WASHINGTON NATURAL HERITAGE PROGRAM

Current Vegetation of Fairchild Air Force Base, Washington State

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Introduction

The objective of this project is to map the vegetation of Fairchild Air Force Base (FAFB) within the National Vegetation Classification (NVC) hierarchy that will assist in management of FAFBs natural values. The NVC was developed as part of the International Vegetation Classification that covers all vegetation of the world. The NVC is supported by the Federal Geographic Data Committee (FGDC 2008), NatureServe (Faber-Langendoen et al. 2009), and the Ecological Society of America (Jennings et al. 2009) and is the recommend standard for federal vegetation mapping (FGDC 2008). The NVC seeks to classify natural, semi-natural and cultural vegetation, wetlands and uplands, and identify types based on vegetation composition and structure and associated ecological factors. The NVC meets several important needs for conservation and resource management. It provides:

- An 8-level, ecologically based framework that allows users to address conservation and management concerns at scales relevant to their work.
- A characterization of ecosystem patterns across the entire landscape or watershed, both upland and wetland.
- Information on the relative rarity of types. Each association has been assessed for conservation status (extinction risk).
- Relationships to other classification systems that are explicitly linked to the NVC types.
- A federal standard for all federal agencies, facilitating sharing of information on ecosystem types (FGDC 2008).
- A framework for classifying cultural vegetation.

This FAFB mapping project used 2009 high-resolution imagery for visual interpretation and polygon delineation. Polygons were drawn independent of previous vegetation map polygons (TNC and NHP 1994) although the earlier polygon attributes were used to interpret recent imagery prior to field visits.

A protocol for developing a range of possible conservation, management or restoration targets is provided. This protocol, referred to as Ecological Integrity Assessments (EIAs), was developed by NatureServe (Faber-Langendoen et al. 2006) and fine-tuned by the Washington Natural Heritage Program (Rocchio and Crawford 2009) as a method for assessing ecological integrity, setting management or restoration goals, and documenting attainment of those goals. The EIA method is briefly described and two example EIAs (Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland and Columbia Basin Scabland Shrubland) are included in the report.

Project Area and Methods

The project area is FAFB as depicted in Figure 1. Polygons were initially determined by visual evaluation of images by Rex Crawford using recent imagery (Spokane 2009 Orthophoto, 0.3 meter color resolution; Flown May-June 2009; File format: jpeg2000;

Tiles: 5000x5000 pix, Published by Aerials Express) supplemented with information gathered from previous FAFB mapping (TNC and NHP 1994), rare plant monitoring projects (Caplow 2005; Arnett 2009) and later modified based on 2010 field reconnaissance. Polygons were typically digitized at the 1:5,000 scale or at finer resolution when habitat differences were not fully apparent or inconclusive at the 1:5,000 scale.

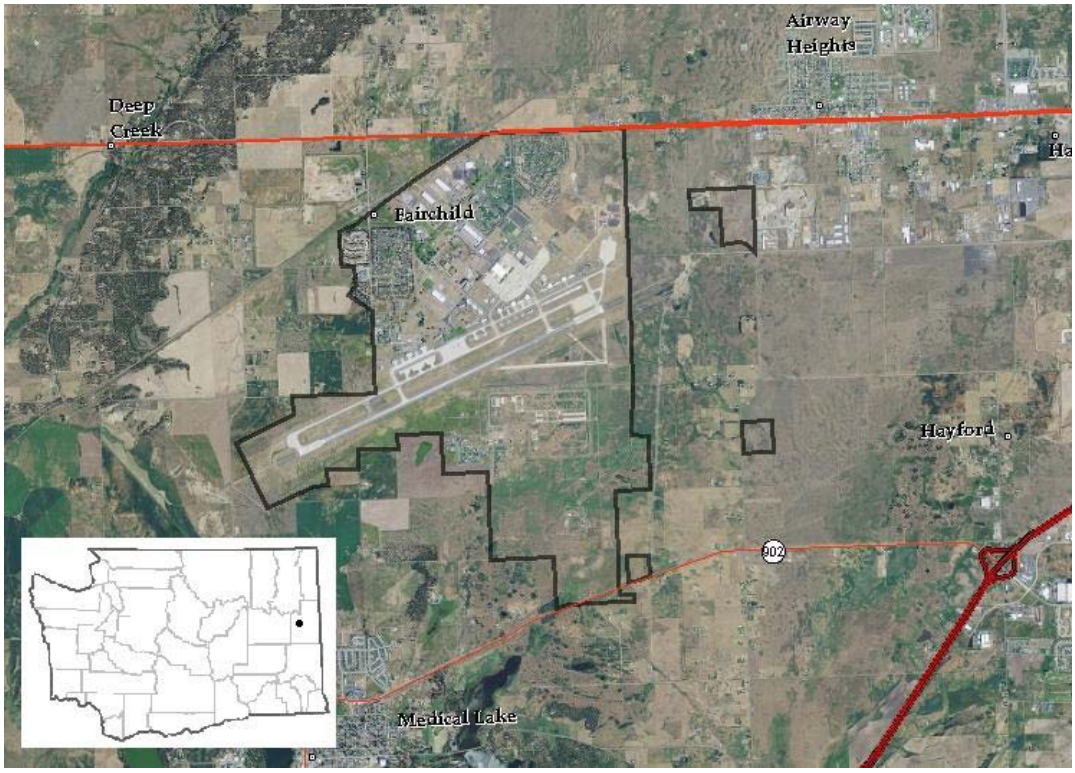

Figure 1. Location of Fairchild Air Force Base, Spokane County, Washington.

Image Interpretation

Based on 1994 vegetation mapping of FAFB by the Washington Natural Heritage Program and knowledge of surrounding vegetation, uniform areas were delineated and initially labeled at the Macrogroup or Group level of the National Vegetation Classification (Table 1). Macrogroup and Group are mid-level units (5th and 6th levels) with broadly similar composition and diagnostic growth that reflect biogeographic differences in composition and in mesoclimate, geology, substrates, hydrology, and disturbance regimes (FGDC 2008). Mid-scale classification is an appropriate thematic scale for remote mapping (Comer et al 2003). Field evaluation in late June 2010 by Rex Crawford focused on gathering information to verify *a priori* classification at the Macrogroup and Group level of the NVC (NatureServe 2010; Table 1). When possible, polygons were classified to plant association, the finest level (8th) of the NVC. In addition to NVC classification labels, other vegetation attributes were documented and

detailed in the data dictionary in Appendix A. For each NVC unit in a polygon, additional attribute labels include:

- Cover class of water, bare ground, litter, biological soil crust, tree species, shrub species, native species, native bunchgrass, native increasers, annual exotics, and perennial exotics;
- The dominant or most abundant tree, shrub, graminoid, forb and annual species;
- The relative proportion of NVC units when two or more units occupy a polygon in a pattern too detailed to delineate or too small or obscure to differentiate;
- A species composition rating indicating the relative deviation the particular NVC unit is from its natural range of variability; and
- A comment field.

Table 1. U.S. National Vegetation hierarchy of vegetation mapped at Fairchild Air Force Base (from the Revised USNVC version 1.0, NatureServe 2010).

Class	Subclass	Formation	Division	Macrogroup	Group	Plant Association
1 Forest & Woodland	1.C Temperate Forest	1.C.2 Cool Temperate Forest	1.C.2.b Western North American Cool Temperate Forest	Northern Rocky Mountain Lower Montane & Foothill Forest	Northern Rocky Mountain Ponderosa Pine Woodland & Savanna Group	Pinus ponderosa / Symphoricarpos albus
		1.C.3 Temperate Flooded & Swamp Forest	1.C.3.c Western North American Flooded & Swamp Forest	Rocky Mountain and Great Basin Flooded & Swamp Forest	Rocky Mountain & Great Basin Depressional Scrub Wetland Group	No recognized associations
2 Shrubland & Grassland	2.C Temperate & Boreal Shrubland & Grassland	2.C.1 Temperate Grassland, Meadow & Shrubland	2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland	Northern Rocky Mountain-Vancouverian Montane & Foothill Grassland & Shrubland	Northern Rocky Mountain Lower Montane, Foothill & Valley Grassland Group	Festuca idahoensis / Eriogonum heracleoides
					Northern Rocky Mountain Montane-Foothill Dry Deciduous Shrubland Group	No recognized associations
				Northern Rocky Mountain-Vancouverian Montane & Foothill Ruderal Grassland & Shrubland [placeholder]	Northern Rocky Mountain Montane-Foothill Ruderal Dry Deciduous Shrubland Group [placeholder]	No recognized associations

						Northern Rocky Mountain Lower Montane Foothill Ruderal Grassland [placeholder]	No recognized associations
			2.C.5 Temperate & Boreal Freshwater Wet Meadow & Marsh	2.C.5.b Western North American Freshwater Wet Meadow & Marsh	Western North American Vernal Pool	North Pacific Vernal Pool Group	No recognized associations
					Western North American Ruderal Wet Meadow & Marsh	Western North American Ruderal Wet Meadow & Marsh Group	No recognized associations
	3 Semi-Desert	3.B Cool Semi-Desert Scrub & Grassland	3.B.1 Cool Semi-Desert Scrub & Grassland	3.B.1.a Western North American Cool Semi-Desert Scrub & Grassland	Great Basin & Intermountain Dwarf Sage Shrubland & Steppe	Columbia Plateau Scabland Shrubland Group	Artemisia rigida / Poa secunda
						Columbia Plateau Scabland Shrubland Group	No recognized associations
					Great Basin & Intermountain Ruderal Dwarf Sage Shrubland & Steppe [placeholder]	Great Basin & Intermountain Ruderal Dwarf Sage Shrubland [placeholder]	No recognized associations
	5 Aquatic Vegetation	5.B Freshwater Aquatic Vegetation	5.B.1 Freshwater Aquatic Vegetation	5.B.1.a North American Freshwater Aquatic Vegetation	Western North American Ruderal Freshwater Aquatic Vegetation	Western North American Ruderal Freshwater Aquatic Vegetation	No recognized associations
	8 Developed Vegetation	8.1. Herbaceous & Woody Developed Vegetation	8.1.A. Developed (Close cropped)	8.1.A.1 Lawn	Temperate and Tropical Lawn	Cool season Lawn	No recognized associations
				8.1.A.x Verges [provisional]	Temperate and Tropical Verges [placeholder]	Cool season Verges [placeholder]	No recognized associations
			8.1.B. Other Developed Urban / Built Up Vegetation	8.1.B.1 Other Urban / Build Up Vegetation	Other Urban / Built Up Vegetation	Other Urban / Built Up Vegetation	No recognized associations

Results and Discussion:

Mapping encompassed 4250 acres and defined 161 polygons that vary between 0.01 and 2040 acres with an average of 26.2 acres (median 1.6 acres) (Table 2). The NVC Class level of Developed Vegetation occupies most of FAFB (85%) (Figure 2). The Developed Vegetation Class is sub-divided into three Groups, listed below in order of abundance:

- Other Urban / Built Up Vegetation - includes areas with residences, buildings, runways, other imperious surfaces and surrounding landscaped or maintained plantings
- Cool season Lawn - includes large areas that are regularly mowed and dominated by planted grasses
- Cool season Verges - a placeholder or provisional Group not in the NVC that encompasses roads and immediate roadside vegetation in polygons through generally undeveloped portions of FAFB.

Distribution of these and other Groups is illustrated in Figure 3.

Table 2. Acres of USNVC Class and Group mapped at Fairchild AFB.

Class	**Acres**
Group	acres
1 Forest & Woodland	**7.2**
Northern Rocky Mountain Ponderosa Pine Woodland & Savanna	7.1
Rocky Mountain & Great Basin Depressional Scrub Wetland	0.1
2 Shrubland & Grassland	**538.1**
Northern Rocky Mountain Lower Montane, Foothill & Valley Grassland	171.2
Northern Rocky Mountain Lower Montane, Foothill & Valley Ruderal Grassland [placeholder]	188.5
Northern Rocky Mountain Montane-Foothill Dry Deciduous Shrubland	1.1
Northern Rocky Mountain Montane-Foothill Ruderal Dry Deciduous Shrubland [placeholder]	2.2
North Pacific Vernal Pool	1.8
Western North American Ruderal Wet Meadow & Marsh	173.4
3 Semi-Desert	**61.1**
Columbia Plateau Scabland Shrubland	60.6
Columbia Plateau Scabland Ruderal Shrubland [placeholder]	0.5
5 Aquatic Vegetation	**5.6**
8 Developed Vegetation	**3636.8**
Cool season Lawn	880.1
Cool season Verges [placeholder]	61.2
Other Urban / Built Up Vegetation	2695.5
Total area	**4248.8**

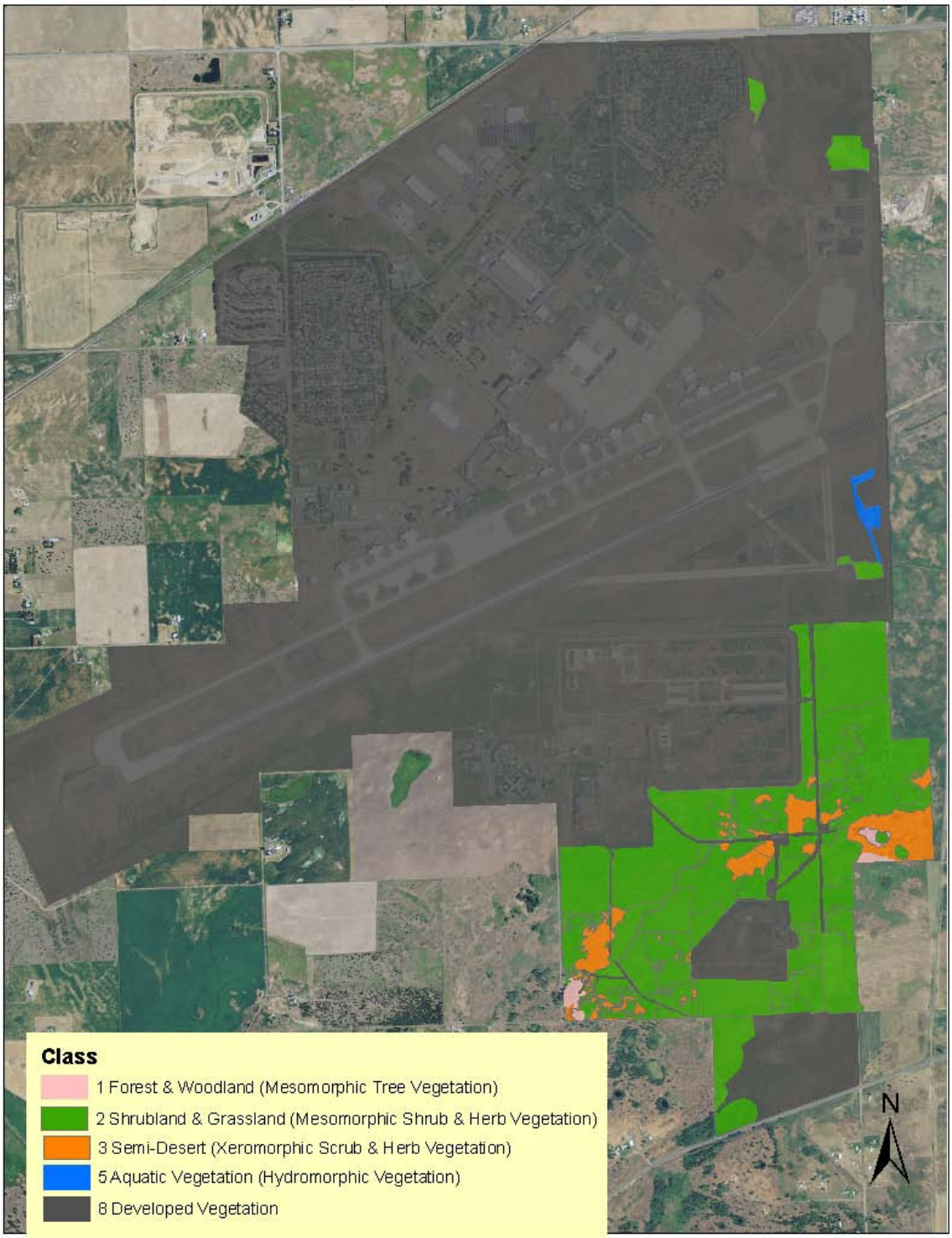

Figure 2. Distribution of NVC Classes at Fairchild Air Force Base, Spokane County, Washington.

The NVC Shrubland and Grassland Class is the most abundant natural/semi-natural vegetation on FAFB, with almost 600 acres located mostly in the southern portion of FAFB (Table 2). Eight NVC Groups, three natural vegetation Groups (including their semi-natural or ruderal counterparts) and two wetland Groups, are recognized in the Shrubland and Grassland Class. Ruderal or semi-natural refers to vegetation in which past or present human activities have or do not eliminate or dominate spontaneous ecological processes but significantly influence vegetation composition or structure (FGDC 2008). This includes old fields and pastures that have been planted with or invaded by native or exotic species and/or invaded by some native species that are **not** regularly tended or cultivated in any way. Ruderal vegetation also includes native-dominated, novel types that result from past human disturbances.

The most abundant natural vegetation (171 acres) within the Shrubland and Grassland Class is the Northern Rocky Mountain Lower Montane, Foothill & Valley Grassland Group that is represented almost exclusively by the Idaho fescue/northern buckwheat (*Festuca idahoensis / Eriogonum heracleoides)* plant association. The Northern Rocky Mountain Lower Montane, Foothill & Valley **Ruderal** Grassland Group covers a slightly greater area (188 acres) than the former natural Group. These ruderal sites are composed of various exotic grasses, such as quackgrass *(Agropyron repens),*smooth brome *(Bromus inermis),*bulbous bluegrass (*Poa bulbosa),* Kentucky bluegrass(*Poa pratensis),* and ventenata (*Ventenata dubia)* with individual or patches of native grassland plants such aswestern yarrow (*Achillea millifolium),* clarkia *(Clarkia pulchella),* northern buckwheat, Idaho fescue, hawkweed (*Hieracium cynoglossoides),* silky lupine (*Lupinus sericeus),* and sweet-march groundsel (*Senecio foetidus).*

The Columbia Plateau Scabland Shrubland Group is estimated to occupy around 60 acres and often includes the stiff sagebrush / bluegrass (*Artemisia rigida / Poa secunda)* association. The remaining scabland areas are very similar in composition but lack stiff sagebrush. The scabland Group is typically found in shallow soil swales within the mound-and-swale topography where it co-occurs with the Northern Rocky Mountain Lower Montane, Foothill & Valley Grassland which is found on fine textured soil mounds or on shallow soil outcrops of basalt rock. Exotic grasses such as bulbous bluegrass and ventenata are frequently encountered throughout the scablands.

The Northern Rocky Mountain Ponderosa Pine Woodland & Savanna Group is represented on approximately 7 acres. The ponderosa pine/common snowberry (*Pinus ponderosa / Symphoricarpos albus)* association is mapped in two general locations in the southwest and southeast corners of FAFB. Two very small occurrences of a newly recognized Group in Washington - the Rocky Mountain and Great Basin Depressional Scrub Wetland Group - are associated with the ponderosa pine patches. They appear in ephemerally flooded ponds within a forest canopy dominated by ponderosa pine. Quaking aspen (*Populus tremuloides),* water birch *(Betula occidentalis),* red-osier dogwood (*Cornus serecia),* and reed canarygrass (*Phalaris arundinacea)* are characteristic of this NVC Group on FAFB.

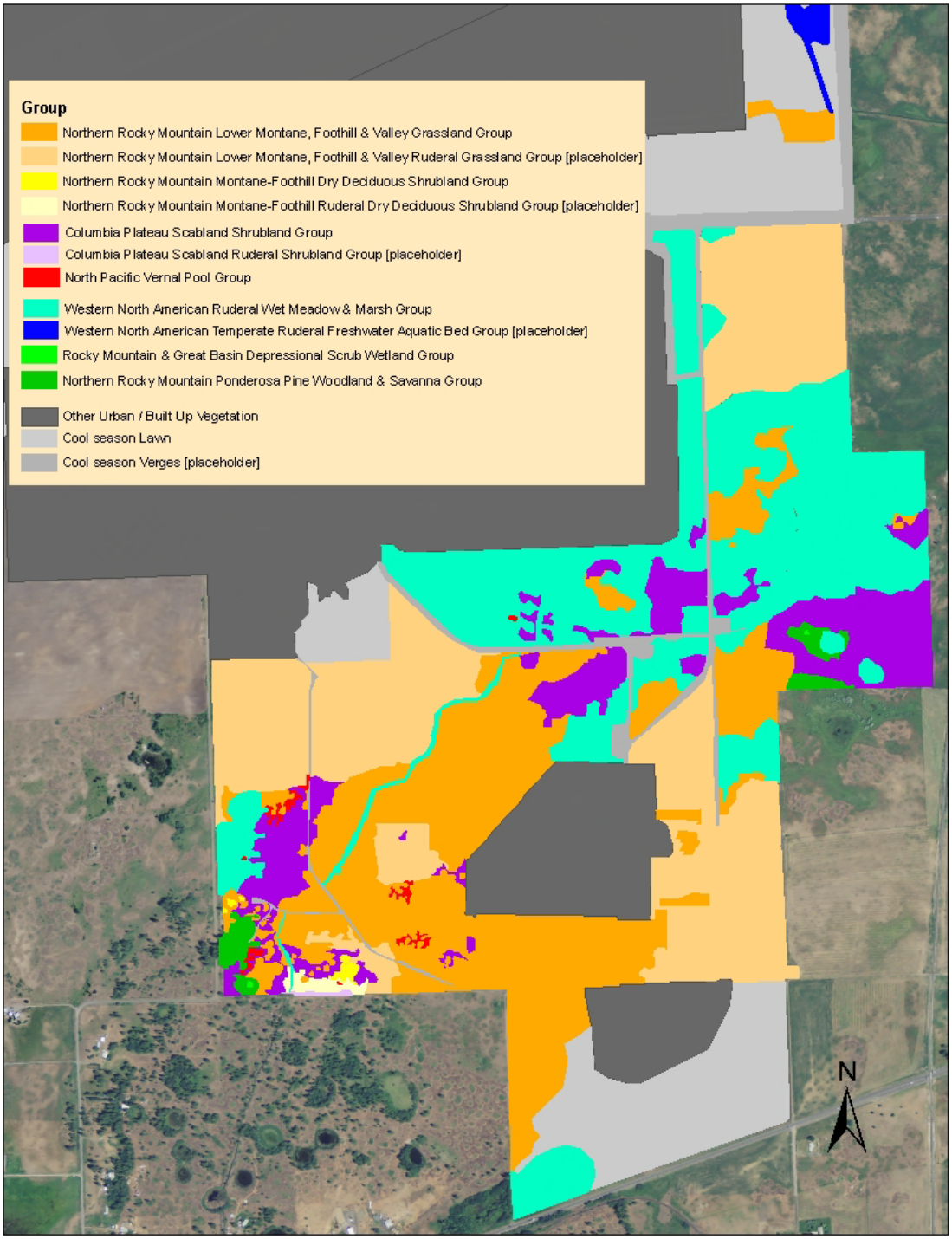

Figure 3. Distribution of NVC Groups at the southern portion of Fairchild Air Force Base, Spokane County, Washington.

The Northern Rocky Mountain Montane-Foothill Dry Deciduous Shrubland Group and the Northern Rocky Mountain Montane-Foothill Ruderal Dry Deciduous Shrubland were

mapped on less than 4 acres and were typically found in transition areas with ponderosa pine woodlands. For the most part, these shrublands are rose (*Rosa woodsii*) and snowberry thickets typically with basin wild rye (*Leymus cinereus)*, bluebunch wheatgrass *(Pseudorogneria spicata)* or other native grassland species. The ruderal deciduous shrubland Group is located on rock and soil debris associated with ditches and contains more weedy species such as smooth brome and cheatgrass (*Bromus tectorum)*.

Two wetland Groups are mapped, with the largest area (173 acres) occupied by the Western North American Ruderal Wet Meadow & Marsh Group. These areas are wet old fields, pastures and seasonally flooded ponds dominated by the exotics species, reed canarygrass and Kentucky bluegrass, often with scattered or patches of Russian-olive (*Elaeagnus angustifolia*) trees. Native increaser forb species, such as, milkweed (*Asclepias speciosa)*, sweet-march groundsel, and horsetail *(Equisetum* spp.), are usually present on these sites. The other wetland group is the North Pacific Vernal Pool Group represented as polygons on less than 2 acres and as GIS points when too small to digitize as polygons. The larger pools are mapped by Caplow (2005) and further sampled by Arnett (2009). Those reports list associated species, including rare species.

Comparison with 1994 Vegetation Map

Higher resolution imagery was available in 2010 and desktop GIS software allowed a finer resolution of distinction between unique vegetation types than in 1994. Consequently, more vegetation polygons were delineated and at smaller size in 2010 when compared to 1994. The 1994 vegetation map included 137 polygons in contrast to 161 polygons in 2010 and median polygon size of 8.7 acre in 1994 compares to 1.6 acre in 2010. The distribution and detail in vegetation polygons also differs by location on FAFB due to a more detailed focus on conservation objectives in focal areas and less emphasis on vegetation in developed areas. For example, the NVC Developed Vegetation Class in 2010 is mapped in 22 polygons (3637 acres), whereas, the equivalent categories to Developed Vegetation in 1994 (condition rank "X" and "NULL" or facilities and residences) included 66 polygons (3628 acres). In 2010 many different dominance types of maintained vegetation around the air fields were clustered into the NVC Cool Season Lawn Group that contributed to the reduction in 2010 polygon numbers. In 1994, 71 polygons of mostly natural vegetation (condition classes Good, Fair or Poor) were mapped, whereas, in 2010 natural vegetation was remapped into 131 polygons. The focus on conservation is reflected in the proposed South Base Special Interest Area (SBSIA) as illustrated in the 1994 report (page 19) contained 55 polygons in 1994; 2010 mapping nearly tripled the polygon number to 140.

The boundaries and shape of mapped polygons differed between 1994 and 2010 thus direct comparison of attributes changes within polygons is difficult. A tally summary of corresponding attributes can give indications of vegetation changes between 1994 and 2010. An indicator of the overall trend in condition of the proposed SBSIA is illustrated in Table 3. The 2010 survey categorized polygon biotic condition as "Species Composition" based on important measures of biological integrity, such as, vegetation composition and diversity, presence of plants more restricted to natural habitats and

invasion of exotics. This is equivalent to the attribute CONDITION in the 1994 survey. A 2010 "A-rank" is vegetation with species diversity/abundance at or near reference standard conditions and ruderal or "weedy" species are absent to minor. This is included in GOOD in the 1994 survey. "B-rank" is vegetation with species diversity/abundance close to reference standard condition. This is also equivalent to GOOD in the 1994 survey. "C-rank" is vegetation with species diversity/abundance different from reference standard condition in, but still largely composed of native species characteristic of the type including some ruderal ("weedy") species. This is equivalent to FAIR in the 1994 survey. "D-rank" is 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. This is equivalent to POOR in the 1994 survey and to "X" in the 1994 survey. The 2010 survey mapped areas that were dominated by exotics species as a "ruderal" NVC group. These are always equivalent to "X" in the 1994 survey.

Table 3. Percent of polygons and acres within equivalent condition classes as estimated in 1994 and 2010 at Fairchild AFB. Condition class definitions are in Appendix A. Percent based on 55 polygons in 1994 and 140 in 2010 and on total of 761 acres.

Condition rating	Year	Percent of Polygons	Percent of Acres
Good	1994	14.5%	7.0%
BA - B ranks	2010	10.0%	1.2%
Fair	1994	29.1%	10.9%
BC – CD ranks	2010	23.6%	10.3%
Poor	1994	32.7%	43.6%
D rank	2010	37.1%	25.9%
X	1994	20.0%	30.7%
Ruderal Groups	2010	25.7%	39.7%
Null	1994	3.6%	8.0%
Developed Class	2010	4.3%	22.8%

This information indicates a decrease in "Good" and "Fair" condition polygons and increase in Poor and Ruderal or semi-natural polygons. Total acreage shows a similar decrease in "Good" condition but no change in "Fair", a decrease in "Poor", and an increase in Ruderal or semi-natural, and Developed Class acreage.

Based on observations made in 1994 on FAFB, the author noticed an apparent increase in abundance in the exotic annual grass, ventenata, during the 2010 field evaluation. That increase is displayed in Figure 4. In polygons where annual dominance was recorded, ventenata was the annual dominant in 6% of 1994 polygons and 32% in 2010 (Table 4). This could be part of the overall decrease in SBSIA condition although the concomitant decrease in cheatgrass another exotic annual grass is puzzling.

Table 4. The mostly frequently listed dominant species within mapped polygons in 1994 and 2010 at Fairchild AFB. N=number of recorded polygons in layer category in that year.

Dominant layer	Species	n	1994	n	2010
DOMINANT SHRUB	*Eriogonum heracleoides*	55	**36.4%**	62	**38.7%**
DOMINANT GRAMINOID	*Bromus inermis* (exotic)	126	**15.1%**	107	**12.1%**
	Pseudoregneria spicata		**7.9%**		**23.4%**
DOMINANT FORB	*Melilotus officinalis* (exotic)	110	**26.4%**	91	**1.1%**
	Lomatium species		**0.0%**		**12.1%**
DOMINANT ANNUAL	*Bromus tectorum* (exotic)	97	**39.2%**	97	**5.2%**
	Ventenata dubia (exotic)		**6.2%**		**32.0%**

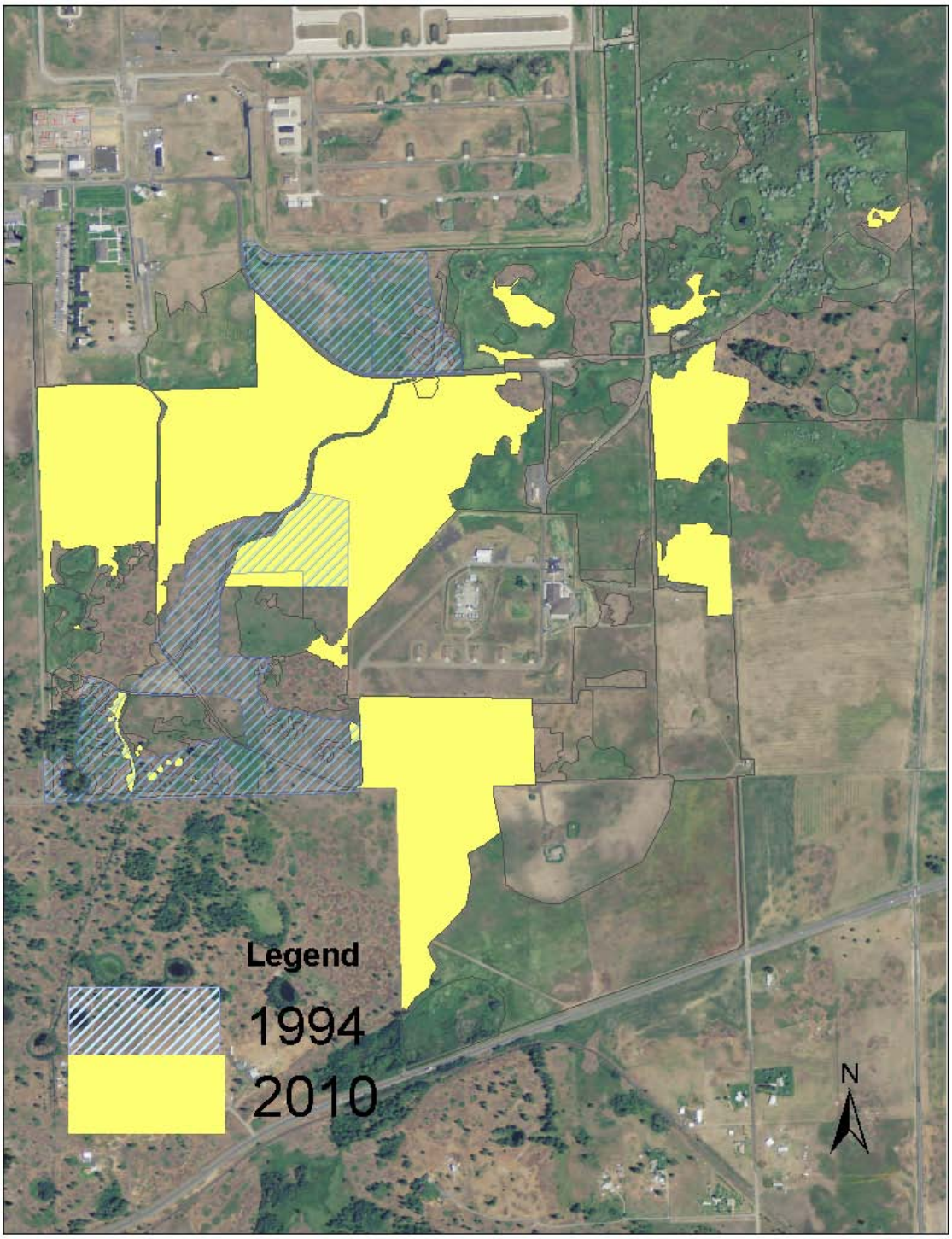

Figure 4. Distribution of ventenata (*Ventenata dubia)* when the dominant annual, in 1994 (Blue hatching) and 2010 (Yellow) polygons, in the southern portion of Fairchild Air Force Base, Spokane County, Washington.

Ecological Integrity Assessments

This project focused on remapping vegetation at FAFB and providing some information on its ecological condition and conservation need. The vegetation map provides a basis to monitor vegetation change and to distinguish specific site characteristics build a management plan. This report section provides a method developed by NatureServe and the Natural Heritage Network for assessing ecological condition that is scaled both in terms of the scale of ecosystem type that is being assessed and the level of information required to conduct the assessment. This method is called the Ecological Integrity Assessment (EIA) (Faber-Langendoen et al. 2006) and is now being implemented for a variety of small- and large-scale projects (Rocchio and Crawford 2009, Tierney et al. 2009). The EIA aims to measure the current ecological integrity of a site through a standardized and repeatable assessment of current ecological conditions associated with the structure, composition, and ecological processes of a particular ecological system. These conditions are then compared or ranked according to conditions expected in those sites operating within the bounds of their natural range of variation for that particular ecological system. The purpose of assigning an index of ecological integrity is to provide a succinct assessment of the current status of the composition, structure and function of occurrences of a particular ecosystem type and to give a general sense of conservation value, management effects, restoration success, etc. The EIA can be applied at a variety of spatial scales ranging from a remote-sensing, GIS-based approach to an on the ground, quantitative analysis these are referred to as Level 1 – remote assessments (GIS), Level 2 – rapid assessments (site) and Level 3 – intensive assessments (plot). A generalized Level 1 EIA is provided in Rocchio and Crawford (2009).

EIAs have been developed to assess units of Ecological Systems, a related but different classification than the NVC. Ecological systems provide a spatial-ecologic perspective on the relation of associations and alliances (fine-scale NVC types), integrating vegetation with natural dynamics, soils, hydrology, landscape setting, and other ecological processes. They can also provide a mapping application of the NVC, much as soil associations help portray the spatial-ecologic relations among soil series in a soil taxonomic hierarchy. Ecological systems types facilitate mapping at meso-scales (1:24,000 – 1:100,000; Comer and Schulz 2007) and a comprehensive, broad-scale ecological systems map exists for Washington State (www.landscope.org). Ecological systems meet several important needs for conservation, management and restoration, because they provide:

- an integrated biotic and abiotic approach that is effective at constraining both biotic and abiotic variability within one classification unit.
- comprehensive maps of all ecological system types are becoming available.
- explicit links to the USNVC, facilitating crosswalks of both mapping and classifications.

Ecological systems are somewhat comparable to the Group level of the NVC hierarchy, thus can be linked to other levels of the NVC hierarchy. For example, the Northern Rocky Mountain Lower Montane, Foothill & Valley Grassland Ecological System is

equivalent to the Northern Rocky Mountain Lower Montane, Foothill & Valley Grassland Group and Columbia Plateau Scabland Shrubland Ecological System is equivalent to NVC's Columbia Plateau Scabland Shrubland Group. Descriptions of the Ecological Systems of Washington state are located at the Washington Natural Heritage website (http://www1.dnr.wa.gov/nhp/refdesk/pubs/index.html). The EIAs developed for Ecological Systems can be then used to assess the ecological integrity of comparable NVC Groups and to nested, finer-level classifications, such as, association. Level 2 EIAs have been developed for these two ecological systems and are included here as a guide for developing a range of possible conservation, management or restoration targets for FAFB. Measurement of all of the metrics in the EIA (see tables below) will indicate which key attributes are contributing to overall integrity. The range of metric values indicates which attributes will contribute increasing or decreasing integrity and thus may be the focus of management. For example, where invasive species cover greater than 10% a site is rated as "poor" for that attributes. Management directed at decreasing invasive cover to between 3-10% would raise that attribute score and contribute to increasing ecological integrity as measured by the EIA.

Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland

Ecological Summary

The Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland ecological system is found at lower montane to foothill elevations in the mountains and large valleys of northeastern Wyoming and western Montana, west through Idaho into the Blue Mountains of Oregon, and north into the Okanagan and Fraser plateaus of British Columbia and the Canadian Rockies. In Washington, this ecological system occurs at elevations from 1500-5500 ft (500 to 1650 m), ranging from small meadows to open parks surrounded by conifers within lower montane forests in the mountains surrounding the Columbia Basin, to foothill and valley grasslands below the lower tree line. The system lies above the Intermountain Basins Big Sagebrush Steppe and below or within Northern Rocky Mountain Ponderosa Pine and Northern Rocky Mountain Dry-Mesic Forest ecological systems. It can be confused with the higher elevation Columbia Basin Canyon Dry Grasslands, remnants of the Columbia Basin Palouse Prairie, Intermountain Basins Montane Big Sagebrush Steppe and the Northern Rocky Mountain Subalpine-Upper Montane Grassland systems.

In Washington, most of this system receives 20-30 inches (50 -75 cm) annual precipitation much as snow and spring rains. Soils are relatively deep to shallow, often with coarse fragments, and non-saline. Soils dry by mid-summer and limit tree and shrub invasion. Unvegetated mineral soil is commonly found between clumps of grass and occasionally a moss/lichen cover particularly on rocky sites. Steep slopes, shallow skeletal soils, and sites with heavy native ungulate use that reduce foliar and litter cover have more exposed soil and apparently support more soil moss/lichens (Johnson and Swanson 2005). Greater crust cover will occur 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. The most important species are cool-season, perennial bunchgrasses and forbs (>25% cover), sometimes with a sparse (<10% cover) shrub layer. Mid-tall bunchgrasses, such as *Pseudoroegneria spicata, Festuca campestris, Festuca idahoensis* or *Koeleria macrantha,* commonly dominate sites on level to moderate slopes and on steep slopes not associated with canyons. *Danthonia unispicata* and *Poa secunda* are important shorter bunchgrasses. Other possible graminoids include *Achnatherum occidentale (= Stipa occidentalis), Achnatherum richardsonii, Bromus inermis, Calamagrostis rubescens, Carex geyeri, Carex pensylvanica, Elymus trachycaulus, Festuca washingtonica, Hesperostipa comata, Hesperostipa curtiseta, Leymus cinereus,* and *Pascopyrum smithii*. Other grassland species include *Artemisia frigida, Antennaria* spp., and *Selaginella densa*. Shrub species may be scattered, including *Eriogonum heracleoides, Amelanchier alnifolia, Rosa* spp., *Symphoricarpos* spp., *Juniperus communis, Artemisia tridentata,* and *Artemisia tripartita*. Common associated forbs include *Geum triflorum, Galium boreale, Campanula rotundifolia, Antennaria microphylla, Geranium viscosissimum,* and *Potentilla gracilis*.

A high-frequency fire regime (presumed to be less than 35 years, (Johnson and Swanson 2005), along with soil drought and herbivory, retards shrub and tree invasion resulting in a patchy distribution of shrubs and trees. The most droughty sites produce little and discontinuous fuel and likely have much longer fire regimes. Isolation of grassland patches by fragmentation may also limit seed dispersal of native shrubs leading to persistence of the grassland. Elk, deer and bighorn sheep are native large grazers in the canyon who used particularly in spring.

4.2 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 Lower Montane, Foothill and Valley Grassland system are associated with livestock practices, exotic species, fire regime alteration, direct soil surface disturbance, and fragmentation. Excessive grazing stresses the system through soil disturbance increasing the probability of establishment of native disturbance increasers and annual grasses, particularly exotic annual bromes (*Bromus commutatus, japonicus, mollis, tectorum*) and *Ventenata dubia*) on more xeric sites and exotic perennial grasses *Bromus inermis*, *Phleum pratense,* and *Poa pratensis* on more mesic sites. Other exotic species threatening this ecological system through invasion and potential complete replacement of native species include *Hypericum perfoliatum, Potentilla recta, Euphorbia esula*, and knapweeds, especially *Centaurea biebersteinii (= Centaurea maculosa).* Persistent grazing will further diminish native perennial cover, expose bare ground, and increase exotics (Johnson and Swanson 2005). Darambazar (2007) cites Johnston (1962) that

when bare ground is approximately 15%, reduced infiltration and increased runoff occur in *Festuca* grassland ecosystems. Fire further stresses livestock altered vegetation by increasing exposure of bare ground and consequent increases in exotic annuals and decrease in perennial bunchgrass. Grazing effects are usually concentrated in less steep slopes although grazing does create contour trail networks that can lead to addition slope failures. Fire suppression leads to deciduous shrubs, *Symphoricarpos* spp., *Physocarpus malvaceus*, *Holodiscus discolor*, and *Ribes* spp. and in some areas trees (*Pseudotsuga menziesii*) to increase.

Davies and others (2009) conclude that sites with heavy litter accumulation, (e.g., an 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 sites regain pre-fire cover of *Festuca* after a few years.

4.3 Conceptual Ecological Model

The general relationships among the key ecological attributes associated with natural range of variability of the Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland Ecological System are presented in Figure 1.

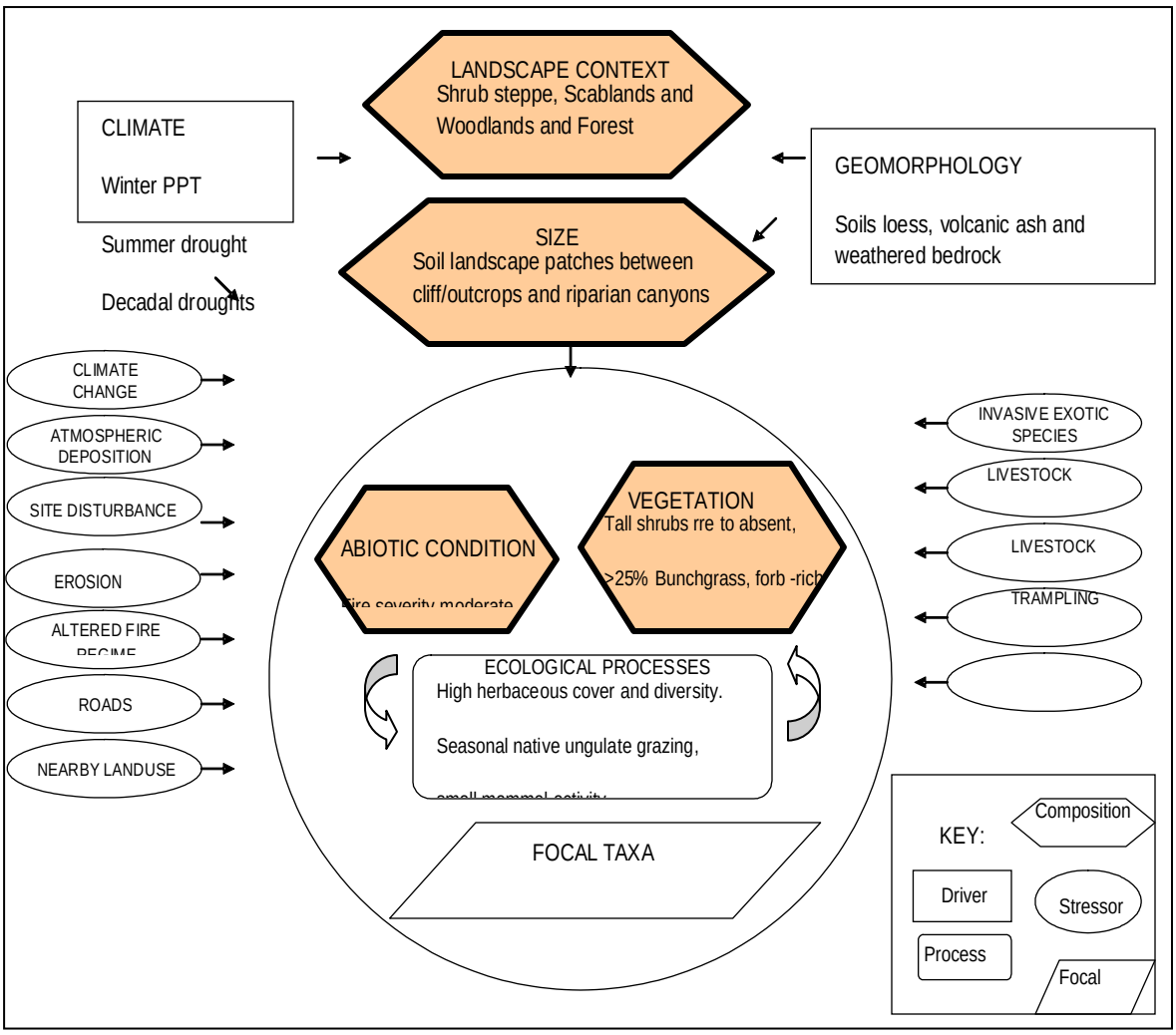

Figure 1. Conceptual Ecological Model for the Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland Ecological System.

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. Northern Rocky Mountain Lower Montane, Foothill and Valley 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	50–75% 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 0.79 – 0.65	Landscape Condition Model Index < 0.65
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation Composition*					
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 <80%.	Cover of native plants < relative 50%.
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.
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).
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.
Key Ecological Attribute: *Vegetation Structure*					
Biological Soil Crust	Crust cover and diversity is greatest where not impacted by trampling, other soil surface disturbance and fragmentation (Tyler 2006; 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 and there is a very limited suite of morphological groups
Key Ecological Attribute: *Physicochemical*					
Soil Surface Condition	Soil disturbance can result in erosion thereby negatively affecting many ecological processes; the amount of bareground 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.
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 (B.C. 2004)	Over 1000 ha (2500 ac)	500-1000 ha (1250-<2500 ac)	10 –500 ha (25 -1250 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)
- Microphytic species composition and abundance (Eldridge and Rosentreter 1999).

4.5 Triggers or Management Assessment Points

Ecological triggers or conditions under which management activities need to be reassessed are show 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 ▪ > than 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.

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February 26, 2010

Columbia Plateau Scabland Shrubland

Ecological Summary

This large to small patch system occurs on the Columbia Plateau in eastern Washington, eastern Oregon, southern Idaho, and extreme northern Nevada. It is a xeric, low (e.g. < 0.5 m tall) open shrubland with short grasses that occurs on sites with little soil development and extensive areas of exposed rock, gravel, or compacted soil. Found across a wide range of elevations from 500 to 5,000 ft, this system is characteristically associated with flats, plateaus, and gentle to steep slopes with rock. Bare ground and rock usually account for greater than 60% of the ground cover. Shallow (4-9 inches) lithic soil occurs over fractured basalt or rarely deep gravel that has limited water-holding capacity and is a major environmental driver. Due to poor drainage through basalt, winter precipitation can saturate soils from fall to spring but typically dry out completely to bedrock by spring to midsummer. Precipitation ranges from 8 to 16 inches.

Total vegetation cover is typically low, generally less than 50% and often much less. The open dwarf-shrub canopy is usually dominated by *Artemisia rigida* along with or only by other dwarf-shrub species, particularly shrubby *Eriogonum* species (*compositum, douglasii, sphaerocephalum, strictum* or *thymoides*). Some sites can be dominated by grasses and semi-woody forbs, such as *Stenotus stenophyllus*. More than a presence of other *Artemisia* species besides *Artemisia rigida* indicates a different ecological system. Low cover of perennial short bunchgrasses, primarily *Poa secunda* with scattered forbs, including species of *Allium, Antennaria, Balsamorhiza, Lomatium, Phlox,* and *Sedum,* characterize these sites. Other short bunchgrasses, *Danthonia unispicata, Elymus elymoides* can characterize sites. Annuals may be seasonally abundant, and cover of moss and lichen is often high in natural areas (e.g. 1-60% cover). Biological soil crust cover in Columbia Plateau Scabland Shrublands is considered to be high (Belnap et al 2001). Tyler (2006) found that tall moss (*Tortula)* is positively correlated with dwarf shrub-steppe in Yakima County, Washington. Hardman (2007) concluded from a study in the Blue Mountains that *Artemisia rigida* steppe and thin soil grasslands are sensitive habitats greatly impacted by soil disturbance and that they host rare lichen and bryophyte species, such as, vagrant lichens *Grimmia ovalis* and *Dermatocarpon bachmannii* and the lichen *Cladonia imbricarica*. Johnson and Swanson (2005) indicated little difference in biological soil crust cover in grazed areas although they stated overgrazing will destroy crusts. Freezing of saturated soils results in "frost-heaving" that churns the soil and is a major disturbance factor in determining vegetation patterns. Native ungulates utilize this ecological system in early spring and also contribute to churning of the soil surface. Severely grazed *Artemisia rigida* bushes are browsed to "compact mats." Vegetation cover is too low to carry fires and scablands "rarely" burn (Agee 1994).

4.2 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).

Land uses in this system are few and stressors to natural processes are confined to livestock use, exotic species invasion and direct use of sites. This system provides little forage and consequently is used only as a final resort by livestock. However, heavy use by livestock or vehicles, particularly after the sites have dried, disrupts the moss/lichen layer and increases exposed rock and bare ground increasing the potential for invasion by non-native plants. Grazing also reduces the cover of bunchgrasses and increases the abundance of many forbs such as *Achillea millefolium, Phlox* sp., *Trifolium macrocephalum, Balsamorhiza serrata, Sitanion hystrix,* and annual bromes. All dwarf-shrub species are intolerant of fire and do not sprout. Consequently, redevelopment of dwarf shrub-steppe habitat is slow following fire or any disturbance that removes shrubs. Wind farms and industrial solar panel "farms" have been developed on scabland sites.

4.3 Conceptual Ecological Model

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

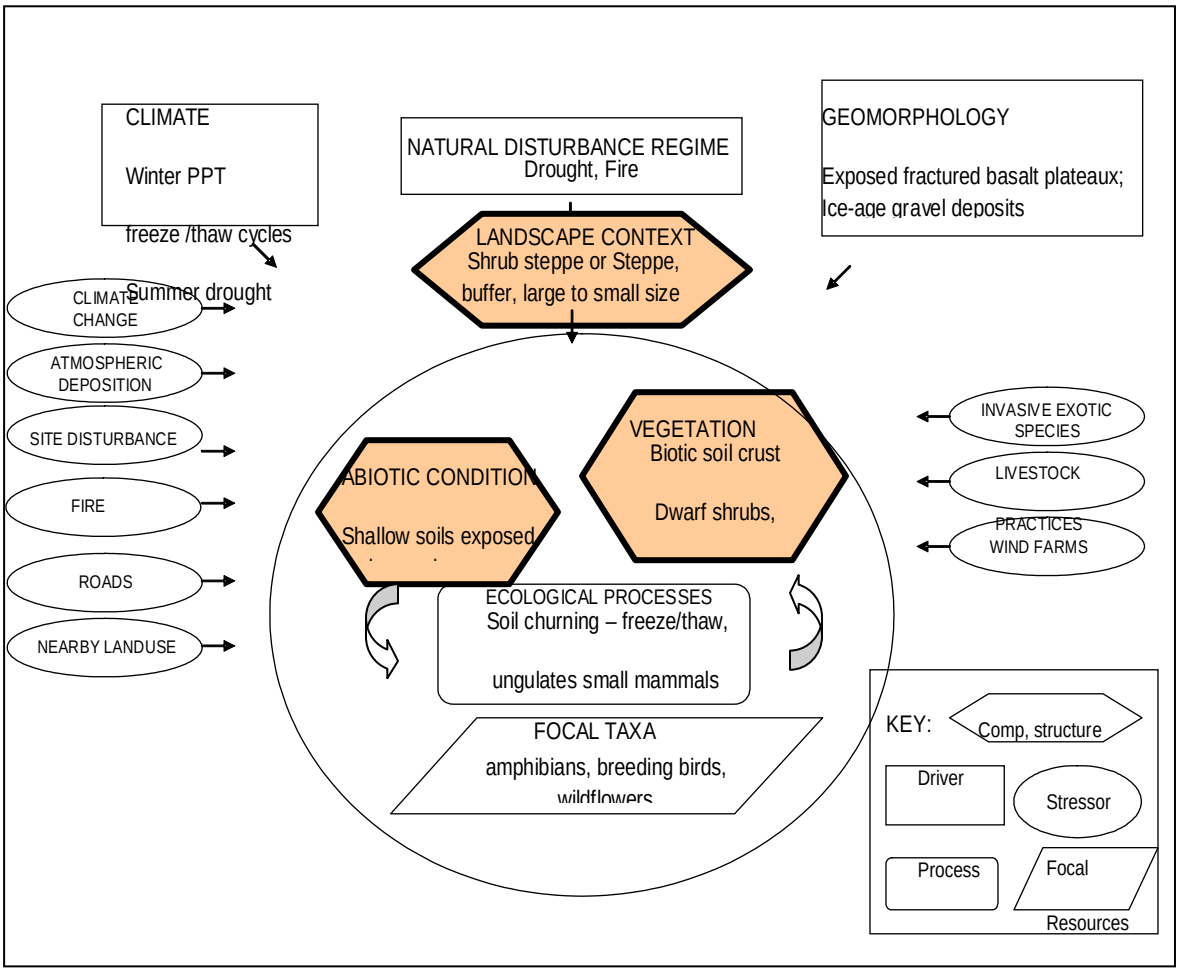

Figure 2. Conceptual Ecological Model for Columbia Basin Scabland Shrubland.

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 3. Columbia Basin Scabland Shrubland 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: *Edge Effects*					
Buffer Length	The buffer can be important to biotic and abiotic aspects as it provideS connectivity and a 'filter' from exogeneous threats.	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 (50–75%) 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	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*					
Cover Native Plant Species	Native species dominate this system; non-natives increase with human impacts.	Relative cover of native plants = relative 95-100%.	Relative cover of native plants relative 80-95%.	Relative cover of native plants relative 50 to <85%.	Relative cover of native plants < relative 50%.
Native Bunchgrass	Native bunchgrass dominate vascular layers	Perennial short bunchgrass dominant cover near site potential.	Perennial short bunchgrass dominant cover but cover reduced from site potential by human stressors	Perennial short bunchgrass dominant cover but cover reduced from site potential by human stressors.	Perennial short bunchgrass dominant cover but cover much reduced from site potential by human stressors.
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).
Species Composition Note: Once developed, the Floristic Quality Assessment index could be 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 (Hardman 2007; Belnap et al. 2001)	Largely intact biological soil crust that nearly matches the site capability where natural site characteristics are **not** limiting.	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: *Vegetation Structure*					
Fire-sensitive Shrubs	Fire, naturally rare, eliminates or reduces *Artemisia rigida* or woody *Eriogonum* cover	Fire-sensitive shrubs mature and recovered from past fires	Fire-sensitive shrubs common not fully recovered from past fires;	Fire-sensitive shrubs present recovering from past fires;	Fire-sensitive shrubs rare due to past fires;
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 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.
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	Scabland patches are determined by soil depth naturally small.	Very Large (>1000 ac; 250 ha)	Large (100-1000 ac; 25-250 ha)	(1-10 ac; 2.5-25 ha).	Small (< 1 ac; 2.5 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:

- Quantitative measurements of range health indicators (Pellant and others 2005)
- Biological Soil Crust Stability Index (Rosentreter and Eldridge 2002).
- Biological soil crust species composition and abundance (Hardman 2007; Eldridge and Rosentreter 1999).

Triggers or Management Assessment Points

Ecological triggers or conditions under which management activities need to be reassessed are show 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 4. 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 ▪ > than 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.

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March 1, 2010

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Appendix A. Fairchild Air Force Base GIS attribute file.

FILE NAME Fairchild_2010.shp

FILE DESCRIPTION created from spreadsheet file (excel) containing attribute information for vegetation mapped on Fairchild Air Force Base joined to shapefile. Field surveyed in July, 2010.

FILE CONTAINS 49 attribute items
151 records

1. Item Polygon

Definition numeric

Description Label unique to each map unit. Polygons delineated by road fences, change in landuse, and change in vegetation. Each polygon was characterized based on its homogeneity. In other words, a polygon may be mosaic of vegetation types, for example, scablands and wetlands, or a single vegetation unit. A polygon label may refer to more than one polygon.

Content:

1-151 unique labels for vegetation polygons

2. Item Class

Definition Text

Description This is Level 1 in the National Vegetation Classification defined as the Formation **Class** that represents broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and/or substrate or aquatic conditions. This is equivalent to FORMATION in 1994 VEG.DBF.

Content:

1 Forest & Woodland
2 Shrubland & Grassland
3 Semi-Desert
5 Aquatic Vegetation
8 Developed Vegetation

3. Item Subclass

Definition Text

Description This is Level 2 in the National Vegetation Classification defined as the Formation **Subclass** that represents combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions.

Content:
1.C Temperate Forest
2.C Temperate & Boreal Shrubland & Grassland
3.B Cool Semi-Desert Scrub & Grassland
5.B Freshwater Aquatic Vegetation
8.1. Herbaceous & Woody Developed Vegetation

4. Item Formation

Definition Text

Description This is Level 3 in the National Vegetation Classification defined as the **Formation** that represents combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.

Content:
1.C.2 Cool Temperate Forest
2.C.1 Temperate Grassland, Meadow & Shrubland
1.C.3 Temperate Flooded & Swamp Forest
2.C.5 Temperate & Boreal Freshwater Wet Meadow & Marsh
3.B.1 Cool Semi-Desert Scrub & Grassland
5.B.1 Freshwater Aquatic Vegetation
8.1.A. Developed (Close cropped)
8.1.B. Other Developed Urban / Built Up Vegetation

5. Item Division

Definition Text

Description This is Level 4 in the National Vegetation Classification defined as the **Division** that represents combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.

Content:
1.C.2.b Western North American Cool Temperate Forest
1.C.3.c Western North American Flooded & Swamp Forest
2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland
2.C.5.b Western North American Freshwater Wet Meadow & Marsh

3.B.1.a Western North American Cool Semi-Desert Scrub & Grassland
5.B.1.a North American Freshwater Aquatic Vegetation
8.1.A.1 Lawn – regularly mowed but not hayed grassland.
8.1.A.x Verges [provisional] - road side vegetation; provisional indicates classification temporary, state name
8.1.B.1 Other Urban / Build Up Vegetation

6. Item Macrogroup

Definition Text

Description This is Level 5 in the National Vegetation Classification defined as the **Macrogroup** that represents combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and subcontinental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.

Content:
Great Basin & Intermountain Dwarf Sage Shrubland & Steppe
Great Basin & Intermountain Ruderal Dwarf Sage Shrubland & Steppe [placeholder] - placeholder indicates classification temporary, state name
Northern Rocky Mountain Lower Montane & Foothill Forest
Northern Rocky Mountain-Vancouverian Montane & Foothill Grassland & Shrubland.
Northern Rocky Mountain-Vancouverian Montane & Foothill Ruderal Grassland & Shrubland [placeholder]- placeholder indicates classification temporary, state name
Other Urban / Built Up Vegetation
Rocky Mountain and Great Basin Flooded & Swamp Forest
Temperate and Tropical Lawn
Temperate and Tropical Verges [placeholder] - road side vegetation; placeholder indicates classification temporary, state name
Western North American Ruderal Freshwater Aquatic Vegetation
Western North American Ruderal Wet Meadow & Marsh
Western North American Vernal Pool

7. Item Group

Definition Text

Description This is Level 6 in the National Vegetation Classification defined as the **Group** that represents combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.

Content:
Columbia Plateau Scabland Shrubland Group
Great Basin & Intermountain Ruderal Dwarf Sage Shrubland

Northern Rocky Mountain Ponderosa Pine Woodland & Savanna Group
Northern Rocky Mountain Lower Montane, Foothill & Valley Grassland Group
Northern Rocky Mountain-Vancouverian Montane & Foothill Ruderal Grassland [placeholder] - placeholder indicates classification temporary, state name
Northern Rocky Mountain Montane-Foothill Dry Deciduous Shrubland Group
Northern Rocky Mountain Montane-Foothill Ruderal Dry Deciduous Shrubland Group [placeholder] - placeholder indicates classification temporary, state name
Rocky Mountain & Great Basin Depressional Scrub Wetland Group
Western North American Ruderal Freshwater Aquatic Vegetation
Western North American Ruderal Wet Meadow & Marsh Group
North Pacific Vernal Pool Group
Cool season Lawn
Cool season Verges [placeholder] - placeholder indicates classification temporary, state name
Other Urban / Built Up Vegetation

8. Item Plant Association

Definition Text

Description This is Level 8 in the National Vegetation Classification defined as the **Association** that represents diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

Content:
Artemisia rigida / Poa secunda
Pinus ponderosa / Symphoricarpos albus
Festuca idahoensis / Eriogonum heracleoides

9. Item Common name

Definition Text

Description Term describing general appearance or land use of polygon.

Content:

Ditch and Berm
facility
forest pond
mound and scabland
mowed field
native grassland
pond
ponderosa pine
retention pond

roadway
Rubble
Scabland
Vernal Pool
Weedy field
Wet field

10. Item Comment

Definition Text

Description Open text field with non-standard description or remarks about the polygon land use, vegetation or land landform structure, relationship to other polygons or to 1994 mapping.

Content:

11. Item Est% of polygon

Definition Numeric

Description Estimated percent cover of the primary group is recorded in polygons with more than one Group (Item 8).

Content:
0-99 Estimated percentage
Blank Assumed to be single Group

12. Item Water

Definition Numeric

Description Estimated cover class of standing water during time of sampling.

Content:
1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

13. Item Bare Ground

Definition Numeric

Description: Estimated cover class of exposed mineral soil or substrate during time of sampling.

Content:
1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

14. Item Litter

Definition Numeric

Description: Estimated cover class of exposed litter during time of sampling.

Content:
1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

15. Item BioSoilCrust

Definition Numeric

Description: Estimated cover class of exposed moss and lichens (excluding crustose lichens on rocks) during time of sampling

Content:
1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

16. Item Tree species

Definition Numeric

Description: Estimated cover class of trees species during time of sampling. This is equivalent to EMTREE_CVR, CANTREE_CVR and SCANTREE_CVR in 1994 VEG.DBF.

Content:

1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

17. Item Shrub species

Definition Numeric

Description: Estimated cover class of shrub species during time of sampling. This is equivalent to TSHRUB_CVR and SSHRUB_CVR in 1994 VEG.DBF.

Content:
1 trace
2 0–<1%
3 1–<2%
4 2–<5%

5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

18. Item Native Species

Definition Numeric

Description: Estimated cover class of native species during time of sampling.

Content:

1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

19. Item Native Bunchgrass

Definition Numeric

Description: Estimated cover class of native bunchgrass species at time of sampling.

Content:

1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%

Blank not estimated in the field; missing value

20. Item Native Increasers

Definition Numeric

Description: Estimated cover class of native plants that are considered to increase in abundance with a human activity (vehicle use) or human-directed activity (livestock).

Content:

1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

21. Item Annual Exotics

Definition Numeric

Description: Estimated cover class of exotic annual plants during time of sampling. This is equivalent to ANN_CVR in 1994 VEG.DBF.

Content
1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

22. Item Perennial Exotics

Definition Numeric

Description: Estimated cover class of exotic perennial plants during time of sampling.

Content:

1 trace
2 0–<1%
3 1–<2%
4 2–<5%
5 5–<10%
6 10–<25%
7 25–<50%
8 50–<75%
9 75–<95%
10 >95%
Blank not estimated in the field; missing value

23. Item Species Composition

Definition Text

Description: A ranking of biotic condition, species composition and diversity, presence of plants more restricted to natural habitats, regeneration, and invasion of exotics are important measures of biological integrity. This is equivalent to CONDITION in 1994 VEG.DBF.

Content:

A 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. This is equivalent to GOOD in 1994 VEG.DBF.
B Species diversity/abundance close to reference standard condition. Some native species reflective of past anthropogenic degradation present. Some indicator/ diagnostic species may be absent. This is equivalent to GOOD in 1994 VEG.DBF.
C 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. This is equivalent to FAIR in 1994 VEG.DBF.
D 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. This is equivalent to POOR and X in 1994 VEG.DBF.

24. Item DOMINANT TREE

Definition Text
Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer. EMTREE_DOM, CANTREE_DOM and SCANTREE_DOM

Content:

PINPON	Pinus ponderosa
POPTRE	Populus tremuloides
BETOCC	Betula occidentalis
ELEANG	Eleagnus angustifolia
CRADOU	Crataegus douglasii
Blank	no trees

25. Item DOMINANT SHRUB

Definition Text

Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer. This is equivalent to TSHRUB_DOM and SSHRUB_DOM in 1994 VEG.DBF.
Content: Text

ARIRIG	Artemesia rigida
CORSER	Cornus sericea
ERIHER	Eriogonum heraceloides
ERINIV	Eriogonum nivium
PHLHOO	Plox hoodii
ROSWOO	Rosa woodsii
SYMALB	Symphoricarpos albus

26. Item DOMINANT GRAMINOID

Definition Text

Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer. This is equivalent to GRAM_DOM in 1994 VEG.DBF.

Content:

AGRREP	Agropyron repens
BROINE	Bromus inermis
DANINT	Danthonia intermedia

ELEPAL	Eleocharis palustris
ELYELY	Elymus elymoides
FESIDA	Festuca idahoensis
LEYCIN	Leymus cinerius
PHAARU	Phalaris arundinacea
PSESPI	Pseudoroegneria spicata
POAPRA	Poa pratensis
POASEC	Poa secunda
STICOL	Stipa columbiana
Blank	missing value

27. Item DOMINANT FORB

Definition Text

Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer. This is equivalent to FORB_DOM in 1994 VEG.DBF.

Content:

ACHMIL	Achillia millifolium
AESSPE	Aesceplis speciosa
ALLsp	Allium species
ARNSOR	Arnica sororia
ARTLUD	Artemisia ludiviciana
CHOJUN	Chondrilla juncea
CIAARV	Cirsium arvense
ERIspp	Erigeron species
GALAPA	Galium aparine
GALARI	Gaillardia aristata
GERRIC	Geranium richardsonii
GRINAN	Grindelia nana
HIECYN	Hieraceum cynoglossoides
LINDAL	Linaria dalmatica
LOMsp	Lomatium species
LUPSER	Lupinus sericeous
MELOFF	Melilotus officinalis
RUMsp	Rumex species
SEDsp	Sedum species
SENFOE	Senecio foetidus
SENINT	Senecio integrrimus
SENSER	Senecio serra
SMISTE	Smilacina stellata
TYPLAT	Typha latifolia
VICsp	Vicia species

99 missing value

28. Item DOMINANT ANNUAL

Definition Text
Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer. This is equivalent to ANN_DOM in 1994 VEG.DBF.

Content:
AMSspp Amsinkia species
BROann Bromus annuals
BROjap Bromus japonicus
BROTEC Bromus tectorum
CLAPUL Clarkia pulchella
EPIPAN Epilobium paniculatum
LACSER Lactuca serrola
NAV Navarettia species
PLAspp Plagiobothyris species
POLsp Polygonum species
POABUL Poa bulbosa
SISALT Sisymbrium altissimum
VENDUB Ventenata dubia
99 missing value

29. Item Group 2

Definition Text

Description Group name of second most abundant NVC Group in polygon.

Content:
Same as Item 7 Group

30. Item Plant Association2

Definition Text

Description Plant association name of second most abundant NVC Group in polygon.

Content:
Same as Item 8 Plant association

31. Item Comment2

Definition Text

Description Open text field with non-standard description or remarks about the polygon land use, vegetation or land landform structure, relationship to other polygons or to 1994 mapping.

Content:
Same as Item 10 Comment

32. Item Est% of polygon2

Definition Numeric

Description Estimated percent cover of the secondary group is recorded in polygons with more than one Group (Item 8).

Content:
Same as Item 11 Est% of polygon

33. Item Water2

Definition Numeric

Description Estimated cover class of standing water during time of sampling.

Content:
Same as Item 12 Water

34. Item Bare Ground2

Definition Numeric

Description: Estimated cover class of exposed mineral soil or substrate during time of sampling.

Content:
Same as Item 13 Bare Ground

35. Item Litter

Definition Numeric

Description: Estimated cover class of exposed litter during time of sampling.

Content:
Same as Item 14 Litter

36. Item BioSoilCrust2

Definition Numeric

Description: Estimated cover class of exposed moss and lichens (excluding crustose lichens on rocks) during time of sampling

Content:
Same as Item 15 BiolSoilCrust

37. Item Tree species2

Definition Numeric

Description: Estimated cover class of trees species during time of sampling

Content:
Same as Item 16 Tree species

38. Item Shrub species2

Definition Numeric

Description: Estimated cover class of shrub species during time of sampling.

Content:
Same as Item 17 Shrub species
2 0–<1%

39. Item Native Species2

Definition Numeric

Description: Estimated cover class of native species during time of sampling.

Content:
Same as Item 18 Native species

40. Item Native Bunchgrass2

Definition Numeric

Description: Estimated cover class of native bunchgrass species at time of sampling.

Content:
Same as Item 19 Native Bunchgrass

41. Item Native Increasers2

Definition Numeric

Description: Estimated cover class of native plants that are considered to increase in abundance with a human activity (vehicle use) or human-directed activity (livestock).

Content:
Same as Item 20 Native Increasers

42. Item Annual Exotics2

Definition Numeric

Description: Estimated cover class of exotic annual plants during time of sampling.

Content
Same as Item 21 Annual Exotics

43. Item Perennial Exotics2

Definition Numeric

Description: Estimated cover class of exotic perennial plants during time of sampling.

Content:
Same as Item 22 Perennial Exotics

44. Item Species Compositon2

Definition Text

Description: A ranking of biotic condition, species composition and diversity, presence of plants more restricted to natural habitats, regeneration, and invasion of exotics are important measures of biological integrity.

Content:
Same as Item 23 Species Compositon

45. Item DOMINANT TREE2

Definition Text
Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer.

Content:
Same as Item 24 DOMINANT TREE

46. Item DOMINANT SHRUB2

Definition Text

Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer.

Content: Text
Same as Item 25 DOMINANT SHRUB

47. Item DOMINANT GRAMINOID2

Definition Text

Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer.

Content:
Same as Item 26 DOMINANT GRAMINOID

48. Item DOMINANT FORB2

Definition Text

Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer.

Content:
Same as Item 27 DOMINANT FORB

49. Item DOMINANT ANNUAL2

Definition Text
Description Values represent the first three letters of the genus and the first three letters of the species of the dominant or most common plant in the layer.

Content:
Same as Item 28 DOMINANT ANNUAL