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 Ponderosa Pine Woodland and Savanna

Ecological Summary

The Northern Rocky Mountain Ponderosa Pine Woodland and Savanna is the predominant ponderosa pine system of eastern Washington and occurs on the driest sites supporting conifers in the Pacific Northwest. This matrix system occurs in the foothills along the eastern Cascades, the Blue Mountains, the Okanogan Highlands, and in the Columbia Basin in northeastern Washington. Precipitation varies from 36-76 cm (~14-30 in.) with most occurring as snowfall. These woodlands occur on warm, dry, exposed sites on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most common. They are generally found on glacial till, glacio-fluvial sand and gravel, dunes, basaltic rubble, colluvium, to deep loess or volcanic ash-derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acidic pH, an abundance of mineral material, rockiness, and periods of drought during the growing season.

These woodlands and savannas are, or at least historically were, fire-maintained and occurring at the lower treeline/ecotone between grasslands or shrublands at lower elevations and more mesic coniferous forests at higher elevations. Canopy coverage typically ranges from 10-60%. Summer drought and frequent, low-severity fires create woodlands composed of widely spaced, large trees with small scattered clumps of dense, even-aged stands which regenerated in forest gaps or were protected from fire due to higher soil moisture or topographic protection. Closed canopy or dense stands were also part of the historical range of stand variability but was a minor component of that landscape. However, such structure is increasing in abundance due to fire suppression. Older stands typically include multiple size and age cohorts and are maintained by frequent surface and mixed-severity fires. Native Americans and lightning were sources of ignition during presettlement era. Historically, many of these woodlands and savannas lacked the shrub component as a result of low severity but high frequency fires (2 - to 10-year fire-return intervals). Some sites, because of low productivity, naturally lacked a dense shrub understory. Mixed-severity fires had a return interval of 25-75 years while stand-replacing fire occurred at an interval of >100 year. The latter two intervals only occur on 20-25% of stands within the landscape while surface fires were the dominant fire regime on over 75% of stands (LANDFIRE Models; www.landfire.gov). Western pine beetle is another significant disturbance and especially affects larger trees. Mistletoe can cause tree mortality in young and small trees. Fires and insect outbreaks resulted in a landscape consisting of a mosaic of open forests of large trees (most abundant patch), small denser patches of trees, and openings (Franklin et al. 2008).

Fire suppression has created conditions that increase the likelihood of all these disturbances. Most areas that may have been savanna in the past are now more nearly closed-canopy woodlands/forests. These “true, fire-maintained savannas” are included with this woodland system, rather than with the climatically-edaphically controlled Northern Rocky Mountain Foothill Conifer Wooded Steppe system (NatureServe 2007). Hot, dry Douglas-fir types with grass are included here as well. *Pinus ponderosa* var. *ponderosa* is the predominant conifer; *Pseudotsuga menziesii* (primarily var. *glauca*) may be present in the tree canopy but is usually absent. *Populus tremuloides* may be present, but is generally <25% of tree canopy. The understory can be shrubby, with *Artemisia tridentata*, *Arctostaphylos uva-ursi*, *Ceanothus velutinus*, *Physocarpus malvaceus*, *Purshia tridentata*, *Symphoricarpos albus*, *Prunus virginiana*, *Amelanchier alnifolia*, and *Rosa* spp. being common. Understory vegetation in the true savanna occurrences is predominantly fire-resistant grasses and forbs that resprout following surface fires and shrubs, understory trees and downed logs are uncommon in these areas. Open stands support grasses such as *Pseudoroegneria spicata*, *Hesperostipa* spp., *Achnatherum* spp., *Festuca idahoensis*, or *Festuca campestris*. The more mesic portions of this system may include *Calamagrostis rubescens* or *Carex geyeri*, species more typical of Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest.

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).

Before 1900, this system was mostly open and park-like with relatively few understory trees. Currently, much of this system has a younger tree cohort, often more shade-tolerant species, resulting in a more closed, multilayered canopy. Fire suppression has lead to a buildup of fuels that in turn increase the likelihood of stand-replacing fires. Heavy grazing, in contrast to fire, removes the grass cover and tends to favor shrub and conifer species. Fire suppression combined with grazing creates conditions that support invasion by conifers. Large late-seral *Pinus ponderosa* and *Pseudotsuga menziesii* are harvested in much of this habitat. Under most management regimes, typical tree size decreases and tree density increases in this habitat.

Since European settlement, fire suppression, timber harvest, livestock grazing, introduced diseases, road building, development, and plantation establishments have all impacted natural disturbance regimes, forest structure, composition, landscape patch diversity, and tree regeneration (Franklin et al. 2008). Timber harvesting has focused on the large, older trees in mid- and late-seral forests thereby eliminating many old forest attributes from stands (Franklin et al. 2008). Fire suppression has resulted in increased tree regeneration and thus a denser understory composed of young trees. Fire suppression has also allowed less fire-resistant, shade-tolerant trees to become established in the understory (and sometimes dominate the canopy) of moist or protected sites creating more dense and multi-layered forests than what historically occurred on the landscape. Overgrazing may have contributed to the contemporary dense stands by eliminating grasses in some areas thereby creating suitable spots for tree regeneration as well as reducing the abundance and distribution of flashy fuels that are important for carrying surface fires. (Franklin et al. 2008; Hessburg et al. 2005). Road development has fragmented many forests creating fire breaks. Under present conditions the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, longer fire-return intervals are now the rule, and multi-layered stands of *Pinus ponderosa* and/or *Pseudotsuga menziesii* provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. The resultant stands at all seral stages tend to lack snags, have high tree density, and are composed of smaller and more shade-tolerant trees. Mid-seral forest structure is currently 70% more abundant than in historical, native systems. Late-seral forests of shade-intolerant species are now essentially absent. Early-seral forest abundance is similar to that found historically but lacks snags and other legacy features.

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with this system are presented in Figure 1.

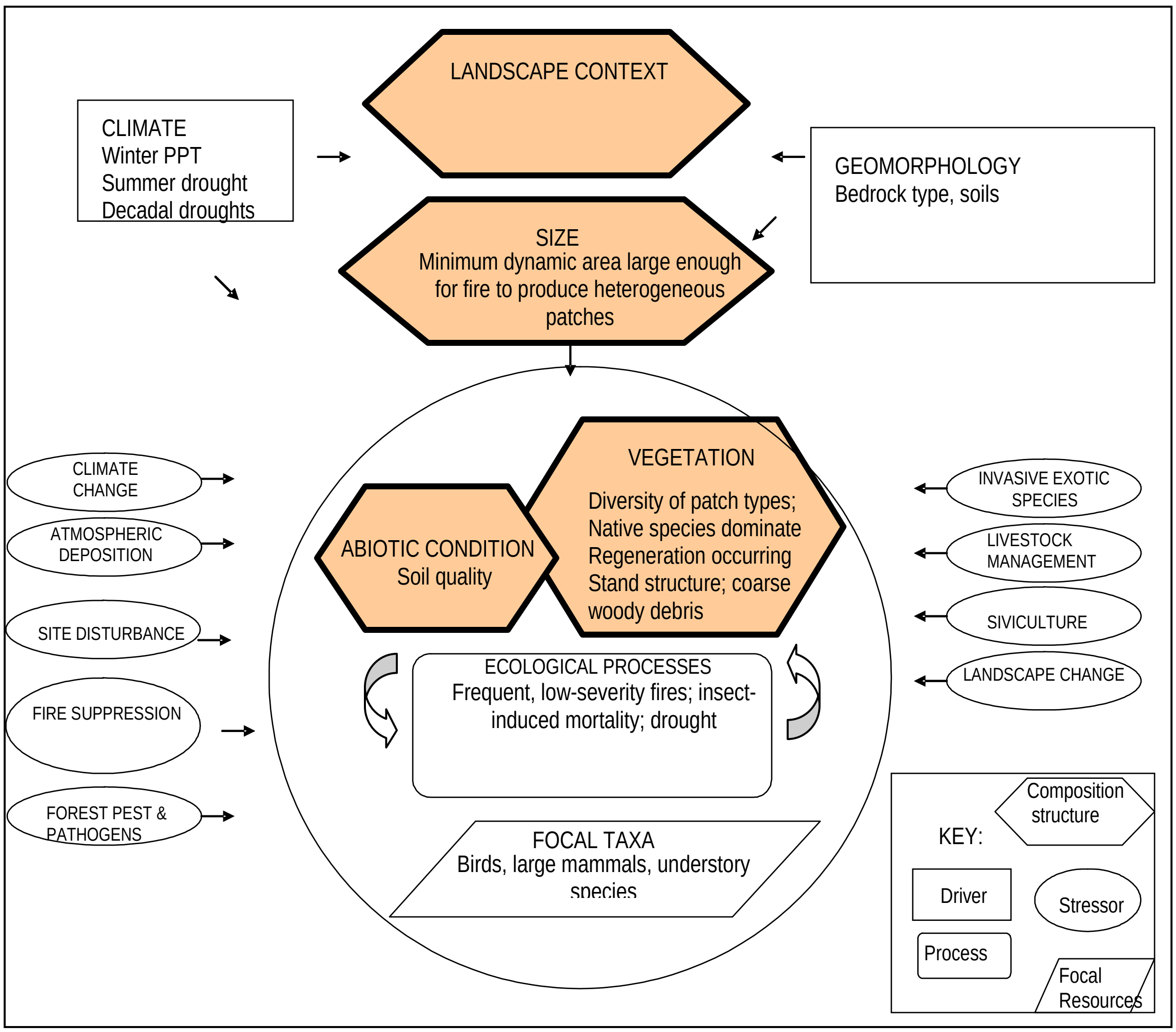

Figure 1. Conceptual Ecological Model for Northern Rocky Mountain Ponderosa Pine Woodland and Savanna.

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 Ponderosa Pine Woodland and Forest Level 2 EIA

Metric	Justification	Rank			
		A (5 pts.)	B (4 pts.)	C (3 pts.)	D (1 pts.)
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Buffer*					
Edge Length	The buffer can be important to biotic and abiotic aspects. Buffer Width Slope Multiplier 5-14% -->1.3; 15-40%-->1.4; >40%-->1.5	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.
Edge Width		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.
Edge Condition		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.
Key Ecological Attribute: *Landscape Structure*					

Connectivity	The percentage of anthropogenic (altered) patches provides an estimate of connectivity among natural ecological systems.	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high. (Remaining natural habitat is in good condition (low modification); and a mosaic with gradients).	Variegated: Embedded in 60-90% natural habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification; (Remaining natural habitat with low to high modification and a mosaic that may have both gradients and abrupt boundaries).	Fragmented: Embedded in 10-60% natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape. (Remaining natural habitat with low to high modifications and gradients shortened).	Relictual: Embedded in < 10% natural habitat; connectivity is essentially absent. Remaining natural habitat generally highly modified and generally uniform).
Landscape Condition Model	The intensity and types of land uses within a 50 ha circle around the occurrence can affect ecological integrity.	Landscape Condition Model >0.8		Landscape Condition Model 0.79 – 0.65	Landscape Condition Model < 0.65
Landscape Fire Regime Condition	Mixed to high 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 Composition*					
Relative Cover Native Understory Plant Species	Native species dominate the understory; non-natives increase with human impacts.	Cover of native plants 95-100%; bunchgrasses 75-100%	Cover of native plants 80-95%; bunchgrasses 50-75%	Cover of native plants 50 to <85%;bunchgrasses 25-50%	Cover of native plants <50%; bunchgrasses 10-25%
Absolute Cover of Invasive Species	Invasive species can inflict a wide range of ecological impacts. Early detection is critical.	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 Understory Increasers	Some stressors can shift or homogenize native composition toward species tolerant of high anthropogenic stress.	Absent or incidental	<10% cover	10-20% cover	>20% cover

Species Composition Once developed the Floristic Quality Assessment Index can replace this metric (FQA measures percentage of conservative native species)	The overall composition of native species can shift when exposed to stressors.	Composed of appropriate species and proportions. Native species sensitive to degradation are present, functional groups indicative of degradation (e.g., pioneer or early successional trees) are absent to minor, full range of diagnostic/indicator species are present.	Functional groups indicative of degradation are present but low in abundance. Some indicator/diagnostic species may be absent.	Native species characteristic of the type remain present but weedy (pioneer, early successional) native species that develop after clearcutting or clearing are dominant. Many indicator/diagnostic species may be absent.	Severely altered from reference condition. Most or all indicator/diagnostic species are absent. Native species consist mostly of weedy species.
Key Ecological Attribute: *Vegetation Structure*					
Late Seral Patches	Stands with late seral trees provide the structural attributes that are found in forests functioning with its natural range of variability.	Vast majority of the old *Pinus ponderosa* trees have not been harvested, i.e. there are only a few if any large stumps; Range of old trees/ ac = >10-30 trees >21"dbh; 2-6 trees >31" dbh. Note: low productivity sites may have old trees < than these diameters; using crown form, bark texture, and color may be needed to determine # of old trees in these sites.	Some (10-30%) of the old (> 150 yrs.) *Pinus ponderosa* may have been harvested.	Many (over 50%) of the old (> 150 yrs.), *Pinus ponderosa* may have been harvested.	Many, if not all, old (> 150 yrs.) *Pinus ponderosa* have been harvested.
Fine-scale mosaic	The diversity and interspersion of seral patches across the occurrence is indicative of intact disturbance regimes.	Over 75% of area dominated by widely-spaced, large, old trees (open stands w/old trees) with herbaceous or shrub understory. Remaining 25% consists of either post-fire shrublands and/or closed canopy of young trees.	50-75% of area with widely-spaced, large, old trees with herbaceous or shrub understory. OR up to 25% of stands with old trees have a continuous cohort of regenerating pine in the understory.	25-50% of area with widely-spaced, large, old trees with herbaceous or shrub understory. OR 25-50% of stands with old trees have a continuous cohort of regenerating pine in the understory	<25% of area with widely-spaced, large, old trees with herbaceous or shrub understory. OR >50% of stands with old trees have a continuous cohort of regenerating pine in the understory
Key Ecological Attribute: *Natural Disturbance Regimes*					
Fire Condition Class	Frequent, low severity fire (~2-10 yrs.) is vital to maintaining ecological integrity.	No departure from historic fire regime. Evidence of multiple low to moderate severity fire since 1900 (Euro-America settlement period) exists in the stand. Most of stand is open and park-like with little risk of fuel laddering.	Slight departure from historic fire regime. Evidence of at least one low to moderate severity fire since 1900 (Euro-America settlement period). Fuel laddering may be present in these areas.		Severe departure from historic fire regime. Fire suppression is evident; Fuel laddering is severe and throughout much of stand.
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 orreddish 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	Absolute size may be important for buffering impacts originating in the surrounding landscape	>7,500 ha	500-7,500 ha	50-500 ha	<50 ha

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

- Fire Regime Condition Class standard landscape worksheet method (FRCC 2010)

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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