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: North Pacific Alpine and Subalpine Dry Grassland

Ecological Summary

The North Pacific Alpine and Subalpine Dry Grassland ecological system is found at subalpine into alpine elevations in the mountains of western Oregon and Washington, north into adjacent the Canadian coast ranges and south into northern California. This high elevation, large patch grassland is dominated by perennial grasses and forbs found on dry sites, particularly south-facing slopes, which are typically embedded in or above subalpine forests and woodlands (Douglas and Bliss 1977). This system is characterized by alpine and subalpine *Festuca viridula* and *F. roemeri* grasslands along the crest of the Cascades and Olympic Mountains in Washington. In Washington, this ecological system occurs between elevations 1370 and 2600 m elevation (4500-8500 ft).

Occurrences appear as small openings to large open ridges above or on sites too dry to support high-elevation conifer trees. These grasslands can appear in transitions with *Larix lyallii* and/or *Abies lasiocarpa* woodlands. In general, soil textures are much finer, and soils are often deeper under grasslands than in the neighboring forests. These grasslands, although composed primarily of tussock-forming species, do exhibit a dense sod that makes root penetration difficult for tree species. Typically more subalpine dominant species include *Festuca idahoensis, Festuca viridula*, and *Festuca roemeri* (the latter species occurring only in the Olympic Mountains). *Eucephalus (=Aster) ledophyllus* is frequently present to sometimes co-dominant. *Lupinus (arcticus* ssp. *subalpinus, latifolius)* or *Ligusticum grayi* is often prominent to co-dominant. *Arnica parryi*, *Nothocalais (=Microseris) alpestris*, and *Penstemon confertus* are somewhat frequent in higher elevation sites. *Carex spectabilis, Luetkea pectinata*, and *Polygonum bistortoides* are often present to prominent. Other common species include *Potentilla flabellifolia, Antennaria lanata, Hieracium gracile, Juncus parryi, Ligusticum grayi*, and *Oreostemma alpigenum* (Crawford and others 2009).

More alpine conditions, drought and site exposure are the primary factors limiting tree growth; however, fire can play a role. Alpine grasslands are characterized by xeric grasses combined with a diverse flora of herbaceous and cryptogram species that often occur as a "turf" of sod-forming sedges, dominated by one or more and often an intermixed combination of species. These grasslands often have one or two species having higher cover than the rest, but with usually at least three of the following species are present: *Carex breweri, Carex nardina, Carex scirpoidea ssp. pseudoscirpoidea,*

Carex phaeocephala, Festuca brachyphylla (in the Cascades), *Festuca saximontana* (in the Olympics), and/or *Festuca roemeri (= Festuca idahoensis var. roemeri)*. A variety of other alpine herbaceous species are also typically present such as *Lupinus arcticus* ssp. *subalpinus, Lupinus latifolius, Lupinus sellulus* var. *lobbii, Minuartia obtusiloba (= Arenaria obtusiloba), Oreostemma alpigenum, Selaginella wallacei, Sibbaldia procumbens, Silene parryi, Smelowskia ovalis, Solidago multiradiata*, and *Trisetum spicatum alpigenum* (Crawford and others 2009). Fire also plays a role in maintaining these open grassy areas.

This system is similar to Northern Rocky Mountain Subalpine-Upper Montane Grassland, differing in that the North Pacific Grassland system includes dry alpine habitats, more North Pacific floristic elements, greater snowpack, and higher overall precipitation. The North Pacific Alpine and Subalpine Dry Grassland is less mesic and includes few if any shrubs than the higher elevation North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow system.

Late season fires may damage *Festuca viridula* plants (Landfire 2007). It is possible that lack of fire has promoted invasion by *Abies lasiocarpa* (Johnson and Claustnitzer 1992). Average fire return interval is estimated to be over 500 years (Landfire 2007) although this type lacks fire history data. Over-grazing can cause soil erosion and an increase in forbs and other grasslike species such as *Lupinus* species, *Juncus parryi, Carex* species, *Achnatherum occidentale* and *Penstemon* species (Landfire 2007). Schreiner (1994) in an Olympic Mountain goat study considered *Achillea millefolium, Cirsium edule,* and *Phacelia hastata* disturbance increasers.

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).

Trampling and associated recreational impacts, e.g., tent sites are a major source of human disturbance. 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).

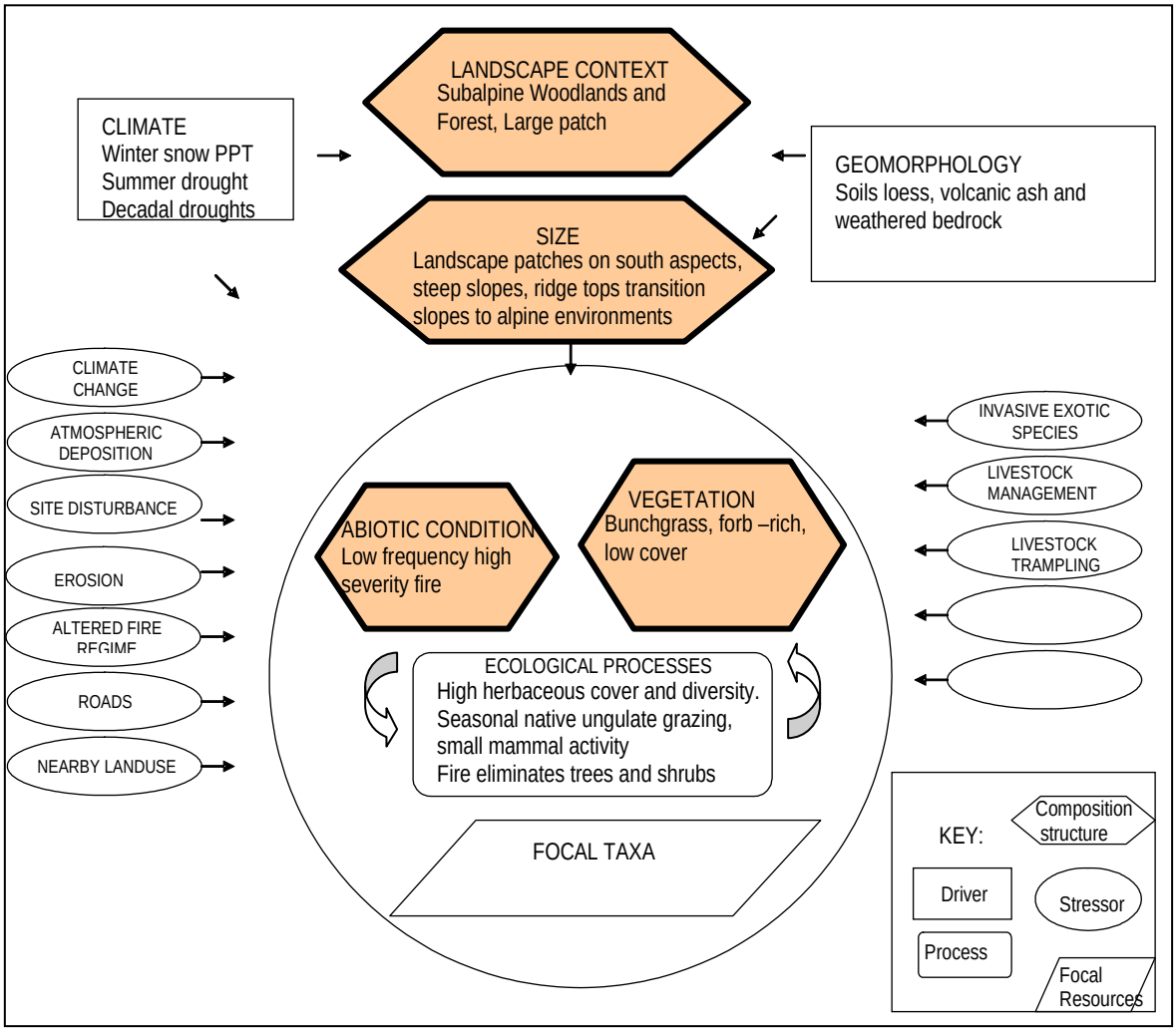
The primary land uses that alter the natural processes of the North Pacific Alpine and Subalpine Dry Grassland system are associated with livestock practices, exotic species, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance and perennial layers to the establishment of native disturbance increasers (*Lupinus* spp.*, Achnatherium* spp.*, Carex rossii, Rudbeckia occidentalis*) in similar Northern Rocky systems (Johnson 2004). Exotic species threatening this ecological system through invasion and potential replacement of native species include *Poa pratensis.* 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).

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with natural range of variability of the North Pacific Alpine and Subalpine Dry Grassland System are presented in Figure 1.

Figure 1. Conceptual Ecological Model for the North Pacific Alpine and Subalpine Dry Grassland 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. North Pacific Alpine and Subalpine Dry Grassland 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 between grasslands	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
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%.
Native Deep-rooted Bunchgrass	Native bunchgrass dominate; high cover is related to community resistance to invasion	Perennial bunchgrasses 80% relative cover and near site potential.	Perennial bunchgrasses 50-80% relative cover and reduced from site potential.	Perennial bunchgrasses 30-50% relative cover and reduced from site potential.	Perennial bunchgrass <30% relative cover and much reduced from site potential.
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, Cirsium edule, Phacelia hastata*.	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: *Physicochemical*					

Soil Surface Condition	Soil disturbance can result in erosion thereby negatively affecting many ecological processes; the amount of bare ground varies naturally with site type.	Bare soil areas are limited to naturally caused disturbances such as burrowing or game trails	Some bare soil due to human/livestock causes but the extent and impact is minimal.		Bare soil areas due to human/livestock causes are common. ORVs or other machinery may have left some shallow ruts.
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 225 ha (500 ac)	20-225 ha (50-500 ac)	10-19 ha (25 -50 ac)	Less than 10 ha (25 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)

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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