This document is part of a collection of Ecological Integrity Assessments addressing 67 of Washington's 99 Ecological Systems. These documents were prepared by the Washington Natural Heritage Program with funding provided by the Washington Department of Fish and Wildlife.

Ecological Integrity Assessment: Northern Rocky Mountain Subalpine Woodland and Parkland

Ecological Summary

The Northern Rocky Mountain Subalpine Woodland and Parkland system consists of a high-elevation mosaic of stunted tree clumps, open woodlands, and herb- or dwarf-shrub-dominated openings. It appears between closed subalpine forest ecosystems and alpine communities. This large patch system occurs in the northern Rocky Mountains, west into the Cascade Mountains and northeastern Olympic Mountains, and east into the mountain "islands" of central Montana. The elevation range of the system varies from 1,981 meters (5600 feet) to 1706 meters (8,800 feet) in southwestern Montana. It is typically either a woodland of scattered trees or a landscape of open areas with clumps of trees. Stands can be dominated by *Pinus albicaulis, Abies lasiocarpa*, and/or *Larix lyallii* occasionally with *Picea engelmannii*.

Northern Rocky Mountain Subalpine Woodland and Parkland sites occur in a climate that is typically very cold in winter and dry in summer. In the Cascades and Olympic Mountains, the climate is more maritime, not as extreme, with heavier snow and wind desiccation. Landforms include ridgetops, mountain slopes, glacial trough walls and moraines, talus slopes, landslides and rockslides, and cirque headwalls and basins. Some sites have little snow accumulation because of high winds and sublimation. *Larix lyallii* stands generally occur at or near upper treeline on north-facing cirques or slopes where snowfields persist until June or July. *Pinus albicaulis* typically occurs on drier sites. On the eastside of the Cascade Mountains and northeastern Olympic Mountains, the tree clump landscape pattern is a common feature, although woodlands with an open canopy are frequent. Woodlands without the tree clump pattern is more common in the Northern Rockies. Trees are often stunted and flagged from damage associated with wind and blowing snow and ice crystals, especially at the upper elevations of the type.

Woodlands are common with *Pinus albicaulis* and *Larix lyallii*. In the Cascades and Olympics, *Abies lasiocarpa* sometimes dominates the tree layer without *Pinus albicaulis* and without more mesic site trees *Tsuga mertensiana* and *Abies amabilis*. As with most subalpine habitats, plant diversity is more related to site differences than with successional development. The undergrowth can be somewhat depauperate on harsh sites while some stands support a dense sward of heath plants, such as *Phyllodoce glanduliflora, Phyllodoce empetriformis, Empetrum nigrum*, and *Cassiope mertensiana*. Stands can include a slightly taller more open shrub layer of *Vaccinium myrtillus* or *Vaccinium scoparium;* either may be present to dominant. The herbaceous layer is sparse

under dense shrub canopies but may be dense where the shrub canopy is open or absent. *Festuca viridula, Vahlodea atropurpurea, Luzula glabrata* var. *hitchcockii,* and *Juncus parryii* are the most commonly associated graminoids. The lowest elevation dries sites in Washington support *Pinus albicaulis* with a grass ground cover of *Calamagrostis rubescens* and *Carex geyeri* with occasional *Paxistima mrysinites* and *Vaccinium myrtillus*, or *Vaccinium scoparium* short shrub layer. These sites are the some of the highest species richness parts of the system (Lilybridge et al 1995).

This woodland and parkland system exists on harsh sites were component trees are not in competition during stand development. Major disturbances there are windthrows and snow avalanches. The system also exists were fire plays a role in removing competing trees and keeping stands in open stage of stand development. The fire regime is highly variable and difficult to document. Lightning strikes are common on the ridges but discontinuous fuels created by rocky terrain effect fire spread that result in high variability in fire severity (Landfire 2007). Ignitions may be common but typically do not spread beyond the initial patch. Infrequent severe crown fires in adjacent spruce-fir forests can spread into this system (Landfire 2007). A 300 year replacement interval is estimated although most fires are mixed severity with an 80 return interval (Fire regime III, Landfire 2007). Fire suppression has contributed to change in habitat structure and functions. Blister rust (*Cornartium ribicola*), an introduced pathogen, is increasing *Pinus albicaulis* mortality in these woodlands (Kendall and Keane 2001) and changing fire regime and successional relationship that accelerates changes in this system.

Mean patch size for this system historically is estimated to be 43.5 ha (107 ac) and currently is 30 ha (74 ac) (Morgan and Murray 2001). Logging can have prolonged effects because of slow invasion rates of trees and other high elevation species on the disturbed sites. This is particularly important on drier sites and in *Larix lyallii* stands. During wet cycles, fire suppression can lead to tree islands coalescing and the conversion of parklands into a more closed forest habitat. Parkland conditions can displace alpine conditions through tree invasions. Livestock use and heavy horse or foot traffic can lead to trampling and soil compaction. Slow growth in this habitat prevents rapid recovery.

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).

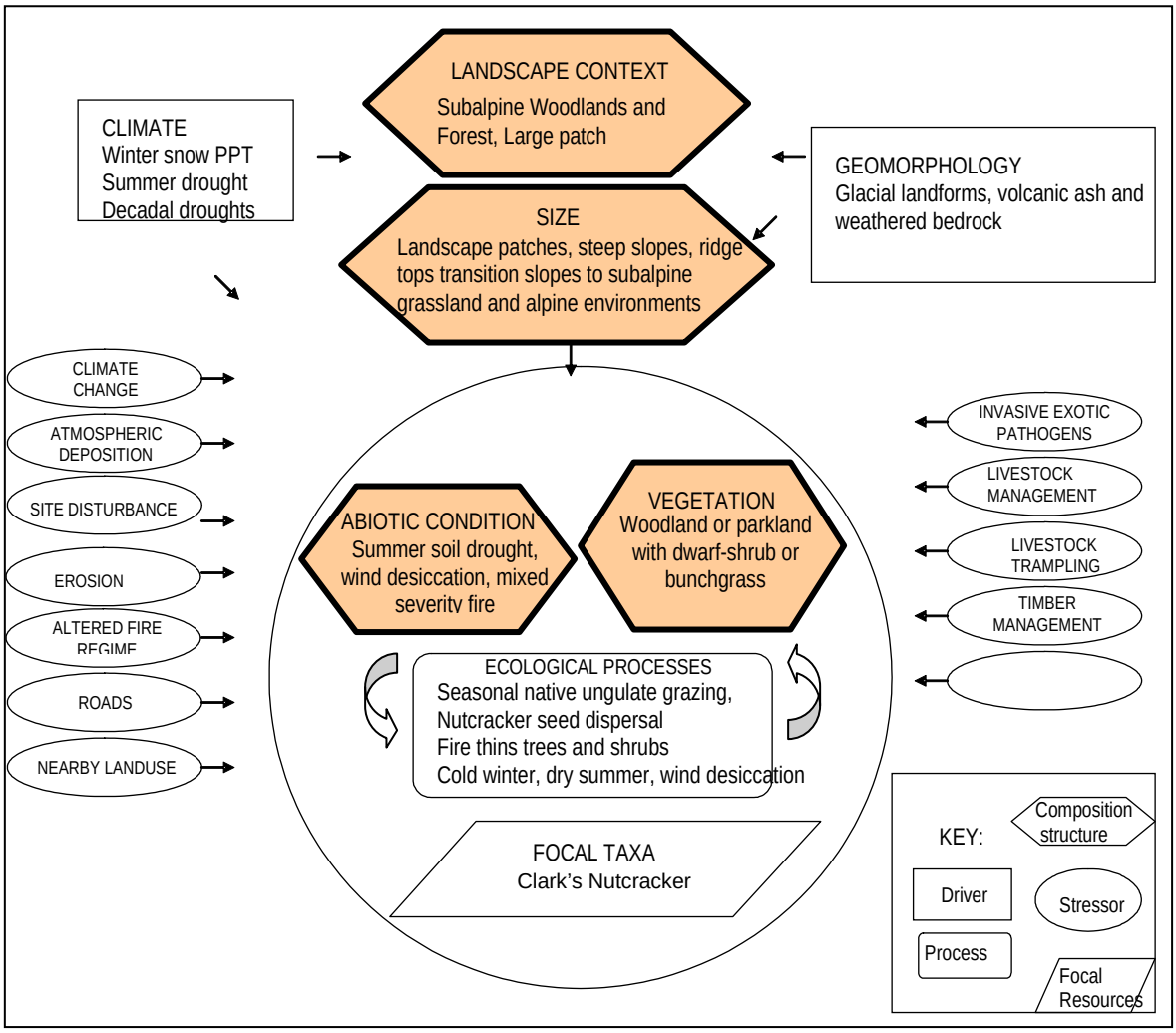
The primary land uses that alter the natural processes of the Northern Rocky Mountain Subalpine Woodland and Parkland system are associated with exotic species, direct soil surface disturbance, timber management, livestock practices, and fragmentation. The introduced pathogen blister rust (*Cornartium ribicola*) increases *Pinus albicaulis* mortality in these woodlands (Kendall and Keane 2001) and changes fire regime, mountain pine beetle effects and successional relationships. Exotic species threatening

this ecological system through invasion and potential replacement of native species include *Poa pratensis.* Excessive grazing stresses the system through soil disturbance and perennial layers to the establishment of native disturbance increasers (*Lupinus* spp., *Juncus parryi, Achillea millifolium*) in similar Northern Rocky systems (Johnson 2004). Persistent grazing will further diminish native perennial cover; expose bare ground, and increase erosion and exotics (Johnson and Swanson 2005). Grazing effects are usually concentrated in less steep slopes although grazing does create contour trail networks that can lead to addition slope failures. Cattle and heavy use by elk can reduce fescue cover and lead to erosion during summer storms (Johnson and Swanson 2005). Introduction of exotic ungulates can have noticeable impacts (e.g., mountain goats in the Olympic Mountains and domestic sheep grazing in the bunchgrass habitats east of the Cascades.) Historical domestic sheep grazing may have occurred in these systems but its cumulative effects are unknown (Landfire 2007). Locally trampling and associated recreational impact can affect sites for decades or longer (Lilybridge et al 1995). Sites are natural low in timber productivity and in stocking rate such that remove of trees can have very long-lasting influence on ecological processes (Lilybridge et al 1995).

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with natural range of variability of the Northern Rocky Mountain Subalpine Woodland and Parkland System are presented in Figure 1.

Figure 1. Conceptual Ecological Model for the Northern Rocky Mountain Subalpine Woodland and Parkland Ecological System.



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 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. Northern Rocky Mountain Subalpine Woodland and Parkland Ecological Integrity Assessment Scorecard

Metric	Justification	Rank			
		A (5 pts.)	B (4 pts.)	C (3 pts.)	D (1 pts.)
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Edge Effects*					
Edge Length	The intactness of the edge can be important to biotic and abiotic aspects of the site.	75 – 100% of edge is bordered by natural communities	50 – 74% of edge is bordered by natural communities	25 – 49% of edge is bordered by natural communities	< 25% of edge is bordered by natural communities
Edge Width		Average width of edge is at least 100 m.	Average width of edge is at least 75-100 m.	Average width of edge is at least 25-75 m.	Average width of edge is at least <25 m.
Edge Condition		>95% cover native vegetation, <5% cover of non-native plants, intact soils	75–95% cover of native vegetation, 5–25% cover of non-native plants, intact or moderately disrupted soils	25–50% cover of non-native plants, moderate or extensive soil disruption	>50% cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils
Key Ecological Attribute: *Landscape Structure*					
Connectivity	Intact areas have a continuous corridor of natural or semi-natural vegetation	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

Landscape Condition Model Index	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 0.79 – 0.65	Landscape Condition Model Index < 0.65
Landscape Fire Regime Condition	Mixed severity fire is vital to maintaining ecological integrity. (Fire Regime Condition Class) 2008)	FRCC 1 No departure from historic fire regime.	FRCC 2 Slight-moderate departure from historic fire regime.		FRCC 3 Severe departure from historic fire regime. Fire suppression is evident; Fuel laddering is severe and throughout much of stand.
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation*					
Relative Cover Native Plant Species	Native species dominate this system; non-natives increase with human impacts.	Relative Cover of native plants 95-100%.	Relative Cover of native plants 80-95%.	Relative Cover of native plants 50 to 80%.	Relative Cover of native plants <50%.
Absolute Cover of Invasive Species	Invasive species, *Poa pratensis,* can inflict a wide range of ecological impacts.	None present.	Invasive species present, but sporadic (<3% cover).	Invasive species prevalent (3–10% absolute cover).	Invasive species abundant (>10% absolute cover).
Relative Cover of Native Increasers	Some stressors such as grazing can shift or homogenize native composition toward species tolerant of stressors such as *Achillea millefolium, Lupinus* spp., *Juncus parryi,*	Absent or incidental	<10% cover	10-20% cover	>20% cover
Species Composition Note: Once developed, the Floristic Quality Assessment index could 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.
Key Ecological Attribute: *Vegetation Structure*					

Biological Legacies	Mixed severity/Moderate fire regimes leave trees, snags, and large woody debris from previous stand.	There are only a few if any cut stumps	Some (10-30%) of the old trees have been	Many (over 50%) of the old trees have been harvested.	Most, if not all, old trees have been harvested.
Key Ecological Attribute: *Natural Disturbance Regimes*					
Forest Pathogens	Forest pathogens are sources of natural tree mortality that influence fire effects and forest structure	Pathogens are all native species and are within the natural range of variability (NRV).	Native pathogen are significantly effecting forest structure beyond NRV	Exotic and native pathogen are significantly effecting forest structure beyond NRV	Exotic and native pathogen are significantly effecting forest structure beyond NRV
Key Ecological Attribute: *Physicochemical*					
Soil Surface Condition	Soil disturbance can result in compaction, erosion thereby negatively affecting many ecological processes (Napper et al 2009)	**Soil-disturbance Class 0** Undisturbed • No evidence of past equipment. • No depressions or wheel tracks. • Forest-floor layers are present and intact. • No soil displacement evident. • No management-generated soil erosion. • No management-created soil compaction. • No management-created platy soils.	**Soil-Disturbance Class 1** • Wheel tracks or depressions evident, but faint and shallow. • Forest-floor layers are present and intact. • Surface soil has not been displaced. • Soil burn severity from prescribed fires is low (slight charring of vegetation, discontinuous). • Soil compaction is shallow (0 to 4 inches). • Soil structure is changed from undisturbed conditions to platy or massive albeit discontinuous.	**Soil Disturbance Class 2** • Wheel tracks or depressions are evident and moderately deep. • Forest-floor layers are partially missing. • Surface soil partially intact and maybe mixed with subsoil. • Soil burn severity from prescribed fires is moderate (black ash evident and water repellency may be increased compared to preburn condition). • Soil compaction is moderately deep (up to 12 inches). •Soil structure is changed from undisturbed conditions and may be platy or massive.	**Soil Disturbance Class 3** • Wheel tracks or depressions are evident and deep. • Forest-floor layers are missing. • Surface soil is removed through gouging or piling. • Surface soil is displaced. • Soil burn severity from prescribed fires is high (white or reddish ash, all litter completely consumed, and soil structureless). • Soil compaction is persistent and deep (greater than 12 inches). • Soil structure is changed from undisturbed and is platy or massive throughout.
Rank Factor: SIZE					
Key Ecological Attribute: *Size*					
Relative Size	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)

Absolute Size	Large occurrences support a mosaic of plant associations likely to contain variability of biophysical gradients and natural disturbances.	Over 450 ha (1110 ac)	45-450 ha (110-1110 ac)	4.5-45 ha (10 -110 ac)	Less than 4.5 ha (10 ac)

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

- Quantitative measurements of range health indicators (Pellant and others 2005)
- Fire Regime Condition Class standard landscape worksheet method (FRCC 2010)

4.?.5 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)	▪ C rank ▪ Shift from A to B rank ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.
Any Key Ecological Attribute	▪ any metric has a C rank ▪ > ½ of all metrics are ranked B ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.

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

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