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## **Ecological Integrity Assessment: Inter-Mountain Basins Cliff and Canyon**

### **Ecological Summary**

The Inter-Mountain Basins Cliff and Canyon ecological system is found from lowland to lower montane elevations and includes barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and smaller rock outcrops of various bedrock types. This includes unstable scree and talus that typically occurs below cliff faces and Pleistocene flood deposits of large, lithic material (NatureServe 2007). Basalt is the dominant parent material in the Columbia Basin in Washington for this system. Other cliff and canyon parent material includes metamorphic volcanic and marine sedimentary rocks associated with the surrounding mountains, Pliocene sedimentary rocks, and Pleistocene sedimentary rocks. This system is found on steep open slopes in the canyons and valleys of the Columbia Basin, particularly along the Columbia and Snake River canyons and their tributaries. It is very common within the Scabland Channel topography (Bretz 1959).

Vegetation occurs in small patches or widely scattered trees and shrubs that generally cover less than 10% of total area. Common woody plants include *Pinus ponderosa*, *Pseudotsuga menziesii* var. *glauca*, *Amelanchier alnifolia*, *Celtis occidentalis* ssp. *reticulata*, *Holodiscus discolor*, *Philadelphus lewisii*, *Rhus glabra*, *Ribes* spp. and other species often common in adjacent plant communities, such as, *Artemisia tridentata*, *Cercocarpus ledifolius*, *Eriogonum compositum*, *E. niveum* or *Purshia tridentata*. These are often restricted to shelves, cracks and crevices in the rock, or other areas where soil accumulation allows growth. Small patches of grassland can occur among rocks where soil accumulates. Common species include *Pseudoroegneria spicata*, *Poa* spp., *Lupinus* spp., *Festuca idahoensis* and *Koeleria macrantha*.

In Colorado, species richness of cliff communities appeared to be controlled by aspect, microsite size, and cliff surface roughness (Graham and Knight 2004). Diversity increases when cliff microhabitats are compressed into a small area. Unfractured cliffs with no rooting space for vascular plants is habitat for lichens which is often next to a ledge where accumulated organic matter, minerals and water support grasses, sedges or small trees (Larson et al. 2000). Cliffs, in general, support high endemism of plants, can be refugia for old trees (Larson et al. 2000), and provide habitat for roosting or nesting birds and bats (Johnson and O'Neil 2001). Cliffs also act as refugia for many plants that currently occur on cliffs but were more common prior to increased human disturbance

(Larson et al. 2000). Due to the sparse nature of vegetation on cliffs, fire rarely has a direct influence on cliff vegetation although this lack of fire influence creates an environment for fire refugia (Graham and Knight 2004).

Cliff and barren systems have relatively discrete boundaries, very specific ecological settings, and strong links to local landscape conditions (Decker 2007). Decker (2007) stated that such small patch communities are often dependent on ecological processes in the surrounding communities. Graham and Knight (2004) concluded that cliff size appears to be less important than the cliff micro-topography and, therefore, larger cliff areas would not necessarily contain greater number of species. Plant species on lists were least similar between large and small cliff faces (Graham and Knight 2004).

Colorado Natural Heritage summarized environmental processes of cliff ecology as follows:

“Larson et al. (2000) define three basic parts of a cliff habitat: 1) the relatively level plateau at the top, 2) the vertical or near-vertical cliff face, and 3) the pediment or talus at the bottom of the face. These three elements share some physical characteristics, are linked by similar ecological processes, and often support the same plants and animals (Larson et al. 2000). Within the larger cliff habitat, steep slopes, small terraces ledges, overhangs, cracks and crevices often form a mosaic of microhabitat types that appears to be the primary factor contributing to cliff biodiversity (Graham and Knight 2004). In addition, the cliff rim is often windier than the surrounding plateau, providing a distinct microhabitat that differs from the nearby flatter areas. At cliff faces there is less hydraulic pressure retaining water within the rock, so liquid water is more consistently found than in the surrounding habitat types (Larson et al. 2000).

Cliff environments are shaped by the parent rock type and strength, climate, aspect, and the weathering patterns produced by physical and chemical processes. Physical weathering includes the downward movement of rock and soil under the influence of gravity (mass wasting), including larger slips, slides and rockfalls, shrinking/swelling in response to changes in water content (mostly in shales and mudstones), direct pressure effects from the formation of ice and mineral crystals, thermal stress, and frost action (Larson et al. 2000). Chemical weathering in cliff environments is directly controlled by precipitation amount and chemistry, rock temperature, and the chemical composition of the rock. Chemical weathering is most prevalent under conditions of higher temperature and high precipitation, whereas physical weathering is more important at lower temperatures (Larson et al. 2000). The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000).“

### *Stressors*

The stressors described below are those primarily associated with the loss of extent and degradation of the ecological integrity of existing occurrences. The stressors are the cause of the system shifting away from its natural range of variability. In other words, type, intensity, and duration of these stressors is what moves a system’s ecological integrity rank away from the expected, natural condition (e.g. A rank) toward degraded integrity ranks (i.e. B, C, or D).

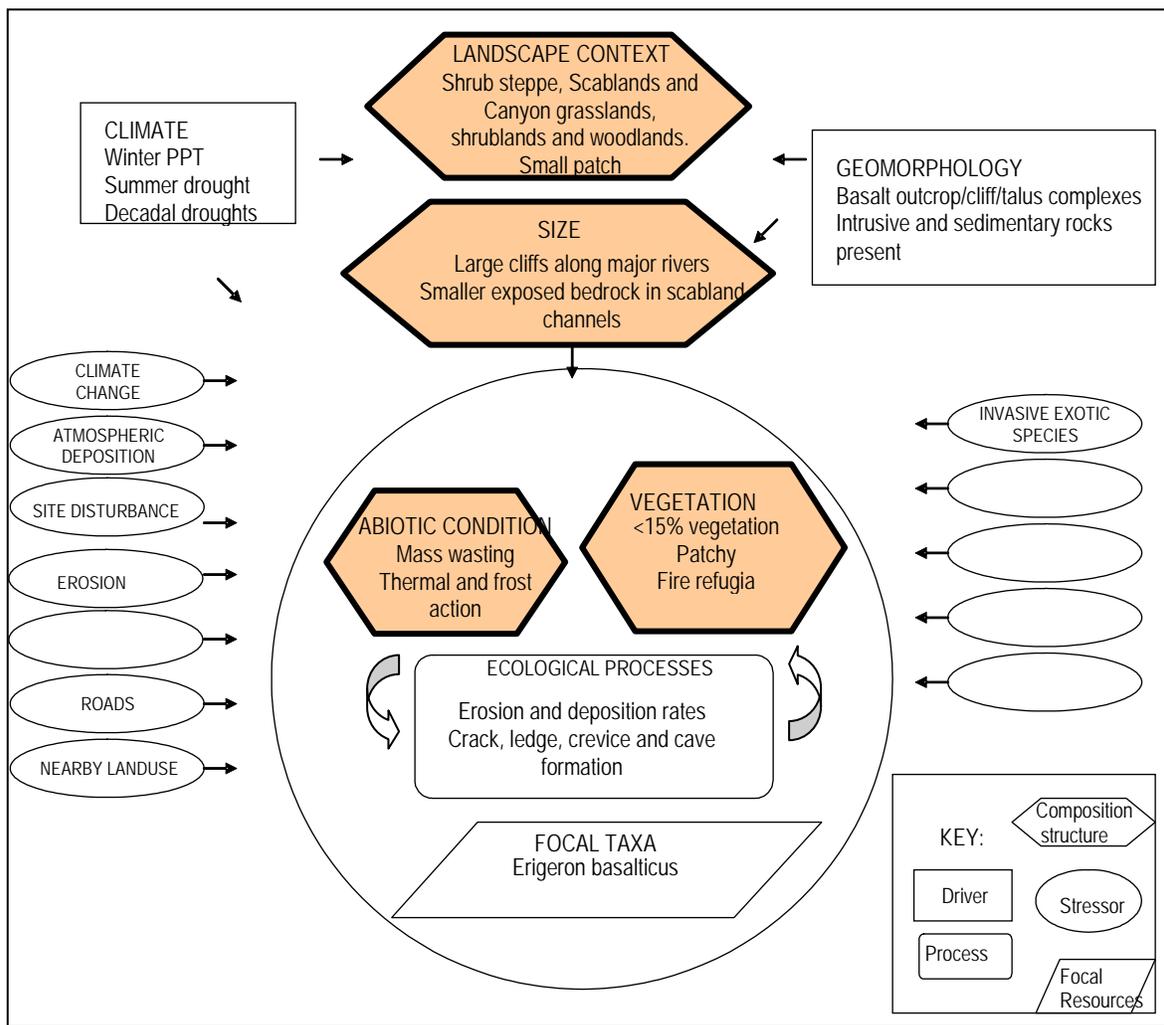
This system usually occurs in inaccessible locations and thus is protected from much disturbance resulting from human activities. Direct stressors remove (localized quarry or borrow pit operations) or modify cliff topography and vegetation patches (recreational activities such as climbing and firearm practice and vehicular use of cliffs composed of

less consolidated material). Agricultural and residential development adjacent or above cliffs and talus modifies cliff microsites through changes in water surface and sub-surface flow or accelerating deposition fine-textured soil that increases or change vegetation cover from perennial to annual cover.

*Conceptual Ecological Model*

The general relationships among the key ecological attributes associated with natural range of variability of the Inter-Mountain Basins Cliff and Canyon Ecological System are presented in Figure 1.

Figure 1. Conceptual Ecological Model for Inter-Mountain Basins Cliff and Canyon.



**Ecological Integrity Assessments**

The assessment of ecological integrity can be done at three levels of intensity depending on the purpose and design of the data collection effort. The three-level approach is intended to provide increasing accuracy of ecological integrity assessment, recognizing

that not all conservation and management decisions need equal levels of accuracy. The three-level approach also allows users to choose their assessment based in part on the level of classification that is available or targeted. If classification is limited to the level of forests vs. wetlands vs. grasslands, the use of remote sensing metrics may be sufficient. If very specific, fine-scale forest, wetland, and grassland types are the classification target then one has the flexibility to decide to use any of the three levels, depending on the need of the assessment. In other words, there is no presumption that a fine-level of classification requires a fine-level of ecological integrity assessment.

Because the purpose is the same for all three levels of assessment (to measure the status of ecological integrity of a site) it is important that the Level 1 assessment use the same kinds of metrics and major attributes as used at Levels 2 and 3. Level 1 assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape integrity and the distribution and abundance of ecological types in the landscape or watershed. Level 2 assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment. Level 3 assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences. They often use quantitative, plot-based protocols coupled with a sampling design to provide data for detailed metrics.

Although the three levels can be integrated into a monitoring framework, each level is developed as a stand-alone method for assessing ecological integrity. **When conducting an ecological integrity assessment, one need only complete a single level that is appropriate to the study at hand.** Typically only one level may be needed, desirable, or cost effective. But for this reason it is very important that each level provide a comparable approach to assessing integrity, else the ratings and ranks will not achieve comparable information if multiple levels are used.

### **Level 1 EIA**

A generalized Level 1 EIA is provided in Rocchio and Crawford (2009). Please refer to that document for the list of metrics applicable to this ecological system.

## Level 2 EIA

The following tables display the metrics chosen to measure most of the key ecological attributes in the conceptual ecological model above. The EIA is used to assess the ecological condition of an assessment area, which may be the same as the element occurrence or a subset of that occurrence based on abrupt changes in condition or on artificial boundaries such as management areas. **Unless otherwise noted, metric ratings apply to both Level 2 and Level 3 EIAs. The difference between the two is that a Level 3 EIA will use more intensive and precise methods to determine metric ratings.** To calculate ranks, each metric is ranked in the field according to the ranking categories listed below. Then, the rank and point total for each metric is entered into the EIA Scorecard and multiplied by the weight factor associated with each metric resulting in a metric 'score'. Metric scores within a key ecological attribute are then summed to arrive at a score (or rank). These are then tallied in the same way to arrive at an overall ecological integrity score.

Table 1. Inter-Mountain Basins Cliff and Canyon Ecological Integrity Assessment Scorecard

Metric	Justification	Rank			
		A (5 pts.)	B (4 pts.)	C (3 pts.)	D (1 pts.)
<b>Rank Factor: LANDSCAPE CONTEXT</b>					
<b>Key Ecological Attribute: <i>Edge Effects</i></b>					
<b>Buffer Length</b>	The buffer can be important to biotic and abiotic aspects of the ecosystem as it provides connectivity and a 'filter' from exogeneous threats.	Buffer is > 75 – 100% of occurrence perimeter.	Buffer is > 50 – 74% of occurrence perimeter.	Buffer is 25 – 49% of occurrence perimeter	Buffer is < 25% of occurrence perimeter.
<b>Buffer Width</b>		Average buffer width of occurrence is > 200 m, adjusted for slope.	Average buffer width is 100 – 199 m, after adjusting for slope.	Average buffer width is 50 – 99 m, after adjusting for slope.	Average buffer width is < 49 m, after adjusting for slope.
<b>Buffer Condition</b>		Abundant (>95%) cover native vegetation, little or no (<5%) cover of non-native plants, intact soils, AND little or no trash or refuse.	Substantial (75–95%) cover of native vegetation, low (5–25%) cover of non-native plants, intact or moderately disrupted soils; minor intensity of human visitation or recreation.	Moderate (25–50%) cover of non-native plants, moderate or extensive soil disruption; moderate intensity of human visitation or recreation.	Dominant (>50%) cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils, moderate or greater intensity of human visitation or recreation, no buffer at all.
<b>Key Ecological Attribute: <i>Landscape Structure</i></b>					

<b>Connectivity</b>	Intact areas have a continuous corridor of natural or semi-natural vegetation between shrub steppe areas	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high.	Variegated: Embedded in 60-90% natural or semi-habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification;	Fragmented: Embedded in 20-60% natural or semi-natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape.	Relictual: Embedded in < 20% natural or semi-natural habitat; connectivity is essentially absent
<b>Landscape Condition Model Index</b>	The intensity and types of land uses in the surrounding landscape can affect ecological integrity.	Landscape Condition Model Index > 0.8		Landscape Condition Model Index 0.75 – 0.65	Landscape Condition Model Index < 0.65
<b>Rank Factor: CONDITION</b>					
<b>Key Ecological Attribute: <i>Vegetation Composition</i></b>					
<b>Relative Cover Native Plant Species</b>	Native species dominate this system; non-natives increase with human impacts.	Cover of native plants = relative 95-100%.	Cover of native plants relative 80-95%.	Cover of native plants relative 50 to <85%.	Cover of native plants < relative 50%.
<b>Absolute Cover of Invasive Species</b>	Invasive species can inflict a wide range of ecological impacts. Early detection is critical. <i>Bromus tectorum</i> abundance is critical.	None present.	Invasive species present, but sporadic (<3% cover).	Invasive species prevalent (3–10% absolute cover).	Invasive species abundant (>10% absolute cover).
<b>Relative Cover of Native Increasers</b>	Some stressors such as grazing can shift or homogenize native composition toward species tolerant of stressors.	Absent or incidental	<10% cover	10-20% cover	>20% cover
<b>Species Composition</b> Note: Once developed, the Floristic Quality Assessment index could be used here instead.	The overall composition of native species can shift when exposed to stressors.	Species diversity/abundance at or near reference standard conditions. Native species sensitive to anthropogenic degradation are present, functional groups indicative of anthropogenic disturbance (ruderal or “weedy” species) are absent to minor, and full range of diagnostic / indicator species are present.	Species diversity/abundance close to reference standard condition. Some native species reflective of past anthropogenic degradation present. Some indicator/ diagnostic species may be absent.	Species diversity/abundance is different from reference standard condition in, but still largely composed of native species characteristic of the type. This may include ruderal (“weedy”) species. Many indicator/diagnostic species may be absent.	Vegetation severely altered from reference standard. Expected strata are absent or dominated by ruderal (“weedy”) species, or comprised of planted stands of non-characteristic species, or unnaturally dominated by a single species. Most or all indicator/diagnostic species are absent.
<b>Key Ecological Attribute: <i>Vegetation Structure</i></b>					

<b>Patch diversity</b>	Spatial heterogeneity of microhabitats strongly influence the abundance and distribution of species that use a particular habitat (Pulliam et al. 1992). Human-induced stress can decrease the range of biotic/abiotic patches from an un-impacted site.	No or little change in patch types* due to human stressors	Less than 50% change in expected patch types* due to human stressors	Over 50% change in expected patch types due to human stressors	All or most patch types changed due to human stressors
<b>Key Ecological Attribute: <i>Physicochemical</i></b>					
<b>Soil Surface Condition</b>	Site disturbance can result in erosion thereby negatively affecting many ecological processes; the amount of bare ground or newly exposed rock varies naturally with site type.	Bare areas are limited to naturally caused disturbances such as frost-cracking or animal trails	Some bare soil due to human causes but the extent and impact is minimal.		Bare soil areas due to human causes are common.
<b>Rank Factor: SIZE</b>					
<b>Key Ecological Attribute: <i>Size</i></b>					
<b>Relative Size</b>	Indicates the proportion lost due to stressors.	Site is at or minimally reduced from natural extent (>95% remains)	Occurrence is only modestly reduced from its original natural extent (80-95% remains)	Occurrence is substantially reduced from its original natural extent (50-80% remains)	Occurrence is severely reduced from its original natural extent (<50% remains)
<b>Absolute Size</b>	Plant species lists were least similar between large and small cliff faces (Graham and Knight 2004).	Large cliffs (>20 m high)	Medium cliffs (10 m - 20 m high)	Small cliffs (5 and 10 m high)	>5 m high

\*Patch types: Tree- Shrub-, Perennial herbaceous-, Annual-, Non-vascular-dominated, Cliff bedrock, Plateau bedrock, Cavities or cracks in bedrock, Unconsolidated rocks (i.e. talus) and Bare ground.

### Level 3 EIA

Level 3 metrics would include more quantitative measures of the metrics listed above. In addition, further consideration might be given to:

- Lichen and moss species composition and abundance (Eldridge and Rosentreter 1999).

### Triggers or Management Assessment Points

Ecological triggers or conditions under which management activities need to be reassessed are shown in the table below. Since the Ecological Integrity rankings are based on hypothesized thresholds, they are used to indicate where triggers might occur. Specific details about how these triggers translate for each metric can be found by referencing the values or descriptions for the appropriate rank provided in the Table above.

Table 2. Triggers for Level 2 & 3 EIA

Key Ecological Attribute or Metric	Trigger	Action
Any metric (except Connectivity)	<ul style="list-style-type: none"> <li>▪ C rank</li> <li>▪ Shift from A to B rank</li> <li>▪ negative trend within the B rating (Level 3)</li> </ul>	<p>Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation</p> <p>Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.</p>
Any Key Ecological Attribute	<ul style="list-style-type: none"> <li>▪ any metric has a C rank</li> <li>▪ &gt; ½ of all metrics are ranked B</li> <li>▪ negative trend within the B rating (Level 3)</li> </ul>	<p>Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation</p> <p>Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.</p>

### Protocol for Integrating Metric Ranks

If desired, the user may wish to integrate the ratings of the individual metrics and produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank. This enables one to report scores or ranks from the various hierarchical scales of the assessment depending on which best meets the user's objectives. Please see Table 5 in Rocchio and Crawford (2009) for specifics about the protocol for integrating or 'rolling-up' metric ratings.

*Supporting documents for the EIAs can be found at:*  
<http://www1.dnr.wa.gov/nhp/refdesk/communities/eia.html>

*Documentation about Ecological Systems can be found at:*  
[http://www1.dnr.wa.gov/nhp/refdesk/communities/ecol\\_systems.html](http://www1.dnr.wa.gov/nhp/refdesk/communities/ecol_systems.html)

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