The Pacific Northwest Regional Gap Analysis Project

Final Report on Land Cover Mapping Methods: Map Zones 8 and 9

1 May, 2006

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This report represents the land cover portion of the final project report for Map Zones 8 and 9 of the Pacific Northwest Regional Gap Analysis Project

Final Report on Land Cover Mapping Methods: Map Zones 8 and 9, Pacific Northwest ReGAP

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Recommended Citation:

Kagan, J.S., J.A. Ohmann, M.J. Gregory, C. Tobalske, J.C. Hak, and J. Fried. 2006. *Final Report on Land Cover Mapping Methods, Map Zones 8 and 9, PNW ReGAP*. Institute for Natural Resources, Oregon State University, Corvallis, OR.

Acknowledgements

Much of this report is taken directly from the Southwest Regional Gap Analysis final report, by J.H. Lowry et al. (2006). The authors greatly appreciate their willingness to share their work. The work here was based on previous projects developed with other key individuals. Steve Knick and Steve Hanser of the USGS Snake River Field Station in Boise, both managed and facilitated the SageMap project, which provided the foundation of most of the vegetation data incorporated. SageMap relied heavily on the 15 year ESI project coordinated by the Burns District of the BLM, vegetation mapping by all the eastern Oregon and Washington National Forests, and shrub steppe mapping done by the Washington Department of Fish and Wildlife. Finally, Rex Crawford of the Washington Natural Heritage Program had a critical part in assuring the Washington portion of the map was not terrible. We gratefully acknowledge the financial support of the USGS BRD, Gap Analysis Program, without which completion of this project could not have been possible, and in particular, would also like to thank Jocelyn Aycrigg and Todd Sajwaj for their patience and support.

Abstract

For more than a decade the USGS Gap Analysis Program has focused considerable effort on mapping land cover to assist in the modeling of wildlife habitat and biodiversity for large geographic areas. The GAP Analysis Program has been traditionally state-centered; each state having the responsibility of implementing a project design for the geographic area within their state boundaries. The Northwest Regional Gap Analysis Project (NW ReGAP) is the third formal GAP project designed at a regional, multi-state scale, building off the work developed by the Southwest Regional Gap Analysis Project (SW ReGAP). A land cover map was generated for USGS Map Zones 8 and 9, covering most of Eastern Washington and Eastern Oregon, parts of western Idaho, and most of northern Nevada. The map was derived from two primary components. The first was a combination of two large regional datasets: SageMap covering eastern Oregon and Washington, and southern Idaho and SW ReGAP, covering the northern Nevada portion of the Map Zone 9. These used regionally consistent geospatial data (Landsat ETM+ imagery and DEM derivatives), similar field data collection protocols, a standardized land cover legend, and a common modeling approach (decision tree classifier). The second was a Gradient Nearest Neighbor (GNN) modeling effort developed for the forests, based on the network of forest vegetation plots in the region. This report presents an overview of the process and methodologies used to create the land cover dataset and results and lessons learned from the different methodologies used.

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Introduction

In its "coarse filter" approach to conservation biology (Jenkins 1985, Noss 1987) gap analysis relies on maps of dominant land cover as the most fundamental spatial component of the analysis for terrestrial environments (Scott et al. 1993). For the purposes of GAP, most of the land cover of interest can be characterized as natural or semi-natural vegetation defined by the dominant plant species.

Vegetation patterns are an integrated reflection of physical and chemical factors that shape the environment of a given land area (Whittaker 1965). Often vegetation patterns are determinants for overall biological diversity patterns (Franklin 1993, Levin 1981, Noss 1990) which can be used to delineate habitat types in conservation evaluations (Specht 1975, Austin 1991). As such, dominant vegetation types need to be recognized over their entire range of distribution (Bourgeron et al. 1994) for beta-scale analysis (*sensu* Whittaker 1960, 1977). Various methods may be used to map vegetation patterns on the landscape, the appropriate method depending on the scale and scope of the project. Projects focusing on smaller regions, such as national parks, may rely on aerial photo interpretation (USGS-NPS 1994). Mapping vegetation over larger regions has commonly been done using digital imagery obtained from satellites, and may be referred to as land cover mapping (Lins and Kleckner 1996).

Generally, land cover mapping is done by segmenting the landscape into areas of relative homogeneity that correspond to land cover classes from an adopted or developed land cover legend. Technical methods to partition the landscape using digital imagery-based methods vary. Unsupervised approaches involve computer-assisted delineation of homogeneity in the imagery and ancillary data, followed by the analyst assigning land cover labels to the homogenous clusters of pixels (Jensen 2005). Supervised approaches utilize representative samples of each land cover class to partition the imagery and ancillary data into clusters of pixels representing each land cover class. Supervised clustering algorithms assign membership of each pixel to a land cover class based on some rule of highest likelihood (Jensen 2005). Supervised-unsupervised hybrid approaches are common and often offer advantages over both approaches (Lillesand and Kieffer 2000).

It is important to point out that a land cover map is never considered a perfect representation of the landscape. Improvements to land cover maps can, and should be made as additional “ground truth” information about actual land cover components and spatial patterns is acquired through time. These improvements should be based on independent assessments of the map’s quality (Stoms 1994).

Land Cover Map Development

Background:

The land cover map developed here is an integration of three largely independent efforts. The first is the Southwest ReGAP project, which developed a land cover map for the states of Colorado, Utah, Nevada, New Mexico and Arizona. The second is the SageMap project, which used the Southwest ReGAP methods to develop a land cover map for non-forested habitats in eastern Oregon, eastern Washington and southern Idaho. The third was a Gradient Nearest Neighbor (GNN) modeling project to map the forests of the USGS Map Zones 8 and 9. These three projects were largely completed independently, and for the most part are non-overlapping. The project team then integrated the three projects into a single grid. Each of the three projects had independent assessments of map accuracy. The three projects are discussed below, first Southwest ReGAP, then SageMap, and the GNN Forest modeling last. There is a fourth section describing the final integration and map improvement efforts.

With the diversity of biogeographic divisions across the area selected for the different projects involved in this integrated map, each of the teams (Southwest ReGAP, SageMap, and PNW Forest Science) recognized the need for a geographical approach for mapping the individual bioregions or ecoregions. While each of the projects chose a geographic approach based on ecological attributes, the mapping zones selected for each of the projects were slightly different. The different mapping zones make for a bit more work, but do not appear to negatively impact the final product. A description of the zones used for the three projects are described separately below.

Southwest ReGap Mapping Zone Boundaries

Ecoregions defined by Bailey et al. (1994) and Omernik (1987) provided a starting point for determining the project mapping zone boundaries. These boundaries were refined by screen digitizing at a scale of approximately 1:500,000 using a regional mosaic of Landsat TM imagery resampled to 90 meters. Initial efforts yielded 73 mapping zones for the region. Through a process of iterative and collaborative steps involving all land cover mapping teams and NatureServe, the final number of mapping zones was reduced to 25 (Figure 1). A more detailed explanation of mapping zone development is found in Manis et al. (2000).

Each state was responsible for between four and six mapping zones roughly corresponding to state jurisdictional boundaries. Initial field data collection protocols were established at a workshop in Las Vegas, Nevada in the spring of 2001. Field data collection occurred during 2002 and 2003. Land cover workshops dedicated to ensuring regionally consistent mapping methods were conducted during the winters of 2002 and 2003. Yearly meetings and monthly teleconferences involving key land cover mapping personnel from all five states and NatureServe ecologists proved invaluable throughout the collaborative mapping process. Mapping efforts were completed on a mapping zone by mapping zone basis by individual states, with the final integration of all mapping zones performed by the regional land cover lab. The seamless land cover map was completed and made available to the public in September 2004.

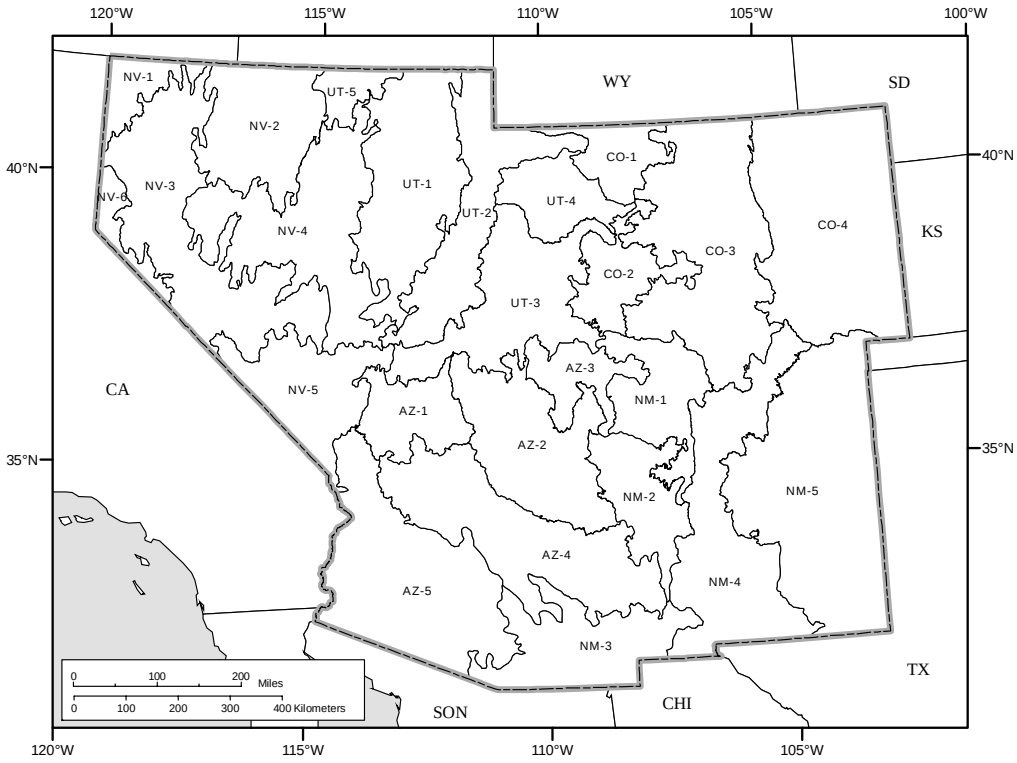

Figure 1. Mapping zone boundaries for SWReGAP land cover mapping effort.

SageMap Mapping and Northwest ReGAP Zone Boundaries

The SageMap process was built on and followed the Southwest ReGAP project, and the primary map zones were selected to connect with the Southwest ReGAP zone boundaries at the Oregon – Nevada, Idaho – Nevada, and Idaho – Utah state lines. Similar methodology was used, although since the objective of SageMap was to map sagebrush, shrub steppe and other non-forest land cover, the map zone boundaries were drawn to reflect the distribution of these cover types. As a result, some map zones were selected primarily to exclude the forested areas. For the Northwest ReGAP project, the team selected the Omernik ecoregions for the Pacific Northwest (Thorson et al. 2003). Map Zone 8 essentially matches the Omernik Columbia Plateau ecoregion, and was treated as a single map zone. Map Zone 9 in eastern Oregon, northern Nevada and southwestern Idaho was split approximately in two parts into the component level 3 ecoregions, the Blue Mountains in the north and the Northern Basin and Range in the south. Figure 2 below shows the mapping zone boundaries used in SageMap and those used in final mapping for this Northwest ReGAP mapping effort.

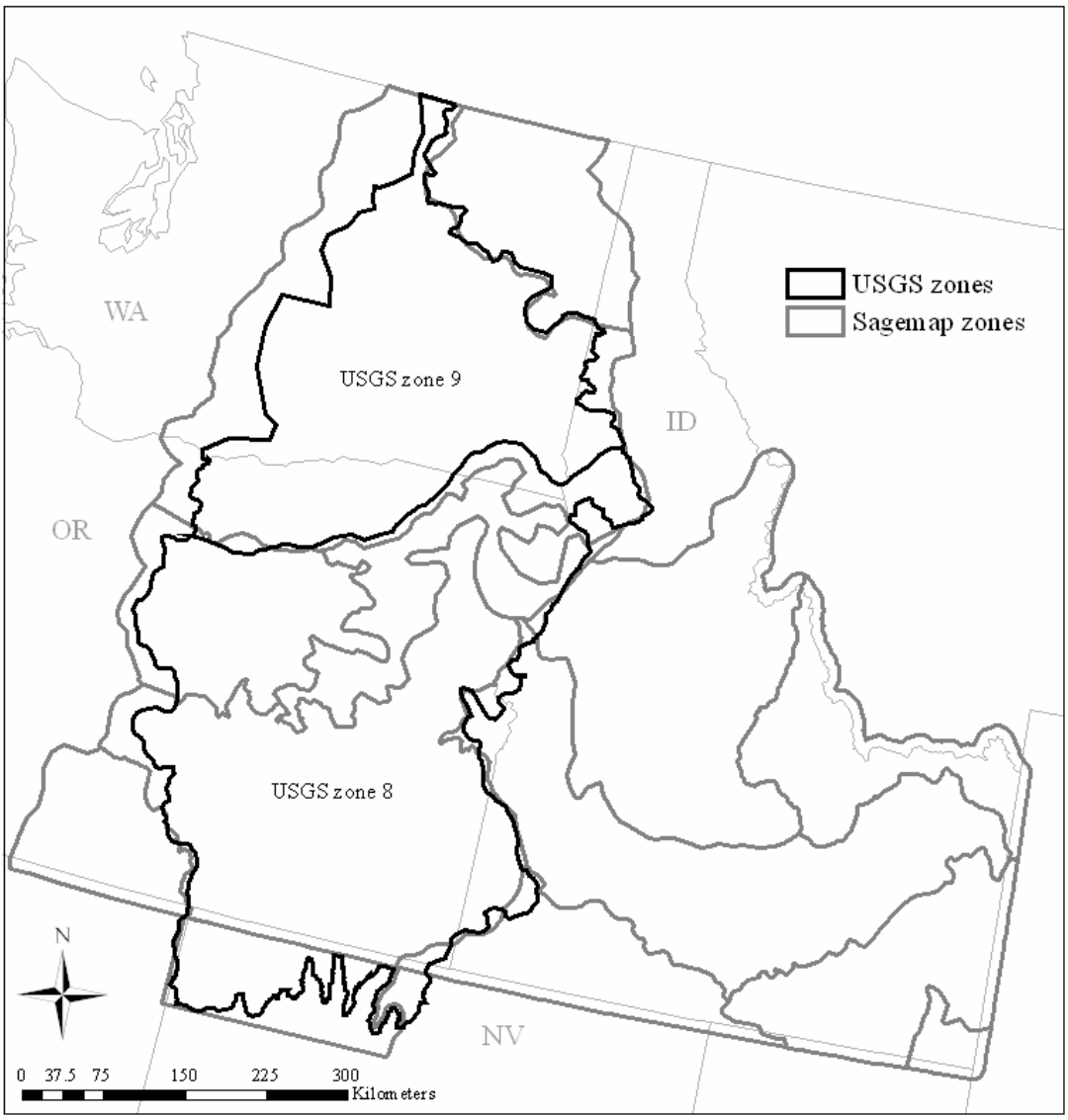

Figure 2. Mapping zone boundaries for SageMap and NWGAP land cover mapping effort.

SageMap

The SageMap project came about due to recognition of large-scale losses and alterations of Sagebrush (*Artemisia* spp.) ecosystems in the Intermountain West. These losses are a conservation concern because of the implications for dependent wildlife such as Greater Sage-grouse (*Centrocercus urophasianus*) and pygmy rabbits (*Brachylagus idahoensis*). Consequently, maps that accurately depict locations and quality of sagebrush stands are needed to assess the potential threats to their long-term well-being.

A four-year effort to classify and map sagebrush and steppe vegetation in the west has recently been completed by the National Biological Information Infrastructure's Great Basin Information

Project, in partnership with NatureServe and Oregon State University. Taking advantage of the products available from the Southwest ReGAP project, the Snake River, the USGS Snake River Office organized the effort to develop a new regional landcover dataset for the Southwest and the Pacific Northwest, which encompasses the entire range of sagebrush in the U.S., outside of Wyoming and Montana.

The project primarily used a decision tree classifier and other techniques to model landcover. Multi-season satellite imagery (Landsat ETM+, 1999-2003) and digital elevation model (DEM) derived datasets (e.g. elevation, landform, aspect, etc.) were utilized to derive rule sets for the various landcover classes. The effort included classification workshops to revise the entire classification of stagebrush habitats, and relate them to various scales for mapping. The Pacific Northwest (PNW) was divided into eleven mapping areas, each characterized by similar ecological and spectral characteristics, equivalent to the map zones used for SW ReGAP. Methods used in the SW ReGAP area described in section two, below. The PNW map was able to take advantage of a fifteen-year old vegetation mapping effort by the BLM in southwestern Oregon, and detailed shrub-steppe modeling effort completed by the Washington Department of Fish and Wildlife in the Columbia Basin, the thousands of plots colleted as part of these efforts, and the expertise in the Natural Heritage Programs of the three PNW states. The final products for SageMap included mapping of overall shrub density, and preliminary indications of habitat quality, at the 30 meter pixel scale, for most of the western U.S.

SageMap included an initial classification workshop to refine the sagebrush and shrub steppe vegetation of the western United States. The National Vegetation Classification System at the Alliance and Plant Association levels were updated, and the Ecological System classification was also updated. The initial mapping protocol was to include mapping at both the alliance and the Ecological System levels, although the final products included only Ecological Systems, with one exception: Wyoming big sagebrush was split from Basin big sagebrush types. This split was not identified in the Northwest ReGAP final product, to assure it matches the SW ReGAP maps, and those identified elsewhere in the U.S.

Plot samples were collected over one field season, by crews in Oregon, Washington and Idaho. All available plot data was collected before the sampling, and NatureServe worked with Oregon State University INR staff to identify the highest priorities for sampling. The model developed focused on the primary variables driving the distribution of Ecological Systems. Climate, topography, elevation, and distance from roads, along with some other variables were used to identify locations where were undersampled by the existing plots available to the mapping team, and which were close enough to an existing road to be sampled. Forested areas and non-vegetated areas were excluded from this analysis. Figure 3 shows the distribution and numbers of plots sampled as part of the SageMap process.

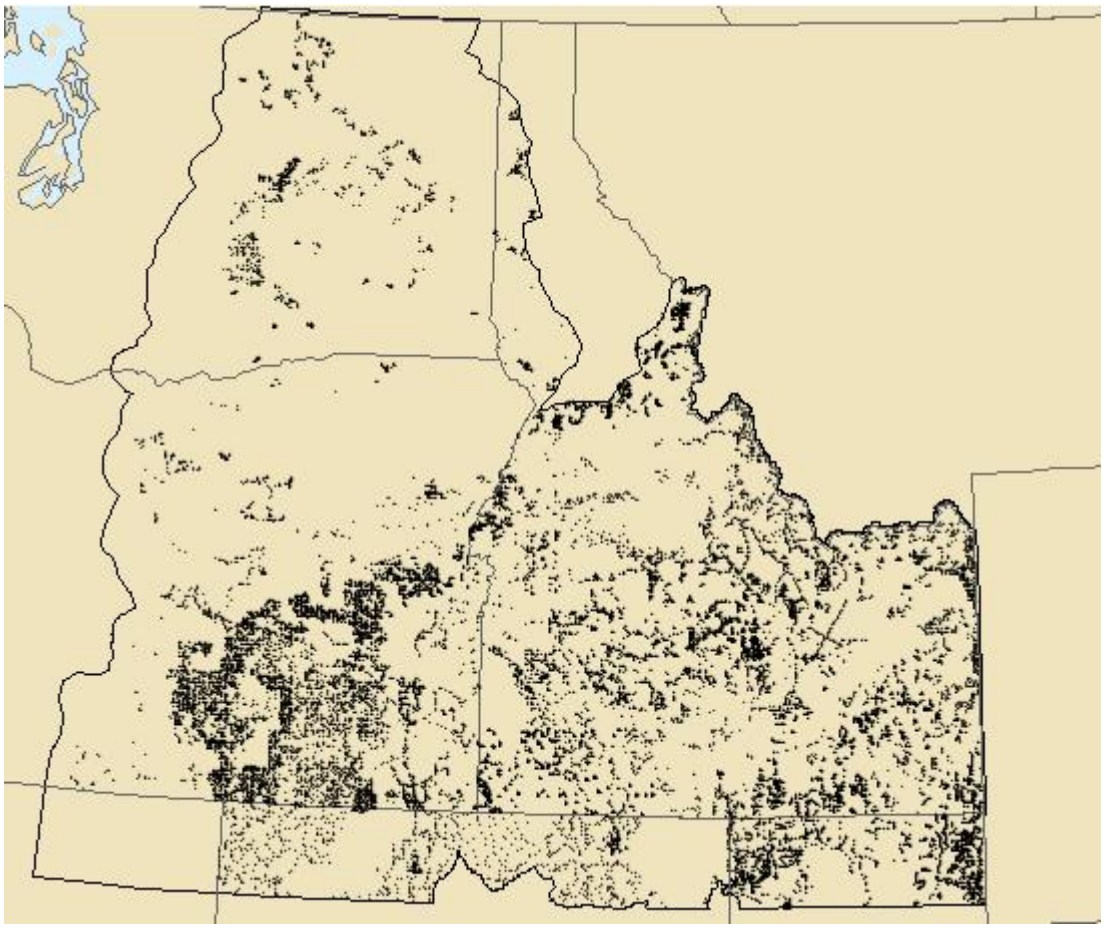

Figure 3. SageMap Plot Samples: Collected: 5,000, Existing: 16,000, Total: 21,000.

Land Cover Legend and Classification

The US National Vegetation Classification System (US-NVCS) has been adopted by the Federal Geographic Data Committee as the classification standard for all federal mapping projects (FGDC 1997) [1]. A nested hierarchical structure of the US-NVCS defines classification units at the highest levels as heterogeneous units based solely on vegetative physiognomy and at the

[1] The FGDC set standards and policy for vegetation classification and map products to enable agencies to collect, report and map vegetation information in a standard format (FGDC 1997). Although the policy for applying the standard is only through the formation level (physiognomy only), agencies are encouraged to aid in the development of the floristic alliance and the association levels (FGDC 1997, pg. 4, 7). FGDC recognized that mapping applications need to be based on the requirement of the project "The specific application of this standard to any mapping activities is dependent on the goals and objectives of the mapping activities…the classification standard merely sets a hierarchical list of classes that should be intelligently employed by the user based on the specifications and limitations of their particular mapping program" (FGDC 1997, pg. 9). Thus, the current FGDC standard is primarily for *describing and classifying* vegetation, whereas mapping units will reflect (1) the needs of the mapping project, (2) the technical tools, methods, and data available for mapping, and (3) the interactions of those factors with the vegetation classification concepts. The nested hierarchical structure was intended to ease applications of these classification concepts to the many and varied circumstances of vegetation mapping.

lower levels as more narrow and homogenous floristic units (figure 2). The upper physiognomic levels of the NVCS framework are adapted from the World Physiognomic Classification of Vegetation (UNESCO 1973) and later modified for application to the United States by Driscoll et al. (1983, 1984). The lower floristic levels (e.g. Alliance and Association) are based on both structural and compositional characteristics of vegetation derived by Mueller-Dombois and Ellenberg (1974). The Nature Conservancy, and now NatureServe—along with the network of Natural Heritage Programs—have worked with others since 1985 on the systematic development, documentation, and description of vegetation types across the United States (Grossman et al. 1994, 1998).

NatureServe and the Natural Heritage Network have been improving upon this system in recent years with significant funding supplied by GAP. Products from this on-going effort include a hierarchical vegetation classification standard (FGDC 1997) and the description of vegetation Alliances for the United States (Drake and Faber-Langendoen 1997, Reid et al. 1999, Sneddon et al. 1994, Weakley et al. 1996). An alliance is a physiognomically uniform group of Associations sharing one or more dominant or diagnostic species, that as a rule are found in the uppermost strata of the vegetation (see Mueller-Dombois and Ellenberg (1974). The basic assumptions and definitions for this system have been described by Jennings (1993) and Grossman et al. (1998).

All three of the projects used this classification, and the Ecological System was the unit for which all of the natural land cover classes were attributed. NatureServe assisted the team by providing consistent national codes integrating the Ecological System Classification for the natural and semi-natural land cover types with the land use types maintained as part of the National Land Cover Database.

Link to FGDC standard	***Hierarchy level***	***U.S. National Vegetation Classification***	***Ecological systems***
Included		Division Order	
Included	Physiognomic levels	Formation Class Formation Subclass Formation Group Formation Subgroup Formation	
Hierarchically linked			Ecological systems
Proposed	Floristic levels	Alliance Association	

Table 1. Hierarchical structure of the U.S. National Vegetation Classification and the linkage with ecological systems.

When the SW ReGAP project began in 1999, and the SageMap project in 2001, the intended thematic mapping unit was the NVC alliance. However, both projects recognized that too many alliances occurred in the large project areas. In SageMap, shrub steppe alliances were initially mapped, although the project found this level of detail impossible to map over the entire region. In response to this need, a regionally consistent meso-scale land cover legend, NatureServe developed the Terrestrial Ecological Systems Classification framework for the conterminous

United States (Comer et al. 2003). Ecological systems are defined as "groups of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates and/or environmental gradients" (Comer et al. 2003). Although distinct from the US-NVC, the vegetation component of an ecological system is described by one or more NVC alliances or associations, though this relationship is not strictly hierarchical. While the ecological system concept emphasizes existing dominant vegetation types, it also incorporates physical components such as landform position, substrates, hydrology, and climate. In this manner, ecological system descriptions are modular, having multiple diagnostic classifiers used to identify several ecological dimensions of the mapping unit (Di Gregorio and Jansen 2000). Diagnostic classifiers include environmental and biogeographic characteristics, which are incorporated in the ecological system name thus providing descriptive information about the system through a standardized naming convention. More detailed information about the Terrestrial Ecological Systems Classification for the United States is available at http://www.natureserve.org/publications/usEcologicalsystems.jsp.

NatureServe Terrestrial Ecological Systems present one approach for mapping efforts to comply with Federal Geographic Data Committee standards. They are defined in terms of the base units (alliances and associations) of the US-NVC, and may be readily attributed to upper-most levels of the FGDC hierarchy (e.g., Division, Order, Class, Subclass). We follow this approach by attributing all mapping units to NLCD land cover classes 1 and 2 which closely follow these upper FGDC levels. This approach facilitates application of these mapped data to these hierarchical levels.

The initial SW ReGAP target legend developed by NatureServe and the mapping teams identified approximately 110 potentially mappable ecological systems from the 140 that occur in the five-state region. Omitted ecological systems were mostly small patch (below minimum mapping unit) or peripheral to the region and lacked adequate training sites. The Terrestrial Ecological Systems Classification focuses on natural and semi-natural ecological communities. For SW ReGAP, altered and disturbed land cover and land use classes were considered separately. These classes were incorporated into the SW ReGAP legend using descriptions adopted from either the National Land Cover Dataset 2001 legend (e.g. Agriculture, Developed-Medium-High Intensity) (Homer et al. 2004) or were given special "altered or disturbed" designation within the SW ReGAP legend (e.g. recently burned, recently logged areas, invasive annual grassland, etc.). SageMap used these identical protocols. Complete descriptions of all of the ecological systems found in map zones 8, 9, 10, 19, and 20 was developed by NatureServe for the PNW Northwest ReGAP (NatureServe 2006). This was edited to remove those systems not found in the two map zones included in this project, and to reflect the classification as applied. This document is included as Appendix A.

The SageMap project also involved the development of a separate grid to map overall shrub cover. The grid was developed using the sum of the cover of all shrub species sampled in all the plots, and used to determine the breaks between the shrub-steppe, shrubland and grassland categories. Within the sagebrush shrubland ecological systems, overall shrub cover also provides a measure of habitat quality, with very high shrub cover generally corresponding to more impacted or lower quality sites. A separate grid was developed to distinguish a subset of the "altered or disturbed" vegetation, those with very high cover of exotic species. In particular,

introduced annual species, the most common of which is cheatgrass (*Bromus tectorum*) is widespread throughout map zones 8 and 9, and the SageMap area overall. So, a distinct grid showing the overall cover of annual exotic grasses, perennial exotic grasses (including the widely planted range forage species, crested wheatgrass (*Agropyron cristatum*), and exotic forbs was developed.

Land Cover Mapping Methods:

Data Sources:

Southwest ReGap

Seventy-nine Landsat Enhanced Thematic Mapper Plus (ETM+) scenes (Figure 2) provided complete coverage of the five-state region, and were acquired from the USGS National Center for Earth Resources Observation and Science (EROS) through the Multi-Resolution Land Characteristics Consortium (MRLC). Spring, summer, and fall images were provided, raising the total number of images to 237 for the region. Optimal imagery dates varied across the region and were selected for peak phenological differences as well as clarity and low cloud cover. Image acquisition dates ranged from 1999 to 2001. All ETM+ scenes were terrain-corrected and provided to Utah State University in NLAPS (National Landsat Archive Processing System) format.

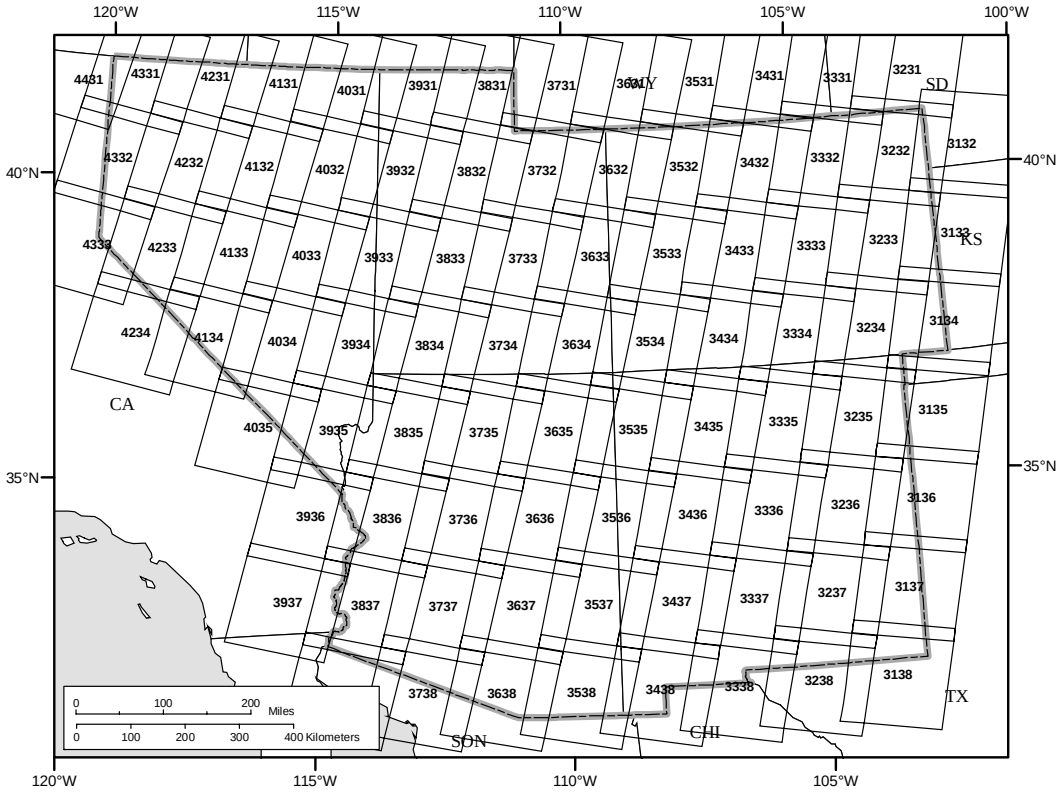

Figure 4. SWReGAP area showing Landsat ETM+ scenes

Our approach involved modeling image mosaics for each mapping zone (see Figure 1) including a 2 kilometer buffer (i.e. a 4 kilometer overlap between mapping zones). To improve image matching, image standardization for solar angle illumination, instrument calibration, and atmospheric haze (i.e. path radiance) was necessary. We determined the most practical approach was to use an image-based method as described by Chavez (1996). Standard protocol was to use a modified COST method (Chavez 1996). We found that using Chavez' COST method over-corrected atmospheric transmittance, particularly for scenes in the arid Southwest. To address this over-correction, we used COST without TAU_z (approximate atmospheric transmittance component of the COST equation). To facilitate image standardization, web-based scripts were developed to automate the process of generating corrected images on a scene-by-scene basis.

Spatial data layer preparation included both image-derived and ancillary data sets. Core image-derived data sets included individual ETM+ bands, the Normalized Difference Vegetation Index (NDVI), and brightness, greenness and wetness bands created using Landsat ETM+ coefficients from Huang et al. (2002). Ancillary data sets were derived from 30 meter digital elevation models (DEM) obtained from the USGS National Elevation Dataset. Digital elevation model-derived data sets were created for each mapping zone and included elevation, slope (in degrees), a 9-class aspect data set, and a 10-class landform data set (Manis et al. 2001). Other ancillary data sets prepared for the region, but not used, included a "stitch map" of 1:500,000 scale state geology digital maps, a soil data set (STATSGO), and 1 kilometer resolution meteorological data (DAYMET). These data sets were not used because their scale was determined to be incompatible with the core Landsat ETM+ and 30 meter DEM-derived data sets.

"Ground truth" data were collected primarily through ground-based field work. Field samples were collected by traversing navigable roads in a mapping zone and opportunistically selecting plots that met criteria of appropriate size (1-hectare minimum) and composition (stand homogeneity). Plot data were collected using ocular estimates of biotic and abiotic land cover elements, including percent cover of dominant species by life form (i.e. trees, shrubs, grasses, and forbs) and physical data such as elevation, slope, aspect and landform. Laptop computers using ArcView® software, Landsat imagery, digital orthophoto quads, and other ancillary information were also used for navigation and plot identification whenever possible. Each plot was identified with a paired UTM coordinate using a GPS and a visually interpreted polygon representing the survey plot. Generally two digital photos were taken at each plot. Field data were recorded onto hardcopy field forms and subsequently entered into a database. Sufficient data were collected to assign a NVC alliance (Grossman et al. 1998) and/or ecological system (Comer et al. 2003) label to each plot. Of an approximate total of 93,000 samples obtained for the project, roughly 45,000 were collected via ground surveys during the course of the two field seasons.

In addition to the SW ReGAP ground-truthed samples as described above, these data were supplemented with sample plot data obtained from other projects roughly contemporary with the time period of our imagery (1999-2001), and via visual interpretation of aerial photography, digital orthophoto quads, or other remotely sensed imagery. Samples obtained from visual interpretation of remotely sensed imagery were given only a label identifying the land cover class.

Land cover modeling was performed on a mapping zone by mapping zone basis with each mapping zone overlapping its adjacent mapping zone(s) with a 2 kilometer buffer (4 km overlap). The project's primary objective was to produce the most accurate and complete map possible. A detailed description of this, and the decision tree process, is included in the SW ReGAP final report (Lowry et al 2005).

SageMap

As mentioned previously, the SageMap process directly followed the SW Re-Gap procedures and methodology described above. The only differences in methodology related to the fact that SageMap made no attempt to model the distribution of a number of natural vegetation types which were not the primary focus of the map. Riparian vegetation was classed as a single type, as were all forest types. In addition, for two of the very minor SageMap mapzones, no accuracy assessment plots were excluded from the classification, since the overall plot dataset was so limited. For these map zones, alternative accuracy assessment methods were developed.

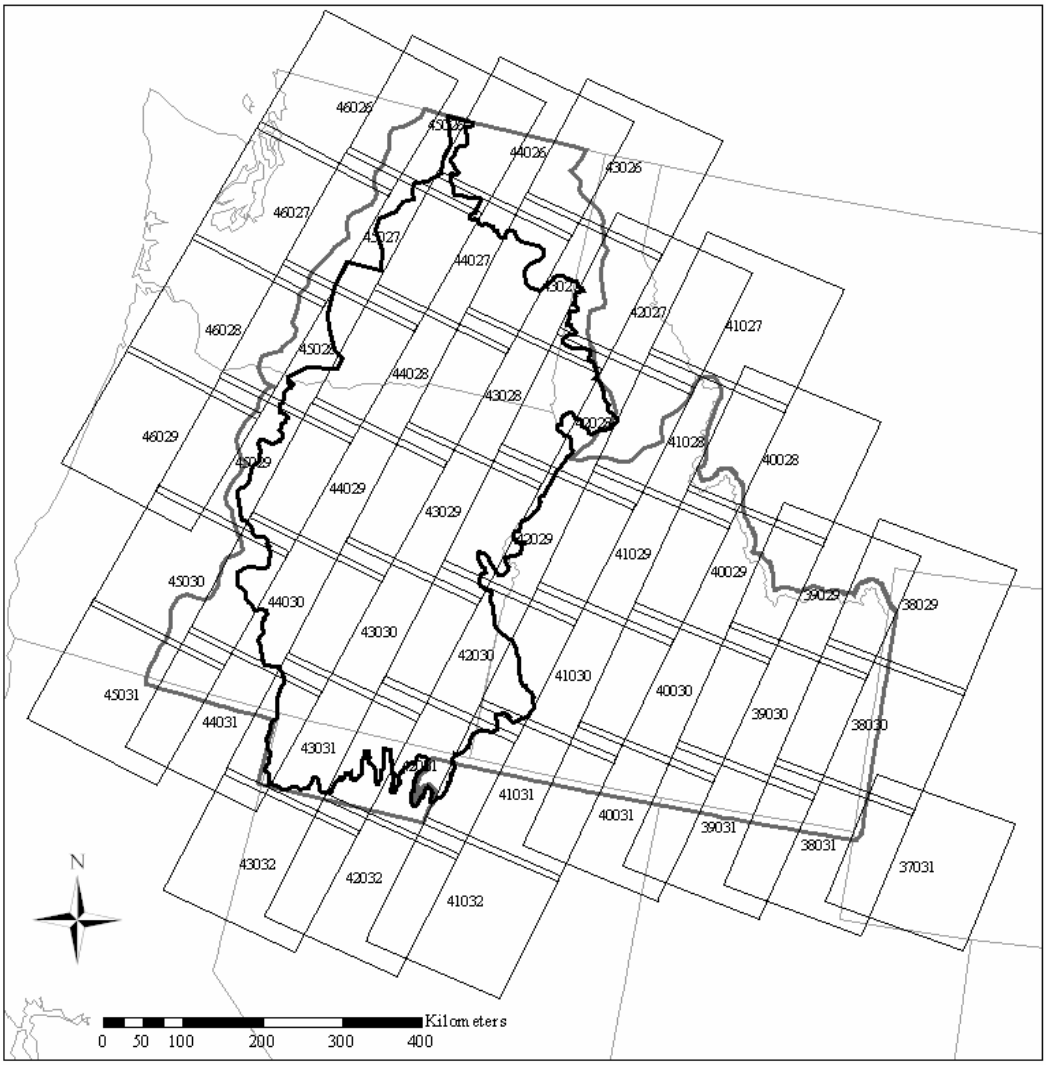

Figure 5. NW Re GAP and SageMap area showing Landsat ETM+ scenes

Image preparation of the LandSat requirements for the ORNHIC portion of mapping is composed of 96 image sets; 28 spring images, 34 summer images, and 30 fall images. Two early summer scenes (Path 43, Row 26, 27) were substituted for spring scenes where no adequate spring imagery was available. The additional summer and fall scenes that have multiple occurrences had similar cloud cover. To separate the image as the "best" scene of the pair we examined the range of values from the Tasseled cap (see Tasseled Cap section) greenness band and used the image set that displayed the greatest range between low and high values. Images were acquired from the USGS National Center for Earth Resources Observation and Science (EROS) through the Multi-Resolution Land Characteristics Consortium (MRLC). Optimal imagery dates varied across the region and were selected for peak phenological differences as well as clarity and low cloud cover. Image acquisition dates ranged from Sept 4, 1999 to June 8, 2003. Cloudy and smoke-obscured regions within the imagery were interpreted using adjacent imagery, where possible, or temporal overlap information to smooth the variance under the obscured portions

Figure 6. SageMap area showing Landsat ETM+ scenes

Image standardization was completed by EROS Data Center under the MRLC Preprocessing Procedure (Huang et al. 2001a). This transformation methodology is described by the equation:

$$\rho_{BandN} = (\Pi((DN_{Band} * Gain_{Band} + Bias_{BandN}) * D2) / (E_{BandN}(E_{BandN}(SIN\theta))$$

ρ_{BandN} = Reflectance for Band N
DN = Digital Number for Band N
D = Normalized Earth-Sun Distance
E_{BandN} = Solar Irradiance for Band N
θ = Solar Elevation
$Gain_{BandN}$ = Provided within header file, and band specific
$Bias_{BandN}$ = Provided within header file, and band specific

Elevation Dataset. Digital elevation model-derived data sets were created for each mapping zone and included elevation, slope (in degrees), a 9-class aspect data set, and a 10-class landform data set (Manis et al. 2001). Other ancillary data sets prepared for the region, but not used, included a "stitch map" of 1:500,000 scale state geology digital maps, a soil data set (STATSGO), and 1 kilometer resolution meteorological data (DAYMET). These data sets were not used because their scale was determined to be incompatible with the core Landsat ETM+ and 30 meter DEM-derived data sets.

"Ground truth" data were collected primarily through ground-based field work. Field samples were collected by traversing navigable roads in a mapping zone and opportunistically selecting plots that met criteria of appropriate size (1-hectare minimum) and composition (stand homogeneity). Plot data were collected using ocular estimates of biotic and abiotic land cover elements, including percent cover of dominant species by life form (i.e. trees, shrubs, grasses, and forbs) and physical data such as elevation, slope, aspect and landform. Laptop computers using ArcView® software, Landsat imagery, digital orthophoto quads, and other ancillary information were also used for navigation and plot identification whenever possible. Each plot

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In addition to the SageMap ground-truthed samples as described above, these data were supplemented with sample plot data obtained from other projects roughly contemporary with the time period of our imagery (1999-2001), and via visual interpretation of aerial photography, digital orthophoto quads, or other remotely sensed imagery. Samples obtained from visual interpretation of remotely sensed imagery were given only a label identifying the land cover class.

SageMap Classification Protocols

Vegetation patterns are an integrated reflection of the physical and chemical factors that shape the environment of a given land area (Whittaker 1965). They also are determinants for overall biological diversity patterns (Franklin 1993, Levin 1981, Noss 1990), and they can be used as a currency for habitat types in conservation evaluations (Specht 1975, Austin 1991). As such, dominant vegetation types need to be recognized over their entire ranges of distribution Bourgeron et al. 1994) for beta-scale analysis. The central concept of ecological system mapping is that the physiognomic and floristic characteristics of vegetation across the landscape can be used to define biologically meaningful, and biogeographic patterns, based upon not only spectral qualities of remote sensing, but the ecological systems location in the landscape. There are likely to be significant and considerable variation in the sub-canopy vegetation layers (community association) that are not resolved when mapping at the level of ecological system, and there is a need to address this part of the process with future mapping efforts. As information accumulates from field studies completed by Shrub Map and others such and the Bureau of Land Management, on patterns of variation in under story layers, it can be attributed to the mapped units of alliances or associations.

Land cover classifications must rely on specified attributes, such as the structural features of plants, their floristic composition, or environmental conditions, to consistently differentiate categories (Küchler and Zonneveld 1988). The criteria for a land cover classification system for SageMap are: (a) an ability to distinguish areas of different actual ecological systems based upon the dominate vegetation; (b) a suitability for use within and among biogeographic (Map Zones) regions; (c) applicability of Landsat Thematic Mapper (TM) imagery; (e) a framework that can interface with classification systems used by other organizations and nations to the greatest extent possible (see http://www.natureserve.org/explorer for current classification systems); and (g) a capability to fit, both categorically and spatially, with classifications of other themes such as agricultural and built environments.

Shrub cover represents a substantial factor in the variance observed in the targeted shrub communities. Sampling protocols followed by project teams (section 2a) required the collection of a visual estimate of percent coverage of individual shrub strata. Following similar methodology used in trial regions of SW-ReGap (Huang et. al 2003, Jennings et. al 2004) a

overall percent shrub cover was estimated for each training site (80%/20% training/validation). The total percent coverage is represented as a continuous surface at each site, and was reclassified to five categorical types following guidelines suggested by LandFire. The continuous surface was generated using an separate CART model.

Category	Range %
Very High	> 45%
High	36-45%
Moderate	26-35%
Steppe	11-25%
Grassland	<10%

SW ReGAP and SageMap - Land Cover Modeling Using Decision Tree Classifiers

Classification and regression trees (CART) were developed by Breiman et al. (1984) and were quickly recognized as a valuable tool for discriminating complex relationships among environmental variables (Verbyla 1987). Early spatial applications of decision trees for remote sensing-based land cover classification focused on continental and global scale mapping using coarse resolution imagery (Hansen et al. 1996, Friedl and Brodley 1997, DeFries et al. 1998, Friedl et al. 1999, Hansen et al. 2000, Friedl et al. 2002). More recently, decision tree classifiers have produced repeatable, accurate results in meso-scale mapping with Landsat Thematic Mapper imagery (Lawrence and Wright 2001, Brown de Colstoun et al. 2003, Pal and Mather 2003, Lawrence et al. 2004).

Decision tree classifiers are well suited for land cover mapping. First, as a non-parametric classifier, decision trees require no prior assumptions of normally distributed training data, which is useful as many land cover classes do not exhibit a normal distribution in spectral feature space. Second, while incorporating ancillary data sets can improve land cover class discrimination (Hutchinson 1982, Homer et al. 1997, Ricchetti 2000; Treitz and Howarth 2000), traditional parametric classifiers have difficulty dealing with differences in spectral and ancillary measurement scales. Decision trees readily accept a variety of measurement scales in addition to categorical variables. Decision tree classifiers have demonstrated improved accuracies over the use of traditional classifiers (Hansen et al. 1996, Pal and Mather 2003). Finally, decision tree software is readily available, computationally efficient, and by using a hierarchical approach to define decision rules, is intuitive to a variety of users.

Decision tree classifiers are considered an exploratory technique used to uncover structure in data (Breiman et al. 1984, Clark and Pregibon 1992). Decision trees use a binary partitioning algorithm to successively split a multidimensional “cloud” of explanatory data into increasingly homogenous subsets. Each binary split is considered a single rule in a chain of rules defining the characteristics of the response variable. Chains of rules can also be thought of as branches, with the final decision represented by a “leaf” or terminal node. For land cover mapping, explanatory variables are the spectral and ancillary data sets and the response variable is the land cover classes. Typically, decision trees recursively split the explanatory data set until no further splits are possible. Over-fitting the decision tree model in this manner usually requires “pruning” the tree, otherwise rules are generated for individual plots rather than groups of plots representing

land cover classes. The challenge with pruning is to establish optimal criteria so the final decision tree is neither too precise nor so general as to be meaningless.

As an alternative to pruning, "ensemble techniques" can be used to produce optimal trees. Ensemble techniques involve generating multiple trees to improve model accuracy and include "bagging" and "boosting" methods. With bagging, multiple trees are generated from randomly selected subsets of the data, where the final tree is produced from a majority "vote" by all the trees. Boosting similarly subsets the data, but generates multiple trees in succession focusing on branches of the tree that are most difficult to classify (based on misclassification rates). In this sense, boosting provides a way for an optimal tree to be generated by "learning" from previous tree models. This is an important benefit considering each split in a single, non-boosted decision tree determines all subsequent splits in the branch, some of which may be sub-optimal. Boosting, rather than bagging, has been more often employed for land cover mapping applications and has produced improved accuracies relative to non-boosted approaches (Pal and Mather 2003, Brown de Colstoun 2003, Lawrence et al. 2004).

A significant technical challenge with using decision trees for land cover mapping lies in the need to spatially apply the decision tree rules within a geographic information system. To successfully implement a boosted decision tree approach for such a large area among five separate teams, an effective tool for applying the decision trees in a spatially explicit context was imperative. Concurrent with our project, the USGS National Center for Earth Resources Observation and Science (EROS) began developing a land cover mapping tool capable of integrating the decision tree software See5/C5.0 (Quinlan 1993) with ERDAS Imagine. The tool, developed for the National Land-Cover Dataset 2001 (Homer et al. 2004) project (hereafter "NLCD mapping tool") provided the ideal solution to our need for an efficient integration of the decision tree software within a spatially explicit modeling environment.

Mapping Process

Land cover modeling was performed on a mapping zone by mapping zone basis with each mapping zone overlapping its adjacent mapping zone(s) with a 2 kilometer buffer (4 km overlap). The project's primary objective was to produce the most accurate and complete map possible. To accomplish this, our mapping procedures required steps we determined made best use of all available training samples. In general, this meant two things:

First, we would rely on the decision tree classifier to discriminate the bulk of the land cover classes. However, recognizing that the classifier had difficulty discriminating certain classes adequately, other methods were employed to map these classes. Natural land cover classes such as lava flows and sand dunes, which are relatively rare and/or isolated on the landscape, were typically not modeled with the decision tree, nor were anthropogenic classes such as recently chained areas, agriculture, or developed land uses.

Second, we conducted our assessment of map quality on an intermediate land cover map generated with a subset of samples rather than the final land cover map which was generated from 100 percent of the samples. We refer to this approach as an internal validation, which should not be confused with an accuracy assessment of the final map. The internal validation

involved randomly selecting 20 percent of available samples stratified by land cover class, and withholding them from the decision tree model generation. The intermediate map (generated with 80 percent of the available samples) was assessed with the 20 percent withheld dataset, producing an error matrix and kappa statistic. The land cover modeling process concluded with the generation of the final map using 100 percent of the available data. Validation results therefore represent an assessment of land cover maps created using 80 percent of the training data. No assessment of the final map produced from 100 percent of the data was made. Details of our validation approach are presented in the validation section of this chapter.

The following steps correspond with Figure 7 and describe the general mapping process in greater detail:

1) **Delineate non-modeled classes:** Delineate land cover classes anticipated to not be modeled with the decision tree classifier. These may include agriculture, developed, water, recently logged, chained, mined, etc. If GIS data exist, particularly for agriculture and developed classes, these may be used. Alternative methods for mapping these classes include screen digitizing and unsupervised clustering.

2) **Prepare explanatory data sets:** Explanatory data sets may be a combination of image- and DEM-derived data sets (see Data Sources). The choice of explanatory data sets may vary by mapping zone and is determined by the land cover analyst.

3) **Prepare sample data:** Sample data may be obtained from a number of sources (see Data Sources). All sample polygons are randomly divided into a training data set (80%) and validation data set (20%) using ArcView. The NLCD mapping tool requires individual pixels for sample observations. While each sample polygon is recognized as an independent observation, we use sub-samples (i.e. cluster sampling) within each polygon to account for spectral and environmental variability within the sample polygon. Sub-samples are randomly selected from each polygon with a maximum of 20 sub-samples per sample polygon using the Randpts extension (Jenness Enterprises 2005) in ArcView.

4) **Model land cover classes with decision tree classifier using 80% of sample data:** Using the NLCD mapping tool, explanatory variables are queried by the response variable data set to produce input files required by See5/C5.0. The decision tree model is created using the boosting option with 10 iterations in See5/C5.0. Output files from See5/C5.0 are spatially applied in Imagine using the NLCD mapping tool. Modeling is an iterative process. After model evaluation (see step 5 below) a different combination of explanatory data sets, or additional samples may be tried to improve the model. At this time the analyst decides which land cover classes are “mappable” given the availability of training data and the discriminating capabilities of the model. When model improvement reaches a point of diminishing returns, proceed to step 6.

5) **Internal validation of intermediate land cover map using 20% withheld sample data:** Model validation is only for those land cover classes being modeled with the decision tree. Using the 20% withheld sample polygons, use the ArcView Kappa extension (Garrard 2003) to create an error matrix and calculate the kappa statistic (Congalton 1991). The Kappa extension intersects the validation sample polygons through the completed map. When the mode (i.e. most frequent) value of pixels in the land cover map agree with the validation polygon label, the reference site is considered correctly mapped.

6) **Create final decision tree model and map using 100% of sample data:** This procedure is the same as step 4 with the exception that 100% of the sample data are used to generate the decision tree.

7) **Map refinement:** The land cover map produced in step 6 is carefully examined to determine where errors exist through a combination of visual examination and evaluation of the error matrix. The decision tree classifier may not have produced good decision rules for a number of possible reasons, such as not having an adequate number of samples for a given land cover class, not having sufficient samples in a given geographic region, or limitations of the explanatory data (spectral and/or ancillary) to discriminate between land cover classes. Known geographic errors can be fixed using Imagine's Recode utility and an *.aoi file. Known environmental errors (e.g. mapping on incorrect slope, elevation or aspect) can be fixed using a conditional statement in a post-classification model (e.g. Imagine *.gmd file). If possible additional sample plots for a geographic area or land cover class are added and the preceding steps repeated.

At this step, it is also possible to correct errors associated with clouds. For example, where clouds exist in one date of imagery but not in others, separate models can be run (see step 4) to correctly classify the land cover classes in the cloud covered areas. Using a conditional post-classification model replace the cloud covered pixels in the final map with those from an alternate decision tree model/map that was not as good overall, but was not impaired by cloud cover (e.g. model using imagery from one season rather than two).

Shrub Cover: Overall percent of shrub cover was described following Jennings et. al 2004. Overlap in the top three occurring shrubs strata where addressed by the following:

$$C_i = \left(1 - \prod_{j=1}^{n} \left(1 - \%\,\mathrm{cov}\ j/100\right)\right) * 100$$

where C_i is the percent cover of stratum i for species or growth form j in stratum i.

8) **Overlay non-modeled classes onto final land cover map:** Non-modeled classes retained from step 1 are converted to an Imagine file format, given the proper integer value, and combined (i.e. overlaid) with the map from step 7. This can be done with a conditional statement in an Imagine *.gmd model.

9) **Convert to minimum mapping unit:** Use Imagine's Clump and Eliminate functions to generalize the image to the minimum mapping unit (i.e. 1 acre). Parameters are set to use 4 connected neighbors for Clump and a minimum of 1 acre for Eliminate. When used together these steps eliminate clumps of 3 pixels or less, where the eliminated pixels assume the majority value of adjacent pixels.

10) **Edge-match to adjacent mapping zones:** Edge-matching requires that the integer values for land cover classes be standardized in accordance with SWReGAP Handbook guidelines (e.g. S001 has value 1, S112 has value 112, D05 has value 305, etc.). Once standardized, adjacent images are mosaiced using Imagine's Mosaic tool with cutline and overlap functions. Cutlines can be drawn as needed within the 4 km overlap area using an *.aoi file.

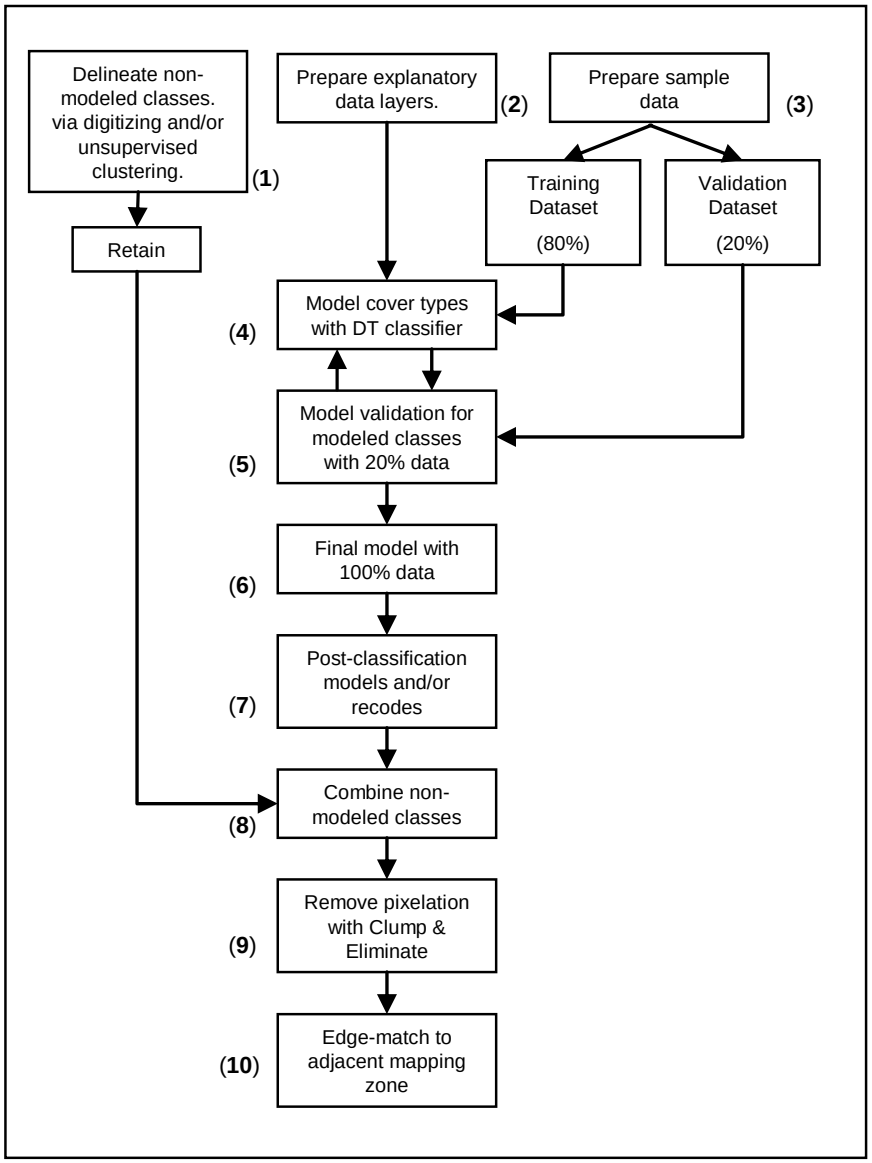

Figure 7. Overview of the NW ReGAP Mapping Process

Gradient Nearest Neighbor Imputation Process

Overview of the GNN Method

GNN uses multivariate gradient modeling to integrate data from regional grids of field plots with satellite imagery and mapped environmental data. A suite of fine-scale plot variables is imputed to each pixel in a digital map, and regional maps can be created for most of the same vegetation attributes available from the field plots. Key advantages of GNN maps are: efficiency in mapping large areas at fine spatial and attribute resolution; analytical flexibility provided by vegetation data at the basic level of tree species, sizes, and densities; representation of full range of variability in regional maps; maintenance of covariance structure of plant communities; and

transparency of methods and accuracy assessment. Although the GNN method has been proven in a variety of western forest ecosystems, most projects thus far have emphasized mapping of forest structure. See Ohmann and Gregory (2002) for detailed information about the GNN method. This project marks the first application of GNN to mapping Ecological Systems.

Plot Data used in GNN Modeling

We developed a relational database containing regional forest inventory plots across all of Oregon and Washington. The plot database is to be used in several mapping projects, including mapping of Ecological Systems for map zones 2 and 7 for GAP. Primary plot data sources are: (1) Most recent periodic inventories of the Forest Inventory and Analysis (FIA) Program, Pacific Northwest Research Station, USDA Forest Service (nonfederal lands), that are currently contained in the FIA Integrated Database (IDB); (2) all intensification and remeasurement plots of the Current Vegetation Survey (R6-CVS), USDA Forest Service, Pacific Northwest Region (on National Forest lands); (3) full intensification of CVS plots installed by the Bureau of Land Management in western Oregon (BLM-CVS). See Table 1 for a summary of plot data used in GNN modeling in this study. As one of our deliverables, we are providing a Microsoft Access database that contains key data tables for plots used in GNN modeling and mapping.

The locations of the FIA inventory plots are proprietary by law and cannot be released to other users or included in this final report or any of the deliverables. Our research using the plot locations is conducted under strict provisions outlined in a Memorandum of Understanding with FIA.

The GNN modeling was confined to areas defined as forest land (currently or with the potential to support at least 10% tree cover), including plots in woodlands (primarily western juniper and Oregon white oak). FIA does not collect field data on plot locations classified as nonforest.

Plots from the FIA Annual Inventory, which is not yet fully implemented, were not used in this study because the periodic plots were a more complete sample and a better temporal match to the 2001 MRLC imagery. Neither did we incorporate FIA plots established by the Rocky Mountain Research Station in the Idaho and Nevada parts of map zones 8 and 9. We were not given access to these plot locations until mid-April 2006, which was too late to incorporate the plots into our database and models. Nor did we use plots from the Landfire plot database in this study: our work schedule for map zones 8 and 9 was ahead of Landfire, our own version of the FIA and CVS plot data was more complete, and the Landfire data were formatted differently. The Landfire database did not contain the detailed tree-level data and potential vegetation information we planned to use in GNN model development and mapping.

Table 2. Number of forest condition plots used in GNN modeling in map zones 8 and 9.

Data source	Number of plots (forest classes)							
	Modeling region 1		Modeling region 2		Modeling region 3		Total*	
	Species	Struc-ture	Species	Struc-ture	Species	Struc-ture	Species	Struc-ture
FIA	157	173	453	485	96	102	660	711
R6-CVS	142	169	2,717	2,792	344	361	3,146	3,254
Total	299	342	3,170	3,277	440	463	3,806	3,965

* Rows do not sum to total because plots in buffer zone for modeling region boundaries can be used more than once.

Summary plot variables for Ecological System and forest condition

For GNN model development and mapping purposes, we derived a core set of summary variables from the basic tree data collected on the plots. All tree data summary and model development was at the level of the 'forest class,' which includes all forested parts of a field plot. A core set of summary vegetation variables is joined to our final GNN grids. These variables are described in Appendix B. At the time of this final report, we have not incorporated snags, down wood, or understory vegetation data into our regional plot database. These data will be added in the near future, and summary variables can be joined to the GNN imputation grid for forest structure modifiers of the Ecological Systems.

All forest plots were classified into one of the forest or woodland Ecological Systems that occur in map zones 8 and 9 (Appendix A). Numbers of plots by Ecological System and modeling region for the GNN species model are in Table 2. We developed a classification key based on summary variables in our plot database, the NatureServe descriptions of the Ecological Systems, draft sequence tables from Landfire, and expert opinion of ecologists (primarily J. Kagan and J. Ohmann). The classification key is in Appendix C. Classification was based primarily on relative abundances (basal area) of tree species, with some additional information on the potential vegetation type and geographic location (ecoregion) of the plot.

Table 3. Number of forest condition plots by Ecological Systems (ESLF code) and GNN modeling regions.

ESLF	Ecological System	MR1	MR2	MR3	TOTAL
4103	NRM Western Larch Savanna	5	83		88
4104	RM Aspen Forest and Woodland	6	4	11	21
4204	CP Western Juniper Woodland and Savanna		300	84	384
4205	EC Mesic Montane Mixed-Conifer Forest and Woodland	68	7		75
4228	NP Mountain Hemlock Forest		3		3
4232	NRM Dry-Mesic Montane Mixed Conifer Forest	60	1252	95	1407
4233	NRM Subalpine Woodland and Parkland		43	1	44
4234	NRM Mesic Montane Mixed Conifer Forest		70		70
4237	RM Lodgepole Pine Forest	5	47	37	89
4240	NRM Ponderosa Pine Woodland and Savanna	90	701	204	995
4242	RM Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	3	91		94
4243	RM Subalpine Mesic Spruce-Fir Forest and Woodland	3	26		29
4244	RM Subalpine-Montane Limber-Bristlecone Pine Woodland		17		17
4266	MRM Montane Douglas-fir Forest and Woodland	31	465		496
4267	RM Poor Site Lodgepole Pine Forest	1	24	5	30
4301	EC Oak-Ponderosa Pine Forest and Woodland	22	29		51
4303	IMB Mountain Mahogany Woodland and Shrubland		3	2	5
9170	CB Foothill Riparian Woodland and Shrubland	4	5		9
9190	NP Hardwood-Conifer Swamp	1		1	2
Total		299	3170	440	3909

Ecological System geographic abbreviations: EC = Eastern Cascades, CP = Columbia Plateau, NP = North Pacific, RM = Rocky Mountain, MRM = Middle Rocky Mountain, NRM = Northern Rocky Mountain, IMB = Inter-Mountain Basins.

Spatial Data Used in Gradient Modeling

All spatial data used in GNN modeling were georegistered, clipped to a rectangle encompassing map zones 8 and 9 with a 10-km buffer, and resampled to 30 m. All spatial data are provided as ArcGIS grids in the national Albers projection, datum NAD 1983, Spheroid GRS 1980. The plot locations were intersected with the spatial data layers in GIS, and values for the explanatory variables were assigned to the plots. Plots were represented using multi-pixel ‘footprints’ that match the actual plot layout on the ground (typically about 1 hectare) as closely as possible. Spatial variables used in modeling are shown in Table 3.

Table 4. Environmental and spectral variables used in GNN gradient models of forest composition (species model) and structure (structure model).

Variable	Species model	Structure model	Description
ANNPRE	X	X	Annual precipitation (natural logarithm mm) (scaled * 1000 and converted to integer)
ANNSWRAD	X	X	Annual sum of total daily incident shortwave radiative flux (MJ^{-2} day^{-1}) (scaled * 10 and converted to integer)
ANNVP	X	X	Annual vapor pressure (scaled * 10 and converted to integer)
AUGMAXT	X	X	Mean August maximum temperature (degrees C) (scaled * 100 and converted to integer)
CONTPRE	X	X	Percentage of annual precipitation falling in June-August (scaled * 1000 and converted to integer)
DECMINT	X	X	Mean December minimum temperature (degrees C) (scaled * 1000 and converted to integer)
SMRTP	X	X	Growing season moisture stress (ratio of temperature to precipitation from May-September) (scaled * 1000 and converted to integer)
DEM	X	X	Elevation (m)
MLI	X	X	McComb's Landform Index (*http://scholar.lib.vt.edu/theses/available/etd-62897-155656/unrestricted/whole2.pdf*)
PRR	X	X	Potential relative radiation
SLPPCT	X	X	Slope (percent) (rounded to nearest integer)
TPI450	X	X	Topographic position index, calculated as difference between cell's elevation and mean elevation of cells within a 450-m-radius window
X			X location (longitude), computed as an index
Y			Y location (latitude), computed as an index
MTCSMR1		X	Landsat ETM tasseled cap transformation axis 1 (brightness), median-filtered, summer 2001 imagery
MTCSMR2		X	Landsat ETM tasseled cap transformation axis 2 (greenness), median-filtered, summer 2001 imagery

MTCSMR3		X	Landsat ETM tasseled cap transformation axis 1 (wetness), median-filtered, summer 2001 imagery
MTCFAL1			Landsat ETM tasseled cap transformation axis 1 (brightness), median-filtered, fall 2001 imagery (available for modeling regions 2 and 3 only)
MTCFAL2			Landsat ETM tasseled cap transformation axis 2 (greenness), median-filtered, fall 2001 imagery (available for modeling regions 2 and 3 only)
MTCFAL3			Landsat ETM tasseled cap transformation axis 3 (wetness), median-filtered, fall 2001 imagery (available for modeling regions 2 and 3 only)
MNDVISMR		X	Normalized Difference Vegetation Index, median-filtered, summer 2001 imagery
MNDVIFAL			Normalized Difference Vegetation Index, median-filtered, fall 2001 imagery (available for modeling regions 2 and 3 only)
ADTCSMR1			Absolute difference texture measure of unfiltered *TCSMR1*
ADTCSMR2			Absolute difference texture measure of unfiltered *TCSMR2*
ADTCSMR3			Absolute difference texture measure of unfiltered *TCSMR3*
ADTCFAL1			Absolute difference texture measure of unfiltered *TCFAL1* (available for modeling regions 2 and 3 only)
ADTCFAL2			Absolute difference texture measure of unfiltered *TCFAL2* (available for modeling regions 2 and 3 only)
ADTCFAL3			Absolute difference texture measure of unfiltered *TCFAL3* (available for modeling regions 2 and 3 only)

Mapped Data on Physical Environment

We developed spatial data layers for several measures of climate, topography, and solar radiation (Table 3). All climate variables were derived from DayMet data (*www.daymet.org*). All topographic variables were derived from 10-m-resolution digital elevation models (DEMs) that were resampled to 30-m resolution. We did not use soils data because SSURGO coverage was incomplete for the study area, and STATSGO data are too coarse for modeling at the plot level.

Mapped Data on Disturbance History

We were unable to locate spatial data on disturbance history that were complete and consistent across the two map zones that could be used in GNN modeling. Maps of forest disturbance, including timber harvest, were available only for the Oregon portion of map zones 8 and 9, but these data were not available until late in our modeling process. These data were developed by Sanborn based on analysis of multi-temporal LANDSAT imagery. Maps of fire history, such as fire perimeters or fire severity, were available only for particular geographic areas or land ownerships. Data on cumulative insect- and disease-caused mortality, developed from aerial surveys from 1980-2002, are available for map zones 8 and 9, but were not incorporated into the GNN models.

Landsat Imagery

We used 2001 Landsat ETM satellite imagery that was processed and mosaicked by the Remote Sensing Applications Center (RSAC) of the USDA Forest Service (*www.fs.fed.us/eng/rsac/*). For GNN modeling, we used the first three axes of the tasseled cap transformation and the normalized difference vegetation index, based on imagery that was median-filtered to reduce fine-scale heterogeneity while preserving distinct vegetation boundaries (Table 3). We used the imagery mosaics developed by RSAC because of past negative experience with GNN models developed from Landsat scenes that are not radiometrically normalized. Boundaries between scenes are quite prominent in resulting GNN maps.

One image mosaic was created using summer imagery for all of map zones 8 and 9, and a second mosaic using fall imagery for map zone 9 only. The fall imagery was available only for our GNN modeling regions 2 and 3, which encompass most of the forest land in map zones 8 and 9 (Figure 8). The following description of methods was provided by RSAC.

Each mosaic was created using a scene calibration technique where the values of what we termed the ‘slave’ image are recomputed to match similar statistics of the ‘master’ image. The first step in this calibration technique is to calculate the statistics of two scenes in an adjoining area. The slave image is then processed through an algorithm using the common statistics of each scene resulting in a calibrated image that can then be mosaicked to the master scene. This process is repeated for each slave scene which creates a new master scene for the next slave image to be calibrated against. This process was also used on individual scenes which needed data replacement due to clouds and cloud shadows. Areas of clouds and cloud shadows in the primary scenes were replaced with data from secondary scenes. For the summer mosaic, scenes were primarily from July and August of 2001 and 2002. For the fall mosaic, scenes were primarily from September and October of 1999-2001.

Steps in the mosaicking were as follows: (1) Adjacent scenes acquired on the same date were mosaicked together and used as a single scene. (2) All scenes (with minor exceptions) were converted from digital numbers (DN) to radiance. (3) Areas of cloud and cloud shadow in primary scenes were replaced with data from secondary scenes after calibrating secondary scenes to the primary scenes as described above. (4) The entire region was mosaicked.

Three GNN Modeling Regions

For GNN modeling, we divided the two map zones into three modeling regions, referred to as MR1, MR2, and MR3 (Figure 8), which roughly follow major ecoregions. Most of the forest land in map zones 8 and 9 is in the Blue Mountains ecoregion, which is encompassed in our MR2. Each modeling region included a 10-km buffer, in order to include plots within a reasonable distance and avoid introducing a perimeter of weaker data inside the modeling region boundaries. Spatial predictions for the three MRs were clipped to the MR boundaries and mosaicked to create the two final GNN maps.

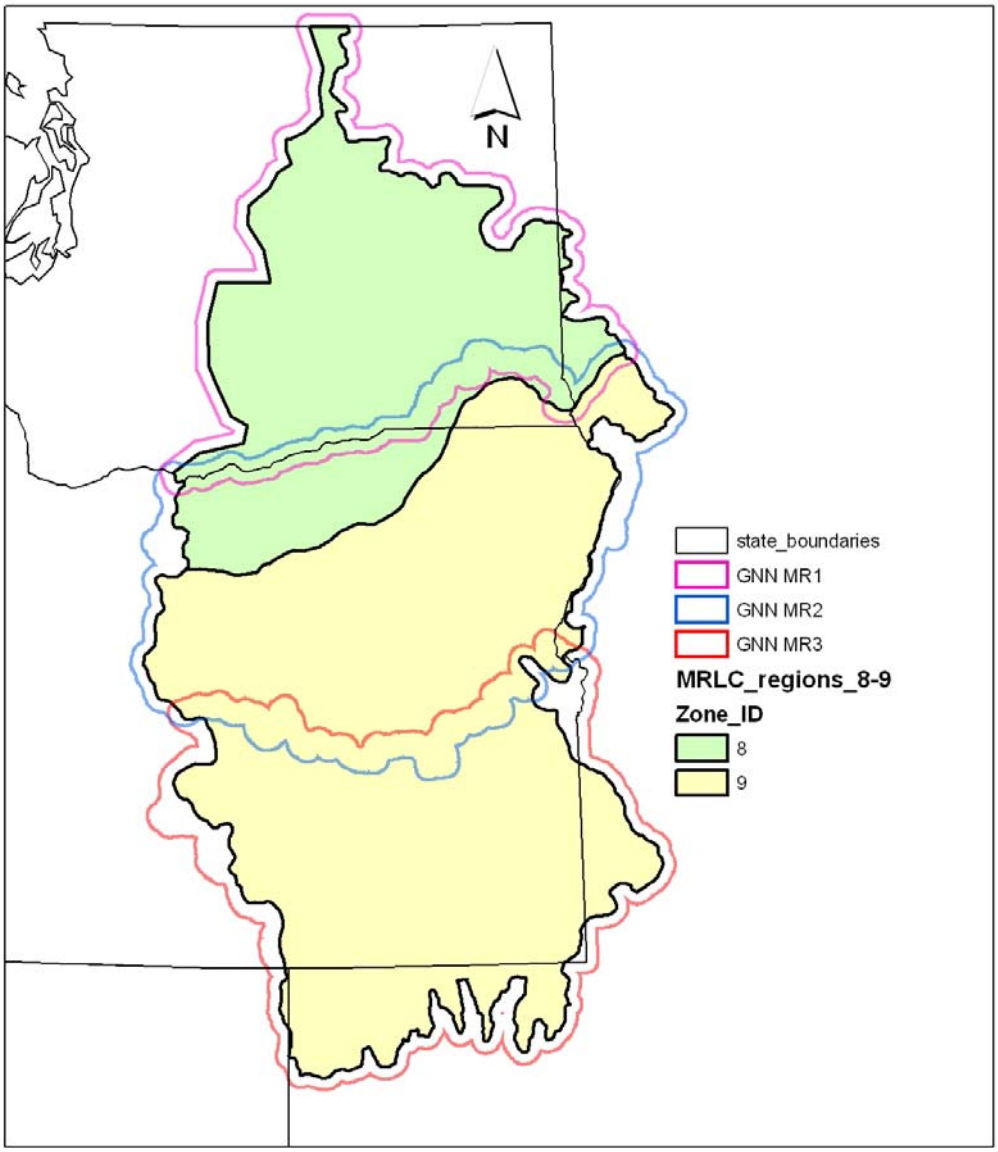

Figure 8. Gradient Nearest Neighbor (GNN) modeling regions (MR1, MR2, and MR3) in map zones 8 and 9.

GNN Species and Structure Models

We developed two multivariate gradient models using canonical correspondence analysis (CCA) (ter Braak 1986), one optimized for predicting species composition (referred to as the 'species model') and one for forest structure (the 'structure model'). We tested and refined many alternative models before selecting the two models provided as deliverables.

In the GNN species model, response (dependent) variables in CCA model development were basal area by tree species. Plots with no trees tallied on them ('no tally' plots) were excluded from the model. Explanatory (independent) variables included measures of physical environment (Table 3), but no variables derived from Landsat imagery, which lower GNN prediction accuracy for individual tree species and plant communities (Ohmann et al., in press). The GNN species model was the basis for the map of forest and woodland Ecological Systems, which are defined floristically.

In the GNN structure model, response variables in CCA model development were basal area by tree species and size-class. Several species-size-class combinations were lumped where frequency of occurrence was low. Explanatory variables included measures of physical environment as well as Landsat-derived variables (Table 3). The GNN map based on the structure model should be used for measures of forest structure variables, which can be used as 'modifiers' of the forested Ecological Systems. Vegetation variables joined to the GNN structure grid are described in Appendix B.

Integrating GNN and SageMap into a Seamless Map of Ecological Systems

The GNN maps for the three modeling regions were clipped to modeling region boundaries and mosaicked into a single GNN map of forest Ecological Systems for map zones 8 and 9. Seams between modeling regions were examined for discontinuities in the GNN predictions, and no problems were found after masking areas of nonforest. Modeling regions were constructed such that most boundaries are in nonforest areas where the GNN models don't apply.

We integrated the GNN and ORNHIC component maps into a single map of all Ecological Systems and land cover. The component grids are listed below in the order that they were merged together:

junsav30 - ORNHIC juniper savanna (ESLF 5404)
mahogany30 - ORNHIC mountain mahogany (ESLF 4303)
aspen30 - ORNHIC aspen in the BLM's Burns District (ESLF 4104)
nwregap30 - ORNHIC "nonforest" grid (all ESs not mapped with GNN)
gnn30 - GNN "forest" grid

Zones 8 and 9 PNW ReGAP Process

For the production of the final grid, the first step included updating the SageMap grid using CART, deductive and imputation models to address only those classes which had not be included in the initial grid. These types were included by updating the list of potential ecological systems which occurred in the map zone. The list of systems had been updated primarily as a result of two workshops which were part of the U.S. Forest Service LandFire (http://www.landfire.gov) process. The types included primarily barren ecological system types: three cliff and canyon ecological systems found in the zones, two mountain rock and massif systems, a sand dune system, and lava flows. These were modeled or mapped separately, based on a series of data points collected from plots, or polygons collected by the Bureau of Land Management, the Oregon Natural Heritage Information Center, and the Washington Natural Heritage Program. Additional points were created using the imagery and known points from expert judgment of primary staff. Details on the process are still in the overall metadata. One sagebrush type, silver sagebrush, was overpredicted in both the southern and northern parts of the overall areas, so this type was remodeled and remapped, with the original results used for the eastern portions, but the available plot data and polygon data restricting the areas in majority of the Northern Basin and Range Ecoregion, in which it is most commonly found. Finally, both salt desert scrub and black greasewood vegetation types were significantly under-mapped in SageMap in the Northern Basin and Range Ecoregion of Oregon (although well mapped elsewhere in the grid). The error was a result of many of these plots having a small amount of Wyoming big sagebrush, which caused them to be incorrectly attributed to a sagebrush shrubland ecological system. These two types were remapped using the 1:24,000 Bureau of Land Management ESI coverage as the basis of the training.

We also developed a separate riparian model for both map zones. The primary data set was a comprehensive database of riparian plots complied for a classification effort covering eastern Oregon and adjacent Washington and Idaho (Crowe et al 2004). We also included riparian plots from the Idaho Conservation Data Center and the Washington Natural Heritage Program. The modeling used a landform model, a 1:24,000 stream order coverage limited to perennial streams, and the imagery to map riparian systems. This separate grid was added to the updated SageMap coverage on top of the other information, but in place of any existing “riparian” labeled polygons. The final step was to check the final grid, by ecoregion, for errors, omissions, and inconsistencies. This step involved reclassing some inappropriate landcover types into natural or semi-natural ecological system types. It included addressing problems related to the model placing Ecological Systems outside of their natural occurring ranges, and errors caused by mislabeling plots. Lastly, quaking aspen (*Populus tremuloides*) stands from the ESI polygon coverage were directly attributed into the SageMap coverage, since these had neither been mapped or modeled, and insufficient plot data was available for use in the overall GNN modeling process.

Land Cover Mapping and GNN Modeling Results

Products from GNN Modeling

We are providing the following products on a DVD. All maps are ArcGIS grids, at 30 m resolution, in national Albers projection. FGDC metadata was still under development at the time of this writing, but all aspects of the GNN component of the maps is documented in this final report.

- Final draft of the integrated grid of Ecological Systems and landcover for map zones 8 and 9, and all component grids used in its development.
- Final draft GNN species model (grid) for map zones 8 and 9, unmasked, with joined Ecological System code. Areas of nonforest must be masked from the GNN grid before use.
- Final draft GNN structure model (grid) for map zones 8 and 9, unmasked, with joined 'modifier' variables on forest structure. Areas of nonforest must be masked from the GNN grid before use.
- Canoco output and solution files for all gradient models, developed using canonical correpondence analysis.
- Maps of nearest-neighbor distance for all GNN models.
- Accuracy assessment products for all GNN models (see detailed list below).
- Microsoft Access database containing plot variables used in GNN model development, classification of Ecological Systems, 'modifiers' joined to the GNN structure model, and several other variables. Metadata for the plots is contained in tables within the database. Only those forest plots used in GNN modeling are included, and all data are at the forest class level of data summary.

GNN Imputation Maps

The value in the GNN imputation grids is a unique plot number that links to the plot database. Selected vegetation variables from the plot database are joined as items in the grids to facilitate viewing and analysis. Descriptions of the vegetation variables are in Appendix B and in the provided plot database. Although we are providing both masked and unmasked versions of the two GNN models, the GNN maps are applicable only to areas of forest and woodland with at least 10% tree cover. The GNN maps always should be combined with maps of nonforest before use. We are providing the unmasked versions of our models in case updates are made to the nonforest component of the Ecological Systems map of these map zones, and for users who want to apply land cover masks from alternative sources. The masked versions of the GNN models are masked with the most recent draft of the nonforest Ecological Systems and land cover.

SageMap Results

Mapping Exotic Grasses and Forbs for SageMap

The installation and propagation of plant species outside of their natural and historical range has become a world-wide problem. Whether introduced purposefully or accidentally, exotic species can wreck havoc on ecosystems by competing with the native flora for resources or by physically impacting other plant species (e.g., choking). Governments and environmental organizations are spending a great deal of effort trying to eradicate such invasive species, while recognizing that acting early, before the weeds are firmly established, is the best form of control.

Knowing the distribution and abundance of exotics is one of the first steps towards weed control. The past decade has seen the multiplication of studies using remote sensing to map vegetation, including exotic species. Satellite images can be obtained over large areas, including roadless and remote places; such regional scale analysis is extremely useful in monitoring weed spread and change over time (McGowen et al. 2001). Reflectance data can also be purchased for different dates within a year, an important feature as certain species will have characteristic reflectance values over a specific period. Manipulated into indices, and combined with topographic variables, satellite images have proven useful for weed mapping (Goel 2003, Gumz and Weller 2005).

The American West has its share of exotics, from annual grasses to perennial forbs, making the spread of invasives in western wildlands "a state of biological emergency" (Asher and Spurrier 1998). Because of the threat that cheatgrass (*Bromus tectorum*) poses to native plant communities, generating predictive models of its distribution has received significant effort recently. In Nevada, Peterson (2003) used a combination of satellite-derived data and topographical data in a tobit regression model; in Idaho, Linear Spectral Unmixing provided the models (PNWRC 2004). In this study, we use a combination of satellite-derived data and topographical variables in classification and regression tree (CART) models to generate predictive maps of invasive annual grasses, perennial grasses, and perennial forbs in a large area of the northwestern United States.

Mapping was conducted for 34,537,664 ha in Washington, Oregon, California, Idaho, Utah and Nevada (Fig. 2). This area corresponds to USGS map zones 8, 9 and 18; the coarse USGS boundaries were somewhat modified to follow The Nature Conservancy's more detailed ecoregional boundaries. Vegetation in this area has undergone extensive changes over the last 150 years, with up to 85 percent of the former sagebrush steppe, Palouse grassland, and riparian communities being converted to dry land wheat, irrigated agriculture, and sites dominated by exotic species; the continued introduction of new non-native species threatens the remaining native vegetation (USGS 2005).

For modeling proposes, this large area was split into four separate map zones, 1) north (Columbia Basin and USGS MZ 8), 2) central (Blue Mountains), 3) south (Northern Basin and Range), and 4) Owyhee Uplands. Such a partitioning has been shown to improve classification accuracy of vegetation types (USGS 2005); it also reflects true differences in weed composition and improves the speed of the modeling process. To improve edgematching, map zone

boundaries were buffered by 10 km going south for the center zone, going south for the north zone, and all around for the Owyhee zone.

Image-derived datasets

Reflectance: Principal Component Analysis (PCA) was performed on Spring, Summer and Fall images using the Principal Components Tool of ArcMap 9.1 (ESRI 2004). Only the first three components were used as independent variables as they accounted for more than 97% of the variance in each zone.

Tasseled cap: after obtaining tasseled cap images using Imagine, PCA was performed as for reflectance; again the first three components explained more than 97% of the variance in each zone.

TNDVI: a Transformed Normalized Difference Vegetation Index was computed for Spring, Summer and Fall using the Indices tool of the Spectral Enhancement menu in Imagine. TNDVI = sqrt((band4 – band3 / band4 + band3) + 0.5).

DEM-derived datasets: Thirty-meter digital elevation models from the EROS Data Center, National Elevation Database (NED) were mosaicked and clipped to each map zone. Slope (in degrees) and aspect were derived from the DEM using the Topographic Analysis Tool of ERDAS Imagine 8.7 (Leica Geosystems 2003).

A 10-class landform grid was created using an Arc/Info AML created by G. Manis for the Southwest Regional Gap Project (Manis et al. 2001). It partitions the landscape into ten classes of valley flats, slopes, and cliffs.

Squared datasets

Squared datasets were obtained in ArcMap 9.1 by multiplying each image with itself for the following variables: elevation, slope, aspect, PCA reflectance, PCA tasseled cap, and TNDVI.

Shrub cover

Although not statistically significant, there was a negative correlation between percent weed cover (Y axis) and percent shrub cover (X axis; 0 = 0%, 1 <= 10%, 11 < 2 <=25%, 26 < 3 <=35%, 36 < 4 <= 45%, 5 > 45%), as shown in the following box-plot (obtained from the R statistical package; R Project (http://www.r-project.org/).

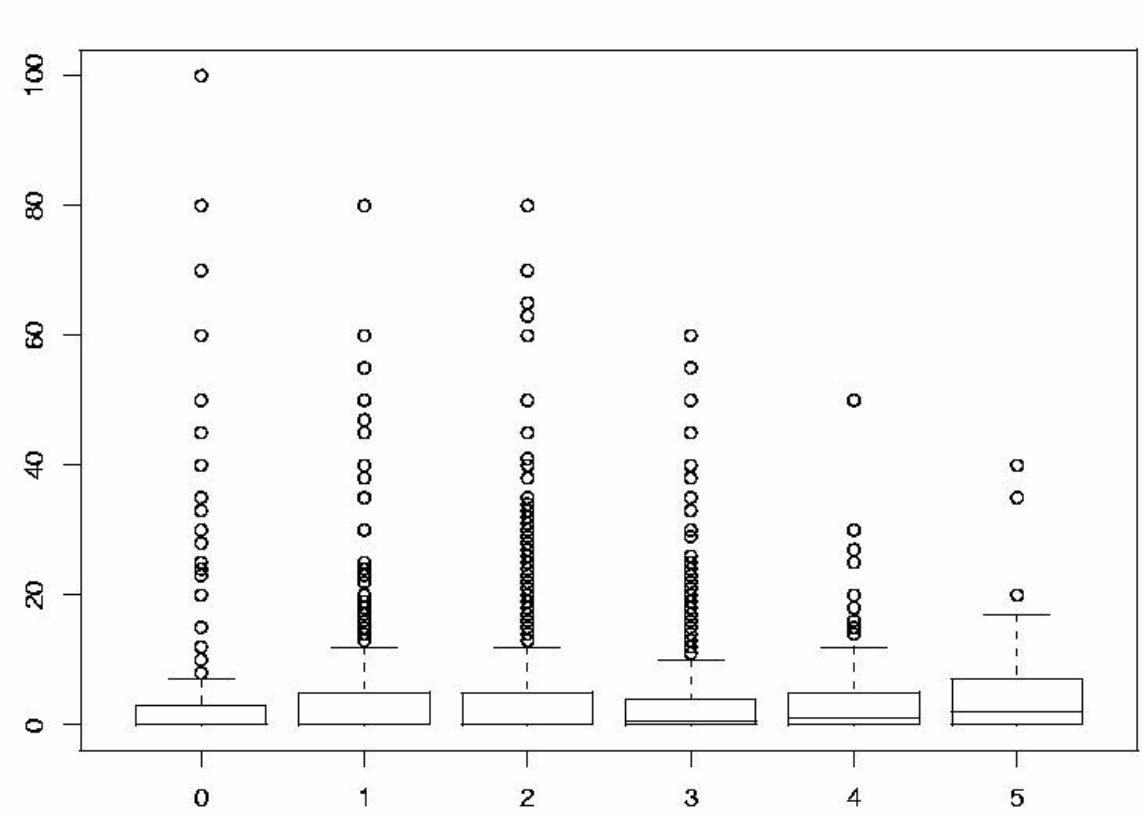

Figure 9. Box Plot of 6 classes of overall shrub cover

Percent shrub cover, using the 6 categories listed above, was obtained from SageMap (a map of current distribution of sagebrush and associated vegetation in the Columbia Basin and southwest regions; USGS 2005) and used as an additional variable in the models.

Weed data

Plots listing the composition and percent cover of invasive species were obtained as points or as polygons from a variety of sources:

Source	N	Type
Burns BLM	5098	Points
Lakeview BLM, north	2351	Points
Lakeview BLM, south	2444	Polygons
Nevada NHP	130	Points
SageMap (OR, WA, ID, NV)	1786	Polygons

Pseudo-replication within SageMap polygons was conducted in order to increase the number of samples used by the classification algorithm. This type of non-independent data has been found to improve classification accuracies, and allowed to take advantage of the known quality of the SageMap samples. Sub-sampling was not done with South Lakeview data (only the polygon centroids were used). Five to ten random points were placed within each SageMap polygon using the ArcMap Hawth's Tools extension.

Three categories of weeds were modeled: annual grasses, perennial grasses, and perennial forbs. Percent cover of annual grasses, perennial grasses, and perennial forbs were obtained at each point by adding percent cover of each species within each weed category. The following tables lists species names along with the number of samples in which they occurred (after sub-sampling SageMap data).

Scientific name	Common name	South	Center	North	Owyhee
Annual grasses					
Bromus	Brome	21	7		
Bromus hordeaceus	Soft brome	20	20		20
Bromus japonicus	Japanese brome	49	81	37	15
Bromus tectorum	Cheatgrass	7789	3084	884	2438
Taeniatherum caput-medusae	Medusahead	60	180	231	100
Perennial grasses					
Agropyron cristatum	Crested wheatgrass	886	447	47	1312
Bromus inermis	Smooth brome	1			
Phleum pratense	Timothy				10
Poa bulbosa	Bulbous bluegrass	300	342	217	746
Poa pratensis	Kentucky bluegrass	26			95
Ventenata dubia	North Africa grass		80		
Forbs					
Cirsium arvense	Canada thistle				10
Cirsium vulgare	Bull thistle				10
Descurainia pinnata	Western tansymustard	283	25		10
Dipsacus fullonum	Fuller's teasel		10		
Halogeton glomeratus	Saltlover	23			
Holosteum umbellatum	Jagged chickweed	10			
Kochia scoparia	Mexican fireweed	25	10		5
Lepidium latifolium	Broadleaved pepperweed	5			
Medicago sativa	alfalfa				15
Melilotus officinalis	Yellow sweetclover	5	1		
Salsola tragus	Prickly Russian thistle	377	6		25
Sisymbrium altissimum	Tall tumblemustard	110	28	40	131
Taraxacum officinale	Dandelion	20	7		10
Thlaspi arvense	Field pennycress				5
Tragopogon dubius	Yellow salsify	60	12		50
Trifolium repens	White clover				5
Verbascum thapsus	Common mullein	12	4		

Cheatgrass largely dominated annual grasses in all map zones; crested wheatgrass and bulbous bluegrass were the most common perennial grasses, with an increase in bluegrass and a decrease in wheatgrass as one progresses north. Western tansymustard and tall tumblemustard dominated the forbs.

Image classification and accuracy assessment for weeds

A CART model was generated for each weed category, for each map zone. Tree methods are non-parametric and non-linear, fast to train, and as or even more accurate than other classifiers (Homer et al. 2004). All the base spectral and biophysical layers were entered in Erdas Imagine's

NLCD Sampling Tool to generate the input files required by See5, a data-mining tool where decision trees were created using a 10-classifier boosting (Rulequest 2004). Predictive maps were generated by applying these rule sets to the input images in Imagine's NLCD Classifier Tool.

Categorization: Percent weed cover in each category (annual grasses, perennial grasses, perennial forbs) was converted from continuous to categorical data using Idaho State University's cheatgrass cover classes (PNWRC 2004): 0% (1), 0.5 - 5% (2), 6 - 15% (3), 16 - 25% (4), > 25% (5). Only 3 classes were used to recode perennial forb cover though, because of small sample sizes: 0% (1), 0.5 – 15% (2), > 15% (3).

Raining and validation data: CART models require zero data, i.e., points with no weeds (or "suspected weed absence"); however, a disproportionately large number of zeros can lead to poor predictive results. When the number of zeros was less than five times the number of points with weeds, models were developed with 80% of the data; the remaining 20% were set aside for validation. When there were too many zeros (for example, when modeling perennial forbs) a percentage of the zero points was randomly selected and added to the 80% non-zero data for model development; validation was conducted on the remaining zeros added to the 20% non-zero data that had been set aside.

Validation: validation points were overlaid with the raster of predicted weed cover, and predicted cover category was extracted at each point using ArcMap Hawth's Tools. The point dataset was opened in ArcView where predicted vs. true values were compared using the Kappa.avx extension. Output from Kappa.avx includes overall accuracy (percent points correctly classified), a matrix of omission and commission errors, and the Kappa statistics (a measure of the model's improvement over chance classification; Titus et al. 1984).

Stitching and post-modeling modifications: predictive grids generated by Imagine's NLCD Classifier for the four areas were merged into a single image (one per weed category). Despite the presence of a 10-km overlap, boundary lines were particularly obvious between the South and Owyhee images. To improve edgematching, 100-m interval contour lines were derived from the DEM in the overlap area, displayed over the images, and the contours that best followed weed patterns were selected and used to generate a mask that was applied to the Owyhee images.

Because no weed sampling was conducted in forested areas, Evergreen Forest, Early Shrub-Tree and Recently Logged pixels were lifted from SageMap and "burned" into the weed images. Other categories extracted from SageMap and added to the final maps were Agriculture, Developed (Open Space, Low, Medium and High Intensity), and Open Water.

Weed Mapping Results

Category	Map zone	Accuracy	Kappa
Annual grasses	South	60.04	0.416691
	Center	79.27	0.724350
	North	67.24	0.579970
	Owyhee	87.11	0.821904
Perennial Grasses	South	89.27	0.2517571
	Center	94.04	0.572351
	North	88.92	0.457955
	Owyhee	85.20	0.785819
Perennial forbs	South	64.61	N/A*
	Center	85.63	0.102996
	North	93.13	0.660737
	Owyhee	97.45	0.72746

*A Kappa value could not be obtained, most likely because of the disproportionately large number of zero values in the validation set.

For comparison, in Idaho, overall accuracy was 49.9% with Kappa = 0.17 for 3 categories of cheatgrass cover (0%, 0.5-15%, >15%; PNWRC 2004). In Nevada, Peterson reported an overall accuracy of 64% for cheatgrass presence/absence data (Peterson 2003).

PNW ReGAP Mapping Results

Tables 5 and 6 on the following pages summarize the results of the final mapping and imputation process. The results show the area of each of the vegetation types. Appendix D shows these for the Omernik ecoregions, map zones and for each of the states.

Table 5. Area in hectares of Systems for Map Zone 8 sorted by Abundance

Land Cover / Ecological System Type	Zone 8 (ha)
Cultivated Crops and Irrigated Agriculture	3432450
Inter-Mountain Basins Big Sagebrush Steppe	1506705
Inter-Mountain Basins Big Sagebrush Shrubland	611768
Introduced Upland Vegetation - Annual and Perennial Grassland	451906
Conservation Reserve Program (CRP)	391270
Columbia Basin Foothill and Canyon Dry Grassland	326026
Columbia Basin Foothill Riparian Woodland and Shrubland	152817
Open Water	110034
Columbia Plateau Steppe and Grassland	88852
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	80905
Recently Burned Vegetation	77195
Inter-Mountain Basins Cliff and Canyon	76883
Developed, Medium Intensity	57643

Columbia Plateau Western Juniper Woodland and Savanna	43272
Columbia Basin Palouse Prairie	38959
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	32137
North Pacific Montane Massive Bedrock, Cliff and Talus	31984
East Cascades Mesic Montane Mixed-Conifer Forest and Woodland	26781
Inter-Mountain Basins Active and Stabilized Dune	18199
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	17988
Barren	13240
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	12823
East Cascades Oak-Ponderosa Pine Forest and Woodland	12306
Inter-Mountain Basins Semi-Desert Grassland	12037
Inter-Mountain Basins Mixed Salt Desert Scrub	10477
Ruderal Wetland	7515
Columbia Plateau Scabland Shrubland	6182
North American Arid West Emergent Marsh	4982
Introduced Upland Vegetation - Shrub	3850
Inter-Mountain Basins Alkaline Closed Depression	3475
Columbia Plateau Low Sagebrush Steppe	3352
North Pacific Oak Woodland	3202
Inter-Mountain Basins Greasewood Flat	2813
Rocky Mountain Aspen Forest and Woodland	2560
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	2214
Inter-Mountain Basins Semi-Desert Shrub-Steppe	1694
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland	1509
Introduced Upland Vegetation - Treed	1279
Introduced Riparian Vegetation	1079
North Pacific Hardwood-Conifer Swamp	952
Inter-Mountain Basins Montane Sagebrush Steppe	808
Developed, Low Intensity	402
Columbia Plateau Ash and Tuff Badland	400
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	370
Introduced Upland Vegetation - Annual and Biennial Forbland	222
Rocky Mountain Lodgepole Pine Forest	180
Rocky Mountain Cliff, Canyon and Massive Bedrock	145
North Pacific Montane Shrubland	137
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	25
Rocky Mountain Poor Site Lodgepole Pine Forest	21
Inter-Mountain Basins Playa	20
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	10
Rocky Mountain Subalpine-Montane Riparian Shrubland	3
Rocky Mountain Alpine-Montane Wet Meadow	1

Table 6. Area in hectares of Systems for Map Zone 9 sorted by Abundance

Ecological System / Land Cover Name	Zone 9 (ha)
Inter-Mountain Basins Big Sagebrush Steppe	3035322
Inter-Mountain Basins Big Sagebrush Shrubland	1640642
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	1163585
Columbia Plateau Western Juniper Woodland and Savanna	942982
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	908105
Columbia Plateau Low Sagebrush Steppe	881726
Inter-Mountain Basins Montane Sagebrush Steppe	556623
Cultivated Crops and Irrigated Agriculture	495805
Introduced Upland Vegetation - Annual and Perennial Grassland	479939
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	465399
Columbia Plateau Steppe and Grassland	401028
Inter-Mountain Basins Cliff and Canyon	310239
Great Basin Xeric Mixed Sagebrush Shrubland	227790
Inter-Mountain Basins Playa	222074
Rocky Mountain Cliff, Canyon and Massive Bedrock	219949
Columbia Basin Foothill and Canyon Dry Grassland	218421
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	196149
Recently Burned Vegetation	195289
Inter-Mountain Basins Greasewood Flat	190414
Pasture/Hay	189291
Inter-Mountain Basins Semi-Desert Grassland	175599
Columbia Basin Foothill Riparian Woodland and Shrubland	136701
Columbia Plateau Scabland Shrubland	115615
Columbia Plateau Ash and Tuff Badland	88464
Inter-Mountain Basins Mixed Salt Desert Scrub	86078
North Pacific Oak Woodland	82767
Rocky Mountain Alpine-Montane Wet Meadow	76827
Barren	72284
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	71194
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest	68322
Open Water	63070
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	62152
Columbia Basin Palouse Prairie	57767
Rocky Mountain Aspen Forest and Woodland	50446
Inter-Mountain Basins Active and Stabilized Dune	49018
Inter-Mountain Basins Volcanic Rock and Cinder Land	38759
Rocky Mountain Lodgepole Pine Forest	38272
Rocky Mountain Subalpine-Montane Riparian Shrubland	36540

Rocky Mountain Subalpine-Montane Mesic Meadow	34925
Northern Rocky Mountain Subalpine Woodland and Parkland	32558
North American Arid West Emergent Marsh	26860
Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub-Steppe	26538
Inter-Mountain Basins Alkaline Closed Depression	24433
Northern Rocky Mountain Subalpine-Upper Montane Grassland	23279
Rocky Mountain Poor Site Lodgepole Pine Forest	20686
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	19804
Rocky Mountain Alpine Bedrock and Scree	15626
Rocky Mountain Subalpine-Montane Riparian Woodland	14399
Inter-Mountain Basins Juniper Savanna	14031
Developed, Medium Intensity	13297
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland	12144
Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland	11361
Northern Rocky Mountain Avalanche Chute Shrubland	3120
Northern Rocky Mountain Subalpine Deciduous Shrubland	1920
Inter-Mountain Basins Semi-Desert Shrub-Steppe	1893
North Pacific Mountain Hemlock Forest	1800
Introduced Upland Vegetation - Annual and Biennial Forbland	1573
Conservation Reserve Program (CRP)	1546
Temperate Pacific Subalpine-Montane Wet Meadow	1393
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	1264
North American Alpine Ice Field	857
Recently Burned Shrubland	744
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland	542
North Pacific Bog and Fen	525
North Pacific Montane Massive Bedrock, Cliff and Talus	511
North Pacific Lowland Riparian Forest and Shrubland	501
Great Basin Semi-Desert Chaparral	218
North Pacific Shrub Swamp	215
North Pacific Avalanche Chute Shrubland	184
Columbia Plateau Vernal Pool	173
Developed, Low Intensity	140
Rocky Mountain Subalpine-Montane Fen	48
Orchards/Vineyards	43
Introduced Upland Vegetation - Treed	10
Introduced Riparian and Wetland Vegetation	8
Developed, Open Space	4
Rocky Mountain Dry Tundra	2
East Cascades Oak-Ponderosa Pine Forest and Woodland	1
North Pacific Montane Shrubland	1

Land Cover Map Validation

Assessing land cover map quality is an important concern for land cover mapping projects. Map quality assessment provides useful information to map users about the reliability of the map product. Various approaches to map quality assessment are recognized (Foody 2002), however, making the assessment helpful to the map user should be of primary importance (Smits et al. 1999). Typically the quality of land cover maps are assessed using a probability based sampling design (Stehman and Czaplewski 1998) with relatively large sample sizes per class (Congalton and Green 1999). These probability based approaches utilize data collected specifically for map quality assessment, and are commonly referred to as "map accuracy assessments."

The process used here, also used in the Southwest ReGAP project, is primarily an internal validation; "validation" in the sense that the purpose is to validate the quality of the map, and "internal" because validation relies on data collected for, and used within, the modeling process (Shtatland et al. 2004). The approach may be viewed as a "split sample" or "hold out" method. This type of validation is not as accurate as a k-fold cross-validation (Goutte 1997) or as robust as an external validation (Shtatland et al. 2004). However, given the large area to be mapped, and the short time available, this was the only approach deemed feasible.

Southwest ReGAP and SageMap Validation Methods

Quantitative validation methods were described briefly in the previous section dealing with the mapping process. Here we provide a more detailed explanation about the quantitative validation process used by ShrubMap, focusing on our use of fuzzy set analysis. We also describe our approach to performing a qualitative assessment of the map product.

Quantitative Assessment using Fuzzy Sets

The Gap Analysis Handbook recommends the use of "fuzzy set" analysis as a means of providing map users additional information about the quality of the map product (Crist and Deitner 2000). Our approach to fuzzy set assessment is based on the work of Gopal and Woodcock (1994) and described by Congalton and Green (1999). Using fuzzy set analysis for map quality assessment has proven useful in various land cover mapping efforts (Falzarano and Thomas 2004, Laba et al. 2002, Woodcock and Gopal 1992, Reiners et al. 2000). The premise behind fuzzy set theory for thematic map assessment is that thematic mapping involves placing a continuum of land cover into (somewhat artificially) discrete land cover classes. This continuum suggests that there can be different magnitudes of error between/among classes. The objective of using fuzzy sets for thematic map assessment is to provide map users with information about the frequency *and* magnitude of map error. In other words, a reference site may have been mapped incorrectly, but how incorrect was it? An answer to this question can be provided by re-evaluating the error matrix within the context of recognized similarities among land cover classes.

The essence of fuzzy set assessment lies in the construction of a "linguistic measurement scale" to assign degrees of correctness to misclassification errors. Gopal and Woodcock (1994) suggest five levels of linguistic values ranging from "absolutely wrong" to "absolutely right" which

experts to use when evaluating a map product relative to the reference sample plots. Determining the appropriate linguistic class, or error type, for any given reference plot is subject to the judgment of the error assessment "expert." Establishing objective criteria for assigning the level of error, therefore, is an important component to a fuzzy set assessment. Criteria for error assignment type may be based on seriousness of the error for its intended application (Reiners et al. 2000) or on some aspect of similarity among land cover classes. The Southwest ReGAP map validation results are more comprehensively described in the final report (Lowry et al 2005).

Accuracy Assessment for GNN models

We assessed the accuracy of the GNN maps in several ways. We assessed 'local-scale accuracy,' at the plot level, using cross-validation based on second-nearest-neighbor analysis as described in Ohmann and Gregory (2002). The GNN-predicted and ground-observed values at plot locations were used to construct two-way error matrices (confusion matrices), kappa statistics (Cohen 1960), and scatterplots for selected vegetation variables. We also developed a map of the nearest-neighbor distance for each GNN model, a measure of sampling sufficiency that indicates potential areas of greater uncertainty in the GNN models. The grid value is the distance to the nearest-neighbor plot that was imputed to the pixel. Distance is unit-less Euclidean distance in eight-dimensional gradient space for the first eight CCA axes, with axes weighted by their explanatory power in the model (eigenvalues), and converted to integer grids.

We assessed 'regional-scale accuracy' by constructing area distributions of selected vegetation attributes from the GNN map and from plot-based estimates based on the systematic sample of inventory plots, for each modeling region. The primary accuracy assessment results related to the Ecological Systems modeling are included below. Table 7 shows the Ecological System Confusion Matrices for each of the three mapping zones. FCorrect = Fuzzy Correct (see separate file for definitions). Table 8 shows the Kappa results for each of the three map zones.

A complete set of accuracy assessment products have been developed and are included on the DVD that accompanies this final report and the grids. They include:

GNN species model(s):
- Kappa statistics for tree species
- Area distributions for forest Ecological Systems
- Map of nearest-neighbor distance

GNN structure models:
- Confusion matrix for vegetation classes (regular and 'fuzzy')
- Kappa statistics for vegetation classes (regular and 'fuzzy')
- Scatterplots of predicted vs. observed values for continuous variables
- Area distributions for vegetation classes
- Map of nearest-neighbor distance

Table 7. Error matrix for forest Ecological Systems* in map zones 8 and 9.

Map Zone 1	Predicted																					
Observed	4103	4104	4205			4232			4237	4240	4242	4243		4266	4267	4301		9170	9190	Total	% Correct	% FCorrect
4103	0	0	0			2			0	1	0	0		2	0	0		0	0	5	0	80
4104	0	0	3			0			0	2	1	0		0	0	0		0	0	6	0	0
4205	0	2	33			14			0	15	0	0		3	0	1		0	0	68	49	91
4232	2	0	15			22			4	11	0	0		4	0	2		0	0	60	37	78
4237	0	0	0			4			1	0	0	0		0	0	0		0	0	5	20	100
4240	2	1	11			7			0	60	2	0		5	0	2		0	0	90	67	67
4242	0	0	1			0			0	1	0	1		0	0	0		0	0	3	0	33
4243	0	0	0			0			1	0	2	0		0	0	0		0	0	3	0	67
4266	1	1	4			1			0	9	0	0		15	0	0		0	0	31	48	87
4267	0	0	1			0			0	0	0	0		0	0	0		0	0	1	0	0
4301	0	0	2			0			0	4	0	0		0	0	15		1	0	22	68	86
9170	0	0	0			0			0	2	0	0		0	0	1		1	0	4	25	25
9190	0	0	0			0			0	0	0	0		1	0	0		0	0	1	0	0
Total	5	4	70			50			6	105	5	1		30	0	21		2	0	299		
% Correct	0	0	47.1			44			16.7	57.1	0	0		50	0	71.429		50	0		49	
% FCorrect	60	25	68.6			86			83.3	83.8	40	100		70	0	71.429		50	0			76

Map Zone 2	Predicted																					
Observed	4103	4104	4204	4205	4228	4232	4233	4234	4237	4240	4242	4243	4244	4266	4267	4301	4303	9170		Total	% Correct	% FCorrect
4103	4	0	1	0	0	51	1	5	2	4	3	1	0	9	2	0	0	0		83	5	83
4104	0	0	0	0	0	2	0	1	0	0	0	0	0	1	0	0	0	0		4	0	75
4204	1	0	179	0	0	27	0	0	0	79	0	0	0	13	0	1	0	0		300	60	86
4205	0	0	0	4	0	1	0	0	0	1	0	0	0	0	0	1	0	0		7	57	86
4228	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0		3	0	0
4232	36	2	16	0	0	774	6	30	22	173	26	8	0	147	11	1	0	0		1252	62	82
4233	1	0	0	0	0	8	11	2	1	0	11	2	5	1	1	0	0	0		43	26	63
4234	3	2	0	0	0	40	2	15	0	1	3	2	0	2	0	0	0	0		70	21	86
4237	2	0	0	0	0	24	0	0	3	6	4	2	0	4	2	0	0	0		47	6	62
4240	7	1	60	0	0	164	0	1	6	394	0	0	0	63	3	2	0	0		701	56	65
4242	4	0	0	0	1	19	11	2	5	0	37	8	0	3	1	0	0	0		91	41	62
4243	1	0	0	0	0	6	1	3	1	1	8	4	0	1	0	0	0	0		26	15	46
4244	0	0	0	0	0	0	7	0	0	0	0	0	10	0	0	0	0	0		17	59	100
4266	7	0	4	0	0	187	0	1	3	66	2	1	0	194	0	0	0	0		465	42	98
4267	1	0	0	0	0	11	1	1	2	4	1	1	0	0	2	0	0	0		24	8	67
4301	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	25	0	0		29	86	90
4303	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0		3	0	0
9170	0	0	0	0	0	1	0	0	0	2	0	0	0	1	0	1	0	0		5	0	0
Total	67	5	261	5	1	1316	40	61	45	734	96	29	15	442	22	31	0	0		3170		
% Correct	6	0	69	80	0	59	28	25	7	54	39	14	67	44	9	81	0	0			52	
% FCorrect	75	40	92	80	0	83	73	85	60	74	58	41	100	80	68	81	0	0				79

Map Zone 3	Predicted																					
Observed		4104	4204			4232	4233		4237	4240					4267		4303		9190	Total	% Correct	% FCorrect
4104		2	0			6	0		1	1					0		0		1	11	18	82
4204		0	57			4	0		0	22					0		1		0	84	68	95
4232		6	3			45	0		11	29					1		0		0	95	47	66
4233		0	0			0	0		1	0					0		0		0	1	0	0
4237		4	0			10	1		13	8					1		0		0	37	35	65
4240		1	13			27	0		8	154					1		0		0	204	75	82
4267		0	1			1	0		1	1					1		0		0	5	20	60
4303		0	1			1	0		0	0					0		0		0	2	0	50
9190		1	0			0	0		0	0					0		0		0	1	0	100
Total		14	75			94	1		35	215					4		1		1	440		
% Correct		14	76			48	0		37	72					25		0		0		62	
% FCorrect		64	95			66	0		71	82					75		100		100			79

*Ecological System land form (ESLF) codes	
4103	Northern Rocky Mountain Western Larch Savanna
4104	Rocky Mountain Aspen Forest and Woodland
4204	Columbia Plateau Western Juniper Woodland and Savanna
4205	East Cascades Mesic Montane Mixed-Conifer Forest and Woodland
4228	North Pacific Mountain Hemlock Forest
4232	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
4233	Northern Rocky Mountain Subalpine Woodland and Parkland
4234	Northern Rocky Mountain Mesic Montane Mixed Conifer Forest
4237	Rocky Mountain Lodgepole Pine Forest
4240	Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
4242	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
4243	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
4244	Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
4266	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland
4267	Rocky Mountain Poor Site Lodgepole Pine Forest
4301	East Cascades Oak-Ponderosa Pine Forest and Woodland
4303	Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland
9170	Columbia Basin Foothill Riparian Woodland and Shrubland
9190	North Pacific Hardwood-Conifer Swamp

Table 8. Kappa statistics for forest Ecological Systems* in GNN Mapping Region 1

GNN Mapping Zone 1			GNN Mapping Zone 2			GNN Mapping Zone 3		
Ecological System*	Kappa	Fuzzy kappa	Ecological System*	Kappa	Fuzzy Kappa	Ecological System*	Kappa	Fuzzy Kappa
4103	-0.02	0.72	4103	0.03	0.81			
4104	-0.02	-0.01	4104	0.00	0.60	4104	0.14	0.71
			4204	0.60	0.88	4204	0.65	0.94
4205	0.32	0.75	4205	0.67	0.86			
			4228	0.00	0.00			
			4232	0.33	0.68	4232	0.33	0.57
4232	0.27	0.78	4233	0.26	0.66	4233	0.00	0.00
			4234	0.21	0.86			
4237	0.17	0.91	4237	0.05	0.61	4237	0.30	0.65
4240	0.43	0.59	4240	0.42	0.58	4240	0.49	0.64
4242	-0.01	0.28	4242	0.38	0.59			
4243	-0.01	0.80	4243	0.14	0.43			
			4244	0.62	1.00			
4266	0.43	0.78	4266	0.33	0.88			
4267	0.00	0.00	4267	0.08	0.68			
4301	0.67	0.79	4301	0.83	0.85	4267	0.21	0.66
			4303	0.00	0.00	4303	0.00	0.67
9170	0.33	0.33	9170	0.00	0.00			
9190	0.00	0.00				9190	0.00	1.00

*Ecological System land form (ESLF) codes	
4103	Northern Rocky Mountain Western Larch Savanna
4104	Rocky Mountain Aspen Forest and Woodland
4204	Columbia Plateau Western Juniper Woodland and Savanna
4205	East Cascades Mesic Montane Mixed-Conifer Forest and Woodland
4228	North Pacific Mountain Hemlock Forest
4232	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
4233	Northern Rocky Mountain Subalpine Woodland and Parkland
4234	Northern Rocky Mountain Mesic Montane Mixed Conifer Forest
4237	Rocky Mountain Lodgepole Pine Forest
4240	Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
4242	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
4243	Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
4244	Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
4266	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland
4267	Rocky Mountain Poor Site Lodgepole Pine Forest
4301	East Cascades Oak-Ponderosa Pine Forest and Woodland
4303	Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland
9170	Columbia Basin Foothill Riparian Woodland and Shrubland
9190	North Pacific Hardwood-Conifer Swamp

Northwest ReGAP Accuracy Assessment

Table 7 below shows the results of the accuracy assessment for the SageMap grid, by SageMap mapping region, and for the NW ReGAP non-vegetated systems models and the riparian assessment. As mentioned, the methods were borrowed directly from the SW ReGAP project, and are described in detail in Lowry et al. 2005.

Table 9. Accuracy Assessement and Sample Size by Region for SageMap and PNW ReGAP

	Basin & Range	Blue Mountains	Columbia Basin	Klamath Basin	Northern Rockies	Owyhee Uplands	Umatilla-Bend	NW ReGap Non_Veg	NW ReGap Riparian
Overall Accuracy	89%	na	92%	90%	66%	73%	70%	97%	na
Kappa	87%	na	89%	89%	54%	65%	64%	96%	na
ORNHIC Samples (2003) used in Training	682	40	425	86	131	204	307	218	4376
ORNHIC Samples (2003) for Validation	182	na	106	26	33	54	68	137	na
Nevada ReGap						847			
Burns BLM	4618								
Lakeview BLM	2481			61					
Vale BLM	1616								
Fremont NF				2276					
Gifford Pinchot NF			564						
Malheur NF	20678	8800							
Mt Hood NF			15114						
Ochoco NF							4541		
Umatilla NF		5824	931				4429		
Wallowa NF		10123	2133						
Winema NF				27060					
Screen Digitized	201	68	244	281	355	184	205	137	0

Discussion

Southwest ReGAP

The Southwest ReGAP focused on developing a methodology that was repeatable and could be consistently applied by multiple land cover mapping team. Their method was based on the decision tree classifier method. The intuitive nature of the decision tree classifier and the easy-to-use software enabled consistency over a large area. Compared to hybrid supervised-unsupervised image classification approaches used in large land cover mapping efforts (Homer et al. 1997, Reese et al. 2002, Ma et al. 2001) Southwest ReGAP found the decision tree classifier considerably more time-efficient.

With the exception of work by Pal and Mather (2003), SW ReGAP found little published literature testing the training data requirements of decision tree classifiers for land cover mapping. Pal and Mather (2003) tested increasing training dataset size and found that classification accuracy increased linearly with size until reaching approximately 300 samples per class, whereupon additional training samples added little benefit. While not tested specifically, it

is reasonable to assume that this is a general guideline and that the optimal number of samples for a given land cover class will vary with the spectral and environmental distinctiveness of each class, as well as the rarity of the class on the landscape. Identifying the optimal number of training samples per land cover class per mapping zone remained an elusive objective throughout the project and is certainly fertile ground for further study. Southwest ReGAP discovered that sampling proportionally to the expected spatial abundance of land cover classes on the landscape produced superior results over using a roughly equal number of samples per class, which tended to over-map spatially rare classes. These findings are similar to those of McIver and Friedl (2002).

SageMap

Unlike Southwest ReGAP, SageMap was focused primarily on creating the most accurate, broadscale map of a focused group of vegetation, shrub steppe habitats. Repeatability and simplicity of the methods was not an objective at all. As a result, SageMap involved extensive experimentation, and the use of methods and local information which are often not available if mapping a wide range of vegetation types, or if most of the data is collected for the project.

In particular, two methods greatly improved the overall map accuracy. The creation of a region-wide total shrub cover grid enabled SageMap to create a fairly accurate model grid of both overall shrub cover, and overall cover of introduced exotic species. By creating an overall sum of the plots, we were able to show the shrub cover, and distinguish between areas which are most appropriately classified as grasslands, steppe and shrublands. The work benefited from a six year modeling effort headed by John Jacobson of the Washington Department of Fish and Wildlife. They were able to distinguish open shrub steppe from grasslands, and were willing to share the results of their models, which we built on. We were also able to identify areas with very high and moderately high cover of exotic annual grasses, which are a major ecosystem force in sagebrush ecosystems in the west. The use of these grids as an attribute in modeling the Ecological System type appears to greatly increase the accuracy of mapping.

The SageMap process also involved the widespread use of local polygon covers developed from 1:24,000 orthophoto quadrangle maps or grids developed from local air photography. In particular, many areas in map zone 9 in Oregon are federal lands managed by different agencies. Most of these areas, including the Burns and Lakeview BLM Districts, the Umatilla, Wallowa-Whitman, Malheur and Ochoco National Forests, and the Hart Mountain and Malheur National Wildlife Refuges, have developed recent, 1:24,000 or 30 meter pixel vegetation maps. Since these were generally developed at a local level with more local data collected, and internal peer reviews, they represent a much more accurate picture of the vegetation. In a few cases, such as with the BLM and the Malheur National Forest, we were able to obtain the plot or training used to develop the local covers. However, mostly these were not available, and we attempted to use the local grids, or polygon covers, to assist us in the modeling.

Gradient Nearest Neighbor Forest System Mapping

Challenges with Plot Classification and Mapping of Ecological Systems

The predicted spatial distribution of ESs from GNN depends to a large degree on how the plots are classified into ESs. We encountered several challenges in this classification process, described below. Because the ESs are defined floristically based on existing vegetation, we primarily used information on relative abundances of tree species in the live tree tally to classify the plots. However, in many cases the ES can only be determined by additional information on the site or geographic location. We therefore used information on ecoregion and the potential vegetation type of the plot as needed (Appendix B). We did not use data on understory (non-tree) vegetation to aid in plot classification because we questioned the consistency and reliability of these data on the regional forest inventory plots. However, we recommend these data be more thoroughly evaluated for their value in aiding classification of Ecological Systems.

Potential vegetation types for inventory plots. We encountered an issue with the potential vegetation classifications on the plots that also needs further evaluation to determine appropriate uses of the information. (Almost) all plots had a recorded potential vegetation type, at the plant association (or ecoclass) level. However, this was recorded at the scale of the subplot for CVS plots, and the condition-class for FIA plots, and therefore each plot could encompass as many as five plant associations. Some of this within-plot variability is undoubtedly due to real ecological differences, and some is due to observer differences or error, and there is no ready way to distinguish which is which. We implemented an approach for generalizing the potential vegetation type to the plot level, at the scale of plant association group and series, based on input from several ecologists in the region.

In some cases we deviated from classification guidelines contained in the ES descriptions written by NatureServe for Landfire and in the Landfire sequence tables. One such case is Northern Rocky Mountain Western Larch Savanna, which is described as single-species, open-canopied savanna. This situation rarely if ever occurs in map zones 8 and 9, and we loosened our definition to encompass any stand dominated by western larch.

The separation of the two lodgepole pine ESs in our map zones (Rocky Mountain Lodgepole Pine Forest and Rocky Mountain Poor Site Lodgepole Pine Forest) was problematic given our available data. For classifying the field plots we relied on the potential vegetation information to distinguish these two ESs, but we do not feel this was fully successful due to the problems described above. Even if we could successfully distinguish the lodgepole ESs on the field plots, spatial prediction would be difficult. The poor site ES is attributed to topo-edaphic conditions that are not accurately mapped in available GIS layers. The SSURGO soils data are incomplete for our study area, and STATSGO is too coarse for plot-level modeling. Neither the existing climate data nor digital elevation models successfully capture fine-grain features such as areas of cold-air accumulation or poor drainage associated with the poor-site lodgepole pine ES.

In map zones 8 and 9, many of the ESs intermingle in the landscape as mosaics that are partly determined by environment and partly by disturbance history. In a situation where classification to an ES often hinges on small shifts in relative abundance of the same species in mixed-conifer

forests, it is not surprising that we had much ‘confusion’ among these types in our modeling. One way we attempted to convey this is by presenting ‘fuzzy’ accuracy assessment statistics in our two-way error matrices (confusion matrices) and kappa statistics. ESs we considered similar (and hence ‘correct’ in a fuzzy sense) are indicated in the two-way error matrices.

The Northern Rocky Mountain Conifer Wooded Steppe was not included in the Landfire sequence tables nor the ES descriptions from NatureServe for our map zones. Because we think it actually does occur here in small amounts, we attempted to write classification rules that would identify plots of this ES. However, without the understory species data we were unsuccessful.

We had difficulty mapping several ESs that are relatively rare in the landscape – primarily the riparian and other hardwood types such as aspen and mountain mahogany. The systematic grids of inventory plots provide a good sample of vegetation types that are relatively common, but provide small samples of less common types. We applied some local editing to the final integrated forest/nonforest ES map to ‘burn in’ some of these ESs, as described in the final report for the nonforest component of the project.

The location of the boundaries of map zones 8 and 9 presented some challenges for modeling of the forested Ecological Systems. Although the map zones are intended to encompass regions that are relatively homogenous ecologically, the western borders of both zones and the northeastern boundary of map zone 8 include a narrow fringe of forest lands from adjacent ecoregions. This introduces several Ecological Systems to the map zones that are rare in the modeling area, which therefore are sampled by relatively few plots. For the same reason (small sample size), we couldn’t model these areas as separate ecoregions.

Another difficulty that faces all land cover mapping projects relying on Landsat imagery is the discrimination of forest from nonforest. One challenge is separating severely disturbed forest sites (e.g., that have been recently clearcut or burned) from ‘true’ nonforest such as agriculture or grasslands. Another difficulty, which is especially important in map zones 8 and 9, is distinguishing areas of sparse trees (e.g., juniper woodland) from grassland and shrubland types. Because of a problem discovered with the nonforest plots and area expansion factors in FIA’s Integrated Database, the GNN accuracy assessment information we are providing does not address the forest/nonforest aspect of map accuracy. In particular, we expect that there is ‘confusion’ in our maps between the nonforest ESs and land cover types with the woodland ESs, but we cannot quantify this at this time.

Area Distributions of Forest and Nonforest

We discovered that the plot expansion factors in the corporate FIA and CVS databases were incorrect, so our summaries of forest area based on the plot sample (Figure ???) should be considered preliminary. Most notably, the expansion factors for nonforest outside National Forest were incorrect, and so our area distributions cannot include the nonforest component of the landscape. Instead, we summarize area of forest as proportional distributions among classes.

Landsat Imagery in GNN Modeling

We explored use of two-date (summer and fall) Landsat imagery in both the GNN species and structure models. In imputation mapping in other regions, prediction accuracy for individual species and plant communities was reduced when Landsat variables were included. This is because a nearest-neighbor plot can be selected for a given map location based on similarity in forest structure (e.g., canopy cover or average tree size) whereas species composition may be quite different. Nevertheless, we hypothesized that the two-date imagery (which we have not used before in GNN) might have explanatory power for tree species with different phenology, in particular the hardwoods and western larch. However, within the multivariate gradient modeling context of GNN, the two-date imagery did not result in any notable improvements in our map accuracy. Furthermore, including Landsat variables in the GNN models resulted in imputation maps of ESs containing a large amount of fine-scale heterogeneity that we deemed undesirable. Our evaluation of spatial pattern in the imputation grids is subjective, and developing quantitative evaluation measures of pattern is a research need.

In the GNN structure model as well, including two-date Landsat variables (see Table 3) resulted in slightly better accuracy for most of the measures of vegetation structure. However, an unexpected result, which we deemed undesirable, was that the use of two imagery dates introduced much more fine-scale heterogeneity ('salt-and-peppering') to the final imputation maps. Until we have time to more fully explore the reasons behind this result, we opted to provide a GNN structure model that is based on a single (summer) imagery data.

Forest Structure 'Modifiers' for the Map of Ecological Systems

The GNN structure model provides information on several measures of forest structure that can be used in combination with the map of Ecological Systems that is based on the GNN species model. An advantage of GNN is that additional vegetation measures can be calculated to meet user objectives, as long as they can be derived from the tree tally, and simply joined to the GNN grid.

Our forest structure modifiers are derived from existing vegetation data on the plots, and as such provide indirect measures of disturbance history. Although it would be useful to identify and map areas of natural and human disturbances (e.g., timber harvest and other forest management activities), GIS data that are consistent across the map zones are not available. The GNN maps of forest structure attributes provide information about stage of forest development (e.g., average stand diameter and height, canopy cover, canopy layering). Although we usually include a measure of stand age, which provides a measure of time since disturbance, hundreds of the plots in the eastern Oregon database lacked any field-recorded tree ages. This prevented us from computing plot- (stand-) level ages. Even given good-quality stand age data on the plots, it would be problematic to spatially distinguish forest stands of similar age and structure that have arisen from different disturbance histories. The task is even more problematic in the Blue Mountains, where forest stands have experienced repeated episodes of partial harvesting and mortality from a variety of human and natural causes over time.

Limitations of Spatial Data on Nonforest Land Uses

Several areas within our combined Ecological Systems grid contain obvious inaccuracies due to incomplete mapping of areas of nonforest such as agriculture. The updated, 2001 version of the NLCD land cover map was not yet available at the time of this project, and the prior version contains many known errors. In our own comparisons of land cover calls on the forest inventory plots against the existing NLCD map, forest area (defined as <10% tree cover) is significantly under-mapped by NLCD. Many of these obvious errors in our Ecological Systems grid (e.g., areas of irrigated cropland in the Idaho portion of map zone 9) can be readily corrected by simply applying the new NLCD land cover map when it becomes available.

Northwest ReGAP

Mapping Non-Vegetated Ecological Systems

One of the most interesting aspects of the method to develop the final, integrated cover was the overall improvement in the grid as a result of mapping the non-vegetated ecological systems. As is the case with many broadscale mapping efforts, the SageMap plot data collection locations were chosen by a landscape analysis of variables driving the distribution of map units, in our case Ecological Systems. Climate, topography, elevation, and distance from roads, along with some other variables were used to identify locations that were undersampled by the existing plots available to the mapping team. While the areas selected represented undersampled areas, plots were almost always located in habitats which were the focus of mapping: shrub steppe, grasslands, exotic annual grasslands, and shrublands. No forests were sampled, but also, non-vegetated areas also were not sampled, largely because the sampling teams did not want to take the time to sample vegetation where there was practically no vegetation present. These areas are also not sampled in the FIA grid, which only samples forested areas.

In particular, recent, fairly barren lava flows, cliffs and canyons, ash beds, playas, and sand dunes were completely absent from the SageMap plot dataset, and as a result, absent from the legend. In updating SageMap to create the ReGAP grid, these areas were modeled separately. While plot data was lacking, we were able to generate sufficient points for modeling and accuracy assessment, using ancillary data. Ash beds provide habitat for a large number of rare, endemic plant species, which are sampled by the endangered species programs of state and federal agencies. This dataset allowed us to identify many small ash beds on the imagery, for which we developed training points. Playas had been mapped by the Bureau of Land Management' ESI (Ecological and Soil Inventory) project for the entire Burns and Lakeview Districts, which account for the majority of the large playas in these map zones. Cliffs and canyons were modeled using new digital elevation models, and the results corresponded exceptionally well to the large known cliff and canyon areas. The sum total of these areas is not very large, but the inclusion of these greatly improves the ability of the grid to predict how wildlife will see the landscape overall.

Riparian Modeling

Also, we were exceptionally fortunate to have a fairly large riparian dataset available for modeling these two map zones. The dataset for Map Zone 9 and the Oregon portions of Map Zone 8 were developed over almost 12 years of sampling by the US Forest Service Ecology Program, and a six year effort to integrate the classification for all of eastern Oregon by ORNHIC (Crowe et al. 2004). As a result of this work, over 3000 riparian plots were available for this map zone, and a model to attribute riparian plant associations to different basins, stream orders, and valley types were developed. In addition, the Washington Natural Heritage Program also just completed a classification by Rex Crawford based on many years of sampling in the Washington Columbia Basin, and these plots were also provided to us for the analysis. Using the NatureServe association lists and knowledge of the riparian systems, we were able to attribute the different plots to ecological system, and develop a separate riparian model.

This riparian grid has not been widely tested, and many of the systems had such a limited number of available plots that no plots were left out for accuracy assessment. In addition, 30 meter pixels do not do a good job of representing remaining riparian forest and shrublands, since most of these linear areas often cover less than half of a pixel, and can not be distinguished from irrigated agriculture. However, from an initial examination, the riparian model looks good and appears to be much better than any previous attempts. We believe we'll be able to greatly improve this grid by using the 2005, half-meter, true-color imagery recently acquired by the state of Oregon through the National Agricultural Imagery Project (NAIP). For now, NAIP is available from Oregon (2005), Idaho (2004) and California (2004). Washington is flying the state in 2006, and when that dataset is completed, we will be able to update the riparian grid for most of both map zones.

Farmland Data Limitations

As mentioned in the GNN discussion, many of the problems found in the final grid are primarily related to the SageMap grid mapping some farmlands as forest. For the SageMap project, sampling and modeling were focused on accurately identifying all of the sagebrush steppe and grassland habitats, and distinguishing farmland from forestlands were not a high priority. In our initial proposal requesting funding for this mapping project, we indicated that we were depending on either getting the National Land Cover Database (NLCD) update, or funds to develop the update ourselves. The EROS Data Center chose to develop the NLCD for these map zones, but unfortunately, the mapping will not be complete for a while. When this updated grid is available, it should be relatively straightforward to incorporate both updated distribution of the extensive farmlands and the limited distribution data will greatly increase the accuracy of this portion of the grid. The team from Oregon and Washington Heritage Programs were able to fix some of these problems in the areas of Oregon and Washington, since these programs contain expertise on the vegetation of most of the state. Due to the more comprehensive methods in SW ReGAP, these errors don't show up in Nevada. However, the mapping team lacks expertise and knowledge of the small areas in these map zones in Idaho, and these are the areas which show the most obvious errors.

Forest Structure, Weeds, Shrub Cover and Conditional Variables

One of the results of the mapping project, due to the methodology of GNN and to the development of weed and shrub density cover for SageMap, is a plethora of information which describes the general condition of most of the ecological systems mapped. This information is particularly important in regards to the use of the data for a gap analysis, since the ancillary data may impact wildlife use of the ecological system types as strongly as the types themselves.

As part of the initial proposal, we suggested that with the creation of the data, it might be relatively simple to integrate this information describing the condition of habitats into a set of modifiers. In the development of the land cover grid for the PNW ReGAP in Map Zone 1, Sanborn used age and size to provide conditional modifiers for the forest ecological systems (Reference ?). The Oregon Natural Heritage Information Center also used size and age to modify the wildlife habitat matrix used in a revision of a statewide Gap Analysis developed for the Oregon Conservation Strategy (ODFW 2005). This resulted in almost doubling the number of habitats used to model species. It also allowed ORNHIC to development a habitat suitability index, and to map species distributions based on how suitable local habitats are. However, the modifiers used by Sanborn and ORNHIC were both very simple, and focused entirely on forests, and integrating these modifiers, each developed differently by map zones, across an area as large as the Pacific Northwest states of Washington, Oregon, Idaho, Montana and Wyoming, is likely to be very difficult.

This clearly points out the need for standards, particularly for the PNW ReGAP project. The large amount of ancillary information developed in this project, makes the development of these standards more difficult. For example, the presence of down wood and snags in a stand may be more significant for many wildlife species than the age of the stand, while basal area or age may be more important for other species. More generally, the overall condition of natural ecological systems can be important as an indicator of ecosystem health. The state of Oregon has chosen to use, “the area of natural habitat” as one of the 18 statewide environmental indicators for the states benchmark program, described in the annual publication, Oregon Shines (Oregon Progress Board 2005). The objective of this benchmark is to measure change in areas of “natural habitats”. While coming up with a standard definition of natural habitats has been fairly straightforward, developing ways to measure change, particularly change resulting from state or federal agency actions, has been more difficult. The use of these ancillary datasets appears to be critical for this purpose. Working out standard ways of integrating this information poses an important challenge, which must be tackled quickly.

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Appendix A.

INTERNATIONAL ECOLOGICAL CLASSIFICATION STANDARD:

TERRESTRIAL ECOLOGICAL CLASSIFICATIONS

Ecological Systems of the Blue Mountains, Columbia Plateau and the Northern Great Basin
GAP Map Zones 8 and 9

27 April 2006

by

NatureServe

1101 Wilson Blvd., 15th floor
Arlington, VA 22209

This subset of the International Ecological Classification Standard covers ecological systens attributed to Map Zones 8, 9, 10, 19, and 21. This classification has been developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to Mary J. Russo, Central Ecology Data Manager, Durham, NC <mary_russo@natureserve.org> and Marion S. Reid, Regional Ecologist, Boulder, CO <marion_reid@natureserve.org>.

Citations:

The following citation should be used in any published materials which reference ecological system and/or International Vegetation Classification (IVC hierarchy) and association data:

NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 27 April 2006.

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These data are extracted from:

NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 27 April 2006.

This document may be generally cited as follows:

NatureServe[1]. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. Ecological Systems of Map Zones 8 and 9. NatureServe Central Databases. Arlington, VA. Data current as of 27 April 2006.

[1] NatureServe is an international organization including NatureServe regional offices, a NatureServe central office, U.S. State Natural Heritage Programs, and Conservation Data Centres (CDC) in Canada and Latin America and the Caribbean. Ecologists from the following organizations have contributed the development of the ecological systems classification:

United States
Central NatureServe Office, Arlington, VA; Eastern Regional Office, Boston, MA; Midwestern Regional Office, Minneapolis, MN; Southeastern Regional Office, Durham, NC; Western Regional Office, Boulder, CO; Alabama Natural Heritage Program, Montgomery AL; Alaska Natural Heritage Program, Anchorage, AK; Arizona Heritage Data Management Center, Phoenix AZ; Arkansas Natural Heritage Commission Little Rock, AR; Blue Ridge Parkway, Asheville, NC; California Natural Heritage Program, Sacramento, CA; Colorado Natural Heritage Program, Fort Collins, CO; Connecticut Natural Diversity Database, Hartford, CT; Delaware Natural Heritage Program, Smyrna, DE; District of Columbia Natural Heritage Program/National Capital Region Conservation Data Center, Washington DC; Florida Natural Areas Inventory, Tallahassee, FL; Georgia Natural Heritage Program, Social Circle, GA; Great Smoky Mountains National Park, Gatlinburg, TN; Gulf Islands National Seashore, Gulf Breeze, FL; Hawaii Natural Heritage Program, Honolulu, Hawaii; Idaho Conservation Data Center, Boise, ID; Illinois Natural Heritage Division/Illinois Natural Heritage Database Program, Springfield, IL; Indiana Natural Heritage Data Center, Indianapolis, IN; Iowa Natural Areas Inventory, Des Moines, IA; Kansas Natural Heritage Inventory, Lawrence, KS; Kentucky Natural Heritage Program, Frankfort, KY; Louisiana Natural Heritage Program, Baton Rouge, LA; Maine Natural Areas Program, Augusta, ME; Mammoth Cave National Park, Mammoth Cave, KY; Maryland Wildlife & Heritage Division, Annapolis, MD; Massachusetts Natural Heritage & Endangered Species Program, Westborough, MA; Michigan Natural Features Inventory, Lansing, MI; Minnesota Natural Heritage & Nongame Research and Minnesota County Biological Survey, St. Paul, MN; Mississippi Natural Heritage Program, Jackson, MI; Missouri Natural Heritage Database, Jefferson City, MO; Montana Natural Heritage Program, Helena, MT; National Forest in North Carolina, Asheville, NC; National Forests in Florida, Tallahassee, FL; National Park Service, Southeastern Regional Office, Atlanta, GA; Navajo Natural Heritage Program, Window Rock, AZ; Nebraska Natural Heritage Program, Lincoln, NE; Nevada Natural Heritage Program, Carson City, NV; New Hampshire Natural Heritage Inventory, Concord, NH; New Jersey Natural Heritage Program, Trenton, NJ; New Mexico Natural Heritage Program, Albuquerque , NM; New York Natural Heritage Program, Latham, NY; North Carolina Natural Heritage Program, Raleigh, NC; North Dakota Natural Heritage Inventory, Bismarck, ND; Ohio Natural Heritage Database, Columbus, OH; Oklahoma Natural Heritage Inventory, Norman, OK; Oregon Natural Heritage Program, Portland, OR; Pennsylvania Natural Diversity Inventory, PA; Rhode Island Natural Heritage Program, Providence, RI; South Carolina Heritage Trust, Columbia, SC; South Dakota Natural Heritage Data Base, Pierre, SD; Tennessee Division of Natural Heritage, Nashville, TN; Tennessee Valley Authority Heritage Program, Norris, TN; Texas Conservation Data Center, San Antonio, TX; Utah Natural Heritage Program, Salt Lake City, UT; Vermont Nongame & Natural Heritage Program, Waterbury, VT; Virginia Division of Natural Heritage, Richmond, VA; Washington Natural Heritage Program, Olympia, WA; West Virginia Natural Heritage Program, Elkins, WV; Wisconsin Natural Heritage Program, Madison, WI; Wyoming Natural Diversity Database, Laramie, WY

Canada
Alberta Natural Heritage Information Centre, Edmonton, AB, Canada; Atlantic Canada Conservation Data Centre, Sackville, New Brunswick, Canada; British Columbia Conservation Data Centre, Victoria, BC, Canada; Manitoba Conservation Data Centre. Winnipeg, MB, Canada; Ontario Natural Heritage Information Centre, Peterborough, ON, Canada; Quebec Conservation Data Centre, Quebec, QC, Canada; Saskatchewan Conservation Data Centre, Regina, SK, Canada; Yukon Conservation Data Centre, Yukon, Canada

Latin American and Caribbean
Centro de Datos para la Conservacion de Bolivia, La Paz , Bolivia; Centro de Datos para la Conservacion de Colombia, Cali,Valle, Columbia; Centro de Datos para la Conservacion de Ecuador, Quito, Ecuador; Centro de Datos para la Conservacion de Guatemala, Ciudad de Guatemala , Guatemala; Centro de Datos para la Conservacion de Panama, Querry Heights , Panama; Centro de Datos para la Conservacion de Paraguay, San Lorenzo , Paraguay; Centro de Datos para la Conservacion de Peru, Lima, Peru; Centro de Datos para la Conservacion de Sonora, Hermosillo, Sonora , Mexico; Netherlands Antilles Natural Heritage Program, Curacao , Netherlands Antilles; Puerto Rico-Departmento De Recursos Naturales Y Ambientales, Puerto Rico; Virgin Islands Conservation Data Center, St. Thomas, Virgin Islands.

NatureServe also has partnered with many International and United States Federal and State organizations, which have also contributed significantly to the development of the International Classification. Partners include the following The Nature Conservancy; Provincial Forest Ecosystem Classification Groups in Canada; Canadian Forest Service; Parks Canada; United States Forest Service; National GAP Analysis Program; United States National Park Service; United States Fish and Wildlife Service; United States Geological Survey; United States Department of Defense; Ecological Society of America; Environmental Protection Agency; Natural Resource Conservation Services; United States Department of Energy; and the Tennessee Valley Authority. Many individual state organizations and people from academic institutions have also contributed to the development of this classification.

Table of Contents

Executive Summary to the North American Ecological Systems Report

(citation: Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. *Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems.* NatureServe, Arlington, VA .)
Available as PDF for download at: http://www.natureserve.org/publications/usEcologicalsystems.jsp

Conservation of the Earth's diversity of life requires a sound understanding of the distribution and condition of the components of that diversity. Efforts to understand our natural world are directed at a variety of biological and ecological scales—from genes and species, to natural communities, local ecosystems, and landscapes. While scientists have made considerable progress classifying fine-grained ecological communities on the one hand, and coarse-grained ecoregions on the other, land managers have identified a critical need for practical, mid-scale ecological units to inform conservation and resource management decisions. This report introduces and outlines the conceptual basis for such a mid-scale classification unit—*ecological systems*.

Ecological systems represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. They are intended to provide a classification unit that is readily mappable, often from remote imagery, and readily identifiable by conservation and resource managers in the field.

NatureServe and its natural heritage program members, with funding from The Nature Conservancy, have completed a working classification of terrestrial ecological systems in the coterminous United States, southern Alaska, and adjacent portions of Mexico and Canada. That report (Comer et al. 2003) summarizes the nearly 600 ecological systems that currently are classified and described. The report documents applications of these ecological systems for conservation assessment, ecological inventory, mapping, land management, ecological monitoring, and species habitat modeling.

Terrestrial ecological systems are specifically defined as a group of plant community types (associations) that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. A given system will typically manifest itself in a landscape at intermediate geographic scales of tens to thousands of hectares and will persist for 50 or more years. This temporal scale allows typical successional dynamics to be integrated into the concept of each unit. With these temporal and spatial scales bounding the concept of ecological systems, we then integrate multiple ecological factors—or *diagnostic classifiers*—to define each classification unit. The multiple ecological factors are evaluated and combined in different ways to explain the spatial co-occurrence of plant associations.

Summarizing across the range of natural variation, some 381 ecological systems (63%) are upland types, 183 (31%) are wetland types, and 35 (6%) are complexes of uplands and wetlands. Considering prevailing vegetation structure, 322 systems (54%) are predominantly forest, woodland, or shrubland, 166 systems (28%) are predominantly herbaceous, savanna, or shrub steppe, and 74 systems (12%) are sparsely vegetated or "barren."

Terrestrial ecological system units represent practical, systematically defined groupings of plant associations that provide the basis for mapping terrestrial communities and ecosystems at multiple scales of spatial and thematic resolution. The systems approach complements the U.S. National Vegetation

Classification, whose finer-scale units provide a basis for interpreting larger-scale ecological system patterns and concepts. The working classification presented in this report will serve as the basis for NatureServe to facilitate the ongoing development and refinement of the U.S. component of an International Terrestrial Ecological Systems Classification.

The current classification of Terrestrial Ecological Systems for the western hemisphere is available on NatureServe's on-line database, NatureServe Explorer http://www.natureserve.org/explorer/

Background on Natureserve Ecological Systems and Mapping Applications

Over the past decade, the partners engaged in regional land cover mapping have gained much practical experience in mapping at thematic and spatial resolutions relevant to resource management. For example, since the mid-1990's, the stated intention of the Gap Analysis Program for land cover mapping has been to use *a priori*, standard vegetation classification in land cover mapping, and to depict vegetation matching the scale and concept of the vegetation Alliance, as described in the National Vegetation Classification System (US-NVC)(FGDC 1997; Grossman *et al.* 1998). The vegetation Alliance is a physiognomically uniform group of US-NVC Associations sharing one or more dominant or diagnostic species, which as a rule are found in the uppermost strata of the vegetation (see Mueller-Dombois and Ellenberg 1974). NatureServe – along with the network of Natural Heritage Programs - have worked with others since 1985 on the systematic development, documentation, and description of vegetation types across the United States. Products from this on-going effort include a hierarchical vegetation classification standard (FGDC 1997) and the description of vegetation Alliances for the United States (e.g. Drake and Faber-Langendoen 1997, Reid *et al.* 1999).

GAP efforts to map vegetation on a statewide scale had considerable difficulty achieving desired levels of mapping accuracy for map units reflecting all US-NVC Alliances. This is due to the reality that not all Alliances occur in sufficiently large and distinctive patches easily mapped with satellite imagery. For example, many wetlands and upland areas of herbaceous vegetation may include several Alliances co-mingled within a one-hectare area. New approaches are required that will 1) allow more broadly defined standard map units to be utilized to achieve desired map accuracy, 2) maintain a direct link to the US-NVC hierarchy, and 3) not preclude the ability of future analysts to meet the stated "Alliance-scale" goal with future technical refinements.

One alternative is to generate more accurate map units driven by a NatureServe classification of more broadly defined units called ***terrestrial ecological systems***. Ecological system units are groups of US-NVC Associations from two or more Alliances that tend to occur together on a given landscape due to similar ecological dynamics (e.g., fire, riverine flooding), underlying environmental features (e.g., deep soils, serpentine bedrock), and/or environmental gradients (elevation). For example, along the Colorado Front Range, Rocky Mountain Foothill Riparian Forest and Shrubland systems include several low-elevation willow and cottonwood-dominated plant Alliances/Associations that all require periodic flooding. Ecological Systems provide additional "mid-scaled" units as a basis for analyzing existing vegetation patterns, habitat usage by animals and plants, and systems-level comparisons across multiple jurisdictions. They also provide useful, systematically defined, groupings of US-NVC Alliances and Associations, forming the basis of map units where Alliance and/or Association level mapping is impractical (Menard and Lauver 2000; Comer and Schulz 2004). NatureServe has developed a classification of terrestrial ecological systems for the coterminous United States (Comer et al. 2003; Josse et al. 2003). A database with description and distribution information is available from the NatureServe website at: http://www.natureserve.org/getData/ecologyData.jsp#US.

Background On The National Vegetation Classification With Relation To Mapping

US-NVC Hierarchy: The US-NVC integrates multiple factors into a nested hierarchical structure. The top division of the classification hierarchy separates vegetated communities from those of unvegetated deepwater habitats and unvegetated subterranean habitats. Vegetated communities include aquatic areas with rooted submerged, floating and emergent vegetation of lakes, ponds, rivers, and marine shorelines, other wetlands, and upland vegetation.
Physiognomic and Floristic Levels: The US-NVC classification structure has seven levels: the five highest (coarsest) levels include physiognomic and environmental factors, and the two lowest (finest) levels are floristic. The levels of the terrestrial classification are listed (**Figure 1**).

NATIONAL VEGETATION CLASSIFICATION SYSTEM	
physiognomic levels	FORMATION CLASS FORMATION SUBCLASS FORMATION GROUP FORMATION SUBGROUP FORMATION
floristic levels	ALLIANCE ASSOCIATION

Figure 1. Hierarchical structure of the National Vegetation Classification System

The physiognomic/environmental portion of the US-NVC hierarchy is a modification of the UNESCO world physiognomic classification of vegetation (1973) and incorporates some of the revisions made by Driscoll et al. (1984) for the United States. Floristic levels were developed using concepts from Whittaker (1962), Braun-Blanquet (1965), Westhoff and van der Maarel (1973), Mueller-Dombois and Ellenberg (1974), and Moravec (1993), among others. Additional background on the US-NVC structure may be found at www.natureserve.org. The NVC provides a multi-tiered, nested hierarchy for classifying vegetation types. Currently the NVC includes over 5,000 vegetation associations and 1,800 vegetation alliances described for the coterminous United States.

Mapping Issues: Some US-NVC Alliances and Associations are mappable using remotely sensed imagery and an understanding of the ecological factors that help define them (e.g., elevation, soil type, aspect). However, it is common for many Alliances and Associations to be indistinguishable using remotely sensed imagery alone. The reasons for this vary; species that differentiate similar Associations occur beneath a dense canopy of trees or shrubs, or differential species among Alliances had very similar signatures when the imagery was acquired, or, in other cases, the scale of the Alliances/Associations occurrence is below the standard minimum mapping unit. In these situations the mapping team must find other ways to define map units. To maintain the *a priori* classification, the mapping team may consider using higher levels of the US-NVC hierarchy as map units. US-NVC units at "middle-levels" of the hierarchy, such as the Formation, are driven primarily by vegetation physiognomy, rather than considerations of spatial scales, ecological variables, or biotic composition. So the higher levels of the US-NVC hierarchy do not necessarily provide suitable classification units for mapping at "coarser" (smaller) scales. Of particular note for applying the US-NVC to mapping, three aspects are worthy of further exploration: 1) the practical "constraints" imposed by the physiognomic hierarchy on classification units, 2)

the variable - and sometime wide - thematic "distance" between Formation, Alliance, and Association levels of the US-NVC, and 3) potential difficulties for mapping some environmental attributes of the US-NVC, regardless of minimum map units size.

1. The US-NVC hierarchy certainly provides a systematic framework for *describing* vegetation at multiple levels, but it does so "at a price" for many mapping applications. Because it is a strictly nested hierarchy, classification attributes from higher levels are carried over to units further down. So for example, physiognomic distinctions (e.g. forest vs. woodland, evergreen vs. deciduous, needleleaf vs. broadleaf, conical crown vs. cylindrical crown), that enter in the classification at the Class, Subclass, Formation Group, and Formation levels are carried over directly to nested Alliance and Association units. Vegetation types that differ in any one physiognomic attribute (e.g. forest vs. woodland, crown shape) form distinct Alliances and Associations, although they may tightly co-mingle on a given landscape (e.g., Red Spruce Forest Alliance, Red Spruce Woodland Alliance).

2. For most types of vegetation, the differences between Formation and Alliance or Association scales are quite large, in a thematic sense. For example, a "short bunch temperate or sub-polar grassland Formation" or "lowland or submontane cold deciduous forest Formation" unit likely encompasses hundreds of Alliances and thousands of Associations around the globe. Similarly, some widely distributed Alliances (e.g. *Pinus ponderosa* Woodland Alliance) includes much variability, as expressed by over 50 Associations, while other Alliances may include only one or just a few Associations. This variability among different hierarchical levels of the US-NVC can make systematic "aggregations" of classification units up to Formations awkward and often undesirable.

3. Although the NVC hierarchy is primarily based on vegetation, it also uses climatic, topographic and other environmental criteria for distinguishing vegetation units. Several environmental attributes enter the US-NVC hierarchy at the Formation level. Among these are hydrologic modifiers (e.g. temporarily flooded, seasonally flooded, semi-permanently flooded, etc.) that require very detailed - if not multi-temporal - data to accurately apply. So simply "aggregating up" from finer scales to what is often viewed as a rather "coarse" Formation scale still may not solve the mapping problem.

The US-NVC, therefore, provides a hierarchical classification structure that allows for varying levels of floristic and physiognomic detail, but depending on the mapping effort, failure to map Alliances or Associations often results in an "ad-hoc" map legend or map units overly driven by observed patterns in available imagery. That type of result largely defeats the purpose of *a priori* classification. One approach to address this situation is to develop standard classification units at a broader thematic resolution of the US-NVC Alliance that circumvent some of the mapping-related problems inherent in the US-NVC hierarchy, but still provide units that are practical and useful for management and conservation. Some of the issues identified above could be resolved by revising the NVC hierarchy itself - indeed, an FGDC hierarchy revisions working group proposes to undertake such revisions. Others, however, may require a different approach that focuses on the ecological and spatial relations among the types, rather than just the conceptual relations among vegetation units. The Ecological Systems classification is intended in part to address this situation.

Ecological Systems: Definition And Concept

A terrestrial ecological system is defined as a group of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. A given terrestrial ecological system will typically manifest itself in a landscape at intermediate geographic scales of 10s to 1,000s of hectares and persist for 50 or more years. Ecological processes include natural disturbances such as fire and flooding. Substrates may include a variety of soil surface and bedrock features, such as shallow soils, alkaline parent materials, sandy/gravelling soils, or peatlands. Finally, environmental gradients include local climates, hydrologically defined patterns in coastal zones, arid grassland or desert areas, or montane, alpine or subalpine zones.

By plant community type, we mean a vegetation classification unit at the association or alliance level of the US-NVC (Grossman et al. 1998, Jennings et al. 2003, NatureServe 2004), or, if these are not available, other comparable vegetation units. NVC associations are used wherever possible to describe the component biotic communities of each terrestrial system.

Ecological systems are defined using both spatial and temporal criteria that influence the grouping of associations. Associations that consistently co-occur on the landscape therefore define biotic components of each ecological system type. Our approach to ecological systems definition using US-NVC associations is similar to the biotope or habitat approach used, for example, by the EUNIS habitat classification, which explicitly links meso-scale habitat units to European Vegetation Survey alliance units (Rodwell et al. 2002).

Our concept of terrestrial ecological systems includes temporal and geographic scales intermediate between those commonly considered for local stand and landscape-scale analyses, which can range from 50 to 1,000s of years and 10s to 1,000s of hectares (Delcourt and Delcourt 1988). These "meso-scales" are intended to constrain the definition of system types to scales that are of prime interest for conservation and resource managers who are managing landscapes in the context of a region or state. More precise bounds on both temporal and geographic scales take into account specific attributes of the ecological patterns that characterize a given region.

Temporal Scale: Within the concept of each classification unit, we clearly acknowledge the dynamic nature of ecosystems over short and long-term time frames. If we assumed that characteristic environmental settings (e.g. landform, soil type) remain constant over the time period that applies to ecological systems (fifty to several hundred years), we would still encounter considerable variation in vegetation throughout any portion of the system occurrence due to disturbance and successional processes. The temporal scale we have chosen determines the means by which we account for both successional changes and disturbance regimes in each classification unit. Relatively rapid successional changes resulting from disturbances are encompassed within the concept of a given system unit. Therefore, daily tidal fluctuations will be encompassed within a system type. Some of the associations describing one system may represent multiple successional stages. For example, a given floodplain system may include both early successional associations and later mature woodland stages that form dynamic mosaics along many kilometers of a river. Many vegetation mosaics resulting from annual to decadal changes in coastal shorelines will be encompassed within a system type. Many forest and grassland systems will encompass common successional pathways that occur over 20-50 year periods. Selecting this temporal scale shares some aspects with the "habitat type" approach to describe potential vegetation

(Daubenmire 1952, Pfister and Arno 1980), but differs in that no "climax" vegetation is implied, and all "seral" components are explicitly included in the system concept.

Pattern and Geographic Scale: Spatial patterns that we observe at "intermediate" scales can often be explained by landscape attributes that control the location and dynamics of moisture, nutrients, and disturbance events. For example, throughout temperate latitudes one can often see distinctions in vegetation occupying south-facing vs. north-facing slopes or from ridge top to valley bottom. Site factors in turn may interact with insect, disease, and fire. Another example can be taken from floodplains. Rivers provide moisture, nutrients, and scouring soil disturbance that regulate the regeneration of some plant species. In these settings we find a number of associations co-occurring due to controlling factors in the environment. We see mosaics of associations from different alliances and formations, such as woodlands, shrublands, and herbaceous meadows, occurring in a complex mosaic along a riparian corridor. Some individual associations may be found in wetland environments apart from riparian areas. But we can often predict that along riparian corridors within a given elevation zone, and along a given river size and gradient, we should encounter a limited suite of associations. It is these "meso" spatial scales that we address using ecological systems.

Diagnostic Classifiers

As the definition for ecological systems indicates, this is a multi-factor approach to ecological classification. Multiple environmental factors – or *diagnostic classifiers* - are evaluated and combined in different ways to explain the spatial co-occurrence of NVC associations (Box 1). Diagnostic classifiers include several factors representing bioclimate, biogeographic history, physiography, landform, physical and chemical substrates, dynamic processes, landscape juxtaposition, and vegetation structure and composition. Diagnostic classifiers are used here in the sense of Di Gregorio and Jansen (2000); that is, the structure of the ecological systems classification is more "modular" in that it aggregates diagnostic classifiers in multiple, varying combinations, without a specific hierarchy. The focus is on a single set of ecological system types. This is in contrast to, for example, the framework and approach of the US-NVC. The nested US-NVC hierarchy groups associations into alliances based on common dominant or diagnostic species in the upper most canopy. This provides more of a taxonomic aggregation with no presumption that associations co-occur in a given landscape. The ecological system unit links US-NVC associations using multiple factors that explain why they tend to be found together in a given landscape. Therefore, ecological systems tend to be better "grounded" as ecological units than most US-NVC alliances and are more readily identified, mapped, and understood as practical ecological classification units.

Box 1
Diagnostic Classifiers
(Categories and Examples)

Ecological Divisions
- Continental Bioclimate and Phytogeography

Bioclimatic Variables
- Regional Bioclimate

Environment
- Landscape Position, Hydrogeomorphology
- Soil Characteristics, Specialized Substrate

Ecological Dynamics
- Hydrologic Regime
- Fire Regime

Landscape Juxtaposition
- Upland-Wetland Mosaics

Vegetation
- Vertical Structure and Patch Type
- Composition of component associations
- Abundance of component association patches

Biogeographic and Bioclimatic Classifiers. Ecological Divisions are sub-continental landscapes reflecting both climate and biogeographic history, modified from Bailey (1997) at the Division scale (Figure 1). Continent-scaled climatic variation, reflecting variable humidity and seasonality (e.g. Mediterranean

vs. dry continental vs. humid oceanic) are reflected in these units, as are broad patterns in phytogeography (e.g. Takhtajan 1986). The Division lines were modified by using ecoregions established by The Nature Conservancy (Groves et al. 2002) and World Wildlife Fund (Olson et al. 2001) throughout the Western Hemisphere. These modified divisional units aid the development of system units because regional patterns of climate, physiography, disturbance regimes, and biogeographic history are well described by each Division. These divisions then, provide a starting point for thinking about the scale and ecological characteristics of each ecological system. Examples of these Divisions include the Inter- Mountain Basins, the North American Warm Desert, the Western Great Plains, the Eastern Great Plains, the Laurentian and Acadian region, the Rocky Mountains, and the Atlantic and Gulf Coastal Plain.

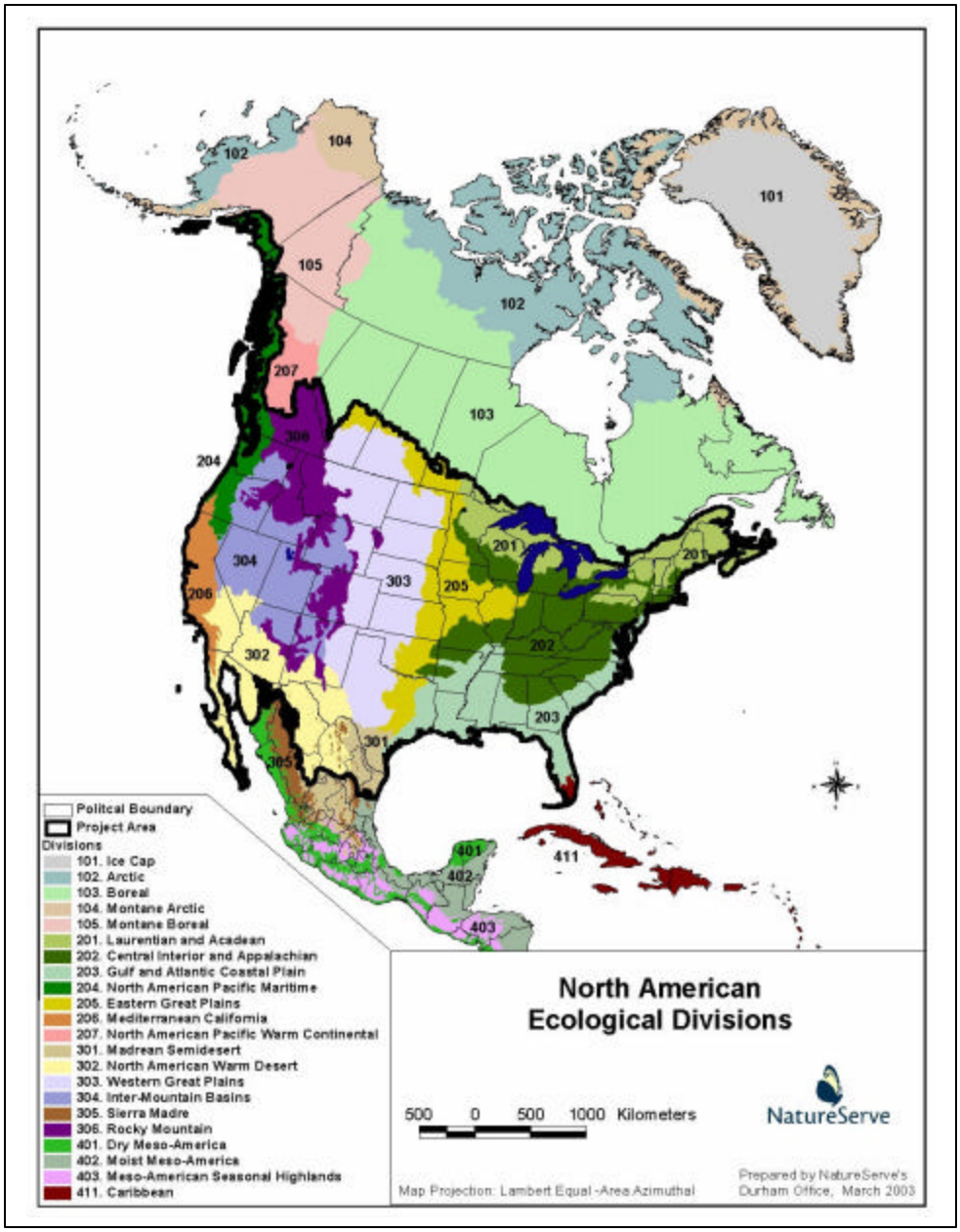

Figure 1. Ecological Divisions of North America used in organization and nomenclature of NatureServe Ecological Systems. *(2001-2003 TNC project area is highlighted).*

Subregional bioclimatic factors are also useful for classification purposes, especially where relatively abrupt elevation-based gradients exist, or where maritime climate has a strong influence on vegetation. We integrated global bioclimatic categories of Rivas-Martinez (1997) to characterize subregional climatic classifiers. These include relative temperature, moisture, and seasonality. They may be applied globally, so they aid in describing life zone concepts (e.g. 'maritime,' 'lowland,' 'montane,' 'subalpine,' 'alpine') in appropriate context from arctic through tropical latitudes.

Biogeography and bioclimate are also utilized in our standard nomenclature for terrestrial ecological system units. Along with reference to vegetation structure, composition, and local environment, a "Rocky Mountain" ecological system type is entirely or predominantly found (>80% of it's total range) within the Rocky Mountain Division. A "Southern Rocky Mountain" ecological system type is limited in distribution to southern portions of the broader Rocky Mountain Division. In a few instances, ecological systems remain very similar across two or more Ecological Divisions. In these instances, the Domain scale of Bailey (1997) was used to name and characterize the distribution of types; e.g. the "North American Arid West Emergent Marsh" spans the North American Dry Domain.

Environment: Within the context of biogeographic and bioclimatic factors, ecological composition, structure and function in upland and wetland systems is strongly influenced by factors determined by local physiography, landform, and surface substrate. Some environmental variables are described through existing, standard classifications and serve as excellent diagnostic classifiers for ecological systems. For example, soil moisture characteristics have been well described by the Natural Resource Conservation Service. Practical hydrogeomorphic classes are established for describing all wetland circumstances (Brinson 1993). Other factors such as landforms, specialized soil chemistry may be defined in standard ways to allow for their consistent application as diagnostic classifiers.

Ecological Dynamics. Many dynamic processes are sufficiently understood to serve as diagnostic classifiers in ecosystem classification. In many instances, a characteristic disturbance regime may provide the single driving factor that distinguishes system types. For example, composition and structure of many similar woodland and forest systems are distinguishable based on the frequency, intensity, periodicity, and patch characteristics of wildfire (Barnes et al. 1998). Many wetland systems are distinguishable based on the hydroperiod, as well as water flow rate, and direction (Brinson 1993; Cowardin 1979). When characterized in standard form (e.g. Frost 1998), these and other dynamic processes can be used in a multi-factor classification.

Landscape Juxtaposition. Local-scale climatic regime, physiography, substrate, and dynamic processes can often result in recurring mosaics. For example, large rivers often support recurring patterns of levee, floodplain, and back swamps, all resulting from seasonal hydrodynamics that continually scour and deposit sediment. Many depressional wetlands or lakeshore have predictable vegetation zonation driven by water level fluctuation. The recurrent juxtaposition of recognizable vegetation communities provides a useful and important criterion for multi-factor classification.

Vegetation Structure, Composition, and Abundance: As is well recognized in vegetation classification, both the physiognomy and composition of vegetation suggests much about ecosystem composition,

structure, and function. However, the relative significance of vegetation physiognomy may vary among different ecosystems, especially at local scales. For example, many upland systems support vegetation of distinct physiognomy in response to fire frequency and soil moisture regimes. In general, physiognomic distinctions such as "forest and woodland," "shrubland" "savanna," "shrub steppe," "grassland, " and "sparsely vegetated" are useful distinctions in upland environments. On the other hand, needleleaf or broadleaf tree species that are either evergreen or deciduous may co-occur in various combinations due more to variable responses to natural disturbance regimes or human activities than to current environmental conditions. Many wetland systems could support herbaceous vegetation, shrubland, and forest structures in the same location, again, based on the particular strategies of the species involved and local site history.

Therefore, while recognizable differences in vegetation physiognomy may initially suggest distinctions among ecosystem types, knowledge of vegetation composition should be relied upon more heavily to indicate significant distinctions. As in vegetation classification, we recognize beta diversity, or the turnover of species composition and abundance through space, as a primary means of differentiating ecosystem types. The task of classification is to recognize where that turnover is relatively abrupt, and to explain why that abrupt change occurs on the ground.

Classifying Ecological Systems

Ecological classifications represent a series of 'working hypotheses' about ecological structure, composition, environmental setting, and dynamics. They should be approached in a way that allows for these hypotheses to be clearly stated, then tested and refined as new data become available. Conceptual decision trees can serve an important function by describing the integration of multiple factors at varying

Selected Diagnostic Classifiers	**UPLAND FORESTS AND WOODLANDS**							
Bioclimatic Zone	Subalpine			Upper Montane			Lower Montane/Foothill	
Relative Landscape Position	High			Upper slopes/Plateaus			Lower Slopes	
Primary disturbance regime	Windthrow (frequent) Fire (infrequent, stand replacing)			Fire (frequent)		Fire (infrequent)	Fire (frequent, more ground-fire)	
Landform/ Topography	Ridge Tops, Side Slope	High Rolling terrain	Toe Slope	Side Slope	Rolling Terrain	Toe Slopes/ North Aspects	Side Slopes	Flats
Substrates	Rocky	Shallow Soils	Deep Soils	Shallow Soils	Fine Textured Soils	Variable Textured Soils	Shallow Soils	Deep Soils

Ecological System Name	R-M Subalpine Limber – Bristlecone Pine Woodland	R-M Subalpine Dry-Mesic Spruce-fir Forest and Woodland	R-M Lodgepole Pine Forest	R-M Subalpine Mesic Spruce-fir Forest and Woodland	R-M Montane Dry-Mesic Mixed Conifer Forest and Woodland	R-M Aspen Forest and Woodland	R-M Montane Mesic Mixed Conifer Forest	R-M Ponderosa Pine Woodland	R-M Pinyon – Juniper Woodland	Colorado Plateau Pinyon-Juniper Woodland	R-M Ponderosa Pine Savanna	R-M Juniper Savanna

Figure 2. Sample Decision Matrix for Classification of Selected Forest and Woodland Ecological Systems in the Rocky Mountain Division.

scales of precision – starting with very broad descriptive categories, then integrating more precise characteristics at lower levels (Figure 2). The categories within this decision matrix integrate major differences in environment and ecological processes that tend to result in significantly different biotic assemblages.

Standardized vegetation classifications, especially at the local scale described by the US-NVC association concept, provide another useful tool for qualitative evaluation of vegetation similarity among draft ecological system units. In locations where NVC associations are well developed, they serve as a useful summary of detailed quantitative data on the physiognomy and floristics of vegetation across the United States. For example, two apparently similar forest ecosystems could be characterized in terms of the NVC associations they support. We can assess the relative similarity of the two systems by comparing the association lists. Of course, detailed and comprehensive association-scale classification is not always available, especially in subtropical and tropical regions. In these instances, qualitative description and evaluation of non-standard classification units is often sufficient for initial characterization of vegetation physiognomy and composition among ecological systems.

While beta diversity is a primary consideration in distinguishing among classification units, the relative abundance of specific community types can also be an important consideration. For example, riparian and floodplain systems may share many plant species, due to their adaptation for dispersal along a seasonally flowing river. However, there may be substantial differences in the relative abundance of vegetation between, for example, riparian systems with small, flash-flood stream dynamics and a large, well-developed river floodplain many kilometers downstream. Measurement of both vegetation patterns and environmental factors that support them, are needed to adequately address this facet of ecological classification.

National Land Cover Database, Ecological Systems And The NVC

Both Ecological Systems and the US-NVC focus on natural and semi-natural ecosystems. For this reason, complete land cover mapping projects will need to rely on more than just these classifications. As part of the development of the Ecological Systems classification, various applications that included integration with the National Land Cover Characterization project have been completed.

The National Land Cover Characterization project was created in 1995 to support the original Multi-Resolution Land Characterization (MRLC) initiative and fulfill the requirement to develop a nationally consistent land cover data set from MRLC data called National Land Cover Data 1992 (NLCD 92). This culminated in the September 2000 completion of land-cover mapping using a modified Anderson level II classification for the conterminous United States. Twenty-one classes of land cover were mapped, using consistent procedures for the entire U.S. and a subsequent accuracy assessment was performed. The resulting land cover dataset is being used for a wide variety of national and regional applications, including watershed management, environmental inventories, transportation modeling, fire risk assessment, and land management (Vogelman et al. 2001).

In the NLCD classification, the "Forest" class is a combination of the "Forest" and "Woodland" Formation Classes in the National Vegetation Classification (NVC). Similarly, the NLCD "Shrubland" class encompasses the "Shrubland" and "Dwarf-shrubland" Formation Class of the NVC, and NLCD "Grasslands/Herbaceous" matches the "Herbaceous" Formation Class of the NVC. The NLCD "Woody Herbaceous" class includes upland NVC Formation Groups of "Temperate or subpolar grassland with a sparse tree layer" and "Temperate and subpolar grassland with a sparse shrub layer." This class is not comprehensively mapped in the NLCD. NLCD "Woody Wetlands" encompasses some 80 wetland and saturated Forest, Woodland, and Shrubland Formations of the NVC. Some 43 wetland and saturated Herbaceous NVC Formations make up the "Emergent/ Herbaceous Wetland" class of NLCD. The NLCD "Bare Rock" class closely matches the NVC Sparse Vegetation Formation Class, but could also include areas classified in the Nonvascular Formation class of the NVC.

Table 3 includes a tally of ecological system types and approximations of total area in categories that closely match those used for mapping land cover in the National Land Cover Data (NLCD) in the United States managed by the USGS Biological Resources Division. The table also illustrates relative diversity of ecological system types in comparison to total mapped area for the coterminous United States *circa* 1992. In these terms, both herbaceous and woody wetland types, as well as sparely vegetated types are relatively diverse, followed by forests, shrublands, and herbaceous types.

Table 3. Breakdown of ecological system types in terms of prevailing vegetation physiognomy and upland/wetland status, closely matching categories mapped in National Land Cover Data.

Prevailing Physiognomy and Environment (modified from NLCD 1992)	Number of Ecological System Types	Percentage of Total Number of Types	Area in Coterminous United States (*circa* 1992) [miles^2 and %]
Forest (Evergreen, Deciduous, Mixed)	152	25%	879,858 (29%)
Shrubland (Tall, Short, Dwarf)	71	12%	564,713 (19%)
Woody Herbaceous	30	5%	N/A
Grasslands/Herbaceous	56	9%	479,074 (16%)
Woody Wetlands	100	17%	85,412 (3%)
Emergent/Herbaceous Wetlands	83	14%	37,982 (1%)

Mixed Upland and Wetland	35	6%	N/A
Bare Rock (Sparsely Vegetated)	74	12%	42,640 (1%)

Conclusion

The NatureServe classification of ecological systems provides a practical starting point for defining an ecologically-based standard for land cover mapping across the United States. Systems units provide a direct, systematic link to the US-NVC and leave options open for future efforts where fine-scale units may be identifiable. Since they are defined with a strong emphasis on environmental settings and dynamic processes, they should also function well as components of fire condition class models. The systems classification has been effectively coupled with the National Land Cover Data for comprehensive land use/land cover applications. It can also be augmented with US-NVC Alliances and structural modifiers to practically describe important variability in existing vegetation.

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Table Of Contents To Ecological Systems Descriptions

FOREST AND WOODLAND (NLCD 40)

Deciduous Forest and Woodland (NLCD 41)

CES304.772 INTER-MOUNTAIN BASINS MOUNTAIN MAHOGANY WOODLAND AND SHRUBLAND

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Aridic; Cercocarpus ledifolius
Concept Summary: This ecological system occurs in hills and mountain ranges of the Intermountain basins from the eastern foothills of the Sierra Nevada northeast to the foothills of the Big Horn Mountains. It typically occurs from 600 m to over 2650 m in elevation on rocky outcrops or escarpments and forms small- to large-patch stands in forested areas. Most stands occur as shrublands on ridges and steep rimrock slopes, but they may be composed of small trees in steppe areas. Scattered junipers or pines may also occur. This system includes both woodlands and shrublands dominated by *Cercocarpus ledifolius. Artemisia tridentata ssp. vaseyana, Purshia tridentata*, with species of *Arctostaphylos, Ribes*, or *Symphoricarpos* are often present. Undergrowth is often very sparse and dominated by bunch grasses, usually *Pseudoroegneria spicata* and *Festuca idahoensis*. *Cercocarpus ledifolius* is a slow-growing, drought-tolerant species that generally does not resprout after burning and needs the protection from fire that rocky sites provide.

DISTRIBUTION

Range: Occurs in hills and mountain ranges of the Intermountain basins from the eastern foothills of the Sierra Nevada northeast to the foothills of the Big Horn Mountains.
Divisions: 206:?, 304:C, 306:C
TNC Ecoregions: 6:P, 9:C, 10:P, 11:C, 12:C
Subnations: CA, CO, ID, MT, NV, OR, UT, WY

CONCEPT

Associations:
- *Artemisia arbuscula - Cercocarpus ledifolius / Pseudoroegneria spicata - Poa secunda* Shrubland (CEGL001487, G4Q)
- *Cercocarpus ledifolius / Artemisia tridentata* Woodland (CEGL000960, G3G4)
- *Cercocarpus ledifolius / Artemisia tridentata* ssp. *vaseyana* Woodland (CEGL001022, G3)
- *Cercocarpus ledifolius / Calamagrostis rubescens* Woodland (CEGL000961, G2)
- *Cercocarpus ledifolius / Festuca idahoensis* Woodland (CEGL000962, G3)
- *Cercocarpus ledifolius / Holodiscus dumosus* Woodland (CEGL000963, G1G2)
- *Cercocarpus ledifolius / Leymus salinus* ssp. *salmonis* Woodland (CEGL000964, G2Q)
- *Cercocarpus ledifolius / Mahonia repens* Shrubland (CEGL000965, GNR)
- *Cercocarpus ledifolius / Prunus virginiana* Shrubland (CEGL000966, G4)
- *Cercocarpus ledifolius / Pseudoroegneria spicata - Festuca idahoensis* Woodland (CEGL000968, G3G4)
- *Cercocarpus ledifolius / Pseudoroegneria spicata* Shrubland (CEGL000967, G4Q)
- *Cercocarpus ledifolius / Symphoricarpos longiflorus* Shrubland (CEGL000969, G4)
- *Cercocarpus ledifolius / Symphoricarpos oreophilus* Woodland (CEGL000970, G2)
- *Cercocarpus ledifolius* Woodland [Placeholder] (CEGL003038, G4?)

Alliances:
- *Cercocarpus ledifolius* Shrubland Alliance (A.828)
- *Cercocarpus ledifolius* Woodland Alliance (A.586)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Dealy 1975, Dealy 1978, Knight 1994, Knight et al. 1987, Lewis 1975b, Mueggler and Stewart 1980, Shiflet 1994
Version: 31 Aug 2005 **Stakeholders:** West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.813 ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND

Primary Division: Rocky Mountain (306)
Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Forest and Woodland (Treed); Long Disturbance Interval; F-Patch/Medium Intensity; F-Landscape/Medium Intensity; Broad-Leaved Deciduous Tree; Populus tremuloides
Concept Summary: This widespread ecological system is more common in the southern and central Rocky Mountains but occurs in the montane and subalpine zones throughout much of the western U.S. and north into Canada. An eastern extension occurs along the Rocky Mountains foothill front and in mountain "islands" in Montana (Big Snowy and Highwood mountains), and the Black Hills of South Dakota. In California, this system is only found on the east side of the Sierra Nevada adjacent to the Great Basin. Large stands are found in the Inyo and White mountains, while small stands occur on the Modoc Plateau. Elevations generally range from 1525 to 3050 m (5000-10,000 feet), but occurrences can be found at lower elevations in some regions. Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand. Secondarily, it is limited by the length of the growing season or low temperatures. These are upland forests and woodlands dominated by *Populus tremuloides* without a significant conifer component (<25% relative tree cover). The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. In California, *Symphyotrichum spathulatum (= Aster occidentalis)* is a common forb. Associated shrub species include *Symphoricarpos* spp., *Rubus parviflorus, Amelanchier alnifolia,* and *Arctostaphylos uva-ursi*. Occurrences of this system originate and are maintained by stand-replacing disturbances such as avalanches, crown fire, insect outbreak, disease and windthrow, or clearcutting by man or beaver, within the matrix of conifer forests. It differs from Northwestern Great Plains Aspen Forest and Parkland (CES303.681), which is limited to plains environments.

DISTRIBUTION

Range: This system is more common in the southern and central Rocky Mountains, but it does occur in the montane and subalpine zones throughout much of the western U.S. and north into Canada, as well as west into California. Elevations generally range from 1525 to 3050 m (5000-10,000 feet), but occurrences can be found at lower elevations in some regions.
Divisions: 204:C, 206:P, 304:C, 306:C
TNC Ecoregions: 1:P, 3:C, 4:P, 5:P, 7:C, 8:C, 9:C, 11:C, 12:P, 18:C, 19:C, 20:C, 21:P, 25:C, 26:C, 81:P
Subnations: AB, AZ, BC, CA, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY

CONCEPT

Associations:
- *Populus tremuloides* - Conifer / *Spiraea betulifolia - Symphoricarpos albus* Forest (CEGL005911, G3?)
- *Populus tremuloides / Acer glabrum* Forest (CEGL000563, G1G2)
- *Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Bromus carinatus* Forest (CEGL000566, G3G5)
- *Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Calamagrostis rubescens* Forest (CEGL000567, G4)
- *Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus* / Mixed Graminoid Forest (CEGL002816, GNR)
- *Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus* / Tall Forbs Forest (CEGL000568, G5)
- *Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Thalictrum fendleri* Forest (CEGL000569, G5)
- *Populus tremuloides / Amelanchier alnifolia / Pteridium aquilinum* Forest (CEGL000565, G2G3)
- *Populus tremuloides / Amelanchier alnifolia* / Tall Forbs Forest (CEGL000570, G3G5)
- *Populus tremuloides / Amelanchier alnifolia / Thalictrum fendleri* Forest (CEGL000571, G3G4)
- *Populus tremuloides / Amelanchier alnifolia* Forest (CEGL000564, G4)
- *Populus tremuloides / Artemisia tridentata / Monardella odoratissima - Kelloggia galioides* Forest (CEGL003146, GNR)
- *Populus tremuloides / Artemisia tridentata* Forest (CEGL000572, G3G4)
- *Populus tremuloides / Bromus carinatus* Forest (CEGL000573, G5)
- *Populus tremuloides / Calamagrostis rubescens* Forest (CEGL000575, G5?)
- *Populus tremuloides / Carex geyeri* Forest (CEGL000579, G4)
- *Populus tremuloides / Carex rossii* Forest (CEGL000580, G5)
- *Populus tremuloides / Carex siccata* Forest (CEGL000578, G4)
- *Populus tremuloides / Ceanothus velutinus* Forest (CEGL000581, G2)
- *Populus tremuloides / Corylus cornuta* Forest (CEGL000583, G3)
- *Populus tremuloides / Festuca thurberi* Forest (CEGL000585, G4)
- *Populus tremuloides / Heracleum maximum* Forest (CEGL000595, G3)
- *Populus tremuloides / Heracleum sphondylium* Forest (CEGL000586, G4Q)
- *Populus tremuloides / Hesperostipa comata* Forest (CEGL000608, G2G4)
- *Populus tremuloides* / Invasive Perennial Grasses Forest (CEGL003748, GNR)
- *Populus tremuloides / Juniperus communis / Carex geyeri* Forest (CEGL000588, G4G5)
- *Populus tremuloides / Juniperus communis / Lupinus argenteus* Forest (CEGL000589, G3G4)
- *Populus tremuloides / Juniperus communis* Forest (CEGL000587, G4)
- *Populus tremuloides / Ligusticum filicinum* Forest (CEGL000591, G4Q)
- *Populus tremuloides / Lonicera involucrata* Forest (CEGL000592, G3)
- *Populus tremuloides / Lupinus argenteus* Forest (CEGL000593, GNR)

- *Populus tremuloides / Mahonia repens* Forest (CEGL000594, G3)
- *Populus tremuloides / Monardella odoratissima* Forest (CEGL003145, G3)
- *Populus tremuloides / Prunus virginiana* Forest (CEGL000596, G3G4)
- *Populus tremuloides / Pteridium aquilinum* Forest (CEGL000597, G4)
- *Populus tremuloides / Quercus gambelii / Symphoricarpos oreophilus* Forest (CEGL000598, GNR)
- *Populus tremuloides / Ribes montigenum* Forest (CEGL000600, G2)
- *Populus tremuloides / Rosa woodsii* Forest (CEGL003149, GNR)
- *Populus tremuloides / Rubus parviflorus* Forest (CEGL000602, G2)
- *Populus tremuloides / Rudbeckia occidentalis* Forest (CEGL000603, GNRQ)
- *Populus tremuloides / Salix scouleriana* Forest (CEGL000604, G4)
- *Populus tremuloides / Sambucus racemosa* Forest (CEGL000605, G2G3)
- *Populus tremuloides / Shepherdia canadensis* Forest (CEGL000606, G3G4)
- *Populus tremuloides / Spiraea betulifolia* Forest (CEGL000607, G4Q)
- *Populus tremuloides / Symphoricarpos albus / Elymus glaucus* Woodland (CEGL000946, G3)
- *Populus tremuloides / Symphoricarpos albus* Forest (CEGL000609, G3?)
- *Populus tremuloides / Symphoricarpos occidentalis* Forest [Provisional] (CEGL005848, GNR)
- *Populus tremuloides / Symphoricarpos oreophilus / Bromus carinatus* Forest (CEGL000611, G5)
- *Populus tremuloides / Symphoricarpos oreophilus / Calamagrostis rubescens* Forest (CEGL000612, G3G5)
- *Populus tremuloides / Symphoricarpos oreophilus / Carex rossii* Forest (CEGL000613, G3G4)
- *Populus tremuloides / Symphoricarpos oreophilus / Festuca thurberi* Forest (CEGL000614, G3?)
- *Populus tremuloides / Symphoricarpos oreophilus* / Tall Forbs Forest (CEGL000615, G3G5)
- *Populus tremuloides / Symphoricarpos oreophilus / Thalictrum fendleri* Forest (CEGL000616, G5)
- *Populus tremuloides / Symphoricarpos oreophilus / Wyethia amplexicaulis* Forest (CEGL000617, G4Q)
- *Populus tremuloides / Symphoricarpos oreophilus* Forest (CEGL000610, G5)
- *Populus tremuloides* / Tall Forbs Forest (CEGL000618, G5)
- *Populus tremuloides / Thalictrum fendleri* Forest (CEGL000619, G5)
- *Populus tremuloides / Urtica dioica* Forest [Provisional] (CEGL005849, G2G3)
- *Populus tremuloides / Vaccinium myrtillus* Forest (CEGL000620, G3)
- *Populus tremuloides / Wyethia amplexicaulis* Forest (CEGL000622, G3)

Alliances:

- *Populus tremuloides* Forest Alliance (A.274)
- *Populus tremuloides* Temporarily Flooded Forest Alliance (A.300)
- *Populus tremuloides* Woodland Alliance (A.610)

Environment: Climate is temperate with a relatively long growing season, typically cold winters and deep snow. Mean annual precipitation is greater than 15 inches and typically greater than 20 inches, except in semi-arid environments where occurrences are restricted to mesic microsites such as seeps or large snow drifts. Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand (Mueggler 1988). Secondarily, its range is limited by the length of the growing season or low temperatures (Mueggler 1988). Topography is variable, sites range from level to steep slopes. Aspect varies according to the limiting factors. Occurrences at high elevations are restricted by cold temperatures and are found on warmer southern aspects. At lower elevations occurrences are restricted by lack of moisture and are found on cooler north aspects and mesic microsites. The soils are typically deep and well developed with rock often absent from the soil. Soil texture ranges from sandy loam to clay loams. Parent materials are variable and may include sedimentary, metamorphic or igneous rocks, but it appears to grow best on limestone, basalt, and calcareous or neutral shales (Mueggler 1988).

Vegetation: Occurrences have a somewhat closed canopy of trees of 5-20 m tall that is dominated by the cold-deciduous, broad-leaved tree

- *Populus tremuloides*. Conifers that may be present but never codominant include *Abies concolor, Abies lasiocarpa, Picea engelmannii, Picea pungens, Pinus ponderosa*, and *Pseudotsuga menziesii*. Conifer species may contribute up to 15% of the tree canopy before the occurrence is reclassified as a mixed occurrence. Because of the open growth form of *Populus tremuloides*, enough light can penetrate for lush understory development. Depending on available soil moisture and other factors like disturbance, the understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs.

Common shrubs include *Acer glabrum, Amelanchier alnifolia, Artemisia tridentata, Juniperus communis, Prunus virginiana, Rosa woodsii, Shepherdia canadensis, Symphoricarpos oreophilus,* and the dwarf-shrubs *Mahonia repens* and *Vaccinium* spp. The herbaceous layers may be lush and diverse. Common graminoids may include *Bromus carinatus, Calamagrostis rubescens, Carex siccata (= Carex foenea), Carex geyeri, Carex rossii, Elymus glaucus, Elymus trachycaulus, Festuca thurberi,* and *Hesperostipa comata*. Associated forbs may include *Achillea millefolium, Eucephalus engelmannii (= Aster engelmannii), Delphinium* spp., *Geranium viscosissimum, Heracleum sphondylium, Ligusticum filicinum, Lupinus argenteus, Osmorhiza berteroi (= Osmorhiza chilensis), Pteridium aquilinum, Rudbeckia occidentalis, Thalictrum fendleri, Valeriana occidentalis, Wyethia amplexicaulis*, and

many others. Exotic grasses such as the perennials *Poa pratensis* and *Bromus inermis* and the annual *Bromus tectorum* are often common in occurrences disturbed by grazing.

Dynamics: Occurrences in this ecological system often originate, and are likely maintained, by stand-replacing disturbances such as crown fire, disease and windthrow, or clearcutting by man or beaver. The stems of these thin-barked, clonal trees are easily killed by ground fires, but they can quickly and vigorously resprout in densities of up to 30,000 stems per hectare (Knight 1993). The stems are relatively short-lived (100-150 years), and the occurrence will succeed to longer-lived conifer forest if undisturbed. Occurrences are favored by fire in the conifer zone (Mueggler 1988). With adequate disturbance a clone may live many centuries. Although *Populus tremuloides* produces abundant seeds, seedling survival is rare because of the long moist conditions required to establish are rare in the habitats that it occurs in. Superficial soil drying will kill seedlings (Knight 1993).

SPATIAL CHARACTERISTICS

Size: This system is not actually very extensive in the Oregon Cascades and probably non-existent in the Coast Ranges. It is not very extensive in western Washington either. Most patches may be too small to map. Many may be relict stands from another climate, just barely hanging on. In the Cascades this system occurs as a small-patch type, not large-patch.

SOURCES

References: Bartos 1979, Bartos and Cambell 1998, Bartos and Mueggler 1979, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Comer et al. 2003, DeByle and Winokur 1985, DeVelice et al. 1986, Eyre 1980, Henderson et al. 1977, Hess and Wasser 1982, Johnston and Hendzel 1985, Keammerer 1974a, Mueggler 1988, Neely et al. 2001, Powell 1988a, Shiflet 1994, Tuhy et al. 2002, Youngblood and Mauk 1985

Version: 20 Apr 2006 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

Evergreen Forest and Woodland (NLCD 42)

CES304.082 COLUMBIA PLATEAU WESTERN JUNIPER WOODLAND AND SAVANNA

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Forest and Woodland (Treed); Ridge/Summit/Upper Slope; Aridic; Juniperus occidentalis

Concept Summary: This woodland system is found along the northern and western margins of the Great Basin, from southwestern Idaho, along the eastern foothills of the Cascades, south to the Modoc Plateau of northeastern California. Elevations range from under 200 m along the Columbia River in central Washington to over 1500 m. Generally soils are medium-textured, with abundant coarse fragments, and derived from volcanic parent materials. In central Oregon, the center of distribution, all aspects and slope positions occur. Where this system grades into relatively mesic forest or grassland habitats, these woodlands become restricted to rock outcrops or escarpments with excessively drained soils. *Pinus monophylla* is not present in this region, so *Juniperus occidentalis* is the only tree species, although *Pinus ponderosa* or *Pinus jeffreyi* may be present in some stands. *Cercocarpus ledifolius* may occasionally codominate. *Artemisia tridentata* is the most common shrub; others are *Purshia tridentata, Ericameria nauseosa, Chrysothamnus viscidiflorus, Ribes cereum,* and *Tetradymia* spp. Graminoids include *Carex filifolia, Festuca idahoensis, Poa secunda,* and *Pseudoroegneria spicata*. These woodlands are generally restricted to rocky areas where fire frequency is low. Throughout much of its range, fire exclusion and removal of fine fuels by grazing livestock have reduced fire frequency and allowed *Juniperus occidentalis* seedlings to colonize adjacent alluvial soils and expand into the shrub-steppe and grasslands. *Juniperus occidentalis* savanna may occur on the drier edges of the woodland where trees are intermingling with or invading the surrounding grasslands and where local edaphic or climatic conditions favor grasslands over shrublands.

Comments: These woodlands are composed of two very different types. There are old-growth *Juniperus occidentalis* woodlands with trees and stands often over 1000 years old, with fairly well-spaced trees with rounded crowns. There are also large areas where juniper has expanded into sagebrush steppe and bunchgrass-dominated areas, with young, pointed-crowned trees growing closely together. Currently, these two very different types are about equally distributed across the landscape, with *Juniperus occidentalis* continuing to expand, either from the combination of fire exclusion, past grazing or climate change. *Juniperus occidentalis* has also expanded into *Pinus ponderosa* and *Pinus ponderosa - Pinus contorta* stands in central Oregon.

DISTRIBUTION

Range: This woodland and savanna system is found along the northern and western margins of the Great Basin, from southwestern Idaho, along the eastern foothills of the Cascades, south to the Modoc Plateau of northeastern California. It also occurs in scattered localities of northern Nevada and south-central Washington.

Divisions: 304:C

TNC Ecoregions: 6:C, 7:C, 68:C
Subnations: CA, ID, NV, OR, WA

CONCEPT

Associations:
- *Juniperus occidentalis / Achnatherum thurberianum* Woodland (CEGL002635, G2)
- *Juniperus occidentalis / Artemisia arbuscula / Festuca idahoensis* Wooded Herbaceous Vegetation (CEGL001716, G3?)
- *Juniperus occidentalis / Artemisia arbuscula / Poa secunda* Wooded Herbaceous Vegetation (CEGL001715, G2)
- *Juniperus occidentalis / Artemisia arbuscula / Pseudoroegneria spicata* Wooded Herbaceous Vegetation (CEGL001717, G3G4)
- *Juniperus occidentalis / Artemisia rigida / Poa secunda* Wooded Herbaceous Vegetation (CEGL001718, G2G3)
- *Juniperus occidentalis / Artemisia tridentata - Purshia tridentata* Wooded Herbaceous Vegetation (CEGL001722, G4Q)
- *Juniperus occidentalis / Artemisia tridentata / Carex filifolia* Wooded Herbaceous Vegetation (CEGL001719, G1)
- *Juniperus occidentalis / Artemisia tridentata / Festuca idahoensis* Wooded Herbaceous Vegetation (CEGL001720, G3)
- *Juniperus occidentalis / Artemisia tridentata / Pseudoroegneria spicata* Wooded Herbaceous Vegetation (CEGL001721, G3G4)
- *Juniperus occidentalis / Artemisia tridentata* ssp. *vaseyana* Woodland (CEGL000723, G4)
- *Juniperus occidentalis / Cercocarpus ledifolius - Symphoricarpos oreophilus* Woodland (CEGL000726, G2)
- *Juniperus occidentalis / Cercocarpus ledifolius / Carex geyeri* Wooded Herbaceous Vegetation (CEGL000724, G2)
- *Juniperus occidentalis / Cercocarpus ledifolius / Leymus cinereus* Wooded Herbaceous Vegetation (CEGL001723, G1Q)
- *Juniperus occidentalis / Cercocarpus ledifolius / Pseudoroegneria spicata* Woodland (CEGL000725, G4)
- *Juniperus occidentalis / Festuca idahoensis* Wooded Herbaceous Vegetation (CEGL001724, G2)
- *Juniperus occidentalis / Poa secunda - Achnatherum occidentale* Wooded Herbaceous Vegetation (CEGL001727, GU)
- *Juniperus occidentalis / Pseudoroegneria spicata* Wooded Herbaceous Vegetation (CEGL001728, G3)
- *Juniperus occidentalis / Purshia tridentata / Festuca idahoensis - Pseudoroegneria spicata* Wooded Herbaceous Vegetation (CEGL002622, G3)

Alliances:
- *Juniperus occidentalis* Wooded Herbaceous Alliance (A.1500)
- *Juniperus occidentalis* Wooded Tall Herbaceous Alliance (A.1489)
- *Juniperus occidentalis* Woodland Alliance (A.535)

SPATIAL CHARACTERISTICS

Adjacent Ecological System Comments: This system likely represents a transition between adjacent woodlands and Inter-Mountain Basins Big Sagebrush Steppe (CES304.778).

SOURCES

References: Barbour and Major 1988, Eyre 1980, Holland and Keil 1995, Johnson and Clausnitzer 1992, Shiflet 1994, Volland 1976, West et al. 1998, Western Ecology Working Group n.d.

Version: 08 Sep 2004 **Stakeholders:** West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES204.086 EAST CASCADES MESIC MONTANE MIXED-CONIFER FOREST AND WOODLAND

Primary Division: North American Pacific Maritime (204)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Forest and Woodland (Treed); Udic; Very Long Disturbance Interval; F-Landscape/Medium Intensity; Needle-Leaved Tree; Abies grandis - Mixed; Tsuga heterophylla, Thuja plicata; Pseudotsuga menziesii; Long (>500 yrs) Persistence
Concept Summary: This ecological system occurs on the upper east slopes of the Cascades in Washington, south of Lake Chelan and south to Mount Hood in Oregon. Elevations range from 610 to 1220 m (2000-4000 feet) in a very restricted range occupying less than 5% of the forested landscape in the east Cascades. This system is associated with a submesic climate regime with annual precipitation ranging from 100 to 200 cm (40-80 inches) and maximum winter snowpacks that typically melt off in spring at lower elevations. This ecological system is composed of variable montane coniferous forests typically below Pacific silver fir forests along the crest east of the Cascades. This system also includes montane forests along rivers and slopes, and in mesic "coves" which were historically protected from wildfires. Most occurrences of this system are dominated by a mix of *Pseudotsuga menziesii* with *Abies grandis* and/or *Tsuga heterophylla*. Several other conifers can dominate or codominate, including *Thuja plicata, Pinus contorta, Pinus monticola*, and *Larix occidentalis*. *Abies grandis* and other fire-sensitive, shade-tolerant species dominate forests on many sites once dominated by *Pseudotsuga menziesii* and *Pinus ponderosa*, which were formerly maintained by wildfire. They are very productive forests in the eastern Cascades which have been priority stands for timber production. *Mahonia nervosa, Linnaea borealis, Paxistima myrsinites, Acer circinatum, Spiraea betulifolia, Symphoricarpos hesperius, Cornus nuttallii, Rubus parviflorus*, and *Vaccinium membranaceum* are common shrub species. The composition of the herbaceous layer reflects local climate and degree of canopy closure and contains

species more restricted to the Cascades, for example, *Achlys triphylla, Anemone deltoidea,* and *Vancouveria hexandra*. Typically, stand-replacement fire-return intervals are 150-500 years with moderate-severity fire-return intervals of 50-100 years.
Comments: Includes *Tsuga heterophylla* and *Thuja plicata* associations and moister *Abies grandis* associations in eastern Cascades.

DISTRIBUTION

Range: This ecological system occurs on the upper east slopes of the Cascades in Washington, south of Lake Chelan and south to Mount Hood in Oregon.
Divisions: 204:C
TNC Ecoregions: 4:C
Subnations: BC, OR, WA

CONCEPT

Associations:
- *Abies concolor - Pinus contorta / Carex pensylvanica - Achnatherum occidentale* Forest (CEGL000256, G3)
- *Abies grandis - Picea engelmannii / Maianthemum stellatum* Forest (CEGL000278, G2)
- *Abies grandis - Pseudotsuga menziesii / Trientalis borealis* ssp. *latifolia* Forest (CEGL000040, G3)
- *Abies grandis - Thuja plicata / Achlys triphylla* Forest (CEGL002669, G2)
- *Abies grandis - Tsuga heterophylla / Clintonia uniflora* Forest (CEGL000286, G2)
- *Abies grandis / Acer circinatum* Forest (CEGL000266, G4)
- *Abies grandis / Achlys triphylla* Forest (CEGL000268, G3)
- *Abies grandis / Arctostaphylos nevadensis* Woodland (CEGL000915, G2G3)
- *Abies grandis / Chrysolepis chrysophylla* Forest (CEGL000038, G1)
- *Abies grandis / Polemonium pulcherrimum* Forest (CEGL000039, G3)
- *Abies grandis / Symphoricarpos albus* Forest (CEGL000282, G3?)
- *Abies grandis / Vaccinium membranaceum - Achlys triphylla* Forest (CEGL000291, G2G3)

Alliances:
- *Abies concolor* Forest Alliance (A.152)
- *Abies grandis* Forest Alliance (A.153)
- *Abies grandis* Woodland Alliance (A.558)

Dynamics: Landfire VDDT models: R#MCONm Eastside mixed conifer moist (GF/DF) model is applied with stages A-B-E.

SPATIAL CHARACTERISTICS

Adjacent Ecological System Comments: This system lies between and interfingers with the higher North Pacific Mountain Hemlock Forest (CES204.838), North Pacific Mesic Western Hemlock-Silver Fir Forest (CES204.097) or Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland (CES306.830) and the lower Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest (CES306.805). Westward in the Columbia River Gorge, this system merges with North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest (CES204.001).

SOURCES

References: Eyre 1980, Hessburg et al. 1999, Hessburg et al. 2000, Lillybridge et al. 1995, Topik 1989, Topik et al. 1988, Western Ecology Working Group n.d.
Version: 31 Mar 2005 **Stakeholders:** Canada, West
Concept Author: R. Crawford **LeadResp:** West

CES304.773 GREAT BASIN PINYON-JUNIPER WOODLAND – *NOT MAPPED, PROBABLY NOT PRESENT*

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Forest and Woodland (Treed); Foothill(s); Piedmont; Plateau; Ridge/Summit/Upper Slope; Aridic; Pinus monophylla, Juniperus osteosperma
Concept Summary: This ecological system occurs on dry mountain ranges of the Great Basin region and eastern foothills of the Sierra Nevada. It is typically found at lower elevations ranging from 1600-2600 m. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Woodlands dominated by a mix of
- *Pinus monophylla* and *Juniperus osteosperma*, pure or nearly pure occurrences of *Pinus monophylla*, or woodlands dominated solely by *Juniperus osteosperma* comprise this system. *Cercocarpus ledifolius* is a common associate. On the east slope of the Sierras in California, *Pinus jeffreyi* and *Juniperus occidentalis var. australis* may be components of these woodlands. Understory layers are variable. Associated species include shrubs such as *Arctostaphylos patula, Artemisia arbuscula, Artemisia nova, Artemisia tridentata, Cercocarpus ledifolius, Cercocarpus intricatus, Coleogyne ramosissima, Quercus gambelii, Quercus*

turbinella, and bunch grasses *Hesperostipa comata, Festuca idahoensis, Pseudoroegneria spicata, Leymus cinereus (= Elymus cinereus)*, and *Poa fendleriana*. This system occurs at lower elevations than Colorado Plateau Pinyon-Juniper Woodland (CES304.767) where sympatric.

DISTRIBUTION

Range: This system occurs on dry mountain ranges of the Great Basin region and eastern foothills of the Sierra Nevada, typically at lower elevations ranging from 1600-2600 m.
Divisions: 206:C, 304:C
TNC Ecoregions: 6:C, 11:C, 12:C, 18:C
Subnations: CA, ID, NV, UT

CONCEPT

Associations:
- *Juniperus osteosperma / Artemisia arbuscula* Woodland (CEGL002757, G5)
- *Juniperus osteosperma / Artemisia nova* / Rock Woodland (CEGL000729, G5)
- *Juniperus osteosperma / Artemisia nova* Woodland (CEGL000728, G5?)
- *Juniperus osteosperma / Artemisia tridentata / Achnatherum hymenoides* Woodland (CEGL000731, G4G5)
- *Juniperus osteosperma / Bromus tectorum* Semi-natural Woodland (CEGL002817, GNR)
- *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733, GNR)
- *Juniperus osteosperma / Pseudoroegneria spicata* Woodland (CEGL000738, G4)
- *Juniperus osteosperma* / Sparse Understory Woodland (CEGL000732, GNRQ)
- *Juniperus scopulorum* Temporarily Flooded Woodland [Placeholder] (CEGL002777, G1)
- *Pinus edulis - Juniperus osteosperma / Atriplex* spp. Woodland [Provisional] (CEGL002366, GNR)
- *Pinus edulis - Juniperus osteosperma / Bromus tectorum* Semi-natural Woodland (CEGL002367, GNR)
- *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148, G5)
- *Pinus monophylla - Juniperus osteosperma - Quercus gambelii / Artemisia tridentata* Woodland (CEGL000837, G4?)
- *Pinus monophylla - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis)* Woodland (CEGL002942, GNR)
- *Pinus monophylla - Juniperus osteosperma / Artemisia arbuscula* Woodland (CEGL000830, G5)
- *Pinus monophylla - Juniperus osteosperma / Artemisia nova* Woodland (CEGL000831, G5?)
- *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* Woodland (CEGL000832, G5?)
- *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* ssp. *vaseyana / Pseudoroegneria spicata* Woodland (CEGL000833, G1)
- *Pinus monophylla - Juniperus osteosperma / Cercocarpus ledifolius / Pseudoroegneria spicata* Woodland (CEGL000834, G1)
- *Pinus monophylla - Juniperus osteosperma / Cercocarpus montanus - Quercus gambelii* Woodland [Provisional] (CEGL002968, GNR)
- *Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima* Woodland [Provisional] (CEGL002971, GNR)
- *Pinus monophylla - Juniperus osteosperma / Gutierrezia sarothrae / Pleuraphis jamesii* Woodland [Provisional] (CEGL002970, GNR)
- *Pinus monophylla - Juniperus osteosperma / Hesperostipa comata* Woodland (CEGL002969, GNR)
- *Pinus monophylla - Juniperus osteosperma / Leymus cinereus* Wooded Herbaceous Vegetation (CEGL000835, G1Q)
- *Pinus monophylla - Juniperus osteosperma / Prunus virginiana* Woodland (CEGL000836, G1Q)
- *Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL002941, GNR)
- *Pinus monophylla - Quercus gambelii / Artemisia tridentata* Woodland (CEGL000838, G4?)
- *Pinus monophylla / Amelanchier alnifolia / Arctostaphylos patula* Woodland (CEGL000826, G3G4)
- *Pinus monophylla / Artemisia tridentata / Elymus elymoides* Woodland [Provisional] (CEGL003154, GNR)
- *Pinus monophylla / Artemisia tridentata* Woodland (CEGL000827, G5)
- *Pinus monophylla / Cercocarpus ledifolius / Artemisia tridentata - Purshia tridentata* Woodland [Provisional] (CEGL003152, GNR)
- *Pinus monophylla / Cercocarpus ledifolius* Woodland (CEGL000828, G5)
- *Pinus monophylla / Ribes velutinum* Woodland [Provisional] (CEGL003153, GNR)
- *Pinus monophylla / Symphoricarpos oreophilus - Artemisia tridentata* Woodland (CEGL000839, G5)
- *Pinus monophylla* Woodland (CEGL000825, G5)
- *Quercus turbinella - Juniperus osteosperma* Shrubland (CEGL000981, G4?)

Alliances:
- *Juniperus osteosperma* Woodland Alliance (A.536)
- *Juniperus scopulorum* Temporarily Flooded Woodland Alliance (A.563)
- *Pinus edulis - (Juniperus* spp.) Woodland Alliance (A.516)
- *Pinus monophylla - (Juniperus osteosperma)* Woodland Alliance (A.543)
- *Pinus monophylla* Wooded Tall Herbaceous Alliance (A.1487)
- *Quercus turbinella* Shrubland Alliance (A.793)

SPATIAL CHARACTERISTICS

SOURCES

References: Barbour and Major 1977, Comer et al. 2003, Eyre 1980, Holland and Keil 1995, Shiflet 1994
Version: 07 Oct 2005 **Stakeholders:** West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.959 MIDDLE ROCKY MOUNTAIN MONTANE DOUGLAS-FIR FOREST AND WOODLAND

Primary Division: Rocky Mountain (306)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Montane, Lower Montane]; Forest and Woodland (Treed); Aridic; Intermediate Disturbance Interval; F-Patch/Medium Intensity; F-Landscape/Medium Intensity; Needle-Leaved Tree; RM Montane Mesic Mixed Conifer; Moderate (100-500 yrs) Persistence
Concept Summary: This ecological system occurs throughout the middle Rocky Mountains of central and southern Idaho (Lemhi, Beaverhead and Lost River ranges) south and east into the greater Yellowstone region and south into the Wind River and Gros Ventre ranges of Wyoming. It extends north into Montana on the east side of the Continental Divide north to about the McDonald Pass area, and also into the Rocky Mountain Front region of Montana. This is a *Pseudotsuga menziesii*-dominated system without the maritime floristic composition; these are forests and woodlands occurring in the central Rockies where the southern monsoon influence is less and maritime climate regime is not important. This system includes extensive *Pseudotsuga menziesii* forests, occasionally with *Pinus flexilis* on calcareous substrates, and *Pinus contorta* at higher elevations. True firs, such as *Abies concolor, Abies grandis*, and *Abies lasiocarpa*, are absent in these occurrences. Understory components include shrubs such as *Physocarpus malvaceus, Juniperus communis, Symphoricarpos oreophilus,* and *Mahonia repens,* and graminoids such as *Calamagrostis rubescens, Carex rossii*, and *Leucopoa kingii*. The fire regime is of mixed severity with moderate frequency. This system often occurs at the lower treeline immediately above valley grasslands, or sagebrush steppe and shrublands. Sometimes there may be a "bath-tub ring" of *Pinus ponderosa* at lower elevations or *Pinus flexilis* between the valley non-forested and the solid *Pseudotsuga menziesii* forest. In the Wyoming Basins, this system occurs as isolated stands of *Pseudotsuga menziesii*, with *Artemisia tridentata, Pseudoroegneria spicata, Leucopoa kingii*, and *Carex rossii*.

DISTRIBUTION

Range: This system occurs throughout the middle Rocky Mountains of central and southern Idaho (Lemhi, Beaverhead and Lost River ranges) south and east into the greater Yellowstone region and south into the Wind River and Gros Ventre ranges of Wyoming. It extends north into Montana on the east side of the Continental Divide to the Rocky Mountain Front and includes all of the Beaverhead Mountains Section (M332E) (Bailey et al. 1994). It may also occur in scattered patches in southeastern Oregon.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:P, 7:?, 8:C, 9:C, 10:C
Subnations: ID, MT, OR?, WY

CONCEPT

Associations:
- *Pinus ponderosa - Pseudotsuga menziesii / Calamagrostis rubescens* Woodland (CEGL000210, G2Q)
- *Pseudotsuga menziesii - Pinus flexilis / Leucopoa kingii* Woodland (CEGL000906, G4Q)
- *Pseudotsuga menziesii / Calamagrostis rubescens* Woodland (CEGL000429, G5)
- *Pseudotsuga menziesii / Carex rossii* Forest (CEGL000431, G2?)
- *Pseudotsuga menziesii / Juniperus communis* Forest (CEGL000439, G4)
- *Pseudotsuga menziesii / Leucopoa kingii* Woodland (CEGL000904, G3G4)
- *Pseudotsuga menziesii / Linnaea borealis* Forest (CEGL000441, G4)
- *Pseudotsuga menziesii / Mahonia repens* Forest (CEGL000442, G5)
- *Pseudotsuga menziesii / Physocarpus malvaceus - Linnaea borealis* Forest (CEGL000448, G4)
- *Pseudotsuga menziesii / Physocarpus malvaceus* Forest (CEGL000447, G5)
- *Pseudotsuga menziesii / Pseudoroegneria spicata* Woodland (CEGL000908, G4)
- *Pseudotsuga menziesii / Spiraea betulifolia* Forest (CEGL000457, G5)
- *Pseudotsuga menziesii / Symphoricarpos albus* Forest (CEGL000459, G5)
- *Pseudotsuga menziesii / Symphoricarpos oreophilus* Forest (CEGL000462, G5)

Alliances:
- *Pinus ponderosa - Pseudotsuga menziesii* Woodland Alliance (A.533)
- *Pseudotsuga menziesii* Forest Alliance (A.157)
- *Pseudotsuga menziesii* Woodland Alliance (A.552)

SPATIAL CHARACTERISTICS

SOURCES

References: Bailey et al. 1994, Eyre 1980, Western Ecology Working Group n.d.
Version: 23 Jan 2006 **Stakeholders:** West
Concept Author: M.S. Reid **LeadResp:** West

CES306.805 NORTHERN ROCKY MOUNTAIN DRY-MESIC MONTANE MIXED CONIFER FOREST

Primary Division: Rocky Mountain (306)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Montane]; Forest and Woodland (Treed); Ustic; Short Disturbance Interval; F-Patch/Low Intensity; Needle-Leaved Tree; Abies grandis - Mixed
Concept Summary: This ecological system is composed of highly variable montane coniferous forests found in the interior Pacific Northwest, from southernmost interior British Columbia, eastern Washington, eastern Oregon, northern Idaho, western and north-central Montana, and south along the east slope of the Cascades in Washington and Oregon. In central Montana it occurs on mountain islands (the Snowy Mountains). This system is associated with a submesic climate regime with annual precipitation ranging from 50 to 100 cm, with a maximum in winter or late spring. Winter snowpacks typically melt off in early spring at lower elevations. Elevations range from 460 to 1920 m. Most occurrences of this system are dominated by a mix of *Pseudotsuga menziesii* and *Pinus ponderosa* (but there can be one without the other) and other typically seral species, including *Pinus contorta, Pinus monticola* (not in central Montana), and *Larix occidentalis* (not in central Montana). *Picea engelmannii* (or *Picea glauca* or their hybrid) becomes increasingly common towards the eastern edge of the range. The nature of this forest system is a matrix of large patches dominated or codominated by one or combinations of the above species; *Abies grandis* (a fire-sensitive, shade-tolerant species not occurring in central Montana) has increased on many sites once dominated by *Pseudotsuga menziesii* and *Pinus ponderosa*, which were formerly maintained by low-severity wildfire. Presettlement fire regimes may have been characterized by frequent, low-intensity ground fires that maintained relatively open stands of a mix of fire-resistant species. Under present conditions the fire regime is mixed severity and more variable, with stand-replacing fires more common, and the forests are more homogeneous. With vigorous fire suppression, longer fire-return intervals are now the rule, and multi-layered stands of *Pseudotsuga menziesii, Pinus ponderosa*, and/or *Abies grandis* provide fuel "ladders," making these forests more susceptible to high-intensity, stand-replacing fires. They are very productive forests which have been priorities for timber production. They rarely form either upper or lower timberline forests. Understories are dominated by graminoids, such as *Pseudoroegneria spicata, Calamagrostis rubescens, Carex geyeri*, and *Carex rossii*, that may be associated with a variety of shrubs, such as *Acer glabrum, Juniperus communis, Physocarpus malvaceus, Symphoricarpos albus, Spiraea betulifolia*, or *Vaccinium membranaceum* on mesic sites. *Abies concolor* and *Abies grandis X concolor* hybrids in central Idaho (the Salmon Mountains) are included here but have very restricted range in this area. *Abies concolor* and *Abies grandis* in the Blue Mountains of Oregon are probably hybrids of the two and mostly *Abies grandis*.
Comments: Need to re-assess the concept of this system in relation to Northern Rocky Mountain Western Larch Savanna (CES306.837) and East Cascades Mesic Montane Mixed-Conifer Forest and Woodland (CES204.086). In PNV (PAGs) concept, this is mostly

- *Pseudotsuga menziesii*, moist *Pinus ponderosa* series, dry *Abies grandis* or warm, dry *Abies lasiocarpa* series in the Canadian Rockies, northern Middle Rockies, East Cascades and Okanagan ecoregions. Everett et al. (2000) indicate that in the eastern Cascades of Washington this system forms fire polygons due to abrupt north and south topography with presettlement fire-return intervals of 11-12 years typically covering less than 810 ha. Currently, fires have 40- to 45-year return intervals with thousands of hectares in size. Northern Rocky Mountain Western Larch Savanna (CES306.837) is a large-patch type that occurs typically within this matrix or the Northern Rocky Mountain Mesic Montane Mixed Conifer Forest (CES306.802) matrix. We need to define the percent cover of larch over 50% or over 75% relative cover of all trees for an occurrence to be placed in Northern Rocky Mountain Western Larch Savanna (CES306.837). This needs to be relative because these look(ed) like ponderosa savanna in places. East Cascades Mesic Montane Mixed-Conifer Forest and Woodland (CES204.086) has North Pacific floristic composition, and is mostly east Cascades ecoregion, peripheral in Okanagan ecoregion, and west Cascades. PAGs most of the *Abies grandis*, dry western red-cedar and western hemlock in the east Cascades. Environmentally, it is equivalent to Northern Rocky Mountain Mesic Montane Mixed Conifer Forest (CES306.802). Contrasting this system (CES306.805) with Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland (CES306.828) and Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland (CES306.830) is important in the Middle Rockies ecoregion and Oregon.

DISTRIBUTION

Range: This system is found in the interior Pacific Northwest, from southern interior British Columbia south and east into Oregon, Idaho (including north and central Idaho, down to the Boise Mountains), and western Montana, and south along the east slope of the Cascades in Washington and Oregon.
Divisions: 204:C, 304:P, 306:C

TNC Ecoregions: 2:P, 4:C, 6:C, 7:C, 8:C, 26:C, 68:C
Subnations: BC, ID, MT, OR, WA

CONCEPT

Associations:
- *Abies grandis / Acer glabrum* Forest (CEGL000267, G3)
- *Abies grandis / Arctostaphylos nevadensis* Woodland (CEGL000915, G2G3)
- *Abies grandis / Bromus vulgaris* Forest (CEGL002601, G3)
- *Abies grandis / Calamagrostis rubescens* Woodland (CEGL000916, G4?)
- *Abies grandis / Carex geyeri* Woodland (CEGL000917, G3)
- *Abies grandis / Linnaea borealis* Forest (CEGL000275, G3)
- *Abies grandis / Physocarpus malvaceus* Forest (CEGL000277, G3)
- *Abies grandis / Spiraea betulifolia* Forest (CEGL000281, G2)
- *Abies grandis / Symphoricarpos albus* Forest (CEGL000282, G3?)
- *Pinus monticola / Clintonia uniflora* Forest (CEGL000176, G1Q)
- *Pinus ponderosa - Pseudotsuga menziesii / Arctostaphylos nevadensis* Woodland (CEGL000208, G2)
- *Pinus ponderosa - Pseudotsuga menziesii / Arctostaphylos patula* Woodland (CEGL000209, G3)
- *Pinus ponderosa - Pseudotsuga menziesii / Carex geyeri* Forest (CEGL000211, GNRQ)
- *Pinus ponderosa - Pseudotsuga menziesii / Penstemon fruticosus* Woodland (CEGL000212, G2G3)
- *Pinus ponderosa - Pseudotsuga menziesii / Physocarpus malvaceus* Forest (CEGL000213, GNRQ)
- *Pinus ponderosa - Pseudotsuga menziesii / Pseudoroegneria spicata* ssp. *inermis* Woodland (CEGL000207, G3Q)
- *Pinus ponderosa - Pseudotsuga menziesii / Purshia tridentata* Woodland (CEGL000214, G3)
- *Pseudotsuga menziesii / Angelica* spp. Forest (CEGL005853, G2?)
- *Pseudotsuga menziesii / Arctostaphylos uva-ursi - Purshia tridentata* Forest (CEGL000426, G3?)
- *Pseudotsuga menziesii / Arctostaphylos uva-ursi* Cascadian Forest (CEGL000425, G3G4)
- *Pseudotsuga menziesii / Arctostaphylos uva-ursi* Forest (CEGL000424, G4)
- *Pseudotsuga menziesii / Arnica cordifolia* Forest (CEGL000427, G4)
- *Pseudotsuga menziesii / Bromus ciliatus* Forest (CEGL000428, G4)
- *Pseudotsuga menziesii / Calamagrostis rubescens* Woodland (CEGL000429, G5)
- *Pseudotsuga menziesii / Carex geyeri* Forest (CEGL000430, G4?)
- *Pseudotsuga menziesii / Carex rossii* Forest (CEGL000431, G2?)
- *Pseudotsuga menziesii / Clintonia uniflora - Xerophyllum tenax* Forest (CEGL005854, G4G5)
- *Pseudotsuga menziesii / Clintonia uniflora* Forest (CEGL005850, G4G5)
- *Pseudotsuga menziesii / Linnaea borealis* Forest (CEGL000441, G4)
- *Pseudotsuga menziesii / Menziesia ferruginea / Clintonia uniflora* Forest (CEGL005851, G3?)
- *Pseudotsuga menziesii / Osmorhiza berteroi* Forest (CEGL000445, G4G5)
- *Pseudotsuga menziesii / Paxistima myrsinites* Forest (CEGL000446, G2G3)
- *Pseudotsuga menziesii / Physocarpus malvaceus - Linnaea borealis* Forest (CEGL000448, G4)
- *Pseudotsuga menziesii / Symphoricarpos occidentalis* Forest (CEGL000461, G3?)
- *Pseudotsuga menziesii / Symphoricarpos oreophilus* Forest (CEGL000462, G5)
- *Pseudotsuga menziesii / Vaccinium caespitosum* Forest (CEGL000465, G5)
- *Pseudotsuga menziesii / Vaccinium membranaceum / Xerophyllum tenax* Forest (CEGL005852, G4G5)
- *Pseudotsuga menziesii / Vaccinium* spp. Forest (CEGL000464, G4Q)

Alliances:
- *Abies grandis* Forest Alliance (A.153)
- *Abies grandis* Woodland Alliance (A.558)
- *Pinus monticola* Forest Alliance (A.133)
- *Pinus ponderosa - Pseudotsuga menziesii* Forest Alliance (A.134)
- *Pinus ponderosa - Pseudotsuga menziesii* Woodland Alliance (A.533)
- *Pseudotsuga menziesii* Forest Alliance (A.157)
- *Pseudotsuga menziesii* Woodland Alliance (A.552)

Dynamics: Landfire VDDT models: R#MCONdy.

SPATIAL CHARACTERISTICS

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1987, Crawford and Johnson 1985, Daubenmire and Daubenmire 1968, Eyre 1980, Lillybridge et al. 1995, Pfister et al. 1977, Steele and Geier-Hayes 1995, Steele et al. 1981, Topik 1989, Topik et al. 1988, Williams and Lillybridge 1983

Version: 23 Jan 2006 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.802 NORTHERN ROCKY MOUNTAIN MESIC MONTANE MIXED CONIFER FOREST

Primary Division: Rocky Mountain (306)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Forest and Woodland (Treed); Udic; Very Long Disturbance Interval; F-Landscape/Medium Intensity; Needle-Leaved Tree; Tsuga heterophylla and Thuja plicata; Long (>500 yrs) Persistence
Concept Summary: This ecological system occurs in the northern Rockies of western Montana west into northeastern Washington and southern British Columbia. These are vegetation types dominated by *Tsuga heterophylla* and *Thuja plicata* in most cases, found in areas influenced by incursions of mild, wet, Pacific maritime air masses. Much of the annual precipitation occurs as rain, but where snow does occur, it can generally be melted by rain during warm winter storms. Occurrences generally are found on all slopes and aspects but grow best on sites with high soil moisture, such as toeslopes and bottomlands. At the periphery of its distribution, this system is confined to moist canyons and cooler, moister aspects. Generally these are moist, non-flooded or upland sites that are not saturated yearlong. Along with *Tsuga heterophylla* and *Thuja plicata, Pseudotsuga menziesii* commonly shares the canopy, and *Pinus monticola, Pinus contorta, Abies grandis, Taxus brevifolia*, and *Larix occidentalis* are major associates. Mesic *Abies grandis* associations are included in this system, and *Abies grandis* is often the dominant in these situations; *Tsuga heterophylla* and *Thuja plicata* can both be absent. *Cornus nuttallii* may be present in some situations. *Picea engelmannii, Abies lasiocarpa*, and *Pinus ponderosa* may be present but only on the coldest or warmest and driest sites. *Linnaea borealis, Paxistima myrsinites, Alnus incana, Acer glabrum, Spiraea betulifolia, Symphoricarpos hesperius (= Symphoricarpos mollis ssp. hesperius), Cornus canadensis, Rubus parviflorus, Menziesia ferruginea*, and *Vaccinium membranaceum* are common shrub species. The composition of the herbaceous layer reflects local climate and degree of canopy closure; it is typically highly diverse in all but closed-canopy conditions. Important forbs and ferns include *Actaea rubra, Anemone piperi, Aralia nudicaulis, Asarum caudatum, Clintonia uniflora, Coptis occidentalis, Thalictrum occidentale, Tiarella trifoliata, Trientalis borealis, Trillium ovatum, Viola glabella, Gymnocarpium dryopteris, Polystichum munitum*, and *Adiantum pedatum*. Typically, stand-replacement, fire-return intervals are 150-500 years, with moderate-severity fire intervals of 50-100 years.

DISTRIBUTION

Range: This system occurs in the northern Rockies of western Montana west into northeastern Washington and southern British Columbia.
Divisions: 306:C
TNC Ecoregions: 7:C, 8:C, 68:C
Subnations: BC, ID, MT, OR, WA

CONCEPT

Associations:
- *Abies grandis / Asarum caudatum* Forest (CEGL000269, G4)
- *Abies grandis / Clintonia uniflora* Forest (CEGL000272, G5)
- *Abies grandis / Coptis occidentalis* Forest (CEGL000273, G2)
- *Abies grandis / Linnaea borealis* Forest (CEGL000275, G3)
- *Abies grandis / Taxus brevifolia* Forest (CEGL000283, G2)
- *Betula papyrifera* Forest [Provisional] (CEGL000520, G4Q)
- *Pinus monticola / Clintonia uniflora* Forest (CEGL000176, G1Q)
- *Thuja plicata / Adiantum pedatum* Forest (CEGL000470, G2?)
- *Thuja plicata / Aralia nudicaulis* Forest (CEGL000471, G2)
- *Thuja plicata / Asarum caudatum* Forest (CEGL000472, G5)
- *Thuja plicata / Clintonia uniflora - Xerophyllum tenax* Forest (CEGL005930, G4?)
- *Thuja plicata / Clintonia uniflora* Forest (CEGL000474, G4)
- *Thuja plicata / Gymnocarpium dryopteris* Forest (CEGL000476, G3)
- *Thuja plicata / Taxus brevifolia / Asarum caudatum* Forest (CEGL000480, G2)
- *Thuja plicata / Vaccinium membranaceum* Forest (CEGL000487, G3G4)
- *Tsuga heterophylla / Aralia nudicaulis* Forest (CEGL000488, G3)
- *Tsuga heterophylla / Asarum caudatum* Forest (CEGL000490, G4)
- *Tsuga heterophylla / Clintonia uniflora* Forest (CEGL000493, G4)
- *Tsuga heterophylla / Gymnocarpium dryopteris* Forest (CEGL000494, G3G4)
- *Tsuga heterophylla / Menziesia ferruginea* Forest (CEGL000496, G2)
- *Tsuga heterophylla / Rubus pedatus* Forest (CEGL000113, G2)
- *Tsuga heterophylla / Xerophyllum tenax* Forest (CEGL000499, G2)

Alliances:
- *Abies grandis* Forest Alliance (A.153)
- *Betula papyrifera* Forest Alliance (A.267)

- *Pinus monticola* Forest Alliance (A.133)
- *Thuja plicata* Forest Alliance (A.166)
- *Tsuga heterophylla* Forest Alliance (A.145)

SPATIAL CHARACTERISTICS

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1987, Daubenmire and Daubenmire 1968, Eyre 1980, Meidinger and Pojar 1991, Pfister et al. 1977

Version: 23 Jan 2006 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.030 NORTHERN ROCKY MOUNTAIN PONDEROSA PINE WOODLAND AND SAVANNA

Primary Division: Rocky Mountain (306)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Matrix

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Ridge/Summit/Upper Slope; Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Sand Soil Texture; Aridic; Intermediate Disturbance Interval [Periodicity/Polycyclic Disturbance]; F-Patch/Medium Intensity; Needle-Leaved Tree; Graminoid; Pinus ponderosa with grassy understory; Pinus ponderosa with shrubby understory

Concept Summary: This inland Pacific Northwest ecological system occurs in the foothills of the northern Rocky Mountains in the Columbia Plateau region and west along the foothills of the Modoc Plateau and eastern Cascades into southern interior British Columbia. These woodlands and savannas occur at the lower treeline/ecotone between grasslands or shrublands and more mesic coniferous forests typically in warm, dry, exposed sites. Elevations range from less than 500 m in British Columbia to 1600 m in the central Idaho mountains. Occurrences are found on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most common. This ecological system generally occurs on glacial till, glacio-fluvial sand and gravel, dune, basaltic rubble, colluvium, to deep loess or volcanic ash-derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acidic pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. In the Oregon "pumice zone" this system occurs as matrix-forming, extensive woodlands on rolling pumice plateaus and other volcanic deposits. These woodlands in the eastern Cascades, Okanagan and northern Rockies regions receive winter and spring rains, and thus have a greater spring "green-up" than the drier woodlands in the central Rockies. *Pinus ponderosa* (primarily *var. ponderosa*) is the predominant conifer; *Pseudotsuga menziesii* may be present in the tree canopy but is usually absent. In southern interior British Columbia, *Pseudotsuga menziesii* or *Pinus flexilis* may form woodlands or fire-maintained savannas with and without *Pinus ponderosa var. ponderosa* at the lower treeline transition into grassland or shrub-steppe. The understory can be shrubby, with *Artemisia tridentata, Arctostaphylos patula, Arctostaphylos uva-ursi, Cercocarpus ledifolius, Physocarpus malvaceus, Purshia tridentata, Symphoricarpos oreophilus* or *Symphoricarpos albus, Prunus virginiana, Amelanchier alnifolia,* and *Rosa* spp. common species. Understory vegetation in the true savanna occurrences is predominantly fire-resistant grasses and forbs that resprout following surface fires; shrubs, understory trees and downed logs are uncommon. These more open stands support grasses such as *Pseudoroegneria spicata, Hesperostipa* spp., *Achnatherum* spp., dry *Carex* species (*Carex inops*), *Festuca idahoensis*, or *Festuca campestris*. The more mesic portions of this system may include *Calamagrostis rubescens* or *Carex geyeri*, species more typical of Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest (CES306.805). Mixed fire regimes and ground fires of variable return intervals maintain these woodlands typically with a shrub-dominated or patchy shrub layer, depending on climate, degree of soil development, and understory density. This includes the northern race of Interior Ponderosa Pine old-growth (USFS Region 6, USFS Region 1). Historically, many of these woodlands and savannas lacked the shrub component as a result of 3- to 7-year fire-return intervals.

Comments: Hot, dry Douglas-fir types with grass are included here. Rocky Mountain Ponderosa Pine Woodland (CES306.827) and Southern Rocky Mountain Ponderosa Pine Savanna (CES306.826) contain mostly *Pinus ponderosa var. scopulorum* and *Pinus arizonica var. arizonica (= Pinus ponderosa var. arizonica)*. The FRIS site describes different varieties of *Pinus ponderosa* and associated species. Johansen and Latta (2003) have mapped the distribution of the two varieties using mitochondrial DNA. They hybridize along the Continental Divide in Montana backing up the FRIS information. Another ponderosa pine system remains to be defined and described for the woodlands and savannas occurring in central and eastern Montana and the Black Hills region. These "northwestern Great Plains ponderosa pine woodlands" are likely to have a floristic component that is more northern Great Plains mixedgrass in nature, as well as being open woodlands generally found in a grassland matrix. Further work is need to identify the geographic and conceptual boundaries between Northern Rocky Mountain Ponderosa Pine Woodland and Savanna (CES306.030) and the northwestern Great Plains system.

Meeting of Pacific Northwest ecologists for Landfire concluded that the "true savanna" of high-frequency / low-intensity fires and grassy understories is now minimally in existence. Most areas that may have been savanna in the past are now more nearly closed-canopy woodlands/forests. Conclusion was that these true savannas should be included with this woodland system, rather than with

the climatically-edaphically controlled Northern Rocky Mountain Foothill Conifer Wooded Steppe (CES306.958). Hence, the "true fire-maintained savanna" is included in this woodland system.

Louisa Evers (pers. comm. 2006) notes that she has not found any evidence that ponderosa pine savanna existed historically in north-central and central Oregon. In north-central Oregon, the savanna would have been oak or pine-oak. In central Oregon, it may well have been western juniper. Condition surveys of the Cascades Forest Reserve and General Land Office survey notes suggest that ponderosa pine formed a woodland with grassy understories, but still was often referred to as open-parklike. Conversely pine-oak and Douglas-fir-oak savannas appeared to have once been quite common in the Willamette Valley (and are classified in North Pacific Oak Woodland (CES204.852)).

DISTRIBUTION

Range: This system is found in the Fraser River drainage of southern British Columbia south along the Cascades and northern Rocky Mountains of Washington, Oregon and California. In the northeastern part of its range, it extends across the northern Rocky Mountains west of the Continental Divide into northwestern Montana, south to the Snake River Plain in Idaho, and east into the foothills of western Montana.
Divisions: 204:C, 304:C, 306:C
TNC Ecoregions: 4:C, 6:C, 7:C, 8:C, 9:C, 10:C, 26:?, 33:?, 68:C
Subnations: BC, ID, MT, NV?, OR, WA

CONCEPT

Associations:
- *Pinus ponderosa - Pseudotsuga menziesii / Pseudoroegneria spicata* ssp. *inermis* Woodland (CEGL000207, G3Q)
- *Pinus ponderosa / Arctostaphylos patula - Arctostaphylos viscida* Forest (CEGL000061, G2Q)
- *Pinus ponderosa / Arctostaphylos patula - Ceanothus velutinus* Woodland (CEGL000062, G1)
- *Pinus ponderosa / Arctostaphylos patula - Purshia tridentata* Woodland (CEGL000063, G3)
- *Pinus ponderosa / Artemisia arbuscula* Woodland (CEGL000845, G2G3Q)
- *Pinus ponderosa / Artemisia tridentata* ssp. *vaseyana / Poa nervosa* Woodland (CEGL000180, G2G3)
- *Pinus ponderosa / Calamagrostis rubescens* Forest (CEGL000181, G2Q)
- *Pinus ponderosa / Carex geyeri* Woodland (CEGL000182, G3G4)
- *Pinus ponderosa / Ceanothus velutinus - Purshia tridentata* Woodland (CEGL000064, G4)
- *Pinus ponderosa / Cercocarpus ledifolius* Woodland (CEGL000850, G4)
- *Pinus ponderosa / Elymus glaucus* Forest (CEGL000184, G2)
- *Pinus ponderosa / Festuca idahoensis* Woodland (CEGL000857, G4)
- *Pinus ponderosa / Hesperostipa comata* Woodland (CEGL000879, G1)
- *Pinus ponderosa / Juniperus communis* Woodland (CEGL000859, G4?)
- *Pinus ponderosa / Mahonia repens* Forest (CEGL000187, G3Q)
- *Pinus ponderosa / Physocarpus malvaceus* Forest (CEGL000189, G2)
- *Pinus ponderosa / Pseudoroegneria spicata* Woodland (CEGL000865, G4)
- *Pinus ponderosa / Purshia tridentata / Carex geyeri* Woodland (CEGL002606, G3)
- *Pinus ponderosa / Purshia tridentata / Carex rossii* Woodland (CEGL000194, G2G3)
- *Pinus ponderosa / Purshia tridentata / Festuca idahoensis* Woodland (CEGL000195, G3)
- *Pinus ponderosa / Purshia tridentata / Pseudoroegneria spicata* Woodland (CEGL000197, G3)
- *Pinus ponderosa / Spiraea betulifolia* Forest (CEGL000202, G1G2)
- *Pinus ponderosa / Symphoricarpos albus* Forest (CEGL000203, G4?)
- *Pinus ponderosa / Symphoricarpos oreophilus* Forest (CEGL000205, G3)
- *Pinus ponderosa / Vaccinium caespitosum* Woodland (CEGL005841, G3?)
- *Pseudotsuga menziesii / Festuca campestris* Woodland (CEGL000901, G4)
- *Pseudotsuga menziesii / Festuca idahoensis* Woodland (CEGL000900, G4)
- *Pseudotsuga menziesii / Pseudoroegneria spicata* Woodland (CEGL000908, G4)

Alliances:
- *Pinus ponderosa - Pseudotsuga menziesii* Woodland Alliance (A.533)
- *Pinus ponderosa* Forest Alliance (A.124)
- *Pinus ponderosa* Woodland Alliance (A.530)
- *Pseudotsuga menziesii* Woodland Alliance (A.552)

Environment: This ecological system within the region occurs at the lower treeline/ecotone between grasslands or shrublands and more mesic coniferous forests typically in warm, dry, exposed sites at elevations ranging from 500-1600 m (1600-5248 feet). It can occur on all slopes and aspects; however, it commonly occurs on moderately steep to very steep slopes or ridgetops. This ecological system generally occurs on most geological substrates from weathered rock to glacial deposits to eolian deposits. Characteristic soil features include good aeration and drainage, coarse textures, circumneutral to slightly acidic pH, an abundance of mineral material, and periods of drought during the growing season. Some occurrences may occur as edaphic climax communities on very skeletal, infertile and/or

excessively drained soils, such as pumice, cinder or lava fields, and scree slopes. Surface textures are highly variable in this ecological system ranging from sand to loam and silt loam. Exposed rock and bare soil consistently occur to some degree in all the associations.
Dynamics: *Pinus ponderosa* is a drought-resistant, shade-intolerant conifer which usually occurs at lower treeline in the major ranges of the western United States. Historically, ground fires and drought were influential in maintaining open-canopy conditions in these woodlands. With settlement and subsequent fire suppression, occurrences have become denser. Presently, many occurrences contain understories of more shade-tolerant species, such as *Pseudotsuga menziesii* and/or *Abies* spp., as well as younger cohorts of *Pinus ponderosa*. These altered occurrence structures have affected fuel loads and alter fire regimes. Presettlement fire regimes were primarily frequent (5- to 15-year return intervals), low-intensity ground fires triggered by lightning strikes or deliberately set fires by Native Americans. With fire suppression and increased fuel loads, fire regimes are now less frequent and often become intense crownfires, which can kill mature *Pinus ponderosa* (Reid et al. 1999).

Establishment is erratic and believed to be linked to periods of adequate soil moisture and good seed crops as well as fire frequencies, which allow seedlings to reach sapling size. Longer fire-return intervals have resulted in many occurrences having dense subcanopies of overstocked and unhealthy young *Pinus ponderosa* (Reid et al. 1999).

White-headed woodpecker, pygmy nuthatch, and flammulated owl are indicators of a healthy ponderosa pine woodland. All of these birds prefer mature trees in an open woodland setting (Winn 1998, Jones 1998, Levad 1998 as cited in Rondeau 2001).

Landfire VDDT models: R#PIPOm.

SPATIAL CHARACTERISTICS

SOURCES

References: Camp et al. 1997, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Comer et al. 2003, Cooper et al. 1987, Daubenmire and Daubenmire 1968, Everett et al. 2000, Evers pers. comm., Eyre 1980, Franklin and Dyrness 1973, Johansen and Latta 2003, Mauk and Henderson 1984, Mehl 1992, Meidinger and Pojar 1991, Pfister et al. 1977, Reid et al. 1999, Shiflet 1994, USFS 1993, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Version: 23 Feb 2006 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.807 NORTHERN ROCKY MOUNTAIN SUBALPINE WOODLAND AND PARKLAND

Primary Division: Rocky Mountain (306)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Upper Montane]; Forest and Woodland (Treed); Ridge/Summit/Upper Slope; Oligotrophic Soil; Very Short Disturbance Interval; W-Patch/High Intensity; W-Patch/Medium Intensity; W-Landscape/Medium Intensity; Larix lyallii; Upper Treeline; Long (>500 yrs) Persistence
Concept Summary: This system of the northern Rockies, Cascade Mountains, and northeastern Olympic Mountains is typically a high-elevation mosaic of stunted tree clumps, open woodlands, and herb- or dwarf-shrub-dominated openings, occurring above closed forest ecosystems and below alpine communities. It includes open areas with clumps of *Pinus albicaulis*, as well as woodlands dominated by *Pinus albicaulis* or *Larix lyallii*. In the Cascade Mountains and northeastern Olympic Mountains, the tree clump pattern is one manifestation, but these are also woodlands with an open canopy, without a tree clump/opening patchiness to them; in fact, that is quite common with *Pinus albicaulis*. The climate is typically very cold in winter and dry in summer. In the Cascades and Olympic Mountains, the climate is more maritime in nature and wind is not as extreme. The upper and lower elevational limits, due to climatic variability and differing topography, vary considerably; in interior British Columbia, this system occurs between 1000 and 2100 m elevation, and in northwestern Montana it occurs up to 2380 m. Landforms include ridgetops, mountain slopes, glacial trough walls and moraines, talus slopes, landslides and rockslides, and cirque headwalls and basins. Some sites have little snow accumulation because of high winds and sublimation. *Larix lyallii* stands generally occur at or near upper treeline on north-facing cirques or slopes where snowfields persist until June or July. In this harsh, often wind-swept environment, trees are often stunted and flagged from damage associated with wind and blowing snow and ice crystals, especially at the upper elevations of the type. The stands or patches often originate when *Picea engelmannii, Larix lyallii*, or *Pinus albicaulis* colonize a sheltered site such as the lee side of a rock. *Abies lasiocarpa* can then colonize in the shelter of the *Picea engelmannii* and may form a dense canopy by branch layering. Major disturbances are windthrow and snow avalanches. Fire is known to occur infrequently in this system, at least where woodlands are present; lightning damage to individual trees is common, but sparse canopies and rocky terrain limit the spread of fire. These high-elevation coniferous woodlands are dominated by *Pinus albicaulis, Abies lasiocarpa*, and/or *Larix lyallii*, with occasional *Picea engelmannii*. In the Cascades and Olympics, *Abies lasiocarpa* sometimes dominates the tree layer without *Pinus albicaulis*, though in this dry parkland *Tsuga mertensiana* and *Abies amabilis* are largely absent. The undergrowth is usually somewhat depauperate, but some stands support a near sward of heath plants, such as *Phyllodoce glanduliflora, Phyllodoce empetriformis, Empetrum nigrum, Cassiope mertensiana*, and *Kalmia polifolia*, and can include a slightly taller layer of *Ribes montigenum, Salix brachycarpa, Salix*

glauca, Salix planifolia, Vaccinium membranaceum, Vaccinium myrtillus, or *Vaccinium scoparium* that may be present to codominant. The herbaceous layer is sparse under dense shrub canopies or may be dense where the shrub canopy is open or absent. *Vahlodea atropurpurea (= Deschampsia atropurpurea), Luzula glabrata var. hitchcockii*, and *Juncus parryi* are the most commonly associated graminoids.

Comments: There is a proposal to either split the dry, subalpine *Pinus albicaulis* woodlands of the Blue Mountains (Oregon) and northern Nevada into a different system; or else to include them in Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland (CES306.819). For Landfire, these *Pinus albicaulis* woodlands were included in this subalpine parkland system, but ecologically and floristically they are more similar to Rocky Mountain dry subalpine woodlands.

DISTRIBUTION

Range: This system occurs in the northern Rocky Mountains, west into the Cascade Mountains and northeastern Olympic Mountains, and east into the mountain "islands" of central Montana.

Divisions: 204:C, 306:C

TNC Ecoregions: 3:C, 7:C, 8:C, 9:P, 26:C, 68:C

Subnations: AB, BC, ID, MT, WA, WY

CONCEPT

Associations:

- *Abies lasiocarpa - Picea engelmannii* Krummholz Shrubland (CEGL000985, G4)
- *Abies lasiocarpa - Picea engelmannii* Tree Island Forest (CEGL000329, GUQ)
- *Abies lasiocarpa - Pinus albicaulis / Arctostaphylos uva-ursi* Woodland (CEGL000751, G2Q)
- *Abies lasiocarpa - Pinus albicaulis / Vaccinium scoparium* Woodland (CEGL000752, G5?)
- *Larix lyallii / Vaccinium deliciosum* Woodland (CEGL000952, G3)
- *Larix lyallii / Vaccinium scoparium / Luzula glabrata* var. *hitchcockii* Woodland (CEGL000951, G2G3)
- *Pinus albicaulis - (Abies lasiocarpa) / Carex geyeri* Woodland (CEGL000754, G2G3)
- *Pinus albicaulis - (Picea engelmannii) / Dryas octopetala* Woodland (CEGL005840, G2G3?)
- *Pinus albicaulis - Abies lasiocarpa / Menziesia ferruginea / Xerophyllum tenax* Woodland (CEGL005836, G3?)
- *Pinus albicaulis - Abies lasiocarpa / Vaccinium membranaceum / Xerophyllum tenax* Woodland (CEGL005837, G3?)
- *Pinus albicaulis - Abies lasiocarpa / Vaccinium scoparium / Luzula glabrata* var. *hitchcockii* Woodland (CEGL005839, G3?)
- *Pinus albicaulis - Abies lasiocarpa / Vaccinium scoparium / Xerophyllum tenax* Woodland (CEGL005838, G3?) Pinus albicaulis - Abies lasiocarpa Woodland (CEGL000128, G5?)
- *Pinus albicaulis / Calamagrostis rubescens* Woodland (CEGL000753, G2)
- *Pinus albicaulis / Carex rossii* Forest (CEGL000129, G3)
- *Pinus albicaulis / Festuca idahoensis* Woodland (CEGL000755, G4)
- *Pinus albicaulis / Juniperus communis* Woodland (CEGL000756, G4?)
- *Pinus albicaulis / Luzula glabrata* var. *hitchcockii* Woodland (CEGL000758, G3)
- *Pinus albicaulis / Vaccinium scoparium* Forest (CEGL000131, G4)
- *Pinus albicaulis* Woodland [Placeholder] (CEGL000127, G5?)

Alliances:

- *Abies lasiocarpa - Picea engelmannii - Pinus flexilis* Krummholz Shrubland Alliance (A.811)
- *Abies lasiocarpa - Picea engelmannii* Forest Alliance (A.168)
- *Larix lyallii* Woodland Alliance (A.631)
- *Pinus albicaulis - Abies lasiocarpa* Woodland Alliance (A.560)
- *Pinus albicaulis* Forest Alliance (A.132)
- *Pinus albicaulis* Woodland Alliance (A.531)

Environment: In the Cascades and Olympic Mountains, the climate is more maritime in nature and wind is not as extreme, but summer drought is a more important process than in the related North Pacific Maritime Mesic Subalpine Parkland (CES204.837).

Dynamics: *Larix lyallii* is a very slow-growing, long-lived tree, with individuals up to 1000 years in age. It is generally shade-intolerant; however, extreme environmental conditions limit potentially competing trees.

SPATIAL CHARACTERISTICS

SOURCES

References: Arno 1970, Arno and Habeck 1972, Burns and Honkala 1990a, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1999, Ecosystems Working Group 1998, Eyre 1980, Lillybridge et al. 1995, Meidinger and Pojar 1991, Williams and Lillybridge 1983, Williams and Smith 1990

Version: 06 Sep 2005 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.820 ROCKY MOUNTAIN LODGEPOLE PINE FOREST

Primary Division: Rocky Mountain (306)

Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Acidic Soil; Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Ustic; Long Disturbance Interval; F-Patch/High Intensity [Seasonality/Fall Fire]; F-Landscape/High Intensity; Needle-Leaved Tree; Pinus contorta; Moderate (100-500 yrs) Persistence
Concept Summary: This ecological system is widespread in upper montane to subalpine elevations of the Rocky Mountains, Intermountain West region, north into the Canadian Rockies and east into mountain "islands" of north-central Montana. These are subalpine forests where the dominance of *Pinus contorta* is related to fire history and topo-edaphic conditions. Following stand-replacing fires, *Pinus contorta* will rapidly colonize and develop into dense, even-aged stands. Most forests in this ecological system occur as early- to mid-successional forests which developed following fires. This system includes *Pinus contorta*-dominated stands that, while typically persistent for >100-year time frames, may succeed to spruce-fir; in the southern and central Rocky Mountains it is seral to Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland (CES306.828). More northern occurrences are seral to Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland (CES306.830). Soils supporting these forests are typically well-drained, gravelly, coarse-textured, acidic, and rarely formed from calcareous parent materials. These forests are dominated by *Pinus contorta* with shrub, grass, or barren understories. Sometimes there are intermingled mixed conifer/*Populus tremuloides* stands, with the latter occurring with inclusions of deeper, typically fine-textured soils. The shrub stratum may be conspicuous to absent; common species include *Arctostaphylos uva-ursi, Ceanothus velutinus, Linnaea borealis, Mahonia repens, Purshia tridentata, Spiraea betulifolia, Spiraea douglasii, Shepherdia canadensis, Vaccinium caespitosum, Vaccinium scoparium, Vaccinium membranaceum, Symphoricarpos albus,* and *Ribes* spp. In southern interior British Columbia, this system is usually an open lodgepole pine forest found extensively between 500 and 1600 m elevation in the Columbia Range. In the Interior Cedar Hemlock and Interior Douglas-fir zones, *Tsuga heterophylla* or *Pseudotsuga menziesii* may present.

DISTRIBUTION

Range: This system occurs at upper montane to subalpine elevations of the Rocky Mountains, Intermountain West region, north into the Canadian Rockies, and east onto mountain "islands" of north-central Montana. In Washington, this system occurs mostly on the east side of the Cascade Crest. In Oregon, this system only occurs in the Blue Mountains; all Oregon Cascades lodgepole pine forest are included in other systems.
Divisions: 304:C, 306:C
TNC Ecoregions: 7:C, 8:C, 9:C, 11:C, 18:C, 20:C, 26:C, 68:C
Subnations: AB, BC, CO, ID, MT, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Ceanothus velutinus* Shrubland (CEGL002167, GNR)
- *Chamerion angustifolium* Rocky Mountain Herbaceous Vegetation [Provisional] (CEGL005856, G4G5)
- *Pinus contorta / Angelica* spp. Woodland (CEGL005915, G3?)
- *Pinus contorta / Arnica cordifolia* Forest (CEGL000135, G4?)
- *Pinus contorta / Carex geyeri* Forest (CEGL000141, G4?)
- *Pinus contorta / Ceanothus velutinus* Forest (CEGL000145, G4)
- *Pinus contorta / Clintonia uniflora - Xerophyllum tenax* Woodland (CEGL005921, G4G5)
- *Pinus contorta / Clintonia uniflora* Forest (CEGL005916, G5)
- *Pinus contorta / Linnaea borealis* Forest (CEGL000153, G5)
- *Pinus contorta / Menziesia ferruginea / Clintonia uniflora* Forest (CEGL005922, G4G5)
- *Pinus contorta / Menziesia ferruginea* Forest (CEGL005928, G3G4)
- *Pinus contorta / Osmorhiza berteroi* Forest (CEGL000155, G3Q)
- *Pinus contorta / Pedicularis racemosa* Forest (CEGL000156, G2Q)
- *Pinus contorta / Shepherdia canadensis* Forest (CEGL000163, G3G4)
- *Pinus contorta / Spiraea betulifolia* Forest (CEGL000164, G3G4)
- *Pinus contorta / Spiraea douglasii* Forest (CEGL002604, G3G4)
- *Pinus contorta / Symphoricarpos albus* Forest (CEGL000166, G3Q)
- *Pinus contorta / Thalictrum occidentale* Forest (CEGL000167, G4Q)
- *Pinus contorta / Vaccinium caespitosum / Clintonia uniflora* Forest (CEGL005923, G4?)
- *Pinus contorta / Vaccinium caespitosum* Forest (CEGL000168, G5)
- *Pinus contorta / Vaccinium membranaceum / Xerophyllum tenax* Forest (CEGL005913, G4G5)
- *Pinus contorta / Vaccinium membranaceum* Forest (CEGL000170, G4?)
- *Pinus contorta / Vaccinium membranaceum* Rocky Mountain Forest (CEGL000169, G3G4)
- *Pinus contorta / Vaccinium scoparium / Calamagrostis rubescens* Forest (CEGL000174, G3Q)
- *Pinus contorta / Vaccinium scoparium / Xerophyllum tenax* Forest (CEGL005924, G3G4)
- *Pinus contorta / Vaccinium scoparium* Forest (CEGL000172, G5)
- *Pinus contorta / Xerophyllum tenax* Forest (CEGL000175, G5)

- *Pinus contorta* var. *latifolia / Vaccinium scoparium / Carex inops* ssp. *inops* Forest (CEGL000173, G3)

Alliances:
- *Ceanothus velutinus* Shrubland Alliance (A.787)
- *Chamerion angustifolium* Herbaceous Alliance (A.3535)
- *Pinus contorta* Forest Alliance (A.118)
- *Pinus contorta* Woodland Alliance (A.512)

Dynamics: *Pinus contorta* is an aggressively colonizing, shade-intolerant conifer which usually occurs in lower subalpine forests in the major ranges of the western United States. Establishment is episodic and linked to stand-replacing disturbances, primarily fire. The incidence of serotinous cones varies within and between varieties of *Pinus contorta*, being most prevalent in Rocky Mountain populations. Closed, serotinous cones appear to be strongly favored by fire, and allow rapid colonization of fire-cleared substrates (Burns and Honkala 1990a). Hoffman and Alexander (1980, 1983) report that in stands where *Pinus contorta* exhibits a multi-aged population structure, with regeneration occurring, there is typically a higher proportion of trees bearing nonserotinous cones.

SPATIAL CHARACTERISTICS

SOURCES

References: Alexander 1986, Alexander et al. 1987, Anderson 1999a, Arno et al. 1985, Barrows et al. 1977, Burns and Honkala 1990a, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Despain 1973a, Despain 1973b, Ecosystems Working Group 1998, Eyre 1980, Hess and Alexander 1986, Hess and Wasser 1982, Hoffman and Alexander 1976, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Johnson and Clausnitzer 1992, Johnston 1997, Kingery 1998, Mauk and Henderson 1984, Mehl 1992, Meidinger and Pojar 1991, Moir 1969a, Nachlinger et al. 2001, Neely et al. 2001, Pfister et al. 1977, Steele et al. 1981, Whipple 1975, Williams and Smith 1990

Version: 20 Apr 2006 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.960 ROCKY MOUNTAIN POOR-SITE LODGEPOLE PINE FOREST

Primary Division: Rocky Mountain (306)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Acidic Soil; Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Ustic; Long Disturbance Interval; F-Patch/High Intensity [Seasonality/Fall Fire]; F-Landscape/High Intensity; Needle-Leaved Tree; Pinus contorta; Moderate (100-500 yrs) Persistence

Concept Summary: This ecological system is widespread but patchy in distribution in upper montane to subalpine elevations of the Rocky Mountains and Intermountain region. These are subalpine forests, occasionally found in the montane zone, where the dominance of *Pinus contorta* is related to topo-edaphic conditions and nutrient-poor soils. These include excessively well-drained pumice deposits, glacial till and alluvium on valley floors where there is cold-air accumulation, warm and droughty shallow soils over fractured quartzite bedrock, and shallow moisture-deficient soils with a significant component of volcanic ash. Pumice soils at lower elevations of the pumice zone of Oregon support this system. Soils on these sites are typically well-drained, gravelly, coarse-textured, acidic, and rarely formed from calcareous parent materials. Following stand-replacing fires, *Pinus contorta* will rapidly colonize and develop into dense, even-aged stands and then persist on these sites that are too extreme for other conifers to establish. In some cases, stands are open to dense and may be multi-aged, not just even-aged. These forests are dominated by *Pinus contorta* with shrub, grass, or barren understories. Sometimes there are intermingled mixed conifer/*Populus tremuloides* stands, with the latter occurring with inclusions of deeper, typically fine-textured soils. In central Oregon, *Pseudotsuga menziesii, Pinus ponderosa*, and *Abies concolor* may be present, and *Populus tremuloides* may be present as small patches. The shrub stratum may be conspicuous to absent; common species include *Arctostaphylos uva-ursi, Artemisia tridentata, Juniperus communis, Ceanothus velutinus, Linnaea borealis, Mahonia repens, Purshia tridentata, Spiraea betulifolia, Shepherdia canadensis, Vaccinium scoparium, Symphoricarpos albus,* and *Ribes* spp. Some open stands with very sparse understories can experience a form of mixed-severity burning via cigarette burning along downed logs (insufficient fuels between logs to carry fire). Depending on the arrangement and loading of logs to living trees, either mortality or fire-scarring may occur.

Comments: The higher elevation *Pinus contorta* forests of the southern Cascades are included in Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland (CES206.912).

DISTRIBUTION

Range: This system is found in the upper montane to subalpine elevations of the Rocky Mountains from north-central Colorado north and west into Wyoming, Montana, Idaho, Oregon and Washington, as well as the Intermountain region (northeast Nevada and north-central Utah). In north-central Montana (mapzone 20), it may occur on appropriate habitats (intrusive volcanics, very nutrient poor) within "island" mountain ranges (Big Snowy and Highwood mountains).

Divisions: 304:C, 306:C

TNC Ecoregions: 7:C, 8:C, 9:C, 11:C, 18:C, 20:C, 26:P, 68:C

Subnations: AB, BC?, CO?, ID, MT, NV?, OR, UT, WA, WY

CONCEPT

Associations:

- *Pinus contorta / Achnatherum occidentale* Woodland (CEGL000165, G4Q)
- *Pinus contorta / Arctostaphylos uva-ursi* Forest (CEGL000134, G5)
- *Pinus contorta / Artemisia tridentata / Elymus elymoides* Woodland (CEGL000137, G3)
- *Pinus contorta / Artemisia tridentata / Festuca idahoensis* Woodland (CEGL000136, G3)
- *Pinus contorta / Calamagrostis rubescens* Forest (CEGL000139, G5)
- *Pinus contorta / Carex geyeri* Forest (CEGL000141, G4?)
- *Pinus contorta / Carex pensylvanica* Forest (CEGL000143, G3G4)
- *Pinus contorta / Carex rossii* Forest (CEGL000144, G5)
- *Pinus contorta / Danthonia californica* Forest (CEGL000146, G3Q)
- *Pinus contorta / Festuca idahoensis* Woodland (CEGL000149, G3)
- *Pinus contorta / Juniperus communis* Woodland (CEGL000764, G5)
- *Pinus contorta / Mahonia repens* Forest (CEGL000154, G4G5)
- *Pinus contorta / Purshia tridentata - Ribes cereum* Woodland (CEGL000161, G4)
- *Pinus contorta / Purshia tridentata / Carex pensylvanica* Forest (CEGL000159, G4)
- *Pinus contorta / Purshia tridentata* Woodland (CEGL000765, G3)
- *Pinus contorta / Vaccinium scoparium / Calamagrostis rubescens* Forest (CEGL000174, G3Q)
- *Pinus contorta / Vaccinium scoparium* Forest (CEGL000172, G5)
- *Pinus contorta* var. *latifolia / Purshia tridentata / Achnatherum occidentale* ssp. *occidentale* Woodland (CEGL000162, G3)
- *Pinus contorta* var. *latifolia / Purshia tridentata / Festuca idahoensis* Woodland (CEGL000160, G3)

Alliances:

- *Pinus contorta* Forest Alliance (A.118)
- *Pinus contorta* Woodland Alliance (A.512)

Dynamics: *Pinus contorta* is an aggressively colonizing, shade-intolerant conifer which usually occurs in lower subalpine forests in the major ranges of the western United States. Establishment is episodic and linked to stand-replacing disturbances, primarily fire. The incidence of serotinous cones varies within and between varieties of *Pinus contorta*, being most prevalent in Rocky Mountain populations. Closed, serotinous cones appear to be strongly favored by fire and allow rapid colonization of fire-cleared substrates (Burns and Honkala 1990a). Hoffman and Alexander (1980, 1983) report that, in stands where *Pinus contorta* exhibits a multi-aged population structure with regeneration occurring, there is typically a higher proportion of trees bearing nonserotinous cones.

Past clearcutting has expanded this type into ponderosa pine forests south of Bend, Oregon, by creating frost pockets that favor lodgepole pine establishment.

SPATIAL CHARACTERISTICS

SOURCES

References: Alexander 1986, Alexander et al. 1987, Anderson 1999a, Arno et al. 1985, Barrows et al. 1977, Burns and Honkala 1990a, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Despain 1973a, Despain 1973b, Ecosystems Working Group 1998, Eyre 1980, Hess and Alexander 1986, Hess and Wasser 1982, Hoffman and Alexander 1976, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Johnson and Clausnitzer 1992, Johnston 1997, Kingery 1998, Mauk and Henderson 1984, Mehl 1992, Meidinger and Pojar 1991, Moir 1969a, Nachlinger et al. 2001, Neely et al. 2001, Pfister et al. 1977, Steele et al. 1981, Western Ecology Working Group n.d., Whipple 1975, Williams and Smith 1990

Version: 23 Jan 2006 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.828 ROCKY MOUNTAIN SUBALPINE DRY-MESIC SPRUCE-FIR FOREST AND WOODLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Matrix

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Upper Montane]; Forest and Woodland (Treed); Acidic Soil; Ustic; Very Long Disturbance Interval [Seasonality/Summer Disturbance]; F-Patch/High Intensity; F-Landscape/High Intensity; Needle-Leaved Tree; Abies lasiocarpa - Picea engelmannii; RM Subalpine Mesic Spruce-Fir; Long (>500 yrs) Persistence

Concept Summary: Engelmann spruce and subalpine fir forests comprise a substantial part of the subalpine forests of the Cascades and Rocky Mountains from southern British Columbia east into Alberta, south into New Mexico and the Intermountain region. They also occur on mountain "islands" of north-central Montana. They are the matrix forests of the subalpine zone, with elevations ranging from 1275 m in its northern distribution to 3355 m in the south (4100-11,000 feet). They often represent the highest elevation forests in an area. Sites within this system are cold year-round, and precipitation is predominantly in the form of snow, which may persist until late summer. Snowpacks are deep and late-lying, and summers are cool. Frost is possible almost all summer and may be common in

restricted topographic basins and benches. Despite their wide distribution, the tree canopy characteristics are remarkably similar, with *Picea engelmannii* and *Abies lasiocarpa* dominating either mixed or alone. *Pseudotsuga menziesii* may persist in occurrences of this system for long periods without regeneration. *Pinus contorta* is common in many occurrences, and patches of pure *Pinus contorta* are not uncommon, as well as mixed conifer/*Populus tremuloides* stands. In some areas, such as Wyoming, *Picea engelmannii*-dominated forests are on limestone or dolomite, while nearby codominated spruce-fir forests are on granitic or volcanic rocks. Upper elevation examples may have more woodland physiognomy, and *Pinus albicaulis* can be a seral component. Xeric species may include *Juniperus communis, Linnaea borealis, Mahonia repens,* or *Vaccinium scoparium.* More northern occurrences often have taller, more mesic shrub and herbaceous species, such as *Empetrum nigrum, Rhododendron albiflorum,* and *Vaccinium membranaceum.* Disturbance includes occasional blowdown, insect outbreaks and stand-replacing fire. Mean return interval for stand-replacing fire is 222 years as estimated in southeastern British Columbia.

DISTRIBUTION

Range: This system is found in the Cascades and Rocky Mountains from southern interior British Columbia east into Alberta, south into New Mexico and the Intermountain region. This type tends to be very limited in the northern Oregon Cascades.
Divisions: 304:C, 306:C
TNC Ecoregions: 4:C, 7:C, 8:C, 9:C, 11:C, 20:C, 21:C, 26:C, 68:C
Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Abies lasiocarpa - Picea engelmannii / Arnica cordifolia* Forest (CEGL000298, G5)
- *Abies lasiocarpa - Picea engelmannii / Arnica latifolia* Forest (CEGL000299, G4)
- *Abies lasiocarpa - Picea engelmannii / Calamagrostis rubescens* Forest (CEGL000301, G4G5)
- *Abies lasiocarpa - Picea engelmannii / Carex geyeri* Forest (CEGL000304, G5)
- *Abies lasiocarpa - Picea engelmannii / Galium triflorum* Forest (CEGL000311, G4)
- *Abies lasiocarpa - Picea engelmannii / Juniperus communis* Woodland (CEGL000919, G4G5)
- *Abies lasiocarpa - Picea engelmannii / Linnaea borealis* Forest (CEGL000315, G5)
- *Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea* Forest (CEGL000319, G5)
- *Abies lasiocarpa - Picea engelmannii* / Moss Forest (CEGL000321, G4)
- *Abies lasiocarpa - Picea engelmannii / Polemonium pulcherrimum* Forest (CEGL000373, G5)
- *Abies lasiocarpa - Picea engelmannii / Symphoricarpos albus* Forest (CEGL000337, G3)
- *Abies lasiocarpa - Picea engelmannii / Thalictrum occidentale* Forest (CEGL000338, G4)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium caespitosum* Forest (CEGL000340, G5)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium membranaceum* Rocky Mountain Forest (CEGL000341, G5)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium myrtillus* Forest (CEGL000343, G5)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium scoparium* Forest (CEGL000344, G5)
- *Abies lasiocarpa - Picea engelmannii* Krummholz Shrubland (CEGL000985, G4)
- *Abies lasiocarpa - Picea engelmannii* Tree Island Forest (CEGL000329, GUQ)
- *Abies lasiocarpa / Carex rossii* Forest (CEGL000305, G4G5)
- *Abies lasiocarpa / Carex siccata* Forest (CEGL000303, G2)
- *Abies lasiocarpa / Jamesia americana* Forest (CEGL000312, G1)
- *Abies lasiocarpa / Lathyrus lanszwertii* var. *leucanthus* Forest (CEGL000313, G3G4)
- *Abies lasiocarpa / Mahonia repens* Forest (CEGL000318, G5)
- *Abies lasiocarpa / Osmorhiza berteroi* Forest (CEGL000323, G4)
- *Abies lasiocarpa / Packera sanguisorboides* Forest (CEGL000333, G3)
- *Abies lasiocarpa / Paxistima myrsinites* Woodland (CEGL000324, G4)
- *Abies lasiocarpa / Pedicularis racemosa* Forest (CEGL000325, G5)
- *Abies lasiocarpa / Physocarpus malvaceus* Forest (CEGL000326, G3)
- *Abies lasiocarpa / Saxifraga bronchialis* Scree Woodland (CEGL000924, G4)
- *Abies lasiocarpa / Spiraea betulifolia* Forest (CEGL000335, G4)
- *Abies lasiocarpa / Xerophyllum tenax* Forest (CEGL000346, G5)
- *Abies lasiocarpa* Scree Woodland (CEGL000925, G5?)
- *Chamerion angustifolium* Rocky Mountain Herbaceous Vegetation [Provisional] (CEGL005856, G4G5)
- *Picea (engelmannii X glauca, engelmannii) / Clintonia uniflora* Forest (CEGL000406, G4)
- *Picea engelmannii / Arnica cordifolia* Forest (CEGL000355, G3G4)
- *Picea engelmannii / Clintonia uniflora* Forest (CEGL000360, G3)
- *Picea engelmannii / Erigeron eximius* Forest (CEGL000364, G5)
- *Picea engelmannii / Galium triflorum* Forest (CEGL002174, G4)
- *Picea engelmannii / Geum rossii* Forest (CEGL000366, G3?)
- *Picea engelmannii / Hypnum revolutum* Forest (CEGL000368, G3)
- *Picea engelmannii / Juniperus communis* Forest (CEGL005925, G3)

- *Picea engelmannii / Leymus triticoides* Forest (CEGL000362, G3)
- *Picea engelmannii / Linnaea borealis* Forest (CEGL002689, G4)
- *Picea engelmannii / Trifolium dasyphyllum* Forest (CEGL000377, G2?)
- *Picea engelmannii / Vaccinium myrtillus* Forest (CEGL000379, G4Q)
- *Picea engelmannii / Vaccinium scoparium* Forest (CEGL000381, G3G5)

Alliances:

- *Abies lasiocarpa - Picea engelmannii - Pinus flexilis* Krummholz Shrubland Alliance (A.811)
- *Abies lasiocarpa - Picea engelmannii* Forest Alliance (A.168)
- *Abies lasiocarpa* Woodland Alliance (A.559)
- *Chamerion angustifolium* Herbaceous Alliance (A.3535)
- *Picea engelmannii* Forest Alliance (A.164)

Dynamics: *Picea engelmannii* can be very long-lived, reaching 500 years of age. *Abies lasiocarpa* decreases in importance relative to

- *Picea engelmannii* with increasing distance from the region of Montana and Idaho where maritime air masses influence the climate. Fire is an important disturbance factor, but fire regimes have a long return interval and so are often stand-replacing. *Picea engelmannii* can rapidly recolonize and dominate burned sites, or can succeed other species such as *Pinus contorta* or *Populus tremuloides*. Due to great longevity, *Pseudotsuga menziesii* may persist in occurrences of this system for long periods without regeneration. Old-growth characteristics in *Picea engelmannii* forests will include treefall and windthrow gaps in the canopy, with large downed logs, rotting woody material, tree seedling establishment on logs or on mineral soils unearthed in root balls, and snags. Landfire VDDT models: #RSPFI.

SPATIAL CHARACTERISTICS

SOURCES

References: Alexander and Ronco 1987, Alexander et al. 1984a, Alexander et al. 1987, Anderson 1999a, Brand et al. 1976, Canadian Rockies Ecoregional Plan 2002, Clagg 1975, Comer et al. 2002, Comer et al. 2003, Cooper et al. 1987, Daubenmire and Daubenmire 1968, DeVelice et al. 1986, Ecosystems Working Group 1998, Eyre 1980, Fitzgerald et al. 1994, Fitzhugh et al. 1987, Graybosch and Buchanan 1983, Hess and Alexander 1986, Hess and Wasser 1982, Hoffman and Alexander 1976, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Hopkins 1979a, Hopkins 1979b, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Komarkova et al. 1988b, Lillybridge et al. 1995, Major et al. 1981, Mauk and Henderson 1984, Mehl 1992, Meidinger and Pojar 1991, Muldavin et al. 1992, Nachlinger et al. 2001, Neely et al. 2001, Peet 1978a, Peet 1981, Pfister 1972, Pfister et al. 1977, Romme 1982, Schaupp et al. 1999, Steele and Geier-Hayes 1995, Steele et al. 1981, Tuhy et al. 2002, Veblen 1986, Whipple and Dix 1979, Williams and Lillybridge 1983, Williams et al. 1995, Wong and Iverson 2004, Wong et al. 2003, Youngblood and Mauk 1985

Version: 20 Apr 2006 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.830 ROCKY MOUNTAIN SUBALPINE MESIC-WET SPRUCE-FIR FOREST AND WOODLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Upper Montane]; Forest and Woodland (Treed); Acidic Soil; Udic; Very Long Disturbance Interval [Seasonality/Summer Disturbance]; F-Patch/High Intensity; F-Landscape/Medium Intensity; Abies lasiocarpa - Picea engelmannii; RM Subalpine Dry-Mesic Spruce-Fir; Long (>500 yrs) Persistence

Concept Summary: This is a high-elevation system of the Rocky Mountains, dry eastern Cascades and eastern Olympic Mountains dominated by *Picea engelmannii* and *Abies lasiocarpa*. It extends westward into the northeastern Olympic Mountains and the northeastern side of Mount Rainier in Washington, and as far east at mountain "islands" of north-central Montana. *Picea engelmannii* is generally more important in southern forests than those in the Pacific Northwest. Occurrences are typically found in locations with cold-air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high-elevation ravines. They can extend down in elevation below the subalpine zone in places where cold-air ponding occurs; northerly and easterly aspects predominate. These forests are found on gentle to very steep mountain slopes, high-elevation ridgetops and upper slopes, plateau-like surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces. In the northern Rocky Mountains of northern Idaho and Montana, *Tsuga mertensiana* occurs as small to large patches within the matrix of this mesic spruce-fir system and only in the most maritime of environments (the coldest and wettest of the more Continental subalpine fir forests). In the Olympics and northern Cascades, the climate is more maritime than typical for this system, but due to the lower snowfall in these rainshadow areas, summer drought may be more significant than snowpack in limiting tree regeneration in burned areas. *Picea engelmannii* is rare in these areas. Mesic understory shrubs include *Menziesia ferruginea, Vaccinium membranaceum, Rhododendron albiflorum, Amelanchier alnifolia, Rubus parviflorus, Ledum glandulosum, Phyllodoce empetriformis,* and *Salix* spp. Herbaceous species include *Actaea rubra, Maianthemum stellatum, Cornus canadensis, Erigeron eximius, Gymnocarpium dryopteris, Rubus pedatus, Saxifraga bronchialis, Tiarella* spp., *Lupinus arcticus ssp. subalpinus, Valeriana sitchensis*, and graminoids *Luzula glabrata var. hitchcockii*

or *Calamagrostis canadensis*. Disturbances include occasional blowdown, insect outbreaks (30-50 years), mixed-severity fire, and stand-replacing fire (every 150-500 years). The more summer-dry climatic areas also have occasional high-severity fires.
Comments: While the name of this system ("Rocky Mountain") suggests a Rocky Mountain distribution, floristic affinities of Engelmann spruce-subalpine fir forests in western Washington and the Oregon Cascades are such that the spruce-fir forests of those regions are included in this system. The subalpine fir-dominated forests of the northeastern Olympic Mountains and the northeastern side of Mount Rainier are included here. They are more similar to subalpine fir forests on the eastern slopes of the Cascades than they are to mountain hemlock forests.

DISTRIBUTION

Range: This system is found at high elevations of the Rocky Mountains, extending west into the northeastern Olympic Mountains and the northeastern side of Mount Rainier in Washington, and as far east as mountain "islands" of north-central Montana.
Divisions: 204:C, 304:C, 306:C
TNC Ecoregions: 1:C, 4:C, 7:C, 8:C, 9:C, 11:C, 20:C, 21:C, 26:C, 68:C
Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Abies lasiocarpa - Picea engelmannii / Acer glabrum* Forest (CEGL000294, G5)
- *Abies lasiocarpa - Picea engelmannii / Actaea rubra* Forest (CEGL000295, G4?)
- *Abies lasiocarpa - Picea engelmannii / Calamagrostis canadensis* Forest (CEGL000300, G5)
- *Abies lasiocarpa - Picea engelmannii / Clintonia uniflora - Xerophyllum tenax* Forest (CEGL005892, G4G5)
- *Abies lasiocarpa - Picea engelmannii / Clintonia uniflora* Forest (CEGL005912, G5)
- *Abies lasiocarpa - Picea engelmannii / Luzula glabrata* var. *hitchcockii* Woodland (CEGL000317, G5)
- *Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea - Vaccinium scoparium* Forest (CEGL005894, G2G4)
- *Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea / Clintonia uniflora* Forest (CEGL005893, G4G5)
- *Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea / Luzula glabrata* var. *hitchcockii* Woodland (CEGL005896, G4?)
- *Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea / Streptopus amplexifolius* Woodland (CEGL005897, G3G4)
- *Abies lasiocarpa - Picea engelmannii / Menziesia ferruginea / Xerophyllum tenax* Forest (CEGL005895, G4G5)
- *Abies lasiocarpa - Picea engelmannii / Ribes (montigenum, lacustre, inerme)* Forest (CEGL000331, G5)
- *Abies lasiocarpa - Picea engelmannii / Salix (brachycarpa, glauca)* Krummholz Shrubland (CEGL000986, GUQ)
- *Abies lasiocarpa - Picea engelmannii / Streptopus amplexifolius - Luzula glabrata* var. *hitchcockii* Woodland (CEGL005920, G2G3)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium caespitosum / Clintonia uniflora* Forest (CEGL005918, G3G4)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium membranaceum / Xerophyllum tenax* Forest (CEGL005917, GNR)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium membranaceum* Rocky Mountain Forest (CEGL000341, G5)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium scoparium / Thalictrum occidentale* Forest (CEGL005919, G3G4)
- *Abies lasiocarpa - Picea engelmannii / Vaccinium scoparium / Xerophyllum tenax* Forest (CEGL005914, G4G5)
- *Abies lasiocarpa - Picea engelmannii / Valeriana sitchensis* Woodland (CEGL005823, G2?)
- *Abies lasiocarpa - Picea engelmannii / Xerophyllum tenax - Luzula glabrata* var. *hitchcockii* Woodland (CEGL005898, G4G5)
- *Abies lasiocarpa - Picea engelmannii* Ribbon Forest (CEGL000328, GUQ)
- *Abies lasiocarpa / Caltha leptosepala* ssp. *howellii* Forest (CEGL000302, G3)
- *Abies lasiocarpa / Clematis columbiana* var. *columbiana* Forest (CEGL000306, G3?)
- *Abies lasiocarpa / Coptis occidentalis* Forest (CEGL000308, G4)
- *Abies lasiocarpa / Cornus canadensis* Forest (CEGL000309, G3G4)
- *Abies lasiocarpa / Erigeron eximius* Forest (CEGL000310, G5)
- *Abies lasiocarpa / Gymnocarpium dryopteris* Forest (CEGL002611, GNRQ)
- *Abies lasiocarpa / Ledum glandulosum* Forest (CEGL000314, G4)
- *Abies lasiocarpa / Phyllodoce empetriformis* Woodland (CEGL000920, G4Q)
- *Abies lasiocarpa / Rhododendron albiflorum* Woodland (CEGL000330, G4)
- *Abies lasiocarpa / Rubus parviflorus* Forest (CEGL000332, G5)
- *Abies lasiocarpa / Vaccinium membranaceum / Valeriana sitchensis* Forest (CEGL002612, G4)
- *Abies lasiocarpa / Vaccinium membranaceum* Forest (CEGL000342, G4)
- *Betula papyrifera* - Conifer / *Clintonia uniflora* Woodland (CEGL005904, G3G4)
- *Chamerion angustifolium* Rocky Mountain Herbaceous Vegetation [Provisional] (CEGL005856, G4G5)
- *Picea (engelmannii X glauca, engelmannii) / Packera streptanthifolia* Forest (CEGL000414, G4)
- *Picea engelmannii / Acer glabrum* Forest (CEGL000354, G2)
- *Picea engelmannii / Maianthemum stellatum* Forest (CEGL000415, G4?)
- *Picea engelmannii* / Moss Forest (CEGL000371, G4)
- *Picea engelmannii / Packera cardamine* Forest (CEGL000375, G2)
- *Picea engelmannii / Physocarpus malvaceus* Forest (CEGL002676, G3)
- *Picea engelmannii / Ribes montigenum* Forest (CEGL000374, G5?)
- *Populus balsamifera* ssp. *trichocarpa - Populus tremuloides* - Conifer / *Clintonia uniflora* Forest (CEGL005906, G3?)

- *Populus tremuloides - Abies lasiocarpa / Amelanchier alnifolia* Forest (CEGL000524, G3?)
- *Populus tremuloides - Abies lasiocarpa / Carex geyeri - Calamagrostis rubescens* Forest (CEGL000525, G3?)
- *Populus tremuloides - Abies lasiocarpa / Juniperus communis* Forest (CEGL000527, G3G4)
- *Tsuga mertensiana / Clintonia uniflora* Forest (CEGL000504, G3)
- *Tsuga mertensiana / Luzula glabrata* var. *hitchcockii* Forest (CEGL000505, G5)
- *Tsuga mertensiana / Menziesia ferruginea* Forest (CEGL000506, G4)
- *Tsuga mertensiana / Rhododendron albiflorum* Forest (CEGL000508, GNR)
- *Tsuga mertensiana / Streptopus amplexifolius* Forest (CEGL000511, G2)
- *Tsuga mertensiana / Vaccinium membranaceum* Forest (CEGL000514, G4)
- *Tsuga mertensiana / Xerophyllum tenax* Forest (CEGL000516, G4)

Alliances:
- *Abies lasiocarpa - Picea engelmannii - Pinus flexilis* Krummholz Shrubland Alliance (A.811)
- *Abies lasiocarpa - Picea engelmannii* Forest Alliance (A.168)
- *Abies lasiocarpa - Populus tremuloides* Forest Alliance (A.422)
- *Abies lasiocarpa* Seasonally Flooded Forest Alliance (A.190)
- *Abies lasiocarpa* Woodland Alliance (A.559)
- *Betula papyrifera* Woodland Alliance (A.603)
- *Chamerion angustifolium* Herbaceous Alliance (A.3535)
- *Picea engelmannii* Forest Alliance (A.164)
- *Picea engelmannii* Seasonally Flooded Forest Alliance (A.191)
- *Populus balsamifera* ssp. *trichocarpa* Temporarily Flooded Forest Alliance (A.311)
- *Tsuga mertensiana* Forest Alliance (A.146)
- *Tsuga mertensiana* Seasonally Flooded Forest Alliance (A.186)

Dynamics: Landfire VDDT models: #RSPFI and #RABLA.

SPATIAL CHARACTERISTICS

SOURCES

References: Alexander and Ronco 1987, Alexander et al. 1984a, Alexander et al. 1987, Anderson 1999a, Brand et al. 1976, Canadian Rockies Ecoregional Plan 2002, Clagg 1975, Comer et al. 2002, Comer et al. 2003, Cooper et al. 1987, Daubenmire and Daubenmire 1968, DeVelice et al. 1986, Ecosystems Working Group 1998, Eyre 1980, Fitzgerald et al. 1994, Graybosch and Buchanan 1983, Henderson et al. 1989, Hess and Alexander 1986, Hess and Wasser 1982, Hoffman and Alexander 1976, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Komarkova et al. 1988b, Lillybridge et al. 1995, Major et al. 1981, Mauk and Henderson 1984, Mehl 1992, Meidinger and Pojar 1991, Muldavin et al. 1996, Neely et al. 2001, Peet 1978a, Peet 1981, Pfister 1972, Pfister et al. 1977, Romme 1982, Schaupp et al. 1999, Steele and Geier-Hayes 1995, Steele et al. 1981, Tuhy et al. 2002, Veblen 1986, Whipple and Dix 1979, Williams and Lillybridge 1983, Williams et al. 1995, Wong and Iverson 2004, Wong et al. 2003, Youngblood and Mauk 1985

Version: 19 Apr 2006 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.819 ROCKY MOUNTAIN SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE WOODLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Ridge/Summit/Upper Slope; Calcareous; Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Aridic; W-Patch/High Intensity; W-Landscape/High Intensity; Needle-Leaved Tree; Pinus flexilis, P. aristata; Upper Treeline

Concept Summary: This ecological system occurs throughout the Rocky Mountains, south of Montana, on dry, rocky ridges and slopes near upper treeline above the matrix spruce-fir forest. It extends down to the lower montane in the northeastern Great Basin mountains where dominated by *Pinus flexilis*. Sites are harsh, exposed to desiccating winds, with rocky substrates and a short growing season that limit plant growth. Higher-elevation occurrences are found well into the subalpine-alpine transition on wind-blasted, mostly west-facing slopes and exposed ridges. Calcareous substrates are important for *Pinus flexilis*-dominated communities in the northern Rocky Mountains and possibly elsewhere. The open tree canopy is often patchy and is strongly dominated by *Pinus flexilis* or *Pinus aristata* with the latter restricted to southern Colorado, northern New Mexico and the San Francisco Mountains in Arizona. In the Wyoming Rockies and northern Great Basin, including the Blue Mountains of Oregon, *Pinus albicaulis* is found in some occurrences, but is a minor component. Other trees such as *Juniperus* spp., *Pinus contorta, Pinus ponderosa*, or *Pseudotsuga menziesii* are occasionally present. *Arctostaphylos uva-ursi, Cercocarpus ledifolius, Juniperus communis, Mahonia repens, Purshia tridentata, Ribes montigenum,* or *Vaccinium* spp. may form an open shrub layer in some stands. The herbaceous layer, if present, is generally sparse and composed of xeric graminoids, such as *Calamagrostis purpurascens, Festuca arizonica, Festuca idahoensis, Festuca thurberi*, or *Pseudoroegneria spicata*, or more alpine plants.

Comments: This system is distinguished from lower montane and foothill limber pine stands in Wyoming and Montana. The foothill system (Rocky Mountain Foothill Limber Pine-Juniper Woodland (CES306.955)) is found at the lower treeline, below the zone of continuous *Pinus ponderosa* or *Pseudotsuga menziesii* woodlands and forest, and extends out into the eastern portions of these states in the foothill zones of mountain ranges, along rock outcrops, breaks along rivers, and on sheltered sites where soil moisture is slightly higher than surrounding grasslands.

This system needs to be more clearly distinguished from Northern Rocky Mountain Subalpine Woodland and Parkland (CES306.807), which also includes woodlands of *Pinus flexilis* and *Pinus albicaulis* and occurs in similar environmental settings of the northern Rocky Mountains, particularly northwestern Wyoming, Montana, and north into Alberta and British Columbia. There is a proposal to include the dry, subalpine *Pinus albicaulis* woodlands of the Blue Mountains (Oregon) and northern Nevada into this system, Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland (CES306.819). For Landfire, these *Pinus albicaulis* woodlands were included in this subalpine parkland system, but ecologically and floristically they are more similar to Rocky Mountain dry subalpine woodlands.

DISTRIBUTION

Range: This system occurs throughout the Rocky Mountains, south of Montana, on dry, rocky ridges and slopes near upper treeline, including the Uinta and northern Wasatch mountains, and the Jarbridge Mountains in northeastern Nevada. It also occurs as very small patches of dry *Pinus albicaulis* woodlands in the Blue Mountains of Oregon.
Divisions: 303:C, 304:C, 306:C
TNC Ecoregions: 6:C, 7:C, 8:C, 9:C, 20:C, 21:C, 26:C, 68:P
Subnations: CO, ID?, MT?, NM, NV, OR, UT, WA?, WY

CONCEPT

Associations:
- *Pinus aristata / Festuca arizonica* Woodland (CEGL000759, G4)
- *Pinus aristata / Festuca thurberi* Woodland (CEGL000760, G5)
- *Pinus aristata / Juniperus communis* Woodland (CEGL002894, GU)
- *Pinus aristata / Ribes montigenum* Woodland (CEGL000761, G3)
- *Pinus aristata / Trifolium dasyphyllum* Woodland (CEGL000762, G2)
- *Pinus aristata / Vaccinium myrtillus* Woodland (CEGL002895, GU)
- *Pinus flexilis / Arctostaphylos uva-ursi* Woodland (CEGL000802, G4)
- *Pinus flexilis / Calamagrostis purpurascens* Woodland (CEGL000803, G4)
- *Pinus flexilis / Cercocarpus ledifolius* Woodland (CEGL000804, G4)
- *Pinus flexilis / Dasiphora fruticosa* ssp. *floribunda / Distichlis spicata* Woodland (CEGL000812, G1)
- *Pinus flexilis / Festuca campestris* Woodland (CEGL000806, G3)
- *Pinus flexilis / Festuca idahoensis* Woodland (CEGL000805, G5)
- *Pinus flexilis / Juniperus communis* Woodland (CEGL000807, G5)
- *Pinus flexilis / Juniperus osteosperma* Woodland (CEGL000808, G3)
- *Pinus flexilis / Juniperus scopulorum* Woodland (CEGL000809, G3)
- *Pinus flexilis / Leucopoa kingii* Woodland (CEGL000810, G3)
- *Pinus flexilis / Mahonia repens* Woodland (CEGL000811, G3?)
- *Pinus flexilis / Pseudoroegneria spicata* Woodland (CEGL000813, G4?)
- *Pseudotsuga menziesii - Pinus flexilis / Leucopoa kingii* Woodland (CEGL000906, G4Q)

Alliances:
- *Pinus aristata* Woodland Alliance (A.537)
- *Pinus flexilis* Temporarily Flooded Woodland Alliance (A.564)
- *Pinus flexilis* Woodland Alliance (A.540)
- *Pseudotsuga menziesii* Woodland Alliance (A.552)

SPATIAL CHARACTERISTICS

SOURCES

References: Baker n.d., Beasley and Klemmedson 1980, Brunstein and Yamaguchi 1992, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Eyre 1980, Knight 1994, Krebs 1972, LaMarche and Mooney 1972, Lanner and Vander Wall 1980, Neely et al. 2001, Ranne 1995, Ranne et al. 1997, Steele et al. 1983
Version: 05 Oct 2004 **Stakeholders:** Canada, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES204.101 SIERRAN-INTERMONTANE DESERT WESTERN WHITE PINE-WHITE FIR WOODLAND

Primary Division: North American Pacific Maritime (204)
Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Woody-Herbaceous; Very Shallow Soil; Aridic; Short Disturbance Interval; F-Patch/Low Intensity; F-Landscape/Low Intensity; Needle-Leaved Tree
Concept Summary: This interior Pacific Northwest ecological system occurs on the Modoc Plateau and Warner Mountains of California, north into the Fremont National Forest along the east slope of the southern Cascades in Oregon, and may also occur in isolated high-elevation ranges of northern Nevada. These forests and woodlands range from just above the zone of ponderosa pine in the montane zone, to the upper montane zone. Elevations range from 1370 m to over 2135 m (4500-7000 feet). Occurrences are found on all slopes and aspects, although more frequently on drier areas, including northwest- and southeast-facing slopes, but also occurs on northerly slopes and ridges. This ecological system generally occurs on basalts, andesite, glacial till, basaltic rubble, colluvium, or volcanic ash-derived soils, and sometimes on granitics (Carson Range). These soils have characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acidic pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. Climatically, this system occurs somewhat in the rainshadow of the Sierras and Cascades and has a more continental regime, similar to the northern Great Basin. This system tends to be more woodland than forest in character, and the undergrowth is more open and drier, with little shrub or herbaceous cover. Tree regeneration is less prolific than in other mixed-montane conifer systems of the Cascades, Sierras and California Coast Ranges. *Pinus monticola* is the dominant conifer in most places, but *Abies concolor var. lowiana* is usually present, at least in the understory, and occasionally as the dominant in the canopy, replacing *Pinus monticola*, particularly at lower elevations, and *Pinus ponderosa* is also often present. In the Warner Mountains, the *Abies concolor var. lowiana* stands range from 1675 to 2135 m (5500-7000 feet) in elevation, and the mixed *Pinus monticola - Abies concolor* is usually above 2135 m (7000 feet). Mixed stands with *Pinus contorta*, in moister locations, as well as *Pinus jeffreyi* and sometimes *Populus tremuloides* occasionally occur. Southern stands (around Babbitt Peak and in the Carson Range) can sometime have *Abies magnifica* in them, sometimes replacing *Abies concolor.* These forests and woodlands are marked by the absence of *Pseudotsuga menziesii, Pinus lambertiana,* and *Calocedrus decurrens,* and the generally drier, continental climatic conditions. In addition, the overall floristic affinities are with the Great Basin rather than Pacific Northwest. Understories are typically open, with moderately low shrub cover and diversity, and include *Arctostaphylos patula, Arctostaphylos nevadensis, Chrysolepis sempervirens, Ceanothus* sp., and *Ribes viscosissimum.* Common herbaceous taxa include *Arnica cordifolia, Festuca* sp., *Poa nervosa, Carex inops, Pyrola picta,* and *Hieracium albiflorum.* In openings, *Wyethia mollis* can be abundant.
Comments: An alternative name could be Modoc Plateau Western White Pine - White Fir Woodland. This system is very similar to Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland (CES206.916), Mediterranean California Mesic Mixed Conifer Forest and Woodland (CES206.915) and Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest (CES306.805). Justification for splitting this system includes the following: it is *Abies concolor var. lowiana* (as opposed to being grand fir, which is found further east and north; hence it's probably not the northern Rocky Mountain system); it lacks Douglas-fir completely which is an important component of the Californian mixed conifer systems in the Sierras; and the understory composition suggests it is drier (due to: lower elevations? volcanic-derived ash/tuff soils? rainshadow of the Cascades?) than the Californian systems.

DISTRIBUTION

Range: This ecological system is found in the transition zone from the northern Sierra Nevada of California and Oregon, east into the Modoc Plateau and Intermountain region of northwestern Nevada. It is found in the Fremont National Forest east of Lake View in Oregon, and in the Modoc Plateau and Warner Mountains of California. It continues farther south in California to the Diamond Mountains south of Honey Lake (a northeast extension of the Sierras), on Babbitt Peak between Lake Tahoe and Sierra Valley, and also in the Carson Range in Nevada east of Lake Tahoe Scattered stands may occur on Hart Mountain and Steens Mountain in Oregon and possibly a few isolated places in the northern Great Basin and the Jarbridge Mountains of Nevada.
Divisions: 204:C, 304:P
TNC Ecoregions: 4:C, 6:C
Subnations: CA, NV, OR

CONCEPT

Associations:
- *Abies concolor - Pinus monticola / Ribes viscosissimum* Forest (CEGL000260, G2)
- *Pinus monticola / Achnatherum occidentale* Woodland (CEGL008622, G3)

Alliances:
- *Abies concolor* Forest Alliance (A.152)
- *Pinus monticola* Woodland Alliance (A.532)

Dynamics: The open nature of the stands suggests regeneration and establishment is slow and sporadic. Stand-replacing events are not frequent; most fire is probably partial stand disturbance. These stands are relatively high elevation, and there are generally widely spaced large and somewhat fire-resistant individuals. Also the discontinuous understory and only patchy regeneration suggests non-stand-replacing fire as the norm., rather patchy burns with isolated trees surviving regularly. Local windthrow, insects, disease (blister rust), and individual lightning strikes probably make up most of the disturbances.

SPATIAL CHARACTERISTICS

SOURCES

References: Eyre 1980, Hopkins 1979a, Volland 1985, Western Ecology Working Group n.d.
Version: 23 Jan 2006 **Stakeholders:** West
Concept Author: M.S. Reid **LeadResp:** West

Mixed Deciduous and Evergreen Forest and Woodland (NLCD 43)

CES204.085 EAST CASCADES OAK-PONDEROSA PINE FOREST AND WOODLAND

Primary Division: North American Pacific Maritime (204)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Ridge/Summit/Upper Slope; Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Aridic; Intermediate Disturbance Interval [Periodicity/Polycyclic Disturbance]; F-Patch/Medium Intensity
Concept Summary: This narrowly restricted ecological system appears at or near lower treeline in foothills of the eastern Cascades in Washington and Oregon within 65 km (40 miles) of the Columbia River Gorge. It also appears in the adjacent Columbia Plateau ecoregion. Elevations range from 460 to 1920 m. Most occurrences of this system are dominated by a mix of *Quercus garryana* and *Pinus ponderosa* or *Pseudotsuga menziesii*. Isolated, taller *Pinus ponderosa* or *Pseudotsuga menziesii* over *Quercus garryana* trees characterize parts of this system. Clonal *Quercus garryana* can create dense patches across a grassy landscape or can dominate open woodlands or savannas. The understory may include dense stands of shrubs or, more often, be dominated by grasses, sedges or forbs. Shrub-steppe shrubs may be prominent in some stands and create a distinct tree / shrub / sparse grassland habitat, including *Purshia tridentata, Artemisia tridentata, Artemisia nova*, and *Chrysothamnus viscidiflorus.* Understories are generally dominated by herbaceous species, especially graminoids. Mesic sites have an open to closed sodgrass understory dominated by *Calamagrostis rubescens, Carex geyeri, Carex rossii, Carex inops*, or *Elymus glaucus.* Drier savanna and woodland understories typically contain bunchgrass steppe species such as *Festuca idahoensis* or *Pseudoroegneria spicata*. Common exotic grasses that often appear in high abundance are *Bromus tectorum* and *Poa bulbosa*. These woodlands occur at the lower treeline/ecotone between *Artemisia* spp. or *Purshia tridentata* steppe or shrubland and *Pinus ponderosa* and/or *Pseudotsuga menziesii* forests or woodlands. In the Columbia River Gorge, this system appears as small to large patches in transitional areas in the Little White Salmon and White Salmon river drainages in Washington and Hood River, Rock Creek, Moiser Creek, Mill Creek, Threemile Creek, Fifteen Mile Creek, and White River drainages in Oregon. *Quercus garryana* can create dense patches often associated with grassland or shrubland balds within a closed *Pseudotsuga menziesii* forest landscape. Commonly the understory is shrubby and composed of *Ceanothus integerrimus, Holodiscus discolor, Symphoricarpos albus*, and *Toxicodendron diversilobum.* Fire plays an important role in creating vegetation structure and composition in this habitat. Decades of fire suppression have led to invasion by *Pinus ponderosa* along lower treeline and by *Pseudotsuga menziesii* in the gorge and other oak patches on xeric sites in the east Cascade foothills. In the past, most of the habitat experienced frequent low-severity fires that maintained woodland or savanna conditions. The mean fire-return interval is 20 years, although variable. Soil drought plays a role, maintaining an open tree canopy in part of this dry woodland habitat.
Comments: Mapping this system presents a typical scale problem. Areas of pure ponderosa pine are found directly adjacent to oak stands. This system is a matrix type with stands of *Pinus ponderosa, Quercus garryana, Pinus ponderosa - (Pseudotsuga menziesii) - Quercus garryana*; still need to get a mapping protocol and concept to distinguish *Pseudotsuga menziesii* with *Quercus garryana* patches in the east gorge White Salmon. The Little White Salmon drainage near Augspurger Mountain is the transition area between North Pacific Oak Woodland (CES204.852) and this system (Dog Mountain is the westernmost in Washington).

DISTRIBUTION

Range: This narrowly restricted ecological system appears at or near lower treeline in foothills of the eastern Cascades in Washington and Oregon within 65 km (40 miles) of the Columbia River Gorge. It also appears in the adjacent Columbia Plateau ecoregion. Disjunct occurrences in Klamath and Siskiyou counties, Oregon, have more sagebrush and bitterbrush in the understory, along with other shrubs.
Divisions: 204:C, 304:C
TNC Ecoregions: 4:C, 6:C
Subnations: BC, OR, WA

CONCEPT

Associations:
- *Pinus ponderosa - Quercus garryana / Balsamorhiza sagittata* Woodland (CEGL000881, G2)
- *Pinus ponderosa - Quercus garryana / Carex geyeri* Woodland (CEGL000882, G2G3)
- *Pinus ponderosa - Quercus garryana / Purshia tridentata* Woodland (CEGL000883, G3)
- *Pinus ponderosa - Quercus garryana / Symphoricarpos albus* Woodland (CEGL000884, G2G3)

- *Pseudotsuga menziesii - Quercus garryana / Symphoricarpos albus* Woodland (CEGL000929, G2G3)
- *Quercus garryana / Carex geyeri* Woodland (CEGL000549, G1G2)
- *Quercus garryana / Elymus glaucus* Woodland (CEGL000550, G1G2)
- *Quercus garryana / Festuca idahoensis* Woodland (CEGL000551, G1?)
- *Quercus garryana / Pseudoroegneria spicata* Woodland (CEGL000552, G1G2)
- *Quercus garryana / Symphoricarpos albus* Woodland (CEGL000553, G2G3)

Alliances:
- *Pinus ponderosa - Quercus garryana* Woodland Alliance (A.689)
- *Pseudotsuga menziesii - Quercus garryana* Woodland Alliance (A.688)
- *Quercus garryana* Woodland Alliance (A.630)

Dynamics: Fire plays an important role in creating vegetation structure and composition in this habitat. Decades of fire suppression have led to invasion by *Pinus ponderosa* along lower treeline and by *Pseudotsuga menziesii* in the gorge and other oak patches on xeric sites in the east Cascade foothills. Most of the habitat experienced frequent low-severity fires that maintained woodland or savanna conditions. The mean fire-return interval is 20 years, although variable. Landfire VDDT models: #R OAP1 Oregon White Oak-Ponderosa Pine model describes general successional pathways treating drier pine succession separate from more mesic Douglas-fir pathways.

SPATIAL CHARACTERISTICS

SOURCES

References: Eyre 1980, John and Tart 1986, Lillybridge et al. 1995, Topik et al. 1988, Western Ecology Working Group n.d.
Version: 23 Jan 2006 **Stakeholders:** Canada, West
Concept Author: R. Crawford **LeadResp:** West

CES304.776 INTER-MOUNTAIN BASINS ASPEN-MIXED CONIFER FOREST AND WOODLAND

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Forest and Woodland (Treed); Needle-Leaved Tree; Broad-Leaved Deciduous Tree; Aspen - Conifer Mix
Concept Summary: This ecological system occurs on montane slopes and plateaus in Utah, western Colorado, northern Arizona, eastern Nevada, southern Idaho, western Wyoming, and in north-central Montana in the Big Snowy Mountains. It also occurs in localized settings in the Klamath Mountains of California, as well as in the Sierra Nevada and adjacent Great Basin mountains (Inyo, White, Warner, and Modoc Plateau). Elevations range from 1700 to 2800 m. Occurrences are typically on gentle to steep slopes on any aspect but are often found on clay-rich soils in intermontane valleys. Soils are derived from alluvium, colluvium and residuum from a variety of parent materials but most typically occur on sedimentary rocks. The tree canopy is composed of a mix of deciduous and coniferous species, codominated by *Populus tremuloides* and conifers, including *Pseudotsuga menziesii, Abies concolor, Abies lasiocarpa, Abies magnifica, Picea engelmannii, Picea glauca X engelmannii, Picea pungens, Pinus contorta, Pinus flexilis, Pinus jeffreyi, Pinus contorta var. murrayana*, and *Pinus ponderosa*. As the occurrences age, *Populus tremuloides* is slowly reduced until the conifer species become dominant. Common shrubs include *Amelanchier alnifolia, Prunus virginiana, Acer grandidentatum, Symphoricarpos oreophilus, Juniperus communis, Paxistima myrsinites, Rosa woodsii, Spiraea betulifolia, Symphoricarpos albus*, or *Mahonia repens*. Herbaceous species include *Bromus carinatus, Calamagrostis rubescens, Carex geyeri, Elymus glaucus, Poa* spp., and *Achnatherum, Hesperostipa, Nassella*, and/or *Piptochaetium* spp. (= *Stipa* spp.), *Achillea millefolium, Arnica cordifolia*, Asteraceae spp., *Erigeron* spp., *Galium boreale, Geranium viscosissimum, Lathyrus* spp., *Lupinus argenteus, Mertensia arizonica, Mertensia lanceolata, Maianthemum stellatum, Osmorhiza berteroi (= Osmorhiza chilensis)*, and *Thalictrum fendleri*. Most occurrences at present represent a late-seral stage of aspen changing to a pure conifer occurrence. Nearly a hundred years of fire suppression and livestock grazing have converted much of the pure aspen occurrences to the present-day aspen-conifer forest and woodland ecological system. This is the typical meadow edge aspen-conifer setting in the Sierra Nevada where frequently, due to fire suppression, the conifers are replacing aspens.

DISTRIBUTION

Range: This system occurs on montane slopes and plateaus in Utah, eastern Nevada, southern Idaho, western Wyoming, and in north-central Montana in the Big Snowy Mountains. Elevations range from 1700 to 2800 m.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:C, 9:C, 11:C, 18:C, 19:P, 26:C
Subnations: AZ, CO, ID, MT, NV, UT, WY

CONCEPT

Associations:
- *Pinus contorta* var. *murrayana - Populus tremuloides / Artemisia tridentata / Poa pratensis* Forest (CEGL008669, GNR)
- *Pinus ponderosa - Populus tremuloides / Carex* spp. - (*Poa* spp.) Forest (CEGL000191, G2G3)

- *Populus tremuloides - Abies concolor / Arctostaphylos patula* Forest (CEGL000522, G4)
- *Populus tremuloides - Abies concolor / Poa pratensis* Semi-natural Forest (CEGL002947, GNA)
- *Populus tremuloides - Abies concolor / Symphoricarpos oreophilus* Forest (CEGL000523, G4G5)
- *Populus tremuloides - Abies lasiocarpa / Amelanchier alnifolia* Forest (CEGL000524, G3?)
- *Populus tremuloides - Abies lasiocarpa / Carex geyeri - Calamagrostis rubescens* Forest (CEGL000525, G3?)
- *Populus tremuloides - Abies lasiocarpa / Carex rossii* Forest (CEGL000526, G5)
- *Populus tremuloides - Abies lasiocarpa / Juniperus communis* Forest (CEGL000527, G3G4)
- *Populus tremuloides - Abies lasiocarpa / Pedicularis racemosa* Forest (CEGL000528, G2)
- *Populus tremuloides - Abies lasiocarpa / Shepherdia canadensis* Forest (CEGL000529, G3?)
- *Populus tremuloides - Abies lasiocarpa / Symphoricarpos oreophilus / Bromus carinatus* Forest (CEGL000530, G3G4)
- *Populus tremuloides - Abies lasiocarpa / Symphoricarpos oreophilus* / Tall Forbs Forest (CEGL000531, G4G5)
- *Populus tremuloides - Abies lasiocarpa / Symphoricarpos oreophilus / Thalictrum fendleri* Forest (CEGL000532, G3?)
- *Populus tremuloides - Abies lasiocarpa* / Tall Forbs Forest (CEGL000533, G5)
- *Populus tremuloides - Abies lasiocarpa / Thalictrum fendleri* Forest (CEGL000534, G4G5)
- *Populus tremuloides - Picea pungens* Forest (CEGL000535, G3G4)
- *Populus tremuloides - Pinus contorta / Carex geyeri - Calamagrostis rubescens* Forest (CEGL000536, G3?)
- *Populus tremuloides - Pinus contorta / Juniperus communis* Forest (CEGL000537, G4G5)
- *Populus tremuloides - Pinus contorta / Symphoricarpos oreophilus* Forest (CEGL000538, G3G4)
- *Populus tremuloides - Pinus contorta / Thalictrum fendleri* Forest (CEGL000539, G3?)
- *Populus tremuloides - Pinus flexilis* Forest (CEGL000540, G2G3)
- *Populus tremuloides - Pinus jeffreyi* Forest (CEGL003147, GNR)
- *Populus tremuloides - Pinus ponderosa* Rocky Mountain Forest (CEGL000541, G3G4)
- *Populus tremuloides - Pseudotsuga menziesii / Amelanchier alnifolia* Forest (CEGL000543, G3?)
- *Populus tremuloides - Pseudotsuga menziesii / Calamagrostis rubescens* Forest (CEGL000544, G3?)
- *Populus tremuloides - Pseudotsuga menziesii / Juniperus communis* Forest (CEGL000545, G3G4)
- *Populus tremuloides - Pseudotsuga menziesii / Symphoricarpos oreophilus* Forest (CEGL000546, G4)

Alliances:

- *Abies concolor - Populus tremuloides* Forest Alliance (A.419)
- *Abies lasiocarpa - Populus tremuloides* Forest Alliance (A.422)
- *Picea pungens - Populus tremuloides* Forest Alliance (A.423)
- *Pinus contorta - Populus tremuloides* Forest Alliance (A.424)
- *Pinus contorta* Forest Alliance (A.118)
- *Pinus flexilis - Populus tremuloides* Forest Alliance (A.425)
- *Pinus ponderosa - Populus tremuloides* Forest Alliance (A.399)
- *Populus tremuloides - Pseudotsuga menziesii* Forest Alliance (A.426)
- *Populus tremuloides* Forest Alliance (A.274)

Environment: The aspen-conifer forest and woodland ecological system is very similar to the aspen forest ecological system with regards to environmental characteristics. It is usually found on montane slopes and plateaus in western Wyoming, Idaho, Utah, eastern Nevada. Elevations range from 1700 to 2800 m. Climate is temperate with cold winters. Mean annual precipitation is greater than 38 cm and typically greater than 50 cm. Occurrences are typically on gentle to steep slopes on any aspect. Soils are derived from alluvium, colluvium and residuum from a variety of parent materials, but most typically occur on sedimentary rocks.

Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand (Mueggler 1988). Secondarily, its range is limited by the length of the growing season; or low temperatures (Mueggler 1988). Topography is variable, sites range from level to steep slopes. Aspect varies according to the limiting factors. Occurrences at high elevations are restricted by cold temperatures and are found on warmer southern aspects. At lower elevations aspen is restricted by lack of moisture and is found on cooler north aspects and mesic microsites. The soils are typically deep and well-developed with rock often absent from the soil. Soil texture ranges from sandy loam to clay loams. Parent materials are variable and may include sedimentary, metamorphic or igneous rocks, but it appears to grow best on limestone, basalt, and calcareous or neutral shales (Mueggler 1988).

Vegetation: The open to moderately closed, mixed evergreen needle-leaved and deciduous broad-leaved tree canopy is composed of short to moderately tall trees, and is codominated by *Populus tremuloides* and conifers, including *Pseudotsuga menziesii, Abies concolor, Abies lasiocarpa, Picea engelmannii, Picea pungens, Pinus contorta, Pinus flexilis*, and *Pinus ponderosa*. As the occurrences age, *Populus tremuloides* is slowly reduced until the conifer species becomes dominant (Mueggler 1988).

The sparse to moderately dense understory may be structurally complex and includes tall-shrub, short-shrub and herbaceous layers, or simple with just an herbaceous layer. Because of the open growth form of *Populus tremuloides*, more light can penetrate the canopy than in a pure conifer occurrence. Typically the understory is usually denser in younger occurrences that are dominated by *Populus tremuloides*, and in more mesic sites with open canopies. If present the tall-shrub layer may be dominated by *Amelanchier alnifolia, Prunus virginiana*, or *Acer grandidentatum*, and short-shrub by *Symphoricarpos oreophilus, Juniperus communis*, or *Mahonia repens*. Other common shrubs include *Paxistima myrsinites, Rosa woodsii, Spiraea betulifolia, Symphoricarpos albus*, and in wet

areas *Salix scouleriana*. Where dense, the herbaceous layer is often dominated by graminoids such as *Bromus carinatus, Calamagrostis rubescens, Carex geyeri, Elymus glaucus, Poa* spp., and *Achnatherum, Hesperostipa, Nassella*, and/or *Piptochaetium* spp. (= *Stipa* spp.). More sparse herbaceous layers are generally a more even mixture of forbs like *Achillea millefolium, Arnica cordifolia, Eucephalus engelmannii (= Aster engelmannii), Erigeron speciosus, Fragaria vesca, Galium boreale, Geranium viscosissimum, Lathyrus* spp., *Lupinus argenteus, Mertensia arizonica, Mertensia lanceolata, Maianthemum stellatum, Osmorhiza berteroi (= Osmorhiza chilensis)*, and *Thalictrum fendleri*. Annuals are typically uncommon. The exotic species *Poa pratensis* and *Taraxacum officinale* are more common in livestock-impacted occurrences (Mueggler 1988).

Dynamics: *Populus tremuloides* is thin-barked and readily killed by fire. It is a fire-adapted species that generally needs a large disturbance to establish and maintain dominance in a forest. These mixed forests are generally seral and, in the absence of stand-replacing disturbance such as fire, will slowly convert to a conifer-dominated forest (Mueggler 1988). The natural fire-return interval is approximately 20 to 50 years for seral occurrences (USFS 1996). Intervals that approach 100 years are typical of late-seral occurrences (USFS 1996). Although the young conifer trees in these occurrences are susceptible to fire, older individuals develop self-pruned lower branches and develop a thick corky bark that make them resistant to ground fires. Most of the occurrences sampled by Mueggler (1988) have had a history of livestock grazing as evidenced by relative abundance of the exotic plants *Taraxacum officinale, Poa pratensis*, and other grazing-tolerant plants, and the scarcity of grazing-susceptible plants (Mueggler 1988). Most occurrences that we see today represent a late-seral stage of aspen changing to a pure conifer occurrence. Nearly a hundred years of fire suppression and livestock grazing have converted much of the pure aspen occurrences to the present-day aspen-conifer forest and woodland ecological system.

SPATIAL CHARACTERISTICS

Adjacent Ecological System Comments: Adjacent occurrences above or beside these mixed forests are typically pure aspen forest or mixed-conifer forest, or subalpine spruce-fir forest and woodlands, while lower elevations may include grasslands and shrublands.

SOURCES

References: Bartos and Cambell 1998, Comer et al. 2003, DeByle and Winokur 1985, DeVelice et al. 1986, Eyre 1980, Henderson et al. 1977, Mueggler 1988, Shiflet 1994, Tuhy et al. 2002, Youngblood and Mauk 1985, Youngblood and Mueggler 1981

Version: 20 Apr 2006 **Stakeholders:** West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

UPLAND SHRUBLAND (NLCD 50)

CES304.770 COLUMBIA PLATEAU SCABLAND SHRUBLAND

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Shrubland

Spatial Scale & Pattern: Matrix

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Lowland [Lowland]; Shrubland (Shrub-dominated); Basalt; Shallow Soil

Concept Summary: This ecological system is found in the Columbia Plateau region and forms extensive low shrublands. These xeric shrublands occur under relatively extreme soil-moisture conditions. Substrates are typically shallow lithic soils with limited water-holding capacity over fractured basalt. Because of poor drainage through basalt, these soils are often saturated from fall to spring by winter precipitation but typically dry out completely to bedrock by midsummer. Total vegetation cover is typically low, generally less than 50% and often much less than that. Vegetation is characterized by an open dwarf-shrub canopy dominated by *Artemisia rigida* along with other shrub and dwarf-shrub species, particularly *Eriogonum* spp. Other shrubs are uncommon in this system; mixes of *Artemisia rigida* and other *Artemisia* species typically belong to different ecological systems than this. Low cover of perennial bunch grasses, such as *Danthonia unispicata, Elymus elymoides, Festuca idahoensis*, or primarily *Poa secunda*, as well as scattered forbs, including species of *Allium, Antennaria, Balsamorhiza, Lomatium, Phlox*, and *Sedum*, characterize these sites. Individual sites can be dominated by grasses and semi-woody forbs, such as *Stenotus stenophyllus*. Annuals may be seasonally abundant, and cover of moss and lichen is often high in undisturbed areas (1-60% cover).

DISTRIBUTION

Range: This system occurs in the Columbia Plateau region of southern Idaho, eastern Oregon and eastern Washington, and extreme northern Nevada.

Divisions: 304:C

TNC Ecoregions: 6:C, 7:C, 68:C

Subnations: CA?, ID, NV, OR, UT?, WA

CONCEPT

Associations:

- *Artemisia rigida / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL002995, G2)
- *Artemisia rigida / Poa secunda* Shrub Herbaceous Vegetation (CEGL001528, G4)
- *Artemisia rigida / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001529, G3)

- *Danthonia californica - Festuca idahoensis* Herbaceous Vegetation (CEGL001607, G1Q)
- *Danthonia unispicata - Poa secunda* Herbaceous Vegetation (CEGL001783, G3)
- *Eriogonum compositum / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001784, G2)
- *Eriogonum douglasii / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001785, G4)
- *Eriogonum microthecum - Physaria oregona* Dwarf-shrubland (CEGL001737, G2)
- *Eriogonum niveum / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001786, G3)
- *Eriogonum sphaerocephalum / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001448, G3)
- *Eriogonum strictum / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001788, G3)
- *Eriogonum thymoides / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001449, G3)
- *Lomatium cous - Poa secunda* Herbaceous Vegetation (CEGL001790, G4)

Alliances:
- *Artemisia rigida* Shrub Herbaceous Alliance (A.1574)
- *Danthonia californica* Herbaceous Alliance (A.1254)
- *Eriogonum microthecum* Dwarf-shrubland Alliance (A.1107)
- *Poa secunda* Dwarf-shrub Herbaceous Alliance (A.1568)
- *Poa secunda* Herbaceous Alliance (A.1291)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Copeland 1980a, Daubenmire 1970, Ganskopp 1979, Hall 1973, Johnson and Simon 1985, Poulton 1955, Shiflet 1994

Version: 25 Apr 2006 **Stakeholders:** West

Concept Author: J. Kagan **LeadResp:** West

CES304.001 GREAT BASIN SEMI-DESERT CHAPARRAL

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Shrubland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Shrubland (Shrub-dominated); Temperate [Temperate Continental]; Broad-Leaved Evergreen Shrub

Concept Summary: This system includes chaparral on sideslopes transitioning from low-elevation desert landscapes up into pinyon-juniper woodlands of the western and central Great Basin. There are limited occurrences extending as far west as the inner Coast Ranges in central California. These are typically fairly open-canopy shrublands with open spaces either bare or supporting patchy grasses and forbs. Characteristic species may include *Arctostaphylos patula, Arctostaphylos pungens, Ceanothus greggii, Ceanothus velutinus, Cercocarpus montanus var. glaber, Cercocarpus intricatus, Eriogonum fasciculatum, Garrya flavescens, Quercus turbinella, Purshia stansburiana,* and *Rhus trilobata*. *Cercocarpus ledifolius* is generally absent. Typical fire regime in these systems varies with the amount of organic accumulation.

DISTRIBUTION

Range: Western and central Great Basin.

Divisions: 206:C, 304:C

TNC Ecoregions: 11:C, 12:C, 15:P

Subnations: CA, NV

CONCEPT

Associations:
- *Arctostaphylos patula - Artemisia tridentata* (ssp. *vaseyana*, ssp. *wyomingensis*) Shrubland (CEGL002694, GNR)
- *Arctostaphylos patula - Quercus gambelii - (Amelanchier utahensis)* Shrubland (CEGL002695, GNR)
- *Arctostaphylos patula / Ceanothus velutinus - Ceanothus prostratus* Shrubland (CEGL000957, G3)
- *Arctostaphylos patula* Shrubland (CEGL002696, GNR)
- *Arctostaphylos pungens* Shrubland (CEGL000958, G4)
- *Ceanothus greggii - Fremontodendron californicum* Shrubland [Placeholder] (CEGL003026, G3?)
- *Ceanothus leucodermis* Shrubland [Placeholder] (CEGL003028, G4?)
- *Cercocarpus montanus* var. *glaber - Eriogonum fasciculatum* Shrubland [Placeholder] (CEGL003036, G3?)
- *Purshia stansburiana / Pseudoroegneria spicata* Shrubland (CEGL001053, G2G4)
- *Purshia stansburiana* Shrubland [Provisional] (CEGL002957, GNR)
- *Quercus turbinella - (Amelanchier utahensis)* Colluvial Shrubland (CEGL002950, GNR)
- *Quercus turbinella - Ephedra viridis* Shrubland (CEGL000980, G3?)
- *Quercus turbinella - Juniperus osteosperma* Shrubland (CEGL000981, G4?)

Alliances:
- *Arctostaphylos patula* Shrubland Alliance (A.788)
- *Arctostaphylos pungens* Shrubland Alliance (A.789)
- *Ceanothus greggii - Fremontodendron californicum* Shrubland Alliance (A.766)
- *Ceanothus leucodermis* Shrubland Alliance (A.767)
- *Cercocarpus montanus - Eriogonum fasciculatum* Shrubland Alliance (A.848)
- *Purshia (stansburiana, mexicana)* Shrubland Alliance (A.833)
- *Quercus turbinella* Shrubland Alliance (A.793)

SPATIAL CHARACTERISTICS

SOURCES

References: Barbour and Major 1977, Comer et al. 2003, Sawyer and Keeler-Wolf 1995, Shiflet 1994
Version: 24 Mar 2003 **Stakeholders:** West
Concept Author: K. Schulz, P. Comer **LeadResp:** West

CES304.774 GREAT BASIN XERIC MIXED SAGEBRUSH SHRUBLAND

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Shrubland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill]; Shrubland (Shrub-dominated); Ridge/Summit/Upper Slope; Aridic; Low Artemisia spp.
Concept Summary: This ecological system occurs in the Great Basin on dry flats and plains, alluvial fans, rolling hills, rocky hillslopes, saddles and ridges at elevations between 1000 and 2600 m. Sites are dry, often exposed to desiccating winds, with typically shallow, rocky, non-saline soils. Shrublands are dominated by *Artemisia nova* (mid and low elevations), *Artemisia arbuscula ssp. longicaulis*, or *Artemisia arbuscula ssp. longiloba* (higher elevation) and may be codominated by *Artemisia tridentata ssp. wyomingensis* or *Chrysothamnus viscidiflorus*. Other shrubs that may be present include *Atriplex confertifolia*, *Ephedra* spp., *Ericameria* spp., *Grayia spinosa*, *Lycium shockleyi*, *Picrothamnus desertorum*, *Sarcobatus vermiculatus*, and *Tetradymia* spp. The herbaceous layer is likely sparse and composed of perennial bunch grasses, such as *Achnatherum hymenoides*, *Achnatherum speciosum*, *Achnatherum thurberianum*, *Elymus elymoides*, or *Poa secunda*.

DISTRIBUTION

Range: This system occurs in the Great Basin on dry flats and plains, alluvial fans, rolling hills, rocky hillslopes, saddles and ridges at elevations between 1000 and 2600 m.
Divisions: 206:C, 304:C
TNC Ecoregions: 6:P, 11:C, 12:C, 18:P
Subnations: CA, ID?, NV, OR, UT

CONCEPT

Associations:
- *Artemisia arbuscula* ssp. *arbuscula - Artemisia tridentata* ssp. *wyomingensis / Festuca idahoensis* Shrubland [Provisional] (CEGL002983, GNR)
- *Artemisia arbuscula* ssp. *longicaulis - Grayia spinosa* Shrubland (CEGL002984, G4)
- *Artemisia arbuscula* ssp. *longicaulis / Bromus tectorum* Semi-natural Shrubland (CEGL002985, GNA)
- *Artemisia arbuscula* ssp. *longicaulis / Elymus elymoides* Shrubland (CEGL002986, G3)
- *Artemisia arbuscula* ssp. *longiloba / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001522, G3)
- *Artemisia arbuscula* ssp. *longiloba / Pascopyrum smithii* Shrub Herbaceous Vegetation (CEGL001415, GU)
- *Artemisia arbuscula* ssp. *longiloba / Poa secunda* Shrub Herbaceous Vegetation (CEGL001523, G3Q)
- *Artemisia arbuscula* ssp. *longiloba / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001416, GNR)
- *Artemisia arbuscula* ssp. *longiloba* Shrubland (CEGL001414, G4G5)
- *Artemisia nova - Ericameria nana* Shrubland (CEGL002773, G3)
- *Artemisia nova - Gutierrezia sarothrae / Bouteloua gracilis - Pleuraphis jamesii* Shrubland (CEGL001419, G4)
- *Artemisia nova / Achnatherum hymenoides* Shrubland (CEGL001422, G4G5)
- *Artemisia nova / Elymus elymoides* Shrubland (CEGL001418, G4G5)
- *Artemisia nova / Hesperostipa comata* Shrubland (CEGL001425, G3?)
- *Artemisia nova / Pleuraphis jamesii* Shrubland (CEGL001420, G3G5)
- *Artemisia nova / Poa fendleriana* Shrubland (CEGL002698, GNR)
- *Artemisia nova / Poa secunda* Shrubland (CEGL001423, G3)
- *Artemisia nova / Pseudoroegneria spicata* Shrubland (CEGL001424, G4G5)
- *Artemisia nova* Shrubland (CEGL001417, G3G5)
- *Artemisia tridentata* ssp. *wyomingensis - Atriplex confertifolia* Shrubland (CEGL001040, G3G5)

- *Artemisia tridentata* ssp. *wyomingensis - Purshia tridentata / Pseudoroegneria spicata* Shrubland (CEGL001050, G3Q)
- *Artemisia tridentata* ssp. *wyomingensis / Achnatherum hymenoides* Shrubland (CEGL001046, G5)
- *Artemisia tridentata* ssp. *wyomingensis / Achnatherum thurberianum* Shrubland (CEGL001052, G3)
- *Artemisia tridentata* ssp. *wyomingensis / Balsamorhiza sagittata* Shrubland (CEGL000994, G5)
- *Artemisia tridentata* ssp. *wyomingensis / Bouteloua gracilis* Shrubland (CEGL001041, G5)
- *Artemisia tridentata* ssp. *wyomingensis / Elymus elymoides* Shrubland (CEGL001043, G4G5)
- *Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Shrubland (CEGL001051, G2)
- *Artemisia tridentata* ssp. *wyomingensis* / Mixed Grasses Shrub Herbaceous Vegetation (CEGL001534, G5)
- *Artemisia tridentata* ssp. *wyomingensis / Poa secunda* Shrubland (CEGL001049, G4)
- *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001535, G4)
- *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* Shrubland (CEGL001009, G5?)
- *Grayia spinosa / Achnatherum hymenoides* Shrubland (CEGL001350, G4)
- *Grayia spinosa / Artemisia nova / Achnatherum speciosum* Shrubland (CEGL001344, G4)

Alliances:

- *Artemisia arbuscula* ssp. *arbuscula* Shrubland Alliance (A.2547)
- *Artemisia arbuscula* ssp. *longicaulis* Shrubland Alliance (A.2548)
- *Artemisia arbuscula* ssp. *longiloba* Shrub Herbaceous Alliance (A.2552)
- *Artemisia arbuscula* ssp. *longiloba* Shrubland Alliance (A.2549)
- *Artemisia nova* Shrubland Alliance (A.1105)
- *Artemisia tridentata* ssp. *wyomingensis* Shrub Herbaceous Alliance (A.1527)
- *Artemisia tridentata* ssp. *wyomingensis* Shrubland Alliance (A.832)
- *Grayia spinosa* Shrubland Alliance (A.1038)

Environment: This ecological system is widely distributed in the western United States. Climate is generally arid with 20 to 30 cm of annual precipitation and warm summers and cold winters. This shrubland system occurs at elevations from 1000 to 2600 m in the southwestern United States. It occupies flat to steeply sloping upland sites, on a wide variety of landform positions. These include toeslopes, lower and middle slopes, badly eroded badland slopes, and foothills. Sites with little slope tend to have deep soils, while those with steeper slopes have shallow to moderately deep soils that are well-drained. Sloping sites tend to have southerly aspects. Soil texture is loam, sandy loam, or clay loam (Hansen and Hoffman 1988), and there is often a significant amount of coarse fragments in the soil profile. Hironaka et al. (1983) reported that most of the habitat occurred on calcareous soils, often with a cemented duripan or silica hardpan at about 1 m in depth.

Dynamics: This shrubland system is associated with shallow, rocky soils which experience extreme drought in summer. The plants are low and widely spaced, which tends to decrease the risk of fire (Chappell et al. 1997). Barbour and Major (1988) report that *Artemisia nova* is utilized by livestock to a much greater degree than other species of *Artemisia*, resulting in low, pruned plants.

- *Artemisia nova* dwarf-shrublands grow in more xeric sites than other *Artemisia* shrublands. Blackburn and Tueller (1970) noted rapid invasion of these communities by *Juniperus osteosperma* and *Pinus monophylla* in Nevada, citing overgrazing coupled with fire suppression, and possibly climate change as causative variables.

SPATIAL CHARACTERISTICS

SOURCES

References: Baker and Kennedy 1985, Barbour and Major 1988, Blackburn and Tueller 1970, Chappell et al. 1997, Comer et al. 2003, Hansen and Hoffman 1988, Hironaka et al. 1983, Shiflet 1994, West 1983a

Version: 25 Apr 2006 **Stakeholders:** West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.777 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Shrubland

Spatial Scale & Pattern: Matrix

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Lowland [Lowland]; Shrubland (Shrub-dominated); Toeslope/Valley Bottom; Deep Soil; Aridic; Artemisia tridentata ssp. tridentata

Concept Summary: This ecological system occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains and foothills between 1500 and 2300 m elevation. Soils are typically deep, well-drained and non-saline. These shrublands are dominated by *Artemisia tridentata ssp. tridentata* and/or *Artemisia tridentata ssp. wyomingensis*. Scattered *Juniperus* spp., *Sarcobatus vermiculatus*, and *Atriplex* spp. may be present in some stands. *Ericameria nauseosa, Chrysothamnus viscidiflorus, Purshia tridentata*, or *Symphoricarpos oreophilus* may codominate disturbed stands. Perennial herbaceous components typically contribute less than 25% vegetative cover. Common graminoid species include *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Festuca idahoensis, Hesperostipa comata, Leymus cinereus, Pleuraphis jamesii, Pascopyrum smithii, Poa secunda*, or

Pseudoroegneria spicata. Some semi-natural communities are included that often originate on abandoned agricultural land or on other disturbed sites. In these locations, *Bromus tectorum* or other annual bromes and invasive weeds can be abundant.

DISTRIBUTION

Range: This system occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains and foothills between 1500-2300 m elevation. It occurs as far east as central and eastern Montana, although much of the sagebrush in this region is more steppe in physiognomy.
Divisions: 303:C, 304:C, 306:C
TNC Ecoregions: 4:C, 6:C, 8:C, 9:C, 10:C, 11:C, 18:C, 19:C, 20:C, 26:C, 27:C
Subnations: CA, CO, ID, MT, NV, OR, UT, WA, WY

CONCEPT

Associations:

- *Artemisia tridentata (*ssp. *tridentata*, ssp. *xericensis) / Pseudoroegneria spicata - Poa secunda* Shrub Herbaceous Vegetation (CEGL001019, G1)
- *Artemisia tridentata (*ssp. *tridentata*, ssp. *xericensis) / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001018, G2G4)
- *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland (CEGL002699, GNR)
- *Artemisia tridentata - Atriplex canescens - Sarcobatus vermiculatus / (Achnatherum hymenoides)* Shrubland (CEGL001355, G1)
- *Artemisia tridentata - Ephedra nevadensis* Shrubland (CEGL001002, G5)
- *Artemisia tridentata - Ephedra viridis* Shrubland (CEGL001003, G5)
- *Artemisia tridentata / Achnatherum hymenoides* Shrubland (CEGL001006, G3G5)
- *Artemisia tridentata / Achnatherum lettermanii* Shrubland (CEGL001011, G5)
- *Artemisia tridentata / Bouteloua gracilis - Pascopyrum smithii* Shrubland (CEGL000997, G5)
- *Artemisia tridentata / Bouteloua gracilis - Pleuraphis jamesii* Shrubland (CEGL000996, G5)
- *Artemisia tridentata / Bouteloua gracilis* Shrubland (CEGL000995, G4)
- *Artemisia tridentata / Chrysothamnus viscidiflorus / Poa secunda* Shrubland (CEGL000999, G5)
- *Artemisia tridentata / Elymus elymoides* Shrubland (CEGL001001, G5?)
- *Artemisia tridentata / Ericameria nauseosa* Shrubland (CEGL000998, G5)
- *Artemisia tridentata / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001530, G4Q)
- *Artemisia tridentata / Leymus cinereus* Shrub Herbaceous Vegetation (CEGL001458, G2G4)
- *Artemisia tridentata / Pleuraphis jamesii* Shrubland (CEGL001005, G5)
- *Artemisia tridentata / Symphoricarpos longiflorus* Shrubland (CEGL001012, G5)
- *Artemisia tridentata* Shrubland (CEGL000991, G5?)
- *Artemisia tridentata* Upperzone Community Shrubland (CEGL001013, G5?)
- *Artemisia tridentata* ssp. *tridentata - Grayia spinosa* Shrubland (CEGL001004, G5)
- *Artemisia tridentata* ssp. *tridentata / Distichlis spicata* Shrubland (CEGL001000, G5)
- *Artemisia tridentata* ssp. *tridentata / Festuca idahoensis* Shrubland (CEGL001014, G4?)
- *Artemisia tridentata* ssp. *tridentata / Hesperostipa comata* Shrubland (CEGL002966, G4?)
- *Artemisia tridentata* ssp. *tridentata / Leymus cinereus* Shrubland (CEGL001016, G2)
- *Artemisia tridentata* ssp. *tridentata / Pascopyrum smithii - (Elymus lanceolatus)* Shrubland (CEGL001017, G3?)
- *Artemisia tridentata* ssp. *tridentata / Pleuraphis jamesii* Shrubland (CEGL001015, G2G4)
- *Artemisia tridentata* ssp. *tridentata / Poa secunda* Shrubland (CEGL001008, G3G5)
- *Artemisia tridentata* ssp. *tridentata / Sporobolus airoides* Shrubland (CEGL002200, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Pascopyrum smithii* Shrubland (CEGL001028, G3?)
- *Artemisia tridentata* ssp. *wyomingensis - Atriplex confertifolia* Shrubland (CEGL001040, G3G5)
- *Artemisia tridentata* ssp. *wyomingensis - Peraphyllum ramosissimum / Festuca idahoensis* Shrubland (CEGL001048, G2)
- *Artemisia tridentata* ssp. *wyomingensis - Purshia tridentata / Pseudoroegneria spicata* Shrubland (CEGL001050, G3Q)
- *Artemisia tridentata* ssp. *wyomingensis / (Agropyron cristatum, Psathyrostachys juncea)* Seeded Grasses Semi-natural Shrubland (CEGL002185, GNR)
- *Artemisia tridentata* ssp. *wyomingensis / Achnatherum hymenoides* Shrubland (CEGL001046, G5)
- *Artemisia tridentata* ssp. *wyomingensis / Achnatherum thurberianum* Shrubland (CEGL001052, G3)
- *Artemisia tridentata* ssp. *wyomingensis / Balsamorhiza sagittata* Shrubland (CEGL000994, G5)
- *Artemisia tridentata* ssp. *wyomingensis / Carex filifolia* Shrubland (CEGL001042, G1Q)
- *Artemisia tridentata* ssp. *wyomingensis* / Disturbed Understory Semi-natural Shrubland (CEGL002083, GNA)
- *Artemisia tridentata* ssp. *wyomingensis / Elymus albicans* Shrubland (CEGL001044, G4)
- *Artemisia tridentata* ssp. *wyomingensis / Elymus elymoides* Shrubland (CEGL001043, G4G5)
- *Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland (CEGL002761, GNR)
- *Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Shrubland (CEGL001051, G2)
- *Artemisia tridentata* ssp. *wyomingensis / Leymus ambiguus* Shrubland (CEGL001045, G2)
- *Artemisia tridentata* ssp. *wyomingensis / Leymus salinus* Shrubland (CEGL002813, GNR)

- *Artemisia tridentata* ssp. *wyomingensis* / Mixed Grasses Shrub Herbaceous Vegetation (CEGL001534, G5)
- *Artemisia tridentata* ssp. *wyomingensis / Pascopyrum smithii* Shrub Herbaceous Vegetation (CEGL001047, G4)
- *Artemisia tridentata* ssp. *wyomingensis / Pleuraphis jamesii* Shrubland (CEGL002084, GNR)
- *Artemisia tridentata* ssp. *wyomingensis / Poa fendleriana* Shrubland (CEGL002775, GNR)
- *Artemisia tridentata* ssp. *wyomingensis / Poa secunda* Shrubland (CEGL001049, G4)
- *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001535, G4)
- *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* Shrubland (CEGL001009, G5?)
- *Artemisia tridentata* ssp. *wyomingensis* / Sparse Understory Shrubland (CEGL002768, GNR)
- *Ericameria nauseosa* Shrubland (CEGL002713, G5)
- *Grayia spinosa / Achnatherum hymenoides* Shrubland (CEGL001350, G4)

Alliances:
- *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) Shrub Herbaceous Alliance (A.1522)
- *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) Shrubland Alliance (A.830)
- *Artemisia tridentata* Shrub Herbaceous Alliance (A.1521)
- *Artemisia tridentata* Shrubland Alliance (A.829)
- *Artemisia tridentata* ssp. *vaseyana* Shrubland Alliance (A.831)
- *Artemisia tridentata* ssp. *wyomingensis* Shrub Herbaceous Alliance (A.1527)
- *Artemisia tridentata* ssp. *wyomingensis* Shrubland Alliance (A.832)
- *Atriplex canescens* Shrubland Alliance (A.869)
- *Ephedra nevadensis* Shrubland Alliance (A.857)
- *Ephedra viridis* Shrubland Alliance (A.858)
- *Ericameria nauseosa* Shrubland Alliance (A.835)
- *Grayia spinosa* Shrubland Alliance (A.1038)

SPATIAL CHARACTERISTICS

SOURCES

References: Barbour and Billings 1988, Barbour and Major 1977, Comer et al. 2003, Holland and Keil 1995, Shiflet 1994, West 1983a
Version: 23 Jan 2006 **Stakeholders:** Midwest, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.784 INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Shrubland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Lowland]; Shrubland (Shrub-dominated); Alluvial flat; Alluvial plain; Plain; Alkaline Soil; Saline Substrate Chemistry; Calcareous; Silt Soil Texture; Clay Soil Texture; Xeromorphic Shrub; Dwarf-Shrub; Atriplex spp.
Concept Summary: This extensive ecological system includes open-canopied shrublands of typically saline basins, alluvial slopes and plains across the Intermountain western U.S. This type also extends in limited distribution into the southern Great Plains. Substrates are often saline and calcareous, medium- to fine-textured, alkaline soils, but include some coarser-textured soils. The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more *Atriplex* species, such as *Atriplex confertifolia, Atriplex canescens, Atriplex polycarpa,* or *Atriplex spinifera*. Northern occurrences lack *Atriplex* species and are typically dominated by *Grayia spinosa, Krascheninnikovia lanata*, and/or *Artemisia tridentata*. Other shrubs present to codominate may include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra nevadensis, Grayia spinosa, Krascheninnikovia lanata, Lycium* spp., *Picrothamnus desertorum*, or *Tetradymia* spp. *Sarcobatus vermiculatus* is generally absent, but if present does not codominate. The herbaceous layer varies from sparse to moderately dense and is dominated by perennial graminoids such as *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus ssp. lanceolatus, Pascopyrum smithii, Pleuraphis jamesii, Pleuraphis rigida, Poa secunda*, or *Sporobolus airoides*. Various forbs are also present.

DISTRIBUTION

Range: Intermountain western U.S., extending in limited distribution into the southern Great Plains.
Divisions: 303:C, 304:C, 306:C
TNC Ecoregions: 4:?, 6:C, 8:?, 9:C, 10:C, 11:C, 18:C, 19:C, 20:C, 21:C, 26:C, 27:C, 28:C
Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Atriplex (lentiformis, polycarpa)* Shrubland [Placeholder] (CEGL003016, G3)
- *Atriplex canescens - Artemisia tridentata* Shrubland (CEGL001282, G4)
- *Atriplex canescens - Ephedra viridis* Talus Shrubland (CEGL001287, G4)

- *Atriplex canescens - Krascheninnikovia lanata* Shrubland (CEGL001285, G5)
- *Atriplex canescens / Achnatherum hymenoides* Shrubland (CEGL001289, G3G5)
- *Atriplex canescens / Bouteloua gracilis* Shrubland (CEGL001283, G3)
- *Atriplex canescens / Calycoseris parryi* Shrubland (CEGL001284, G2)
- *Atriplex canescens / Parthenium confertum* Shrubland (CEGL001290, GNRQ)
- *Atriplex canescens / Pleuraphis jamesii* Shrubland (CEGL001288, G3G4)
- *Atriplex canescens / Purshia stansburiana* Shrubland (CEGL001286, GUQ)
- *Atriplex canescens / Sporobolus airoides* Shrubland (CEGL001291, G5?)
- *Atriplex canescens / Sporobolus wrightii* Shrubland (CEGL001292, GNRQ)
- *Atriplex canescens* Shrubland (CEGL001281, G5)
- *Atriplex confertifolia - Ephedra nevadensis* Shrubland (CEGL001303, G5)
- *Atriplex confertifolia - Krascheninnikovia lanata* Shrubland (CEGL001301, G3G5)
- *Atriplex confertifolia - Lycium andersonii* Shrubland (CEGL001308, G3)
- *Atriplex confertifolia - Lycium pallidum / Mirabilis pudica* Shrubland (CEGL001309, G3G4Q)
- *Atriplex confertifolia - Lycium shockleyi* Shrubland (CEGL001310, G4)
- *Atriplex confertifolia - Picrothamnus desertorum / Achnatherum hymenoides* Shrubland (CEGL001297, G5?)
- *Atriplex confertifolia - Picrothamnus desertorum / Krascheninnikovia lanata* Shrubland (CEGL001296, G5?)
- *Atriplex confertifolia - Picrothamnus desertorum / Sarcobatus vermiculatus* Shrubland (CEGL001298, G5?)
- *Atriplex confertifolia - Picrothamnus desertorum* Shrubland (CEGL001295, G5)
- *Atriplex confertifolia - Sarcobatus vermiculatus* Shrubland (CEGL001313, G5)
- *Atriplex confertifolia / Achnatherum hymenoides* Shrubland (CEGL001311, G3)
- *Atriplex confertifolia / Elymus elymoides* Shrubland (CEGL001302, G3G5)
- *Atriplex confertifolia / Ericameria nauseosa* Shrubland (CEGL001300, G3Q)
- *Atriplex confertifolia / Hesperostipa comata* Shrubland (CEGL001314, G2)
- *Atriplex confertifolia / Kochia americana* Shrubland (CEGL001305, G3G5)
- *Atriplex confertifolia / Leymus salinus* Shrubland (CEGL001307, G3G5)
- *Atriplex confertifolia / Leymus salinus* ssp. *salmonis* Shrubland (CEGL001306, G2Q)
- *Atriplex confertifolia / Pleuraphis jamesii* Shrubland (CEGL001304, G3G5)
- *Atriplex confertifolia / Pseudoroegneria spicata* Shrubland (CEGL001312, G3)
- *Atriplex confertifolia / Tetradymia glabrata* Shrubland (CEGL001315, G3G5)
- *Atriplex confertifolia* Great Basin Shrubland (CEGL001294, G5)
- *Atriplex confertifolia* Wyoming Basins Shrubland (CEGL001293, G5)
- *Atriplex obovata / Sporobolus airoides - Pleuraphis jamesii* Shrub Herbaceous Vegetation (CEGL001775, GU)
- *Atriplex obovata / Sporobolus airoides - Sporobolus cryptandrus* Dwarf-shrubland (CEGL001447, G1Q)
- *Atriplex obovata / Tidestromia carnosa* Dwarf-shrubland (CEGL004575, G2?)
- *Atriplex parryi* Shrubland [Placeholder] (CEGL002711, G3)
- *Atriplex polycarpa / Pleuraphis mutica* Shrubland (CEGL001319, GU)
- *Atriplex polycarpa* Shrubland (CEGL001318, G5)
- *Atriplex spinifera* Shrubland [Placeholder] (CEGL003015, G3?)
- *Krascheninnikovia lanata / Achnatherum hymenoides* Dwarf-shrubland (CEGL001323, G4)
- *Krascheninnikovia lanata / Hesperostipa comata* Dwarf-shrubland (CEGL001327, G3)
- *Krascheninnikovia lanata* Dwarf-shrubland [Provisional] (CEGL001320, G5?)
- *Picrothamnus desertorum / Elymus elymoides* Shrubland [Provisional] (CEGL002992, GNR)
- *Picrothamnus desertorum* Shrubland (CEGL001452, G3G4)

Alliances:

- *Atriplex (lentiformis, polycarpa)* Shrubland Alliance (A.864)
- *Atriplex canescens* Shrubland Alliance (A.869)
- *Atriplex confertifolia* Shrubland Alliance (A.870)
- *Atriplex obovata* Dwarf-shrubland Alliance (A.1108)
- *Atriplex parryi* Shrubland Alliance (A.2507)
- *Atriplex polycarpa* Shrubland Alliance (A.873)
- *Atriplex spinifera* Shrubland Alliance (A.865)
- *Krascheninnikovia lanata* Dwarf-shrubland Alliance (A.1104)
- *Picrothamnus desertorum* Shrubland Alliance (A.1128)
- *Sporobolus airoides - (Pleuraphis jamesii)* Shrub Herbaceous Alliance (A.1532)

Environment: This salt-desert shrubland system is a matrix system in the Intermountain West. This system is comprised of arid to semi-arid shrublands on lowland and upland sites usually at elevations between 1520 and 2200 m (4987-7218 feet). Sites can be found on all aspects and include valley bottoms, alluvial and alkaline flats, mesas and plateaus, playas, drainage terraces, washes and interdune basins, bluffs, and gentle to moderately steep sandy or rocky slopes. Slopes are typically gentle to moderately steep, but are sometimes unstable and prone to surface movement. Many areas within this system are degraded due to erosion and may resemble

?badlands.? Soil surface is often very barren in occurrences of this system. The interspaces between the characteristic plant clusters are commonly covered by a microphytic crust (West 1982).

This is typically a system of extreme climatic conditions, with warm to hot summers and freezing winters. Annual precipitation ranges from approximately 13-33 cm. In much of the ecological system, the period of greatest moisture will be mid- to late summer, although in the more northern areas a moist period is to be expected in the cold part of the year. However, plotted seasonality of occurrence is probably of less importance on this desert system than in other ecosystems because desert precipitation comes with an extreme irregularity that does not appear in graphs of long-term seasonal or monthly averages (Blaisdell and Holmgren 1984). Soils are shallow to moderately deep, poorly developed, and a product of an arid climate and little precipitation. Soils are often alkaline or saline. Vegetation within this system is tolerant of these soil conditions but not restricted to it. The shallow soils of much of the area are poorly developed Entisols. Vegetation within this system can occur on level pediment remnants where coarse-textured and well-developed soil profiles have been derived from sandstone gravel and are alkaline, or on Mancos shale badlands, where soil profiles are typically fine-textured and non-alkaline throughout (West and Ibrahim 1968). They can also occur in alluvial basins where parent materials from the other habitats have been deposited over Mancos shale and the soils are heavy-textured and saline-alkaline throughout the profile (West and Ibrahim 1968).

Vegetation: Occurrences of this ecological system vary from almost pure occurrences of single species to fairly complex mixtures. The characteristic mix of low shrubs and grasses is sparse, with large open spaces between the plants (Blaisdell and Holmgren 1984). Occurrences have a sparse to moderately dense cover of woody species that is dominated by *Atriplex canescens* (may codominate with *Artemisia tridentata*), *Atriplex confertifolia* (may codominate with *Lycium andersonii*), *Atriplex obovata, Picrothamnus desertorum*, or *Krascheninnikovia lanata*. Other shrubs that may occur within these occurrences include *Purshia stansburiana, Psorothamnus polydenius, Ephedra* spp., *Acacia greggii, Encelia frutescens, Tiquilia latior, Parthenium confertum, Atriplex polycarpa, Atriplex lentiformis, Atriplex spinifera, Picrothamnus desertorum (= Artemisia spinescens), Frankenia salina, Artemisia frigida, Chrysothamnus* spp., *Lycium* ssp., *Suaeda* spp., *Yucca glauca,* and *Tetradymia spinosa*. Dwarf-shrubs include *Gutierrezia sarothrae* and *Eriogonum* spp. Warm-season medium-tall and short perennial grasses dominate in the sparse to moderately dense graminoid layer. The species present depend on the geographic range of the grasses, alkalinity/salinity and past land use. Species may include *Pleuraphis jamesii, Bouteloua gracilis, Sporobolus airoides, Sporobolus cryptandrus, Achnatherum hymenoides, Elymus elymoides, Distichlis spicata, Leymus salinus, Pascopyrum smithii, Hesperostipa comata, Pseudoroegneria spicata, Poa secunda, Leymus ambiguus,* and *Muhlenbergia torreyi*. A number of annual species may also grow in association with the shrubs and grasses of this system, although they are usually rare and confined to areas of recent disturbance (Blaisdell and Holmgren 1984). Forb cover is generally sparse. Perennial forbs that might occur include *Sphaeralcea coccinea, Chaetopappa ericoides, Xylorhiza venusta, Descurainia sophia*, and *Mentzelia* species. Annual natives include *Plantago* spp., *Vulpia octoflora*, or *Monolepis nuttalliana*. Associated halophytic annuals include *Salicornia rubra, Salicornia bigelovii*, and *Suaeda* species. Exotic annuals that may occur include *Salsola kali, Bromus rubens,* and *Bromus tectorum.* Cacti like *Opuntia* spp. and *Echinocereus* spp. may be present in some occurrences. Trees are not usually present but some scattered *Juniperus* spp. may be found.

Dynamics: West (1982) stated that ?salt desert shrub vegetation occurs mostly in two kinds of situations that promote soil salinity, alkalinity, or both. These are either at the bottom of drainages in enclosed basins or where marine shales outcrop.? However, salt-desert shrub vegetation may be an indication of climatically dry as well as physiologically dry soils (Blaisdell and Holmgren 1984). Not all salt-desert shrub soils are salty, and their hydrologic characteristics may often be responsible for the associated vegetation (Naphan 1966). Species of the salt-desert shrub complex have different degrees of tolerance to salinity and aridity, and they tend to sort themselves out along a moisture/salinity gradient (West 1982). Species and communities are apparently sorted out along physical, chemical, moisture, and topographic gradients through complex relations that are not understood and are in need of further study (Blaisdell and Holmgren 1984).

The winter months within this system are a good time for soil moisture accumulation and storage. There is generally at least one good snow storm per season that will provide sufficient moisture to the vegetation. The winter moisture accumulation amounts will affect spring plant growth. Plants may grow as little as a few inches to 1 m. Unless more rains come in the spring, the soil moisture will be depleted in a few weeks, growth will slow and ultimately cease, and the perennial plants will assume their various forms of dormancy (Blaisdell and Holmgren 1984). If effective rain comes later in the warm season, some of the species will renew their growth from the stage at which it had stopped. Others, having died back, will start over as if emerging from winter dormancy (Blaisdell and Holmgren 1984). *Atriplex confertifolia* shrubs often develop large leaves in the spring, which increase the rate of photosynthesis. As soil moisture decreases, the leaves are lost, and the plant takes on a dead appearance. During late fall, very small overwintering leaves appear which provide some photosynthetic capability through the remainder of the year (IVC 1999). Other communities are maintained by intra- or inter-annual cycles of flooding followed by extended drought, which favor accumulation of transported salts. The moisture supporting these intermittently flooded wetlands is usually derived off-site, and they are dependent upon natural watershed function for persistence (Reid et al. 1999).

In summary, desert communities of perennial plants are dynamic and changing. The composition within this system may change dramatically and may be both cyclic and unidirectional. Superimposed on the compositional change is great variation from year to year in growth of all the vegetation ? the sum of varying growth responses of individual species to specific conditions of different years (Blaisdell and Holmgren 1984). Desert plants grow when temperature is satisfactory, but only if soil moisture is available at the same

time. Because amount of moisture is variable from year to year and because different species flourish under different seasons of soil moisture, seldom do all components of the vegetation thrive in the same year (Blaisdell and Holmgren 1984).

SPATIAL CHARACTERISTICS

SOURCES

References: Barbour and Major 1988, Blaisdell and Holmgren 1984, Branson et al. 1967, Branson et al. 1976, Brown 1982, Campbell 1977, Comer et al. 2003, Francis 1986, Holland and Keil 1995, Reid et al. 1999, Shiflet 1994, West 1979, West 1982, West 1983b, West and Ibrahim 1968

Version: 23 Jan 2006 **Stakeholders:** Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.801 NORTHERN ROCKY MOUNTAIN AVALANCHE CHUTE SHRUBLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Mixed Upland and Wetland

Spatial Scale & Pattern: Small patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

Diagnostic Classifiers: Shrubland (Shrub-dominated); Avalanche chute; Very Short Disturbance Interval [Periodicity/Nonrandom Disturbance]; Avalanche

Concept Summary: This ecological system occurs in the mountains throughout the northern Rockies, from Wyoming north and west into British Columbia and Alberta. It is composed of a diverse mix of deciduous shrubs or trees, and conifers found on steep, frequently disturbed slopes in the mountains. Occurrences are found on the lower portions and runout zones of avalanche tracks, and slopes are generally steep, ranging from 15-60%. Aspects vary, but are more common where unstable or heavy snowpack conditions frequently occur. Sites are often mesic to wet because avalanche paths are often in stream gullies, and snow deposition can be heavy in the run-out zones. The vegetation consists of moderately dense, woody canopy characterized by dwarfed and damaged conifers and small, deciduous trees/shrubs. Characteristic species include *Abies lasiocarpa, Acer glabrum, Alnus viridis ssp. sinuata* or *Alnus incana, Populus balsamifera ssp. trichocarpa, Populus tremuloides*, or *Cornus sericea*. Other common woody plants include *Paxistima myrsinites, Sorbus scopulina*, and *Sorbus sitchensis*. The ground cover is moderately dense to dense forb-rich, with *Senecio triangularis, Castilleja* spp., *Athyrium filix-femina, Thalictrum occidentale, Urtica dioica, Erythronium grandiflorum, Myosotis asiatica (= Myosotis alpestris), Veratrum viride, Heracleum maximum (= Heracleum lanatum)*, and *Xerophyllum tenax*. Mosses and ferns are often present.

DISTRIBUTION

Range: This ecological system occurs in the mountains throughout the northern Rockies, from Wyoming north and west into British Columbia and Alberta. It is likely to occur in the Colorado Rockies, but no association from that area have been classified as "avalanche chute" communities.

Divisions: 306:C

TNC Ecoregions: 7:C, 8:C, 9:C

Subnations: AB, BC, CO, MT, OR, WA, WY

CONCEPT

Associations:

- *Abies lasiocarpa - Acer glabrum* Avalanche Chute Shrubland (CEGL000984, G5)
- *Acer glabrum* Avalanche Chute Shrubland (CEGL001061, G5)
- *Alnus* spp. Avalanche Chute Shrubland (CEGL001158, G5)
- *Alnus viridis* ssp. *sinuata / Athyrium filix-femina - Cinna latifolia* Shrubland (CEGL001156, G4)
- *Alnus viridis* ssp. *sinuata* / Mesic Forbs Shrubland (CEGL002633, G3G4)
- *Populus balsamifera* ssp. *trichocarpa / Cornus sericea* Forest (CEGL000672, G3G4)
- *Populus tremuloides / Amelanchier alnifolia* Avalanche Chute Shrubland (CEGL005886, G3?)
- *Populus tremuloides / Cornus sericea* Forest (CEGL000582, G4)

Alliances:

- *Abies lasiocarpa - Acer glabrum* Shrubland Alliance (A.1052)
- *Acer glabrum* Shrubland Alliance (A.915)
- *Alnus (viridis* ssp. *sinuata, incana)* Temporarily Flooded Shrubland Alliance (A.965)
- *Alnus viridis* ssp. *sinuata* Temporarily Flooded Shrubland Alliance (A.966)
- *Amelanchier alnifolia* Shrubland Alliance (A.913)
- *Populus balsamifera* ssp. *trichocarpa* Temporarily Flooded Forest Alliance (A.311)
- *Populus tremuloides* Temporarily Flooded Forest Alliance (A.300)

SPATIAL CHARACTERISTICS

SOURCES

References: Butler 1979, Butler 1985, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Malanson and Butler 1984
Version: 20 Feb 2003 **Stakeholders:** Canada, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.994 NORTHERN ROCKY MOUNTAIN MONTANE-FOOTHILL DECIDUOUS SHRUBLAND

Primary Division: Rocky Mountain (306)
Land Cover Class: Shrubland
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Shrubland (Shrub-dominated); Very Shallow Soil; Broad-Leaved Deciduous Shrub; Moderate (100-500 yrs) Persistence
Concept Summary: This shrubland ecological system is found in the lower montane and foothill regions around the Columbia Basin, and north and east into the northern Rockies. These shrublands typically occur below treeline, within the matrix of surrounding low-elevation grasslands and sagebrush shrublands. They also occur in the ponderosa pine and Douglas-fir zones, but rarely up into the subalpine zone (on dry sites). The shrublands are usually found on steep slopes of canyons and in areas with some soil development, either loess deposits or volcanic clays; they occur on all aspects. Fire, flooding and erosion all impact these shrublands, but they typically will persist on sites for long periods. These communities develop near talus slopes as garlands, at the heads of dry drainages, and toeslopes in the moist shrub-steppe and steppe zones. *Physocarpus malvaceus, Prunus emarginata, Prunus virginiana, Rosa* spp., *Rhus glabra, Acer glabrum, Amelanchier alnifolia, Symphoricarpos albus,* and *Holodiscus discolor* are the most common dominant shrubs, occurring alone or any combination. *Rubus parviflorus* and *Ceanothus velutinus* are other important shrubs in this system, being more common in montane occurrences than in subalpine situations. In moist areas *Crataegus douglasii* can be common. *Shepherdia canadensis* and *Spiraea betulifolia* can be abundant in some cases, but also occur in Northern Rocky Mountain Subalpine Deciduous Shrubland (CES306.961). *Festuca idahoensis, Festuca campestris, Calamagrostis rubescens, Carex geyeri, Koeleria macrantha, Pseudoroegneria spicata,* and *Poa secunda* are the most important grasses. *Achnatherum thurberianum* and *Leymus cinereus* can be locally important. *Poa pratensis* and *Phleum pratense* are common introduced grasses. *Geum triflorum, Potentilla gracilis, Lomatium triternatum, Balsamorhiza sagittata,* and species of *Eriogonum, Phlox,* and *Erigeron* are important forbs. These occur in the zone of "rattlesnakes not grizzly bears."
Comments: Seral shrub fields of comparable composition that typically will develop into a seral stage with trees (within 50 years) are excluded from this shrub system and are included in their appropriate forest system.

DISTRIBUTION

Range: This system is found in the lower montane and foothill regions around the Columbia Basin, and north and east into the northern Rockies, including east into central Montana around the "Sky Island" ranges.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:C, 7:C, 8:C, 26:C, 68:C
Subnations: AB, BC, ID, MT, OR, WA

CONCEPT

Associations:
- *Amelanchier alnifolia* / (Mixed Grass, Forb) Shrubland (CEGL005885, GNR)
- *Crataegus douglasii / Rosa woodsii* Shrubland (CEGL001095, G2)
- *Holodiscus discolor* Shrubland [Placeholder] (CEGL003053, G4?)
- *Physocarpus malvaceus - Symphoricarpos albus* Shrubland (CEGL001171, G3)
- *Prunus virginiana - (Prunus americana)* Shrubland (CEGL001108, G4Q)
- *Rhamnus alnifolia* Shrubland (CEGL001132, G3)
- *Rhus glabra / Aristida purpurea* var. *longiseta* Shrub Herbaceous Vegetation (CEGL001507, G1)
- *Rhus glabra / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001122, G2)
- *Ribes lacustre / Chamerion angustifolium* Shrubland [Provisional] (CEGL005889, G2?)
- *Rosa woodsii* Shrubland (CEGL001126, G5)
- *Spiraea betulifolia* Shrubland (CEGL005835, G3?)
- *Spiraea douglasii* Shrubland (CEGL001129, G5)
- *Symphoricarpos albus - Rosa nutkana* Shrubland (CEGL001130, G3)
- *Symphoricarpos albus* Shrubland (CEGL005890, G4?)

Alliances:
- *Amelanchier alnifolia* Shrubland Alliance (A.913)
- *Crataegus douglasii* Shrubland Alliance (A.917)
- *Holodiscus discolor* Shrubland Alliance (A.901)

- *Physocarpus malvaceus* Shrubland Alliance (A.928)
- *Prunus virginiana* Shrubland Alliance (A.919)
- *Rhamnus alnifolia* Temporarily Flooded Shrubland Alliance (A.962)
- *Rhus glabra* Shrub Herbaceous Alliance (A.1536)
- *Ribes lacustre* Temporarily Flooded Shrubland Alliance (A.970)
- *Rosa woodsii* Temporarily Flooded Shrubland Alliance (A.959)
- *Spiraea betulifolia* Shrubland Alliance (A.2636)
- *Spiraea douglasii* Seasonally Flooded Shrubland Alliance (A.997)
- *Symphoricarpos albus* Shrubland Alliance (A.925)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Ecosystems Working Group 1998, Franklin and Dyrness 1973, Hall 1973, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Poulton 1955, Shiflet 1994, Tisdale 1986

Version: 23 Jan 2006 **Stakeholders:** Canada, West

Concept Author: M. Reid, J. Kagan **LeadResp:** West

CES306.961 NORTHERN ROCKY MOUNTAIN SUBALPINE DECIDUOUS SHRUBLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Shrubland

Spatial Scale & Pattern: Large patch, Small patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Upper Montane]; Shrubland (Shrub-dominated); Very Shallow Soil; Broad-Leaved Deciduous Shrub; Moderate (100-500 yrs) Persistence

Concept Summary: This shrubland ecological system is found within the zone of continuous forest in the upper montane and lower subalpine zones of the northern Rocky Mountains. Soils tend to be moist to wet. Stands are typically initiated by fires and will persist on sites for long periods because of repeated burns and changes in the presence of volatile oils in the soil which impedes tree regeneration.

- *Menziesia ferruginea, Rhamnus alnifolia, Ribes lacustre, Rubus parviflorus, Alnus viridis, Rhododendron albiflorum, Sorbus scopulina, Sorbus sitchensis, Vaccinium myrtillus, Vaccinium scoparium,* and *Vaccinium membranaceum* are the most common dominant shrubs, occurring alone or in any combination. Other shrubs can include *Shepherdia canadensis* and *Ceanothus velutinus,* but these also commonly occur in Northern Rocky Mountain Montane-Foothill Deciduous Shrubland (CES306.994). *Rubus parviflorus* and *Ceanothus velutinus* are occasionally present, being more common in montane shrublands than in this subalpine system. Important forbs include *Xerophyllum tenax, Chamerion angustifolium,* and *Pteridium aquilinum,* reflecting the mesic nature of many of these shrublands. These occur in the zone of "grizzly bears not rattlesnakes."

Comments: This system is floristically somewhat similar to Northern Rocky Mountain Avalanche Chute Shrubland (CES306.801), but the avalanche chutes originate from very different processes, tend to be more diverse within stands, and are wetter, being driven ecologically by snow-loading and concomitant snowmelt. Seral shrub fields of comparable composition that typically will develop into a seral stage with trees (within 50 years) are excluded from this shrub system and are included in their appropriate forest system.

DISTRIBUTION

Range: This system is found in the subalpine and upper montane zones in the northern Rockies, south and west around the Columbia Basin.

Divisions: 304:C, 306:C

TNC Ecoregions: 6:C, 7:C, 8:C, 26:C, 68:C

Subnations: AB, BC, ID, MT, OR, WA

CONCEPT

Associations:

- *Menziesia ferruginea / Xerophyllum tenax* Shrubland (CEGL005888, G3G4)
- *Rhamnus alnifolia* Shrubland (CEGL001132, G3)
- *Ribes lacustre / Chamerion angustifolium* Shrubland [Provisional] (CEGL005889, G2?)
- *Vaccinium membranaceum / Xerophyllum tenax* Shrubland (CEGL005891, G3?)

Alliances:

- *Menziesia ferruginea* Shrubland Alliance (A.2633)
- *Rhamnus alnifolia* Temporarily Flooded Shrubland Alliance (A.962)
- *Ribes lacustre* Temporarily Flooded Shrubland Alliance (A.970)
- *Vaccinium membranaceum* Shrubland Alliance (A.2632)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Ecosystems Working Group 1998, Franklin and Dyrness 1973, Hall 1973, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Poulton 1955, Tisdale 1986, Western Ecology Working Group n.d.

Version: 23 Jan 2006 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.810 ROCKY MOUNTAIN ALPINE DWARF-SHRUBLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Shrubland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Alpine/AltiAndino [Alpine/AltiAndino]; Patterned ground (undifferentiated); Glaciated; Acidic Soil; Udic; Very Long Disturbance Interval; Dwarf-Shrub; Alpine Slopes

Concept Summary: This widespread ecological system occurs above upper timberline throughout the Rocky Mountain cordillera, including alpine areas of ranges in Utah and Nevada, and north into Canada. Elevations are above 3360 m in the Colorado Rockies but drop to less than 2100 m in northwestern Montana and in the mountains of Alberta. This system occurs in areas of level or concave glacial topography, with late-lying snow and subirrigation from surrounding slopes. Soils have become relatively stabilized in these sites, are moist but well-drained, strongly acid, and often with substantial peat layers. Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost, and a short growing season. This ecological system is characterized by a semi-continuous layer of ericaceous dwarf-shrubs or dwarf willows which form a heath type ground cover less than 0.5 m in height. Dense tuffs of graminoids and scattered forbs occur. *Dryas octopetala* or *Dryas integrifolia* communities are not included here, except for one very moist association, because they occur on more windswept and drier sites than the heath communities. Within these communities *Cassiope mertensiana, Salix arctica, Salix reticulata, Salix vestita,* or *Phyllodoce empetriformis* can be dominant shrubs. *Vaccinium* spp., *Ledum glandulosum, Phyllodoce glanduliflora*, and *Kalmia microphylla* may also be shrub associates. The herbaceous layer is a mixture of forbs and graminoids, especially sedges, including, *Erigeron* spp., *Luetkea pectinata, Antennaria lanata, Oreostemma alpigenum (= Aster alpigenus), Pedicularis* spp., *Castilleja* spp., *Deschampsia caespitosa, Caltha leptosepala, Erythronium* spp., *Juncus parryi, Luzula piperi, Carex spectabilis, Carex nigricans,* and *Polygonum bistortoides*. Fell-fields often intermingle with the alpine dwarf-shrubland.

DISTRIBUTION

Range: This system occurs above upper timberline throughout the Rocky Mountain cordillera, including alpine areas of ranges in Utah and Nevada, and north into Canada. Elevations are above 3360 m in the Colorado Rockies but drop to less than 2100 m in northwestern Montana.

Divisions: 304:C, 306:C

TNC Ecoregions: 4:P, 7:C, 8:C, 9:C, 11:C, 19:C, 20:C, 21:C, 68:P

Subnations: AB, BC, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:

- *Cassiope mertensiana - Phyllodoce empetriformis* Dwarf-shrubland (CEGL001398, G5)
- *Cassiope mertensiana / Carex paysonis* Dwarf-shrubland (CEGL001396, G3?)
- *Dryas integrifolia - Carex* spp. Dwarf-shrub Herbaceous Vegetation (CEGL001890, G3Q)
- *Dryas octopetala - Polygonum viviparum* Dwarf-shrub Herbaceous Vegetation (CEGL001894, G3?)
- *Kalmia microphylla / Carex scopulorum* Dwarf-shrubland (CEGL001403, G3G4)
- *Phyllodoce empetriformis / Antennaria lanata* Dwarf-shrubland (CEGL001405, G3?)
- *Phyllodoce empetriformis / Lupinus latifolius* Dwarf-shrubland (CEGL001406, G4?)
- *Phyllodoce empetriformis / Vaccinium deliciosum* Dwarf-shrubland (CEGL001407, G4)
- *Phyllodoce empetriformis* Parkland Dwarf-shrubland (CEGL001404, G5)
- *Phyllodoce glanduliflora / Oreostemma alpigenum* Dwarf-shrubland (CEGL001408, G3G4)
- *Phyllodoce glanduliflora / Sibbaldia procumbens* Dwarf-shrubland (CEGL005877, G2G3)
- *Salix arctica - (Salix petrophila, Salix nivalis) / Polygonum bistortoides* Dwarf-shrubland (CEGL001431, G2G3Q)
- *Salix arctica - Salix nivalis* Dwarf-shrubland (CEGL001432, G2Q)
- *Salix arctica - Salix petrophila / Caltha leptosepala* Dwarf-shrubland (CEGL001429, G2G3)
- *Salix arctica / Carex nigricans* Dwarf-shrubland (CEGL005878, GNR)
- *Salix arctica / Geum rossii* Dwarf-shrubland (CEGL001430, G4)
- *Salix glauca* Shrubland (CEGL001136, G3?)
- *Salix nivalis / Geum rossii* Dwarf-shrubland (CEGL005936, GNR)
- *Salix reticulata / Caltha leptosepala* Dwarf-shrubland (CEGL001435, G3)

- *Vaccinium (caespitosum, scoparium)* Dwarf-shrubland (CEGL001140, G4)
- *Vaccinium (myrtillus, scoparium) / Luzula glabrata* var. *hitchcockii* Dwarf-shrubland (CEGL005879, G2G3)

Alliances:
- *Cassiope mertensiana* Dwarf-shrubland Alliance (A.1081)
- *Cassiope mertensiana* Temporarily Flooded Dwarf-shrubland Alliance (A.1089)
- *Dryas integrifolia* Dwarf-shrub Herbaceous Alliance (A.1576)
- *Dryas octopetala* Dwarf-shrub Herbaceous Alliance (A.1577)
- *Kalmia microphylla* Saturated Dwarf-shrubland Alliance (A.1096)
- *Phyllodoce empetriformis* Dwarf-shrubland Alliance (A.1083)
- *Phyllodoce glanduliflora* Dwarf-shrubland Alliance (A.1084)
- *Salix (reticulata, nivalis)* Dwarf-shrubland Alliance (A.1119)
- *Salix arctica* Dwarf-shrubland Alliance (A.1117)
- *Salix arctica* Saturated Dwarf-shrubland Alliance (A.1124)
- *Salix glauca* Temporarily Flooded Shrubland Alliance (A.963)
- *Salix reticulata* Saturated Dwarf-shrubland Alliance (A.1125)
- *Vaccinium (caespitosum, myrtillus, scoparium)* Dwarf-shrubland Alliance (A.1114)

SPATIAL CHARACTERISTICS

SOURCES

References: Anderson 1999a, Bamberg 1961, Bamberg and Major 1968, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1997, Douglas and Bliss 1977, Ecosystems Working Group 1998, Komarkova 1976, Komarkova 1980, Meidinger and Pojar 1991, Neely et al. 2001, Schwan and Costello 1951, Shiflet 1994, Thilenius 1975, Willard 1963

Version: 01 Sep 2005 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.822 ROCKY MOUNTAIN LOWER MONTANE-FOOTHILL SHRUBLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Shrubland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Shrubland (Shrub-dominated); Very Shallow Soil; Aridic; Intermediate Disturbance Interval [Periodicity/Polycyclic Disturbance]

Concept Summary: This ecological system is found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico extending north into Wyoming, and west into the Intermountain region. These shrublands occur between 1500-2900 m elevations and are usually associated with exposed sites, rocky substrates, and dry conditions, which limit tree growth. It is common where *Quercus gambelii* is absent such as the northern Colorado Front Range and in drier foothills and prairie hills. This system is generally drier than Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818), but may include mesic montane shrublands where *Quercus gambelii* does not occur. Scattered trees or inclusions of grassland patches or steppe may be present, but the vegetation is typically dominated by a variety of shrubs including *Amelanchier utahensis, Cercocarpus montanus, Purshia tridentata, Rhus trilobata, Ribes cereum, Symphoricarpos oreophilus*, or *Yucca glauca*. In northeastern Wyoming and north into adjacent Montana, *Cercocarpus ledifolius*, usually with *Artemisia tridentata*, is the common dominant shrub. Grasses are represented as species of *Muhlenbergia, Bouteloua, Hesperostipa*, and *Pseudoroegneria spicata*. Fires play an important role in this system as the dominant shrubs usually have a severe die-back, although some plants will stump sprout. *Cercocarpus montanus* requires a disturbance such as fire to reproduce, either by seed sprout or root crown sprouting. Fire suppression may have allowed an invasion of trees into some of these shrublands, but in many cases sites are too xeric for tree growth.

DISTRIBUTION

Range: Found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico extending north into Wyoming, and west into the Intermountain region.

Divisions: 303:C, 306:C

TNC Ecoregions: 10:C, 20:C, 21:C, 25:C, 26:C, 27:C

Subnations: CO, MT, NE?, NM, SD, WY

CONCEPT

Associations:
- *Artemisia frigida / Bouteloua gracilis* Dwarf-shrubland [Provisional] (CEGL002782, GNR)
- *Artemisia nova / Leymus salinus* Shrub Herbaceous Vegetation (CEGL001421, G1G2Q)
- *Cercocarpus montanus - Rhus trilobata / Andropogon gerardii* Shrubland (CEGL002912, G2G3)
- *Cercocarpus montanus / Achnatherum scribneri* Shrubland (CEGL002913, G3)

- *Cercocarpus montanus / Bouteloua curtipendula* Shrubland (CEGL001086, G5)
- *Cercocarpus montanus / Elymus lanceolatus* ssp. *lanceolatus* Shrubland (CEGL001087, GU)
- *Cercocarpus montanus / Garrya flavescens* Shrubland (CEGL001088, GNR)
- *Cercocarpus montanus / Hesperostipa comata* Shrubland (CEGL001092, G2)
- *Cercocarpus montanus / Hesperostipa neomexicana* Shrubland (CEGL002911, G2G3)
- *Cercocarpus montanus / Muhlenbergia emersleyi* Shrub Herbaceous Vegetation (CEGL001500, G4)
- *Cercocarpus montanus / Muhlenbergia montana* Shrubland (CEGL002914, GU)
- *Cercocarpus montanus / Muhlenbergia pauciflora* Shrubland (CEGL001089, GNR)
- *Cercocarpus montanus / Pseudoroegneria spicata* Shrubland (CEGL001090, G4)
- *Cercocarpus montanus / Rhus trilobata* var. *trilobata* Shrubland (CEGL001091, GNRQ)
- *Cercocarpus montanus* var. *paucidentatus / Petrophyton caespitosum* Shrubland (CEGL004589, G3?)
- *Prunus virginiana - (Prunus americana)* Shrubland (CEGL001108, G4Q)
- *Purshia tridentata / Artemisia frigida / Hesperostipa comata* Shrubland (CEGL001055, G1G2)
- *Purshia tridentata / Muhlenbergia montana* Shrubland (CEGL001057, G2)
- *Rhus trilobata / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001505, G2?)
- *Rhus trilobata / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001120, G4)
- *Rhus trilobata* Rocky Mountain Shrub Herbaceous Vegetation (CEGL002910, G2)
- *Ribes cereum / Leymus ambiguus* Shrubland (CEGL001124, G2)
- *Spiraea betulifolia* Shrubland (CEGL005835, G3?)
- *Symphoricarpos occidentalis* Shrubland (CEGL001131, G4G5)
- *Symphoricarpos oreophilus* Shrubland (CEGL002951, GNR)

Alliances:
- *Artemisia frigida* Dwarf-shrubland Alliance (A.2565)
- *Artemisia nova* Shrub Herbaceous Alliance (A.1567)
- *Cercocarpus montanus* Shrub Herbaceous Alliance (A.1538)
- *Cercocarpus montanus* Shrubland Alliance (A.896)
- *Prunus virginiana* Shrubland Alliance (A.919)
- *Purshia tridentata* Shrubland Alliance (A.825)
- *Rhus trilobata* Shrub Herbaceous Alliance (A.1537)
- *Ribes cereum* Shrubland Alliance (A.923)
- *Spiraea betulifolia* Shrubland Alliance (A.2636)
- *Symphoricarpos occidentalis* Temporarily Flooded Shrubland Alliance (A.961)
- *Symphoricarpos oreophilus* Shrubland Alliance (A.2530)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Dick-Peddie 1993, Hess 1981, Hess and Wasser 1982, Hoffman and Alexander 1987, Marriott and Faber-Langendoen 2000, Mueggler and Stewart 1980, Muldavin 1994, Muldavin et al. 2000b, Neely et al. 2001, Roughton 1972, Shiflet 1994, Thilenius et al. 1995

Version: 20 Feb 2003 **Stakeholders:** Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

SAVANNA AND SHRUB-STEPPE

Savanna

CES304.782 INTER-MOUNTAIN BASINS JUNIPER SAVANNA

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Steppe/Savanna
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Temperate [Temperate Continental]; Intermediate Disturbance Interval; F-Landscape/Medium Intensity; Evergreen Sclerophyllous Tree; Graminoid
Concept Summary: This widespread ecological system occupies dry foothills and sandsheets of western Colorado, northwestern New Mexico, northern Arizona, Utah, west into the Great Basin of Nevada and southern Idaho. It is typically found at lower elevations ranging from 1500-2300 m. This system is generally found at lower elevations and more xeric sites than Great Basin Pinyon-Juniper Woodland (CES304.773) or Colorado Plateau Pinyon-Juniper Woodland (CES304.767). These occurrences are found on lower mountain

slopes, hills, plateaus, basins and flats often where juniper is expanding into semi-desert grasslands and steppe. The vegetation is typically open savanna, although there may be inclusions of more dense juniper woodlands. This savanna is typically dominated by *Juniperus osteosperma* trees with high cover of perennial bunch grasses and forbs, with *Bouteloua gracilis, Hesperostipa comata*, and *Pleuraphis jamesii* being most common. In the southern Colorado Plateau, *Juniperus monosperma* or juniper hybrids may dominate the tree layer. Pinyon trees are typically not present because sites are outside the ecological or geographic range of *Pinus edulis* and *Pinus monophylla*.

DISTRIBUTION

Range: This juniper savanna occurs from northwestern New Mexico, northern Arizona, western Colorado, Utah, west into the Great Basin of Nevada and southern Idaho.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:C, 9:C, 10:C, 11:C, 18:C, 19:C, 20:C, 21:C
Subnations: AZ, CA, CO, ID, NM, NV, OR, UT, WY

CONCEPT

Associations:
- *Juniperus monosperma / Andropogon hallii* Woodland (CEGL000704, G3?)
- *Juniperus monosperma / Bouteloua curtipendula* Woodland (CEGL000708, G5)
- *Juniperus monosperma / Bouteloua eriopoda* Woodland (CEGL000709, GNR)
- *Juniperus monosperma / Bouteloua gracilis* Woodland (CEGL000710, G5)
- *Juniperus monosperma / Cercocarpus montanus - Ribes cereum* Woodland (CEGL000714, GU)
- *Juniperus monosperma / Cercocarpus montanus* Woodland (CEGL000713, GNR)
- *Juniperus monosperma / Hesperostipa neomexicana* Woodland (CEGL000722, G4)
- *Juniperus osteosperma / Hesperostipa comata* Wooded Herbaceous Vegetation (CEGL001489, G1Q)
- *Juniperus osteosperma / Hesperostipa neomexicana* Woodland (CEGL000740, GUQ)
- *Juniperus osteosperma / Leymus salinus* ssp. *salmonis* Wooded Herbaceous Vegetation (CEGL001488, G1Q)
- *Juniperus osteosperma / Pleuraphis mutica* Woodland (CEGL000736, G2)
- *Juniperus osteosperma / Pseudoroegneria spicata* Woodland (CEGL000738, G4)
- *Juniperus osteosperma / Symphoricarpos oreophilus* Woodland (CEGL000741, GU)
- *Juniperus scopulorum / Pseudoroegneria spicata* Woodland (CEGL000748, G4)
- *Juniperus scopulorum / Schizachyrium scoparium* Woodland (CEGL000750, G2)

Alliances:
- *Juniperus monosperma* Woodland Alliance (A.504)
- *Juniperus osteosperma* Wooded Herbaceous Alliance (A.1502)
- *Juniperus osteosperma* Woodland Alliance (A.536)
- *Juniperus scopulorum* Woodland Alliance (A.506)

SPATIAL CHARACTERISTICS

SOURCES

References: Bassett et al. 1987, Blackburn and Tueller 1970, Comer et al. 2003, Eyre 1980, Fitzhugh et al. 1987, Francis 1986, Knight 1994, Larson and Moir 1986, Larson and Moir 1987, Shiflet 1994, Tuhy et al. 2002
Version: 05 Oct 2004 **Stakeholders:** West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.958 NORTHERN ROCKY MOUNTAIN FOOTHILL CONIFER WOODED STEPPE

Primary Division: Rocky Mountain (306)
Land Cover Class: Steppe/Savanna
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Woody-Herbaceous; Shallow Soil; Aridic; Short Disturbance Interval; F-Patch/Low Intensity; F-Landscape/Low Intensity; Needle-Leaved Tree
Concept Summary: This inland Pacific Northwest ecological system occurs in the foothills of the northern Rocky Mountains in the Columbia Plateau region and west along the foothills of the Modoc Plateau and eastern Cascades into southern interior British Columbia. It also occurs east across Idaho into the eastern foothills of the Montana Rockies, and in the Missouri Breaks and mountain islands of central Montana. The system also occurs on the lower treeline slopes of the Wyoming Rockies. These wooded steppes occur at the lower treeline/ecotone between grasslands or shrublands and forests and woodlands, typically on warm, dry, exposed sites too droughty to support a closed tree canopy. This is not a fire-maintained system. The "savanna" character results from a climate-edaphic interaction that results in widely scattered trees over shrubs or grasses, and even in the absence of fire, "woodland" or "forest" structure will not be obtained. Elevations range from less than 500 m in British Columbia to 1600 m in the central Idaho mountains. Occurrences are found on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most

common. This system can occur in association with cliff and canyon systems. It generally occurs on glacial till, glacio-fluvial sand and gravel, dune, basaltic rubble, colluvium, to deep loess or volcanic ash-derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acidic pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. These can also occur on areas of sand dunes, scablands, and pumice where the edaphic conditions limit tree abundance. *Pinus ponderosa* (vars. *ponderosa* and *scopulorum*) and *Pseudotsuga menziesii* are the predominant conifers (not always together); *Pinus flexilis* may be present or common in the tree canopy. In interior British Columbia, *Pseudotsuga menziesii* is the characteristic canopy dominant. In transition areas with big sagebrush steppe systems, *Purshia tridentata, Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. tridentata*, and *Artemisia tripartita* may be common in fire-protected sites such as rocky areas. Deciduous shrubs, such as *Physocarpus malvaceus, Symphoricarpos albus*, or *Spiraea betulifolia*, can be abundant in more northerly sites or more moist climates. Important grass species include *Pseudoroegneria spicata, Poa secunda, Hesperostipa* spp., *Achnatherum* spp., and *Elymus elymoides*. In the Missouri Breaks region, *Pseudotsuga menziesii* provides a very open canopy over grassy undergrowth, predominantly composed of *Pseudoroegneria spicata*, with little to no shrubs present.
Comments: This is not a fire-maintained system; it occurs on sites too droughty to support a closed tree canopy. It does burn with a high-frequency / low-intensity regime, but fire is not carried because of the sparse vegetation of the edaphically-constrained sites (rock outcrops, dunes, super-dry, sparse trees over shrubs and sometime grasses but widely spaced). True "savannas" with grassy understories and high-frequency / low-intensity fires are now placed into Northern Rocky Mountain Ponderosa Pine Woodland and Savanna (CES306.030). Rocky Mountain Ponderosa Pine Woodland (CES306.827) and Southern Rocky Mountain Ponderosa Pine Savanna (CES306.826) mostly contain *Pinus ponderosa var. scopulorum* and *Pinus arizonica var. arizonica (= Pinus ponderosa var. arizonica)*. The FRIS site describes different varieties of *Pinus ponderosa* and associated species. Johansen and Latta (2003) have mapped the distribution of the two varieties using mitochondrial DNA. They hybridize along the Continental Divide in Montana backing up the FRIS information.

DISTRIBUTION

Range: This system is found in the Fraser River drainage of southern British Columbia south along the Cascades into the Modoc Plateau of California, and the northern Rocky Mountains of Washington and Oregon. In the northeastern part of its range, it extends across the northern Rocky Mountains west of the Continental Divide into northwestern Montana and south to the Snake River Plain in Idaho. It also occurs in central and eastern Montana, particularly along the "breaks" of the Missouri River, and into the eastern foothills of the Wyoming Rockies. In Oregon, it is most common in south-central Oregon, in lands managed by the Lakeview District of the BLM, and by the adjacent Fremont and Deschutes national forests. It also occurs on the marginal lands coming south out of the Blue Mountains, on the edge of the northern Basin and Range.
Divisions: 204:C, 304:C, 306:C
TNC Ecoregions: 4:C, 6:C, 7:C, 8:C, 9:C, 10:C, 26:C, 68:C
Subnations: BC, ID, MT, OR, WA

CONCEPT

Associations:
- *Pinus ponderosa - Pseudotsuga menziesii / Purshia tridentata* Woodland (CEGL000214, G3)
- *Pinus ponderosa / Artemisia tridentata - Purshia tridentata* Woodland (CEGL000178, G3)
- *Pinus ponderosa / Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Woodland (CEGL000179, G1)
- *Pinus ponderosa / Hesperostipa comata* Woodland (CEGL000879, G1)
- *Pinus ponderosa / Pseudoroegneria spicata* Woodland (CEGL000865, G4)
- *Pinus ponderosa / Purshia tridentata / Achnatherum hymenoides* Woodland (CEGL000196, G1)
- *Pinus ponderosa / Purshia tridentata* Woodland (CEGL000867, G3G5)
- *Pinus ponderosa* Scree Woodland (CEGL000878, G4)
- *Pseudotsuga menziesii / Purshia tridentata* Woodland (CEGL000909, G3Q)

Alliances:
- *Pinus ponderosa - Pseudotsuga menziesii* Woodland Alliance (A.533)
- *Pinus ponderosa* Woodland Alliance (A.530)
- *Pseudotsuga menziesii* Woodland Alliance (A.552)

Dynamics: Periodic drought that limits tree establishment is the driving factor in this system. The concept is that of the climate-edaphic interaction that results in widely scattered trees over "shrub-steppe" of sage, bitterbrush, or sparsely distributed grasses. Tree growth is likely episodic, with regeneration episodes in years with available moisture. Tree density is limited in some areas by available growing space due to rocky conditions of the site. The tree canopy in this system will never reach woodland density or close due to the interaction of climate and edaphic factors, even in the absence of fire. This system burns occasionally, but the vegetation is sparse enough that fires are typically not carried through the stand. Fire frequency is speculated to be 30-50 years. It can also occur on areas of sand dunes, scablands, and pumice where the edaphic conditions limit tree abundance. *Pinus ponderosa* is a drought-resistant, shade-intolerant conifer which usually occurs at lower treeline in the major ranges of the western United States.

SPATIAL CHARACTERISTICS

SOURCES

References: Camp et al. 1997, Comer et al. 2002, Comer et al. 2003, Cooper et al. 1987, Daubenmire and Daubenmire 1968, Everett et al. 2000, Eyre 1980, Franklin and Dyrness 1973, Johansen and Latta 2003, Mauk and Henderson 1984, Mehl 1992, Meidinger and Pojar 1991, Pfister et al. 1977, Reid et al. 1999, Shiflet 1994, USFS 1993, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Version: 20 Apr 2006 **Stakeholders:** Canada, West

Concept Author: Western Ecology Group **LeadResp:** West

CES306.837 NORTHERN ROCKY MOUNTAIN WESTERN LARCH SAVANNA – *NOTE, AS MAPPED THIS IS NOT STANDARD*

Primary Division: Rocky Mountain (306)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Forest and Woodland (Treed); Udic; Very Long Disturbance Interval; F-Landscape/Medium Intensity; Other Floristics/Dominants [User-defined]; Moderate (100-500 yrs) Persistence

Concept Summary: This ecological system is restricted to the interior montane zone of the Pacific Northwest in northern Idaho and adjacent Montana, Washington, Oregon, and in southeastern interior British Columbia. It also appears in the east Cascades of Washington. Winter snowpacks typically melt off in early spring at lower elevations. Elevations range from 680 to 2195 m (2230-7200 feet), and sites include drier, lower montane settings of toeslopes and ash deposits. This system is composed of open-canopied "savannas" of the deciduous conifer *Larix occidentalis*, which may have been initiated following stand-replacing crownfires of other conifer systems, but are maintained by a higher frequency, surface-fire regime. These savannas are found in settings where low-intensity, high-frequency fires create open larch woodlands, often with the undergrowth dominated by low-growing *Arctostaphylos uva-ursi, Calamagrostis rubescens, Linnaea borealis, Spiraea betulifolia, Vaccinium caespitosum,* or *Xerophyllum tenax*. Less frequent or absence of fire creates mixed-dominance stands with often shrubby undergrowth; *Vaccinium caespitosum* is common, and taller shrubs can include *Acer glabrum, Ceanothus velutinus, Shepherdia canadensis, Physocarpus malvaceus, Rubus parviflorus*, or *Vaccinium membranaceum.* Fire suppression has led to invasion of the more shade-tolerant tree species *Abies grandis, Abies lasiocarpa, Picea engelmannii*, or *Tsuga* spp. and loss of much of the single-story canopy woodlands.

Comments: Stands initiated following crownfires in areas with stand-replacing fire frequencies greater than 150 years are included in the more mesic adjacent forest systems (Northern Rocky Mountain Mesic Montane Mixed Conifer Forest (CES306.802) and Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest (CES306.805)). This is a fire-dependant system and was much more extensive in the past; it is now very patchy in distribution. Most *Larix occidentalis* is a seral component of the dry-mesic mixed montane forest.

DISTRIBUTION

Divisions: 204:C, 306:C

TNC Ecoregions: 3:C, 4:C, 6:P, 7:C, 8:P, 68:C

Subnations: BC?, ID, MT, OR, WA

CONCEPT

Associations:

- *Larix occidentalis / Clintonia uniflora - Xerophyllum tenax* Forest (CEGL005881, GNR)
- *Larix occidentalis / Clintonia uniflora* Forest (CEGL005880, GNR)
- *Larix occidentalis / Vaccinium caespitosum / Clintonia uniflora* Forest (CEGL005883, GNR)
- *Larix occidentalis / Vaccinium caespitosum* Forest (CEGL005882, GNR)

Alliances:

- *Larix occidentalis* Forest Alliance (A.275)

Dynamics: *Larix occidentalis* is a long-lived species (in excess of 700 years in the northern Rocky Mountains), and thus stands fitting this concept are themselves long-persisting; the life of *Larix*-dominated stands probably does not much exceed 250 years due to various mortality sources and the ingrowth of shade-tolerant species. Occurrences of this ecological system are generated by stand-replacing fire, the fire-return interval for which is speculated to be on the order of 80 to 200 years. These sites may be maintained in a seral status for hundreds of years due to the fact that *Larix occidentalis* is a long-lived species and the understory is often dominated by *Pseudotsuga*, which will grow into the upper canopy. The potential dominants *Abies lasiocarpa, Picea engelmannii*, or *Abies grandis* are slow to establish on these sites and grow slowly presenting the distinct probability, given the fire-return intervals for this type, that the "climax" (long-term stable) condition is never realized.

It has been noted in northern Idaho that, following disturbance (particularly logging) in some mesic-site occurrences, *Larix occidentalis* does not necessarily succeed itself, the first tree-dominated successional stages being dominated by *Pseudotsuga*

menziesii, Pinus contorta, or less frequently by more shade-tolerant species (Cooper et al. 1987); this response is a consequence of the episodic nature of favorable cone crop years in *Larix occidentalis*.

Landfire VDDT models: #RMCONm and #RMCONdy classes B, C, & D.

SPATIAL CHARACTERISTICS

SOURCES

References: Agee 1993, Cooper et al. 1987, Daubenmire and Daubenmire 1968, Driscoll et al. 1984, Eyre 1980, Hessburg et al. 1999, Hessburg et al. 2000, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Leavell 2000, Lillybridge et al. 1995, Pfister et al. 1977, Steele et al. 1981, Western Ecology Working Group n.d., Williams et al. 1995

Version: 01 Sep 2005 **Stakeholders:** Canada, West

Concept Author: R.C. Crawford and M.S. Reid **LeadResp:** West

CES306.837 NORTHERN ROCKY MOUNTAIN WESTERN LARCH WOODLAND AND SAVANNA – *AS MAPPED IN ZONES 8 AND 9*

Primary Division: Rocky Mountain (306)

Land Cover Class: Forest and Woodland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Forest and Woodland (Treed); Udic; Very Long Disturbance Interval; F-Landscape/Medium Intensity; Other Floristics/Dominants [User-defined]; Moderate (100-500 yrs) Persistence

Concept Summary: This ecological system is restricted to the interior montane zone of the Pacific Northwest in northern Idaho and adjacent Montana, Washington, Oregon, and in southeastern interior British Columbia. It also appears in the east Cascades of Washington. Winter snowpacks typically melt off in early spring at lower elevations. Elevations range from 680 to 2195 m (2230-7200 feet), and sites include drier, lower montane settings of toeslopes and ash deposits. it is a large patch type restricted to the interior montane forests of the Pacific Northwest. This ecological system is found in the interior Pacific Northwest in northern Idaho and adjacent Montana, Washington, Oregon and in southeast interior British Columbia. It also appears in the east Cascades of Washington. The deciduous conifer *Larex occidentalis* is dominant or co-dominant (over 50% of total canopy cover) with evergreen conifers trees, usually *Pseudotsuga menziesii*. These stands initate following crown fires in areas with stand replacing fire-frequency greater than 150 years. Low intensity/frequency fire creates open larch woodlands often with undergrowth dominated by *Calamagrostis rubescens.* Less frequent or absense of fire creates mixed dominance stands with often shrubby undergrowth. Most occurrences of this system are dominated by a mix of *Pseudotsuga menziesii*, *Pinus contorta or P monticola* with lesser amounts of *Abies grandis* or *Abies lasiocarpa*. Winter snow packs typically melt off in early spring at lower elevation sites.

Comments: Stands initiated following crownfires in areas with stand-replacing fire frequencies greater than 150 years are included in the more mesic adjacent forest systems (Northern Rocky Mountain Mesic Montane Mixed Conifer Forest (CES306.802) and Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest (CES306.805)). This is a fire-dependant system and was much more extensive in the past; it is now very patchy in distribution. Areas with extensive *Larix occidentalis* cover are placed here, rather than as a seral component of the dry-mesic mixed montane forest.

DISTRIBUTION

Divisions: 204:C, 306:C

TNC Ecoregions: 3:C, 4:C, 6:P, 7:C, 8:P, 68:C

Subnations: BC?, ID, MT, OR, WA

CONCEPT

Associations:

- *Larix occidentalis / Clintonia uniflora - Xerophyllum tenax* Forest (CEGL005881, GNR)
- *Larix occidentalis / Clintonia uniflora* Forest (CEGL005880, GNR)
- *Larix occidentalis / Vaccinium caespitosum / Clintonia uniflora* Forest (CEGL005883, GNR)
- *Larix occidentalis / Vaccinium caespitosum* Forest (CEGL005882, GNR)

Alliances:

- *Larix occidentalis* Forest Alliance (A.275)

Dynamics: *Larix occidentalis* is a long-lived species (in excess of 700 years in the northern Rocky Mountains), and thus stands fitting this concept are themselves long-persisting; the life of *Larix*-dominated stands probably does not much exceed 250 years due to various mortality sources and the ingrowth of shade-tolerant species. Occurrences of this ecological system are generated by stand-replacing fire, the fire-return interval for which is speculated to be on the order of 80 to 200 years. These sites may be maintained in a seral status for hundreds of years due to the fact that *Larix occidentalis* is a long-lived species and the understory is often dominated by *Pseudotsuga,* which will grow into the upper canopy. The potential dominants *Abies lasiocarpa, Picea engelmannii*, or *Abies grandis* are slow to establish on these sites and grow slowly presenting the distinct probability, given the fire-return intervals for this type, that the "climax" (long-term stable) condition is never realized.

It has been noted in northern Idaho that, following disturbance (particularly logging) in some mesic-site occurrences, *Larix occidentalis* does not necessarily succeed itself, the first tree-dominated successional stages being dominated by *Pseudotsuga menziesii, Pinus contorta,* or less frequently by more shade-tolerant species (Cooper et al. 1987); this response is a consequence of the episodic nature of favorable cone crop years in *Larix occidentalis*.

Landfire VDDT models: #RMCONm and #RMCONdy classes B, C, & D.

SPATIAL CHARACTERISTICS

SOURCES

References: Agee 1993, Cooper et al. 1987, Daubenmire and Daubenmire 1968, Driscoll et al. 1984, Eyre 1980, Hessburg et al. 1999, Hessburg et al. 2000, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Leavell 2000, Lillybridge et al. 1995, Pfister et al. 1977, Steele et al. 1981, Western Ecology Working Group n.d., Williams et al. 1995

Version: 01 Sep 2005 **Stakeholders:** Canada, West

Concept Author: R.C. Crawford and M.S. Reid

Shrub-steppe

CES304.080 COLUMBIA PLATEAU LOW SAGEBRUSH STEPPE

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Steppe/Savanna

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Lowland [Foothill, Lowland]; Shrubland (Shrub-dominated); Ridge/Summit/Upper Slope; Sideslope; Shallow Soil; Silt Soil Texture; Clay Soil Texture; Aridic; W-Landscape/High Intensity; Low Artemisia spp.

Concept Summary: This matrix ecological system is composed of sagebrush dwarf-shrub-steppe that occurs in a variety of shallow-soil habitats throughout eastern Oregon, northern Nevada and southern Idaho. *Artemisia arbuscula ssp. arbuscula* and close relatives (*Artemisia arbuscula ssp. longiloba* and occasionally *Artemisia nova*) form stands that typically occur on mountain ridges and flanks and broad terraces, ranging from 1000 to 3000 m in elevation. Substrates are shallow, fine-textured soils, poorly drained clays, shallow-soiled areas, almost always very stony, characterized by recent rhyolite or basalt. Other shrubs and dwarf-shrubs present may include *Purshia tridentata, Eriogonum* spp., and other species of *Artemisia*. Common graminoids include *Festuca idahoensis, Koeleria macrantha, Pseudoroegneria spicata,* and *Poa secunda*. Many forbs also occur and may dominate the herbaceous vegetation, especially at the higher elevations. Isolated individuals of *Juniperus occidentalis* (western juniper) and *Cercocarpus ledifolius* (mountain-mahogany) can often be found in this system.

DISTRIBUTION

Range: This system is found throughout the basins of eastern Oregon and southern Idaho, south into northern Nevada and northeastern California.

Divisions: 304:C

TNC Ecoregions: 6:C, 11:C

Subnations: CA, ID, MT?, NV, OR, WY?

CONCEPT

Associations:

- *Artemisia arbuscula* ssp. *arbuscula - Artemisia tridentata* ssp. *vaseyana / Festuca idahoensis* Shrubland [Provisional] (CEGL002982, GNR)
- *Artemisia arbuscula* ssp. *arbuscula - Purshia tridentata / Pseudoroegneria spicata - Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001518, G2G3)
- *Artemisia arbuscula* ssp. *arbuscula / Achnatherum thurberianum* Shrub Herbaceous Vegetation (CEGL001413, G4G5)
- *Artemisia arbuscula* ssp. *arbuscula / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001409, G5)
- *Artemisia arbuscula* ssp. *arbuscula / Leymus salinus* ssp. *salmonis* Shrub Herbaceous Vegetation (CEGL001410, G1G2Q)
- *Artemisia arbuscula* ssp. *arbuscula / Poa secunda* Shrub Herbaceous Vegetation (CEGL001411, G5)
- *Artemisia arbuscula* ssp. *arbuscula / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001412, G5)
- *Artemisia arbuscula* ssp. *longiloba / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001522, G3)
- *Artemisia arbuscula* ssp. *longiloba / Pascopyrum smithii* Shrub Herbaceous Vegetation (CEGL001415, GU)
- *Artemisia arbuscula* ssp. *longiloba / Poa secunda* Shrub Herbaceous Vegetation (CEGL001523, G3Q)
- *Artemisia arbuscula* ssp. *longiloba / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001416, GNR)
- *Artemisia arbuscula* ssp. *longiloba* Shrubland (CEGL001414, G4G5)

Alliances:

- *Artemisia arbuscula* ssp. *arbuscula* Shrub Herbaceous Alliance (A.1566)
- *Artemisia arbuscula* ssp. *arbuscula* Shrubland Alliance (A.2547)
- *Artemisia arbuscula* ssp. *longiloba* Shrub Herbaceous Alliance (A.2552)
- *Artemisia arbuscula* ssp. *longiloba* Shrubland Alliance (A.2549)

SPATIAL CHARACTERISTICS

SOURCES

References: Shiflet 1994, West 1983a, Western Ecology Working Group n.d.

Version: 08 Sep 2004 **Stakeholders:** West

Concept Author: J. Kagan **LeadResp:** West

CES304.083 COLUMBIA PLATEAU STEPPE AND GRASSLAND

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Steppe/Savanna
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill, Lowland]; Sideslope; Very Shallow Soil; Landslide; Xeromorphic Shrub; Graminoid
Concept Summary: These grasslands are similar floristically to Inter-Mountain Basins Big Sagebrush Steppe (CES304.778) but are defined by a more frequent fire regime and the absence or low cover of shrubs over large areas, occasionally entire landforms. These are extensive grasslands, not grass-dominated patches within the sagebrush shrub-steppe ecological system. This system occurs throughout much of the Columbia Plateau and is found at slightly higher elevations farther south. Soils are variable, ranging from relatively deep, fine-textured often with coarse fragments, and non-saline often with a microphytic crust, to stony volcanic-derived clays to alluvial sands. This grassland is dominated by perennial bunch grasses and forbs (>25% cover), sometimes with a sparse (<10% cover) shrub layer; *Chrysothamnus viscidiflorus, Ericameria nauseosa, Tetradymia* spp., or *Artemisia* spp. may be present in disturbed stands. 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. The rapid fire-return regime of this ecological system maintains a grassland by retarding shrub invasion, and landscape isolation and fragmentation limit seed dispersal of native shrub species. Fire frequency is presumed to be less than 20 years. Through isolation from a seed source, combined with repeated burning, these are "permanently" (more than 50 years) converted to grassland.
Comments: How this differs from Columbia Basin Palouse Prairie (CES304.792) is unclear.

DISTRIBUTION

Range: This system occurs throughout the Columbia Plateau region, from north-central Idaho, south and west into Washington, Oregon, southern Idaho, and northern Nevada. Whether it also occurs in northeastern California, in the western ranges of Wyoming, or the central Wyoming Basins is unclear.
Divisions: 304:C, 306:C
TNC Ecoregions: 4:C, 6:C, 8:C, 9:C, 10:P, 11:C
Subnations: CA?, ID, MT?, NV, OR, UT?, WA, WY?

CONCEPT

Associations:
Alliances:
•
Dynamics: The natural fire regime of this ecological system likely maintains a patchy distribution of shrubs so the general aspect of the vegetation is a grassland. Shrubs may increase following heavy grazing and/or with fire suppression, particularly in moist portions in the northern Columbia Plateau where it forms a landscape mosaic pattern with shallow-soil scabland shrublands. Microphytic crust is very important in this ecological system.

SPATIAL CHARACTERISTICS

SOURCES

References: Daubenmire 1970, Shiflet 1994, Western Ecology Working Group n.d.

Version: 23 Jan 2006 **Stakeholders:** West

Concept Author: R. Crawford **LeadResp:** West

CES304.778 INTER-MOUNTAIN BASINS BIG SAGEBRUSH STEPPE

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Steppe/Savanna
Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Lowland]; Deep Soil; Aridic; Xeromorphic Shrub; Bunch grasses; Artemisia tridentata ssp. tridentata
Concept Summary: This widespread matrix-forming ecological system occurs throughout much of the Columbia Plateau and northern Great Basin and Wyoming and north and east onto the western fringe of the Great Plains in Montana and South Dakota. It is found at slightly higher elevations farther south. In central Montana, this system differs slightly with more summer rain than winter precipitation, more precipitation annually, and it occurs on glaciated landscapes. Soils are typically deep and non-saline, often with a microphytic crust. This shrub-steppe is dominated by perennial grasses and forbs (>25% cover) with *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. xericensis, Artemisia tridentata ssp. wyomingensis, Artemisia tripartita ssp. tripartita, Artemisia cana ssp cana*, and/or *Purshia tridentata* dominating or codominating the open to moderately dense (10-40% cover) shrub layer. *Atriplex confertifolia, Chrysothamnus viscidiflorus, Ericameria nauseosa, Sarcobatus vermiculatus, Tetradymia* spp., or *Artemisia frigida* may be common especially in disturbed stands. In Montana and Wyoming, stands are more mesic, with more biomass of grass, have less shrub diversity than stands farther west, and 50 to 90% of the occurrences are dominated by *Artemisia tridentata ssp. wyomingensis* with *Pascopyrum smithii*. In addition, *Bromus japonicus* and *Bromus tectorum* are indicators of disturbance, and *Bromus tectorum* is never as abundant as in the Intermountain West, primarily due to a colder climate. Associated graminoids include *Achnatherum hymenoides, Calamagrostis montanensis, Elymus lanceolatus ssp. lanceolatus, Festuca idahoensis, Festuca campestris* (in Montana there is an absence of *Festuca*, except *Vulpia octoflora*), *Koeleria macrantha, Poa secunda, Pascopyrum smithii, Hesperostipa comata, Nassella viridula, Bouteloua gracilis*, and *Pseudoroegneria spicata*. Common forbs are *Phlox hoodii, Arenaria* spp., *Opuntia* spp., *Sphaeralcea coccinea, Dalea purpurea, Liatris punctata*, and *Astragalus* spp. Areas with deeper soils more commonly support *Artemisia tridentata ssp. tridentata* but have largely been converted for other land uses. The natural fire regime of this ecological system likely maintains a patchy distribution of shrubs, so the general aspect of the vegetation is a grassland. Shrubs may increase following heavy grazing and/or with fire suppression, particularly in moist portions of the northern Columbia Plateau where it forms a landscape mosaic pattern with shallow-soil scabland shrublands. Where fire frequency has allowed for shifts to a native grassland condition, maintained without significant shrub invasion over a 50- to 70-year interval, the area would be considered Columbia Basin Foothill and Canyon Dry Grassland (CES304.993).

DISTRIBUTION

Range: This system occurs throughout much of the Columbia Plateau, the northern Great Basin and Wyoming, and is found at slightly higher elevations farther south.
Divisions: 304:C, 306:C
TNC Ecoregions: 4:C, 6:C, 8:C, 9:C, 10:C, 11:C, 20:C, 26:C
Subnations: BC, CA, CO, ID, MT, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Artemisia cana* ssp. *cana / Pascopyrum smithii* Shrub Herbaceous Vegetation (CEGL001556, G4)
- *Artemisia tridentata (*ssp. *tridentata*, ssp. *xericensis) / Pseudoroegneria spicata - Poa secunda* Shrub Herbaceous Vegetation (CEGL001019, G1)
- *Artemisia tridentata (*ssp. *tridentata*, ssp. *xericensis) / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001018, G2G4)
- *Artemisia tridentata / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001530, G4Q)
- *Artemisia tridentata / Leymus cinereus* Shrub Herbaceous Vegetation (CEGL001458, G2G4)
- *Artemisia tridentata / Sporobolus cryptandrus - Achnatherum hymenoides* Shrub Herbaceous Vegetation (CEGL001545, G2?)
- *Artemisia tridentata* ssp. *tridentata - Grayia spinosa* Shrubland (CEGL001004, G5)
- *Artemisia tridentata* ssp. *tridentata / Distichlis spicata* Shrubland (CEGL001000, G5)
- *Artemisia tridentata* ssp. *tridentata / Festuca idahoensis* Shrubland (CEGL001014, G4?)
- *Artemisia tridentata* ssp. *tridentata / Hesperostipa comata* Shrubland (CEGL002966, G4?)
- *Artemisia tridentata* ssp. *tridentata / Leymus cinereus* Shrubland (CEGL001016, G2)
- *Artemisia tridentata* ssp. *tridentata / Pascopyrum smithii - (Elymus lanceolatus)* Shrubland (CEGL001017, G3?)
- *Artemisia tridentata* ssp. *tridentata / Pleuraphis jamesii* Shrubland (CEGL001015, G2G4)
- *Artemisia tridentata* ssp. *tridentata / Poa secunda* Shrubland (CEGL001008, G3G5)
- *Artemisia tridentata* ssp. *wyomingensis* / Mixed Grasses Shrub Herbaceous Vegetation (CEGL001534, G5)
- *Artemisia tridentata* ssp. *wyomingensis / Pascopyrum smithii* Shrub Herbaceous Vegetation (CEGL001047, G4)
- *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001535, G4)
- *Artemisia tripartita* ssp. *tripartita / Festuca campestris* Shrub Herbaceous Vegetation (CEGL001537, G2?)
- *Artemisia tripartita* ssp. *tripartita / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001536, G3)
- *Artemisia tripartita* ssp. *tripartita / Hesperostipa comata* Shrub Herbaceous Vegetation (CEGL001539, G1)
- *Artemisia tripartita* ssp. *tripartita / Leymus cinereus* Shrub Herbaceous Vegetation (CEGL002994, GU)
- *Artemisia tripartita* ssp. *tripartita / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001538, G2G3)
- *Purshia tridentata / Festuca campestris* Shrub Herbaceous Vegetation (CEGL001494, G2?)
- *Purshia tridentata / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL002674, G3G5)

- *Purshia tridentata / Hesperostipa comata* Shrub Herbaceous Vegetation (CEGL001498, G2)
- *Purshia tridentata / Poa secunda* Shrubland (CEGL001059, G1?Q)
- *Purshia tridentata / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001495, G3)

Alliances:
- *Artemisia cana* ssp. *cana* Shrub Herbaceous Alliance (A.2554)
- *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) Shrub Herbaceous Alliance (A.1522)
- *Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) Shrubland Alliance (A.830)
- *Artemisia tridentata* Shrub Herbaceous Alliance (A.1521)
- *Artemisia tridentata* ssp. *wyomingensis* Shrub Herbaceous Alliance (A.1527)
- *Artemisia tripartita* ssp. *tripartita* Shrub Herbaceous Alliance (A.1528)
- *Purshia tridentata* Shrub Herbaceous Alliance (A.1523)
- *Purshia tridentata* Shrubland Alliance (A.825)
- *Sporobolus cryptandrus* Shrub Herbaceous Alliance (A.1525)

Dynamics: The natural fire regime of this ecological system likely maintains patchy distribution of shrubs, so the general aspect of the vegetation is a grassland. Shrubs may increase following heavy grazing and/or with fire suppression, particularly in moist portions of the northern Columbia Plateau where it forms a landscape mosaic pattern with shallow-soil scabland shrublands. Response to grazing can be variable depending on the type of grazer and the season in which grazing occurs. *Hesperostipa comata* can increase in abundance in response to either grazing or fire. In central and eastern Montana (and possibly elsewhere), complexes of prairie dog towns are common in this ecological system. Microphytic crust is very important in this ecological system.

SPATIAL CHARACTERISTICS

SOURCES

References: Barbour and Major 1977, Barbour and Major 1988, Comer et al. 2003, Daubenmire 1970, Ecosystems Working Group 1998, Knight 1994, Mueggler and Stewart 1980, Shiflet 1994, West 1983c

Version: 20 Apr 2006 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.785 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Steppe/Savanna

Spatial Scale & Pattern: Matrix

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Upper Montane, Montane, Lower Montane]; Woody-Herbaceous

Concept Summary: This ecological system includes sagebrush communities occurring at montane and subalpine elevations across the western U.S. from 1000 m in eastern Oregon and Washington to over 3000 m in the southern Rockies. In Montana, it occurs on mountain "islands" in the north-central portion of the state and possibly along the Boulder River south of Absarokee and at higher elevations. In British Columbia, it occurs between 450 and 1650 m in the southern Fraser Plateau and the Thompson and Okanagan basins. Climate is cool, semi-arid to subhumid. This system primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes. In general, this system shows an affinity for mild topography, fine soils, and some source of subsurface moisture. Across its range of distribution, this is a compositionally diverse system. It is composed primarily of *Artemisia tridentata ssp. vaseyana, Artemisia cana ssp. viscidula*, and related taxa such as *Artemisia tridentata ssp. spiciformis (= Artemisia spiciformis)*. *Purshia tridentata* may codominate or even dominate some stands. *Artemisia arbuscula ssp. arbuscula*-dominated shrublands commonly occur within this system. Other common shrubs include *Symphoricarpos* spp., *Amelanchier* spp., *Ericameria nauseosa, Peraphyllum ramosissimum, Ribes cereum,* and *Chrysothamnus viscidiflorus.* Most stands have an abundant perennial herbaceous layer (over 25% cover), but this system also includes *Artemisia tridentata ssp. vaseyana* shrublands. Common graminoids include *Festuca arizonica, Festuca idahoensis, Hesperostipa comata, Poa fendleriana, Elymus trachycaulus, Bromus carinatus, Poa secunda, Leucopoa kingii, Deschampsia caespitosa, Calamagrostis rubescens,* and *Pseudoroegneria spicata*. In many areas, frequent wildfires maintain an open herbaceous-rich steppe condition, although at most sites, shrub cover can be unusually high for a steppe system (>40%), with the moisture providing equally high grass and forb cover.

DISTRIBUTION

Range: This system is found at montane and subalpine elevations across the western U.S. from 1000 m in eastern Oregon and Washington to over 3000 m in the southern Rockies. In British Columbia, it occurs in the southern Fraser Plateau and the Thompson and Okanagan basins. This system occurs in mapzone 20 on the Rocky Mountain island ranges and on the western edge with mapzone 19.

Divisions: 304:C, 306:C

TNC Ecoregions: 6:C, 7:C, 8:C, 9:C, 12:C, 18:C, 19:C, 20:C, 26:C, 68:C

Subnations: AZ?, BC, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:

- *Artemisia arbuscula* ssp. *arbuscula - Artemisia tridentata* ssp. *vaseyana / Festuca idahoensis* Shrubland [Provisional] (CEGL002982, GNR)
- *Artemisia arbuscula* ssp. *arbuscula - Purshia tridentata / Pseudoroegneria spicata - Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001518, G2G3)
- *Artemisia arbuscula* ssp. *arbuscula / Achnatherum thurberianum* Shrub Herbaceous Vegetation (CEGL001413, G4G5)
- *Artemisia arbuscula* ssp. *arbuscula / Eriogonum microthecum* Shrubland (CEGL003483, G2G3)
- *Artemisia arbuscula* ssp. *arbuscula / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001409, G5)
- *Artemisia arbuscula* ssp. *arbuscula / Leptodactylon pungens* Shrubland (CEGL003482, G4?)
- *Artemisia arbuscula* ssp. *arbuscula / Leymus salinus* ssp. *salmonis* Shrub Herbaceous Vegetation (CEGL001410, G1G2Q)
- *Artemisia arbuscula* ssp. *arbuscula / Poa secunda* Shrub Herbaceous Vegetation (CEGL001411, G5)
- *Artemisia arbuscula* ssp. *arbuscula / Pseudoroegneria spicata* Shrub Herbaceous Vegetation (CEGL001412, G5)
- *Artemisia arbuscula* ssp. *thermopola / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001519, G2)
- *Artemisia rothrockii / Monardella odoratissima* Shrubland (CEGL008652, G3?)
- *Artemisia rothrockii* Shrubland [Provisional] (CEGL003014, G3?)
- *Artemisia tridentata* (ssp. *vaseyana*, ssp. *wyomingensis*) - *Amelanchier utahensis* Shrubland (CEGL002820, GNR)
- *Artemisia tridentata / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001530, G4Q)
- *Artemisia tridentata* Upperzone Community Shrubland (CEGL001013, G5?)
- *Artemisia tridentata* ssp. *spiciformis / Bromus carinatus* Shrubland (CEGL002989, GNR)
- *Artemisia tridentata* ssp. *spiciformis / Carex geyeri* Shrubland (CEGL002990, GNR)
- *Artemisia tridentata* ssp. *spiciformis* Shrub Herbaceous Vegetation [Provisional] (CEGL002993, GNR)
- *Artemisia tridentata* ssp. *vaseyana - Purshia tridentata / Pseudoroegneria spicata* Shrubland (CEGL001032, G5?)
- *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Bromus carinatus* Shrubland (CEGL001035, G4Q)
- *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Elymus trachycaulus* ssp. *trachycaulus* Shrubland (CEGL001034, G3G4)
- *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Festuca idahoensis* Shrubland (CEGL001036, G4)
- *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Hesperostipa comata* Shrubland (CEGL001039, G3?)
- *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Poa secunda* Shrubland (CEGL001037, G5?)
- *Artemisia tridentata* ssp. *vaseyana - Symphoricarpos oreophilus / Pseudoroegneria spicata* Shrubland (CEGL001038, G5?)
- *Artemisia tridentata* ssp. *vaseyana / Achnatherum lettermanii* Shrubland (CEGL002811, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Achnatherum occidentale* Shrubland (CEGL001033, G2)
- *Artemisia tridentata* ssp. *vaseyana / Balsamorhiza sagittata* Shrubland (CEGL001020, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Bromus carinatus* Shrubland (CEGL001021, G4?)
- *Artemisia tridentata* ssp. *vaseyana / Carex exserta* Shrubland (CEGL008651, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Carex geyeri* Shrub Herbaceous Vegetation (CEGL001532, G3)
- *Artemisia tridentata* ssp. *vaseyana / Festuca campestris* Shrub Herbaceous Vegetation (CEGL001531, G3Q)
- *Artemisia tridentata* ssp. *vaseyana / Festuca idahoensis - Bromus carinatus* Shrubland (CEGL001023, G4Q)
- *Artemisia tridentata* ssp. *vaseyana / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001533, G5)
- *Artemisia tridentata* ssp. *vaseyana / Festuca thurberi* Shrubland (CEGL001024, G3G4)
- *Artemisia tridentata* ssp. *vaseyana / Hesperostipa comata* Shrubland (CEGL002931, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Leucopoa kingii - Koeleria macrantha* Shrubland (CEGL001026, G4)
- *Artemisia tridentata* ssp. *vaseyana / Leucopoa kingii* Shrubland (CEGL001025, G3)
- *Artemisia tridentata* ssp. *vaseyana / Leymus cinereus* Shrubland (CEGL001027, G4?)
- *Artemisia tridentata* ssp. *vaseyana / Monardella odoratissima* Shrubland (CEGL003476, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Pascopyrum smithii* Shrubland (CEGL001028, G3?)
- *Artemisia tridentata* ssp. *vaseyana / Phlox condensata* Shrubland (CEGL002770, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Poa fendleriana* Shrubland (CEGL002812, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Poa secunda* Shrubland (CEGL001029, G3)
- *Artemisia tridentata* ssp. *vaseyana / Pseudoroegneria spicata - Poa fendleriana* Shrubland (CEGL001031, G5)
- *Artemisia tridentata* ssp. *vaseyana / Pseudoroegneria spicata* Shrubland (CEGL001030, G5)
- *Artemisia tridentata* ssp. *wyomingensis - Peraphyllum ramosissimum / Festuca idahoensis* Shrubland (CEGL001048, G2)

Alliances:

- *Artemisia arbuscula* ssp. *arbuscula* Shrub Herbaceous Alliance (A.1566)
- *Artemisia arbuscula* ssp. *arbuscula* Shrubland Alliance (A.2547)
- *Artemisia arbuscula* ssp. *thermopola* Shrub Herbaceous Alliance (A.2553)
- *Artemisia rothrockii* Shrubland Alliance (A.1098)
- *Artemisia tridentata* Shrub Herbaceous Alliance (A.1521)
- *Artemisia tridentata* Shrubland Alliance (A.829)
- *Artemisia tridentata* ssp. *spiciformis* Shrub Herbaceous Alliance (A.2555)

- *Artemisia tridentata* ssp. *spiciformis* Shrubland Alliance (A.2550)
- *Artemisia tridentata* ssp. *vaseyana* Shrub Herbaceous Alliance (A.1526)
- *Artemisia tridentata* ssp. *vaseyana* Shrubland Alliance (A.831)
- *Artemisia tridentata* ssp. *wyomingensis* Shrubland Alliance (A.832)

Environment: This ecological system occurs in many of the western United States, usually at middle elevations (1000-2500 m). The climate regime is cool, semi-arid to subhumid, with yearly precipitation ranging from 25 to 90 cm/year. Much of this precipitation falls as snow. Temperatures are continental with large annual and diurnal variation. In general this system shows an affinity for mild topography, fine soils, and some source of subsurface moisture. Soils generally are moderately deep to deep, well-drained, and of loam, sandy loam, clay loam, or gravelly loam textural classes; soils often have a substantial volume of coarse fragments, and are derived from a variety of parent materials. This system primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes. All aspects are represented, but the higher elevation occurrences may be restricted to south- or west-facing slopes.

Vegetation: Vegetation types within this ecological system are usually less than 1.5 m tall and dominated by *Artemisia tridentata ssp. vaseyana, Artemisia cana ssp. viscidula*, or *Artemisia tridentata ssp. spiciformis*. A variety of other shrubs can be found in some occurrences, but these are seldom dominant. They include *Artemisia rigida, Artemisia arbuscula, Ericameria nauseosa, Chrysothamnus viscidiflorus, Symphoricarpos oreophilus, Purshia tridentata, Peraphyllum ramosissimum, Ribes cereum, Rosa woodsii, Ceanothus velutinus*, and *Amelanchier alnifolia*. The canopy cover is usually between 20-80%. The herbaceous layer is usually well represented, but bare ground may be common in particularly arid or disturbed occurrences. Graminoids that can be abundant include *Festuca idahoensis, Festuca thurberi, Festuca ovina, Elymus elymoides, Deschampsia caespitosa, Danthonia intermedia, Danthonia parryi, Stipa* spp., *Pascopyrum smithii, Bromus carinatus, Elymus trachycaulus, Koeleria macrantha, Pseudoroegneria spicata, Poa fendleriana*, or *Poa secunda*, and *Carex* spp. Forbs are often numerous and an important indicator of health. Forb species may include *Castilleja, Potentilla, Erigeron, Phlox, Astragalus, Geum, Lupinus*, and *Eriogonum, Balsamorhiza sagittata, Achillea millefolium, Antennaria rosea*, and *Eriogonum umbellatum, Fragaria virginiana, Artemisia ludoviciana, Hymenoxys hoopesii (= Helenium hoopesii)*, etc.

Dynamics: Healthy sagebrush shrublands are very productive, are often grazed by domestic livestock, and are strongly preferred during the growing season (Padgett et al. 1989). Prolonged livestock use can cause a decrease in the abundance of native bunch grasses and increase in the cover of shrubs and non-native grass species, such as *Poa pratensis*. *Artemisia cana* resprouts vigorously following spring fire, and prescribed burning may increase shrub cover. Conversely, fire in the fall may decrease shrub abundance (Hansen et al. 1995). *Artemisia tridentata* is generally killed by fires and may take over ten years to form occurrences of some 20% cover or more. The condition of most sagebrush steppe has been degraded due to fire suppression and heavy livestock grazing. It is unclear how long restoration will take to restore degraded occurrences.

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Ecosystems Working Group 1998, Hansen et al. 1995, Hironaka et al. 1983, Johnston 2001, Mueggler and Stewart 1980, Neely et al. 2001, Padgett et al. 1989, Shiflet 1994, West 1983c

Version: 25 Apr 2006 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.788 INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB-STEPPE

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Steppe/Savanna

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Lowland [Foothill, Lowland]; Woody-Herbaceous; Temperate [Temperate Xeric]; Alkaline Soil; Aridic; Very Short Disturbance Interval; G-Landscape/High Intensity; Graminoid

Concept Summary: This ecological system occurs throughout the intermountain western U.S., typically at lower elevations on alluvial fans and flats with moderate to deep soils, and extends into south-central Montana between the Pryor and Beartooth ranges where a distinct rainshadow effect occurs. This semi-arid shrub-steppe is typically dominated by graminoids (>25% cover) with an open shrub layer. The most widespread (but not dominant) species is *Pseudoroegneria spicata*, which occurs from the Columbia Basin to the northern Rockies. Characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Distichlis spicata, Poa secunda, Poa fendleriana, Sporobolus airoides , Hesperostipa comata, Pleuraphis jamesii*, and *Leymus salinus*. The woody layer is often a mixture of shrubs and dwarf-shrubs. Characteristic species include *Atriplex canescens, Artemisia tridentata, Chrysothamnus greenei Chrysothamnus viscidiflorus, Ephedra* spp., *Ericameria nauseosa, Gutierrezia sarothrae*, and *Krascheninnikovia lanata*. *Artemisia tridentata* may be present but does not dominate. Annual grasses, especially the exotics *Bromus japonicus* and *Bromus tectorum*, may be present to abundant. Forbs are generally of low importance and are highly variable across the range but may be diverse in some occurrences. The general aspect of occurrences may be either open shrubland with patchy grasses or patchy open herbaceous layer. Disturbance may be important in maintaining the woody component. Microphytic crust is very important in some stands.

DISTRIBUTION

Range: This system occurs throughout the intermountain western U.S., typically at lower elevations, and extends into Wyoming and Montana across the Great Divide Basin. It barely gets as far north into north-central Montana (mapzone 20) but is unlikely to be mapped.

Divisions: 304:C

TNC Ecoregions: 4:C, 6:C, 8:C, 9:C, 10:C, 11:C, 18:C, 19:C, 20:C, 21:C

Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WY

CONCEPT

Associations:

- *Achnatherum speciosum* Shrub Herbaceous Vegetation [Placeholder] (CEGL003113, G1Q)
- *Artemisia bigelovii / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL001742, GNR)
- *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland (CEGL002699, GNR)
- *Artemisia tridentata - Atriplex confertifolia* Shrubland (CEGL000993, G4)
- *Artemisia tridentata* ssp. *wyomingensis / Leymus salinus* Shrubland (CEGL002813, GNR)
- *Atriplex obovata / Sporobolus airoides - Pleuraphis jamesii* Shrub Herbaceous Vegetation (CEGL001775, GU)
- *Bouteloua eriopoda* Coconino Plateau Shrub Herbaceous Vegetation (CEGL002787, GNR)
- *Bouteloua gracilis - Hesperostipa comata* Herbaceous Vegetation [Provisional] (CEGL002932, GNR)
- *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation [Placeholder] (CEGL005810, GNR)
- *Chrysothamnus viscidiflorus - Ericameria parryi* Shrub Herbaceous Vegetation [Provisional] (CEGL002781, GNR)
- *Chrysothamnus viscidiflorus / Hesperostipa comata* Shrubland (CEGL002799, GNR)
- *Chrysothamnus viscidiflorus / Leymus salinus* ssp. *salinus* Shrub Herbaceous Vegetation (CEGL001501, G2G4)
- *Chrysothamnus viscidiflorus / Poa pratensis* Semi-Natural Shrub Herbaceous Vegetation (CEGL002933, GNR)
- *Ephedra nevadensis* Basalt Shrubland [Provisional] (CEGL002936, GNR)
- *Ephedra torreyana - Artemisia bigelovii* Sparse Vegetation (CEGL002350, GNR)
- *Ephedra torreyana / Achnatherum hymenoides - Pleuraphis jamesii* Shrubland (CEGL002352, GNR)
- *Ephedra viridis / Achnatherum hymenoides - Bouteloua gracilis* Shrub Herbaceous Vegetation (CEGL001648, G2G4)
- *Ephedra viridis / Achnatherum hymenoides - Sporobolus cryptandrus* Shrub Herbaceous Vegetation (CEGL001649, G2G4)
- *Ericameria nauseosa / Bouteloua gracilis* Shrub Herbaceous Vegetation (CEGL003495, GNR)
- *Ericameria nauseosa / Bromus tectorum* Semi-natural Shrubland (CEGL002937, GNR)
- *Ericameria nauseosa / Muhlenbergia pungens - Achnatherum hymenoides* Shrub Herbaceous Vegetation (CEGL002921, GNR)
- *Ericameria nauseosa / Pleuraphis jamesii - (Hesperostipa comata)* Shrub Herbaceous Vegetation (CEGL002996, GNR)
- *Ericameria parryi / Achnatherum hymenoides* Shrubland (CEGL003751, GNR)
- *Ericameria parryi / Pleuraphis jamesii - Bouteloua gracilis* Shrubland (CEGL001331, GUQ)
- *Gutierrezia sarothrae* - (*Opuntia* spp.) / *Pleuraphis jamesii* Dwarf-shrubland (CEGL002690, GNR)
- *Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda* Shrub Herbaceous Vegetation (CEGL001733, G2)
- *Gutierrezia sarothrae / Pleuraphis rigida* Shrub Herbaceous Vegetation (CEGL001543, G2Q)
- *Gutierrezia sarothrae / Sporobolus airoides - Pleuraphis jamesii* Shrub Herbaceous Vegetation (CEGL001776, GU)
- *Krascheninnikovia lanata / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL001321, G4)
- *Krascheninnikovia lanata / Pascopyrum smithii - Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL001324, G4)
- *Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland (CEGL001322, G3G4)
- *Krascheninnikovia lanata / Poa secunda* Dwarf-shrubland (CEGL001326, G3)
- *Opuntia polyacantha / Pleuraphis jamesii* Shrubland (CEGL002299, GNR)
- *Poliomintha incana / (Pleuraphis jamesii)* Shrubland (CEGL002930, GNR)

Alliances:

- *Achnatherum hymenoides* Shrub Herbaceous Alliance (A.1543)
- *Achnatherum speciosum* Shrub Herbaceous Alliance (A.1549)
- *Artemisia tridentata* Shrubland Alliance (A.829)
- *Artemisia tridentata* ssp. *wyomingensis* Shrubland Alliance (A.832)
- *Bouteloua eriopoda* Microphyllous Evergreen Shrub Herbaceous Alliance (A.1545)
- *Bouteloua eriopoda* Xeromorphic Shrub Herbaceous Alliance (A.1553)
- *Bouteloua gracilis* Dwarf-shrub Herbaceous Alliance (A.1571)
- *Bouteloua gracilis* Herbaceous Alliance (A.1282)
- *Chrysothamnus viscidiflorus* Shrubland Alliance (A.2651)
- *Chrysothamnus viscidiflorus* Shrub Herbaceous Alliance (A.1524)
- *Ephedra nevadensis* Shrubland Alliance (A.857)
- *Ephedra torreyana* Shrubland Alliance (A.2572)
- *Ephedra torreyana* Sparsely Vegetated Alliance (A.2571)
- *Ericameria nauseosa* Shrub Short Herbaceous Alliance (A.1546)

- *Ericameria nauseosa* Shrubland Alliance (A.835)
- *Ericameria parryi* Shrubland Alliance (A.818)
- *Gutierrezia sarothrae* Dwarf-shrubland Alliance (A.2528)
- *Krascheninnikovia lanata* Dwarf-shrub Herbaceous Alliance (A.1565)
- *Krascheninnikovia lanata* Dwarf-shrubland Alliance (A.1104)
- *Opuntia* spp. Shrubland Alliance (A.2650)
- *Pleuraphis rigida / Gutierrezia sarothrae* Shrub Herbaceous Alliance (A.1529)
- *Poliomintha incana* Shrubland Alliance (A.862)
- *Sporobolus airoides - (Pleuraphis jamesii)* Shrub Herbaceous Alliance (A.1532)

Environment: This ecological system occurs throughout the Intermountain West from the western Great Basin to the northern Rocky Mountains and Colorado Plateau at elevations ranging from 300 m up to 2500 m. The climate where this system occurs is generally hot in summers and cold in winters with low annual precipitation, ranging from 18-40 cm and high inter-annual variation. Much of the precipitation falls as snow, and growing-season drought is characteristic. Temperatures are continental with large annual and diurnal variation. Sites are generally alluvial fans and flats with moderate to deep soils. Some sites can be flat, poorly drained and intermittently flooded with a shallow or perched water table often within 1 m depth (West 1983). Substrates are generally shallow, calcareous, fine-textured soils (clays to silt-loams), derived from alluvium; or deep, fine to medium-textured alluvial soils with some source of sub-irrigation during the summer season. Soils may be alkaline and typically moderately saline (West 1983). Some occurrences occur on deep, sandy soils, or soils that are highly calcareous (Hironaka et al. 1983).

Vegetation: The plant associations in this system are characterized by a somewhat sparse to moderately dense (10-70% cover) shrub layer of

- *Artemisia filifolia, Ephedra cutleri, Ephedra nevadensis, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Sarcobatus vermiculatus,* or *Atriplex canescens.* Other shrubs occasionally present include *Purshia tridentata* and *Tetradymia canescens. Artemisia tridentata* may be present but does not dominate. Trees are very rarely present in this system, but some individuals of *Pinus ponderosa, Juniperus scopulorum, Juniperus occidentalis,* or *Cercocarpus ledifolius* may occur. The herbaceous layer is dominated by bunch grasses which occupy patches in the shrub matrix. The most widespread species is *Pseudoroegneria spicata,* which occurs from the Columbia Basin to the northern Rockies. Other locally dominant or important species include *Sporobolus airoides, Leymus cinereus, Festuca idahoensis, Pascopyrum smithii, Bouteloua gracilis, Distichlis spicata, Pleuraphis jamesii, Elymus lanceolatus, Elymus elymoides, Koeleria macrantha, Muhlenbergia richardsonis, Hesperostipa comata,* and *Poa secunda*. Annual grasses, especially the exotics *Bromus japonicus* and *Bromus tectorum,* may be present to abundant. Forbs are generally of low importance and are highly variable across the range, but may be diverse in some occurrences. Species that often occur are *Symphyotrichum ascendens (= Aster adscendens), Collinsia parviflora, Penstemon caespitosus, Achillea millefolium, Erigeron compositus, Senecio* spp, and *Taraxacum officinale*. Other important genera include *Astragalus, Oenothera, Eriogonum,* and *Balsamorhiza*. Mosses and lichens may be important ground cover. Forbs are common on disturbed weedy sites. Weedy annual forbs may include the exotics *Descurainia* spp., *Helianthus annuus, Halogeton glomeratus, Lactuca serriola,* and *Lepidium perfoliatum.*

SPATIAL CHARACTERISTICS

SOURCES

References: Branson et al. 1976, Comer et al. 2003, Hanson 1929, Hironaka et al. 1983, Shiflet 1994, Tuhy et al. 2002, West 1983e

Version: 20 Apr 2006 **Stakeholders:** West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

Herbaceous

CES304.993 COLUMBIA BASIN FOOTHILL AND CANYON DRY GRASSLAND

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Herbaceous

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Lowland [Foothill, Lowland]; Sideslope; Very Shallow Soil; Landslide; Graminoid

Concept Summary: These grasslands are similar floristically to Columbia Basin Palouse Prairie (CES304.792) but are distinguished by landform, soil, and process characteristics. They occur in the canyons and valleys of the Columbia Basin, particularly along the Snake River canyon, the lower foothill slopes of the Blue Mountains, and along the main stem of the Columbia River in eastern Washington. Occurrences are found on steep open slopes, from 90 to 1525 m (300-5000 feet) elevation. Annual precipitation is low, ranging from 4 to 10 cm. Settings are primarily long, steep slopes of 100 m to well over 400 m, with soils derived from residuum and having patchy, thin, wind-blown surface deposits. Slope failures are a common process. Fire frequency is presumed to be less than 20 years. The vegetation is dominated by patchy graminoid cover, cacti, and some forbs. *Pseudoroegneria spicata, Festuca idahoensis,* and *Opuntia*

polyacantha are common species. Deciduous shrubs *Symphoricarpos* spp., *Physocarpus malvaceus, Holodiscus discolor,* and *Ribes* spp. are infrequent native species that may increase with fire exclusion.

DISTRIBUTION

Range: Occurs in the canyons and valleys of the Columbia Basin, particularly along the Snake River canyon, the lower foothill slopes of the Blue Mountains, and along the main stem of the Columbia River in eastern Washington, on steep open slopes, from 90 to 1525 m (300-5000 feet) elevation.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:C, 8:C, 68:P
Subnations: ID, OR, WA

CONCEPT

Associations:
- *Aristida purpurea* var. *longiseta - Poa secunda* Herbaceous Vegetation (CEGL001781, G3)
- *Aristida purpurea* var. *longiseta - Pseudoroegneria spicata - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001589, G2)
- *Aristida purpurea* var. *longiseta - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001515, G1)
- *Pseudoroegneria spicata - Festuca idahoensis* Canyon Herbaceous Vegetation (CEGL001669, G3)
- *Pseudoroegneria spicata - Opuntia polyacantha - (Poa secunda)* Herbaceous Vegetation (CEGL001673, G3)
- *Sporobolus cryptandrus - Poa secunda* Herbaceous Ve getation (CEGL001516, G2)

Alliances:
- *Poa secunda* Herbaceous Alliance (A.1291)
- *Pseudoroegneria spicata* Herbaceous Alliance (A.1265)
- *Sporobolus cryptandrus* Herbaceous Alliance (A.1252)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Hall 1973, Johnson and Clausnitzer 1992, Johnson and Simon 1985, Shiflet 1994, Tisdale 1986, Tisdale and Bramble-Brodahl 1983
Version: 08 Sep 2004 **Stakeholders:** West
Concept Author: R. Crawford, J. Kagan, M. Reid **LeadResp:** West

CES304.792 COLUMBIA BASIN PALOUSE PRAIRIE

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Herbaceous
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Herbaceous; Loess deposit (undifferentiated); Deep Soil; Mineral: W/ A-Horizon >10 cm; Graminoid; Cool-season bunch grasses; Long (>500 yrs) Persistence
Concept Summary: This once-extensive grassland system occurs in eastern Washington and Oregon, and west-central Idaho, though in very small patches there. In much of its range it is characterized by rolling topography composed of loess hills and plains over basalt plains. The climate of this region has warm-hot, dry summers and cool, wet winters. Annual precipitation is high, 38-76 cm (15-30 inches). The soils are typically deep, well-developed, and old. The cool-season bunch grasses that dominate the vegetation are adapted to this winter precipitation. Characteristic species are *Pseudoroegneria spicata* and *Festuca idahoensis* with *Hesperostipa comata, Achnatherum scribneri, Leymus condensatus, Leymus cinereus, Koeleria macrantha, Pascopyrum smithii*, or *Poa secunda*. Shrubs commonly found include *Amelanchier alnifolia, Rosa* spp., *Eriogonum* spp., *Symphoricarpos albus,* and *Crataegus douglasii*. Excessive grazing, past land use and invasion by introduced annual species have resulted in a massive conversion to agriculture or shrub-steppe and annual grasslands dominated by *Artemisia* spp. and *Bromus tectorum* or *Poa pratensis*. Remnant grasslands are now typically associated with steep and rocky sites or small and isolated sites within an agricultural landscape.

DISTRIBUTION

Range: This system occurs in eastern Washington and Oregon, and west-central Idaho.
Divisions: 304:C, 306:P
TNC Ecoregions: 6:C, 8:P
Subnations: BC?, ID, OR, WA

CONCEPT

Associations:
- *(Balsamorhiza serrata) - Poa secunda* Herbaceous Vegetation (CEGL001782, G2)
- *Elymus lanceolatus - Hesperostipa comata* Herbaceous Vegetation (CEGL001746, G1)
- *Eriogonum compositum / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001784, G2)
- *Eriogonum douglasii / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001785, G4)

- *Eriogonum sphaerocephalum / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001448, G3)
- *Eriogonum thymoides / Poa secunda* Dwarf-shrub Herbaceous Vegetation (CEGL001449, G3)
- *Festuca idahoensis - Eriogonum caespitosum* Herbaceous Vegetation (CEGL001615, G2?Q)
- *Festuca idahoensis - Hieracium cynoglossoides* Herbaceous Vegetation (CEGL001619, G1G2)
- *Festuca idahoensis - Koeleria macrantha* Herbaceous Vegetation (CEGL001620, G3Q)
- *Festuca idahoensis - Symphoricarpos albus* Herbaceous Vegetation (CEGL001509, G1)
- *Hesperostipa comata - Poa secunda* Herbaceous Vegetation (CEGL001704, G1)
- *Leymus cinereus* Herbaceous Vegetation (CEGL001479, G2G3Q)
- *Pseudoroegneria spicata - Balsamorhiza sagittata - Poa secunda* Herbaceous Vegetation (CEGL001662, G3)
- *Pseudoroegneria spicata - Festuca idahoensis* Palouse Herbaceous Vegetation (CEGL001670, G1G2)
- *Pseudoroegneria spicata - Hesperostipa comata* Herbaceous Vegetation (CEGL001679, G4)
- *Pseudoroegneria spicata - Poa secunda* Herbaceous Vegetation (CEGL001677, G4?)
- *Pseudoroegneria spicata - Poa secunda* Lithosolic Herbaceous Vegetation (CEGL001678, G3)
- *Rosa nutkana - Festuca idahoensis* Herbaceous Vegetation (CEGL001626, G1G2Q)
- *Symphoricarpos albus - Rosa nutkana* Shrubland (CEGL001130, G3)

Alliances:
- *Elymus lanceolatus* Herbaceous Alliance (A.1242)
- *Festuca idahoensis* Herbaceous Alliance (A.1251)
- *Hesperostipa comata* Bunch Herbaceous Alliance (A.1270)
- *Leymus cinereus* Herbaceous Alliance (A.1204)
- *Poa secunda* Dwarf-shrub Herbaceous Alliance (A.1568)
- *Poa secunda* Herbaceous Alliance (A.1291)
- *Pseudoroegneria spicata* Herbaceous Alliance (A.1265)
- *Symphoricarpos albus* Shrubland Alliance (A.925)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Daubenmire 1988, Shiflet 1994, Tisdale 1982
Version: 23 Jan 2006 **Stakeholders:** Canada, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.787 INTER-MOUNTAIN BASINS SEMI-DESERT GRASSLAND

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Herbaceous
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill, Lowland]; Herbaceous; Temperate [Temperate Xeric]; Alkaline Soil; Aridic; Graminoid
Concept Summary: This widespread ecological system occurs throughout the Intermountain western U.S. on dry plains and mesas, at approximately 1450 to 2320 m (4750-7610 feet) elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesatops, plateau parks, alluvial flats, and plains, but sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. When they occur near foothill grasslands they will be at lower elevations. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants. These grasslands are typically dominated or codominated by *Achnatherum hymenoides, Aristida* spp., *Bouteloua gracilis, Hesperostipa comata, Muhlenbergia* spp., or *Pleuraphis jamesii* and may include scattered shrubs and dwarf-shrubs of species of *Artemisia, Atriplex, Coleogyne, Ephedra, Gutierrezia,* or *Krascheninnikovia lanata*.

DISTRIBUTION

Range: This system occurs throughout the Intermountain western U.S. on dry plains and mesas, at approximately 1450 to 2320 m (4750-7610 feet) in elevation.
Divisions: 304:C, 306:C
TNC Ecoregions: 4:C, 6:C, 8:C, 9:C, 10:C, 11:C, 18:C, 19:C, 20:C, 21:C
Subnations: AZ, CA, CO, ID, MT?, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Achnatherum hymenoides - Sporobolus contractus* Herbaceous Vegetation (CEGL001652, G2G4)
- *Achnatherum hymenoides* Colorado Plateau Herbaceous Vegetation (CEGL002343, GNR)
- *Achnatherum lettermanii - Oxytropis oreophila* Herbaceous Vegetation (CEGL002734, G2?)
- *Achnatherum nelsonii - Koeleria macrantha* Herbaceous Vegetation (CEGL001707, GNR)

- *Achnatherum speciosum* Herbaceous Vegetation [Placeholder] (CEGL003112, G1Q)
- *Aristida purpurea* Herbaceous Vegetation (CEGL005800, GNR)
- *Aristida purpurea* var. *longiseta - Poa secunda* Herbaceous Vegetation (CEGL001781, G3)
- *Aristida purpurea* var. *longiseta - Pseudoroegneria spicata - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001589, G2)
- *Aristida purpurea* var. *longiseta - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001515, G1)
- *Atriplex obovata / Sporobolus airoides - Pleuraphis jamesii* Shrub Herbaceous Vegetation (CEGL001775, GU)
- *Bouteloua eriopoda - Hesperostipa neomexicana* Herbaceous Vegetation (CEGL001753, GNRQ)
- *Bouteloua eriopoda - Pleuraphis jamesii* Herbaceous Vegetation (CEGL001751, G3)
- *Bouteloua eriopoda* Semi-desert Herbaceous Vegetation (CEGL001752, G2Q)
- *Bouteloua gracilis - Bouteloua curtipendula* Herbaceous Vegetation (CEGL001754, G5)
- *Bouteloua gracilis - Bouteloua hirsuta* Herbaceous Vegetation (CEGL001755, G3G4)
- *Bouteloua gracilis - Hesperostipa comata* Herbaceous Vegetation [Provisional] (CEGL002932, GNR)
- *Bouteloua gracilis - Pleuraphis jamesii* Herbaceous Vegetation (CEGL001759, G2G4)
- *Bouteloua gracilis* Herbaceous Vegetation (CEGL001760, G4Q)
- *Bouteloua hirsuta - Bouteloua radicosa* Herbaceous Vegetation (CEGL001765, G2)
- *Bromus inermis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation (CEGL005264, GNA)
- *Bromus tectorum* Semi-natural Herbaceous Vegetation (CEGL003019, GNA)
- *Elymus lanceolatus* Herbaceous Vegetation (CEGL002588, GNR)
- *Ericameria nauseosa / Bouteloua gracilis* Shrub Herbaceous Vegetation (CEGL003495, GNR)
- *Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda* Shrub Herbaceous Vegetation (CEGL001733, G2)
- *Hesperostipa comata - (Bouteloua eriopoda, Pleuraphis jamesii)* Herbaceous Vegetation (CEGL002997, GNR)
- *Hesperostipa comata - Achnatherum hymenoides* Herbaceous Vegetation (CEGL001703, G2?)
- *Hesperostipa comata* Great Basin Herbaceous Vegetation (CEGL001705, G2G4)
- *Hesperostipa neomexicana* Herbaceous Vegetation (CEGL001708, G3)
- *Muhlenbergia asperifolia* Herbaceous Vegetation (CEGL001779, GU)
- *Muhlenbergia pungens* Herbaceous Vegetation (CEGL002363, GNR)
- *Pleuraphis jamesii* Herbaceous Vegetation (CEGL001777, G2G4)
- *Pleuraphis rigida* Herbaceous Vegetation [Placeholder] (CEGL003051, G3G4)
- *Pleuraphis rigida* Shrub Herbaceous Vegetation [Placeholder] (CEGL003052, G3G4)
- *Poa fendleriana* ssp. *fendleriana* Herbaceous Vegetation (CEGL001655, G2)
- *Poa secunda - Muhlenbergia richardsonis* Herbaceous Vegetation (CEGL002755, GNR)
- *Poa secunda* Herbaceous Vegetation (CEGL001657, G4?)
- *Pseudoroegneria spicata - Achnatherum hymenoides* Herbaceous Vegetation (CEGL001674, G3G4)
- *Pseudoroegneria spicata* ssp. *inermis* Herbaceous Vegetation (CEGL001661, GNR)
- *Sporobolus airoides - Bouteloua gracilis* Herbaceous Vegetation (CEGL001686, GNRQ)
- *Sporobolus airoides* Monotype Herbaceous Vegetation (CEGL001688, GUQ)
- *Sporobolus airoides* Sod Herbaceous Vegetation [Placeholder] (CEGL001791, GNR)
- *Sporobolus cryptandrus - Poa secunda* Herbaceous Vegetation (CEGL001516, G2)
- *Sporobolus cryptandrus* Great Basin Herbaceous Vegetation (CEGL002691, GNR)
- *Sporobolus cryptandrus* Shrub Herbaceous Vegetation (CEGL001514, G2)
- *Thinopyrum intermedium* Semi-natural Herbaceous Vegetation (CEGL002935, GNA)

Alliances:

- *Achnatherum hymenoides* Herbaceous Alliance (A.1262)
- *Achnatherum lettermanii* Herbaceous Alliance (A.2524)
- *Achnatherum nelsonii* Herbaceous Alliance (A.1271)
- *Achnatherum speciosum* Herbaceous Alliance (A.1290)
- *Aristida purpurea* Herbaceous Alliance (A.2570)
- *Bouteloua eriopoda* Herbaceous Alliance (A.1284)
- *Bouteloua eriopoda* Microphyllous Evergreen Shrub Herbaceous Alliance (A.1545)
- *Bouteloua gracilis* Herbaceous Alliance (A.1282)
- *Bouteloua hirsuta* Herbaceous Alliance (A.1285)
- *Bromus inermis* Semi-natural Herbaceous Alliance (A.3561)
- *Bromus tectorum* Semi-natural Herbaceous Alliance (A.1814)
- *Elymus lanceolatus* Herbaceous Alliance (A.1242)
- *Ericameria nauseosa* Shrub Short Herbaceous Alliance (A.1546)
- *Hesperostipa comata* Bunch Herbaceous Alliance (A.1270)
- *Hesperostipa neomexicana* Herbaceous Alliance (A.1272)
- *Muhlenbergia asperifolia* Intermittently Flooded Herbaceous Alliance (A.1334)
- *Muhlenbergia pungens* Herbaceous Alliance (A.2652)

- *Pleuraphis jamesii* Herbaceous Alliance (A.1287)
- *Pleuraphis rigida* Herbaceous Alliance (A.1246)
- *Pleuraphis rigida* Shrub Herbaceous Alliance (A.1539)
- *Poa fendleriana* Herbaceous Alliance (A.1263)
- *Poa secunda* Herbaceous Alliance (A.1291)
- *Poa secunda* Seasonally Flooded Herbaceous Alliance (A.1410)
- *Pseudoroegneria spicata* Herbaceous Alliance (A.1265)
- *Sporobolus airoides - (Pleuraphis jamesii)* Shrub Herbaceous Alliance (A.1532)
- *Sporobolus airoides* Herbaceous Alliance (A.1267)
- *Sporobolus airoides* Sod Herbaceous Alliance (A.1241)
- *Sporobolus cryptandrus* Herbaceous Alliance (A.1252)
- *Sporobolus cryptandrus* Shrub Herbaceous Alliance (A.1525)
- *Thinopyrum intermedium* Semi-natural Herbaceous Alliance (A.2529)

Environment: Low-elevation grasslands in the Intermountain West region occur in semi-arid to arid climates at approximately 1450 to 2320 m (4750-7610 feet) in elevation. Grasslands within this system are typically characterized by a sparse to moderately dense herbaceous layer dominated by medium-tall and short bunch grasses, often in a sod-forming growth. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesa tops, plateau parks, alluvial flats, and plains. These grasslands typically occur on xeric sites. This system experiences cold temperate conditions. Hot summers and cold winters with freezing temperatures and snow are common. Annual precipitation is usually from 20-40 cm (7.9-15.7 inches). A significant portion of the precipitation falls in July through October during the summer monsoon storms, with the rest falling as snow during the winter and early spring months.

These grasslands occur on a variety of aspects and slopes. Sites may range from flat to moderately steep. Soils supporting this system also vary from deep to shallow, and from sandy to finer-textured. The substrate is typically sand- or shale-derived. Some sandy soil occurrences have a high cover of cryptogams on the soil. These cryptogamic species would tend to increase the stability of the highly erodible sandy soils of these grasslands during torrential summer rains and heavy wind storms (Kleiner and Harper 1977). *Muhlenbergia*-dominated grasslands which flood temporarily, combined with high evaporation rates in this dry system, can have accumulations of soluble salts in the soil. Soil salinity depends on the amount and timing of precipitation and flooding.

Dynamics: This system is maintained by frequent fires and sometimes associated with specific soils, often well-drained clay soils. A combination of precipitation, temperature, and soils limits this system to the lower elevations within the region. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants. Grasses that dominate semi-arid grasslands develop a dense network of roots concentrated in the upper parts of the soil where rainfall penetrates most frequently (Blydenstein 1966, Cable 1969, Sala and Lauenroth 1985, as cited by McClaran and Van Devender 1995). *Bouteloua gracilis* is also very grazing-tolerant and generally forms a short sod. *Pleuraphis jamesii* is only moderately palatable to livestock, but decreases when heavily grazed during drought and in the more arid portions of its range where it is the dominant grass (West 1972). This grass reproduces extensively from scaly rhizomes. These rhizomes make the plant resistant to trampling by livestock and have good soil-binding properties (Weaver and Albertson 1956, West 1972). *Achnatherum hymenoides* is one of the most drought-tolerant grasses in the western U.S. (USDA 1937). It is also a valuable forage grass in arid and semi-arid regions. Improperly managed livestock grazing could increase soil erosion, decrease cover of this palatable plant species and increase weedy species (USDA 1937). *Muhlenbergia asperifolia* with its flooding regime combined with high evaporation rate in these dry climates causes accumulations of soluble salts in the soil. Total vegetation cover (density and height), species composition and soil salinity depend on the amount and timing of precipitation and flooding. Growth-inhibiting salt concentrations are diluted when the soil is saturated allowing the growth of less salt-tolerant species. As the saturated soils dry, the salt concentrates until it precipitates out on the soil surface (Dodd and Coupland 1966, Ungar 1968). *Hesperostipa comata* is a deep-rooted grass that uses soil moisture below 0.5 m during the dry summers.

SPATIAL CHARACTERISTICS

SOURCES

References: Cable 1967, Cable 1969, Cable 1975, Comer et al. 2003, Dodd and Coupland 1966, Kleiner and Harper 1977, Mast et al. 1997, Mast et al. 1998, McClaran and Van Devender 1995, Shiflet 1994, Tuhy et al. 2002, Ungar 1968, Weaver and Albertson 1956, West 1983e

Version: 20 Feb 2003 **Stakeholders:** West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.040 NORTHERN ROCKY MOUNTAIN LOWER MONTANE, FOOTHILL AND VALLEY GRASSLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Herbaceous

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Lowland [Foothill, Lowland]; Herbaceous; Sideslope; Very Shallow Soil; Loam Soil Texture; Silt Soil Texture; Ustic; Landslide; Graminoid; Cool-season bunch grasses

Concept Summary: This ecological system of the northern Rocky Mountains 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. They also occur to the east in the central Montana mountain "islands," foothills, as well as the Rocky Mountain Front and Big and Little Belt ranges. These grasslands are floristically similar to Inter-Mountain Basins Big Sagebrush Steppe (CES304.778), Columbia Basin Foothill and Canyon Dry Grassland (CES304.993), and Columbia Basin Palouse Prairie (CES304.792), but are defined by shorter summers, colder winters, and young soils derived from recent glacial and alluvial material. These northern lower montane and valley grasslands represent a shift in the precipitation regime from summer monsoons and cold snowy winters found in the southern Rockies to predominantly dry summers and winter precipitation. In the eastern portion of its range in Montana, winter precipitation is replaced by a huge spring peak in precipitation. They are found at elevations from 300 to 1650 m, ranging from small meadows to large open parks surrounded by conifers in the lower montane, to extensive foothill and valley grasslands below the lower treeline. Many of these valleys may have been primarily sage-steppe with patches of grassland in the past, but because of land-use history post-settlement (herbicide, grazing, fire suppression, pasturing, etc.), they have been converted to grassland-dominated areas. Soils are relatively deep, fine-textured, often with coarse fragments, and non-saline, often with a microphytic crust. The most important species are cool-season perennial bunch grasses and forbs (>25% cover), sometimes with a sparse (<10% cover) shrub layer. *Pseudoroegneria spicata, Festuca campestris, Festuca idahoensis*, or *Hesperostipa comata* commonly dominate sites on all aspects of level to moderate slopes and on certain steep slopes with a variety of other grasses, such as *Achnatherum hymenoides, Achnatherum richardsonii, Hesperostipa curtiseta, Koeleria macrantha, Leymus cinereus, Elymus trachycaulus, Bromus inermis ssp. pumpellianus (= Bromus pumpellianus), Achnatherum occidentale (= Stipa occidentalis), Pascopyrum smithii*, and other graminoids such as *Carex filifolia* and *Danthonia intermedia*. Other grassland species include *Opuntia fragilis, Artemisia frigida, Carex petasata, Antennaria* spp., and *Selaginella densa*. Important exotic grasses include *Phleum pratense, Bromus inermis*, and *Poa pratensis*. Shrub species may be scattered, including *Amelanchier alnifolia, Rosa* spp., *Symphoricarpos* spp., *Juniperus communis, Artemisia tridentata*, and in Wyoming *Artemisia tripartita ssp. rupicola*. Common associated forbs include *Geum triflorum, Galium boreale, Campanula rotundifolia, Antennaria microphylla, Geranium viscosissimum*, and *Potentilla gracilis*. A soil crust of lichen covers almost all open soil between clumps of grasses; *Cladonia* and *Peltigera* are the most common lichens. Unvegetated mineral soil is commonly found between clumps of grass and the lichen cover. The fire regime of this ecological system maintains a grassland due to rapid fire return that retards shrub invasion or landscape isolation and fragmentation that limits seed dispersal of native shrub species. Fire frequency is presumed to be less than 20 years. These are extensive grasslands, not grass-dominated patches within the sagebrush shrub steppe ecological system. *Festuca campestris* is easily eliminated by grazing and does not occur in all areas of this system.
Comments: This is the same as the Interior Plateau Grassland also called "Northern Plateau Grassland" of the Okanagan Ecoregional Plan.

DISTRIBUTION

Range: This lower montane, foothill and valley grassland system occurs throughout the southern interior and southern portion of the Fraser Plateau, as well as the valleys around the Fraser River in the Pavilion Ranges, the Nicola River and the Similkameen River in British Columbia. It also occurs in the mountains and large valleys of northeastern Wyoming and western Montana, east to central Montana rocky mountain front and mountain "island" ranges, west through Idaho into the Blue Mountains of Oregon. In northern Idaho it has been nearly eliminated by conversion to agriculture, and many occurrences in other portions of its range have been similarly converted or heavily managed, grazed, or pastured.
Divisions: 207:C, 306:C
TNC Ecoregions: 6:P, 7:C, 8:C, 9:P, 26:C, 68:C
Subnations: BC, ID, MT, OR, WA, WY

CONCEPT

Associations:
- *Achnatherum nelsonii - Lupinus sericeus* Herbaceous Vegetation (CEGL005860, G2G3)
- *Bromus marginatus - Pseudoroegneria spicata* Herbaceous Vegetation [Provisional] (CEGL005861, G2?)
- *Calamagrostis rubescens* Herbaceous Vegetation (CEGL005862, G3G4?)
- *Elymus repens* Semi-natural Herbaceous Vegetation (CEGL005868, GNA)
- *Festuca campestris - (Festuca idahoensis) - Achnatherum richardsonii* Herbaceous Vegetation (CEGL005869, G2G3?)
- *Festuca campestris - Festuca idahoensis - Geranium viscosissimum* Herbaceous Vegetation (CEGL005870, G3?)
- *Festuca campestris - Festuca idahoensis* Herbaceous Vegetation (CEGL005875, G3)
- *Festuca campestris - Pseudoroegneria spicata* Herbaceous Vegetation (CEGL001629, G4)
- *Festuca idahoensis - Achnatherum richardsonii* Herbaceous Vegetation (CEGL001625, G3)
- *Festuca idahoensis - Carex filifolia* Herbaceous Vegetation (CEGL001898, G3)
- *Festuca idahoensis - Carex hoodii* Herbaceous Vegetation (CEGL001609, G3G4)
- *Festuca idahoensis - Eriogonum heracleoides* Herbaceous Vegetation (CEGL001616, G2)
- *Festuca idahoensis - Koeleria macrantha* Herbaceous Vegetation (CEGL001620, G3Q)
- *Festuca idahoensis - Leucopoa kingii* Herbaceous Vegetation (CEGL001901, G2?)
- *Festuca idahoensis - Pascopyrum smithii* Herbaceous Vegetation (CEGL001621, G4)
- *Festuca idahoensis - Pseudoroegneria spicata* Herbaceous Vegetation (CEGL001624, G4)

- *Festuca idahoensis* Herbaceous Vegetation (CEGL001897, G3Q)
- *Leymus salinus* ssp. *salmonis - Enceliopsis nudicaulis* Sparse Vegetation (CEGL001642, G2Q)
- *Leymus salinus* ssp. *salmonis - Lupinus argenteus* Sparse Vegetation (CEGL001643, G2Q)
- *Phleum pratense - Poa pratensis - Bromus inermis* Semi-natural Herbaceous Vegetation (CEGL005874, GNA)
- *Pseudoroegneria spicata - Carex filifolia* Herbaceous Vegetation (CEGL001665, G4)
- *Pseudoroegneria spicata - Eriogonum heracleoides* Herbaceous Vegetation (CEGL001668, G2Q)

Alliances:
- *Achnatherum nelsonii* Herbaceous Alliance (A.1271)
- *Calamagrostis rubescens* Herbaceous Alliance (A.2637)
- *Elymus repens* Herbaceous Alliance (A.2658)
- *Festuca campestris* Herbaceous Alliance (A.1255)
- *Festuca idahoensis* Alpine Herbaceous Alliance (A.1313)
- *Festuca idahoensis* Herbaceous Alliance (A.1251)
- *Leymus salinus* Sparsely Vegetated Alliance (A.1258)
- *Poa pratensis* Semi-natural Herbaceous Alliance (A.3562)
- *Pseudoroegneria spicata* Herbaceous Alliance (A.1265)

Dynamics: The natural fire regime of this ecological system likely maintains patchy distribution of shrubs, so the general aspect of the vegetation is a grassland. Shrubs may increase following heavy grazing and/or with fire suppression. Microphytic crust is very important in this ecological system. *Festuca campestris* is highly palatable throughout the grazing season. Summer overgrazing for 2 to 3 years can result in the loss of *Festuca campestris* in the stand. Although a light stocking rate for 32 years did not affect range condition, a modest increase in stocking rate led to a marked decline in range condition. The major change was a measurable reduction in basal area of *Festuca campestris*. Long-term heavy grazing on moister sites can result in a shift to a *Poa pratensis - Phleum pratense* (Kentucky bluegrass - timothy) type. *Pseudoroegneria spicata* shows an inconsistent reaction to grazing, increasing on some grazed sites while decreasing on others. It seems to recover more quickly from overgrazing than *Festuca campestris*. It tolerates dormant-period grazing well but is sensitive to defoliation during the growing season. Light spring use or fall grazing can help retain plant vigor. It is particularly sensitive to defoliation in late spring. Exotic species threatening this ecological system through invasion and potential complete replacement of native species include *Bromus japonicus, Potentilla recta, Euphorbia esula*, and all manner of knapweed, especially *Centaurea biebersteinii (= Centaurea maculosa)*.

SPATIAL CHARACTERISTICS

SOURCES

References: BCCDC unpubl. data, Ecosystems Working Group 1998, Shiflet 1994, Western Ecology Working Group n.d.

Version: 20 Apr 2006 **Stakeholders:** Canada, West

Concept Author: R. Crawford **LeadResp:** West

CES306.806 NORTHERN ROCKY MOUNTAIN SUBALPINE-UPPER MONTANE GRASSLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Herbaceous

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Upper Montane]; Herbaceous; Deep Soil; Ustic; Intermediate Disturbance Interval; Graminoid; Tussock-forming grasses

Concept Summary: This is an upper montane to subalpine, high-elevation, lush grassland system dominated by perennial grasses and forbs on dry sites, particularly south-facing slopes. It is most extensive in the Canadian Rockies portion of the Rocky Mountain cordillera, extending south into western Montana, eastern Oregon, eastern Washington and Idaho. Subalpine dry grasslands are small meadows to large open parks surrounded by conifer trees but lack tree cover within them. In general, soil textures are much finer, and soils are often deeper under grasslands than in the neighboring forests. Grasslands, although composed primarily of tussock-forming species, do exhibit a dense sod that makes root penetration difficult for tree species. Disturbance such as fire also plays a role in maintaining these open grassy areas. Typical dominant species include *Leymus innovatus (= Elymus innovatus), Koeleria macrantha, Festuca campestris, Festuca idahoensis, Festuca viridula, Achnatherum occidentale (= Stipa occidentalis), Achnatherum richardsonii (= Stipa richardsonii), Bromus inermis ssp. pumpellianus (= Bromus pumpellianus), Elymus trachycaulus, Phleum alpinum, Trisetum spicatum*, and a variety of Carices, such as *Carex hoodii, Carex obtusata*, and *Carex scirpoidea*. Important forbs include *Lupinus argenteus var. laxiflorus, Potentilla diversifolia, Potentilla flabellifolia, Fragaria virginiana*, and *Chamerion angustifolium (= Epilobium angustifolium)*. This system is similar to Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland (CES306.040) but is found at higher elevations and is more often composed of *Festuca* spp. and *Achnatherum* and/or *Hesperostipa* spp. (= *Stipa* spp.) with additional floristic components of more subalpine taxa.

DISTRIBUTION

Range: It is most extensive in the Canadian Rockies portion of the Rocky Mountain cordillera, extending south into western Montana, central and eastern Oregon, eastern Washington and Idaho. It also occurs in the "island Ranges" of central Montana, though it is not common.

Divisions: 306:C

TNC Ecoregions: 4:P, 7:C, 8:C, 9:P, 26:C, 68:C

Subnations: AB, BC, ID, MT, OR, WA, WY

CONCEPT

Associations:

- *Calamagrostis rubescens* Herbaceous Vegetation (CEGL005862, G3G4?)
- *Carex hoodii - Festuca idahoensis* Herbaceous Vegetation (CEGL001595, G2)
- *Festuca campestris* Herbaceous Vegetation [Provisional] (CEGL001627, G3Q)
- *Festuca idahoensis - (Festuca campestris) / Potentilla diversifolia* Herbaceous Vegetation (CEGL001623, G3)
- *Festuca idahoensis - Carex filifolia* Herbaceous Vegetation (CEGL001898, G3)
- *Festuca idahoensis - Carex obtusata* Herbaceous Vegetation (CEGL001611, G3Q)
- *Festuca idahoensis - Carex scirpoidea* Herbaceous Vegetation (CEGL001899, G2Q)
- *Festuca idahoensis - Danthonia intermedia* Herbaceous Vegetation (CEGL001612, G3?Q)
- *Festuca idahoensis - Deschampsia caespitosa* Herbaceous Vegetation (CEGL001900, G3G4)
- *Festuca idahoensis - Elymus trachycaulus* Herbaceous Vegetation (CEGL001614, G4)
- *Festuca viridula - Carex hoodii* Herbaceous Vegetation (CEGL001596, G3)
- *Festuca viridula - Festuca idahoensis* Herbaceous Vegetation (CEGL001633, G2?Q)
- *Festuca viridula - Lupinus argenteus* var. *laxiflorus* Herbaceous Vegetation (CEGL001634, G3Q)
- *Festuca viridula - Potentilla flabellifolia* Herbaceous Vegetation (CEGL001636, GNRQ)
- *Phleum alpinum - Elymus trachycaulus* Herbaceous Vegetation (CEGL001923, G2Q)

Alliances:

- *Calamagrostis rubescens* Herbaceous Alliance (A.2637)
- *Carex hoodii* Herbaceous Alliance (A.1253)
- *Deschampsia caespitosa* Temporarily Flooded Herbaceous Alliance (A.1355)
- *Festuca campestris* Herbaceous Alliance (A.1255)
- *Festuca idahoensis* Alpine Herbaceous Alliance (A.1313)
- *Festuca idahoensis* Herbaceous Alliance (A.1251)
- *Festuca viridula* Herbaceous Alliance (A.1257)
- *Phleum alpinum* Herbaceous Alliance (A.1310)

SPATIAL CHARACTERISTICS

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1995, Johnson 2004, Shiflet 1994

Version: 07 Sep 2005 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.811 ROCKY MOUNTAIN ALPINE FELL-FIELD – *NOT MAPPED*

Primary Division: Rocky Mountain (306)

Land Cover Class: Herbaceous

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Alpine/AltiAndino [Alpine/AltiAndino]; Herbaceous; Ridge/Summit/Upper Slope; Oligotrophic Soil; Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Very Short Disturbance Interval; W-Patch/High Intensity; Cushion plants; Alpine Slopes

Concept Summary: This ecological system is found discontinuously at alpine elevations throughout the Rocky Mountains, west into the mountainous areas of the Great Basin, and north into the Canadian Rockies. Small areas are represented in the west side of the Okanagan Ecoregion in the eastern Cascades. These are wind-scoured fell-fields that are free of snow in the winter, such as ridgetops and exposed saddles, exposing the plants to severe environmental stress. Soils on these windy unproductive sites are shallow, stony, low in organic matter, and poorly developed; wind deflation often results in a gravelly pavement. Most fell-field plants are cushioned or matted, frequently succulent, flat to the ground in rosettes and often densely haired and thickly cutinized. Plant cover is 15-50%, while exposed rocks make up the rest. Fell-fields are usually within or adjacent to alpine tundra dry meadows. Common species include *Arenaria capillaris, Geum rossii, Kobresia myosuroides, Minuartia obtusiloba, Myosotis asiatica, Paronychia pulvinata, Phlox pulvinata, Sibbaldia procumbens, Silene acaulis, Trifolium dasyphyllum,* and *Trifolium parryi*.

Comments: Alpine fell-fields in the Cascades occur at a very small-scale spatial pattern not mappable (recognizable) at landscape levels. These small-scale fell-fields are conceptually included here.

DISTRIBUTION

Range: This system is found discontinuously at alpine elevations throughout the Rocky Mountains, west into the mountainous areas of the Great Basin. Outlier sites occur in the northeastern Cascades and on Mount Rainier in Washington.
Divisions: 304:C, 306:C
TNC Ecoregions: 7:C, 8:C, 9:C, 11:C, 20:C, 21:C, 68:C
Subnations: AB, BC, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Arenaria capillaris / Polytrichum piliferum* Herbaceous Vegetation (CEGL005855, G2G3)
- *Carex albonigra - Myosotis asiatica* Herbaceous Vegetation (CEGL005863, G2G3)
- *Carex paysonis - Sibbaldia procumbens* Herbaceous Vegetation (CEGL005865, G3G4?)
- *Dasiphora fruticosa* ssp. *floribunda / Artemisia michauxiana* Shrub Herbaceous Vegetation [Provisional] (CEGL005833, G3G4)
- *Geum rossii - Minuartia obtusiloba* Herbaceous Vegetation (CEGL001965, G3?)
- *Kobresia myosuroides - Euphrasia disjuncta* Herbaceous Vegetation (CEGL005872, G2?)
- *Minuartia obtusiloba* Herbaceous Vegetation (CEGL001919, G4)
- *Paronychia pulvinata - Silene acaulis* Dwarf-shrubland (CEGL001976, G5)
- *Phlox pulvinata - Trifolium dasyphyllum* Herbaceous Vegetation (CEGL001980, G2Q)
- *Phlox pulvinata* Herbaceous Vegetation [Provisional] (CEGL002740, G4)
- *Potentilla sierrae-blancae* Herbaceous Vegetation (CEGL001982, G1)
- *Rubus idaeus* Scree Shrubland (CEGL001134, GU)
- *Sibbaldia procumbens - Polygonum bistortoides* Herbaceous Vegetation (CEGL001933, G3?)
- *Silene acaulis* Herbaceous Vegetation (CEGL001934, G5?)
- *Trifolium dasyphyllum* Herbaceous Vegetation (CEGL001935, G4)
- *Trifolium parryi* Herbaceous Vegetation (CEGL001936, GU)

Alliances:
- *Arenaria capillaris* Herbaceous Alliance (A.2630)
- *Carex albonigra* Herbaceous Alliance (A.2638)
- *Carex paysonis* Herbaceous Alliance (A.2640)
- *Dasiphora fruticosa* ssp. *floribunda* Shrub Herbaceous Alliance (A.1534)
- *Geum rossii* Herbaceous Alliance (A.1645)
- *Kobresia myosuroides* Herbaceous Alliance (A.1326)
- *Minuartia obtusiloba* Herbaceous Alliance (A.1630)
- *Paronychia pulvinata* Dwarf-shrubland Alliance (A.1085)
- *Phlox pulvinata* Herbaceous Alliance (A.1651)
- *Potentilla sierrae-blancae* Herbaceous Alliance (A.1652)
- *Rubus idaeus* ssp. *strigosus* Shrubland Alliance (A.927)
- *Sibbaldia procumbens* Herbaceous Alliance (A.1635)
- *Silene acaulis* Herbaceous Alliance (A.1636)
- *Trifolium (dasyphyllum, nanum)* Herbaceous Alliance (A.1637)
- *Trifolium parryi* Herbaceous Alliance (A.1638)

SPATIAL CHARACTERISTICS

SOURCES

References: Bamberg 1961, Bamberg and Major 1968, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1997, Douglas and Bliss 1977, Hamann 1972, Komarkova 1976, Komarkova 1980, Meidinger and Pojar 1991, Neely et al. 2001, Shiflet 1994, Willard 1963
Version: 07 Sep 2005 **Stakeholders:** Canada, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.816 ROCKY MOUNTAIN DRY TUNDRA

Primary Division: Rocky Mountain (306)
Land Cover Class: Herbaceous
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Alpine/AltiAndino [Alpine/AltiAndino]; Oligotrophic Soil; Very Shallow Soil; Mineral: W/ A-Horizon <10 cm; Aridic; Very Long Disturbance Interval; Graminoid; Alpine Slopes
Concept Summary: This widespread ecological system occurs above upper treeline throughout the Rocky Mountain cordillera, including alpine areas of ranges in Utah and Nevada, and isolated alpine sites in the northeastern Cascades. It is found on gentle to

moderate slopes, flat ridges, valleys, and basins, where the soil has become relatively stabilized and the water supply is more or less constant. Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost, and a short growing season. This system is characterized by a dense cover of low-growing, perennial graminoids and forbs. Rhizomatous, sod-forming sedges are the dominant graminoids, and prostrate and mat-forming plants with thick rootstocks or taproots characterize the forbs. Dominant species include *Artemisia arctica, Carex elynoides, Carex siccata, Carex scirpoidea, Carex nardina, Carex rupestris, Festuca brachyphylla, Festuca idahoensis, Geum rossii, Kobresia myosuroides, Phlox pulvinata,* and *Trifolium dasyphyllum.* Many other graminoids, forbs, and prostrate shrubs can also be found, including *Calamagrostis purpurascens, Deschampsia caespitosa, Dryas octopetala, Leucopoa kingii, Poa arctica, Saxifraga* spp., *Selaginella densa, Sibbaldia procumbens, Silene acaulis, Solidago* spp., and *Trifolium parryi*. Although alpine dry tundra is the matrix of the alpine zone, it typically intermingles with alpine bedrock and scree, ice field, fell-field, alpine dwarf-shrubland, and alpine/subalpine wet meadow systems.

DISTRIBUTION

Range: This system occurs above upper treeline throughout the North American Rocky Mountain cordillera, including alpine areas of ranges in Utah and Nevada, and isolated alpine sites in the northeastern Cascades.
Divisions: 204:P, 306:C
TNC Ecoregions: 7:C, 8:C, 9:C, 11:C, 20:C, 21:C, 68:C
Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Arctostaphylos uva-ursi / Festuca campestris - Festuca idahoensis* Dwarf-shrubland (CEGL005830, G3G4)
- *Arctostaphylos uva-ursi / Pseudoroegneria spicata* Dwarf-shrubland (CEGL005831, G2G3)
- *Arctostaphylos uva-ursi / Solidago multiradiata* Dwarf-shrubland (CEGL005832, G2G3)
- *Artemisia arctica* ssp. *arctica* Herbaceous Vegetation (CEGL001848, GU)
- *Calamagrostis purpurascens* Herbaceous Vegetation (CEGL001850, G2)
- *Carex arapahoensis* Herbaceous Vegetation (CEGL001851, GU)
- *Carex duriuscula - Poa secunda* Herbaceous Vegetation (CEGL001736, G2Q)
- *Carex ebenea - Trifolium parryi* Herbaceous Vegetation (CEGL001873, GUQ)
- *Carex elynoides - Geum rossii* Herbaceous Vegetation (CEGL001853, G4)
- *Carex elynoides - Lupinus argenteus* Herbaceous Vegetation (CEGL001854, G3)
- *Carex elynoides - Oreoxis* spp. Herbaceous Vegetation (CEGL001855, G4)
- *Carex elynoides - Oxytropis sericea* Herbaceous Vegetation (CEGL001856, G3)
- *Carex elynoides* Herbaceous Vegetation (CEGL001852, G4)
- *Carex haydeniana* Herbaceous Vegetation (CEGL001875, GU)
- *Carex perglobosa - Silene acaulis* Herbaceous Vegetation (CEGL001858, GU)
- *Carex rupestris - Geum rossii* Herbaceous Vegetation (CEGL001861, G4)
- *Carex rupestris - Potentilla ovina* Herbaceous Vegetation (CEGL001862, G4)
- *Carex rupestris - Trifolium dasyphyllum* Herbaceous Vegetation (CEGL001863, G3G4)
- *Carex rupestris* var. *drummondiana* Herbaceous Vegetation (CEGL001864, G4)
- *Carex scirpoidea - Geum rossii* Herbaceous Vegetation (CEGL001866, G4)
- *Carex scirpoidea - Potentilla diversifolia* Herbaceous Vegetation (CEGL001867, G3?)
- *Carex scirpoidea - Zigadenus elegans* Herbaceous Vegetation (CEGL005866, G4G5)
- *Carex siccata - Geum rossii* Herbaceous Vegetation (CEGL001808, GU)
- *Carex* spp. - *Geum rossii* Herbaceous Vegetation (CEGL001870, G4Q)
- *Carex vernacula* Herbaceous Vegetation (CEGL001868, GU)
- *Cirsium scopulorum - Polemonium viscosum* Herbaceous Vegetation (CEGL001959, GU)
- *Dryas octopetala - Carex rupestris* Dwarf-shrub Herbaceous Vegetation (CEGL001892, G4)
- *Dryas octopetala - Carex* spp. Dwarf-shrub Herbaceous Vegetation (CEGL001893, G3?)
- *Dryas octopetala* Dwarf-shrub Herbaceous Vegetation (CEGL001891, G3?)
- *Festuca brachyphylla - Geum rossii* var. *turbinatum* Herbaceous Vegetation (CEGL001895, GUQ)
- *Festuca brachyphylla - Trisetum spicatum* Herbaceous Vegetation (CEGL001896, G3?)
- *Festuca brachyphylla* Herbaceous Vegetation (CEGL001797, G4?)
- *Festuca thurberi* Subalpine Grassland Herbaceous Vegetation (CEGL001631, G3)
- *Geum rossii - Carex albonigra* Herbaceous Vegetation (CEGL001966, G1G2Q)
- *Geum rossii - Minuartia obtusiloba* Herbaceous Vegetation (CEGL001965, G3?)
- *Geum rossii - Selaginella densa* Herbaceous Vegetation (CEGL001968, G2G3Q)
- *Geum rossii - Trifolium* spp. Herbaceous Vegetation (CEGL001970, G3)
- *Geum rossii* Herbaceous Vegetation (CEGL001964, G4G5Q)
- *Kobresia myosuroides - Carex rupestris* var. *drummondiana* Herbaceous Vegetation (CEGL001907, G3)
- *Kobresia myosuroides - Geum rossii* Herbaceous Vegetation (CEGL001908, G5)
- *Kobresia myosuroides - Trifolium dasyphyllum* Herbaceous Vegetation (CEGL001909, GU)

- *Leucopoa kingii - Carex elynoides* Herbaceous Vegetation (CEGL001911, G3)
- *Leucopoa kingii - Oxytropis campestris* Herbaceous Vegetation (CEGL001912, G3?)
- *Leucopoa kingii - Phlox pulvinata* Herbaceous Vegetation (CEGL001913, G3)
- *Leucopoa kingii - Poa fendleriana* ssp. *fendleriana* Herbaceous Vegetation (CEGL001914, G3)
- *Leucopoa kingii* Herbaceous Vegetation (CEGL001910, G3Q)
- *Minuartia obtusiloba* Herbaceous Vegetation (CEGL001919, G4)
- *Poa arctica* ssp. *grayana* Herbaceous Vegetation (CEGL001924, GU)
- *Poa lettermanii* Herbaceous Vegetation (CEGL001927, GU)
- *Poa nervosa - Achnatherum lettermanii* Herbaceous Vegetation (CEGL001656, G1G2)
- *Pseudoroegneria spicata* - Cushion Plants Herbaceous Vegetation (CEGL001666, G3?)
- *Ribes montigenum* Shrubland (CEGL001133, GU)
- *Saxifraga chrysantha* Sparse Vegetation (CEGL001929, GU)
- *Sibbaldia procumbens - Polygonum bistortoides* Herbaceous Vegetation (CEGL001933, G3?)

Alliances:

- *Arctostaphylos uva-ursi* Dwarf-shrubland Alliance (A.1079)
- *Artemisia arctica* Herbaceous Alliance (A.1624)
- *Calamagrostis purpurascens* Herbaceous Alliance (A.1301)
- *Carex (ebenea, haydeniana)* Herbaceous Alliance (A.1302)
- *Carex arapahoensis* Herbaceous Alliance (A.1319)
- *Carex duriuscula* Herbaceous Alliance (A.1283)
- *Carex elynoides* Herbaceous Alliance (A.1303)
- *Carex perglobosa* Herbaceous Alliance (A.1304)
- *Carex rupestris* Herbaceous Alliance (A.1307)
- *Carex scirpoidea* Herbaceous Alliance (A.1308)
- *Carex siccata* Herbaceous Alliance (A.1298)
- *Carex vernacula* Herbaceous Alliance (A.1309)
- *Cirsium scopulorum* Herbaceous Alliance (A.1608)
- *Dryas octopetala* Dwarf-shrub Herbaceous Alliance (A.1577)
- *Festuca brachyphylla* Herbaceous Alliance (A.1321)
- *Festuca thurberi* Herbaceous Alliance (A.1256)
- *Geum rossii* Herbaceous Alliance (A.1645)
- *Kobresia myosuroides* Herbaceous Alliance (A.1326)
- *Leucopoa kingii* Herbaceous Alliance (A.1323)
- *Minuartia obtusiloba* Herbaceous Alliance (A.1630)
- *Poa arctica* Herbaceous Alliance (A.1311)
- *Poa lettermanii* Herbaceous Alliance (A.1327)
- *Poa nervosa* Herbaceous Alliance (A.1264)
- *Pseudoroegneria spicata* Herbaceous Alliance (A.1265)
- *Ribes montigenum* Shrubland Alliance (A.926)
- *Saxifraga (chrysantha, mertensiana)* Sparsely Vegetated Alliance (A.1632)
- *Sibbaldia procumbens* Herbaceous Alliance (A.1635)

SPATIAL CHARACTERISTICS

SOURCES

References: Anderson 1999a, Baker 1980a, Bamberg 1961, Bamberg and Major 1968, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1997, Douglas and Bliss 1977, Ecosystems Working Group 1998, Komarkova 1976, Komarkova 1980, Meidinger and Pojar 1991, Neely et al. 2001, Schwan and Costello 1951, Shiflet 1994, Thilenius 1975, Willard 1963

Version: 23 Jan 2006 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.829 ROCKY MOUNTAIN SUBALPINE-MONTANE MESIC MEADOW

Primary Division: Rocky Mountain (306)

Land Cover Class: Herbaceous

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland

Diagnostic Classifiers: Montane [Upper Montane]; Herbaceous; Silt Soil Texture; Clay Soil Texture; Udic; Forb

Concept Summary: This Rocky Mountain ecological system is restricted to sites from lower montane to subalpine where finely textured soils, snow deposition, or windswept dry conditions limit tree establishment. Many occurrences are small patch in spatial character, and are often found in mosaics with woodlands, more dense shrublands, or just below alpine communities. It is typically

found above 2000 m in elevation in the southern part of its range and above 600 m in the northern part. These upland communities occur on gentle to moderate-gradient slopes and relatively moist habitats. The soils are typically seasonally moist to saturated in the spring, but if so will dry out later in the growing season. These sites are not as wet as those found in Rocky Mountain Alpine-Montane Wet Meadow (CES306.812). Vegetation is typically forb-rich, with forbs often contributing more to overall herbaceous cover than graminoids. Some stands are comprised of dense grasslands, these often being taxa with relatively broad and soft blades, but where the moist habitat promotes a rich forb component. Important taxa include *Erigeron* spp., Asteraceae spp., *Mertensia* spp., *Penstemon* spp., *Campanula* spp., *Lupinus* spp., *Solidago* spp., *Ligusticum* spp., *Thalictrum occidentale, Valeriana sitchensis, Rudbeckia occidentalis, Balsamorhiza sagittata,* and *Wyethia* spp. Important grasses include *Deschampsia caespitosa, Koeleria macrantha,* perennial *Bromus* spp., and a number of *Carex* species. *Dasiphora fruticosa ssp. floribunda* and *Symphoricarpos* spp. are occasional but not abundant. Burrowing mammals can increase the forb diversity.

Comments: There are probably quite a number of *Carex*- and *Calamagrostis*-dominated types that could be cited as constituent associations.

DISTRIBUTION

Range: This system is very widespread in the Rocky Mountain cordillera from New Mexico north into Canada. It probably occurs in the Black Hills region, as well as the "island ranges" of central Montana.

Divisions: 304:C, 306:C

TNC Ecoregions: 7:C, 8:C, 9:C, 11:C, 18:C, 19:C, 20:C, 21:C, 26:C, 68:C

Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:

- *Agastache urticifolia - Heliomeris multiflora* Herbaceous Vegetation (CEGL001937, GNR)
- *Antennaria microphylla - Artemisia scopulorum* Herbaceous Vegetation (CEGL001847, G1Q)
- *Chamerion angustifolium* Rocky Mountain Herbaceous Vegetation [Provisional] (CEGL005856, G4G5)
- *Deschampsia caespitosa - Achillea millefolium* var. *occidentalis* Herbaceous Vegetation (CEGL001880, G5)
- *Deschampsia caespitosa - Geum rossii* Herbaceous Vegetation (CEGL001884, G5)
- *Deschampsia caespitosa - Ligusticum tenuifolium* Herbaceous Vegetation (CEGL001885, GU)
- *Deschampsia caespitosa - Mertensia ciliata* Herbaceous Vegetation (CEGL001887, GU)
- *Deschampsia caespitosa - Phleum alpinum* Herbaceous Vegetation (CEGL001888, G3Q)
- *Deschampsia caespitosa - Potentilla diversifolia* Herbaceous Vegetation (CEGL001889, G5)
- *Deschampsia caespitosa - Symphyotrichum foliaceum* Herbaceous Vegetation (CEGL001881, G2Q)
- *Geum rossii - Trifolium* spp. Herbaceous Vegetation (CEGL001970, G3)
- *Heracleum maximum - Rudbeckia occidentalis* Herbaceous Vegetation (CEGL001940, G4)
- *Ivesia gordonii - Eriogonum caespitosum* Herbaceous Vegetation (CEGL001903, G2?)
- *Ivesia gordonii - Minuartia obtusiloba* Herbaceous Vegetation (CEGL001902, G2?)
- *Ligusticum filicinum - Delphinium X occidentale* Herbaceous Vegetation (CEGL001941, G3)
- *Ligusticum porteri - Lupinus parviflorus* ssp. *myrianthus* Herbaceous Vegetation (CEGL001915, GU)
- *Ligusticum porteri - Vicia americana* Herbaceous Vegetation (CEGL001916, G3)
- *Ligusticum tenuifolium - Trollius laxus* ssp. *albiflorus* Herbaceous Vegetation (CEGL001917, GU)
- *Lupinus argenteus - Fragaria virginiana* Herbaceous Vegetation (CEGL001942, G3?)
- *Lupinus* spp. - *Poa* spp. Herbaceous Vegetation (CEGL001943, G1Q)
- *Luzula glabrata* var. *hitchcockii - Erythronium grandiflorum* Herbaceous Vegetation (CEGL005873, GNR)
- *Mertensia ciliata* Herbaceous Vegetation (CEGL001944, G3)
- *Phleum alpinum - Achillea millefolium* Herbaceous Vegetation (CEGL001920, G5)
- *Trifolium dasyphyllum* Herbaceous Vegetation (CEGL001935, G4)
- *Trifolium parryi* Herbaceous Vegetation (CEGL001936, GU)
- *Wyethia amplexicaulis* Herbaceous Vegetation (CEGL001947, G3?)
- *Xerophyllum tenax* Herbaceous Vegetation (CEGL005859, GNR)

Alliances:

- *Agastache urticifolia* Herbaceous Alliance (A.1602)
- *Antennaria microphylla* Herbaceous Alliance (A.1623)
- *Chamerion angustifolium* Herbaceous Alliance (A.3535)
- *Deschampsia caespitosa* Seasonally Flooded Herbaceous Alliance (A.1408)
- *Deschampsia caespitosa* Temporarily Flooded Herbaceous Alliance (A.1355)
- *Geum rossii* Herbaceous Alliance (A.1645)
- *Heracleum maximum* Temporarily Flooded Herbaceous Alliance (A.1661)
- *Ivesia gordonii* Herbaceous Alliance (A.1627)
- *Ligusticum filicinum* Herbaceous Alliance (A.1604)
- *Ligusticum porteri* Herbaceous Alliance (A.1601)
- *Ligusticum tenuifolium* Herbaceous Alliance (A.1628)

- *Lupinus argenteus* Herbaceous Alliance (A.1605)
- *Luzula glabrata* var. *hitchcockii* Herbaceous Alliance (A.2641)
- *Mertensia ciliata* Herbaceous Alliance (A.1606)
- *Phleum alpinum* Herbaceous Alliance (A.1310)
- *Trifolium (dasyphyllum, nanum)* Herbaceous Alliance (A.1637)
- *Trifolium parryi* Herbaceous Alliance (A.1638)
- *Wyethia amplexicaulis* Herbaceous Alliance (A.1607)
- *Xerophyllum tenax* Herbaceous Alliance (A.1600)

SPATIAL CHARACTERISTICS

SOURCES

References: Buckner 1977, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Ellison 1954, Fritz 1981, Gregory 1983, Hall 1971, Hammerson 1979, Marr 1977a, Meidinger and Pojar 1991, Nachlinger 1985, Neely et al. 2001, Potkin and Munn 1989, Shiflet 1994, Starr 1974

Version: 23 Jan 2006 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

WOODY WETLANDS AND RIPARIAN (NLCD 91)

CES304.768 COLUMBIA BASIN FOOTHILL RIPARIAN WOODLAND AND SHRUBLAND

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Linear

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Riverine / Alluvial; Short (<5 yrs) Flooding Interval; Short (50-100 yrs) Persistence

Concept Summary: This is a low-elevation riparian system found on the periphery of the mountains surrounding the Columbia River Basin, along major tributaries and the main stem of the Columbia at relatively low elevations. This is the riparian system associated with all streams at and below lower treeline, including permanent, intermittent and ephemeral streams with woody riparian vegetation. These forests and woodlands require flooding and some gravels for reestablishment. They are found in low-elevation canyons and draws, on floodplains, or in steep-sided canyons, or narrow V-shaped valleys with rocky substrates. Sites are subject to temporary flooding during spring runoff. Underlying gravels may keep the water table just below the ground surface and are favored substrates for cottonwood. Large bottomlands may have large occurrences, but most have been cut over or cleared for agriculture. Rafted ice and logs in freshets may cause considerable damage to tree boles. Beavers crop younger cottonwood and willows and frequently dam side channels occurring in these stands. In steep-sided canyons, streams typically have perennial flow on mid to high gradients. Important and diagnostic trees include *Populus balsamifera ssp. trichocarpa, Alnus rhombifolia, Populus tremuloides, Celtis laevigata var. reticulata, Betula occidentalis,* or *Pinus ponderosa*. Important shrubs include *Crataegus douglasii, Philadelphus lewisii, Cornus sericea, Salix lucida ssp. lasiandra, Salix eriocephala, Rosa nutkana, Rosa woodsii, Amelanchier alnifolia, Prunus virginiana,* and *Symphoricarpos albus.* Grazing is a major influence in altering structure, composition, and function of the community.

DISTRIBUTION

Range: Found on the periphery of the northern Rockies in the Columbia River Basin, along major tributaries and the main stem of the Columbia at relatively low elevations.

Divisions: 304:C, 306:C

TNC Ecoregions: 6:C, 7:C, 68:C

Subnations: BC, CA, ID, MT?, NV, OR, UT, WA

CONCEPT

Associations:

- *(Populus tremuloides) / Crataegus douglasii / Heracleum maximum* Shrubland (CEGL001094, G1)
- *(Populus tremuloides) / Crataegus douglasii / Symphoricarpos albus* Shrubland (CEGL001096, G3)
- *Alnus rhombifolia - Abies grandis* Forest (CEGL000630, G2?)
- *Alnus rhombifolia / Amelanchier alnifolia* Forest (CEGL000631, G3)
- *Alnus rhombifolia / Betula occidentalis* Forest (CEGL000632, G1)
- *Alnus rhombifolia / Celtis laevigata* var. *reticulata* Forest (CEGL000633, G1?)
- *Alnus rhombifolia / Philadelphus lewisii* Forest (CEGL000634, G1)
- *Alnus rhombifolia / Prunus virginiana* Forest (CEGL000635, G1?)
- *Alnus rhombifolia / Rosa woodsii* Forest (CEGL000636, G1)

- *Alnus rhombifolia / Sambucus nigra* ssp. *caerulea* Forest (CEGL000637, G2?)
- *Alnus rhombifolia* Forest [Placeholder] (CEGL000629, G2Q)
- *Alnus rubra / Adiantum pedatum* Forest (CEGL002600, G1)
- *Alnus rubra / Athyrium filix-femina - Asarum caudatum* Forest (CEGL000008, G1)
- *Alnus rubra / Physocarpus capitatus - Philadelphus lewisii* Forest (CEGL000002, G1)
- *Alnus viridis* ssp. *sinuata* / Mesic Forbs Shrubland (CEGL002633, G3G4)
- *Alnus viridis* ssp. *sinuata / Rubus (lasiococcus, parviflorus)* Shrubland (CEGL002602, G4)
- *Betula occidentalis - Celtis laevigata* var. *reticulata* Shrubland (CEGL003450, G2)
- *Betula occidentalis / Crataegus douglasii* Shrubland (CEGL001081, G1)
- *Betula occidentalis / Philadelphus lewisii - Symphoricarpos albus* Shrubland (CEGL000489, G1G2)
- *Betula occidentalis / Philadelphus lewisii* Shrubland (CEGL002668, G2)
- *Betula occidentalis* Shrubland (CEGL001080, G3G4)
- *Celtis laevigata* var. *reticulata / Philadelphus lewisii* Woodland (CEGL000792, G1)
- *Celtis laevigata* var. *reticulata / Pseudoroegneria spicata* Woodland (CEGL001085, G2G3)
- *Celtis laevigata* var. *reticulata / Toxicodendron rydbergii* Woodland (CEGL003451, G2)
- *Cornus sericea / Heracleum maximum* Shrubland (CEGL001167, G3)
- *Crataegus douglasii / Rosa woodsii* Shrubland (CEGL001095, G2)
- *Philadelphus lewisii / Symphoricarpos albus* Shrubland (CEGL000875, G1G2)
- *Philadelphus lewisii* Intermittently Flooded Shrubland (CEGL001170, G2)
- *Pinus monticola / Deschampsia caespitosa* Forest (CEGL003441, G1)
- *Pinus ponderosa / Symphoricarpos albus* Temporarily Flooded Woodland (CEGL000866, G2)
- *Populus balsamifera* (ssp. *trichocarpa*, ssp. *balsamifera*) / *Symphoricarpos (albus, oreophilus, occidentalis)* Forest (CEGL000677, G2)
- *Populus balsamifera* ssp. *trichocarpa / Alnus incana* Forest (CEGL000667, G3)
- *Populus balsamifera* ssp. *trichocarpa / Cicuta douglasii* Forest (CEGL000671, G1)
- *Populus balsamifera* ssp. *trichocarpa / Cornus sericea* Forest (CEGL000672, G3G4)
- *Populus balsamifera* ssp. *trichocarpa / Crataegus douglasii* Forest (CEGL000673, G1)
- *Populus balsamifera* ssp. *trichocarpa* / Mixed Herbs Forest (CEGL000675, G3?)
- *Populus balsamifera* ssp. *trichocarpa / Salix exigua* Forest (CEGL000676, G1)
- *Populus balsamifera* ssp. *trichocarpa / Salix lucida* ssp. *caudata* Woodland (CEGL003431, G2)
- *Populus tremuloides / Alnus incana / Betula nana - Ribes* spp. Forest (CEGL001149, G1)
- *Populus tremuloides / Carex pellita* Forest (CEGL000577, G2)
- *Salix amygdaloides / Salix exigua* Woodland (CEGL000948, G1Q)

Alliances:

- *Abies grandis - Alnus rhombifolia* Forest Alliance (A.429)
- *Alnus rhombifolia* Temporarily Flooded Forest Alliance (A.306)
- *Alnus rubra* Temporarily Flooded Forest Alliance (A.305)
- *Alnus viridis* ssp. *sinuata* Temporarily Flooded Shrubland Alliance (A.966)
- *Betula occidentalis* Intermittently Flooded Shrubland Alliance (A.936)
- *Betula occidentalis* Seasonally Flooded Shrubland Alliance (A.996)
- *Celtis laevigata* var. *reticulata* Woodland Alliance (A.632)
- *Cornus sericea* Temporarily Flooded Shrubland Alliance (A.968)
- *Crataegus douglasii* Intermittently Flooded Shrubland Alliance (A.937)
- *Crataegus douglasii* Shrubland Alliance (A.917)
- *Philadelphus lewisii* Intermittently Flooded Shrubland Alliance (A.939)
- *Pinus monticola* Seasonally Flooded Forest Alliance (A.2590)
- *Pinus ponderosa* Temporarily Flooded Woodland Alliance (A.565)
- *Populus balsamifera* ssp. *trichocarpa* Temporarily Flooded Forest Alliance (A.311)
- *Populus balsamifera* ssp. *trichocarpa* Temporarily Flooded Woodland Alliance (A.635)
- *Populus tremuloides* Temporarily Flooded Forest Alliance (A.300)
- *Salix amygdaloides* Temporarily Flooded Woodland Alliance (A.645)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Ecosystems Working Group 1998, Eyre 1980, Johnson and Simon 1985

Version: 09 Feb 2005 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.084 COLUMBIA PLATEAU SILVER SAGEBRUSH SEASONALLY FLOODED SHRUB-STEPPE

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Woody Wetland
Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland
Diagnostic Classifiers: Montane [Upper Montane, Montane, Lower Montane]; Lowland [Lowland]; Playa; Temperate [Temperate Xeric]; Depressional; Impermeable Layer; Intermittent Flooding
Concept Summary: This ecological system includes sagebrush communities occurring at lowland and montane elevations in the Columbia Plateau-northern Great Basin region, east almost to the Great Plains. These are generally depressional wetlands or non-alkaline playas, occurring as small- or occasionally large-patch communities, in a sagebrush or montane forest matrix. Climate is generally semi-arid, although it can be cool in montane areas. This system occurs in poorly drained depressional wetlands, the largest characterized as playas, the smaller as vemal pools, or along seasonal stream channels in valley bottoms or mountain meadows. *Artemisia cana ssp. bolanderi* or *Artemisia cana ssp. viscidula* are dominant, with *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. wyomingensis*, or *Artemisia tridentata ssp. vaseyana* occasionally codominant. Understory graminoids and forbs are characteristic, with *Poa secunda (= Poa nevadensis), Poa cusickii, Muhlenbergia filiformis, Muhlenbergia richardsonis*, and *Leymus cinereus* dominant at the drier sites; *Eleocharis palustris, Deschampsia caespitosa*, and *Carex* species dominate at wetter or higher-elevation sites.

DISTRIBUTION

Range: This ecological system includes sagebrush communities occurring at lowland and montane elevations in the Columbia Plateau-northern Great Basin region, east almost to the Great Plains.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:C, 7:C, 8:C, 9:C, 12:C, 18:C, 19:C, 20:C
Subnations: CA, CO?, ID, MT, NV, OR, UT?, WA?, WY

CONCEPT

Associations:
- *Artemisia cana (*ssp. *bolanderi*, ssp. *viscidula) - Artemisia tridentata* ssp. *vaseyana / Poa cusickii* Shrub Herbaceous Vegetation [Provisional] (CEGL001549, G2)
- *Artemisia cana (*ssp. *bolanderi*, ssp. *viscidula) / Leymus cinereus* Shrubland (CEGL001460, G1)
- *Artemisia cana (*ssp. *bolanderi*, ssp. *viscidula) / Poa fendleriana* ssp. *fendleriana* Shrub Herbaceous Vegetation (CEGL001551, G2)
- *Artemisia cana* (ssp. *bolanderi*, ssp. *viscidula) / Poa pratensis* Semi-natural Shrubland (CEGL002988, GNA)
- *Artemisia cana (*ssp. *bolanderi*, ssp. *viscidula) / Poa secunda* Shrubland (CEGL001548, G2)
- *Artemisia cana* ssp. *bolanderi / Eleocharis palustris* Shrubland (CEGL002987, GU)
- *Artemisia cana* ssp. *bolanderi / Iris missouriensis - Juncus balticus* Shrubland (CEGL003475, GNR)
- *Artemisia cana* ssp. *bolanderi / Muhlenbergia richardsonis* Shrub Herbaceous Vegetation (CEGL001743, G3)
- *Artemisia cana* ssp. *viscidula* - (*Salix* spp.) / *Festuca idahoensis* Shrubland (CEGL001075, G3)
- *Artemisia cana* ssp. *viscidula / Deschampsia caespitosa* Shrubland (CEGL001074, G2G3)
- *Artemisia cana* ssp. *viscidula / Festuca idahoensis* Shrub Herbaceous Vegetation (CEGL001552, G3?)
- *Artemisia cana* ssp. *viscidula / Festuca ovina* Shrubland (CEGL001076, G4G5)
- *Artemisia cana* ssp. *viscidula / Festuca thurberi* Shrubland (CEGL001071, G2G3)
- *Artemisia cana* ssp. *viscidula / Purshia tridentata* Shrubland (CEGL001073, G3)

Alliances:
- *Artemisia cana* (ssp. *bolanderi*, ssp. *viscidula*) Shrub Herbaceous Alliance (A.1531)
- *Artemisia cana* (ssp. *bolanderi*, ssp. *viscidula*) Shrubland Alliance (A.2557)

SPATIAL CHARACTERISTICS

SOURCES

References: Shiflet 1994, Western Ecology Working Group n.d.
Version: 08 Sep 2004 **Stakeholders:** West
Concept Author: J. Kagan **LeadResp:** West

CES304.045 GREAT BASIN FOOTHILL AND LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Woody Wetland
Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Forest and Woodland (Treed); Riverine / Alluvial; Short (<5 yrs) Flooding Interval; Riparian Mosaic
Concept Summary: This system occurs in mountain ranges of the Great Basin and along the eastern slope of the Sierra Nevada within a broad elevation range from about 1220 m (4000 feet) to over 2135 m (7000 feet). This system often occurs as a mosaic of multiple

communities that are tree-dominated with a diverse shrub component. The variety of plant associations connected to this system reflects elevation, stream gradient, floodplain width, and flooding events. Dominant trees may include *Abies concolor, Alnus incana, Betula occidentalis, Populus angustifolia, Populus balsamifera ssp. trichocarpa, Populus fremontii, Salix laevigata, Salix gooddingii,* and *Pseudotsuga menziesii*. Dominant shrubs include *Artemisia cana, Cornus sericea, Salix exigua, Salix lasiolepis, Salix lemmonii,* or *Salix lutea*. Herbaceous layers are often dominated by species of *Carex* and *Juncus,* and perennial grasses and mesic forbs such *Deschampsia caespitosa, Elymus trachycaulus, Glyceria striata, Iris missouriensis, Maianthemum stellatum,* or *Thalictrum fendleri*. Introduced forage species such as *Agrostis stolonifera, Poa pratensis, Phleum pratense,* and the weedy annual *Bromus tectorum* are often present in disturbed stands. These are disturbance-driven systems that require flooding, scour and deposition for germination and maintenance. Livestock grazing is a major influence in altering structure, composition, and function of the community.

DISTRIBUTION

Range: Occurs in mountain ranges of the Great Basin and along the eastern slope of the Sierra Nevada within a broad elevation range from about 1220 m (4000 feet) to over 2135 m (7000 feet).
Divisions: 304:C
TNC Ecoregions: 6:P, 11:C, 12:C
Subnations: CA, NV, OR, UT

CONCEPT

Associations:
- *Alnus incana / Cornus sericea* Shrubland (CEGL001145, G3G4)
- *Artemisia cana (*ssp. *bolanderi,* ssp. *viscidula) / Leymus cinereus* Shrubland (CEGL001460, G1)
- *Artemisia cana* ssp. *viscidula / Deschampsia caespitosa* Shrubland (CEGL001074, G2G3)
- *Artemisia nova - Ericameria nana* Shrubland (CEGL002773, G3)
- *Betula occidentalis / Cornus sericea* Shrubland (CEGL001161, G3)
- *Betula occidentalis / Maianthemum stellatum* Shrubland (CEGL001162, G4?)
- *Betula occidentalis* / Mesic Graminoids Shrubland (CEGL002654, G3)
- *Cornus sericea* Shrubland (CEGL001165, G4Q)
- *Populus angustifolia / Betula occidentalis* Woodland (CEGL000648, G3)
- *Populus angustifolia / Rhus trilobata* Woodland (CEGL000652, G3)
- *Populus balsamifera* ssp. *trichocarpa / Alnus incana* Forest (CEGL000667, G3)
- *Populus balsamifera* ssp. *trichocarpa* / Mixed Herbs Forest (CEGL000675, G3?)
- *Populus fremontii / Leymus triticoides* Woodland (CEGL002756, GNR)
- *Populus fremontii* / Mesic Forbs Woodland (CEGL002470, GNR)
- *Populus fremontii* / Mesic Graminoids Woodland (CEGL002473, GNR)
- *Populus fremontii / Salix exigua* Forest (CEGL000666, GNR)
- *Populus fremontii / Salix geyeriana* Woodland (CEGL000943, G3?)
- *Salix lasiolepis / Rosa woodsii* / Mixed Herbs Shrubland (CEGL001217, G3Q)
- *Salix lemmonii* / Mesic-Tall Forbs Shrubland (CEGL002771, G3?)
- *Salix lemmonii / Rosa woodsii* Shrubland (CEGL002772, G3)
- *Salix lutea / Carex utriculata* Shrubland (CEGL001220, G4)
- *Salix lutea* / Mesic Forbs Shrubland (CEGL002774, G3?)

Alliances:
- *Alnus incana* Temporarily Flooded Shrubland Alliance (A.950)
- *Artemisia cana* (ssp. *bolanderi,* ssp. *viscidula*) Shrubland Alliance (A.2557)
- *Artemisia nova* Shrubland Alliance (A.1105)
- *Betula occidentalis* Seasonally Flooded Shrubland Alliance (A.996)
- *Betula occidentalis* Temporarily Flooded Shrubland Alliance (A.967)
- *Cornus sericea* Temporarily Flooded Shrubland Alliance (A.968)
- *Populus angustifolia* Temporarily Flooded Woodland Alliance (A.641)
- *Populus balsamifera* ssp. *trichocarpa* Temporarily Flooded Forest Alliance (A.311)
- *Populus fremontii* Seasonally Flooded Woodland Alliance (A.654)
- *Populus fremontii* Temporarily Flooded Forest Alliance (A.313)
- *Populus fremontii* Temporarily Flooded Woodland Alliance (A.644)
- *Salix lasiolepis* Temporarily Flooded Shrubland Alliance (A.977)
- *Salix lemmonii* Seasonally Flooded Shrubland Alliance (A.2523)
- *Salix lutea* Seasonally Flooded Shrubland Alliance (A.1007)
- *Salix lutea* Temporarily Flooded Shrubland Alliance (A.980)

SPATIAL CHARACTERISTICS

SOURCES

References: Barbour and Billings 1988, Barbour and Major 1977, Comer et al. 2003, Eyre 1980, Manning and Padgett 1989, Sawyer and Keeler-Wolf 1995, Shiflet 1994

Version: 16 Apr 2003 **Stakeholders:** West

Concept Author: J. Nachlinger and K. Schulz **LeadResp:** West

CES304.780 INTER-MOUNTAIN BASINS GREASEWOOD FLAT

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Mixed Upland and Wetland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland; Wetland

Diagnostic Classifiers: Lowland [Lowland]; Shrubland (Shrub-dominated); Toeslope/Valley Bottom; Alkaline Soil; Deep Soil; Xeromorphic Shrub

Concept Summary: This ecological system occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains and into central Montana. It typically occurs near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations. This system usually occurs as a mosaic of multiple communities, with open to moderately dense shrublands dominated or codominated by *Sarcobatus vermiculatus.* Other shrubs that may be present to codominant in some occurrences include *Atriplex canescens, Atriplex confertifolia, Atriplex gardneri, Artemisia cana ssp. cana,* or *Krascheninnikovia lanata*. Occurrences are often surrounded by mixed salt desert scrub or big sagebrush shrublands. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Sporobolus airoides, Pascopyrum smithii, Distichlis spicata* (where water remains ponded the longest), *Calamovilfa longifolia, Poa pratensis,* or *Eleocharis palustris* herbaceous types.

DISTRIBUTION

Range: This system occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains.

Divisions: 303:C, 304:C

TNC Ecoregions: 4:C, 6:C, 8:C, 9:C, 10:C, 11:C, 19:C, 20:C, 26:C

Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:

- *Distichlis spicata - (Scirpus nevadensis)* Herbaceous Vegetation (CEGL001773, G4)
- *Distichlis spicata - Lepidium perfoliatum* Herbaceous Vegetation (CEGL001772, GNA)
- *Distichlis spicata* Herbaceous Vegetation (CEGL001770, G5)
- *Distichlis spicata* Mixed Herb Herbaceous Vegetation (CEGL001771, G3G5)
- *Eleocharis palustris* Herbaceous Vegetation (CEGL001833, G5)
- *Ericameria nauseosa / Sporobolus airoides* Shrubland (CEGL002918, G3Q)
- *Leymus cinereus - Distichlis spicata* Herbaceous Vegetation (CEGL001481, G3)
- *Leymus cinereus* Bottomland Herbaceous Vegetation (CEGL001480, G1)
- *Leymus cinereus* Herbaceous Vegetation (CEGL001479, G2G3Q)
- *Puccinellia nuttalliana* Herbaceous Vegetation (CEGL001799, G3?)
- *Salicornia rubra* Herbaceous Vegetation (CEGL001999, G2G3)
- *Sarcobatus vermiculatus - Atriplex parryi / Distichlis spicata* Shrubland (CEGL002764, GNR)
- *Sarcobatus vermiculatus - Psorothamnus polydenius* Shrubland (CEGL002763, GNR)
- *Sarcobatus vermiculatus / Achnatherum hymenoides* Shrubland (CEGL001373, G4)
- *Sarcobatus vermiculatus / Artemisia tridentata* Shrubland (CEGL001359, G4)
- *Sarcobatus vermiculatus / Atriplex confertifolia - (Picrothamnus desertorum, Suaeda moquinii)* Shrubland (CEGL001371, G5?)
- *Sarcobatus vermiculatus / Atriplex gardneri* Shrubland (CEGL001360, G4?)
- *Sarcobatus vermiculatus / Bouteloua gracilis* Shrubland (CEGL001361, G1Q)
- *Sarcobatus vermiculatus / Distichlis spicata* Shrubland (CEGL001363, G4)
- *Sarcobatus vermiculatus / Elymus elymoides - Pascopyrum smithii* Shrubland (CEGL001365, G2?)
- *Sarcobatus vermiculatus / Elymus elymoides* Shrubland (CEGL001372, G4)
- *Sarcobatus vermiculatus / Juncus balticus* Sparse Vegetation (CEGL002919, G3?)
- *Sarcobatus vermiculatus / Leymus cinereus* Shrubland (CEGL001366, G3)
- *Sarcobatus vermiculatus / Nitrophila occidentalis - Suaeda moquinii* Shrubland (CEGL001369, G5?)
- *Sarcobatus vermiculatus / Pascopyrum smithii - (Elymus lanceolatus)* Shrub Herbaceous Vegetation (CEGL001508, G4)
- *Sarcobatus vermiculatus / Pseudoroegneria spicata* Shrubland (CEGL001367, G3)

- *Sarcobatus vermiculatus / Sporobolus airoides* Sparse Vegetation (CEGL001368, G3?)
- *Sarcobatus vermiculatus / Suaeda moquinii* Shrubland (CEGL001370, GUQ)
- *Sarcobatus vermiculatus* Shrubland (CEGL001357, G5)
- *Sporobolus airoides - Distichlis spicata* Herbaceous Vegetation (CEGL001687, G4?)
- *Sporobolus airoides* Southern Plains Herbaceous Vegetation (CEGL001685, G3Q)

Alliances:
- *Distichlis spicata* Intermittently Flooded Herbaceous Alliance (A.1332)
- *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance (A.1422)
- *Ericameria nauseosa* Shrubland Alliance (A.835)
- *Leymus cinereus* Herbaceous Alliance (A.1204)
- *Leymus cinereus* Intermittently Flooded Herbaceous Alliance (A.1329)
- *Puccinellia nuttalliana* Intermittently Flooded Herbaceous Alliance (A.1335)
- *Salicornia rubra* Seasonally Flooded Herbaceous Alliance (A.1818)
- *Sarcobatus vermiculatus* Intermittently Flooded Shrub Herbaceous Alliance (A.1554)
- *Sarcobatus vermiculatus* Intermittently Flooded Shrubland Alliance (A.1046)
- *Sarcobatus vermiculatus* Intermittently Flooded Sparsely Vegetated Alliance (A.1877)
- *Sarcobatus vermiculatus* Shrubland Alliance (A.1041)
- *Sporobolus airoides* Herbaceous Alliance (A.1267)
- *Sporobolus airoides* Intermittently Flooded Herbaceous Alliance (A.1331)

High-ranked species: Astragalus pterocarpus (G3), Atriplex bonnevillensis (G2G3Q), Phacelia parishii (G2G3), Pseudocopaeodes eunus (G3G4), Puccinellia simplex (G3G4)

SPATIAL CHARACTERISTICS

Other Comments: Carmen says this is NOT in Okanagan in BC. She put their DISSTR in to playas.

SOURCES

References: Comer et al. 2003, Knight 1994, Shiflet 1994, West 1983b

Version: 23 Jan 2006 **Stakeholders:** Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES204.865 NORTH PACIFIC SHRUB SWAMP

Primary Division: North American Pacific Maritime (204)

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Forest and Woodland (Treed); Depressional [Lakeshore]; Broad-Leaved Deciduous Tree; Broad-Leaved Deciduous Shrub; Eutrophic Water

Concept Summary: Swamps vegetated by shrublands occur throughout the Pacific Northwest coast, from Cook Inlet and Prince William Sound, Alaska, to the southern coast of Oregon. These are deciduous broadleaf tall shrublands that are located in depressions, around lakes or ponds, or river terraces where water tables fluctuate seasonally (mostly seasonally flooded regime), in areas that receive nutrient-rich waters. These are nutrient-rich systems with muck or mineral soils. Various species of *Salix, Spiraea douglasii, Malus fusca, Cornus sericea, Alnus incana ssp. tenuifolia (= Alnus tenuifolia), Alnus viridis ssp. crispa (= Alnus crispa),* and *Alnus viridis ssp. sinuata (= Alnus sinuata)* are the major dominants. They may occur in mosaics with marshes or forested swamps, being on average more wet than forested swamps and more dry than marshes. However, it is also frequent for them to dominate entire wetland systems. Hardwood-dominated stands (especially *Fraxinus latifolia*) may be considered a shrub swamp when they are not surrounded by conifer forests. Typical landscape for the *Fraxinus latifolia* stands were very often formerly dominated by prairies and now by agriculture.

Comments: Shrub swamps are usually not intermixed with the forested swamps and tend to be more wet. Deciduous and conifer forested swamps are often intermixed and more similar to each other in hydrology, and so are combined into North Pacific Hardwood-Conifer Swamp (CES204.090).

DISTRIBUTION

Range: This system occurs throughout the Pacific Northwest Coast, from Cook Inlet Basin and Prince William Sound, Alaska, to the southern coast of Oregon.

Divisions: 204:C

TNC Ecoregions: 1:C, 2:C, 3:C, 4:C, 69:C, 70:C, 71:C, 81:C

Subnations: AK, BC, OR, WA

CONCEPT

Associations:
- *Alnus (incana, viridis* ssp. *sinuata) / Lysichiton americanus - Oenanthe sarmentosa* Shrubland (CEGL003293, G1)

- *Cornus sericea - Salix (hookeriana, sitchensis)* Shrubland (CEGL003292, G3)
- *Cornus sericea* Shrubland (CEGL001165, G4Q)
- *Fraxinus latifolia / Carex deweyana - Urtica dioica* Forest (CEGL003365, G1)
- *Fraxinus latifolia / Carex obnupta* Forest (CEGL000640, G4)
- *Fraxinus latifolia / Juncus patens* Forest (CEGL003391, G2)
- *Fraxinus latifolia / Spiraea douglasii* Forest (CEGL003392, G3)
- *Fraxinus latifolia / Symphoricarpos albus* Forest (CEGL003393, G4)
- *Malus fusca* Shrubland (CEGL003385, G3)
- *Salix (hookeriana, sitchensis) - Spiraea douglasii* Shrubland (CEGL003386, G3G4)
- *Salix geyeriana - Salix hookeriana* Shrubland (CEGL003295, G1)
- *Salix hookeriana - (Malus fusca) / Carex obnupta - Lysichiton americanus* Shrubland (CEGL003432, G3)
- *Salix hookeriana - (Salix sitchensis)* Shrubland (CEGL003387, G2)
- *Salix sitchensis* Shrubland (CEGL002896, G4)
- *Spiraea douglasii* Shrubland (CEGL001129, G5)

Alliances:
- *Alnus incana* Seasonally Flooded Shrubland Alliance (A.986)
- *Cornus sericea* Temporarily Flooded Shrubland Alliance (A.968)
- *Fraxinus latifolia* Seasonally Flooded Forest Alliance (A.343)
- *Malus fusca* Seasonally Flooded Shrubland Alliance (A.2577)
- *Salix hookeriana* Seasonally Flooded Shrubland Alliance (A.999)
- *Salix sitchensis* Seasonally Flooded Shrubland Alliance (A.2599)
- *Spiraea douglasii* Seasonally Flooded Shrubland Alliance (A.997)

High-ranked species: Howellia aquatilis (G3)

SPATIAL CHARACTERISTICS

SOURCES

References: Boggs 2002, Chappell and Christy 2004, Comer et al. 2003, Franklin and Dyrness 1973, Viereck et al. 1992

Version: 25 Apr 2006 **Stakeholders:** Canada, West

Concept Author: G. Kittel, P. Comer, K. Boggs, C. Chappell **LeadResp:** West

CES306.803 NORTHERN ROCKY MOUNTAIN CONIFER SWAMP

Primary Division: Rocky Mountain (306)

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Forest and Woodland (Treed); Seepage-Fed Sloping [Mineral]; Depressional; Mineral: W/ A-Horizon <10 cm; Saturated Soil

Concept Summary: This ecological system occurs in the northern Rocky Mountains from northwestern Wyoming north into the Canadian Rockies and west into eastern Oregon and Washington. It is dominated by conifers on poorly drained soils that are saturated year-round or may have seasonal flooding in the spring. These are primarily on flat to gently sloping lowlands, but also occur up to near the lower limits of continuous forest (below the subalpine parkland). It can occur on steeper slopes where soils are shallow over unfractured bedrock. This system is indicative of poorly drained, mucky areas, and areas are often a mosaic of moving water and stagnant water. Soils can be woody peat, muck or mineral but tend toward mineral. Stands generally occupy sites on benches, toeslopes or valley bottoms along mountain streams. Associations present include wetland phases of *Thuja plicata, Tsuga heterophylla,* and *Picea engelmannii* forests. The wetland types are generally distinguishable from other upland forests and woodlands by shallow water tables and mesic or hydric undergrowth vegetation; some of the most typical species include *Athyrium filix-femina, Dryopteris* spp., *Lysichiton americanus, Equisetum arvense, Senecio triangularis, Mitella breweri, Mitella pentandra, Streptopus amplexifolius, Calamagrostis canadensis,* or *Carex disperma*.

Comments: May need to split out calcareous cedar (*Thuja plicata*) swamps from the other conifer swamps- needs more review.

DISTRIBUTION

Range: This system occurs in the northern Rocky Mountains from northwestern Wyoming and central Montana, north into the Canadian Rockies and west into eastern Oregon and Washington.

Divisions: 306:C

TNC Ecoregions: 7:C, 8:C, 9:P, 26:C, 68:C

Subnations: AB, BC, ID, MT, OR, WA, WY

CONCEPT

Associations:
- *Abies lasiocarpa - Picea engelmannii / Oplopanax horridus* Forest (CEGL000322, G3)

- *Abies lasiocarpa - Picea engelmannii / Streptopus amplexifolius* Forest (CEGL000336, G4)
- *Betula nana / Carex* spp. Shrubland (CEGL005887, GNR)
- *Betula nana / Carex utriculata* Shrubland (CEGL001079, G4?)
- *Picea (engelmannii X glauca, engelmannii) / Carex disperma* Forest (CEGL000405, G2Q)
- *Picea (engelmannii X glauca, engelmannii) / Lysichiton americanus* Forest (CEGL000412, G2)
- *Picea engelmannii / Calamagrostis canadensis* Forest (CEGL002678, G4)
- *Picea engelmannii / Caltha leptosepala* Forest (CEGL000357, G3?)
- *Picea engelmannii / Carex disperma* Forest (CEGL000358, G2)
- *Picea engelmannii / Equisetum arvense* Forest (CEGL005927, G4)
- *Thuja plicata - Tsuga heterophylla / Lysichiton americanus / Sphagnum* spp. Forest (CEGL001787, G3G4)
- *Thuja plicata - Tsuga heterophylla / Lysichiton americanus* Forest (CEGL002670, G3?)
- *Thuja plicata - Tsuga heterophylla / Oplopanax horridus* Rocky Mountain Forest (CEGL000479, G3)
- *Thuja plicata / Athyrium filix-femina* Forest (CEGL000473, G3G4)
- *Thuja plicata / Carex disperma* Forest [Provisional] (CEGL005931, G2?)

Alliances:
- *Abies lasiocarpa* Seasonally Flooded Forest Alliance (A.190)
- *Abies lasiocarpa* Temporarily Flooded Forest Alliance (A.177)
- *Betula nana* Seasonally Flooded Shrubland Alliance (A.995)
- *Picea engelmannii* Saturated Forest Alliance (A.204)
- *Picea engelmannii* Seasonally Flooded Forest Alliance (A.191)
- *Thuja plicata* Forest Alliance (A.166)
- *Thuja plicata* Seasonally Flooded Forest Alliance (A.193)
- *Tsuga heterophylla* Saturated Forest Alliance (A.203)

SPATIAL CHARACTERISTICS

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Eyre 1980, Meidinger and Pojar 1991

Version: 07 Sep 2005 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.804 NORTHERN ROCKY MOUNTAIN LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Linear

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Montane [Lower Montane]; Riverine / Alluvial; Short (<5 yrs) Flooding Interval [Short interval, Spring Flooding]

Concept Summary: This ecological system of the northern Rocky Mountains and the east slopes of the Cascades consists of deciduous, coniferous, and mixed conifer-deciduous forests that occur on streambanks and river floodplains of the lower montane and foothill zones. Riparian forest stands are maintained by annual flooding and hydric soils throughout the growing season. Riparian forests are often accomp anied by riparian shrublands or open areas dominated by wet meadows. *Populus balsamifera* is the key indicator species. Several other tree species can be mixed in the canopy, including *Populus tremuloides, Betula papyrifera, Betula occidentalis, Picea mariana,* and *Picea glauca*. *Abies grandis, Thuja plicata,* and *Tsuga heterophylla* are commonly dominant canopy species in western Montana and northern Idaho occurrences, in lower montane riparian zones. Shrub understory components include *Cornus sericea, Acer glabrum, Alnus incana, Betula papyrifera, Oplopanax horridus,* and *Symphoricarpos albus.* Ferns and forbs of mesic sites are commonly present in many occurrences, including such species as *Athyrium filix-femina, Gymnocarpium dryopteris,* and *Senecio triangularis*.

Comments: This system is from the Canadian Rockies ecoregion project and represents lower montane riparian in Montana north into Canada. In the Okanagan, this is defined as all the cottonwood-dominated or codominated riparian systems below subalpine and above the Ponderosa pine zone. This system occurs in fire-dominated landscapes, which distinguishes it from North Pacific and subalpine/alpine landscapes that have significantly different fire regimes. This system is distinguished from the similar Rocky Mountain Subalpine-Montane Riparian Woodland (CES306.833) by the floristic component of northern Rocky Mountain species, both in the woody layers and in the herbaceous taxa.

DISTRIBUTION

Range: This system is found in the northern Rocky Mountains.

Divisions: 303:P, 306:C

TNC Ecoregions: 7:C, 8:C, 68:C

Subnations: AB, BC, ID, MT, OR?, WA

CONCEPT

Associations:

- *Abies grandis / Athyrium filix-femina* Forest (CEGL000270, G3Q)
- *Abies grandis / Senecio triangularis* Forest (CEGL000280, G3)
- *Betula papyrifera* Forest [Provisional] (CEGL000520, G4Q)
- *Populus balsamifera* (ssp. *trichocarpa*, ssp. *balsamifera*) / *Symphoricarpos (albus, oreophilus, occidentalis)* Forest (CEGL000677, G2)
- *Populus balsamifera* ssp. *trichocarpa - (Populus tremuloides) / Heracleum maximum* Forest (CEGL000542, G2)
- *Populus balsamifera* ssp. *trichocarpa / Alnus incana* Forest (CEGL000667, G3)
- *Populus balsamifera* ssp. *trichocarpa / Betula papyrifera* Forest (CEGL000670, GNRQ)
- *Populus balsamifera* ssp. *trichocarpa / Calamagrostis canadensis* Forest [Provisional] (CEGL005845, G2?)
- *Populus balsamifera* ssp. *trichocarpa / Cornus sericea* Forest (CEGL000672, G3G4)
- *Populus balsamifera* ssp. *trichocarpa / Oplopanax horridus - Acer glabrum* Forest (CEGL000482, G2)
- *Thuja plicata - Tsuga heterophylla / Oplopanax horridus* Rocky Mountain Forest (CEGL000479, G3)
- *Thuja plicata / Gymnocarpium dryopteris* Forest (CEGL000476, G3)
- *Tsuga heterophylla / Athyrium filix-femina* Forest (CEGL000491, G2Q)
- *Tsuga heterophylla / Gymnocarpium dryopteris* Forest (CEGL000494, G3G4)

Alliances:

- *Abies grandis* Temporarily Flooded Forest Alliance (A.176)
- *Betula papyrifera* Forest Alliance (A.267)
- *Populus balsamifera* ssp. *trichocarpa* Temporarily Flooded Forest Alliance (A.311)
- *Thuja plicata* Forest Alliance (A.166)
- *Thuja plicata* Seasonally Flooded Forest Alliance (A.193)
- *Tsuga heterophylla* Forest Alliance (A.145)
- *Tsuga heterophylla* Temporarily Flooded Forest Alliance (A.174)

SPATIAL CHARACTERISTICS

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Ecosystems Working Group 1998, Eyre 1980, Hansen et al. 1988b, Hansen et al. 1989

Version: 07 Sep 2005 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.821 ROCKY MOUNTAIN LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Linear

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Montane [Lower Montane]; Riverine / Alluvial; Mineral: W/ A-Horizon <10 cm; Unconsolidated; Short (<5 yrs) Flooding Interval; Short (50-100 yrs) Persistence

Concept Summary: This system is found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 to 2800 m. This system often occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks. They can form large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplains swales and irrigation ditches. Dominant trees may include *Acer negundo, Populus angustifolia, Populus balsamifera, Populus deltoides, Populus fremontii, Pseudotsuga menziesii, Picea pungens, Salix amygdaloides*, or *Juniperus scopulorum.* Dominant shrubs include *Acer glabrum, Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Forestiera pubescens, Prunus virginiana, Rhus trilobata, Salix monticola, Salix drummondiana, Salix exigua, Salix irrorata, Salix lucida, Shepherdia argentea*, or *Symphoricarpos* spp. Exotic trees of *Elaeagnus angustifolia* and *Tamarix* spp. are common in some stands. Generally, the upland vegetation surrounding this riparian system is different and ranges from grasslands to forests.

DISTRIBUTION

Range: This system is found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 to 2800 m. It is also found in the island mountain ranges of central and eastern Montana.

Divisions: 304:C, 306:C

TNC Ecoregions: 6:P, 8:C, 9:C, 11:C, 18:C, 19:C, 20:C, 21:C, 25:C, 26:C

Subnations: AZ, CO, ID, MT, NM, NV, OR, SD, UT, WY

CONCEPT

Associations:

- *Acer negundo - Celtis laevigata* var. *reticulata* Woodland (CEGL002599, GNR)
- *Acer negundo - Populus angustifolia / Cornus sericea* Forest (CEGL000627, G2)
- *Acer negundo / Betula occidentalis* Woodland (CEGL000936, G1G2)
- *Acer negundo / Brickellia grandiflora* Woodland [Provisional] (CEGL002692, GNR)
- *Acer negundo / Cornus sericea* Forest (CEGL000625, G3?)
- *Acer negundo* / Disturbed Understory Woodland (CEGL002693, GNR)
- *Acer negundo / Equisetum arvense* Forest (CEGL000626, G2?)
- *Acer negundo / Prunus virginiana* Forest (CEGL000628, G3)
- *Betula occidentalis / Purshia tridentata / Hesperostipa comata* Shrubland (CEGL001084, G1)
- *Betula papyrifera / Corylus cornuta* Forest (CEGL002079, G2G3)
- *Elaeagnus angustifolia* Semi-natural Woodland (CEGL005269, GNA)
- *Equisetum (arvense, variegatum)* Herbaceous Ve getation (CEGL005148, GNR)
- *Equisetum hyemale* Herbaceous Vegetation (CEGL002760, GNR)
- *Equisetum laevigatum* Herbaceous Vegetation (CEGL002241, GNR)
- *Forestiera pubescens* Shrubland (CEGL001168, G1G2)
- *Fraxinus anomala* Woodland (CEGL002752, GUQ)
- *Juniperus scopulorum / Cornus sericea* Woodland (CEGL000746, G4)
- *Juniperus scopulorum* Temporarily Flooded Woodland [Placeholder] (CEGL002777, G1)
- *Juniperus scopulorum* Woodland (CEGL003550, GNR)
- *Pinus ponderosa / Alnus incana* Woodland (CEGL002638, G2)
- *Pinus ponderosa / Cornus sericea* Woodland (CEGL000853, G3)
- *Pinus ponderosa / Crataegus douglasii* Woodland (CEGL000855, G1)
- *Pinus ponderosa / Juglans major* Woodland (CEGL000858, G2)
- *Pinus ponderosa* Temporarily Flooded Woodland [Provisional] (CEGL002766, G3)
- *Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation [Placeholder] (CEGL003081, GNA)
- *Populus angustifolia - Juniperus scopulorum* Woodland (CEGL002640, G2G3)
- *Populus angustifolia - Picea pungens / Alnus incana* Woodland (CEGL000934, G3)
- *Populus angustifolia - Pinus ponderosa* Woodland (CEGL000935, G4Q)
- *Populus angustifolia - Populus deltoides - Salix amygdaloides* Forest (CEGL000656, GUQ)
- *Populus angustifolia - Pseudotsuga menziesii* Woodland (CEGL002641, G3)
- *Populus angustifolia / Acer grandidentatum* Forest (CEGL000646, G2G3)
- *Populus angustifolia / Alnus incana* Woodland (CEGL002642, G3)
- *Populus angustifolia / Betula occidentalis* Woodland (CEGL000648, G3)
- *Populus angustifolia / Cornus sericea* Woodland (CEGL002664, G4)
- *Populus angustifolia / Crataegus rivularis* Woodland (CEGL002644, G2?)
- *Populus angustifolia / Lonicera involucrata* Forest (CEGL000650, GUQ)
- *Populus angustifolia / Prunus virginiana* Woodland (CEGL000651, G2Q)
- *Populus angustifolia / Rhus trilobata* Woodland (CEGL000652, G3)
- *Populus angustifolia / Rosa woodsii* Forest (CEGL000653, G2G3)
- *Populus angustifolia / Salix (monticola, drummondiana, lucida)* Woodland (CEGL002645, G3)
- *Populus angustifolia / Salix drummondiana - Acer glabrum* Woodland (CEGL002646, G2?)
- *Populus angustifolia / Salix exigua* Woodland (CEGL000654, G4)
- *Populus angustifolia / Salix irrorata* Woodland (CEGL002647, G2)
- *Populus angustifolia / Salix ligulifolia - Shepherdia argentea* Woodland (CEGL000655, G1)
- *Populus angustifolia / Symphoricarpos (albus, occidentalis, oreophilus)* Woodland (CEGL002648, G2Q)
- *Populus angustifolia* Sand Dune Forest (CEGL002643, G1)
- *Populus deltoides* (ssp. *wislizeni*, ssp. *monilifera) / Artemisia tridentata* Woodland (CEGL005966, G2G3)
- *Populus deltoides* (ssp. *wislizeni*, ssp. *monilifera*) / *Salix exigua* Woodland (CEGL002685, G3)
- *Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior)* Woodland (CEGL000659, G3G4)
- *Populus deltoides / Symphoricarpos occidentalis* Woodland (CEGL000660, G2G3)
- *Populus deltoides* ssp. *wislizeni / Rhus trilobata* Woodland (CEGL000940, G2)
- *Populus fremontii / Betula occidentalis* Wooded Shrubland (CEGL002981, GNR)
- *Populus fremontii / Ericameria nauseosa* Woodland (CEGL002465, GNR)
- *Populus fremontii / Leymus triticoides* Woodland (CEGL002756, GNR)
- *Populus fremontii* / Mesic Forbs Woodland (CEGL002470, GNR)
- *Populus fremontii* / Mesic Graminoids Woodland (CEGL002473, GNR)
- *Populus fremontii / Salix exigua* Forest (CEGL000666, GNR)
- *Populus fremontii / Salix geyeriana* Woodland (CEGL000943, G3?)

- *Pseudotsuga menziesii / Betula occidentalis* Woodland (CEGL002639, G3?)
- *Pseudotsuga menziesii / Cornus sericea* Woodland (CEGL000899, G4)
- *Rhus trilobata* Intermittently Flooded Shrubland (CEGL001121, G3)
- *Salix amygdaloides* Woodland (CEGL000947, G3)
- *Salix eastwoodiae / Carex aquatilis* Shrubland (CEGL001195, G2)
- *Salix eastwoodiae / Carex utriculata* Shrubland (CEGL001196, G2?)
- *Salix eastwoodiae* Shrubland (CEGL001194, G2Q)
- *Salix exigua - Salix ligulifolia* Shrubland (CEGL002655, G2G3)
- *Salix exigua - Salix lucida* ssp. *caudata* Shrubland (CEGL001204, G2)
- *Salix exigua / Agrostis stolonifera* Shrubland (CEGL001199, GNA)
- *Salix exigua* / Barren Shrubland (CEGL001200, G5)
- *Salix exigua / Elymus X pseudorepens* Shrubland (CEGL001198, G3)
- *Salix exigua / Equisetum arvense* Shrubland (CEGL001201, G3?)
- *Salix exigua* / Mesic Forbs Shrubland (CEGL001202, G2)
- *Salix exigua* / Mesic Graminoids Shrubland (CEGL001203, G5)
- *Salix exigua* Temporarily Flooded Shrubland (CEGL001197, G5)
- *Salix irrorata* Shrubland (CEGL001214, GNR)
- *Salix lasiolepis - Cornus sericea / Rosa woodsii* Shrubland (CEGL003453, G2G3)
- *Salix lasiolepis* / Barren Ground Shrubland (CEGL001216, G3?)
- *Salix lasiolepis / Rosa woodsii* / Mixed Herbs Shrubland (CEGL001217, G3Q)
- *Shepherdia argentea* Shrubland (CEGL001128, G3G4)

Alliances:

- *Acer negundo* Seasonally Flooded Forest Alliance (A.341)
- *Acer negundo* Temporarily Flooded Forest Alliance (A.278)
- *Acer negundo* Temporarily Flooded Woodland Alliance (A.642)
- *Betula occidentalis* Intermittently Flooded Shrubland Alliance (A.936)
- *Betula occidentalis* Temporarily Flooded Shrubland Alliance (A.967)
- *Betula papyrifera* Forest Alliance (A.267)
- *Elaeagnus angustifolia* Semi-natural Woodland Alliance (A.3566)
- *Equisetum (arvense, variegatum, hyemale)* Semipermanently Flooded Herbaceous Alliance (A.3539)
- *Equisetum laevigatum* Semipermanently Flooded Herbaceous Alliance (A.2648)
- *Forestiera pubescens* Temporarily Flooded Shrubland Alliance (A.969)
- *Fraxinus anomala* Temporarily Flooded Woodland Alliance (A.2511)
- *Juniperus scopulorum* Temporarily Flooded Woodland Alliance (A.563)
- *Juniperus scopulorum* Woodland Alliance (A.506)
- *Pinus ponderosa* Temporarily Flooded Woodland Alliance (A.565)
- *Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Alliance (A.1382)
- *Populus angustifolia* Temporarily Flooded Forest Alliance (A.310)
- *Populus angustifolia* Temporarily Flooded Woodland Alliance (A.641)
- *Populus deltoides* Temporarily Flooded Woodland Alliance (A.636)
- *Populus fremontii* Seasonally Flooded Woodland Alliance (A.654)
- *Populus fremontii* Temporarily Flooded Forest Alliance (A.313)
- *Populus fremontii* Temporarily Flooded Woodland Alliance (A.644)
- *Pseudotsuga menziesii* Temporarily Flooded Woodland Alliance (A.568)
- *Rhus trilobata* Intermittently Flooded Shrubland Alliance (A.938)
- *Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance (A.947)
- *Salix amygdaloides* Temporarily Flooded Woodland Alliance (A.645)
- *Salix eastwoodiae* Seasonally Flooded Shrubland Alliance (A.1005)
- *Salix irrorata* Temporarily Flooded Shrubland Alliance (A.976)
- *Salix lasiolepis* Temporarily Flooded Shrubland Alliance (A.977)
- *Shepherdia argentea* Temporarily Flooded Shrubland Alliance (A.960)

Environment: This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. This ecological system is found within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks. It can form large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplains swales and irrigation ditches. It may also occur in upland areas of mesic swales and hillslopes below seeps and springs.

The climate of this system is continental with typically cold winters and hot summers.

Surface water is generally high for variable periods. Soils are typically alluvial deposits of sand, clays, silts and cobbles that are highly stratified with depth due to flood scour and deposition. Highly stratified profiles consist of alternating layers of clay loam and organic material with coarser sand or thin layers of sandy loam over very coarse alluvium. Soils are fine-textured with organic material over coarser alluvium. Some soils are more developed due to a slightly more stable environment and greater input of organic matter.
Dynamics: This ecological system contains early-, mid- and late-seral riparian plant associations. It also contains non-obligate riparian species. Cottonwood communities are early-, mid- or late-seral, depending on the age class of the trees and the associated species of the occurrence (Kittel et al. 1998). Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood occurrences do not regenerate in place, but regenerate by "moving" up and down a river reach. Over time a healthy riparian area supports all stages of cottonwood communities (Kittel et al. 1999b).

SPATIAL CHARACTERISTICS

SOURCES

References: Baker 1988, Baker 1989a, Baker 1989b, Baker 1990, Comer et al. 2002, Comer et al. 2003, Crowe and Clausnitzer 1997, Daubenmire 1952, Eyre 1980, Kittel et al. 1999b, Kovalchik 1987, Kovalchik 1992, Manning and Padgett 1995, Muldavin et al. 2000a, Nachlinger et al. 2001, Neely et al. 2001, Padgett et al. 1989, Shiflet 1994, Szaro 1989, Tuhy et al. 2002, Walford 1996, Walford et al. 1997, Walford et al. 2001

Version: 20 Feb 2003 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.832 ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN SHRUBLAND

Primary Division: Rocky Mountain (306)
Land Cover Class: Woody Wetland
Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Montane [Upper Montane, Montane]; Shrubland (Shrub-dominated); Riverine / Alluvial; Broad-Leaved Deciduous Shrub; Short (<5 yrs) Flooding Interval; RM Subalpine/Montane Riparian Woodland; Short (50-100 yrs) Persistence
Concept Summary: This system is found throughout the Rocky Mountain cordillera from New Mexico north into Montana, and also occurs in mountainous areas of the Intermountain region and Colorado Plateau. These are montane to subalpine riparian shrublands occurring as narrow bands of shrubs lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels. Generally it is found at higher elevations, but can be found anywhere from 1700-3475 m. Occurrences can also be found around seeps, fens, and isolated springs on hillslopes away from valley bottoms. Many of the plant associations found within this system are associated with beaver activity. This system often occurs as a mosaic of multiple communities that are shrub- and herb-dominated and includes above-treeline, willow-dominated, snowmelt-fed basins that feed into streams. The dominant shrubs reflect the large elevational gradient and include *Alnus incana, Betula nana, Betula occidentalis, Cornus sericea, Salix bebbiana, Salix boothii, Salix brachycarpa, Salix drummondiana, Salix eriocephala, Salix geyeriana, Salix monticola, Salix planifolia,* and *Salix wolfii*. Generally the upland vegetation surrounding these riparian systems are of either conifer or aspen forests.

DISTRIBUTION

Range: This system is found throughout the Rocky Mountain cordillera from New Mexico north into Montana (including the isolated island mountain ranges of central and eastern Montana), and also occurs in mountainous areas of the Intermountain West and Colorado Plateau.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:P, 7:C, 8:C, 9:C, 11:C, 18:C, 19:C, 20:C, 21:C, 25:C, 26:C, 68:C
Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY

CONCEPT

Associations:
- *Acer glabrum* Drainage Bottom Shrubland (CEGL001062, G4?)
- *Alnus incana - Betula occidentalis* Shrubland (CEGL001142, G2G3)
- *Alnus incana - Salix (monticola, lucida, ligulifolia)* Shrubland (CEGL002651, G3)
- *Alnus incana - Salix drummondiana* Shrubland (CEGL002652, G3)
- *Alnus incana / Athyrium filix-femina* Shrubland (CEGL002628, G3)
- *Alnus incana / Calamagrostis canadensis* Shrubland (CEGL001143, G3Q)
- *Alnus incana / Carex (aquatilis, deweyana, lenticularis, luzulina, pellita)* Shrubland (CEGL001144, G3)
- *Alnus incana / Carex scopulorum* var. *prionophylla* Shrubland (CEGL000122, G1)
- *Alnus incana / Cornus sericea* Shrubland (CEGL001145, G3G4)
- *Alnus incana / Equisetum arvense* Shrubland (CEGL001146, G3)
- *Alnus incana / Glyceria striata* Shrubland (CEGL000228, G3)
- *Alnus incana / Lysichiton americanus* Shrubland (CEGL002629, G3)

- *Alnus incana* / Mesic Forbs Shrubland (CEGL001147, G3)
- *Alnus incana* / Mesic Graminoids Shrubland (CEGL001148, G3)
- *Alnus incana / Ribes (inerme, hudsonianum, lacustre)* Shrubland (CEGL001151, G3)
- *Alnus incana / Scirpus microcarpus* Shrubland (CEGL000481, G2G3)
- *Alnus incana / Spiraea douglasii* Shrubland (CEGL001152, G3)
- *Alnus incana / Symphoricarpos albus* Shrubland (CEGL001153, G3G4)
- *Alnus incana* Shrubland (CEGL001141, GNRQ)
- *Alnus incana* ssp. *tenuifolia - Salix irrorata* Shrubland (CEGL002687, G3)
- *Alnus oblongifolia / Symphoricarpos oreophilus* Forest (CEGL001063, GU)
- *Alnus viridis* ssp. *sinuata / Athyrium filix-femina - Cinna latifolia* Shrubland (CEGL001156, G4)
- *Alnus viridis* ssp. *sinuata* Shrubland [Placeholder] (CEGL001154, GNRQ)
- *Betula nana* / Mesic Forbs - Mesic Graminoids Shrubland (CEGL002653, G3G4)
- *Betula occidentalis - Dasiphora fruticosa* ssp. *floribunda* Shrubland (CEGL001083, G2Q)
- *Betula occidentalis / Cornus sericea* Shrubland (CEGL001161, G3)
- *Betula occidentalis / Maianthemum stellatum* Shrubland (CEGL001162, G4?)
- *Betula occidentalis* / Mesic Graminoids Shrubland (CEGL002654, G3)
- *Betula occidentalis* Shrubland (CEGL001080, G3G4)
- *Cornus sericea / Galium triflorum* Shrubland (CEGL001166, G3?)
- *Cornus sericea / Heracleum maximum* Shrubland (CEGL001167, G3)
- *Cornus sericea* Shrubland (CEGL001165, G4Q)
- *Corylus cornuta* Shrubland [Provisional] (CEGL002903, G3)
- *Dasiphora fruticosa* ssp. *floribunda / Deschampsia caespitosa* Shrubland (CEGL001107, G4)
- *Fraxinus anomala* Woodland (CEGL002752, GUQ)
- *Ribes lacustre - Ribes hudsonianum / Cinna latifolia* Shrubland (CEGL003445, G2)
- *Ribes lacustre - Ribes hudsonianum / Glyceria striata* Shrubland (CEGL003446, G2G3)
- *Ribes lacustre / Mertensia ciliata* Shrubland (CEGL001172, G1G2Q)
- *Salix (boothii, geyeriana) / Carex aquatilis* Shrubland (CEGL001176, G3)
- *Salix bebbiana* / Mesic Graminoids Shrubland (CEGL001174, G3)
- *Salix bebbiana* Shrubland (CEGL001173, G3?)
- *Salix boothii - Salix eastwoodiae / Carex nigricans* Shrubland (CEGL002607, G3)
- *Salix boothii - Salix geyeriana / Carex angustata* Shrubland (CEGL001185, G2)
- *Salix boothii - Salix geyeriana* Shrubland (CEGL001184, GU)
- *Salix boothii - Salix lemmonii* Shrubland (CEGL001186, G3)
- *Salix boothii / Calamagrostis canadensis* Shrubland (CEGL001175, G3G4Q)
- *Salix boothii / Carex nebrascensis* Shrubland (CEGL001177, G4G5)
- *Salix boothii / Carex utriculata* Shrubland (CEGL001178, G4)
- *Salix boothii / Deschampsia caespitosa - Geum rossii* Shrubland (CEGL002904, G4)
- *Salix boothii / Equisetum arvense* Shrubland (CEGL002671, G3)
- *Salix boothii / Maianthemum stellatum* Shrubland (CEGL001187, G3Q)
- *Salix boothii* / Mesic Forbs Shrubland (CEGL001180, G3)
- *Salix boothii* / Mesic Graminoids Shrubland (CEGL001181, G3?)
- *Salix boothii / Poa palustris* Shrubland (CEGL001183, GNA)
- *Salix brachycarpa / Carex aquatilis* Shrubland (CEGL001244, G2G3)
- *Salix brachycarpa* / Mesic Forbs Shrubland (CEGL001135, G4)
- *Salix candida / Carex utriculata* Shrubland (CEGL001188, G2)
- *Salix commutata / Carex scopulorum* Shrubland (CEGL001189, G3)
- *Salix commutata* / Mesic Graminoid Shrubland (CEGL003497, GNR)
- *Salix drummondiana / Calamagrostis canadensis* Shrubland (CEGL002667, G3)
- *Salix drummondiana / Carex scopulorum* var. *prionophylla* Shrubland (CEGL001584, G2G3)
- *Salix drummondiana / Carex utriculata* Shrubland (CEGL002631, G4)
- *Salix drummondiana* / Mesic Forbs Shrubland (CEGL001192, G4)
- *Salix drummondiana* Shrubland [Placeholder] (CEGL001190, G3Q)
- *Salix eriocephala / Ribes aureum - Rosa woodsii* Shrubland (CEGL001233, G3)
- *Salix geyeriana - Salix eriocephala* Shrubland (CEGL001213, GU)
- *Salix geyeriana - Salix lemmonii / Carex aquatilis* var. *dives* Shrubland (CEGL001212, G3)
- *Salix geyeriana - Salix monticola / Calamagrostis canadensis* Shrubland (CEGL001247, G3)
- *Salix geyeriana - Salix monticola* / Mesic Forbs Shrubland (CEGL001223, G3)
- *Salix geyeriana / Calamagrostis canadensis* Shrubland (CEGL001205, G5)
- *Salix geyeriana / Carex aquatilis* Shrubland (CEGL001206, G3)
- *Salix geyeriana / Carex utriculata* Shrubland (CEGL001207, G5)

- *Salix geyeriana / Deschampsia caespitosa* Shrubland (CEGL001208, G4)
- *Salix geyeriana* / Mesic Forbs Shrubland (CEGL002666, G3)
- *Salix geyeriana* / Mesic Graminoids Shrubland (CEGL001210, G3?)
- *Salix geyeriana / Poa palustris* Shrubland (CEGL001211, GNA)
- *Salix glauca / Deschampsia caespitosa* Shrubland (CEGL001137, G4)
- *Salix lemmonii* / Mesic-Tall Forbs Shrubland (CEGL002771, G3?)
- *Salix lemmonii / Rosa woodsii* Shrubland (CEGL002772, G3)
- *Salix ligulifolia / Carex utriculata* Shrubland [Provisional] (CEGL002975, GNR)
- *Salix ligulifolia* Shrubland (CEGL001218, G2G3)
- *Salix lucida* ssp. *caudata / Rosa woodsii* Shrubland (CEGL002621, G3)
- *Salix lucida* ssp. *caudata* Shrubland [Provisional] (CEGL001215, G3Q)
- *Salix lutea / Calamagrostis canadensis* Shrubland (CEGL001219, G3?)
- *Salix lutea / Carex utriculata* Shrubland (CEGL001220, G4)
- *Salix lutea* / Mesic Forbs Shrubland (CEGL002774, G3?)
- *Salix lutea / Rosa woodsii* Shrubland (CEGL002624, G3)
- *Salix monticola / Angelica ampla* Shrubland (CEGL001221, GNR)
- *Salix monticola / Calamagrostis canadensis* Shrubland (CEGL001222, G3)
- *Salix monticola / Carex aquatilis* Shrubland (CEGL002656, G3)
- *Salix monticola / Carex utriculata* Shrubland (CEGL002657, G3)
- *Salix monticola* / Mesic Forbs Shrubland (CEGL002658, G4)
- *Salix monticola* / Mesic Graminoids Shrubland (CEGL002659, G3)
- *Salix monticola* Thicket Shrubland (CEGL001139, G2Q)
- *Salix planifolia / Calamagrostis canadensis* Shrubland (CEGL001225, G4)
- *Salix planifolia / Caltha leptosepala* Shrubland (CEGL002665, G4)
- *Salix planifolia / Carex aquatilis* Shrubland (CEGL001227, G5)
- *Salix planifolia / Carex scopulorum* Shrubland (CEGL001229, G4)
- *Salix planifolia / Deschampsia caespitosa* Shrubland (CEGL001230, G2G3)
- *Salix planifolia* / Mesic Forbs Shrubland (CEGL002893, G4)
- *Salix planifolia* Shrubland (CEGL001224, G4)
- *Salix wolfii / Carex aquatilis* Shrubland (CEGL001234, G4)
- *Salix wolfii / Carex microptera* Shrubland (CEGL001235, G3Q)
- *Salix wolfii / Carex nebrascensis* Shrubland (CEGL001236, G3Q)
- *Salix wolfii / Carex utriculata* Shrubland (CEGL001237, G4)
- *Salix wolfii / Deschampsia caespitosa* Shrubland (CEGL001238, G3)
- *Salix wolfii / Fragaria virginiana* Shrubland (CEGL001239, G4?)
- *Salix wolfii* / Mesic Forbs Shrubland (CEGL001240, G3)
- *Salix wolfii / Poa palustris* Shrubland (CEGL001241, GNA)
- *Salix wolfii / Swertia perennis - Pedicularis groenlandica* Shrubland (CEGL001242, G2)

Alliances:

- *Acer glabrum* Temporarily Flooded Shrubland Alliance (A.952)
- *Alnus incana* Seasonally Flooded Shrubland Alliance (A.986)
- *Alnus incana* Temporarily Flooded Shrubland Alliance (A.950)
- *Alnus oblongifolia* Temporarily Flooded Forest Alliance (A.953)
- *Alnus viridis* ssp. *sinuata* Temporarily Flooded Shrubland Alliance (A.966)
- *Betula nana* Seasonally Flooded Shrubland Alliance (A.995)
- *Betula occidentalis* Seasonally Flooded Shrubland Alliance (A.996)
- *Betula occidentalis* Temporarily Flooded Shrubland Alliance (A.967)
- *Cornus sericea* Temporarily Flooded Shrubland Alliance (A.968)
- *Corylus cornuta* Temporarily Flooded Shrubland Alliance (A.2596)
- *Dasiphora fruticosa* Temporarily Flooded Shrubland Alliance (A.958)
- *Fraxinus anomala* Temporarily Flooded Woodland Alliance (A.2511)
- *Ribes lacustre* Temporarily Flooded Shrubland Alliance (A.970)
- *Salix bebbiana* Temporarily Flooded Shrubland Alliance (A.971)
- *Salix boothii* Seasonally Flooded Shrubland Alliance (A.1001)
- *Salix boothii* Temporarily Flooded Shrubland Alliance (A.972)
- *Salix brachycarpa* Seasonally Flooded Shrubland Alliance (A.998)
- *Salix candida* Seasonally Flooded Shrubland Alliance (A.1002)
- *Salix commutata* Seasonally Flooded Shrubland Alliance (A.1003)
- *Salix drummondiana* Seasonally Flooded Shrubland Alliance (A.1004)
- *Salix drummondiana* Temporarily Flooded Shrubland Alliance (A.973)

- *Salix eriocephala* Temporarily Flooded Shrubland Alliance (A.974)
- *Salix geyeriana* Seasonally Flooded Shrubland Alliance (A.1006)
- *Salix geyeriana* Temporarily Flooded Shrubland Alliance (A.975)
- *Salix glauca* Temporarily Flooded Shrubland Alliance (A.963)
- *Salix lemmonii* Seasonally Flooded Shrubland Alliance (A.2523)
- *Salix ligulifolia* Temporarily Flooded Shrubland Alliance (A.978)
- *Salix lucida* Temporarily Flooded Shrubland Alliance (A.979)
- *Salix lutea* Seasonally Flooded Shrubland Alliance (A.1007)
- *Salix lutea* Temporarily Flooded Shrubland Alliance (A.980)
- *Salix monticola* Temporarily Flooded Shrubland Alliance (A.981)
- *Salix planifolia* Seasonally Flooded Shrubland Alliance (A.1008)
- *Salix planifolia* Temporarily Flooded Shrubland Alliance (A.982)
- *Salix wolfii* Seasonally Flooded Shrubland Alliance (A.1009)
- *Salix wolfii* Temporarily Flooded Shrubland Alliance (A.983)

SPATIAL CHARACTERISTICS

SOURCES

References: Baker 1988, Baker 1989a, Baker 1989b, Baker 1990, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Comer et al. 2003, Crowe and Clausnitzer 1997, Kittel 1993, Kittel 1994, Kittel et al. 1996, Kittel et al. 1999a, Kittel et al. 1999b, Kovalchik 1987, Kovalchik 1993, Kovalchik 2001, Manning and Padgett 1995, Muldavin et al. 2000a, Nachlinger et al. 2001, Neely et al. 2001, Padgett 1982, Padgett et al. 1988a, Padgett et al. 1988b, Rondeau 2001, Shiflet 1994, Szaro 1989, Tuhy et al. 2002, Walford 1996

Version: 20 Feb 2003 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.833 ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN WOODLAND

Primary Division: Rocky Mountain (306)

Land Cover Class: Woody Wetland

Spatial Scale & Pattern: Linear

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Montane [Upper Montane, Montane]; Forest and Woodland (Treed); Riverine / Alluvial; Short (<5 yrs) Flooding Interval; RM Subalpine/Montane Riparian Shrubland

Concept Summary: This riparian woodland system is comprised of seasonally flooded forests and woodlands found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, and west into the Intermountain region and the Colorado Plateau. It occurs throughout the interior of British Columbia and the eastern slopes of the Cascade Mountains. This system contains the conifer and aspen woodlands that line montane streams. These are communities tolerant of periodic flooding and high water tables. Snowmelt moisture in this system may create shallow water tables or seeps for a portion of the growing season. Stands typically occur at elevations between 1500 and 3300 m (4920-10,830 feet), farther north elevation ranges between 900 and 2000 m. This is confined to specific riparian environments occurring on floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons (where there is cold-air drainage). Less frequently, occurrences are found in moderate-wide valley bottoms on large floodplains along broad, meandering rivers, and on pond or lake margins. Dominant tree species vary across the latitudinal range, although it usually includes *Abies lasiocarpa* and/or *Picea engelmannii*; other important species include *Pseudotsuga menziesii, Picea pungens, Picea engelmannii X glauca, Populus tremuloides,* and *Juniperus scopulorum.* Other trees possibly present but not usually dominant include *Alnus incana, Abies concolor, Abies grandis, Pinus contorta, Populus angustifolia, Populus balsamifera ssp. trichocarpa,* and *Juniperus osteosperma*.

DISTRIBUTION

Range: This system is found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, Alberta and British Columbia, and west into the Intermountain region and the Colorado Plateau.

Divisions: 204:P, 304:C, 306:C

TNC Ecoregions: 4:P, 6:P, 7:C, 8:C, 9:C, 11:C, 18:C, 19:C, 20:C, 21:C, 25:C, 68:C

Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY

CONCEPT

Associations:

- *Abies concolor - Picea pungens - Populus angustifolia / Acer glabrum* Forest (CEGL000255, G2)
- *Abies lasiocarpa - Picea engelmannii / Alnus incana* Forest (CEGL000296, G5)
- *Abies lasiocarpa - Picea engelmannii / Alnus viridis* ssp. *sinuata* Forest (CEGL000297, G4)
- *Abies lasiocarpa - Picea engelmannii / Mertensia ciliata* Forest (CEGL002663, G5)
- *Abies lasiocarpa - Picea engelmannii / Oplopanax horridus* Forest (CEGL000322, G3)
- *Abies lasiocarpa - Picea engelmannii / Salix drummondiana* Forest (CEGL000327, G5)

- *Abies lasiocarpa - Picea engelmannii / Streptopus amplexifolius* Forest (CEGL000336, G4)
- *Abies lasiocarpa / Carex aquatilis* Forest (CEGL002636, G4)
- *Abies lasiocarpa / Trautvetteria caroliniensis* Forest (CEGL000339, G3)
- *Picea engelmannii - Populus angustifolia / Heracleum maximum* Forest (CEGL000367, G3G4)
- *Picea engelmannii / Caltha leptosepala* Forest (CEGL000357, G3?)
- *Picea engelmannii / Carex angustata* Forest (CEGL000359, G3)
- *Picea engelmannii / Carex scopulorum* var. *prionophylla* Woodland (CEGL002630, G3)
- *Picea engelmannii / Cornus sericea* Woodland (CEGL002677, G3)
- *Picea engelmannii / Eleocharis quinqueflora* Woodland (CEGL000361, G3)
- *Picea engelmannii / Salix drummondiana* Woodland [Provisional] (CEGL005843, G2G3)
- *Picea engelmannii / Senecio triangularis* Forest (CEGL000376, G3Q)
- *Picea glauca* Alluvial Black Hills Forest (CEGL002057, G2G3)
- *Picea pungens / Alnus incana* Woodland (CEGL000894, G3)
- *Picea pungens / Betula occidentalis* Woodland (CEGL002637, G2)
- *Picea pungens / Cornus sericea* Woodland (CEGL000388, G4)
- *Picea pungens / Dasiphora fruticosa* ssp. *floribunda* Woodland (CEGL000396, G2G3)
- *Picea pungens / Equisetum arvense* Woodland (CEGL000389, G3?)
- *Pinus contorta / Calamagrostis canadensis* Forest (CEGL000138, G5)
- *Pinus contorta / Carex (aquatilis, angustata)* Woodland (CEGL000140, G4Q)
- *Pinus contorta / Cornus sericea* Woodland (CEGL005929, G2G3)
- *Pinus contorta / Deschampsia caespitosa* Forest (CEGL000147, G3)
- *Populus balsamifera* ssp. *trichocarpa* - Conifer / *Cornus sericea* Forest (CEGL005905, G2G3)
- *Populus balsamifera* ssp. *trichocarpa - Picea engelmannii / Equisetum arvense* Forest (CEGL005907, G2?)
- *Populus tremuloides - Abies lasiocarpa - Picea engelmannii / Calamagrostis canadensis* Forest [Provisional] (CEGL005909, G2?)
- *Populus tremuloides - Abies lasiocarpa - Picea engelmannii / Streptopus amplexifolius* Forest (CEGL005908, G2G3)
- *Populus tremuloides* - Conifer / *Heracleum maximum* Forest (CEGL005910, G2?)
- *Populus tremuloides / Alnus incana - Salix* spp. Forest (CEGL001082, G4)
- *Populus tremuloides / Alnus incana / Betula nana - Ribes* spp. Forest (CEGL001149, G1)
- *Populus tremuloides / Alnus incana* Forest (CEGL001150, G3)
- *Populus tremuloides / Betula occidentalis* Forest (CEGL002650, G3)
- *Populus tremuloides / Calamagrostis canadensis* Forest (CEGL000574, G3)
- *Populus tremuloides / Carex aquatilis* var. *aquatilis* Forest (CEGL003442, G1?)
- *Populus tremuloides / Carex obnupta* Forest (CEGL003371, G2)
- *Populus tremuloides / Carex pellita* Forest (CEGL000577, G2)
- *Populus tremuloides / Cornus sericea* Forest (CEGL000582, G4)
- *Populus tremuloides / Corylus cornuta* Forest (CEGL000583, G3)
- *Populus tremuloides / Equisetum arvense* Forest (CEGL000584, G4)
- *Populus tremuloides / Quercus gambelii / Symphoricarpos oreophilus* Forest (CEGL000598, GNR)
- *Populus tremuloides / Ranunculus alismifolius* Forest (CEGL000599, G2?)
- *Populus tremuloides / Ribes montigenum* Forest (CEGL000600, G2)
- *Populus tremuloides / Salix drummondiana* Forest (CEGL002902, G3G4)
- *Populus tremuloides / Senecio bigelovii* var. *bigelovii* Forest (CEGL000590, G1?)
- *Populus tremuloides / Veratrum californicum* Forest (CEGL000621, G3?)
- *Populus tremuloides* Canyon Formation Forest (CEGL000576, GUQ)

Alliances:

- *Abies concolor* Forest Alliance (A.152)
- *Abies lasiocarpa - Populus tremuloides* Forest Alliance (A.422)
- *Abies lasiocarpa* Seasonally Flooded Forest Alliance (A.190)
- *Abies lasiocarpa* Temporarily Flooded Forest Alliance (A.177)
- *Picea engelmannii* Seasonally Flooded Forest Alliance (A.191)
- *Picea engelmannii* Seasonally Flooded Woodland Alliance (A.572)
- *Picea engelmannii* Temporarily Flooded Forest Alliance (A.179)
- *Picea engelmannii* Temporarily Flooded Woodland Alliance (A.566)
- *Picea glauca* Temporarily Flooded Forest Alliance (A.172)
- *Picea pungens* Temporarily Flooded Woodland Alliance (A.567)
- *Pinus contorta* Seasonally Flooded Forest Alliance (A.188)
- *Pinus contorta* Temporarily Flooded Forest Alliance (A.175)
- *Pinus contorta* Temporarily Flooded Woodland Alliance (A.562)
- *Pinus contorta* Woodland Alliance (A.512)
- *Populus balsamifera* ssp. *trichocarpa* Temporarily Flooded Forest Alliance (A.311)

- *Populus tremuloides* Forest Alliance (A.274)
- *Populus tremuloides* Seasonally Flooded Forest Alliance (A.340)
- *Populus tremuloides* Temporarily Flooded Forest Alliance (A.300)

SPATIAL CHARACTERISTICS

SOURCES

References: Baker 1988, Baker 1989a, Baker 1989b, Baker 1990, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Comer et al. 2003, Crowe and Clausnitzer 1997, Ecosystems Working Group 1998, Eyre 1980, Kittel 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1999a, Kittel et al. 1999b, Kovalchik 1987, Kovalchik 1993, Kovalchik 2001, Manning and Padgett 1995, Muldavin et al. 2000a, Nachlinger et al. 2001, Neely et al. 2001, Padgett 1982, Padgett et al. 1988a, Padgett et al. 1988b, Rondeau 2001, Shiflet 1994, Tuhy et al. 2002

Version: 09 Feb 2005 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

HERBACEOUS WETLANDS (NLCD 92)

CES304.057 COLUMBIA PLATEAU VERNAL POOL

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Herbaceous Wetland
Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Depressional [Vernal Pool]; Impermeable Layer; 1-29-day hydroperiod; Vernal Pool Mosaic
Concept Summary: This system includes shallow ephemeral water bodies found in very small (3 square meters to 1 acre) to large depressions (1500 square meters to a square mile, average size of vernal pools are 1600 square meters, while average size on non-alkaline playa lakes are 5-10 acres) throughout the exposed volcanic scablands of the Columbia Plateau in Washington, Oregon, and northern Nevada. Most of these pools and lakes are located on massive basalt flows exposed by Pleistocene floods; southward they also occur on andesite or rhyodacite caprock. Inundation is highly irregular, sometimes not occurring for several years. Depressions usually (but not always) fill with water during winter and spring. They are generally dry again within 9 months, though in exceptional times they can remain inundated for two years in a row. Water is from rainfall and snowmelt in relatively small closed basins, on average probably no more than 5-15 times the area of the ponds themselves. Because these pools and playas are perched above the general surrounding landscape, they are not generally subject to runoff from major stream systems. They typically have silty clay soils, sometimes with sandy margins. Pools are often found within a mounded or biscuit-swale topography with *Artemisia* shrub-steppe or rarely *Pinus ponderosa* savanna. In the northern Columbia Plateau, characteristic species are predominantly annual and diverse. Floristically akin to California vernal pool flora (one-third), however, many of the most abundant species are not reported in Californian pools. Characteristic species include *Callitriche marginata, Camissonia tanacetifolia, Elatine* spp., *Epilobium densiflorum (= Boisduvalia densiflora), Eryngium vaseyi, Juncus uncialis, Myosurus X clavicaulis, Plagiobothrys* spp., *Polygonum polygaloides ssp. confertiflorum, Polygonum polygaloides ssp. polygaloides, Psilocarphus brevissimus, Psilocarphus elatior, Psilocarphus oregonus,* and *Trifolium cyathiferum. Artemisia ludoviciana ssp. ludoviciana* can occur on better developed soils. In northern Nevada, most of the species by biomass are perennials and include *Polygonum, Rumex, Juncus balticus, Eleocharis, Carex douglasii, Muhlenbergia richardsonis,* and *Polyctenium* species, in addition to *Camissonia tanacetifolia* and *Psilocarphus brevissimus.* Endemic plant species *Navarretia leucocephala ssp. diffusa* and *Polyctenium williamsiae* may occur.
Comments: This includes Bjork (1997) vernal pool annual-dominated, vernal pool perennial-dominated and rain pools.

DISTRIBUTION

Range: This system is restricted to the northern Columbia Plateau ecoregion commonly called the Columbia Basin and perhaps the Okanagan Valley in British Columbia, and to the western Great Basin.
Divisions: 304:C
TNC Ecoregions: 6:C, 68:P
Subnations: BC?, NV, OR, WA

CONCEPT

Associations:
Alliances:
•
High-ranked species: Ivesia pityocharis (G2), Juncus uncialis (G3G4), Myosurus sessilis (G2), Polyctenium williamsiae (G2Q), Polygonum polygaloides ssp. confertiflorum (G4G5T3T4)
Environment: Winters are colder (coldest average median temperature month in the high 20 degrees F) than California vernal pools and are climatically defined by wet winters (November through January, sporadically so southward) and severe summer drought (July-

September), although May or June can be wet. The northernmost vernal pools are adapted to cold spring and long summer days (18 hours).

SPATIAL CHARACTERISTICS

Size: Depressions (3-4608 square meters to a square mile; average 1600 sq.m to 10 acres), mean depth 0.47 to 1.5 m.
Adjacent Ecological System Comments: Primarily Columbia Plateau Scabland Shrubland (CES304.770) or Inter-Mountain Basins Big Sagebrush Steppe (CES304.778) (three-tip sagebrush) rarely into ponderosa pine savanna or pinyon-juniper.

SOURCES

References: Bjork 1997, Bjork and Dunwiddie n.d., Comer et al. 2003
Version: 27 Jun 2005 **Stakeholders:** Canada, West
Concept Author: R. Crawford **LeadResp:** West

CES304.998 INTER-MOUNTAIN BASINS ALKALINE CLOSED DEPRESSION

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Herbaceous Wetland
Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Concept Summary: This system is very similar to Western Great Plains Closed Depression Wetland (CES303.666). Sites are seasonally to semipermanently flooded, usually retaining water into the growing season and drying completely only in drought years. Many are associated with hot and cold springs, located in basins with internal drainage. Soils are alkaline to saline clays with hardpans. Seasonal drying exposes mudflats colonized by annual wetland vegetation. Salt encrustations can occur on the surface in some examples of this system, and the soils are severely affected and have poor structure. Species that typify this system are salt-tolerant and halophytic species such as *Distichlis spicata, Puccinellia lemmonii, Poa secunda, Muhlenbergia* spp., *Leymus triticoides (= Elymus triticoides), Schoenoplectus maritimus, Schoenoplectus americanus, Triglochin maritima*, and *Salicornia* spp. During exceptionally wet years, an increase in precipitation can dilute the salt concentration in the soils of some examples of this system which may allow for less salt-tolerant species to occur. Communities found within this system may also occur in floodplains (i.e., more open depressions), but probably should not be considered a separate system unless they transition to areas outside the immediate floodplain. Types often occur along the margins of perennial lakes, in alkaline closed basins, with extremely low-gradient shorelines.

DISTRIBUTION

Range: This system can occur throughout the Columbia Plateau and the northern Great Basin but is most common in eastern Oregon and northern Nevada.
Divisions: 304:C
TNC Ecoregions: 6:C
Subnations: CA, ID, NV, OR, UT, WA?

CONCEPT

Associations:
- *Distichlis spicata* Herbaceous Vegetation (CEGL001770, G5)
- *Eleocharis (montevidensis, palustris, quinqueflora)* Seasonally Flooded Herbaceous Vegetation [Placeholder] (CEGL003050, G5)
- *Eleocharis palustris - Distichlis spicata* Herbaceous Vegetation (CEGL001834, G2G4)
- *Eleocharis palustris - Juncus balticus* Herbaceous Vegetation (CEGL001835, G2G4)
- *Leymus triticoides - Carex* spp. Herbaceous Vegetation (CEGL001571, G4?)
- *Leymus triticoides - Poa secunda* Herbaceous Vegetation (CEGL001572, G2)
- *Poa secunda - Muhlenbergia richardsonis* Herbaceous Vegetation (CEGL002755, GNR)
- *Puccinellia lemmonii - Poa secunda* Seasonally Flooded Herbaceous Vegetation (CEGL001658, G1)
- *Schoenoplectus americanus - Eleocharis palustris* Herbaceous Vegetation (CEGL001585, G4)

Alliances:
- *Distichlis spicata* Intermittently Flooded Herbaceous Alliance (A.1332)
- *Eleocharis (montevidensis, palustris, quinqueflora)* Seasonally Flooded Herbaceous Alliance (A.1371)
- *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance (A.1422)
- *Leymus triticoides* Temporarily Flooded Herbaceous Alliance (A.1353)
- *Poa secunda* Seasonally Flooded Herbaceous Alliance (A.1410)
- *Schoenoplectus americanus* Semipermanently Flooded Herbaceous Alliance (A.1432)

High-ranked species: Astragalus applegatei (G1), Astragalus diversifolius (G2), Astragalus lemmonii (G3?), Astragalus phoenix (G2), Astragalus pterocarpus (G3), Calochortus striatus (G2), Castilleja salsuginosa (G1Q), Centaurium namophilum (G2Q), Cirsium mohavense (G2G3), Cordylanthus tecopensis (G2), Downingia bicornuta (G3G4), Downingia bicornuta var. bicornuta (G3G4T3T4), Eriogonum ampullaceum (G3), Eriogonum argophyllum (G1), Goodmania luteola (G3), Grindelia fraxinopratensis (G2), Ivesia kingii (G3), Ivesia kingii var. eremica (G3T1T2Q), Juncus kelloggii (G3?), Juncus uncialis (G3G4), Lepidium davisii (G3), Microtus californicus scirpensis (G5T1), Phacelia parishii (G2G3), Plagiobothrys salsus (G2G3), Plagiobothrys stipitatus var. micranthus (G4T3T4), Pogogyne

floribunda (G3), Polygonum polygaloides ssp. confertiflorum (G4G5T3T4), Polygonum polygaloides ssp. esotericum (G4G5T2), Potentilla basaltica (G1), Potentilla newberryi (G3G4), Pseudocopaeodes eunus obscurus (G3G4T1), Sisyrinchium funereum (G2G3), Spiranthes infernalis (G1), Thelypodium brachycarpum (G3), Thelypodium howellii ssp. spectabilis (G2T1)
Environment: This system is distinct from the freshwater depression systems by its brackish nature caused by strongly saline soils. Salt encrustations could occur near the surface in some examples of this system.
Vegetation: Salt-tolerant and halophytic species such as *Distichlis spicata* typify the system.
Dynamics: Hydrology processes primarily drive this system. Increases in precipitation and/or runoff can dilute the salt concentration and allow for less salt-tolerant species to occur. Conversion to agriculture and pastureland can also impact this system, especially when it alters the hydrology of the system.

SPATIAL CHARACTERISTICS

SOURCES

References: Shiflet 1994, Western Ecology Working Group n.d.
Version: 07 Jun 2004 **Stakeholders:** West
Concept Author: J. Kagan **LeadResp:** West

CES304.059 INTER-MOUNTAIN BASINS INTERDUNAL SWALE WETLAND – *NOT MAPPED*

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Herbaceous Wetland
Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Dune (Landform); Dune field; Dune (Substrate); Temperate [Temperate Xeric]; Depressional; Isolated Wetland [Partially Isolated]; Sand Soil Texture; W-Landscape/High Intensity; Graminoid
Concept Summary: This ecological system occurs within dune fields in the intermountain western U.S. as small (usually less than 0.1 ha) interdunal wetlands that occur in wind deflation areas, where sands are scoured down to the water table. Small ponds may be associated. Water table may be perched over an impermeable layer of caliche or clay layer or, in the case of the Great Sand Dunes of Colorado, a geologic dike that creates a closed basin that traps water. These wetland areas are typically dominated by common emergent herbaceous vegetation such as species of *Eleocharis, Juncus,* and *Schoenoplectus.* Dune field ecological processes distinguish these emergent wetlands from similar non-dune wetlands.
Comments: This system was originally included within Inter-Mountain Basins Active and Stabilized Dune (CES304.775). These small-scale wetlands were pulled out into their own system because they are isolated wetlands and support completely different biota than the surrounding dry dunes. Many dune fields in the Great Basin are associated with playas and playa lakes such as Washoe Lake, Great Salt Lake, and Mono Lake. At Great Sand Dunes National Monument, Colorado, isolated interdunal swale wetlands occur where winds scour sand to expose wet sand at the water table, largely on the west side (windward) of the main dune field. The same groundwater source also feeds springs that form intermittent creeks that are not part of this interdunal swale system.

DISTRIBUTION

Range: The system occurs in some dune fields across the intermountain western U.S., including the Great Sand Dunes in southern Colorado and the Pink Coral Dunes in Utah. Interdunal wetlands may also occur in dune fields in northeastern Arizona and the Great Basin as well as in southwestern Wyoming and southern Idaho.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:?, 10:?, 11:?, 19:?, 20:C
Subnations: AZ?, CO, ID, NV, UT, WY?

CONCEPT

Associations:
- *Carex nebrascensis* Herbaceous Vegetation (CEGL001813, G4)
- *Carex utriculata* Herbaceous Vegetation (CEGL001562, G5)
- *Juncus balticus - Carex rossii* Herbaceous Vegetation (CEGL001839, G2G4)
- *Juncus balticus* Herbaceous Vegetation (CEGL001838, G5)
- *Salicornia rubra* Herbaceous Vegetation (CEGL001999, G2G3)
- *Schoenoplectus acutus* Herbaceous Vegetation (CEGL001840, G5)
- *Schoenoplectus americanus - Carex* spp. Herbaceous Vegetation (CEGL004144, GNR)
- *Schoenoplectus americanus - Eleocharis palustris* Herbaceous Vegetation (CEGL001585, G4)
- *Schoenoplectus americanus - Eleocharis* spp. Herbaceous Vegetation (CEGL001586, GNR)
- *Schoenoplectus americanus* Western Herbaceous Vegetation (CEGL001841, G3Q)
- *Schoenoplectus maritimus* Herbaceous Vegetation (CEGL001843, G4)
- *Schoenoplectus pungens* Herbaceous Vegetation (CEGL001587, G3G4)
- *Typha (latifolia, angustifolia)* Western Herbaceous Vegetation (CEGL002010, G5)
- *Typha domingensis* Western Herbaceous Vegetation (CEGL001845, G5?)

Alliances:
- *Carex (rostrata, utriculata)* Seasonally Flooded Herbaceous Alliance (A.1403)
- *Carex nebrascensis* Seasonally Flooded Herbaceous Alliance (A.1417)
- *Juncus balticus* Seasonally Flooded Herbaceous Alliance (A.1374)
- *Salicornia rubra* Seasonally Flooded Herbaceous Alliance (A.1818)
- *Schoenoplectus acutus - (Schoenoplectus tabernaemontani)* Semipermanently Flooded Herbaceous Alliance (A.1443)
- *Schoenoplectus americanus* Semipermanently Flooded Herbaceous Alliance (A.1432)
- *Schoenoplectus maritimus* Semipermanently Flooded Herbaceous Alliance (A.1444)
- *Schoenoplectus pungens* Semipermanently Flooded Herbaceous Alliance (A.1433)
- *Typha (angustifolia, latifolia) - (Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance (A.1436)
- *Typha domingensis* Seasonally Flooded Temperate Herbaceous Alliance (A.1392)

Environment: Occurs in wet interdunal swales.
Vegetation: A variety of emergent herbaceous vegetation may occur including, *Juncus balticus, Schoenoplectus pungens, Typha* spp.,
- *Cyperus* spp., *Eleocharis* spp., and *Salix exigua*.

Dynamics: The dunes are shaped by the wind and continue to change. The size and exact location of the wet swales may change as the sand dunes shift, due to active dune migration. Dune "blowouts" and subsequent stabilization through succession are characteristic processes of the active dunes which surround the interdunal swales.

SPATIAL CHARACTERISTICS

Spatial Summary: Small patch.
Adjacent Ecological System Comments: This wetland system occurs in wet swales within Inter-Mountain Basins Active and Stabilized Dune (CES304.775).

SOURCES

References: Bowers 1982, Bowers 1984, Bowers 1986, Brand and Sanderson 2002, Cooper and Severn 1992, Hammond 1998, Pineada et al. 1999, Pineda 2000, Rondeau 2001, Westem Ecology Working Group n.d.
Version: 12 May 2005 **Stakeholders:** West
Concept Author: Hammond (1998) **LeadResp:** West

CES300.729 NORTH AMERICAN ARID WEST EMERGENT MARSH

Primary Division:
Land Cover Class: Herbaceous Wetland
Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Herbaceous; Depressional [Lakeshore, Pond]; Mineral: W/ A-Horizon >10 cm; Aquatic Herb; Graminoid; Deep (>15 cm) Water; Saturated Soil
Concept Summary: This widespread ecological system occurs throughout much of the arid and semi-arid regions of western North America, typically surrounded by savanna, shrub steppe, steppe, or desert vegetation. Natural marshes may occur in depressions in the landscape (ponds, kettle ponds), as fringes around lakes, and along slow-flowing streams and rivers (such riparian marshes are also referred to as sloughs). Marshes are frequently or continually inundated, with water depths up to 2 m. Water levels may be stable, or may fluctuate 1 m or more over the course of the growing season. Water chemistry may include some alkaline or semi-alkaline situations, but the alkalinity is highly variable even within the same complex of wetlands. Marshes have distinctive soils that are typically mineral, but can also accumulate organic material. Soils have characteristics that result from long periods of anaerobic conditions in the soils (e.g., gleyed soils, high organic content, redoximorphic features). The vegetation is characterized by herbaceous plants that are adapted to saturated soil conditions. Common emergent and floating vegetation includes species of *Scirpus* and/or *Schoenoplectus, Typha, Juncus, Potamogeton, Polygonum, Nuphar,* and *Phalaris*. This system may also include areas of relatively deep water with floating-leaved plants (*Lemna, Potamogeton*, and *Brasenia*) and submergent and floating plants (*Myriophyllum, Ceratophyllum,* and *Elodea*).
Comments: This ecological system occurs in the arid and semi-arid regions of western North America, where semipermanently flooded habitats are found as small patches in the matrix of a relatively dry landscape.

DISTRIBUTION

Range: Occurs throughout much of the arid and semi-arid regions of western North America.
Divisions: 301:C, 302:C, 303:C, 304:C, 305:C, 306:C
TNC Ecoregions: 6:C, 7:C, 8:C, 9:C, 11:C, 17:C, 18:C, 19:C, 20:C, 21:C, 23:C, 24:C, 26:C, 27:C, 28:C, 29:?, 30:C, 68:C
Subnations: AB, AZ, BC, CA, CO, ID, MT, MXBC, MXCH, MXSO, ND, NE, NM, NV, OK, OR, SD, TX, UT, WA, WY

CONCEPT

Associations:
- *Calamagrostis canadensis* Western Herbaceous Vegetation (CEGL001559, G4)

- *Carex nebrascensis* Herbaceous Vegetation (CEGL001813, G4)
- *Carex utriculata* Herbaceous Vegetation (CEGL001562, G5)
- *Carex vesicaria* Herbaceous Vegetation (CEGL002661, G4Q)
- *Distichlis spicata - (Scirpus nevadensis)* Herbaceous Vegetation (CEGL001773, G4)
- *Eleocharis (montevidensis, palustris, quinqueflora)* Seasonally Flooded Herbaceous Vegetation [Placeholder] (CEGL003050, G5)
- *Glyceria borealis* Herbaceous Vegetation (CEGL001569, G4)
- *Juncus balticus - Carex rossii* Herbaceous Vegetation (CEGL001839, G2G4)
- *Juncus balticus* Herbaceous Vegetation (CEGL001838, G5)
- *Lemna* spp. Permanently Flooded Herbaceous Vegetation (CEGL003059, G3?)
- *Myriophyllum sibiricum* Herbaceous Vegetation (CEGL002000, GUQ)
- *Nuphar lutea* ssp. *polysepala* Herbaceous Vegetation (CEGL002001, G5)
- *Phalaris arundinacea* Western Herbaceous Vegetation (CEGL001474, G5)
- *Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation (CEGL001475, G5)
- *Potamogeton diversifolius* Herbaceous Vegetation (CEGL002007, G1?)
- *Potamogeton foliosus* Herbaceous Vegetation (CEGL002742, G3?)
- *Potamogeton natans* Herbaceous Vegetation (CEGL002925, G5?)
- *Ranunculus aquatilis - Callitriche palustris* Herbaceous Vegetation (CEGL001984, GU)
- *Ruppia (cirrhosa, maritima)* Permanently Flooded Herbaceous Vegetation [Placeholder] (CEGL003119, G1G3)
- *Salicornia rubra* Herbaceous Vegetation (CEGL001999, G2G3)
- *Schoenoplectus acutus - Typha latifolia - (Schoenoplectus tabernaemontani)* Sandhills Herbaceous Vegetation (CEGL002030, G4)
- *Schoenoplectus acutus* Herbaceous Vegetation (CEGL001840, G5)
- *Schoenoplectus americanus - Carex* spp. Herbaceous Vegetation (CEGL004144, GNR)
- *Schoenoplectus americanus - Eleocharis palustris* Herbaceous Vegetation (CEGL001585, G4)
- *Schoenoplectus americanus - Eleocharis* spp. Herbaceous Vegetation (CEGL001586, GNR)
- *Schoenoplectus americanus - Flaveria chlorifolia - (Helianthus paradoxus)* Herbaceous Vegetation (CEGL004592, G1)
- *Schoenoplectus americanus* Western Herbaceous Vegetation (CEGL001841, G3Q)
- *Schoenoplectus maritimus* Herbaceous Vegetation (CEGL001843, G4)
- *Schoenoplectus pungens* Herbaceous Vegetation (CEGL001587, G3G4)
- *Schoenoplectus tabernaemontani* Temperate Herbaceous Vegetation (CEGL002623, G5)
- *Sparganium angustifolium* Herbaceous Vegetation (CEGL001990, G4)
- *Sparganium eurycarpum* Herbaceous Vegetation (CEGL003323, G4)
- *Spartina gracilis* Herbaceous Vegetation (CEGL001588, GU)
- *Spartina pectinata* Western Herbaceous Vegetation (CEGL001476, G3?)
- *Stuckenia filiformis* Herbaceous Vegetation (CEGL002008, GU)
- *Triglochin maritima* Herbaceous Vegetation (CEGL001995, GU)
- *Typha (latifolia, angustifolia)* Western Herbaceous Vegetation (CEGL002010, G5)
- *Typha domingensis* Western Herbaceous Vegetation (CEGL001845, G5?)

Alliances:

- *(Potamogeton diversifolius, Stuckenia filiformis)* Permanently Flooded Herbaceous Alliance (A.1763)
- *Calamagrostis canadensis* Seasonally Flooded Herbaceous Alliance (A.1400)
- *Carex (rostrata, utriculata)* Seasonally Flooded Herbaceous Alliance (A.1403)
- *Carex nebrascensis* Seasonally Flooded Herbaceous Alliance (A.1417)
- *Carex vesicaria* Seasonally Flooded Herbaceous Alliance (A.2501)
- *Distichlis spicata* Intermittently Flooded Herbaceous Alliance (A.1332)
- *Eleocharis (montevidensis, palustris, quinqueflora)* Seasonally Flooded Herbaceous Alliance (A.1371)
- *Glyceria borealis* Semipermanently Flooded Herbaceous Alliance (A.1445)
- *Juncus balticus* Seasonally Flooded Herbaceous Alliance (A.1374)
- *Lemna* spp. Permanently Flooded Herbaceous Alliance (A.1747)
- *Myriophyllum sibiricum* Permanently Flooded Herbaceous Alliance (A.1761)
- *Nymphaea odorata - Nuphar* spp. Permanently Flooded Temperate Herbaceous Alliance (A.1984)
- *Phalaris arundinacea* Seasonally Flooded Herbaceous Alliance (A.1381)
- *Phragmites australis* Semipermanently Flooded Herbaceous Alliance (A.1431)
- *Potamogeton foliosus* Permanently Flooded Herbaceous Alliance (A.2518)
- *Potamogeton* spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Alliance (A.1754)
- *Ranunculus aquatilis* Semipermanently Flooded Herbaceous Alliance (A.1679)
- *Ruppia (cirrhosa, maritima)* Permanently Flooded Herbaceous Alliance (A.1755)
- *Salicornia rubra* Seasonally Flooded Herbaceous Alliance (A.1818)
- *Schoenoplectus acutus - (Schoenoplectus tabernaemontani)* Semipermanently Flooded Herbaceous Alliance (A.1443)
- *Schoenoplectus americanus* Semipermanently Flooded Herbaceous Alliance (A.1432)
- *Schoenoplectus maritimus* Semipermanently Flooded Herbaceous Alliance (A.1444)

- *Schoenoplectus pungens* Semipermanently Flooded Herbaceous Alliance (A.1433)
- *Sparganium angustifolium* Permanently Flooded Herbaceous Alliance (A.1760)
- *Sparganium eurycarpum* Permanently Flooded Herbaceous Alliance (A.2598)
- *Spartina gracilis* Seasonally Flooded Herbaceous Alliance (A.1407)
- *Spartina pectinata* Temporarily Flooded Herbaceous Alliance (A.1347)
- *Triglochin maritima* Semipermanently Flooded Herbaceous Alliance (A.1681)
- *Typha (angustifolia, latifolia) - (Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance (A.1436)
- *Typha domingensis* Seasonally Flooded Temperate Herbaceous Alliance (A.1392)

High-ranked species: Agelaius tricolor (G2G3), Bufo exsul (G1Q), Cyprinodon macularius (G1), Cyprinodon radiosus (G1), Cyprinodon salinus (G1Q), Sidalcea neomexicana ssp. thurberi (G4?T3T4)

SPATIAL CHARACTERISTICS

SOURCES

References: Brown 1982, Comer et al. 2003, Cooper 1986b, Dick-Peddie 1993, Faber-Langendoen et al. 1997, Hansen et al. 1995, Kittel et al. 1994, Neely et al. 2001, Padgett et al. 1989, Rondeau 2001, Szaro 1989, Ungar 1965, Ungar 1972

Version: 14 Dec 2004 **Stakeholders:** Canada, Latin America, Midwest, Southeast, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.058 NORTHERN COLUMBIA PLATEAU BASALT POTHOLE PONDS – *NOT MAPPED*

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Herbaceous Wetland

Spatial Scale & Pattern: Small patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Depressional; Impermeable Layer

Concept Summary: This system includes shallow freshwater water bodies found in small depressions gouged into basalt by Pleistocene floods. These are found throughout channeled scablands of the Columbia Plateau in Washington's eastern Columbia River Gorge. They typically occupy the bottom of a basalt cliff (1-20+ m tall) lined circular or linear depression. Characteristic shoreline vegetation lining the aquatic environment is an emergent marsh that includes species of *Scirpus* and/or *Schoenoplectus, Typha, Juncus, Potamogeton, Polygonum, Nuphar*, and *Phalaris*. This system may also include areas of relatively deep water with floating-leaved plants (*Lemna, Potamogeton*, and *Brasenia*). Woody plants, including *Populus tremuloides, Salix exigua, Crataegus douglasii*, or *Rosa woodsii*, are present adjacent to more northerly potholes. Ponds are within *Artemisia* shrub-steppe and *Pinus ponderosa* savanna or woodland. The wetland vegetation occupies a narrow zone (0.5-10 m) between open water and upland vegetation.

Comments: This may be a subset of North American Arid West Emergent Marsh (CES300.729), or it could be a freshwater aquatic system with primarily zoological species composition (amphibians and invertebrates).

DISTRIBUTION

Range: Restricted to the northern Columbia Plateau ecoregion commonly called the Columbia Basin.

Divisions: 304:C

TNC Ecoregions: 6:C, 68:P

Subnations: OR, WA

CONCEPT

Associations:

- *Carex utriculata* Herbaceous Vegetation (CEGL001562, G5)
- *Carex vesicaria* Herbaceous Vegetation (CEGL002661, G4Q)
- *Juncus balticus* Herbaceous Ve getation (CEGL001838, G5)
- *Lemna* spp. Permanently Flooded Herbaceous Vegetation (CEGL003059, G3?)
- *Nuphar lutea* ssp. *polysepala* Herbaceous Vegetation (CEGL002001, G5)
- *Phalaris arundinacea* Western Herbaceous Vegetation (CEGL001474, G5)
- *Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation (CEGL001475, G5)
- *Schoenoplectus acutus* Herbaceous Vegetation (CEGL001840, G5)
- *Schoenoplectus americanus* Western Herbaceous Vegetation (CEGL001841, G3Q)
- *Schoenoplectus maritimus* Herbaceous Vegetation (CEGL001843, G4)
- *Schoenoplectus tabernaemontani* Temperate Herbaceous Vegetation (CEGL002623, G5)
- *Typha (latifolia, angustifolia)* Western Herbaceous Vegetation (CEGL002010, G5)

Alliances:

- *Carex (rostrata, utriculata)* Seasonally Flooded Herbaceous Alliance (A.1403)
- *Carex vesicaria* Seasonally Flooded Herbaceous Alliance (A.2501)
- *Juncus balticus* Seasonally Flooded Herbaceous Alliance (A.1374)

- *Lemna* spp. Permanently Flooded Herbaceous Alliance (A.1747)
- *Nymphaea odorata - Nuphar* spp. Permanently Flooded Temperate Herbaceous Alliance (A.1984)
- *Phalaris arundinacea* Seasonally Flooded Herbaceous Alliance (A.1381)
- *Phragmites australis* Semipermanently Flooded Herbaceous Alliance (A.1431)
- *Schoenoplectus acutus - (Schoenoplectus tabernaemontani)* Semipermanently Flooded Herbaceous Alliance (A.1443)
- *Schoenoplectus americanus* Semipermanently Flooded Herbaceous Alliance (A.1432)
- *Schoenoplectus maritimus* Semipermanently Flooded Herbaceous Alliance (A.1444)
- *Typha (angustifolia, latifolia) - (Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance (A.1436)

High-ranked species: Howellia aquatilis (G3), Ivesia aperta var. aperta (G2T2)

SPATIAL CHARACTERISTICS

Size: Depressions (50-10,000 sq m)

Adjacent Ecological System Comments: Primarily Inter-Mountain Basins Big Sagebrush Steppe (CES304.778) and Columbia Plateau Scabland Shrubland (CES304.770).

SOURCES

References: Comer et al. 2003

Version: 08 Sep 2005 **Stakeholders:** West

Concept Author: R. Crawford **LeadResp:** West

CES306.812 ROCKY MOUNTAIN ALPINE-MONTANE WET MEADOW

Primary Division: Rocky Mountain (306)

Land Cover Class: Herbaceous Wetland

Spatial Scale & Pattern: Small patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Alpine/AltiAndino [Alpine/AltiAndino]; Montane [Upper Montane]; Herbaceous; Seepage-Fed Sloping [Mineral]; Depressional [Lakeshore, Pond]; Graminoid

Concept Summary: These are high-elevation communities found throughout the Rocky Mountains and Intermountain regions, dominated by herbaceous species found on wetter sites with very low-velocity surface and subsurface flows. They range in elevation from montane to alpine (1000-3600 m). These types occur as large meadows in montane or subalpine valleys, as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on sub-irrigated sites with slopes up to 10%. In alpine regions, sites typically are small depressions located below late-melting snow patches or on snowbeds. Soils of this system may be mineral or organic. In either case, soils show typical hydric soil characteristics, including high organic content and/or low chroma and redoximorphic features. This system often occurs as a mosaic of several plant associations, often dominated by graminoids, including *Calamagrostis stricta, Caltha leptosepala, Cardamine cordifolia, Carex illota, Carex microptera, Carex nigricans, Carex scopulorum, Carex utriculata, Carex vernacula, Deschampsia caespitosa, Eleocharis quinqueflora, Juncus drummondii, Phippsia algida, Rorippa alpina, Senecio triangularis, Trifolium parryi*, and *Trollius laxus*. Often alpine dwarf-shrublands, especially those dominated by *Salix*, are immediately adjacent to the wet meadows. Wet meadows are tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.

Comments: Similar systems to this one include Temperate Pacific Subalpine-Montane Wet Meadow (CES200.998) and Boreal Wet Meadow (CES103.873). The Rocky Mountain Alpine-Montane Wet Meadow (CES306.812) occurs to the east of the coastal and Sierran mountains, in the semi-arid interior regions of western North America. Boreal wet meadow systems occur further north and east in boreal regions where the climatic regime is generally colder than that of the Rockies or Pacific Northwest regions. Floristics of these three systems are somewhat similar, but there are differences related to biogeographic affinities of the species composing the vegetation.

DISTRIBUTION

Range: Found throughout the Rocky Mountains and Intermountain regions, ranging in elevation from montane to alpine (1000-3600 m).

Divisions: 304:C, 306:C

TNC Ecoregions: 7:C, 8:C, 9:C, 11:C, 18:C, 19:C, 20:C, 21:C, 22:P, 25:C, 68:C

Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, SD, UT, WA, WY

CONCEPT

Associations:

- *Betula nana / Carex* spp. Shrubland (CEGL005887, GNR)
- *Betula nana / Carex utriculata* Shrubland (CEGL001079, G4?)
- *Betula nana* / Mesic Forbs - Mesic Graminoids Shrubland (CEGL002653, G3G4)
- *Calamagrostis canadensis - Carex scopulorum - Mertensia ciliata* Herbaceous Vegetation (CEGL001560, GUQ)
- *Calamagrostis canadensis - Senecio triangularis* Herbaceous Vegetation (CEGL001561, G2Q)

- *Calamagrostis canadensis* Western Herbaceous Vegetation (CEGL001559, G4)
- *Calamagrostis stricta* Herbaceous Vegetation [Provisional] (CEGL002891, GU)
- *Caltha leptosepala - Polygonum bistortoides* Herbaceous Vegetation (CEGL001956, G2Q)
- *Caltha leptosepala - Rhodiola rhodantha* Herbaceous Vegetation (CEGL001957, GNRQ)
- *Caltha leptosepala* Herbaceous Vegetation (CEGL001954, G4)
- *Camassia cusickii* Herbaceous Vegetation (CEGL003440, G2)
- *Cardamine cordifolia - Caltha leptosepala* Herbaceous Vegetation (CEGL001958, GU)
- *Cardamine cordifolia - Mertensia ciliata - Senecio triangularis* Herbaceous Vegetation (CEGL002662, G4)
- *Carex amplifolia* Herbaceous Vegetation (CEGL003427, G3)
- *Carex aperta* Herbaceous Vegetation (CEGL001801, G1?)
- *Carex aquatilis - Carex utriculata* Herbaceous Vegetation (CEGL001803, G4)
- *Carex aquatilis - Pedicularis groenlandica* Herbaceous Vegetation (CEGL001804, GU)
- *Carex aquatilis* Herbaceous Vegetation (CEGL001802, G5)
- *Carex aquatilis* var. *dives* Herbaceous Vegetation (CEGL001826, G4)
- *Carex capillaris - Polygonum viviparum* Herbaceous Vegetation (CEGL001872, GU)
- *Carex duriuscula* Herbaceous Vegetation (CEGL001874, GUQ)
- *Carex illota* Herbaceous Vegetation (CEGL001876, GUQ)
- *Carex lachenalii* Herbaceous Vegetation (CEGL001871, GU)
- *Carex microglochin* Herbaceous Vegetation (CEGL001877, GU)
- *Carex microptera* Herbaceous Vegetation (CEGL001792, G4)
- *Carex nebrascensis - Carex microptera* Herbaceous Vegetation (CEGL001815, G3G4)
- *Carex nebrascensis - Catabrosa aquatica* Herbaceous Vegetation (CEGL001814, G1?)
- *Carex nebrascensis* Herbaceous Vegetation (CEGL001813, G4)
- *Carex nebrascensis* Slope Herbaceous Vegetation (CEGL002890, GU)
- *Carex nigricans - Juncus drummondii* Herbaceous Vegetation (CEGL001818, GU)
- *Carex nigricans - Sibbaldia procumbens* Herbaceous Vegetation (CEGL005824, G4G5)
- *Carex nigricans* Herbaceous Vegetation (CEGL001816, G4)
- *Carex pellita* Herbaceous Vegetation (CEGL001809, G3)
- *Carex praegracilis - Carex aquatilis* Herbaceous Vegetation (CEGL001821, G3)
- *Carex praegracilis* Herbaceous Vegetation (CEGL002660, G3G4)
- *Carex pyrenaica* Herbaceous Vegetation (CEGL001860, GU)
- *Carex saxatilis* Herbaceous Vegetation (CEGL001769, G3)
- *Carex scirpoidea* ssp. *pseudoscirpoidea* Herbaceous Vegetation (CEGL001865, G3?)
- *Carex scopulorum - Caltha leptosepala* Herbaceous Vegetation (CEGL001823, G4)
- *Carex scopulorum - Elymus trachycaulus* Herbaceous Vegetation (CEGL001824, GU)
- *Carex scopulorum* Herbaceous Vegetation (CEGL001822, G5)
- *Carex simulata* Herbaceous Vegetation (CEGL001825, G4)
- *Carex spectabilis - Arnica X diversifolia* Herbaceous Vegetation (CEGL005867, G3G4)
- *Carex straminiformis* Herbaceous Vegetation (CEGL001793, G3?)
- *Carex utriculata* Herbaceous Vegetation (CEGL001562, G5)
- *Carex vernacula - Poa fendleriana* Herbaceous Vegetation (CEGL001869, G2G3)
- *Carex vesicaria* Herbaceous Vegetation (CEGL002661, G4Q)
- *Dasiphora fruticosa* ssp. *floribunda / Carex* spp. Shrubland (CEGL001106, G3?)
- *Dasiphora fruticosa* ssp. *floribunda / Deschampsia caespitosa* Shrubland (CEGL001107, G4)
- *Dasiphora fruticosa* ssp. *floribunda* Shrubland [Provisional] (CEGL001105, G5?)
- *Deschampsia caespitosa - Achillea millefolium* var. *occidentalis* Herbaceous Vegetation (CEGL001880, G5)
- *Deschampsia caespitosa - Caltha leptosepala* Herbaceous Vegetation (CEGL001882, G4)
- *Deschampsia caespitosa - Carex douglasii* Herbaceous Vegetation (CEGL001602, G2)
- *Deschampsia caespitosa - Carex microptera* Herbaceous Vegetation (CEGL001883, G2G3)
- *Deschampsia caespitosa - Carex nebrascensis* Herbaceous Vegetation (CEGL001601, G3?Q)
- *Deschampsia caespitosa - Carex* spp. Herbaceous Vegetation (CEGL001603, G4Q)
- *Deschampsia caespitosa - Geum rossii* Herbaceous Vegetation (CEGL001884, G5)
- *Deschampsia caespitosa - Ligusticum tenuifolium* Herbaceous Vegetation (CEGL001885, GU)
- *Deschampsia caespitosa - Luzula multiflora* Herbaceous Vegetation (CEGL001886, G2Q)
- *Deschampsia caespitosa - Mertensia ciliata* Herbaceous Vegetation (CEGL001887, GU)
- *Deschampsia caespitosa - Phleum alpinum* Herbaceous Vegetation (CEGL001888, G3Q)
- *Deschampsia caespitosa - Potentilla diversifolia* Herbaceous Vegetation (CEGL001889, G5)
- *Deschampsia caespitosa - Symphyotrichum foliaceum* Herbaceous Vegetation (CEGL001881, G2Q)
- *Deschampsia caespitosa* Herbaceous Vegetation (CEGL001599, G4)
- *Eleocharis acicularis* Herbaceous Vegetation (CEGL001832, G4?)

- *Eleocharis palustris - Distichlis spicata* Herbaceous Vegetation (CEGL001834, G2G4)
- *Eleocharis palustris - Juncus balticus* Herbaceous Vegetation (CEGL001835, G2G4)
- *Eleocharis palustris* Herbaceous Vegetation (CEGL001833, G5)
- *Eleocharis quinqueflora - Carex scopulorum* Herbaceous Vegetation (CEGL001837, G3G4)
- *Eleocharis quinqueflora* Herbaceous Vegetation (CEGL001836, G4)
- *Eleocharis rostellata* Herbaceous Vegetation (CEGL003428, G3)
- *Equisetum arvense* Herbaceous Vegetation (CEGL003314, G5)
- *Equisetum fluviatile* Herbaceous Vegetation (CEGL002746, G4)
- *Equisetum laevigatum* Herbaceous Vegetation (CEGL002241, GNR)
- *Geum rossii - Polygonum bistortoides* Herbaceous Vegetation (CEGL001967, G4G5)
- *Geum rossii - Sibbaldia procumbens* Herbaceous Vegetation (CEGL001969, GU)
- *Glyceria borealis* Herbaceous Vegetation (CEGL001569, G4)
- *Glyceria grandis* Herbaceous Vegetation (CEGL003429, G2?)
- *Glyceria striata* Herbaceous Vegetation (CEGL000219, G3)
- *Heracleum maximum - Rudbeckia occidentalis* Herbaceous Vegetation (CEGL001940, G4)
- *Heracleum maximum* Herbaceous Vegetation (CEGL005857, G3G4)
- *Juncus balticus - Carex rossii* Herbaceous Vegetation (CEGL001839, G2G4)
- *Juncus balticus* Herbaceous Vegetation (CEGL001838, G5)
- *Juncus drummondii - Antennaria lanata* Herbaceous Vegetation (CEGL001904, G3?)
- *Juncus drummondii - Carex* spp. Herbaceous Vegetation (CEGL001905, G4)
- *Juncus parryi - Erigeron ursinus* Herbaceous Vegetation (CEGL001906, G2?)
- *Juncus parryi / Sibbaldia procumbens* Herbaceous Vegetation (CEGL005871, G3G4)
- *Phippsia algida* Herbaceous Vegetation (CEGL002892, GU)
- *Phleum alpinum - Carex aquatilis* Herbaceous Vegetation (CEGL001921, G2Q)
- *Phleum alpinum - Carex microptera* Herbaceous Vegetation (CEGL001922, G2Q)
- *Poa glauca* Herbaceous Vegetation (CEGL001926, GU)
- *Poa palustris* Herbaceous Vegetation (CEGL001659, GNA)
- *Primula parryi* Herbaceous Vegetation (CEGL001983, GNR)
- *Rhodiola rhodantha* Herbaceous Vegetation (CEGL001931, GU)
- *Rorippa alpina* Herbaceous Vegetation (CEGL002009, GU)
- *Saxifraga odontoloma* Herbaceous Vegetation (CEGL001985, GU)
- *Senecio triangularis - Mimulus guttatus* Herbaceous Vegetation (CEGL001988, G3?)
- *Senecio triangularis - Veratrum californicum* Herbaceous Vegetation (CEGL001989, G4)
- *Senecio triangularis* Herbaceous Vegetation (CEGL001987, G5?)
- *Trichophorum caespitosum - Carex livida* Herbaceous Vegetation (CEGL001842, G1)
- *Trollius laxus - Parnassia fimbriata* Herbaceous Vegetation (CEGL005858, G3?)
- *Valeriana sitchensis - Veratrum viride* Herbaceous Vegetation (CEGL001998, G4)

Alliances:

- *Betula nana* Seasonally Flooded Shrubland Alliance (A.995)
- *Calamagrostis canadensis* Seasonally Flooded Herbaceous Alliance (A.1400)
- *Calamagrostis stricta* Temporarily Flooded Herbaceous Alliance (A.2594)
- *Caltha leptosepala* Saturated Herbaceous Alliance (A.1698)
- *Camassia (cusickii, quamash)* Seasonally Flooded Herbaceous Alliance (A.2587)
- *Cardamine cordifolia* Saturated Herbaceous Alliance (A.1699)
- *Carex (lachenalii, capillaris, illota)* Seasonally Flooded Herbaceous Alliance (A.1424)
- *Carex (rostrata, utriculata)* Seasonally Flooded Herbaceous Alliance (A.1403)
- *Carex amplifolia* Saturated Herbaceous Alliance (A.2584)
- *Carex aperta* Saturated Herbaceous Alliance (A.1468)
- *Carex aquatilis* Seasonally Flooded Herbaceous Alliance (A.1404)
- *Carex aquatilis* var. *dives* Seasonally Flooded Herbaceous Alliance (A.1412)
- *Carex duriuscula* Herbaceous Alliance (A.1283)
- *Carex microglochin* Saturated Herbaceous Alliance (A.1470)
- *Carex microptera* Seasonally Flooded Herbaceous Alliance (A.1411)
- *Carex nebrascensis* Seasonally Flooded Herbaceous Alliance (A.1417)
- *Carex nigricans* Seasonally Flooded Herbaceous Alliance (A.1418)
- *Carex pellita* Seasonally Flooded Herbaceous Alliance (A.1414)
- *Carex praegracilis* Seasonally Flooded Herbaceous Alliance (A.1419)
- *Carex pyrenaica* Herbaceous Alliance (A.1320)
- *Carex saxatilis* Temporarily Flooded Herbaceous Alliance (A.1357)
- *Carex scirpoidea* ssp. *pseudoscirpoidea* Herbaceous Alliance (A.1306)

- *Carex scopulorum* Seasonally Flooded Herbaceous Alliance (A.1420)
- *Carex simulata* Saturated Herbaceous Alliance (A.1469)
- *Carex spectabilis* Herbaceous Alliance (A.1300)
- *Carex straminiformis* Herbaceous Alliance (A.1314)
- *Carex vernacula* Herbaceous Alliance (A.1309)
- *Carex vesicaria* Seasonally Flooded Herbaceous Alliance (A.2501)
- *Dasiphora fruticosa* Temporarily Flooded Shrubland Alliance (A.958)
- *Deschampsia caespitosa* Saturated Herbaceous Alliance (A.1456)
- *Deschampsia caespitosa* Seasonally Flooded Herbaceous Alliance (A.1408)
- *Deschampsia caespitosa* Temporarily Flooded Herbaceous Alliance (A.1355)
- *Eleocharis (quinqueflora, rostellata)* Saturated Herbaceous Alliance (A.1423)
- *Eleocharis acicularis* Seasonally Flooded Herbaceous Alliance (A.1421)
- *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance (A.1422)
- *Equisetum (arvense, variegatum, hyemale)* Semipermanently Flooded Herbaceous Alliance (A.3539)
- *Equisetum fluviatile* Semipermanently Flooded Herbaceous Alliance (A.1678)
- *Equisetum laevigatum* Semipermanently Flooded Herbaceous Alliance (A.2648)
- *Geum rossii* Herbaceous Alliance (A.1645)
- *Glyceria (grandis, striata)* Seasonally Flooded Herbaceous Alliance (A.2578)
- *Glyceria borealis* Semipermanently Flooded Herbaceous Alliance (A.1445)
- *Heracleum maximum* Temporarily Flooded Herbaceous Alliance (A.1661)
- *Juncus balticus* Seasonally Flooded Herbaceous Alliance (A.1374)
- *Juncus drummondii* Herbaceous Alliance (A.1324)
- *Juncus parryi* Herbaceous Alliance (A.1325)
- *Phippsia algida* Saturated Herbaceous Alliance (A.2595)
- *Phleum alpinum* Temporarily Flooded Herbaceous Alliance (A.1360)
- *Poa glauca* Temporarily Flooded Herbaceous Alliance (A.1361)
- *Poa palustris* Semi-natural Seasonally Flooded Herbaceous Alliance (A.1409)
- *Primula parryi* Temporarily Flooded Herbaceous Alliance (A.1665)
- *Rhodiola rhodantha* Temporarily Flooded Herbaceous Alliance (A.1659)
- *Rorippa alpina* Saturated Herbaceous Alliance (A.1700)
- *Saxifraga odontoloma* Temporarily Flooded Herbaceous Alliance (A.1666)
- *Senecio triangularis* Semipermanently Flooded Herbaceous Alliance (A.1680)
- *Senecio triangularis* Temporarily Flooded Herbaceous Alliance (A.1667)
- *Trichophorum caespitosum* Semipermanently Flooded Herbaceous Alliance (A.1446)
- *Trollius laxus* Saturated Herbaceous Alliance (A.2631)
- *Valeriana sitchensis* Herbaceous Alliance (A.1611)

High-ranked species: Ptilagrostis kingii (G3?), Rana pretiosa (G2), Speyeria nokomis (G3)

Environment: Moisture for these wet meadow community types is acquired from groundwater, stream discharge, overland flow, overbank flow, and on-site precipitation. Salinity and alkalinity are generally low due to the frequent flushing of moisture through the meadow. Depending on the slope, topography, hydrology, soils and substrate, intermittent, ephemeral, or permanent pools may be present. These areas may support species more representative of purely aquatic environments. Standing water may be present during some or all of the growing season, with water tables typically remaining at or near the soil surface. Fluctuations of the water table throughout the growing season are not uncommon, however. On drier sites supporting the less mesic types, the late-season water table may be one meter or more below the surface.

Soils typically possess a high proportion of organic matter, but this may vary considerably depending on the frequency and magnitude of alluvial deposition (Kittel et. al. 1998). Organic composition of the soil may include a thin layer near the soil surface or accumulations of highly sapric material of up to 120 cm thick. Soils may exhibit gleying and/or mottling throughout the profile.

Wet meadow ecological systems provide important water filtration, flow attenuation, and wildlife habitat functions.

Dynamics: Associations in this ecological system are adapted to soils that may be flooded or saturated throughout the growing season. They may also occur on areas with soils that are only saturated early in the growing season, or intermittently. Typically these associations are tolerant of moderate-intensity ground fires and late-season livestock grazing (Kovalchik 1987). Most appear to be relatively stable types, although in some areas these may be impacted by intensive livestock grazing.

SPATIAL CHARACTERISTICS

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Comer et al. 2003, Cooper 1986b, Crowe and Clausnitzer 1997, Kittel et al. 1999b, Komarkova 1976, Komarkova 1986, Kovalchik 1987, Kovalchik 1993, Manning and Padgett 1995, Meidinger and Pojar

1991, Nachlinger 1985, Nachlinger et al. 2001, Neely et al. 2001, Padgett et al. 1988a, Reed 1988, Sanderson and Kettler 1996, Shiflet 1994, Tuhy et al. 2002

Version: 14 Dec 2004 **Stakeholders:** Canada, Midwest, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.831 ROCKY MOUNTAIN SUBALPINE-MONTANE FEN

Primary Division: Rocky Mountain (306)

Land Cover Class: Herbaceous Wetland

Spatial Scale & Pattern: Small patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Moss/Lichen (Nonvascular); Seepage-Fed Sloping [Peaty]; Organic Peat (>40 cm); Graminoid; Bryophyte; Extreme (Mineral) Rich and Iron-Rich; Saturated Soil

Concept Summary: This system occurs infrequently throughout the Rocky Mountains from Colorado north into Canada. It is confined to specific environments defined by groundwater discharge, soil chemistry, and peat accumulation of at least 40 cm. This system includes extreme rich fens and iron fens, both being quite rare. Fens form at low points in the landscape or near slopes where groundwater intercepts the soil surface. Groundwater inflows maintain a fairly constant water level year-round, with water at or near the surface most of the time. Constant high water levels lead to accumulation of organic material. In addition to peat accumulation and perennially saturated soils, the extreme rich and iron fens have distinct soil and water chemistry, with high levels of one or more minerals such as calcium, magnesium, or iron. These fens usually occur as a mosaic of several plant associations dominated by *Carex aquatilis, Carex limosa, Carex lasiocarpa, Betula nana, Kobresia myosuroides, Kobresia simpliciuscula,* and *Trichophorum pumilum (= Scirpus pumilus)*. *Sphagnum* spp. (peatmoss) is indicative of iron fens. The surrounding landscape may be ringed with other wetland systems, e.g., riparian shrublands, or a variety of upland systems from grasslands to forests.

Comments: Need to clarify this system in relation to Boreal Fen system. In Montana, small fens are found in scattered locations in the plains and the small isolated mountain ranges of the central part of the state; these are included here.

DISTRIBUTION

Range: This system occurs infrequently throughout the Rocky Mountains from Colorado north into Canada. In Montana, small fens included here are found in scattered locations in the plains and the small isolated mountain ranges of the central part of the state.

Divisions: 304:C, 306:C

TNC Ecoregions: 7:C, 8:P, 9:P, 11:P, 18:C, 19:P, 20:C, 21:P, 68:P

Subnations: AB, AZ, BC, CO, ID, MT, NV, OR, UT, WA, WY

CONCEPT

Associations:

- *Betula nana / Carex* spp. Shrubland (CEGL005887, GNR)
- *Betula nana / Sphagnum* spp. Shrubland (CEGL002899, GU)
- *Carex aquatilis - Sphagnum* spp. Herbaceous Vegetation (CEGL002898, G2G3)
- *Carex buxbaumii* Herbaceous Vegetation (CEGL001806, G3)
- *Carex lasiocarpa* Herbaceous Vegetation (CEGL001810, G4?)
- *Carex limosa* Herbaceous Vegetation (CEGL001811, G2)
- *Carex simulata* Herbaceous Vegetation (CEGL001825, G4)
- *Carex utriculata* Herbaceous Vegetation (CEGL001562, G5)
- *Carex utriculata* Perched Wetland Herbaceous Vegetation (CEGL002922, G3?)
- *Dulichium arundinaceum* Seasonally Flooded Herbaceous Vegetation (CEGL001831, G3)
- *Kobresia myosuroides - Thalictrum alpinum* Herbaceous Vegetation (CEGL002900, G2)
- *Kobresia simpliciuscula - Trichophorum pumilum* Saturated Herbaceous Vegetation (CEGL002901, G2)
- *Ledum glandulosum* Shrubland [Provisional] (CEGL002739, G4)

Alliances:

- *Betula nana* Seasonally Flooded Shrubland Alliance (A.995)
- *Carex (rostrata, utriculata)* Seasonally Flooded Herbaceous Alliance (A.1403)
- *Carex aquatilis* Seasonally Flooded Herbaceous Alliance (A.1404)
- *Carex buxbaumii* Seasonally Flooded Herbaceous Alliance (A.1413)
- *Carex lasiocarpa* Seasonally Flooded Herbaceous Alliance (A.1415)
- *Carex limosa* Seasonally Flooded Herbaceous Alliance (A.1416)
- *Carex simulata* Saturated Herbaceous Alliance (A.1469)
- *Dulichium arundinaceum* Seasonally Flooded Herbaceous Alliance (A.1398)
- *Kobresia myosuroides - (Kobresia simpliciuscula)* Saturated Herbaceous Alliance (A.2504)
- *Ledum glandulosum* Saturated Shrubland Alliance (A.2514)

Environment: The montane fen ecological system is a small-patch system comprised of mountain wetlands that support a unique ecology of rare plants not found in other types of wetlands. These fens are confined to specific environments defined by groundwater

discharge, soil chemistry, and peat accumulation of at least 40 cm. Fens form at low points in the landscape or near slopes where groundwater intercepts the soil surface (Rondeau 2001). Groundwater inflows maintain a fairly constant water level year-round, with water at or near the surface most of the time. Constant high water levels lead to accumulations of organic material (Rondeau 2001).

Within the region this system occurs at montane elevations ranging from 2440-3500 m (8000-11480 feet) and is characterized by mosaics of plant communities. These communities typically occur in seeps and wet sub-irrigated meadows in narrow to broad valley bottoms. Surface topography is typically smooth to concave with slopes ranging from 0-10%. The soils within this system are organic Histosols with 40 cm or more of organic material. These Histosols range in texture from clayey-skeletal to loamy-skeletal and fine-loams. They may occur on a variety of parent materials including alluvial and colluvial deposits of granitic and gneiss origins (NatureServe 2001). The pH of wetlands within this system in generally between 4.8 and 6.0-7.0.

Dynamics: Mountain fens act as natural filters cleaning ground and surface water. Fens also act as sponges by absorbing heavy precipitation, slowly releasing it downstream, minimizing erosion and recharging groundwater systems (Windell et al. 1986). The persistent groundwater and cold temperatures allow organic matter to accumulate (forming peat) which allows classification of wetlands within this system as fens. Fens produce peat that accumulates at the rate of 8 to 11 inches per 1000 years, making peatlands a repository of 10,000 years of post glacial history (Windell et al. 1986).

SPATIAL CHARACTERISTICS

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper 1986b, Cooper and Sanderson 1997, Neely et al. 2001, Rondeau 2001, Windell et al. 1986

Version: 23 Jan 2006 **Stakeholders:** Canada, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES200.876 TEMPERATE PACIFIC FRESHWATER AQUATIC BED – *NOT MAPPED*

Primary Division:

Land Cover Class: Herbaceous Wetland

Spatial Scale & Pattern: Small patch

Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)

Diagnostic Classifiers: Herbaceous; Temperate [Temperate Continental]; Depressional [Pond]; Aquatic Herb

Concept Summary: Freshwater aquatic beds are found throughout the humid temperate regions of the Pacific Coast of North America. They are small patch in size, confined to lakes, ponds, and slow-moving portions of rivers and streams. In large bodies of water, they are usually restricted to the littoral region where penetration of light is the limiting factor for growth. A variety of rooted or floating aquatic herbaceous species may dominate, including *Azolla* spp., *Nuphar lutea, Polygonum* spp., *Potamogeton* spp., *Ranunculus* spp., and *Wolffia* spp. Submerged vegetation, such as *Myriophyllum* spp., *Ceratophyllum* spp., and *Elodea* spp., is often present. These communities occur in water too deep for emergent vegetation.

DISTRIBUTION

Range: Throughout the humid temperate regions of Pacific Coast of North America.

Divisions: 204:C, 206:C

TNC Ecoregions: 1:C, 14:C, 15:C, 69:C, 70:C, 71:C, 74:C

Subnations: AK, BC, CA, OR, WA

CONCEPT

Associations:

- *Brasenia schreberi* Herbaceous Vegetation (CEGL004527, G4?)
- *Callitriche heterophylla* Herbaceous Vegetation [Provisional] (CEGL003301, G5)
- *Elodea canadensis* Herbaceous Vegetation [Provisional] (CEGL003303, G5)
- *Fontinalis (antipyretica* var. *antipyretica, antipyretica* var. *oregonensis)* Nonvascular Vegetation (CEGL003304, G5)
- *Lemna minor* Herbaceous Vegetation (CEGL003305, G5)
- *Menyanthes trifoliata* Herbaceous Vegetation [Provisional] (CEGL003410, G5)
- *Nuphar lutea* ssp. *polysepala* Herbaceous Vegetation (CEGL002001, G5)
- *Polygonum amphibium* Permanently Flooded Herbaceous Vegetation [Placeholder] (CEGL002002, G5)
- *Ranunculus aquatilis* Herbaceous Vegetation [Provisional] (CEGL003307, G5)
- *Ranunculus lobbii* Herbaceous Vegetation [Provisional] (CEGL003308, G2)
- *Schoenoplectus subterminalis* Herbaceous Vegetation [Provisional] (CEGL003309, G3)
- *Utricularia macrorhiza* Herbaceous Vegetation [Provisional] (CEGL003310, G5)
- *Wolffia (borealis, columbiana)* Herbaceous Vegetation [Provisional] (CEGL003311, G4)

Alliances:

- *Brasenia schreberi* Permanently Flooded Herbaceous Alliance (A.1742)
- *Fontinalis* spp. Saturated Nonvascular Alliance (A.2628)

- *Lemna* spp. Permanently Flooded Herbaceous Alliance (A.1747)
- *Nymphaea odorata - Nuphar* spp. Permanently Flooded Temperate Herbaceous Alliance (A.1984)
- *Polygonum* spp. (section *Persicaria*) Seasonally Flooded Herbaceous Alliance (A.1881)

SPATIAL CHARACTERISTICS

SOURCES

References: Chappell and Christy 2004, Comer et al. 2003, Holland and Keil 1995, Shiflet 1994, Viereck et al. 1992
Version: 21 Nov 2003 **Stakeholders:** Canada, West
Concept Author: G. Kittel, P. Comer, C. Chappell, K. Boggs **LeadResp:** West

CES200.998 TEMPERATE PACIFIC SUBALPINE-MONTANE WET MEADOW

Primary Division:
Land Cover Class: Herbaceous Wetland
Spatial Scale & Pattern: Small patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Herbaceous; Muck; Graminoid; 30-180-day hydroperiod
Concept Summary: Montane and subalpine wet meadows occur in open wet depressions, basins and flats among montane and subalpine forests from California's Transverse and Peninsular ranges north to the Alaskan coastal forests at varying elevations depending on latitude. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles. They may have surface water for part of the year, but depths rarely exceed a few centimeters. Soils are mostly mineral and may show typical hydric soil characteristics, and shallow organic soils may occur as inclusions. This system often occurs as a mosaic of several plant associations with varying dominant herbaceous species that may include *Camassia quamash, Carex bolanderi, Carex utriculata, Carex exsiccata, Dodecatheon jeffreyi, Glyceria striata (= Glyceria elata), Carex nigricans, Calamagrostis canadensis, Juncus nevadensis, Caltha leptosepala ssp. howellii, Veratrum californicum,* and *Scirpus* and/or *Schoenoplectus* spp. Trees occur peripherally or on elevated microsites and include *Picea engelmannii, Abies lasiocarpa, Abies amabilis, Tsuga mertensiana,* and *Chamaecyparis nootkatensis*. Common shrubs may include *Salix* spp., *Vaccinium uliginosum, Betula nana,* and *Vaccinium macrocarpon*. Wet meadows are tightly associated with snowmelt and typically are not subjected to high disturbance events such as flooding.
Comments: Rocky Mountain Alpine-Montane Wet Meadow (CES306.812) occurs to the east of the coastal and Sierran mountains, in the semi-arid interior regions of western North America. Boreal wet meadow systems occur further north and east in boreal regions where the climatic regime is generally colder than that of the Rockies or Pacific Northwest regions. Floristics of these three systems are somewhat similar, but there are differences related to biogeographic affinities of the species composing the vegetation.

DISTRIBUTION

Range: This system is found from California's Transverse and Peninsular ranges north to the Alaskan coastal forests at varying elevations depending on latitude.
Divisions: 204:C, 206:C
TNC Ecoregions: 3:C, 4:C, 5:C, 12:C, 16:C, 69:C, 81:C
Subnations: AK, BC, CA, NV, OR, WA

CONCEPT

Associations:
- *Calamagrostis canadensis* Western Herbaceous Vegetation (CEGL001559, G4)
- *Carex amplifolia* Herbaceous Vegetation (CEGL003427, G3)
- *Carex aquatilis* Herbaceous Vegetation (CEGL001802, G5)
- *Carex lasiocarpa* Herbaceous Vegetation (CEGL001810, G4?)
- *Carex nebrascensis - Carex microptera* Herbaceous Vegetation (CEGL001815, G3G4)
- *Carex nebrascensis* Herbaceous Vegetation (CEGL001813, G4)
- *Carex nigricans - Erythronium montanum* Herbaceous Vegetation (CEGL001817, G4)
- *Carex nigricans - Luetkea pectinata* Herbaceous Vegetation (CEGL001819, G4)
- *Carex nigricans* Herbaceous Vegetation (CEGL001816, G4)
- *Carex scopulorum* Herbaceous Vegetation (CEGL001822, G5)
- *Carex simulata* Herbaceous Vegetation (CEGL001825, G4)
- *Deschampsia caespitosa* Herbaceous Vegetation (CEGL001599, G4)
- *Eleocharis acicularis* Herbaceous Vegetation (CEGL001832, G4?)
- *Eleocharis palustris* Herbaceous Vegetation (CEGL001833, G5)
- *Juncus balticus* Herbaceous Vegetation (CEGL001838, G5)
- *Senecio triangularis - Mimulus guttatus* Herbaceous Vegetation (CEGL001988, G3?)
- *Senecio triangularis - Veratrum californicum* Herbaceous Vegetation (CEGL001989, G4)
- *Vaccinium uliginosum / Deschampsia caespitosa* Dwarf-shrubland (CEGL001250, G2)

- *Veratrum californicum - Juncus nevadensis* Herbaceous Vegetation (CEGL001946, G3G4)

Alliances:

- *Calamagrostis canadensis* Seasonally Flooded Herbaceous Alliance (A.1400)
- *Carex amplifolia* Saturated Herbaceous Alliance (A.2584)
- *Carex aquatilis* Seasonally Flooded Herbaceous Alliance (A.1404)
- *Carex lasiocarpa* Seasonally Flooded Herbaceous Alliance (A.1415)
- *Carex nebrascensis* Seasonally Flooded Herbaceous Alliance (A.1417)
- *Carex nigricans* Seasonally Flooded Herbaceous Alliance (A.1418)
- *Carex scopulorum* Seasonally Flooded Herbaceous Alliance (A.1420)
- *Carex simulata* Saturated Herbaceous Alliance (A.1469)
- *Deschampsia caespitosa* Seasonally Flooded Herbaceous Alliance (A.1408)
- *Eleocharis acicularis* Seasonally Flooded Herbaceous Alliance (A.1421)
- *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance (A.1422)
- *Juncus balticus* Seasonally Flooded Herbaceous Alliance (A.1374)
- *Senecio triangularis* Semipermanently Flooded Herbaceous Alliance (A.1680)
- *Senecio triangularis* Temporarily Flooded Herbaceous Alliance (A.1667)
- *Vaccinium uliginosum* Saturated Dwarf-shrubland Alliance (A.1123)
- *Veratrum californicum* Temporarily Flooded Herbaceous Alliance (A.1663)

High-ranked species: Antennaria pulchella (G3), Arnica chamissonis var. bernardina (G5T2T3), Astragalus lentiginosus var. kernensis (G5T3?), Bufo canorus (G2), Carex sartwelliana (G3?), Carex tiogana (G1), Castilleja lasiorhyncha (G2), Cinna bolanderi (G3), Claytonia palustris (G3), Crepis runcinata ssp. andersonii (G5T3?), Delphinium hesperium ssp. cuyamacae (G4T2), Epilobium howellii (G1), Gentiana plurisetosa (G3), Ivesia unguiculata (G3), Juncus duranii (G3), Juncus macrandrus (G3G4), Lilium pardalinum ssp. shastense (G5T3T4), Lilium parryi (G3), Limnanthes montana (G3?), Lophochlaena californica var. davyi (G5T3), Lotus oblongifolius var. cupreus (G5T2), Lupinus polyphyllus ssp. bernardianus (G5T2T3), Lupinus polyphyllus var. grandifolius (G5T3?), Madia yosemitana (G2G3), Mimulus biolettii (G2G3), Mimulus exiguus (G2), Mimulus filicaulis (G2), Mimulus grayi (G3), Mimulus inconspicuus (G3), Mimulus microphyllus (G3Q), Mimulus primuloides var. linearifolius (G4T2T3), Mimulus pulchellus (G3), Mimulus purpureus (G2), Navarretia peninsularis (G3?), Packera bernardina (G2), Parnassia cirrata (G2), Perideridia parishii ssp. parishii (G4T3T4), Phacelia orogenes (G3), Phalacroseris bolanderi (G3G4), Phalacroseris bolanderi var. bolanderi (G3G4T3?), Phalacroseris bolanderi var. coronata (G3G4T2T3), Plagiobothrys distantiflorus (G3?), Plagiobothrys tener var. subglaber (G4T1T3), Plebejus podarce (G3G4), Poa atropurpurea (G2), Potentilla glandulosa ssp. ewanii (G5T1), Raillardella pringlei (G2), Rana cascadae (G3G4), Rana pretiosa (G2), Ranunculus eschscholtzii var. oxynotus (G5T3?), Rudbeckia californica var. intermedia (G4T2?), Scirpus diffusus (G3G4), Sidalcea hirsuta (G3G4), Sidalcea oregana ssp. eximia (G5T1), Sidalcea oregana ssp. hydrophila (G5T2?), Sidalcea pedata (G1), Sidalcea ranunculacea (G3?), Taraxacum californicum (G2), Thelypodium stenopetalum (G1), Thermopsis californica var. semota (G3T2), Trichophorum clementis (G3), Trifolium barbigerum var. andrewsii (G5T3?), Trifolium bolanderi (G3), Trifolium polyodon (G1Q), Veratrum fimbriatum (G3), Viola adunca var. kirkii (G5T1T3), Zigadenus fontanus (G3)

SPATIAL CHARACTERISTICS

SOURCES

References: Barbour and Major 1988, Comer et al. 2003, Holland and Keil 1995, Sawyer and Keeler-Wolf 1995, Shiflet 1994

Version: 31 Mar 2005 **Stakeholders:** Canada, West

Concept Author: P. Comer **LeadResp:** West

SPARSELY VEGETATED (NLCD 30)

CES304.081 COLUMBIA PLATEAU ASH AND TUFF BADLAND

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Barren

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland

Diagnostic Classifiers: Lowland [Lowland]; Badlands; Alkaline Soil; Silt Soil Texture; Clay Soil Texture

Concept Summary: This ecological system of the Columbia Plateau region is composed of barren and sparsely vegetated substrates (<10% plant cover) typically derived from highly eroded volcanic ash and tuff. Landforms are typically rounded hills and plains that form a rolling topography. The harsh soil properties and high rate of erosion and deposition are driving environmental variables supporting sparse dwarf-shrubs and forbs. Characteristic species include *Grayia spinosa, Artemisia tridentata, Salvia dorrii, Achnatherum* sp.,

- *Eriogonum* sp., *Sarcobatus vermiculatus, Purshia tridentata,* and *Atriplex confertifolia*. Characteristic forbs are short-lived annuals, including *Cleome, Mentzelia, Camissonia,* and *Mimulus* species, although these habitats often support endemic perennial forbs.

Comments: Associations assigned to this system are not well-classified, but as many support G1 and G2 plant taxa, they are well sampled.

DISTRIBUTION

Range: This system is found on the Columbia Plateau of southern Idaho west into southern Oregon, northern Nevada, and extreme northeastern California.
Divisions: 304:C
TNC Ecoregions: 4:P, 6:C
Subnations: CA, ID, NV, OR, WA?

CONCEPT

Associations:
- *Achnatherum hymenoides* Shale Barren Herbaceous Vegetation (CEGL001651, G2)
- *Artemisia tridentata* ssp. *wyomingensis - Atriplex confertifolia* Shrubland (CEGL001040, G3G5)
- *Salvia dorrii / Pseudoroegneria spicata* Dwarf-shrubland (CEGL001453, G4)

Alliances:
- *Achnatherum hymenoides* Herbaceous Alliance (A.1262)
- *Artemisia tridentata* ssp. *wyomingensis* Shrubland Alliance (A.832)
- *Salvia dorrii* Dwarf-shrubland Alliance (A.1129)

SPATIAL CHARACTERISTICS

SOURCES

References: Western Ecology Working Group n.d.
Version: 08 Sep 2004 **Stakeholders:** West
Concept Author: J. Kagan **LeadResp:** West

CES304.775 INTER-MOUNTAIN BASINS ACTIVE AND STABILIZED DUNE

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Barren
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Dune (Landform); Dune field; Dune (Substrate); Temperate [Temperate Continental]; Sand Soil Texture; Aridic; W-Landscape/High Intensity
Concept Summary: This ecological system occurs in Intermountain West basins and is composed of unvegetated to moderately vegetated (<10-30% plant cover), active and stabilized dunes and sandsheets. Species occupying these environments are often adapted to shifting, coarse-textured substrates (usually quartz sand) and form patchy or open grasslands, shrublands or steppe, and occasionally woodlands. Vegetation varies and may be composed of *Achnatherum hymenoides, Artemisia filifolia, Artemisia tridentata ssp. tridentata, Atriplex canescens, Ephedra* spp., *Coleogyne ramosissima, Ericameria nauseosa, Leymus flavescens, Psoralidium lanceolatum, Purshia tridentata, Redfieldia flexuosa, Sporobolus airoides, Sarcobatus vermiculatus, Tetradymia tetrameres,* or *Tiquilia* spp. In the Centennial Valley of southwestern Montana, where the dunes are more stable, *Artemisia tridentata ssp. tridentata* and *Artemisia tripartita ssp. tripartita* can have moderate cover and are associated with *Hesperostipa comata* or *Festuca idahoensis* (in more mesic settings). Early-seral communities in these dunes are dominated by *Ericameria nauseosa* and *Hesperostipa comata*. Several rare plant species occur in the Centennial Valley dunes, and are associated with early-successional stages. These dunes are very similar to the St. Anthony dunes in Idaho.

DISTRIBUTION

Range: This system occurs in intermountain basins of the western U.S. including southwestern Montana in the Centennial Valley.
Divisions: 304:C, 306:C
TNC Ecoregions: 6:C, 8:C, 10:C, 11:C, 19:C
Subnations: AZ, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Achnatherum hymenoides - Psoralidium lanceolatum* Herbaceous Vegetation (CEGL001650, G3Q)
- *Achnatherum hymenoides - Sporobolus contractus* Herbaceous Vegetation (CEGL001652, G2G4)
- *Artemisia filifolia - Ephedra (torreyana, viridis)* Shrubland (CEGL002786, GNR)
- *Elymus lanceolatus - Phacelia hastata* Herbaceous Vegetation (CEGL001745, G2)
- *Ephedra cutleri* Shrubland [Provisional] (CEGL005804, GNR)

- *Ephedra torreyana - Achnatherum hymenoides* Hummock Shrubland (CEGL005802, GNR)
- *Ericameria nauseosa / Leymus flavescens / Psoralidium lanceolatum* Shrubland (CEGL001329, G1?)
- *Ericameria nauseosa* Sand Deposit Sparse Shrubland (CEGL002980, GNR)
- *Eriogonum leptocladon* Sparse Vegetation (CEGL002822, GNR)
- *Leymus flavescens* Herbaceous Vegetation (CEGL001563, G2)
- *Pinus ponderosa / Achnatherum hymenoides* Sparse Vegetation (CEGL001490, G1)
- *Populus angustifolia* Sand Dune Forest (CEGL002643, G1)
- *Psorothamnus polydenius* var. *polydenius / Achnatherum hymenoides* Shrubland (CEGL001353, G3G4)
- *Purshia tridentata - Artemisia tridentata* ssp. *tridentata* Shrubland (CEGL001054, G1)
- *Purshia tridentata - Ericameria nauseosa* Shrubland (CEGL001056, G1)
- *Purshia tridentata / Achnatherum hymenoides* Shrubland (CEGL001058, G1)
- *Purshia tridentata / Prunus virginiana* Shrubland (CEGL001060, G1?)
- *Quercus havardii* var. *tuckeri* Shrubland (CEGL002486, GNR) Redbeds (Siltstone, Sandstone, Gypsum) Sparse Vegetation (CEGL005261, GNR)
- *Redfieldia flexuosa - (Psoralidium lanceolatum)* Herbaceous Vegetation (CEGL002917, G1?)
- *Sarcobatus vermiculatus* Dune Shrubland (CEGL001364, G5?)
- *Tetradymia tetrameres* Dune Sparse Vegetation (CEGL002759, G3Q)

Alliances:

- *Achnatherum hymenoides* Herbaceous Alliance (A.1262)
- *Artemisia filifolia* Shrubland Alliance (A.816)
- *Elymus lanceolatus* Herbaceous Alliance (A.1242)
- *Ephedra cutleri* Shrubland Alliance [Provisional] (A.2644)
- *Ephedra torreyana* Shrubland Alliance (A.2572)
- *Ericameria nauseosa* Shrubland Alliance (A.835)
- *Leymus flavescens* Herbaceous Alliance (A.1237)
- *Pinus ponderosa* Sparsely Vegetated Alliance (A.1859)
- *Populus angustifolia* Temporarily Flooded Forest Alliance (A.310)
- *Psorothamnus polydenius* Shrubland Alliance (A.1039)
- *Purshia tridentata* Shrubland Alliance (A.825)
- *Quercus havardii* var. *tuckeri* Shrubland Alliance (A.2654)
- *Redfieldia flexuosa* Herbaceous Alliance (A.2505)
- *Sarcobatus vermiculatus* Shrubland Alliance (A.1041)
- *Tetradymia tetrameres* Sparsely Vegetated Alliance (A.2525)
- Painted Desert Sparsely Vegetated Alliance (A.2545)
- Rock Outcrop Sparsely Vegetated Alliance (A.1838)

SPATIAL CHARACTERISTICS

SOURCES

References: Anderson 1999a, Bowers 1982, Caicco and Wellner 1983e, Comer et al. 2003, Fryberger et al. 1990, Knight 1994, Pineada et al. 1999

Version: 20 Apr 2006 **Stakeholders:** West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.779 INTER-MOUNTAIN BASINS CLIFF AND CANYON

Primary Division: Inter-Mountain Basins (304)

Land Cover Class: Barren

Spatial Scale & Pattern: Large patch

Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland

Diagnostic Classifiers: Cliff (Landform); Rock Outcrops/Barrens/Glades

Concept Summary: This ecological system is found from foothill to subalpine elevations and includes barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. Also included is vegetation of unstable scree and talus slopes that typically occurs below cliff faces. Widely scattered trees and shrubs may include *Abies concolor, Pinus edulis, Pinus flexilis, Pinus monophylla, Juniperus* spp., *Artemisia tridentata, Purshia tridentata, Cercocarpus ledifolius, Ephedra* spp., *Holodiscus discolor,* and other species often common in adjacent plant communities.

DISTRIBUTION

Divisions: 304:C

TNC Ecoregions: 4:?, 6:C, 11:C, 18:C

Subnations: CA, ID, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Cercocarpus intricatus* Montane Shrubland (CEGL002587, GNR)
- *Cercocarpus intricatus* Slickrock Sparse Vegetation (CEGL002977, GNR)
- *Cercocarpus montanus* Rock Pavement Sparse Vegetation (CEGL002978, GNR)
- *Chrysothamnus viscidiflorus* Talus Shrubland (CEGL002347, GNR)
- *Crataegus rivularis* Shrubland (CEGL002889, G2Q)
- *Glossopetalon spinescens* var. *aridum / Pseudoroegneria spicata* Shrubland (CEGL001100, G4)
- *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733, GNR)
- *Leymus salinus* Shale Sparse Vegetation (CEGL002745, GNR)
- *Pinus monophylla - Juniperus osteosperma* / Sparse Understory Woodland (CEGL000829, G5)
- *Pinus ponderosa* Slickrock Sparse Vegetation (CEGL002972, GNR)

Alliances:
- *Cercocarpus intricatus* Shrubland Alliance (A.2659)
- *Cercocarpus intricatus* Sparsely Vegetated Alliance (A.2543)
- *Cercocarpus montanus* Sparsely Vegetated Alliance (A.2544)
- *Chrysothamnus viscidiflorus* Shrubland Alliance (A.2651)
- *Crataegus rivularis* Temporarily Flooded Shrubland Alliance (A.2597)
- *Glossopetalon spinescens* Shrubland Alliance (A.1032)
- *Juniperus osteosperma* Woodland Alliance (A.536)
- *Leymus salinus* Sparsely Vegetated Alliance (A.1258)
- *Pinus monophylla - (Juniperus osteosperma)* Woodland Alliance (A.543)
- Wooded Bedrock Sparsely Vegetated Alliance (A.2546)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Knight 1994
Version: 20 Feb 2003 **Stakeholders:** Midwest, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.786 INTER-MOUNTAIN BASINS PLAYA

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Barren
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland; Wetland
Diagnostic Classifiers: Lowland [Lowland]; Playa; Temperate [Temperate Xeric]; Depressional; Alkaline Soil; Saline Substrate Chemistry; Aridic; Alkaline Water; Saline Water Chemistry; Caliche Layer; Impermeable Layer; Intermittent Flooding
Concept Summary: This ecological system is composed of barren and sparsely vegetated playas (generally <10% plant cover) found in the intermountain western U.S. Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. These systems are intermittently flooded. The water is prevented from percolating through the soil by an impermeable soil subhorizon and is left to evaporate. Soil salinity varies greatly with soil moisture and greatly affects species composition. Characteristic species may include *Allenrolfea occidentalis, Sarcobatus vermiculatus, Grayia spinosa, Puccinellia lemmonii, Leymus cinereus, Distichlis spicata*, and/or *Atriplex* spp.
Comments: Bjork (1997) refers to these as vernal lakes in Washington; his one example was ditched and may be artificial. There might have been these in Grand Coulee prior to Columbia Basin irrigation project.

DISTRIBUTION

Range: This system occurs throughout the Intermountain western U.S., extending east into the southwestern Great Plains.
Divisions: 304:C
TNC Ecoregions: 6:C, 10:C, 11:C, 19:C
Subnations: CA, CO, ID, NM, NV, OR, UT, WA?, WY

CONCEPT

Associations:
- *(Sarcocornia utahensis) - (Arthrocnemum subterminale)* Seasonally Flooded Herbaceous Vegetation [Placeholder] (CEGL003120, GNR)
- *Allenrolfea occidentalis / Atriplex gardneri* Shrubland (CEGL000989, G4?)
- *Allenrolfea occidentalis* Shrubland (CEGL000988, G3)

- *Artemisia papposa / Danthonia californica - Festuca idahoensis* Shrubland (CEGL002991, GNR)
- *Atriplex spinifera* Shrubland [Placeholder] (CEGL003015, G3?)
- *Chrysothamnus albidus / Puccinellia nuttalliana* Shrubland (CEGL001328, G3)
- *Distichlis spicata - (Scirpus nevadensis)* Herbaceous Vegetation (CEGL001773, G4)
- *Distichlis spicata - Lepidium perfoliatum* Herbaceous Vegetation (CEGL001772, GNA)
- *Distichlis spicata* Herbaceous Vegetation (CEGL001770, G5)
- *Distichlis spicata* Mixed Herb Herbaceous Vegetation (CEGL001771, G3G5)
- *Hordeum jubatum* Herbaceous Vegetation (CEGL001798, G4)
- *Krascheninnikovia lanata / Poa secunda* Dwarf-shrubland (CEGL001326, G3)
- *Leymus cinereus - Distichlis spicata* Herbaceous Vegetation (CEGL001481, G3)
- *Leymus cinereus - Pascopyrum smithii* Herbaceous Vegetation (CEGL001483, G3Q)
- *Leymus cinereus* Bottomland Herbaceous Vegetation (CEGL001480, G1)
- *Leymus triticoides - Carex* spp. Herbaceous Vegetation (CEGL001571, G4?)
- *Leymus triticoides - Poa secunda* Herbaceous Vegetation (CEGL001572, G2)
- *Pluchea sericea* Seasonally Flooded Shrubland [Placeholder] (CEGL003080, G3?)
- *Poa secunda - Muhlenbergia richardsonis* Herbaceous Vegetation (CEGL002755, GNR)
- *Puccinellia lemmonii - Poa secunda* Seasonally Flooded Herbaceous Vegetation (CEGL001658, G1)
- *Sarcobatus vermiculatus - Atriplex parryi / Distichlis spicata* Shrubland (CEGL002764, GNR)
- *Sarcobatus vermiculatus - Psorothamnus polydenius* Shrubland (CEGL002763, GNR)
- *Sarcobatus vermiculatus / Achnatherum hymenoides* Shrubland (CEGL001373, G4)
- *Sarcobatus vermiculatus / Artemisia tridentata* Shrubland (CEGL001359, G4)
- *Sarcobatus vermiculatus / Atriplex confertifolia - (Picrothamnus desertorum, Suaeda moquinii)* Shrubland (CEGL001371, G5?)
- *Sarcobatus vermiculatus / Distichlis spicata* Shrubland (CEGL001363, G4)
- *Sarcobatus vermiculatus / Elymus elymoides - Pascopyrum smithii* Shrubland (CEGL001365, G2?)
- *Sarcobatus vermiculatus / Elymus elymoides* Shrubland (CEGL001372, G4)
- *Sarcobatus vermiculatus / Ericameria nauseosa* Shrubland (CEGL001362, G5)
- *Sarcobatus vermiculatus / Leymus cinereus* Shrubland (CEGL001366, G3)
- *Sarcobatus vermiculatus / Nitrophila occidentalis - Suaeda moquinii* Shrubland (CEGL001369, G5?)
- *Sarcobatus vermiculatus / Pascopyrum smithii - (Elymus lanceolatus)* Shrub Herbaceous Vegetation (CEGL001508, G4)
- *Sarcobatus vermiculatus / Sporobolus airoides* Sparse Vegetation (CEGL001368, G3?)
- *Sarcobatus vermiculatus* Shrubland (CEGL001357, G5)
- *Spartina gracilis* Herbaceous Vegetation (CEGL001588, GU)
- *Sporobolus airoides - Distichlis spicata* Herbaceous Vegetation (CEGL001687, G4?)
- *Suaeda moquinii* Shrubland (CEGL001991, G5)

Alliances:

- *(Sarcocornia utahensis) - (Arthrocnemum subterminale)* Semipermanently Flooded Herbaceous Alliance (A.1676)
- *Allenrolfea occidentalis* Shrubland Alliance (A.866)
- *Artemisia papposa* Shrubland Alliance (A.2551)
- *Atriplex spinifera* Shrubland Alliance (A.865)
- *Chrysothamnus albidus* Shrubland Alliance (A.834)
- *Distichlis spicata* Intermittently Flooded Herbaceous Alliance (A.1332)
- *Hordeum jubatum* Temporarily Flooded Herbaceous Alliance (A.1358)
- *Krascheninnikovia lanata* Dwarf-shrubland Alliance (A.1104)
- *Leymus cinereus* Herbaceous Alliance (A.1204)
- *Leymus cinereus* Intermittently Flooded Herbaceous Alliance (A.1329)
- *Leymus triticoides* Temporarily Flooded Herbaceous Alliance (A.1353)
- *Pluchea sericea* Seasonally Flooded Shrubland Alliance (A.798)
- *Poa secunda* Seasonally Flooded Herbaceous Alliance (A.1410)
- *Sarcobatus vermiculatus* Intermittently Flooded Shrub Herbaceous Alliance (A.1554)
- *Sarcobatus vermiculatus* Intermittently Flooded Shrubland Alliance (A.1046)
- *Sarcobatus vermiculatus* Intermittently Flooded Sparsely Vegetated Alliance (A.1877)
- *Spartina gracilis* Seasonally Flooded Herbaceous Alliance (A.1407)
- *Sporobolus airoides* Intermittently Flooded Herbaceous Alliance (A.1331)
- *Suaeda moquinii* Intermittently Flooded Shrubland Alliance (A.941)

High-ranked species: Atriplex spinifera (G3?), Gratiola heterosepala (G3), Lepidium davisii (G3), Phacelia inundata (G2), Phacelia parishii (G2G3), Pseudocopaeodes eunus (G3G4), Rorippa calycina (G3), Sidalcea covillei (G3), Sisyrinchium funereum (G2G3)

SPATIAL CHARACTERISTICS

SOURCES

References: Bjork 1997, Comer et al. 2003, Knight 1994, Nachlinger et al. 2001

Version: 14 Dec 2004 **Stakeholders:** West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.791 INTER-MOUNTAIN BASINS VOLCANIC ROCK AND CINDER LAND

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Barren
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Cinder cone; Lava flow (undifferentiated); Lava; Cinder; Basalt; Temperate [Temperate Continental]
Concept Summary: This ecological system occurs in the intermountain western U.S. and is limited to barren and sparsely vegetated volcanic substrates (generally <10% plant cover) such as basalt lava (malpais), basalt dikes with associated colluvium, basalt cliff faces and uplifted "backbones," tuff, cinder cones or cinder fields. It may occur as large-patch, small-patch and linear (dikes) spatial patterns. Vegetation is variable and includes a variety of species depending on local environmental conditions, e.g., elevation, age and type of substrate. At montane and foothill elevations scattered *Pinus ponderosa, Pinus flexilis*, or *Juniperus* spp. trees may be present. Shrubs such as *Ephedra* spp., *Atriplex canescens, Eriogonum corymbosum, Eriogonum ovalifolium,* and *Fallugia paradoxa* are often present on some lava flows and cinder fields. Species typical of sand dunes such as *Andropogon hallii* and *Artemisia filifolia* may be present on cinder substrates.

DISTRIBUTION

Range: This system occurs in the Intermountain western U.S. and is limited to barren and sparsely vegetated volcanic substrates. It occurs in Montana along the Rocky Mountain Front (east of the Continental Divide).
Divisions: 304:C
TNC Ecoregions: 4:C, 6:C, 8:C, 9:C, 11:C, 18:C, 19:C, 20:C, 21:C
Subnations: AZ, ID, MT, NM, NV, OR, UT

CONCEPT

Associations:
- *Andropogon hallii* Colorado Plateau Herbaceous Vegetation (CEGL002785, GNR)
- *Artemisia filifolia - Ephedra (torreyana, viridis)* Shrubland (CEGL002786, GNR)
- *Artemisia tridentata* ssp. *vaseyana / Poa secunda* Shrubland (CEGL001029, G3)
- *Ephedra nevadensis* Basalt Shrubland [Provisional] (CEGL002936, GNR)
- *Eriogonum corymbosum* Cinder Sparse Vegetation (CEGL005803, GNR)
- *Eriogonum fasciculatum* Rock Outcrop Shrubland (CEGL001260, G5?)
- *Eriogonum ovalifolium* var. *depressum* Dwarf-shrubland (CEGL001401, G1)
- *Fallugia paradoxa - (Atriplex canescens, Ephedra torreyana)* Cinder Shrubland (CEGL005806, GNR)
- *Juniperus monosperma* Cinder Wooded Herbaceous Vegetation (CEGL005807, GNR)
- *Pinus flexilis / Purshia tridentata* Woodland (CEGL000814, G1?)
- *Pinus ponderosa - (Populus tremuloides) / Fallugia paradoxa - (Holodiscus dumosus)* Lava Bed Sparse Vegetation (CEGL002929, GNR)
- *Pinus ponderosa / Andropogon hallii* Woodland (CEGL005808, GNR)
- *Pinus ponderosa* / Cinder Woodland (CEGL002998, GNR)
- *Purshia tridentata / Pseudoroegneria spicata - Leymus cinereus* Shrub Herbaceous Vegetation (CEGL001497, G1?)
- *Tiquilia latior / Sporobolus airoides* Dwarf-shrubland [Provisional] (CEGL005809, GNR)

Alliances:
- *Andropogon hallii* Herbaceous Alliance (A.1193)
- *Artemisia filifolia* Shrubland Alliance (A.816)
- *Artemisia tridentata* ssp. *vaseyana* Shrubland Alliance (A.831)
- *Ephedra nevadensis* Shrubland Alliance (A.857)
- *Eriogonum corymbosum* Sparsely Vegetated Alliance (A.2573)
- *Eriogonum fasciculatum* Shrubland Alliance (A.868)
- *Eriogonum ovalifolium* var. *depressum* Dwarf-shrubland Alliance (A.1082)
- *Fallugia paradoxa* Shrubland Alliance (A.2575)
- *Juniperus monosperma* Wooded Herbaceous Alliance (A.2576)
- *Pinus flexilis* Woodland Alliance (A.540)
- *Pinus ponderosa* Woodland Alliance (A.530)
- *Purshia tridentata* Shrub Tall Herbaceous Alliance (A.1517)
- *Tiquilia hispidissima* Dwarf-shrubland Alliance (A.1101)
- Aa Lava Bed Sparsely Vegetated Alliance (A.2569)

Dynamics: This ecological system is relatively young (geologically speaking). Lichens are the primary erosion process in this system and therefore soil buildup is a slow process. Lichens are susceptible to changes in air quality (Brodo et. al. 2001) and are considered a good indication of the health of air quality.

SPATIAL CHARACTERISTICS

SOURCES

References: Barbour and Billings 2000, Comer et al. 2003, Day and Wright 1985, Hansen et al. 2004c, Tisdale et al. 1965
Version: 23 Jan 2006 **Stakeholders:** West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES304.781 INTER-MOUNTAIN BASINS WASH

Primary Division: Inter-Mountain Basins (304)
Land Cover Class: Barren
Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland; Wetland
Diagnostic Classifiers: Lowland [Lowland]; Shrubland (Shrub-dominated); Wash; Toeslope/Valley Bottom; Riverine / Alluvial; Alkaline Soil; Xeromorphic Shrub; Sarcobatus vermiculatus
Concept Summary: This barren and sparsely vegetated (generally <10% plant cover) ecological system is restricted to intermittently flooded streambeds and banks that are often lined with shrubs such as *Sarcobatus vermiculatus, Ericameria nauseosa, Fallugia paradoxa*, and/or *Artemisia cana ssp. cana* (in more northern and mesic stands). *Grayia spinosa* may dominate in the Great Basin. Shrubs form a continuous or intermittent linear canopy in and along drainages but do not extend out into flats. Typically it includes patches of saltgrass meadow where water remains for the longest periods. Soils are generally less alkaline than those found in the playa system. Desert scrub species (e.g., *Acacia greggii, Prosopis* spp.), that are common in the Mojave, Sonoran and Chihuahuan desert washes, are not present. This type can occur in limited portions of the southwestern Great Plains.
Comments: Compare with Inter-Mountain Basins Greasewood Flat (CES304.780); should it include nonsparse shrublands? Invasive, exotic shrubs shrub as *Tamarix* spp. or *Chamaebatiaria millefolium* may be present to dominant in these washes where disturbed.

DISTRIBUTION

Range: This system occurs throughout the Intermountain western U.S. extending east into the western Great Plains.
Divisions: 303:C, 304:C, 306:C
TNC Ecoregions: 4:C, 6:C, 8:C, 9:C, 10:C, 11:C, 19:C, 20:C, 26:C
Subnations: AZ, CA, CO, ID, MT, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Distichlis spicata - (Scirpus nevadensis)* Herbaceous Vegetation (CEGL001773, G4)
- *Distichlis spicata - Lepidium perfoliatum* Herbaceous Vegetation (CEGL001772, GNA)
- *Distichlis spicata* Herbaceous Vegetation (CEGL001770, G5)
- *Distichlis spicata* Mixed Herb Herbaceous Vegetation (CEGL001771, G3G5)
- *Ericameria nauseosa / Bromus tectorum* Semi-natural Shrubland (CEGL002937, GNR)
- *Ericameria nauseosa* Desert Wash Shrubland (CEGL002261, GNR)
- *Fraxinus anomala* Woodland (CEGL002752, GUQ)
- *Grayia spinosa / Poa secunda* Shrubland (CEGL001351, G1)
- *Hordeum brachyantherum* Herbaceous Vegetation (CEGL003430, G2)
- *Leymus cinereus - Pascopyrum smithii* Herbaceous Vegetation (CEGL001483, G3Q)
- *Sarcobatus vermiculatus - Atriplex parryi / Distichlis spicata* Shrubland (CEGL002764, GNR)
- *Sarcobatus vermiculatus - Psorothamnus polydenius* Shrubland (CEGL002763, GNR)
- *Sarcobatus vermiculatus / Achnatherum hymenoides* Shrubland (CEGL001373, G4)
- *Sarcobatus vermiculatus / Atriplex confertifolia - (Picrothamnus desertorum, Suaeda moquinii)* Shrubland (CEGL001371, G5?)
- *Sarcobatus vermiculatus / Atriplex gardneri* Shrubland (CEGL001360, G4?)
- *Sarcobatus vermiculatus / Distichlis spicata* Shrubland (CEGL001363, G4)
- *Sarcobatus vermiculatus / Elymus elymoides - Pascopyrum smithii* Shrubland (CEGL001365, G2?)
- *Sarcobatus vermiculatus / Elymus elymoides* Shrubland (CEGL001372, G4)
- *Sarcobatus vermiculatus / Ericameria nauseosa* Shrubland (CEGL001362, G5)
- *Sarcobatus vermiculatus / Leymus cinereus* Shrubland (CEGL001366, G3)
- *Sarcobatus vermiculatus / Nitrophila occidentalis - Suaeda moquinii* Shrubland (CEGL001369, G5?)
- *Sarcobatus vermiculatus / Pascopyrum smithii - (Elymus lanceolatus)* Shrub Herbaceous Vegetation (CEGL001508, G4)
- *Sarcobatus vermiculatus / Sporobolus airoides* Sparse Vegetation (CEGL001368, G3?)
- *Sarcobatus vermiculatus / Suaeda moquinii* Shrubland (CEGL001370, GUQ)
- *Sarcobatus vermiculatus* Shrubland (CEGL001357, G5)

Alliances:
- *Distichlis spicata* Intermittently Flooded Herbaceous Alliance (A.1332)
- *Ericameria nauseosa* Shrubland Alliance (A.835)
- *Fraxinus anomala* Temporarily Flooded Woodland Alliance (A.2511)
- *Grayia spinosa* Shrubland Alliance (A.1038)
- *Hordeum brachyantherum* Temporarily Flooded Herbaceous Alliance (A.2585)
- *Leymus cinereus* Herbaceous Alliance (A.1204)
- *Sarcobatus vermiculatus* Intermittently Flooded Shrub Herbaceous Alliance (A.1554)
- *Sarcobatus vermiculatus* Intermittently Flooded Shrubland Alliance (A.1046)
- *Sarcobatus vermiculatus* Intermittently Flooded Sparsely Vegetated Alliance (A.1877)

SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Knight 1994, Shiflet 1994, West 1983b
Version: 05 Oct 2004 **Stakeholders:** Midwest, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES300.728 NORTH AMERICAN ALPINE ICE FIELD

Primary Division:
Land Cover Class: Barren
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Alpine/AltiAndino [Alpine/AltiAndino]; Ice Fields / Glaciers; Glaciated; Alpine Slopes
Concept Summary: This widespread ecological system is composed of unvegetated landscapes of annual/perennial ice and snow at the highest elevations, where snowfall accumulation exceeds melting. The primary ecological processes include snow/ice retention, wind desiccation, and permafrost. The snowpack/ice field never melts or, if so, then for only a few weeks. The alpine substrate/ice field ecological system is part of the alpine mosaic consisting of alpine bedrock and scree, tundra dry meadow, wet meadow, fell-fields, and dwarf-shrubland.
Comments: The barren rock and rubble within the glaciers is part of this system, not the alpine rock and scree systems.

DISTRIBUTION

Range: This ecological system is found throughout North America where altitude results in permanent ice and snow fields, from the mountains of Alaska south and east through the cordillera of the Cascades and the Rocky Mountains.
Divisions: 104:C, 105:C, 204:C, 306:C
TNC Ecoregions: 3:C, 7:C, 9:C, 20:C, 69:C, 70:C, 71:P, 76:C, 77:P, 78:C, 79:C
Subnations: AB, AK, BC, CO, ID, MT, OR, WA, WY

CONCEPT

Associations:
Alliances:
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SPATIAL CHARACTERISTICS

SOURCES

References: Comer et al. 2003, Meidinger and Pojar 1991, Neely et al. 2001
Version: 04 Apr 2005 **Stakeholders:** Canada, Midwest, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.809 ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE

Primary Division: Rocky Mountain (306)
Land Cover Class: Barren
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Alpine/AltiAndino [Alpine/AltiAndino]; Talus (Substrate); Rock Outcrops/Barrens/Glades; Oligotrophic Soil; Very Shallow Soil; Alpine Slopes
Concept Summary: This ecological system is restricted to the highest elevations of the Rocky Mountains, from Alberta and British Columbia south into New Mexico, west into the highest mountain ranges of the Great Basin. It is composed of barren and sparsely vegetated alpine substrates, typically including both bedrock outcrop and scree slopes, with nonvascular- (lichen) dominated

communities. Exposure to desiccating winds, rocky and sometimes unstable substrates, and a short growing season limit plant growth. There can be sparse cover of forbs, grasses, lichens and low shrubs.

DISTRIBUTION

Range: Restricted to the highest elevations of the Rocky Mountains, from Alberta and British Columbia south into New Mexico, west into the highest mountain ranges of the Great Basin.
Divisions: 304:C, 306:C
TNC Ecoregions: 7:C, 8:C, 9:C, 11:C, 19:C, 20:C, 21:C, 68:C
Subnations: AB, AZ, BC, CO, ID, MT, NM, NV, OR, UT, WA, WY

CONCEPT

Associations:
- *Aquilegia caerulea - Cirsium scopulorum* Scree Sparse Vegetation (CEGL001938, GU)
- *Aquilegia flavescens - Senecio megacephalus* Sparse Vegetation (CEGL005899, G2G3)
- *Athyrium americanum - Cryptogramma acrostichoides* Sparse Vegetation (CEGL005900, G2G3)
- *Cirsium scopulorum - Polemonium viscosum* Herbaceous Vegetation (CEGL001959, GU)
- *Claytonia megarhiza* Herbaceous Vegetation (CEGL001878, GU)
- *Ivesia cryptocaulis* Alpine Sparse Vegetation (CEGL002735, G1)
- *Phacelia hastata - (Penstemon ellipticus*) Sparse Vegetation (CEGL005901, G2G3)
- *Polemonium viscosum* Herbaceous Vegetation (CEGL001928, G3G4)
- *Saxifraga bronchialis* Scree Slope Sparse Vegetation (CEGL005902, G3?)
- *Saxifraga mertensiana* Cliff Crevice Sparse Vegetation (CEGL005903, G2?)
- *Senecio taraxacoides - Oxyria digyna* Herbaceous Vegetation (CEGL001932, GU) Sparse Nonvascular Vegetation (on rock and unconsolidated substrates) (CEGL002888, GNR)

Alliances:
- *Aquilegia (caerulea, flavescens)* Sparsely Vegetated Alliance (A.1603)
- *Athyrium americanum* Sparsely Vegetated Alliance (A.1625)
- *Cirsium scopulorum* Herbaceous Alliance (A.1608)
- *Claytonia megarhiza* Herbaceous Alliance (A.1626)
- *Ivesia cryptocaulis* Sparsely Vegetated Alliance (A.2513)
- *Phacelia hastata* Sparsely Vegetated Alliance (A.2634)
- *Polemonium viscosum* Herbaceous Alliance (A.1631)
- *Saxifraga (chrysantha, mertensiana)* Sparsely Vegetated Alliance (A.1632)
- *Saxifraga bronchialis* Sparsely Vegetated Alliance (A.2635)
- *Senecio taraxacoides* Herbaceous Alliance (A.1634)
- Sparse Nonvascular Vegetation Alliance (on rock and unconsolidated substrates) (A.2660)

SPATIAL CHARACTERISTICS

SOURCES

References: Anderson 1999a, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1997, Komarkova 1976, Komarkova 1980, Meidinger and Pojar 1991, Neely et al. 2001, Nelson 1998, Shiflet 1994, Willard 1963
Version: 20 Feb 2003 **Stakeholders:** Canada, Midwest, West
Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES306.815 ROCKY MOUNTAIN CLIFF, CANYON AND MASSIVE BEDROCK

Primary Division: Rocky Mountain (306)
Land Cover Class: Barren
Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Canyon; Cliff (Landform); Ridgetop bedrock outcrop; Talus (Substrate); Rock Outcrops/Barrens/Glades; Oligotrophic Soil; Very Shallow Soil; Landslide
Concept Summary: This ecological system of barren and sparsely vegetated landscapes (generally <10% plant cover) is found from foothill to subalpine elevations on steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous (intrusives), sedimentary, and metamorphic bedrock types. It is located throughout the Rocky Mountains and northeastern Cascade Ranges in North America. Also included are unstable scree and talus slopes that typically occur below cliff faces. In general these are the dry sparsely vegetated places on a landscape. The biota on them reflect what is surrounding them, unless it is an extreme parent material. There may be small patches of dense vegetation, but it typically includes scattered trees and/or shrubs. Characteristic trees includes species from the surrounding landscape, such as *Pseudotsuga menziesii, Pinus ponderosa, Pinus flexilis, Populus tremuloides, Abies concolor, Abies lasiocarpa*, or *Pinus edulis* and *Juniperus* spp. at lower elevations. There may be scattered shrubs present, such as

species of *Holodiscus, Ribes, Physocarpus, Rosa, Juniperus,* and *Jamesia americana, Mahonia repens, Rhus trilobata*, or *Amelanchier alnifolia*. Soil development is limited, as is herbaceous cover.

Comments: This has a very broad elevation range (<3350 m) for a system; consider dividing into foothills/montane and subalpine. And/or by floristic division. This is in the Okanagan and Rockies as the montane sparse. North Pacific Montane Massive Bedrock, Cliff and Talus (CES204.093) includes everything in the Cascades and west, except the northeastern Cascades, where occurrences are this system (CES306.815). Inter-Mountain Basins Cliff and Canyon (CES304.779) occurs in the dry foothills on the east side of EDC MapZone1.

DISTRIBUTION

Range: This system is located throughout the Rocky Mountain, including the isolated island ranges of central Montana, and northeastern Cascade Ranges in North America.

Divisions: 306:C

TNC Ecoregions: 7:C, 8:C, 9:C, 20:C, 21:C, 25:C, 26:C, 68:C

Subnations: AB, AZ, BC, CO, ID, MT, NM, OR, TX, UT, WA, WY

CONCEPT

Associations:

- *Abies concolor / Holodiscus dumosus* Scree Woodland (CEGL000889, G4)
- *Abies concolor / Jamesia americana* Scree Woodland (CEGL000890, GNR)
- *Abies lasiocarpa / Holodiscus dumosus* Scree Woodland (CEGL000918, G3)
- *Abies lasiocarpa / Salix brachycarpa* Scree Woodland (CEGL000922, GUQ)
- *Abies lasiocarpa / Salix glauca* Scree Woodland (CEGL000923, GUQ)
- *Abies lasiocarpa / Saxifraga bronchialis* Scree Woodland (CEGL000924, G4)
- *Abies lasiocarpa* Scree Woodland (CEGL000925, G5?)
- *Aletes anisatus - Scutellaria brittonii* Scree Herbaceous Vegetation (CEGL001948, GU)
- *Athyrium americanum* Sparse Vegetation (CEGL001849, GU)
- *Carex nardina* Scree Herbaceous Vegetation (CEGL001812, GNR) Granite - Metamorphic Black Hills Rock Outcrop Sparse Vegetation (CEGL002295, G4)
- *Heuchera bracteata - Heuchera parvifolia* var. *nivalis* Herbaceous Vegetation (CEGL001971, GU) Igneous - Metamorphic Black Hills Butte Sparse Vegetation (CEGL005283, GNR)
- *Jamesia americana* Rock Outcrop Shrubland (CEGL002783, GNR)
- *Picea engelmannii / Saxifraga bronchialis* Scree Sparse Vegetation (CEGL000893, G4)
- *Pinus contorta* Scree Woodland (CEGL000766, G5?)
- *Pinus flexilis* Scree Woodland (CEGL000815, G3Q)
- *Pinus ponderosa / Ribes inerme* Scree Woodland (CEGL000876, G4)
- *Pinus ponderosa* Limestone Cliff Sparse Vegetation (CEGL002055, G4?)
- *Populus tremuloides / Physocarpus malvaceus - Amelanchier alnifolia* Scree Woodland (CEGL000945, G4Q)
- *Pseudotsuga menziesii / Holodiscus dumosus* Scree Woodland (CEGL000902, G3G4)
- *Pseudotsuga menziesii* Scree Woodland (CEGL000911, G5)
- *Ribes cereum / Leymus ambiguus* Shrubland (CEGL001124, G2)
- *Rubus idaeus* Scree Shrubland (CEGL001134, GU)
- *Saxifraga rivularis* Herbaceous Vegetation (CEGL001930, GU) Scree - Talus Black Hills Sparse Vegetation (CEGL002307, GNR) Sparse Nonvascular Vegetation (on rock and unconsolidated substrates) (CEGL002888, GNR)

Alliances:

- *Abies concolor* Woodland Alliance (A.553)
- *Abies lasiocarpa* Woodland Alliance (A.559)
- *Aletes anisatus* Herbaceous Alliance (A.1639)
- *Athyrium americanum* Sparsely Vegetated Alliance (A.1625)
- *Carex nardina* Herbaceous Alliance (A.1299)
- *Heuchera bracteata* Herbaceous Alliance (A.1646)
- *Jamesia americana* Shrubland Alliance (A.2566)
- *Picea engelmannii* Sparsely Vegetated Alliance (A.556)
- *Pinus contorta* Woodland Alliance (A.512)
- *Pinus flexilis* Woodland Alliance (A.540)
- *Pinus ponderosa* Woodland Alliance (A.530)
- *Populus tremuloides* Woodland Alliance (A.610)
- *Pseudotsuga menziesii* Woodland Alliance (A.552)
- *Ribes cereum* Shrubland Alliance (A.923)
- *Rubus idaeus* ssp. *strigosus* Shrubland Alliance (A.927)
- *Saxifraga rivularis* Herbaceous Alliance (A.1633)
- Lowland Talus Sparsely Vegetated Alliance (A.1847)

- Open Cliff Sparsely Vegetated Alliance (A.1836)
- Rock Outcrop Sparsely Vegetated Alliance (A.1838)
- Sparse Nonvascular Vegetation Alliance (on rock and unconsolidated substrates) (A.2660)

SPATIAL CHARACTERISTICS

SOURCES

References: Andrews and Righter 1992, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Ecosystems Working Group 1998, Hess and Wasser 1982, Larson et al. 2000, Neely et al. 2001, Peet 1981

Version: 04 Apr 2005 **Stakeholders:** Canada, Midwest, Southeast, West

Concept Author: NatureServe Western Ecology Team **LeadResp:** West

CES200.878 TEMPERATE PACIFIC FRESHWATER MUDFLAT

Primary Division:

Land Cover Class: Barren

Spatial Scale & Pattern: Small patch

Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.)

Diagnostic Classifiers: Herbaceous; Temperate [Temperate Oceanic]; Extensive Wet Flat

Concept Summary: Freshwater mudflats are found scattered throughout the temperate regions of the Pacific Coast of North America. In the Pacific Northwest, they occur primarily in seasonally flooded shallow lakebeds on floodplains, especially along the lower Columbia River. During any one year, they may be absent because of year-to-year variation in river water levels. Mudflats must be exposed before the vegetation develops from the seedbank. They are dominated mainly by low-stature annual plants. They range in physiognomy from sparsely vegetated mud to extensive sods of herbaceous vegetation. The predominant species include *Eleocharis obtusa*, *Lilaeopsis occidentalis*, *Crassula aquatica*, *Limosella aquatica*, *Gnaphalium palustre*, *Eragrostis hypnoides*, and *Ludwigia palustris*.

Comments: Revised to eliminate overlap with North Pacific Intertidal Freshwater Wetland (CES204.875) and to better clarify the type, with input from John Christy.

DISTRIBUTION

Range: This system is found throughout the temperate regions of the Pacific Coast of North America.

Divisions: 204:C, 206:C

TNC Ecoregions: 2:C, 14:C, 15:C, 16:C

Subnations: CA, OR, WA

CONCEPT

Associations:

- *Bidens cernua* Herbaceous Vegetation [Provisional] (CEGL003324, G3)
- *Eleocharis obtusa* Herbaceous Vegetation [Provisional] (CEGL003326, G4)
- *Eragrostis hypnoides - Gnaphalium palustre* Herbaceous Vegetation [Provisional] (CEGL003327, G2)
- *Euthamia occidentalis* Herbaceous Vegetation [Provisional] (CEGL003328, G3)
- *Ludwigia palustris - Polygonum hydropiperoides* Herbaceous Vegetation [Provisional] (CEGL003330, G2)
- *Myriophyllum hippuroides* Herbaceous Vegetation [Provisional] (CEGL003331, G3)

Alliances:

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SPATIAL CHARACTERISTICS

SOURCES

References: Chappell and Christy 2004, Comer et al. 2003, Holland and Keil 1995

Version: 07 Feb 2005 **Stakeholders:** West

Concept Author: C. Chappell **LeadResp:** West

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APPENDIX A. Content Of Ecological System Descriptions & Definitions Of Fields

CES306.805 NORTHERN ROCKY MOUNTAIN DRY-MESIC MONTANE MIXED CONIFER FOREST

Primary Division: Rocky Mountain (306)
Land Cover Class: Forest and Woodland
Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Montane, Lower Montane]; Forest and Woodland (Treed); Aridic …
Concept Summary: This ecological system is composed of highly variable montane coniferous forests found in the interior Pacific Northwest, from southernmost interior British Columbia, eastern Washington, eastern ….
Comments: Need to re-assess the concept of this system in relation to Northern Rocky Mountain Western Larch Savanna (CES306.837) and East Cascades Mesic Montane Mixed-Conifer Forest and Woodland (CES204.086). …

DISTRIBUTION

Range: This system is found in the interior Pacific Northwest, from southern interior British Columbia south and east into Oregon, Idaho (including north and central Idaho, down to the Boise Mountains), and western Montana, and south along the east slope of the Cascades in Washington and Oregon.
Divisions: 204:C, 304:P, 306:C
TNC Ecoregions: 2:P, 4:C, 6:C, 7:C, 8:C, 68:C
Subnations: BC, ID, MT, OR, WA

CONCEPT

Associations:
- *Abies grandis / Arctostaphylos nevadensis* Woodland (CEGL000915, G2G3)
- *Abies grandis / Bromus vulgaris* Forest (CEGL002601, G3)
- *Abies grandis / Calamagrostis rubescens* Woodland (CEGL000916, G4?)
- *Abies grandis / Carex geyeri* Woodland (CEGL000917, G3)

Alliances:
- *Abies grandis* Forest Alliance (A.153)
- *Abies grandis* Woodland Alliance (A.558)
- *Pinus monticola* Forest Alliance (A.133)

Environment: Climate is temperate with a relatively long growing season, typically cold winters and deep snow. Mean annual precipitation is ….
Vegetation: This highly variable ecological system is comprised of mixed conifer forests at montane elevations throughout the northern intermountain region….
Dynamics: Landfire VDDT models:…

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2003, Cooper et al. 1987, Crawford and Johnson 1985, Daubenmire and Daubenmire 1968, Lillybridge et al. 1995, Pfister et al. 1977, ..…
Version: 23 Jan 2006 Stakeholders: West
Concept Author: R. Crawford, C. Chappell and M.S. Reid LeadResp: West

Field definitions

IDENTIFIERS

Elcode (Identifier)

For Ecological Systems, the unique identifier code begins with the string "CES" (Community Ecological System) followed by the Primary Division code followed by a 3-digit tiebreaker.

Global Name

The nomenclature for the Ecological Systems classification includes three primary components that communicate aspects of the system's characteristics, including its regional distribution (Primary Ecological Division), vegetation physiognomy and composition, and/or environmental setting. The final name used is a combination of these ecological characteristics with consideration given to local usage and practicality (e.g., length of name).

Ecological Divisions: These division-scaled units typically form part of each classification unit's name. That is, a "Rocky Mountain" ecological system unit is entirely or predominantly found (>80% of its total range) within the Rocky Mountain Division but could also occur in neighboring divisions. This nomenclatural standard is applicable to most Ecological Systems, except for those types that span many divisions (e.g., some tidal or freshwater marsh systems), or that are more localized (>80% of the range) within a subunit of the division (e.g., Colorado Plateau, within the Inter-Mountain Basins Division).

Vegetation Structure and Composition: Vegetation structure (e.g., Forest and Woodland, Grassland) and vegetation composition (e.g., Pinyon-Juniper, mixed conifer) are commonly used in the name of a system. In sparse to unvegetated types, reference to characteristic landforms (e.g., badland, cliff) may substitute for vegetation structure and/or composition. It will typically come after Ecological Division but may come before or after Environment (see below).

Environment: Environmental factors (e.g., xeric, flats, montane) can be used in conjunction with Vegetation Structure and Composition or on their own to name system types. This will typically come after Ecological Division but may come before or after Vegetation Structure and Composition.

Primary Division

The Ecological System unit is entirely or predominantly found (>80% of its total range) within the Named Primary Division but could also occur in neighboring divisions. Ecological Divisions are sub-continental landscapes reflecting both climate and biogeographic history (**see Figure 1 below**). Continent-scaled climatic variation, reflecting variable humidity and seasonality (e.g. Mediterranean vs. dry continental vs. humid oceanic) are reflected in these units, as are broad patterns in phytogeography. These modified divisional units aid the development of system units because regional patterns of climate, physiography, disturbance regimes, and biogeographic history are well described by each Division.

Values:

Boreal (103)
Montane Boreal (105)
North American Pacific Maritime (204)
Mediterranean California (206)
Madrean Semidesert (301)
North American Warm Desert (302)
Western Great Plains (303)
Inter-Mountain Basins (304)
Sierra Madre (305)
Rocky Mountain (306)

Land Cover Class

Land cover classes mapped in the United States in the National Land Cover Data (NLCD) by the National Land Cover Characterization project managed by the USGS Biological Resources Division. Each Ecological System unit has been matched to an NLCD land cover class.

Values:

Barren
Forest and Woodland
Herbaceous
Herbaceous Wetland
Mixed Upland and Wetland
Shrubland
Steppe/Savanna
Woody Wetland

Spatial Pattern

The major spatial pattern of the Ecological System throughout its range.

Values:

MATRIX = Communities that form the dominant matrix of an area (occurrences are generally 200 to 1,000,000 acres)
LARGE PATCH = Communities that occur as large patches covering generally 20 to 1,000 acres
SMALL PATCH = Communities that typically occur as very small, 1 to 50 acre patches
LINEAR = Communities that typically occur in long, linear spatial patterns, for example those that follow water courses. Riparian shrublands and deciduous forest types are an example of linear communities

Required Classifiers

Values:

Natural/Semi-natural or Planted/Cultivated
Vegetated (>10% vasc.) or Unvegetated (<10% vasc.)
Upland
Wetland

Diagnostic Classifiers

As the definition for ecological systems indicates, this is a multi-factor approach to ecological classification. Multiple environmental factors—or diagnostic classifiers—are evaluated and combined in different ways to explain the spatial co-occurrence of NVC associations. Diagnostic classifiers are used here in the sense of Di Gregorio and Jansen (2000); that is, the structure of the ecological systems classification is more "modular" in that it aggregates diagnostic classifiers in multiple, varying combinations. Instead of a specific hierarchy, we present a single set of ecological system types. This is in contrast to, for example, the framework and approach of the IVC. The nested IVC hierarchy groups associations into alliances based on common dominant or diagnostic species in the upper-most canopy. This provides more of a taxonomic aggregation with no presumption that associations within the alliance co-occur in a given landscape. The ecological system unit links IVC associations using multiple factors that help to explain why they tend to be found together in a given landscape. Therefore, ecological systems tend to be better "grounded" as ecological units than most IVC alliances and are more readily identified, mapped, and understood as practical ecological units. Diagnostic classifiers include a wide variety of factors representing bioclimate, biogeographic history, physiography, landform, physical and chemical substrates, dynamic processes, landscape juxtaposition, and vegetation structure and composition.

Categories and Examples:

Ecological Divisions
- Continental Bioclimate and Phytogeography

Bioclimatic Variables
- Regional Bioclimate

Environment
- Landscape Position, Hydrogeomorphology
- Soil Characteristics, Specialized Substrate

Ecological Dynamics
- Hydrologic Regime
- Fire Regime

Landscape Juxtaposition
- Upland-Wetland Mosaics

Vegetation
- Vertical Structure and Patch Type
- Composition of component associations
- Abundance of component association patches

CONCEPT

Concept Summary

A summary of the structure/physiognomy, composition, and environmental setting associated with the ecological system, enough to convey the "gist" of the system, including a general understanding of the type, often with some concept of its distribution and information on what key diagnostic characters distinguish this system from others like it.

Comments

Comments about classification criteria used to define the Ecological System or any remaining issues associated with its classification. This may include the rationale for any arbitrary decisions that have been made related to the classification of the Ecological System. Also included here are references to similar types whose classification is not clearly resolved.

Associations

List of NVC Associations (Association Name, Elcode, and Global Rank) that are members of this Ecological System. Associaitons not yet incorporated into the NVC are not listed.

Alliances

List of Alliances (Alliance Name and Alliance Key) that are members of this Ecological System.

Environment

A summary of available information on the environmental conditions associated with the Ecological System and any other important aspects of the environment which affect this particular system, including elevation ranges and, where relevant, information on large landscape context, geology and soils.

Vegetation

A summary of available information on the leaf type and phenology, species composition, structure, and variability of the vegetation of this Ecological System and any additional comments.

Dynamics

A summary of information on the important natural disturbance regimes, successional status, and temporal dynamics for this Ecological System with additional comments relevant to dynamic processes associated with the Ecological System. These may include a discussion of the past and future successional stages known, whether succession is likely to occur with its given disturbance regime, and information on age structure, dispersal agents, old-growth characteristics, etc., if applicable.

DISTRIBUTION

Range

A description of the total range (present and historic) of the Ecological System, using names of nations, subnations or states, ecoregions, etc.

Divisions

Values:

Boreal (103)
Montane Boreal (105)
North American Pacific Maritime (204)
Mediterranean California (206)
Madrean Semidesert (301)
North American Warm Desert (302)
Western Great Plains (303)
Inter-Mountain Basins (304)
Sierra Madre (305)
Rocky Mountain (306)

Division Occurrence Status
The occurrence status of the Ecological System in that Ecological Division.

Values:

C = Confident or certain. The system is confidently assumed or known to occur in the division.
P = Predicted or probable. The system is predicted to occur in the division based on the fact pattern (e.g., presence of suitable habitat or conditions and historical record and/or presence in adjacent ecoregions).
? = Possible. The system possibly or potentially occurs in the division.
X = Presumed extirpated. The system is documented or predicted to have occurred in the division but now is presumed extirpated.
[ ] = Data entry incomplete.

TNC Ecoregions
The code(s) for the TNC Conservation Ecoregion(s) (see figure 2 below) where the Ecological System occurs, may occur, or has occurred.

Values:

1 - West Cascades and Coastal Forests
2 - Puget Trough - Willamette Valley - Georgia Basin
3 - North Cascades and Pacific Ranges
4 - Modoc Plateau and East Cascades
5 - Klamath Mountains
6 - Columbia Plateau
7 - Canadian Rocky Mountains
8 - Middle Rockies - Blue Mountains
9 - Utah-Wyoming Rocky Mountains
10 - Wyoming Basins
11 - Great Basin
12 - Sierra Nevada
13 - Great Central Valley
14 - California North Coast
15 - California Central Coast
16 - California South Coast
17 - Mojave Desert
18 - Utah High Plateaus
19 - Colorado Plateau
20 - Southern Rocky Mountains
21 - Arizona-New Mexico Mountains
22 - Apache Highlands
23 - Sonoran Desert
24 - Chihuahuan Desert
25 - Black Hills
26 - Northern Great Plains Steppe
27 - Central Shortgrass Prairie
28 - Southern Shortgrass Prairie
29 - Edwards Plateau
30 - Tamaulipan Thorn Scrub
31 - Gulf Coast Prairies and Marshes
32 - Crosstimbers and Southern Tallgrass Prairie
33 - Central Mixed-Grass Prairie
34 - Dakota Mixed-Grass Prairie
35 - Northern Tallgrass Prairie
36 - Central Tallgrass Prairie
37 - Osage Plains/Flint Hills Prairie
38 - Ozarks
39 - Ouachita Mountains
40 - Upper West Gulf Coastal Plain
41 - West Gulf Coastal Plain
42 - Mississippi River Alluvial Plain
43 - Upper East Gulf Coastal Plain
44 - Interior Low Plateau
45 - North Central Tillplain
46 - Prairie-Forest Border
47 - Superior Mixed Forest
48 - Great Lakes
49 - Western Allegheny Plateau
50 - Cumberlands and Southern Ridge and Valley
51 - Southern Blue Ridge
52 - Piedmont
53 - East Gulf Coastal Plain
54 - Tropical Florida
55 - Florida Peninsula
56 - South Atlantic Coastal Plain
57 - Mid-Atlantic Coastal Plain
58 - Chesapeake Bay Lowlands
59 - Central Appalachian Forest
60 - High Allegheny Plateau
61 - Lower New England/Northern Piedmont
62 - North Atlantic Coast
63 - Northern Appalachian-Boreal Forest
64 - St. Lawrence-Champlain Valley
65 - Hawaiian High Islands
66 - Aspen Parkland
67 - Fescue-Mixed Grass Prairie
68 - Okanagan
69 - Alaska Coastal Forest and Mountains
70 - Gulf of Alaska Mountains and Fjordlands
71 - Cook Inlet Basin
72 - Alaska Peninsula
73 - Bering Sea and Aleutian Islands
74 - Bristol Bay Basin

75 - Beringian Tundra
76 - Alaska Range
77 - Interior Alaska Taiga
78 - Yukon Plateau and Flats
79 - Brooks Range Tundra Coastal Plain
80 - Northern Gulf Coast

TNC Ecoregion Occurrence Status

The occurrence status of the Ecological System in that TNC Ecoregion.

Values:

C = Confident or certain. The system is confidently assumed or known to occur in the ecoregion.
P = Predicted or probable. The system is predicted to occur in the ecoregion based on the fact pattern (e.g., presence of suitable habitat or conditions and historical record and/or presence in adjacent ecoregions).
? = Possible. The system possibly or potentially occurs in the ecoregion.
X = Presumed extirpated. The system is documented or predicted to have occurred in the ecoregion but now is presumed extirpated.
[ ] = Data entry incomplete.

Subnations

The two-letter postal codes for U.S. states and Canadian provinces in which the Ecological System occurs. Mexican two-letter state abbreviations are preceded by "MX". When the occurrence of the system in a state/province is uncertain, a "?" is appended.

Values:

AB Alberta, CA
AK Alaska, US
AL Alabama, US
AR Arkansas, US
AZ Arizona, US
BC British Columbia, CA
CA California, US
CO Colorado, US
CT Connecticut, US
DC District of Columbia, US
DE Delaware, US
FL Florida, US
GA Georgia, US
HI Hawaii, US
IA Iowa, US
ID Idaho, US
IL Illinois, US
IN Indiana, US
KS Kansas, US
KY Kentucky, US
LA Louisiana, US
MA Massachusetts, US
MB Manitoba, CA
MD Maryland, US
ME Maine, US
MI Michigan, US
MN Minnesota, US
MO Missouri, US
MS Mississippi, US
MT Montana, US
MXBC Baja California, MX
MXCH Chihuahua, MX
MXCO Coahuila, MX
MXNU Nuevo Leon, MX
MXSL San Luis Potosi, MX
MXSO Sonora, MX
MXTM Tamaulipas, MX
MXVE Veracruz, MX
MXZA Zacatecas, MX
NB New Brunswick, CA
NC North Carolina, US
ND North Dakota, US
NE Nebraska, US
NF Newfoundland, CA
NH New Hampshire, US
NJ New Jersey, US
NM New Mexico, US
NS Nova Scotia, CA
NV Nevada, US
NY New York, US
OH Ohio, US
OK Oklahoma, US
ON Ontario, CA
OR Oregon, US
PA Pennsylvania, US
PE Prince Edward Island, CA
QC Quebec, CA
RI Rhode Island, US
SC South Carolina, US
SD South Dakota, US
SK Saskatchewan, CA
TN Tennessee, US
TX Texas, US
UT Utah, US
VA Virginia, US
VT Vermont, US
WA Washington, US
WI Wisconsin, US
WV West Virginia, US
WY Wyoming, US

SOURCES

References

Short citations of all references used in documenting the classification/concept and characterization of this Ecological System.

Version
The date of the current version of the Ecological System characterization (i.e., the date that it was first completed or, since then, comprehensively revised).

Stakeholders
The NatureServe region(s) in which the Ecological System occurs or may occur. *Values:* East, Southeast, Midwest, West, Latin America.

Concept Author
The name of the author(s) of the Ecological System concept and/or its description (including the description in the Summary above). This field is used to give proper formal credit to authors of the type or its description. "mod." indicates that an earlier version by the author first listed has been modified by the author listed subsequently.

Classification Responsibility (LeadResp)
The NatureServe region which has been assigned lead responsibility for the classification of the Ecological System. *Values:* East, Southeast, Midwest, West, Latin America.

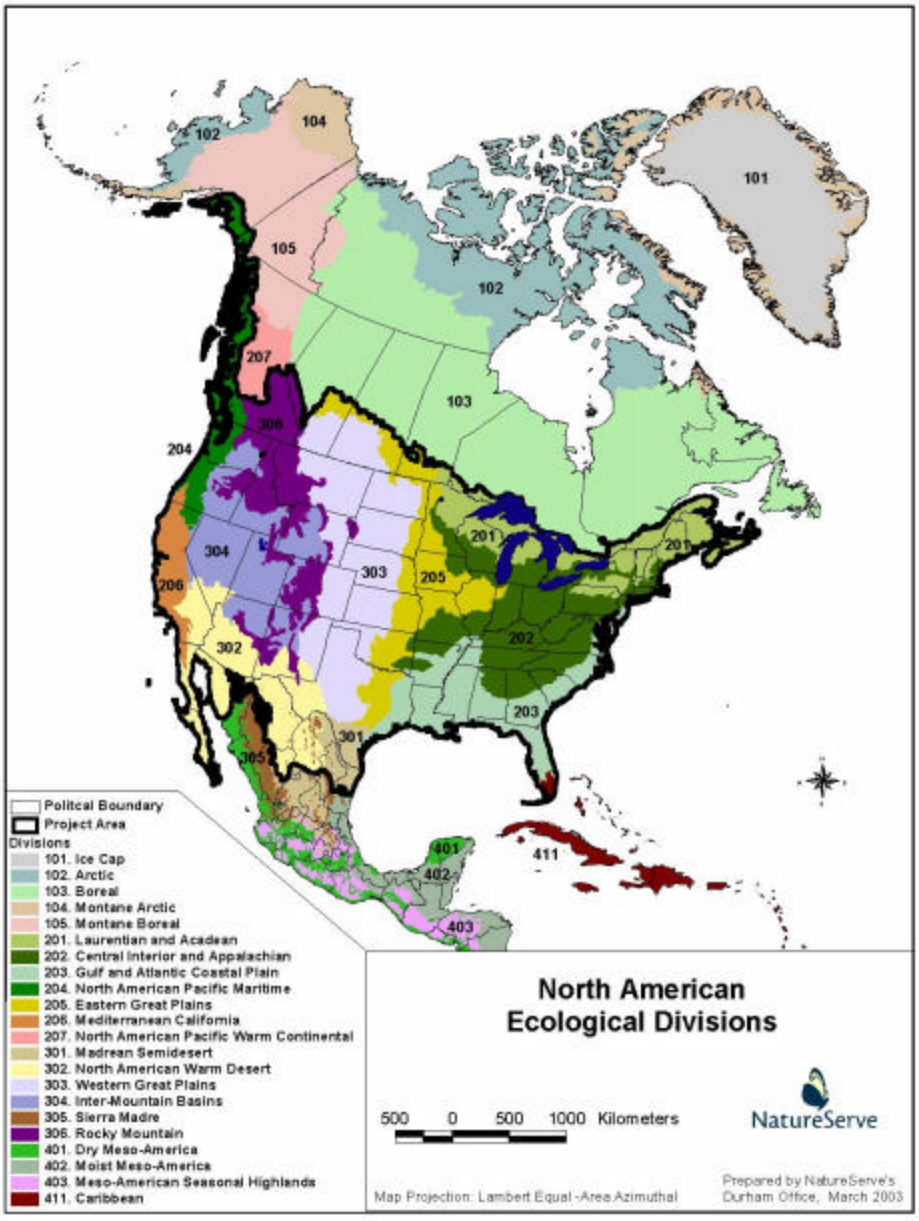
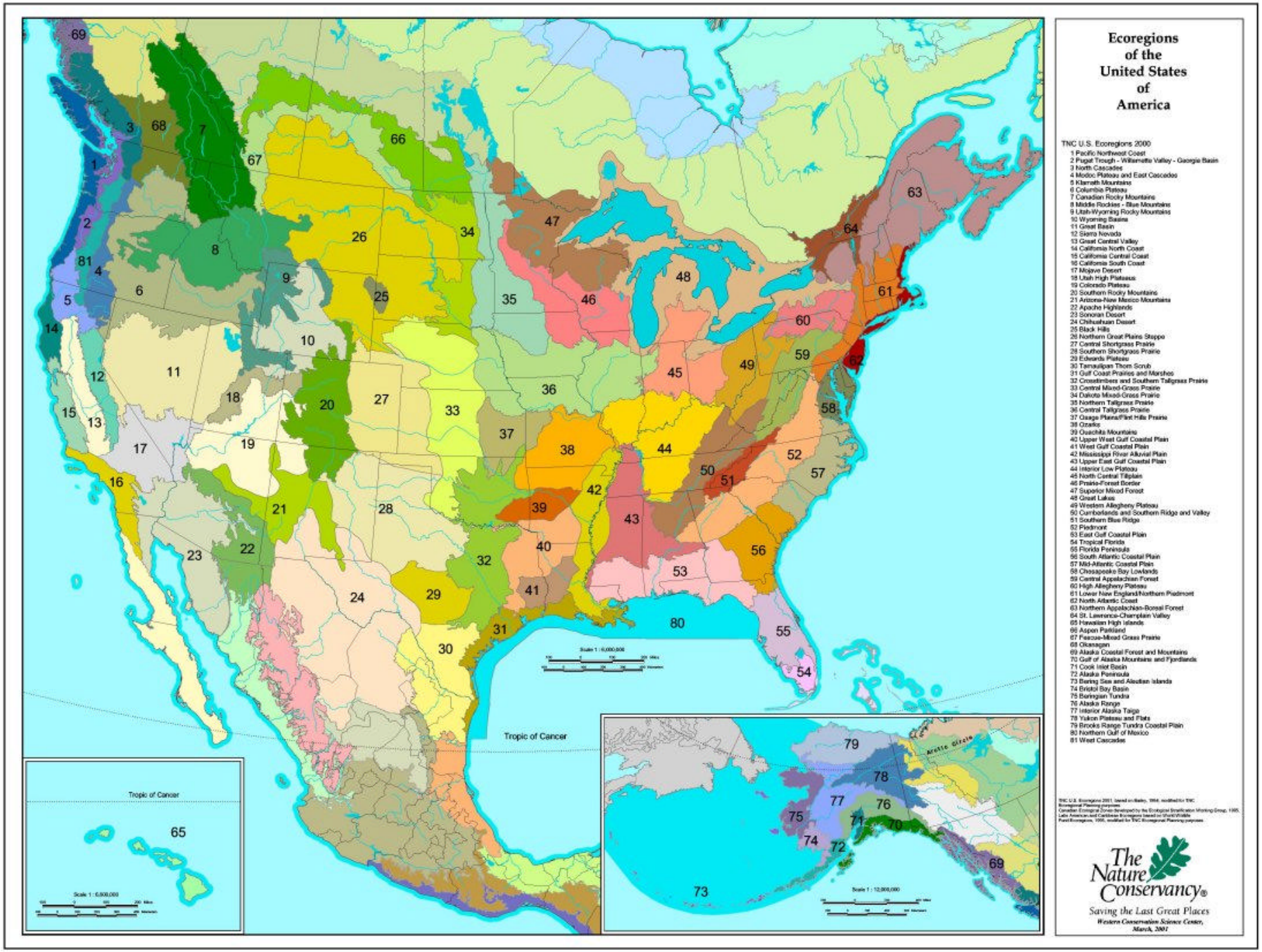


Figure 1. Ecological Divisions of North America used in organization and nomenclature of NatureServe Ecological Systems. ***(2001-2003 TNC project area is highlighted).***

Figure 2. Ecoregions defined by The Nature Conservancy



Appendix B. Vegetation variables joined to grids and used in accuracy assessment for the GNN models. All variables are at the at the forest class level (summary of all portions of a plot that are forest).

Variables joined to GNN species model

Variable name	**Description**
PLTID	Unique plot identification number.
FCID	Unique forest class identification number.
DATA_SOURCE	Source of the plot data: FIAEW = FIA in eastern Washington, R6 = Forest Service Region 6
ESLF	Ecological System life form: 4103 Northern Rocky Mountain Western Larch Savanna 4104 Rocky Mountain Aspen Forest and Woodland 4204 Columbia Plateau Western Juniper Woodland and Savanna 4205 East Cascades Mesic Montane Mixed-Conifer Forest and Woodland 4206 Great Basin Pinyon-Juniper Woodland 4228 North Pacific Mountain Hemlock Forest 4232 Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest 4233 Northern Rocky Mountain Subalpine Woodland and Parkland 4234 Northern Rocky Mountain Mesic Montane Mixed Conifer Forest 4237 Rocky Mountain Lodgepole Pine Forest 4240 Northern Rocky Mountain Ponderosa Pine Woodland and Savanna 4242 Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland 4243 Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland 4244 Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland 4266 Middle Rocky Mountain Montane Douglas-fir Forest and Woodland 4267 Rocky Mountain Poor Site Lodgepole Pine Forest 4301 East Cascades Oak-Ponderosa Pine Forest and Woodland 4302 Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland 4303 Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland 5426 Northern Rocky Mountain Foothill Conifer Wooded Steppe 9104 Inter-Mountain Basins Montane Riparian Systems 9109 Rocky Mountain Montane Riparian Systems 9111 Northern Rocky Mountain Conifer Swamp 9156 Rocky Mountain Lower Montane Riparian Woodland and Shrubland 9170 Columbia Basin Foothill Riparian Woodland and Shrubland 9171 Rocky Mountain Subalpine/Upper Montane Riparian Systems 9190 North Pacific Hardwood-Conifer Swamp

Variables joined to GNN structure model

Variable name	Description
PLTID	Unique plot identification number.
FCID	Unique forest class identification number.
DATA_ SOURCE	Source of the plot data: FIAEW = FIA in eastern Washington, FIAEO = FIA in eastern Oregon, FIAEO-JUN = FIA juniper inventory in eastern Oregon, R6 = Forest Service Region 6.
BAA_GE_3	Basal area (m^2/ha) of all live trees >=2.54 cm dbh.
BAC_GE_3	Basal area (m^2/ha) of all live conifers >=2.54 cm dbh.
BAH_GE_3	Basal area (m^2/ha) of all live hardwoods >=2.54 cm dbh.
BAH_PROP	Proportion of total live tree basal area that is hardwood.
QMDA_DOM	Quadratic mean diameter (QMD) (cm) of all dominant and codominant trees.
QMDC_DOM	QMD (cm) of all dominant and codominant conifers.
QMDH_DOM	QMD (cm) of all dominant and codominant hardwoods.
CANCOV	Canopy cover (percent) of all live trees, calculated using methods in the Forest Vegetation Simulator (Crookston and Stage 1999).
CANCOV_CON	Canopy cover (percent) of all conifers, calculated using methods in the Forest Vegetation Simulator (Crookston and Stage 1999).
CANCOV_HDW	Canopy cover (percent) of all hardwoods, calculated using methods in the Forest Vegetation Simulator (Crookston and Stage 1999).
STNDHGT	Average height (m) of dominant and codominant trees.
LAYERS	Number of canopy layers present (0-3). Canopy strata are defined by dividing the height of tallest tree into thirds, and checking for presence of trees (>=10% canopy cover) in each layer.

VEGCLASS	Vegetation class from Johnson and O'Neil (2001) 1 Sparse (*CANCOV* <10) 2 Open (*CANCOV* 10-39) 3 Broadleaf, sap/pole, mod/closed (*CANCOV* >=40, *BAH_PROP* >=0.65, *QMDA_DOM* <25 cm) 4 Broadleaf, sm/med/lg, mod/closed (*CANCOV* >=40, *BAH_PROP* >=0.65, *QMDA_DOM* >25 cm) 5 Mixed, sap/pole, mod/closed (*CANCOV* >=40, *BAH_PROP* 0.20-0.64, *QMDA_DOM* <25 cm) 6 Mixed, sm/med, mod/closed (*CANCOV* >=40, *BAH_PROP* 0.20-0.64, *QMDA_DOM* 25-50 cm) 7 Mixed, large+giant, mod/closed (*CANCOV* >=40, *BAH_PROP* 0.20-0.64, *QMDA_DOM* >50 cm) 8 Conifer, sap/pole, mod/closed (*CANCOV* >=40, *BAH_PROP* <0.20, *QMDA_DOM* <25 cm) 9 Conifer, sm/med, mod/closed (*CANCOV* >=40, *BAH_PROP* <0.20, *QMDA_DOM* 25-50 cm) 10 Conifer, large, mod/closed (*CANCOV* >=40, *BAH_PROP* <0.20, *QMDA_DOM* 50-75 cm) 11 Conifer, giant, mod/closed (*CANCOV* >=40, *BAH_PROP* <0.20, *QMDA_DOM* >75 cm)
SIZECL	Size class from Johnson and O'Neil (2001, p. 116-119) 1 Shrub/seedling (*QMDA_DOM* <2.5 or *CANCOV* <10) 2 Sapling/pole (*QMDA_DOM* >=2.5 and <25.0) 3 Small tree (*QMDA_DOM* >=25.0 and <37.5) 4 Medium tree (*QMDA_DOM* >=37.5 and <50.0) 5 Large tree (*QMDA_DOM* >=50.0 and <75) 6 Giant tree (*QMDA_DOM* >=75.0)
COVCL	Cover class from Johnson and O'Neil (2001, p. 116-119) 1 Sparse/remnant (*CANCOV* <10) 2 Open (*CANCOV* >=10 and <40) 3 Moderate (*CANCOV* >=40 and <70) 4 Closed (*CANCOV* >=70)

Literature Cited

Crookston, NL, and AR Stage. 1999. Percent canopy cover and stand structure statistics from the Forest Vegetation Simulator. RMRS-GTR-24. 8 pp.

Johnson, DH, and TA O'Neil. 2001, eds. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press; Corvallis, OR; 736 p.

Appendix C. Key for classifying forest plots into Ecological Systems of map zones 8 and 9. Classification steps are checked sequentially, and the plot is assigned to the first Ecological System where the condition is met. We developed the classification rules from Landfire sequence tables, NatureServe's descriptions of the Ecological Systems, and review and expert opinion by J. Kagan and J. Ohmann. All tree species variables are relative cover (tree species cover relative to total tree cover). See end of document for definitions of variables used in classification. Ecological System geographic abbreviations: EC = Eastern Cascades, CP = Columbia Plateau, NP = North Pacific, RM = Rocky Mountain, MRM = Middle Rocky Mountain, NRM = Northern Rocky Mountain, IMB = Inter-Mountain Basins.

If no tree tally on the plot:	
If SERIES = CJ then	CP Western Juniper Woodland and Savanna
Else	No tally

Cottonwood:

If (HDWPLBA = POBAT or HDWPLIV = POBAT) then:	CB Foothill Riparian Woodland and Shrubland

Oak:

If QUGA4 >0 or SERIES = HO then:	EC Oak-Ponderosa Pine Forest and Woodland

P. pine, w. juniper, and m. mahogany:

If (CELE3 + JUOC + PIPO) >75 or SERIES = CJ:	
If [CELE3 >50 and (PIPO + POTR5 + PSME) <25] or	
HDWPLBA = CELE3 or HDWPLIV = CELE3 then:	IMB Mountain Mahogany Woodland and Shrubland
If (JUOC >25 and PIPO <25 and CELE3 <50) or SERIES = CJ then	CP Western Juniper Woodland and Savanna
Else	NRM Ponderosa Pine Woodland and Savanna

Aspen:

If POTR5 >70 then	RM Aspen Forest and Woodland
If POTR5 >25 and (POTR5 + POBAT + BEPAC) >70 then	RM Aspen Forest and Woodland
If POTR5 >25:	
If (ABGR +ABCO + ABLA + LAOC + PIEN + PIAL + PIFL + PIMO3 +	
PIPO + PSME + TSHE + THPL) <20:	

If (ECOREG =9 or ECOREG = 77)* then	NP Hardwood-Conifer Swamp
Else	IMB Aspen-Mixed Conifer Forest and Woodland
Else	RM Aspen Forest and Woodland

Subalpine:

If (CONPLBA = TSME or CONPLIV = TSME or SERIES = CM) then	NP Mountain Hemlock Forest
If (CONPLBA = PIFL or CONPLIV = PIFL or CONPLBA = PIAL or CONPLIV = PIAL) then	RM Subalpine-Montane Limber-Bristlecone Pine Woodland
If [(ABLA + LALY + PIAL + PIFL) >25 and (LALY + PIAL) >0 and (ABGRC + PIMO3 + TSME) <10] or SERIES = CA then	NRM Subalpine Woodland and Parkland
If (ABLA + PIEN + TSME) >50:	
If ABLA > (PIEN + TSME) then	RM Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
Else	RM Subalpine Mesic Spruce-Fir Forest and Woodland

Lodgepole:

If PICO >70:	
If (ABGRC + ABLA + BEPAC + LAOC + LALY + PIEN + PIAL + PIMO3 + POTR5 + PSME + TABR2 + THPL + TSHE + TSME) =0 and (CLG3 + CLG4 + CLS1 + CLS2 < half of plot) then	RM Poor Site Lodgepole Pine Forest
Else	RM Lodgepole Pine Forest

Larch:

If (CONPLBA = LAOC or CONPLIV = LAOC) then	NRM Western Larch Savanna

Mixed conifer:

If (TSHE >0 or THPL >0 or SERIES = CH or TABR2 >0 or PIEN >5) and (ABGRC + PIEN + TABR2) >75):	
If (ECOREG =9 or ECOREG = 77)* then	EC Mesic Montane Mixed-Conifer Forest and Woodland
Else	NRM Moist-Mesic Montane Mixed Conifer Forest
If (CONPLBA = PSME or CONPLIV = PSME) and (ABCO + ABGR + ABLA + BEPAC + LALY + LAOC + PIEN + PIAL + PIMO3 + TSME) <20 :	

If (ECOREG =9 or ECOREG = 77)* then	EC Mesic Montane Mixed-Conifer Forest and Woodland
Else	MRM Montane Douglas-fir Forest and Woodland
Else	NRM Dry-Mesic Montane Mixed Conifer Forest

Variables used in classification of forest Ecological Systems

PLNASSN – Plant association level of potential vegetation classification.
PAG – Plant association group level of potential vegetation classification.
SERIES – Series level of potential vegetation classification.
CONPLBA – conifer tree species with the plurality of basal area
CONPLIV – conifer tree species with the greatest importance value (calculated from basal area and density)
HDWPLBA – hardwood tree species with the plurality of basal area
CONPLIV – hardwood tree species with the greatest importance value (calculated from basal area and density)

1 ECOREG (Level III EPA ecoregion):Coast Range
2 Puget Lowlands
3 Willamette Valley
4 Cascades
9 Eastern Cascades Slopes and Foothills
10 Columbia Plateau
11 Blue Mountains
12 Snake River Basin / High Desert
15 Northern Rockies
77 North Cascades
78 Klamath Mountains
80 Northern Basin and Range

Tree species present on forest plots in map zones 8 and 9:

Code	Scientific name	Common name
ABAM	*Abies amabilis*	Pacific silver fir
ABCO	*Abies concolor*	white fir
ABGR	*Abies grandis*	grand fir
ABLA	*Abies lasiocarpa*	subalpine fir
ABPR	*Abies procera*	noble fir
ACMA3	*Acer macrophyllum*	bigleaf maple
ALRH2	*Alnus rhombifolia*	white alder
BEPAC	*Betula papyrifera*	western paper birch
CADE27	*Calocedrus decurrens*	incense cedar
CELE3	*Cercocarpus ledifolius*	curlleaf mountain mahogany
JUOC	*Juniperus occidentalis*	western juniper
LAOC	*Larix occidentalis*	western larch
PIAL	*Pinus albicaulis*	whitebark pine
PICO	*Pinus contorta*	lodgepole pine
PIEN	*Picea engelmannii*	Engelmann spruce
PILA	*Pinus lambertiana*	sugar pine
PIMO3	*Pinus monticola*	western white pine
PIPO	*Pinus ponderosa*	ponderosa pine
POBAT	*Populus balsamifera* ssp. *trichocarpa*	black cottonwood
POTR5	*Populus tremuloides*	quaking aspen
PRUNU	*Prunus* spp.	cherry
PSME	*Pseudotsuga menziesii*	Douglas-fir
QUGA4	*Quercus garryana*	Oregon white oak
SALIX	*Salix* spp.	willow
TABR2	*Taxus brevifolia*	Pacific yew
THPL	*Thuja plicata*	western redcedar
TSHE	*Tsuga heterophylla*	western hemlock
TSME	*Tsuga mertensiana*	mountain hemlock

Appendix D. Summary of Mapping Results	Land cover (ha)								
Ecological system	USGS zone		State				Ecoregion		
	Zone 8	Zone 9	WA	OR	ID	NV	CB	BM	NBR
Barren	13240	72284	10819	57442	12336	4578	13296	18735	53495
Columbia Basin Foothill and Canyon Dry Grassland	326026	218421	217514	279188	44420	3417	360235	161124	23180
Columbia Basin Foothill Riparian Woodland and Shrubland	152817	136701	126524	140986	19739	2176	165056	89676	34807
Columbia Basin Palouse Prairie	38959	57767	27527	68926	275		39517	57211	
Columbia Plateau Ash and Tuff Badland	400	88464	37	84165	2407	2255	548	14362	73955
Columbia Plateau Low Sagebrush Steppe	3352	881726	3491	779136	40135	59427	3523	204792	676763
Columbia Plateau Scabland Shrubland	6182	115615	4625	102279	11586	3248	6189	43456	72151
Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub-Steppe		26538		25581	438	451	0	2876	23662
Columbia Plateau Steppe and Grassland	88852	401028	93699	339354	30382	26420	89978	219706	180195
Columbia Plateau Vernal Pool		173	2	172				173	
Columbia Plateau Western Juniper Woodland and Savanna	43272	942982	2660	866415	97885	19145	51802	660922	273560
CRP	391270	1546	334410	58412			392607	215	
Cultivated Crops and Irrigated Agriculture	3432450	495805	2839265	826116	261532	1399	3555476	280181	92664
Developed, Low Intensity	402	140	345	185	11		402	140	
Developed, Medium Intensity	57643	13297	46965	21730	2246		57851	9451	3639
Developed, Open Space		4		4				4	
East Cascades Mesic Montane Mixed-Conifer Forest and Woodland	26781		26770		16		26787		
East Cascades Oak-Ponderosa Pine Forest and Woodland	12306	1	5863	5035	1411		12250	59	
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland		542		520	2	20		41	501
Great Basin Semi-Desert Chaparral		218				218			218
Great Basin Xeric Mixed Sagebrush Shrubland		227790		16624	2394	208755		10392	217398
Inter-Mountain Basins Active and Stabilized Dune	18199	49018	18199	48140	846	23	18199	18067	30952
Inter-Mountain Basins Alkaline Closed Depression	3475	24433	2924	24054	389	512	3604	542	23762
Inter-Mountain Basins Big Sagebrush Shrubland	611768	1640642	516090	1282568	49136	404148	614745	203417	1434269
Inter-Mountain Basins Big Sagebrush Steppe	1506705	3035322	964328	3290594	143703	140833	1526068	713530	2302557
Inter-Mountain Basins Cliff and Canyon	76883	310239	54229	235905	45149	51838	99005	195082	93051
Inter-Mountain Basins Greasewood Flat	2813	190414	2392	170829	403	19576	2813	6427	183987
Inter-Mountain Basins Juniper Savanna		14031		4	60	13968			14029
Inter-Mountain Basins Mixed Salt Desert Scrub	10477	86078	3885	77900	1832	12934	10476	471	85608
Inter-Mountain Basins Montane Sagebrush Steppe	808	556623	844	268488	104829	182900	1069	143773	412589
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	10	62152		26585	2257	33316	4	21415	40737
Inter-Mountain Basins Playa	20	222074		188902	962	31999	20	2531	219544
Inter-Mountain Basins Semi-Desert Grassland	12037	175599	10865	160939	2799	13032	12077	2700	172859
Inter-Mountain Basins Semi-Desert Shrub-Steppe	1694	1893	1530	289	6	1762	1696	117	1774
Inter-Mountain Basins Volcanic Rock and Cinder Land		38759		38368	15	263		751	38008
Introduced Riparian Vegetation	1079	5	982	32	71		1063	22	
Introduced Upland Vegetation - Annual and Biennial Forbland	222	1573	191	38		1567	229	0	1567
Introduced Upland Vegetation - Annual and Perennial Grassland	451906	479939	265729	603441	41956	20734	459980	138664	333228
Introduced Upland Vegetation - Shrub	3850		3204	619	28		3850		
Introduced Upland Vegetation - Treed	1279	10	1147	103	39		1283	6	

Appendix D. Summary of Mapping Results	Land cover (ha)								
Ecological system	USGS zone		State				Ecoregion		
	Zone 8	Zone 9	WA	OR	ID	NV	CB	BM	NBR
Introduced Wetland Vegetation		3				3			3
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	17988	465399	53144	375214	55063		76135	407259	27
North American Alpine Ice Field		857		857				857	
North American Arid West Emergent Marsh	4982	26860	4694	23710	135	3210	5198	6396	20249
North Pacific Avalanche Chute Shrubland		184		184				184	
North Pacific Bog and Fen		525		525				525	
North Pacific Hardwood-Conifer Swamp	952		952				952		
North Pacific Lowland Riparian Forest and Shrubland		501	4	497			1	500	
North Pacific Montane Massive Bedrock, Cliff and Talus	31984	511	31963	537			31981	519	
North Pacific Montane Shrubland	137	1	62	75	1		138	1	
North Pacific Mountain Hemlock Forest		1800	10	1789				1800	
North Pacific Oak Woodland	3202	82767	4310	77803	3861		5744	80230	
North Pacific Shrub Swamp		215	1	214			0	214	
Northern Rocky Mountain Avalanche Chute Shrubland		3120	344	2721	55		21	3099	
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	32137	1163585	82805	1083684	26380	2875	78116	1112329	5302
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrublan	1509	12144	2534	10784	335		1781	11872	
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest		68322	8558	59762	1		110	68212	
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	12823	196149	8998	162690	35272	2011	28503	155548	24921
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	80905	908105	79665	798591	85451	25278	157048	793502	38500
Northern Rocky Mountain Subalpine Deciduous Shrubland		1920		1461	28	431		204	1715
Northern Rocky Mountain Subalpine Woodland and Parkland		32558	1899	30385		273		32285	273
Northern Rocky Mountain Subalpine-Upper Montane Grassland		23279		18156	982	4141		5639	17639
Open Water	110034	63070	97944	71316	2006	1730	109966	17422	45724
Orchards/Vineyards		43		43				43	
Pasture/Hay		189291		178639	7153	3500		2731	186560
Recently Burned Shrubland		744		49		695			744
Recently Burned Vegetation	77195	195289	77231	151410	20599	23246	77488	70540	124459
Rocky Mountain Alpine Bedrock and Scree		15626		12883	8	2734		11089	4537
Rocky Mountain Alpine-Montane Wet Meadow	1	76827	330	74348	1369	736	291	71348	5189
Rocky Mountain Aspen Forest and Woodland	2560	50446	3765	22683	365	26187	3636	8031	41336
Rocky Mountain Cliff, Canyon and Massive Bedrock	145	219949	38673	173677	5571	2174	78	217671	2345
Rocky Mountain Dry Tundra		2				2			2
Rocky Mountain Lodgepole Pine Forest	180	38272	212	38230		10	185	38249	17
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	2214	1264	2222	1135	121		2316	1163	
Rocky Mountain Poor Site Lodgepole Pine Forest	21	20686	25	20528	153		62	20644	1
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	370	71194	8820	62664	79		373	71191	
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	25	19804	935	18887	8		26	19804	
Rocky Mountain Subalpine-Montane Fen		48		48				46	
Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland		11361		11361				11361	
Rocky Mountain Subalpine-Montane Mesic Meadow		34925	2	32673	1106	1145	19	32411	2495

Appendix D. Summary of Mapping Results	Land cover (ha)								
Ecological system	**USGS zone**		**State**				**Ecoregion**		
	Zone 8	**Zone 9**	**WA**	**OR**	**ID**	**NV**	**CB**	**BM**	**NBR**
Rocky Mountain Subalpine-Montane Riparian Shrubland	3	36540	419	35137	724	239	200	29712	6631
Rocky Mountain Subalpine-Montane Riparian Woodland		14399	357	14026	16		29	14365	5
Ruderal Wetland	7515		7223	205	87		7515	0	
Temperate Pacific Subalpine-Montane Wet Meadow		1393		973	406	14	2	369	1022