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: Rocky Mountain Aspen Forest and Woodland

Ecological Summary

The Rocky Mountain Aspen Forest and Woodland system is a widespread, large patch system found throughout much of the western U.S. and Canada. It is most common in the southern and central Rocky Mountains. In Washington, *Populus tremuloides* forests and woodlands are a minor, small patch type found east of the Cascades, most common in the north and in the Okanogan Highlands. *Populus tremuloides* probably makes up less than one percent of the trees on the Okanogan and Wenatchee National Forests (Hadfield and Magelssen 2004). Although *Populus tremuloides* can be associated with streams, ponds, or wetlands, the Rocky Mountain Aspen Forests and Woodland system consists of **upland aspen** stands found from low to moderate elevation as patches or stands primarily within Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest systems. Rockfalls, talus, or stony north slopes are often typical sites and the aspen system may occur in Intermountain Basin big sagebrush landscapes on such moist microsites. *Populus tremuloides* stands are small patches in Washington with more than half of surveyed stands cover less than two acres (Hadfield and Magelssen 2004, 2006).

This system is characterized by dominance of *Populus tremuloides* in forests or woodlands with less than 25% total tree canopy cover by conifers. The tree canopy is typically closed and essentially all *Populus tremuloides* regeneration results from asexual vegetative production of sprouts from roots following disturbances (Hadfield and Magelssen 2004, 2006). *Populus tremuloides* is the sole dominant in many stands although scattered *Abies grandis*, *Pinus ponderosa*, *Pinus contorta* or *Pseudotsuga menziesii* trees are common in Washington stands (Hadfield and Magelssen 2004, 2006). *Symphoricarpos oreophilus* and *S. albus* are the most common dominant shrubs. Tall shrubs, such as *Acer glabrum*, *Salix scouleriana* and *Amelanchier alnifolia* may be abundant. In some stands, *Calamagrostis rubescens* may dominate the ground cover without shrubs. Other common grasses are *Festuca idahoensis*, *Bromus carinatus*, or *Elymus glaucus*. Characteristic tall forbs include *Agastache* spp., *Aster* spp., *Senecio* spp., *Rudbeckia* spp. Low forbs include *Thalictrum* spp., *Galium* spp., *Osmorhiza* spp., and *Lupinus* spp.

Occurrences of this system originate and are maintained by stand-replacing disturbances such as crown fire, insect outbreak, disease and windthrow within the matrix of conifer forests. Fire plays an important role in maintenance of this habitat. *Populus tremuloides* will colonize sites after fire or other stand disturbances through root sprouting. The stems of these thin-barked,

clonal trees are easily killed by ground fires, but they can quickly and vigorously resprout in densities of up to 30,000 stems per hectare (CNHP 2005). With adequate disturbance a clone may live many centuries or millennia. The stems are relatively short-lived (100-150 years), and stands will succeed to longer-lived conifer forest if left undisturbed. Natural fire return interval may be as frequent as 7-10 years although Landfire Modeling (2007) cites 35-100 year frequency of mixed severity fires as fire regime III (Landfire modeling of this system in the central Rockies assumes fire regime I). Ungulate browsing plays a variable role in aspen habitat by slowing tree regeneration by eating *Populus tremuloides* sprouts on some sites. Wolf predation plays a role in reducing elk browse effects and thus structure of *Populus tremuloides* stands in Yellowstone (Halofsky et al 2008). Although *Populus tremuloides* produces abundant seeds, seedling survival is rare because the long moist conditions required to establish them are rare in these habitats (Romme et al. 1997). Grazing reduces the fine fuels thereby reducing the risk of fires spreading into the stands and killing aspen stems and small conifers (Hadfield and Magelssen 2004, 2006).

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).

Heavy livestock browsing can adversely impact *Populus tremuloides* growth and regeneration. Cattle and elk commonly graze on grasses and forbs in *Populus tremuloides* stands allowing conifers to become established (Hadfield and Magelssen 2004, 2006). With fire suppression and alteration of fine fuels, fire rejuvenation of aspen habitat has been greatly reduced since about 1900. Conifers now dominate many seral *Populus tremuloides* stands and extensive stands of young *Populus tremuloides* are uncommon. Many stands surveyed on the Okanogan and Wenatchee National Forests are successional to conifers and shrinking in size. Hadfield and Magelssen (2004, 2006) conclude that *Populus tremuloides* occupied a considerably larger area in Washington in the past than now. Major factors contributing to this condition are browsing by wild and domestic ungulates and exclusion of fires. Grazing also increases invasion by exotics species, such as, *Poa pratensis* and *Cirsium* spp.

Conceptual Ecological Model

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

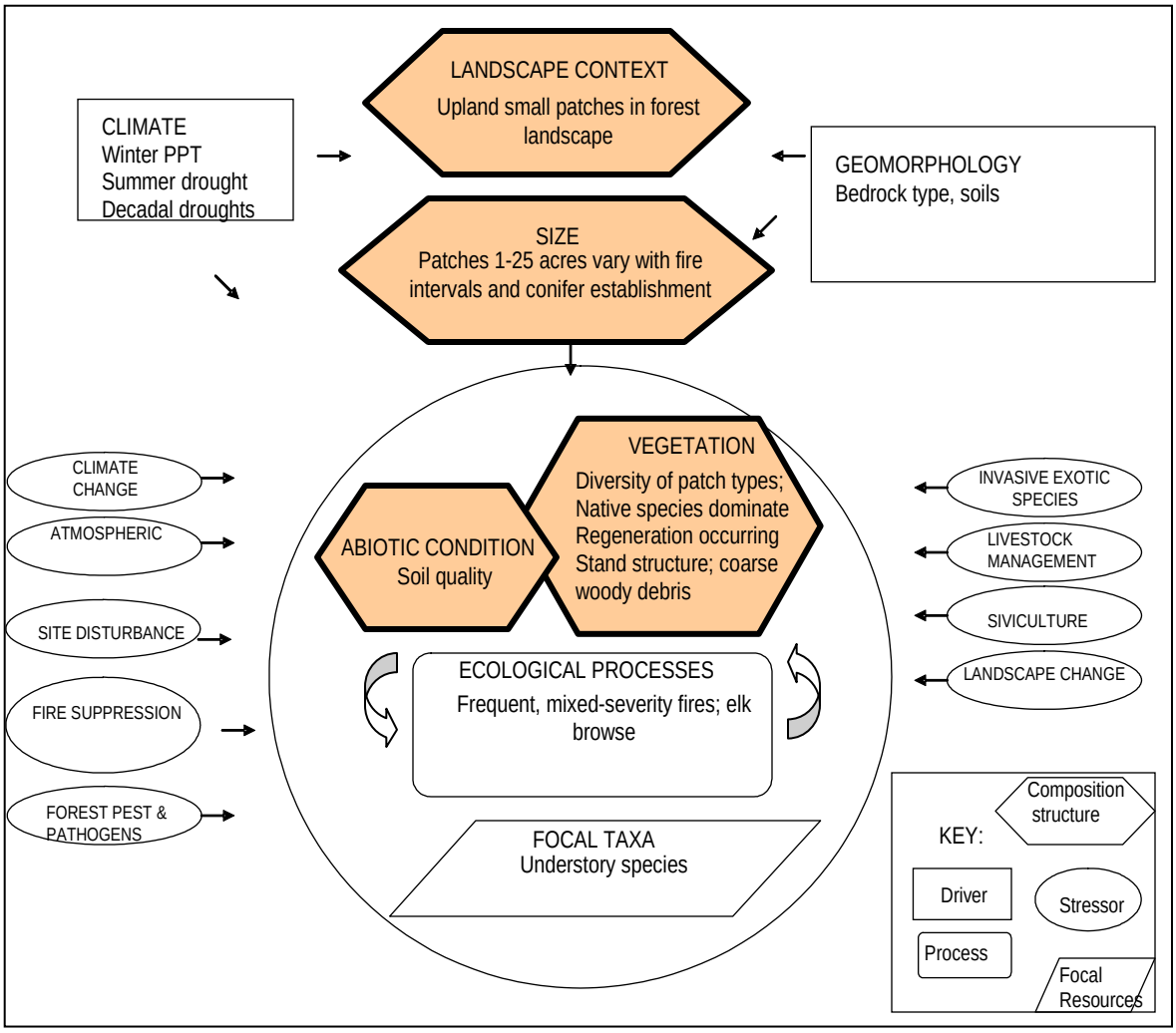

Figure 1. Conceptual Ecological Model for Rocky Mountain Aspen Forest and Woodland.

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. Rocky Mountain Aspen Forest and Woodland 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*					
Buffer Length	The buffer can be important to biotic and abiotic aspects of the ecosystem. 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.
Buffer 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.
Buffer 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	Infrequent mixed severity fire (~35-100 yrs.) is vital to maintaining ecological integrity reducing conifer invasion and induce aspen sprouting (Fire Regime Condition Class) 2008)	FRCC 1 No departure from historic fire regime.	FRCC 2 Slight departure from historic fire regime. .		FRCC 3 Severe departure from historic fire regime. Fire suppression effects evident
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 plants95-100%; bunchgrasses 75-100%	Cover of native plants 80-95%; bunchgrasses 50-75%	Cover of native plants 50 to 79%;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 Understory Native 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*					
Aspen Stand Condition	The overall condition of the stand was assigned to one of three condition classes developed for characterizing condition of aspen stands (Hadfield and Magelssen 2004, 2006).	"Stable" condition is characterized by the presence of multiple size aspen stems and young regeneration around the edges and little mortality. These stands are vigorous.	"Successional to conifers" condition is characterized by conifers replacing aspen. Some aspen regeneration may be present but it is not abundant.		"Decadent" condition is characterized by little to no aspen regeneration and ample aspen stem mortality. Decadent aspen stands have an open appearance with many dead aspen stems. Conifers may or may not be present in decadent aspen stands.
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	Absolute size may be important for buffering impacts originating in the surrounding landscape	>10 ac	4-10 ac	1-4 ac	<1 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:

- Size distribution of stems: "seedling" (<1.0" DBH), "sapling" (1.0" – 4.9" DBH), "pole" (5.0" – 9.9"), and "mature" (10.0" and larger DBH).
- Roots, butt (lowest 2'), stem, and foliage examined for damage-causing agents (Hadfield and Magelssen 2004, 2006).
- 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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