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: Columbia Basin Steppe and Grassland

Ecological Summary

This steppe system occurs over large areas, occasionally entire landforms, and is an alternative state of the Inter-Mountain Basins Big Sagebrush Steppe ecological system type where a frequent fire (< 20 years) or fire severity resulted in an absence or very low cover of deep-rooted, fire intolerant shrubs (Laycock 1991). **Notably *Artemisia tridentata, Artemisia tripartita* and *Purshia tridentata* are absent and are unlikely to re-establish due to lack of seed source.** Distinguishing this steppe system from shrubless bunchgrass-dominated patches within the Big Sagebrush Steppe or Semi-desert shrubsteppe ecological system occurrences is an on-the-ground determination based on the presence or absence of shrubsteppe indicator shrubs in relatively homogeneous environment areas typically well over 50 acres, often including whole landforms. Columbia Steppe and Grassland is dominated by perennial bunchgrasses and forbs (>25% cover), and can have very little exposed bare ground due to mosses and lichens carpeting the area between plants. Associated graminoids include *Achnatherum hymenoides, Elymus elymoides, Elymus lanceolatus* ssp. *lanceolatus, Hesperostipa comata, Festuca idahoensis, Koeleria macrantha, Poa secunda*, and *Pseudoroegneria spicata*. Common forbs are *Phlox hoodii, Arenaria* spp., and *Astragalus* spp. Areas with deeper soils are rare because of conversion to other land uses. Shrubs such as *Chrysothamnus viscidiflorus, Ericameria nauseosa,* or *Tetradymia* spp. may be present in burned or grazed stands. Biological soil crust is very important in this ecological system. Soils are variable, ranging from relatively deep, fine-textured often with coarse fragments, non-saline, and often with a biological soil crust, to stony volcanic-derived clays, to alluvial sands. Burrowing animals and their predators likely played important roles in creating small-scale patch patterns.

Soil depth and soil texture within precipitation zones largely drive the distribution of shrub steppe and associated systems on the Columbia Basin in Washington. Geographically (climatically), this steppe system is associated with the Inter-Mountain Basins Big Sagebrush Steppe system, rings the driest portion of the Basin that supports the Big Sagebrush Shrubland and the Semi-desert Shrub Steppe systems and is bounded by montane woodlands and the Palouse prairie. Northern Rocky Mountain Foothill and Valley Grasslands are more productive, and typically associated woodlands or forests. Deep canyons (Snake River) dissecting the southeastern corner of the basin, support Dry Canyon grasslands that are distinguished by primarily colluvial soils derived from basalt and loess and by periodic slope failures and slumping. Shallow soils (lithic or deep, gravel flood deposits) occur in Pleistocene flood channels that fan across the basin and support Columbia Scabland system. Columbia Steppe and Grassland soils are deep to shallow (over 6 inches) and non-saline, often with a biological soil crust. Greater crust cover occurs on north- and east-facing slopes at mid elevations with stable, silt-loam or calcareous soils where not disturbed (Tyler 2006) or where vascular cover and litter are not limiting. Tyler (2006) found that shrub-steppe plots were generally correlated with biological soil crust variables, while grass-steppe plots were generally aligned with *Bromus tectorum* and *Salsola*. He stated that pattern reflected that grass-steppe habitats on Yakima Firing Range mostly resulted from the conversion of shrub-steppe habitats by past wildfire.

Fire return interval for productive shrub steppe is 12-15 years (fire regime I) and 50-100 years (fire regime II) in less productive areas (Miller and Eddleman 2001) or alternatively Baker (2006) concludes that Wyoming sagebrush fire rotations are 100-240 years (fire regime V). Grassland or steppe fire intervals are 1-23 years (Perryman 2001). Where fire frequency has allowed for shift to a native grassland condition maintained without significant shrub invasion over a 50 to 70 year interval is the Columbia Basin Steppe and Grassland system. Based on literature summarizing sagebrush recruitment, we estimate approximately 1 acre/2 years or approximately 25 acres in 50 years of natural sagebrush invasion in best conditions. We conclude 50 acres is a minimum persistent patch of bunchgrass steppe. For example, Perryman et al. (2001) calculated a mean recruitment interval of 2.3 (±0.7) years for sagebrush stands in Wyoming. Shrubs produce large quantities of small seeds beginning at 3 to 4 years of age. FEIS summarizes that approximately 90% of big sagebrush seed is dispersed within 30 feet (9 m) of the parent and few seeds are carried more than 100 feet (30 m) (http://www.fs.fed.us/database/feis/plants/shrub/arttrit).

Large native ungulate grazing in the Columbia Basin differed from that in the Great Plains grasslands in duration, seasonality, and severity (Mack and Thompson 1982, Burkhart 1995). In general, grazing was dispersed and was during the winter and spring when forage was available. Davies and others (2009) conclude that sites with heavy litter accumulation, (e.g., ungrazed *Artemisia tridentata* ssp. *wyomingensis/Festuca idahoensis* – *Achnatherium thurberiana* community) are more susceptible to exotic annual invasion following fire than those with less litter accumulation. They note that introduced species and changes in climate can change ecosystem response to natural disturbance regimes.

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 this system are associated with livestock practices, annual exotic species, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance, trampling and displacing the biological soil crust, altering the composition of perennial species, and increasing the establishment of native disturbance increasers and exotic annual grasses, particularly *Bromus tectorum*. Persistent grazing will further diminish perennial cover, expose bare ground, and increase exotic annuals. Fire further stresses livestock-altered vegetation by increasing exposure of bare ground and consequent increases in exotic annuals and decrease in perennial bunchgrass. In more mesic steppe, fire is not as important in maintenance of perennial grasses and forbs. Any disturbances to soil and bunchgrass layers, such as vehicle tracks and chaining shrubs, will increase the probability of alteration of vegetation structure and composition and response to fire as discussed above. Davies and others (2009) conclude that sites with heavy litter accumulation, (e.g., ungrazed *Artemisia tridentata* ssp. *wyomingensis / Festuca idahoensis – Achnatherium thurberiana* community) are more susceptible to exotic annual invasion following fire than those with less litter accumulation. They note that introduced species and changes in climate can change ecosystem response to natural disturbance regimes. Johnson and Swanson (2005) note that *Festuca idahoensis* decreases following fire but following a flush of annuals these sites regain pre-fire cover after a few years.

Fragmentation of shrub steppe by agriculture increases cover of annual grass, total annual/biennial forbs, bare ground, decreases cover of perennial forbs and biological soil crusts, and reduces obligate insects (Quinn 2004), obligate birds and small mammals (Vander Haegen et al 2003). These fragmentation responses are similarly expected in steppe vegetation.

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with natural range of variability of the Columbia Basin Steppe and Grassland Ecological System are presented in Figure 1.

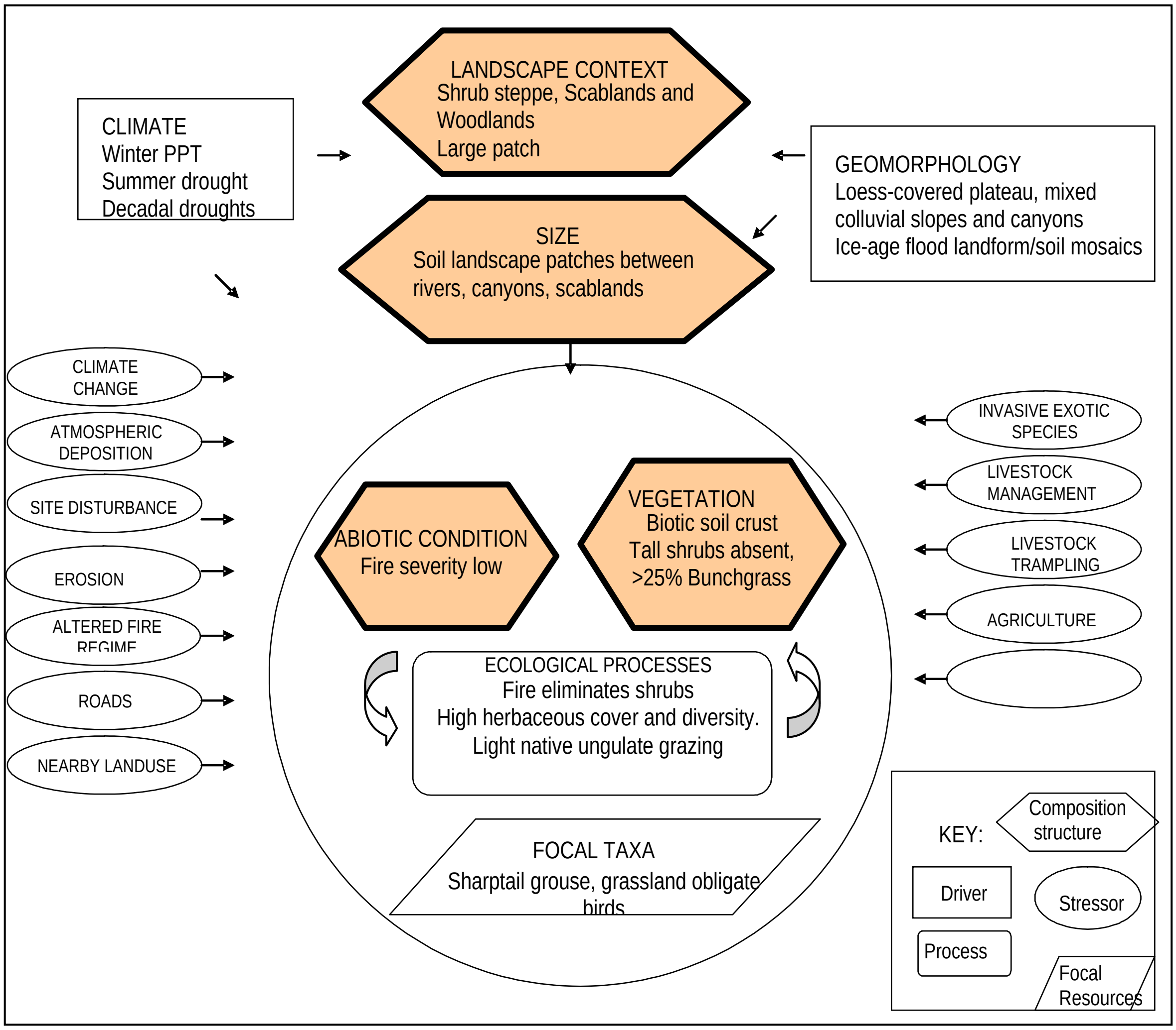

Figure 1. Conceptual Ecological Model for Columbia Basin Steppe and Grassland.

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. Columbia Basin Steppe and Grassland Ecological Integrity Assessment Level 2 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 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

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 0.65 – 0.79	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.	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%.
Relative Native 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 can inflict a wide range of ecological impacts. Early detection is critical. *Bromus tectorum* 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).
Relative Cover of Native Increasers	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
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.
Biological Soil Crust	Crust cover and diversity is greatest where not impacted by trampling, other soil surface disturbance and fragmentation (Tyler 2006; Rosentreter and Eldridge 2002; Belnap et al. 2001)	Largely intact biological soil crust that nearly matches the site capability where natural site characteristics are **not** limiting, i.e. steep unstable, south aspect, dense native grass	Biological soil crust is evident throughout the site but its continuity is broken	Biological soil crust is present in protected areas and with a minor component elsewhere	Biological soil crust, if present , is found only in protected areas

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 causes but the extent and impact is minimal. The depth of disturbance is limited to only a few inches	Bare soil areas due to human causes are common. There may be disturbance/compaction to several inches. ORVs or other machinery may have left some shallow ruts.	Bare soil areas substantially & contribute to long-lasting impacts. Deep ruts from ORVs or machinery may be present, or livestock and/or trails are widespread. Water will be channeled or ponded.
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 based on steppe obligate grasshopper sparrow conservation size min≥10-15 ha (Palzek 2004)Altman and Holmes 2000)	Over 100 ha (250 ac)	50-100 ha (125-250 ac)	10 –50 ha (25 -125 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)
- Biological Soil Crust Stability Index (Rosentreter and Eldridge 2002).
- Biological Soil Crust 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 Tables 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

References

Altman, B. and A. Holmes. 2000. Conservation strategy for landbirds in the Columbia Plateau of eastern Oregon and Washington. Oregon-Washington Partners in Flight. The Plains, VA: American Bird Conservancy.

Baker, W.L. 2006. Fire and Restoration of Sagebrush Ecosystems. Wildlife Society Bulletin: 34(1):177-185.

Belnap, J., J. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. Biological Soil Crusts: Ecology and Management. Technical Report 1730-2, United States Department of the Interior. 110 pp.

Burkhardt, J.W. 1996. Herbivory in the Intermountain West. An overview of evolutionary history, historic cultural impacts and lessons from the past. Station Bulletin 58. Idaho Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow. 35 pp.

Davies, K.W., T.J. Svejcar and J.D. Bates. 2009. Interaction of historical and nonhistorical disturbances maintains native plant communities. Ecological Applications, 19(6), pp. 1536–1545.

Eldridge, D. J. and R. Rosentreter 1999 Morphological groups: a framework for monitoring microphytic crusts in arid landscapes. Journal of Arid Environments, Volume 41(1):11-25.

Paczek, S. 2004. Grasshopper Sparrow. Accounts and Measures for Managing Identified Wildlife.
http://www.env.gov.bc.ca/wld/frpa/iwms/documents/Birds/b_grasshoppersparrow.pdf

Johnson, C.G. and D.K. Swanson. 2005. Bunchgrass Communities of the Blue and Ochoco Mountains: A Guide for Managers. U.S.D.A. For. Ser. PNW-GTR-641.

Johnson, D.H. and T.A. O'Neil. 2001. Wildlife-Habitat Relationships in Oregon and Washington. Oregon State University Press, Corvallis, OR.

Miller, R.F., and L.L. Eddleman. 2001. Spatial and temporal changes of sage grouse habitat in the sagebrush biome. Oregon State Univ. Agric. Exp. Sta. Tech Bull. 151. 35pp.

Mack, R.N. and J.N. Thompson. 1982. Evolution in steppe with few large, hoofed animals. American Naturalist 119: 757-773.

NatureServe Explorer. 2007. Descriptions of Ecological Systems for the State of Washington. Data current as of October 06, 2007. NatureServe, Arlington, VA. [http://www.natureserve.org/explorer/index.htm]

Pellant, M. 1996. Cheatgrass: The Invader that Won the West- Bureau of Land Management, Idaho State Office, Interior Columbia Basin Ecosystem Management Project. 22 p.

Perryman, B. L., A. M. Maier, A. L. Hild and R. A. Olson. 2001. Demographic characteristics of 3 *Artemisia tridentata* Nutt. subspecies. Journal of Range Management 54: 166-170.

Ponzetti, J., B. McCune, and D.A. Pyke. 2007. Biotic soil crusts in relation to topography, cheatgrass and fire in the Columbia Basin, Washington. The Bryologist 110(4):706-722.

Rocchio, F.J. and R.C. Crawford. 2009. Monitoring Desired Ecological Conditions on Washington State Wildlife Areas Using an Ecological Integrity Assessment Framework. Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia, WA.

Rostentreter, R A and D.J. Eldridge. 2002. Monitoring Biodiversity and Ecosystem Function: Grasslands, Deserts, And Steppe. IN: Monitoring with Lichens—Monitoring Lichens. Edited by Nimis, Scheidegger and Wolseley. Dordrect: Kluwer Academic Publishers.199-233 pp.

Tyler, K.J. 2006. Biological Crusts: Analysis of Monitoring Techniques at the Yakima Training Center, Washington. M.S. Thesis Central Washington University, Ellensberg, Wa. 117p.

Vander Haegen, W. M., F. C. Dobler, and D. J. Pierce. 2000. Shrubsteppe bird response to habitat and landscape variables in eastern Washington, USA. Conservation Biology 14:1145-1160.

Vander Haegen, W.M, S.M. McCorquodale, C.R. Pearson, G.A.Green, and E.Yensen. 2001. Wildlife of Eastside Shrubland and Grassland Habitats. Chpter 11 *in*: Johnson, D.H. and O'Neil T.A. Wildlife-Habitat Relationships in Oregon and Washington. OSU Press. Corvallis, OR. 317-341pp.

Vander Haegen, W. M., M. A. Schroeder, S. S. Germaine, S. D. West, and R. A. Gitzen. 2005. Wildlife on Conservation Reserve Program lands and native shrubsteppe in Washington: Progress Report for 2004. Washington Department of Fish and Wildlife, Olympia. 51pp.

Authorship: Rex Crawford, Washington Natural Heritage Program
February 28, 2011