mountains.

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

Etc.

Edition

RANK SPECS AUTHOR (Joe Rocchio; mod. D. Faber-Langendoen)

RANK SPECS EDITION DATE (2006-08-29)

RANK SPECS NOTES (See full details in **CES306.812 Rocky Mountain Alpine-Montane Wet Meadow, Joe Rocchio**)