

Appendix III: Ecological System Definitions

Descriptions Of Ecological Systems (Terrestrial Habitats) Found In Wyoming

It should again be noted, if an individual ecosystem consists of fewer than ten acres in Wyoming, it was excluded from the habitat analysis. As such these areas have not been defined here. This information was derived from the NatureServe document, *Ecological Systems of the United States, A Working Classification Of U.S. Terrestrial Systems* and the associated database, systems2000.mdb. Both were obtained from the NatureServe Website (<http://www.natureserve.org/publications/usEcologicalsystems.jsp>) on April 8, 2005.

CES303.659 CENTRAL MIXEDGRASS PRAIRIE

Division 303, Herbaceous

Spatial Scale & Pattern: Matrix

Classification Confidence: high

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

Concept: This mixedgrass prairie system ranges from South Dakota to northern Texas and is bordered by the shortgrass prairie on the western edge and the tallgrass prairie to the east. The loessal regions in west-central Kansas and central Nebraska, the Red Hills region of south-central Kansas and northern Oklahoma are all located within this system. Because of its proximity to other ecoregions, this system contains elements from both shortgrass and tallgrass prairies, which combine to form the mixedgrass prairie ecological system throughout its range. The distribution, species richness and productivity of plant species within the mixedgrass ecological system is controlled primarily by environmental conditions, in particular soil moisture and topography. Grazing and fire are important dynamic processes in this system. The relative dominance of the various grass and forb species within different associations in the system also can strongly depend on the degree of natural or human disturbance. This system can contain grass species such as *Bouteloua curtipendula*, *Schizachyrium scoparium*, *Andropogon gerardii*, *Hesperostipa comata*, *Sporobolus heterolepis*, and *Bouteloua gracilis*, although the majority of the associations within the region are dominated by *Pascopyrum smithii* or *Schizachyrium scoparium*. Numerous forb and sedge species (*Carex* spp.) can also occur within the mixedgrass system in the Western Great Plains. Although forbs do not always significantly contribute to the canopy, they can be very important. Some dominant forb species include *Ambrosia psilostachya*, *Echinacea angustifolia*, and *Lygodesmia juncea*. Oak species such as *Quercus macrocarpa* can occur also in areas protected from fire due to topographic position. This can cause an almost oak savanna situation in certain areas, although fire suppression may allow for a more closed canopy and expansion of bur oak beyond those sheltered areas. In those situations, further information will be needed to determine if those larger areas with a more closed canopy of bur oak should be considered part of Western Great Plains Dry Bur Oak Forest and Woodland (CES303.667). Likewise, within the mixedgrass system, small seeps may occur, especially during the wettest years. Although these are not considered a separate system, the suppression of fire within the region has enabled the invasion of both exotics and some shrub species such as *Juniperus virginiana* and also allowed for the establishment of *Pinus ponderosa* in some northern areas.

References: Barbour and Billings 1988, Ricketts et al. 1999, Weaver and Albertson 1956, Weaver and Bruner 1948

CES304.775 INTER-MOUNTAIN BASINS ACTIVE AND STABILIZED DUNE

Division 304, Barren

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

Required Classifiers: Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland

Diagnostic Classifiers: Dune (Landform), Dune field, Dune (Substrate), Temperate [Temperate Continental], Sand Soil Texture, Aridic, W-Landscape/High Intensity

Concept: This ecological system occurs in the Intermountain 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 the shifting, coarse-textured substrate (usually quartz sand) and form patchy or open grasslands, shrublands or steppe composed of *Achnatherum hymenoides*, *Artemisia filifolia*, *Artemisia tridentata* ssp. *tridentata*,

Atriplex canescens, *Ephedra* spp., *Coleogyne ramosissima*, *Ericameria nauseosa*, *Leymus flavescens*, *Prunus virginiana*, *Psoralidium lanceolatum*, *Purshia tridentata*, *Sporobolus airoides*, *Tetradymia tetrameres*, or *Tiquilia* spp.

References: Anderson 1999, Bowers 1982, Fryberger et al. 1990, Knight 1994, Pineada et al. 1999

CES304.777 INTER-MOUNTAIN BASINS BIG SAGEBRUSH SHRUBLAND

Division 304, Shrubland

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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: This ecological system occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains and foothills between 1500-2300 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 *Sarcobatus vermiculatus* and *Atriplex* spp. may be present in some stands. *Ericameria nauseosa* or *Chrysothamnus viscidiflorus* 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*.

References: Barbour and Billings 1988, Barbour and Major 1977, Holland and Keil 1995, West 1983a

CES304.778 INTER-MOUNTAIN BASINS BIG SAGEBRUSH STEPPE

Division 304, Steppe/Savanna

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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: This widespread matrix ecological system occurs throughout much of the Columbia Plateau and northern Great Basin and Wyoming, and is found at slightly higher elevations further south. 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*, and/or *Purshia tridentata* dominating or codominating the open to moderately dense (10-40% cover) shrub layer. *Atriplex confertifolia*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Tetradymia* spp., or *Artemisia frigida* may be common especially in disturbed stands. Associated graminoids include *Achnatherum hymenoides*, *Calamagrostis montanensis*, *Elymus lanceolatus* ssp. *lanceolatus*, *Festuca idahoensis*, *Festuca campestris*, *Koeleria macrantha*, *Poa secunda*, and *Pseudoroegneria spicata*. Common forbs are *Phlox hoodii*, *Arenaria* spp., and *Astragalus* spp. Areas with deeper soils more commonly support *Artemisia tridentata* ssp. *tridentata* but have largely been converted for other land uses. Microphytic crust is very important in this ecological system. 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 in the northern Columbia Plateau where it forms a landscape mosaic pattern with shallow-soil scabland shrublands.

References: Barbour and Major 1977, Barbour and Major 1988, Daubenmire 1970, Knight 1994, Mueggler and Stewart 1980, West 1983c

CES304.779 INTER-MOUNTAIN BASINS CLIFF AND CANYON

Division 304, Barren

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

Required Classifiers: Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland

Diagnostic Classifiers: Cliff (Landform), Rock Outcrops/Barrens/Glades

Concept: 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 are unstable scree and talus slopes that typically occur 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.

References: Knight 1994

CES304.780 INTER-MOUNTAIN BASINS GREASEWOOD FLAT

Division 304, Mixed Upland and Wetland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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: This ecological system occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains. It typically occurs near drainages on stream terraces and flats or may form rings around playas. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. This system usually occurs as a mosaic of multiple communities, with open to moderately dense shrublands dominated or codominated by *Sarcobatus vermiculatus*. *Atriplex canescens*, *Atriplex confertifolia*, or *Krascheninnikovia lanata* may be present to codominant. Occurrences are often surrounded by mixed salt desert scrub. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Sporobolus airoides*, *Distichlis spicata* (where water remains ponded the longest), or *Eleocharis palustris* herbaceous types.

References: Knight 1994, West 1983b

CES304.784 INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB

Division 304, Shrubland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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: This extensive ecological system includes open-canopied shrublands of typically saline desert 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*. 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*.

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

CES304.785 INTER-MOUNTAIN BASINS MONTANE SAGEBRUSH STEPPE

Division 304, Steppe/Savanna

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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

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

Concept: 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. 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. It is composed primarily of mountain sagebrush (*Artemisia tridentata* ssp. *vaseyana*) and related taxa such as *Artemisia tridentata* ssp. *spiciformis* (= *Artemisia spiciformis*), non-riparian *Artemisia cana* ssp. *viscidula*, and *Artemisia arbuscula* ssp. *arbuscula*. *Purshia tridentata* may codominate or even dominate some stands. 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*, and *Pseudoroegneria spicata*. Frequent wildfire maintains an open herbaceous-rich steppe condition.

References: Hansen et al. 1995, Hironaka et al. 1983, Johnston 2001, Mueggler and Stewart 1980, Neely et al. 2001, Padgett et al. 1989, West 1983c

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

Division 304, Forest and Woodland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Montane [Lower Montane], Lowland [Foothill], Aridic, *Cercocarpus ledifolius*

Concept: 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 it may occur as a small tree in steppe areas. 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. Scattered junipers or pines may also occur. *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.

References: Knight 1994, Knight et al. 1987, Lewis 1975, Mueggler and Stewart 1980

CES304.786 INTER-MOUNTAIN BASINS PLAYA

Division 304, Barren

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

Required Classifiers: Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland, Wetland

Diagnostic Classifiers: Lowland [Lowland], Playa, Temperate [Temperate Xeric], Alkaline Soil, Saline Substrate Chemistry, Aridic, Depressional, Alkaline Water, Saline Water Chemistry, Caliche Layer, Impermeable Layer, Intermittent Flooding

Concept: 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 sub-horizon 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: Need to incorporate material from Oregon and Idaho, Wyoming? See Jimmy's Columbia Plateau systems list for associations of playas.

References: Knight 1994, Nachlinger et al. 2001

CES304.787 INTER-MOUNTAIN BASINS SEMI-DESERT GRASSLAND

Division 304, Herbaceous

Spatial Scale & Pattern: Large Patch**Classification Confidence:** medium**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland**Diagnostic Classifiers:** Lowland [Foothill], Lowland [Lowland], Herbaceous, Temperate [Temperate Xeric], Alkaline Soil, Aridic, Graminoid

Concept: 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) in elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesa tops, 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 foothills 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 torreyana*, or *Pleuraphis jamesii*, and may include scattered shrubs and dwarf-shrubs of species of *Artemisia*, *Atriplex*, *Coleogyne*, *Ephedra*, *Gutierrezia*, or *Krascheninnikovia lanata*.

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

CES304.789 INTER-MOUNTAIN BASINS SHALE BADLAND

Division 304, Shrubland

Spatial Scale & Pattern: Large Patch**Classification Confidence:** medium**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland**Diagnostic Classifiers:** Lowland [Lowland], Badlands, Badland, Alkaline Soil, Shale and Mudstone, Silt Soil Texture, Clay Soil Texture

Concept: This widespread ecological system of the Intermountain western U.S. is composed of barren and sparsely vegetated substrates (<10% plant cover) typically derived from marine shales, but also including substrates derived from siltstones and mudstones (clay). 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, e.g., *Atriplex corrugata*, *Atriplex gardneri*, *Artemisia pedatifida*, and herbaceous vegetation.

References: DeVelice and Lesica 1993, Knight 1994, Knight et al. 1987

CES300.728 NORTH AMERICAN ALPINE ICE FIELD

Division 300, Barren

Spatial Scale & Pattern: Large Patch**Classification Confidence:** high**Required Classifiers:** Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland**Diagnostic Classifiers:** Alpine/AltiAndino [Alpine/AltiAndino], Ice Fields / Glaciers, Glaciated, Alpine Slopes

Concept: Widespread ecological system is composed of unvegetated landscapes of annual/perennial ice and snow at the highest elevations, where snowfall exceeds melting. The primary ecological processes include snow 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 tundra dry meadow, wet meadow, fell-fields, and dwarf-shrubland.

References: Meidinger and Pojar 1991, Neely et al. 2001

CES300.729 NORTH AMERICAN ARID WEST EMERGENT MARSH

Division 300, Herbaceous Wetland

Spatial Scale & Pattern: Small Patch**Classification Confidence:** high**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Wetland

Diagnostic Classifiers: Herbaceous, Mineral: W/ A-Horizon >10 cm, Graminoid, Aquatic Herb, Depressional [Lakeshore], Depressional [Pond], Deep (>15 cm) Water, Saturated Soil

Concept: This widespread ecological system occurs throughout much of the arid and semi-arid regions of western North America. 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. 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*).

References: Brown 1982, 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

CES306.807 NORTHERN ROCKY MOUNTAIN SUBALPINE DRY PARKLAND

Division 306, Forest and Woodland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Montane [Upper Montane], Ridge/Summit/Upper Slope, Very Short Disturbance Interval, W-Patch/High Intensity, W-Landscape/Medium Intensity, Upper Treeline

Concept: This system of the northern Rockies is typically a high-elevation mosaic of stunted tree clumps 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*. Above the continuous forest line, these woodlands occur as a mosaic of tree islands or patches separated by subalpine meadow or rock outcrops. Landforms include ridgetops, mountain slopes, glacial trough walls and moraines, talus slopes, land and rock slides, and cirque headwalls and basins. Some sites have little snow accumulation because of high winds and sublimation. In this harsh wind-swept environment trees are stunted and flagged from wind damage. The stands or patches often originate when *Picea engelmannii* or *Pinus albicaulis* colonize a sheltered site such as the lee side of a rock. *Abies lasiocarpa* then can colonize in the shelter of the *Picea engelmannii*, and may form a dense canopy by branch layering. Other woody species include shrubs and dwarf-shrubs, such as *Phyllodoce glanduliflora*, *Kalmia polifolia*, *Ribes montigenum*, *Salix brachycarpa*, *Salix glauca*, *Salix planifolia*, *Vaccinium membranaceum* and *Vaccinium scoparium*, that may be present to codominant. The herbaceous layer is sparse under dense shrub canopy, or may be dense where the shrub canopy is open or absent.

References: Canadian Rockies Ecoregional Plan 2002, Meidinger and Pojar 1991

CES303.674 NORTHWESTERN GREAT PLAINS MIXEDGRASS PRAIRIE

Division 303, Herbaceous

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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

Concept: This system can extend from northern Nebraska into southern Canada on loamy glacial tills and clay to clay-loam soils. The topography where this system occurs is broken by many glacial pothole lakes, and this system may be proximate to Great Plains Prairie Pothole (CES303.661). Historically, this system covered approximately 38 million ha in Nebraska, North and South Dakota, and Canada; now it covers approximately 270,000 km². This system is similar to Central Mixedgrass Prairie (CES303.659) and can contain elements of Great Plains tallgrass and shortgrass systems. However, it differs from Central Mixedgrass Prairie (CES303.659) in that the cooler climate in this region allows natural cool-season grasses to be more important (greater than 50% cover). The growing season and rainfall are intermediate to drier units to the west and mesic tallgrass regions to the east. Typical dominants include *Festuca* spp., *Pascopyrum smithii*, and *Nassella* spp. Shrub species such as *Symphoricarpos* spp. and *Artemisia frigida* also occur. Those areas with greater than 60% cover of natural shrub species would be considered part of Northwestern Great Plains Shrubland (CES303.662). Fire and grazing constitute the primary dynamics

affecting this system. Drought can also impact this system. With fire suppression and heavy grazing, cool-season exotics such as *Poa pratensis* and *Bromus inermis* can increase in dominance. Likewise, shrub species such as *Juniperus virginiana* can also increase in dominance with fire suppression. This system is one of the most disturbed grassland systems (an estimated 75% percent of the region where this system occurs has been heavily altered), and only few remnant patches have escaped conversion to agriculture.

References: Bailey et al. 1994, Barbour and Billings 1988, Ricketts et al. 1999, Weaver 1954

CES306.809 ROCKY MOUNTAIN ALPINE BEDROCK AND SCREE

Division 306, Barren

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

Required Classifiers: Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland

Diagnostic Classifiers: Alpine/AltiAndino [Alpine/AltiAndino], Talus (Substrate), Rock Outcrops/Barrens/Glades, Oligotrophic Soil, Very Shallow Soil, Alpine Slopes

Concept: 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.

References: Anderson 1999, Canadian Rockies Ecoregional Plan 2002, Cooper et al. 1997, Komarkova 1980, Komarkova 1976, Meidinger and Pojar 1991, Neely et al. 2001, Nelson 1998, Willard 1963

CES306.813 ROCKY MOUNTAIN ASPEN FOREST AND WOODLAND

Division 306, Forest and Woodland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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: This widespread ecological system is more common in the southern and central Rocky Mountains, but occurs throughout much of the western U.S. and north into Canada, in the montane and subalpine zones. 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, and secondarily 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. 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.

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

CES306.815 ROCKY MOUNTAIN CLIFF AND CANYON

Division 306, Barren

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

Required Classifiers: Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland

Diagnostic Classifiers: Canyon, Cliff (Landform), Ridgetop bedrock outcrop, Talus (Substrate), Rock Outcrops/Barrens/Glades, Oligotrophic Soil, Very Shallow Soil, Landslide

Concept: 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 type. Also included are unstable scree and talus slopes that typically occur below cliff faces. There may be small patches of dense vegetation, but it typically includes scattered trees and/or shrubs. Characteristic trees includes *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: Very broad elevation range (<3350 m) for system - consider dividing into foothills/montane and subalpine?

References: Andrews and Righter 1992, Canadian Rockies Ecoregional Plan 2002, Hess and Wasser 1982, Neely et al. 2001, Peet 1981

CES306.816 ROCKY MOUNTAIN DRY TUNDRA

Division 306, Herbaceous

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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: 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. 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*, *Deschampsia caespitosa*, *Festuca brachyphylla*, *Festuca idahoensis*, *Geum rossii*, *Kobresia myosuroides*, *Phlox pulvinata*, and *Trifolium dasyphyllum*. Although alpine tundra dry meadow 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.

References: Anderson 1999, Baker 1980a, Bamberg 1961, Bamberg and Major 1968, Canadian Rockies Ecoregional Plan 2002, Cooper et al. 1997, Komarkava 1980, Komarkova 1976, Meidinger and Pojar 1991, Neely et al. 2001, Schwan and Costello 1951, Thilenius 1975, Willard 1963

CES306.817 ROCKY MOUNTAIN FOOTHILL GRASSLAND

Division 306, Herbaceous

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Lowland [Foothill], Toeslope/Valley Bottom, Clay Soil Texture, Aridic, Short Disturbance Interval [Periodicity/Irregular Disturbance], F-Patch/Low Intensity, Graminoid

Concept: This system typically occurs between 1600-2200 m in elevation. It is best characterized as a mixed-grass to tallgrass prairie on mostly moderate to gentle slopes, usually at the base of foothill slopes, e.g., the hogbacks of the Rocky Mountain Front Range. It typically occurs as a relatively narrow elevational band between montane woodlands and shrublands and the shortgrass steppe, but extends east on the Front Range piedmont, along the chalk bluffs along the Colorado-Wyoming border, out from the Palmer Divide, and on piedmont slopes below mesas in northeastern New Mexico. A combination of increased precipitation from orographic rain, temperature, and soils limit this system to the lower elevations zone with approximately 40 cm of precipitation/year. It is maintained by frequent fire and associated with well-drained clay soils. Usually occurrences of this system have multiple plant associations that may be dominated by *Andropogon gerardii*, *Schizachyrium scoparium*, *Muhlenbergia montana*, *Nassella viridula*, *Pascopyrum smithii*, *Sporobolus cryptandrus*, *Bouteloua gracilis*, *Hesperostipa comata*, or *Hesperostipa neomexicana*. In Wyoming, typical grasses found in this system include *Pseudoroegneria spicata*,

Festuca idahoensis, *Hesperostipa comata*, and species of *Poa*. Typical adjacent ecological systems include foothill shrublands, ponderosa pine savannas, juniper savannas, as well as shortgrass prairie.

Comments: Need to incorporate Northern Rockies information.

References: Anderson 1999, Hess and Wasser 1982, Mast et al. 1997, Mast et al. 1998, Neely et al. 2001, Opler and Krizek 1984

CES306.955 ROCKY MOUNTAIN FOOTHILL LIMBER PINE-JUNIPER WOODLAND

Division 306, Forest and Woodland

Spatial Scale & Pattern: Large Patch

Classification Confidence: low

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

Diagnostic Classifiers: Lowland [Foothill], Forest and Woodland (Treed), Very Shallow Soil, Mineral: W/ A-Horizon <10 cm, Sand Soil Texture, Aridic, Long Disturbance Interval, F-Patch/High Intensity, Needle-Leaved Tree, *Pinus flexilis*, *Juniperus scopulorum*, *J. osteosperma*

Concept: This ecological system occurs in foothill and lower montane zones in the Rocky Mountains from northern Montana south to central Colorado and on escarpments across Wyoming extending out into the western Great Plains. Elevation ranges from 1000-2400 m. It is restricted to shallow soils and fractured bedrock derived from a variety of parent material including limestone, sandstone, dolomite, granite and colluvium. Soils have a high rock component (typically over 50% cover) and are coarse to fine-textured, often gravelly and calcareous. Slopes are typically moderately steep to steep. At higher elevations it is limited to the most xeric aspects on rock outcrops, and at lower elevations to the relatively mesic north aspects. Fire is infrequent and spotty because rocky substrates prevent a continuous vegetation canopy needed to spread. Vegetation is characterized by an open tree canopy or patchy woodland that is dominated by either *Pinus flexilis*, *Juniperus osteosperma*, or *Juniperus scopulorum*. *Pinus edulis* is not present. A sparse to moderately dense short-shrub layer, if present, may include a variety of shrubs, such as *Artemisia nova*, *Artemisia tridentata*, *Cercocarpus ledifolius*, *Cercocarpus montanus*, *Cornus sericea*, *Ericameria nauseosa*, *Purshia tridentata*, *Rhus trilobata*, or *Rosa woodsii*. Herbaceous layers are generally sparse, but range to moderately dense and are typically dominated by perennial graminoids such as *Bouteloua gracilis*, *Leucopoa kingii*, *Hesperostipa comata*, *Koeleria macrantha*, *Piptatherum micranthum*, *Poa secunda*, or *Pseudoroegneria spicata*. Within this ecological system there may be small patches of grassland or shrubland composed of some of the above species.

References: Canadian Rockies Ecoregional Plan 2002, DeVelice and Lesica 1993, Hansen and Hoffman 1988, Knight 1994, Knight et al. 1987, Thilenius et al. 1995

CES306.818 ROCKY MOUNTAIN GAMBEL OAK-MIXED MONTANE SHRUBLAND

Division 306, Shrubland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Shrubland (Shrub-dominated), Shallow Soil, Mineral: W/ A-Horizon <10 cm, Sand Soil Texture, Loam Soil Texture, Ustic, Unconsolidated, Intermediate Disturbance Interval [Periodicity/Polycyclic Disturbance], Broad-Leaved Deciduous Shrub

Concept: This ecological system occurs in the mountains, plateaus and foothills in the southern Rocky Mountains and Colorado Plateau including the Uinta and Wasatch ranges and the Mogollon Rim. These shrublands are most commonly found along dry foothills, lower mountain slopes, and at the edge of the western Great Plains from approximately 2000 to 2900 m in elevation, and are often situated above pinyon-juniper woodlands. Substrates are variable and include soil types ranging from calcareous, heavy, fine-grained loams to sandy loams, gravelly loams, clay loams, deep alluvial sand, or coarse gravel. The vegetation is typically dominated by *Quercus gambelii* alone or codominant with *Amelanchier alnifolia*, *Amelanchier utahensis*, *Artemisia tridentata*, *Cercocarpus montanus*, *Prunus virginiana*, *Purshia stansburiana*, *Purshia tridentata*, *Robinia neomexicana*, *Symphoricarpos oreophilus*, or *Symphoricarpos rotundifolius*. There may be inclusions of other mesic montane shrublands with *Quercus gambelii* absent or as a relatively minor component. This ecological system intergrades with the lower montane-foothills shrubland system and shares many of the same site characteristics. Density and cover of *Quercus gambelii* and *Amelanchier* spp. often increase after fire.

References: Christensen 1955, Comer et al. 2002, Johnston and Hendzel 1985, Kunzler and Harper 1980, Kunzler et al. 1981, McKell 1950, Neely et al. 2001, Price and Brotherson 1987, Ream 1960, Ream 1964, Rondeau 2001, Shepperd 1990, Tuhy et al. 2002

CES306.820 ROCKY MOUNTAIN LODGEPOLE PINE FOREST

Division 306, Forest and Woodland

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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: This system is widespread in upper montane to subalpine elevations of the Rocky Mountains, Intermountain region, and north into the Canadian Rockies. 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 are early to mid-successional forests which developed following fires. Some *Pinus contorta* forests will persist on sites that are too extreme for other conifers to establish. 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. Soils supporting these forests are typically well-drained, gravelly, have coarse textures, are 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.

References: Alexander 1986, Alexander et al. 1987, Anderson 1999, Arno et al. 1985, Barrows et al. 1977, Burns and Honkala 1990a, Canadian Rockies Ecoregional Plan 2002, Despain 1973a, Despain 1973b, 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

CES306.822 ROCKY MOUNTAIN LOWER MONTANE-FOOTHILL SHRUBLAND

Division 306, Shrubland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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: 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.

References: 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, Thilenius et al. 1995

CES306.821 ROCKY MOUNTAIN LOWER MONTANE RIPARIAN WOODLAND AND SHRUBLAND

Division 306, Woody Wetland

Spatial Scale & Pattern: Linear

Classification Confidence: medium

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

Diagnostic Classifiers: Montane [Lower Montane], Mineral: W/ A-Horizon <10 cm, Unconsolidated, Short (50-100 yrs) Persistence, Riverine / Alluvial, Short (<5 yrs) Flooding Interval

Concept: This system is found throughout the Rocky Mountain region 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.

References: Baker 1988, Baker 1989a, Baker 1989b, Baker 1990, Comer et al. 2002, Crowe and Clausnitzer 1997, Daubenmire 1952, 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, Szaro 1989, Tuhy et al. 2002, Walford 1996, Walford et al. 1997, Walford et al. 2001

CES306.823 ROCKY MOUNTAIN MONTANE DRY-MESIC MIXED CONIFER FOREST AND WOODLAND

Division 306, Forest and Woodland

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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

Diagnostic Classifiers: Montane [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: This is a highly variable ecological system of the montane zone of the Rocky Mountains. It occurs throughout the southern Rockies, north and west into Utah, Nevada, western Wyoming and Idaho. These are mixed-conifer forests occurring on all aspects at elevations ranging from 1200 to 3300 m. Rainfall averages less than 75 cm per year (40-60 cm) with summer "monsoons" during the growing season contributing substantial moisture. The composition and structure of overstory is dependent upon the temperature and moisture relationships of the site, and the successional status of the occurrence. *Pseudotsuga menziesii* and *Abies concolor* are most frequent, but *Pinus ponderosa* may be present to codominant. *Pinus flexilis* is common in Nevada. *Pseudotsuga menziesii* forests occupy drier sites, and *Pinus ponderosa* is a common codominant. *Abies concolor*-dominated forests occupy cooler sites, such as upper slopes at higher elevations, canyon sideslopes, ridgetops, and north- and east-facing slopes which burn somewhat infrequently. *Picea pungens* is most often found in cool, moist locations, often occurring as smaller patches within a matrix of other associations. As many as seven conifers can be found growing in the same occurrence, and there are a number of cold-deciduous shrub and graminoid species common, including *Arctostaphylos uva-ursi*, *Mahonia repens*, *Paxistima myrsinites*, *Symphoricarpos oreophilus*, *Jamesia americana*,

Quercus gambelii, and *Festuca arizonica*. This system was undoubtedly characterized by a mixed severity fire regime in its "natural condition," characterized by a high degree of variability in lethality and return interval.

References: Alexander et al. 1984b, Alexander et al. 1987, Boyce 1977, Bunin 1975c, Burns and Honkala 1990a, Canadian Rockies Ecoregional Plan 2002, Chappell et al. 1997, Comer et al. 2002, Cooper et al. 1987, DeVelice et al. 1986, Fitzhugh et al. 1987, Giese 1975, Heinze et al. 1962, Hess 1981, Hess and Alexander 1986, Hess and Wasser 1982, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Komarkova et al. 1988b, Mauk and Henderson 1984, Muldavin et al. 1996, Nachlinger et al. 2001, Neely et al. 2001, Pfister 1972, Pfister et al. 1977, Steele et al. 1981, Tuhy et al. 2002, Youngblood and Mauk 1985

CES306.825 ROCKY MOUNTAIN MONTANE MESIC MIXED CONIFER FOREST AND WOODLAND

Division 306, Forest and Woodland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Forest and Woodland (Treed), Ravine, Stream terrace (undifferentiated), Toeslope, Mesotrophic Soil, Ustic, Long Disturbance Interval, F-Patch/Low Intensity, F-Landscape/Low Intensity, Needle-Leaved Tree, RM Montane Dry-Mesic Mixed Conifer

Concept: These are mixed-conifer forests of the Rocky Mountains west into the ranges of the Great Basin, occurring predominantly in cool ravines and on north-facing slopes. Elevations range from 1200 to 3300 m. Occurrences of this system are found on cooler and more mesic sites than Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland (CES306.823). Such sites include lower and middle slopes of ravines, along stream terraces, moist, concave topographic positions and north- and east-facing slopes which burn somewhat infrequently. *Pseudotsuga menziesii* and *Abies concolor* are most common canopy dominants, but *Picea engelmannii*, *Picea pungens*, or *Pinus ponderosa* may be present. This system includes mixed conifer/*Populus tremuloides* stands. A number of cold-deciduous shrub species can occur, including *Acer glabrum*, *Acer grandidentatum*, *Alnus incana*, *Betula occidentalis*, *Cornus sericea*, *Jamesia americana*, *Physocarpus malvaceus*, *Robinia neomexicana*, *Vaccinium membranaceum*, and *Vaccinium myrtillus*. Herbaceous species include *Bromus ciliatus*, *Carex geyeri*, *Carex rossii*, *Carex siccata*, *Muhlenbergia virescens*, *Pseudoroegneria spicata*, *Erigeron eximius*, *Fragaria virginiana*, *Luzula parviflora*, *Osmorhiza berteroi*, *Packera cardamine*, *Thalictrum occidentale*, and *Thalictrum fendleri*. Naturally occurring fires are of variable return intervals, and mostly light, erratic, and infrequent due to the cool, moist conditions.

Comments: This system will need to be modeled to separate from similar dry-mesic system.

References: Agree 1982, Alexander et al. 1984a, Alexander et al. 1984b, Alexander et al. 1987, Anderson 1999, Boyce 1977, Bunin 1975c, Comer et al. 2002, Cooper et al. 1987, DeVelice and Ludwig 1983c, DeVelice et al. 1986, Dieterich 1979, Fitzhugh et al. 1987, Fowells 1965, Giese 1975, Heinze et al. 1962, Hess 1981, Hess and Alexander 1986, Hess and Wasser 1982, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Hopkins 1982, Komarkova et al. 1988b, Mauk and Henderson 1984, Moir and Ludwig 1979, Nachlinger et al. 2001, Neely et al. 2001, Parson and DeBenedetti 1979, Pfister 1972, Tuhy et al. 2002, Youngblood and Mauk 1985

CES306.826 ROCKY MOUNTAIN PONDEROSA PINE SAVANNA

Division 306, Steppe/Savanna

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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, Graminoid, *Pinus ponderosa* with grassy understory

Concept: This ecological system occurs throughout the inland portions of western North America, primarily in the foothills and montane zones from approximately a low elevation of 335 m in southern British Columbia, to well over 2700 m on the higher plateaus of the Southwest. It is found on rolling plains, plateaus, or dry slopes usually on more southerly aspects. This system is best described as a savanna that has widely spaced (>150 years old) *Pinus ponderosa*. It is maintained by a fire regime of frequent, low-intensity surface fires. A healthy occurrence often consists of open and park-like stands dominated by *Pinus ponderosa*. 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. Important species include *Festuca arizonica*, *Pseudoroegneria spicata*,

Andropogon gerardii, *Schizachyrium scoparium*, *Festuca* spp., and *Bouteloua gracilis*. A century of anthropogenic disturbance and fire suppression has resulted in a higher density of *Pinus ponderosa* trees, altering the fire regime and species composition. Presently, many stands contain understories of more shade-tolerant species, such as *Pseudotsuga menziesii* and/or *Abies* spp., as well as younger cohorts of *Pinus ponderosa*.

References: Anderson 1999, Harrington and Sackett 1992, Jones 1998, Levad 1998, Mehl 1992, Meidinger and Pojar 1991, Winn 1998

CES306.827 ROCKY MOUNTAIN PONDEROSA PINE WOODLAND

Division 306, Forest and Woodland

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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, *Pinus ponderosa* with shrubby understory

Concept: This very widespread ecological system is most common throughout the cordillera of the Rocky Mountains. It is also found in the Colorado Plateau region, west into scattered locations in the Great Basin, and north into southern British Columbia. These woodlands occur at the lower treeline/ecotone between grassland or shrubland and more mesic coniferous forests typically in warm, dry, exposed sites. Elevations range from less than 500 m in British Columbia to 2800 m in the New Mexico 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 igneous, metamorphic, and sedimentary material derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acid pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. 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* is the predominant conifer; *Pseudotsuga menziesii*, *Pinus edulis*, and *Juniperus* spp. may be present in the tree canopy. The understory is usually shrubby, with *Artemisia nova*, *Artemisia tridentata*, *Arctostaphylos patula*, *Arctostaphylos uva-ursi*, *Cercocarpus montanus*, *Cercocarpus ledifolius*, *Purshia stansburiana*, *Purshia tridentata*, *Quercus gambelii*, *Symphoricarpos oreophilus*, *Prunus virginiana*, *Amelanchier alnifolia*, and *Rosa* spp. common species. *Pseudoroegneria spicata* and species of *Hesperostipa*, *Achnatherum*, *Festuca*, *Muhlenbergia*, and *Bouteloua* are some of the common grasses. Mixed fire regimes and ground fires of variable return interval maintain these woodlands, depending on climate, degree of soil development, and understory density.

Comments: This system intergrades with Rocky Mountain Ponderosa Pine Savanna (CES306.826). They are distinguished by the high frequency, surface-fire regime, less steep or rocky environmental setting, and more open grassy understory structure of the savanna system.

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Cooper et al. 1987, Daubenmire and Daubenmire 1968, DeVelice et al. 1986, Hess and Alexander 1986, Hoffman and Alexander 1976, Komarkova et al. 1988b, Marriott and Faber-Langendoen 2000, Mauk and Henderson 1984, Mehl 1992, Meidinger and Pojar 1991, Muldavin et al. 1987, Muldavin et al. 1996, Nachlinger et al. 2001, Neely et al. 2001, Pfister et al. 1977, Reid et al. 1999, Rondeau 2001, Tuhy et al. 2002, Youngblood and Mauk 1985

CES306.833 ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN WOODLAND

Division 306, Woody Wetland

Spatial Scale & Pattern: Linear

Classification Confidence: medium

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

Diagnostic Classifiers: Montane [Upper Montane], Montane [Montane], Forest and Woodland (Treed), RM Subalpine/Montane Riparian Shrubland, Riverine / Alluvial, Short (<5 yrs) Flooding Interval

Concept: 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. 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 1500-3300 m (4920-10,830 feet) and are 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 include *Abies lasiocarpa*, *Picea engelmannii*, *Pseudotsuga menziesii*, *Picea pungens*, *Populus tremuloides*, and *Juniperus scopulorum*. Other trees that may be present include *Alnus incana*, *Abies concolor*, *Pinus contorta*, *Populus angustifolia*, *Acer negundo*, and *Juniperus osteosperma*.

References: Baker 1988, Baker 1989a, Baker 1989b, Baker 1990, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Crowe and Clausnitzer 1997, 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, Tuhy et al. 2002

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

Division 306, Forest and Woodland

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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: 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 are the matrix forests of the subalpine zone, with elevations ranging from 1525 to 3355 m (5000-11,000 feet). 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. *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. Xeric species may include *Juniperus communis*, *Linnaea borealis*, *Mahonia repens*, or *Vaccinium scoparium*. Disturbance includes occasional blow-down, insect outbreaks and stand-replacing fire.

References: Alexander and Ronco 1987, Alexander et al. 1984a, Alexander et al. 1987, Anderson 1999, Brand et al. 1976, Canadian Rockies Ecoregional Plan 2002, Clagg 1975, Comer et al. 2002, Cooper et al. 1987, Daubenmire and Daubenmire 1968, DeVelice et al. 1986, 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, Komarkova et al. 1988b, 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, Youngblood and Mauk 1985

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

Division 306, Forest and Woodland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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: This is a high-elevation system of the Rocky Mountains, dominated by *Picea engelmannii* and *Abies lasiocarpa*. 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, plateaulike surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces. Mesic understory shrubs include *Rhododendron albiflorum*, *Amelanchier alnifolia*, *Rubus parviflorus*, *Ledum glandulosum*, *Phyllodoce empetriformis*, and *Salix* spp. Herbaceous species include *Actaea rubra*, *Maianthemum stellatum*, *Cornus canadensis*, *Erigeron eximius*, *Saxifraga bronchialis*, *Luzula glabrata* var. *hitchcockii*, or *Calamagrostis canadensis*. Disturbances include occasional blow-down, insect outbreaks and stand-replacing fire.

References: Alexander and Ronco 1987, Alexander et al. 1984a, Alexander et al. 1987, Anderson 1999, Brand et al. 1976, Canadian Rockies Ecoregional Plan 2002, Clagg 1975, Comer et al. 2002, Cooper et al. 1987, Daubenmire and Daubenmire 1968, DeVelice et al. 1986, Fitzgerald et al. 1994, Graybosch and Buchanan 1983, Hess and Alexander 1986, Hess and Wasser 1982, Hoffman and Alexander 1976, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Komarkova et al. 1988b, 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, Youngblood and Mauk 1985

CES306.829 ROCKY MOUNTAIN SUBALPINE MESIC MEADOW

Division 306, Herbaceous

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

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

Concept: This Rocky Mountain ecological system is restricted to sites in the subalpine zone where finely textured soils, snow deposition, or wind-swept dry conditions limit tree establishment. It is found typically above 3000 m in elevation in the southern part of its range and above 1500 m in the northern part. These upland communities occur on gentle to moderate-gradient slopes. The soils are typically seasonally moist to saturated in the spring, but if so will dry out later in the growing season. They are not as wet as found in Rocky Mountain Alpine-Montane Wet Meadow (CES306.812). Vegetation is typically forb-rich, with forbs contributing more to overall herbaceous cover than graminoids. Important taxa include *Erigeron* spp., Asteraceae spp., *Mertensia* spp., *Penstemon* spp., *Campanula* spp., *Lupinus* spp., *Solidago* spp., *Ligusticum* spp., *Thalictrum occidentale*, *Valeriana sitchensis*, *Balsamorhiza sagittata*, *Wyethia* spp., *Deschampsia caespitosa*, *Koeleria macrantha*, and *Dasiphora fruticosa*. Burrowing mammals can increase the forb diversity.

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

CES306.832 ROCKY MOUNTAIN SUBALPINE-MONTANE RIPARIAN SHRUBLAND

Division 306, Woody Wetland

Spatial Scale & Pattern: Linear

Classification Confidence: medium

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

Diagnostic Classifiers: Montane [Upper Montane], Montane [Montane], Shrubland (Shrub-dominated), Broad-Leaved Deciduous Shrub, RM Subalpine/Montane Riparian Woodland, Short (50-100 yrs) Persistence, Riverine / Alluvial, Short (<5 yrs) Flooding Interval

Concept: 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.

References: Baker 1988, Baker 1989a, Baker 1989b, Baker 1990, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, 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, Szaro 1989, Tuhy et al. 2002, Walford 1996

CES306.824 SOUTHERN ROCKY MOUNTAIN MONTANE GRASSLAND

Division 306, Herbaceous

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Herbaceous, Acidic Soil, Mineral: W/ A-Horizon >10 cm, Loam Soil Texture, Silt Soil Texture, Aridic, Short Disturbance Interval, Graminoid, Cool-season bunch grasses

Concept: This Rocky Mountain ecological system typically occurs between 2200-3000 m (in the Colorado Rockies) on flat to rolling plains and parks or on lower sideslopes that are dry. Soils resemble prairie soils in that the A-horizon is dark brown, relatively high in organic matter, slightly acid, and usually well-drained. An occurrence usually consists of a mosaic of two or three plant associations with one of the following dominant bunch grasses: *Danthonia intermedia*, *Danthonia parryi*, *Festuca idahoensis*, *Festuca arizonica*, *Festuca thurberi*, *Muhlenbergia filiculmis*, or *Pseudoroegneria spicata*. The subdominants include *Muhlenbergia montana*, *Bouteloua gracilis*, and *Poa secunda*. These large-patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole, ponderosa pine, and aspen forests. In limited circumstances (e.g., South Park in Colorado) they form the "matrix" of high-elevation plateaus.

Comments: Montane grasslands are very similar and intergrade with their subalpine counterparts, but are separated here to represent those species that do not occur at higher altitudes.

References: Bowns and Bagley 1986, Comer et al. 2002, Hess 1981, Hess and Wasser 1982, Moir 1967, Neely et al. 2001, Passey et al. 1982, Shepherd 1975, Stewart 1940, Tuhy et al. 2002, Turner 1975, Turner and Dortignac 1954

CES303.663 WESTERN GREAT PLAINS BADLANDS

Division 303, Barren

Spatial Scale & Pattern: Small Patch

Classification Confidence: high

Required Classifiers: Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland

Concept: This system is found within the northern Great Plains region of the United States and Canada with some of the more known and extensive examples in North and South Dakota. In contrast to Western Great Plains Cliff and Outcrop (CES303.665), this system is typified by extremely dry and easily eroded, consolidated clays soils with bands of sandstone or isolated consolidates and little to no cover of vegetation (usually less than 10%). In those areas with vegetation, species can include scattered individuals of *Grindelia squarrosa*, *Gutierrezia sarothrae*, or *Eriogonum* spp. Patches of *Artemisia* spp. can also occur. This system occurs where the land lies well above its local base level and is created by several factors including elevation, rainfall, carving action of streams, and parent material.

References: Von Loh et al. 1999

CES303.665 WESTERN GREAT PLAINS CLIFF AND OUTCROP

Division 303, Barren

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

Required Classifiers: Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland

Concept: This system includes cliffs and outcrops throughout the Western Great Plains Division. Substrate can range from sandstone and limestone, which can often form bands in the examples of this system. Vegetation is restricted to shelves, cracks and crevices in the rock. However, this system differs from Western Great Plains Badlands (CES303.663) in that often the soil is slightly developed and less erodible, and some grass and shrub

species can occur at greater than 10%. Common species in this system include short shrubs such as *Rhus trilobata* and *Artemisia longifolia* and mixedgrass species such as *Bouteloua curtipendula* and *Bouteloua gracilis* and *Calamovilfa longifolia*. Drought and wind erosion are the most common natural dynamics affecting this system.

CES303.666 WESTERN GREAT PLAINS CLOSED DEPRESSION WETLAND

Division 303, Herbaceous Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Concept: Communities associated with the playa lakes in the southern areas of this province and the rainwater basins in Nebraska characterize this system. They are primarily upland depressional basins. This hydric system is typified by the presence of an impermeable layer such as a dense clay, hydric soil and is usually recharged by rainwater and nearby runoff. They are rarely linked to outside groundwater sources and do not have an extensive watershed. Ponds and lakes associated with this system can experience periodic drawdowns during drier seasons and years, and are often replenished by spring rains. *Eleocharis* spp., *Hordeum jubatum*, along with common forbs such as *Coreopsis tinctoria*, *Symphyotrichum subulatum* (= *Aster subulatus*), and *Polygonum pensylvanicum* (= *Polygonum bicornne*) are common vegetation in the wetter and deeper depression, while *Pascopyrum smithii* and *Buchloe dactyloides* are more common in shallow depressions in rangeland. Species richness can vary considerably among individual examples of this system and is especially influenced by adjacent land use, which is often agriculture, and may provide nutrient and herbicide runoff. Dynamic processes that affect these depressions are hydrological changes, grazing, and conversion to agricultural use.

Comments: Open and emergent marshes may be a separate system from wet meadows and wet prairies.

References: Hoagland 2000, Lauver et al. 1999

CES303.667 WESTERN GREAT PLAINS DRY BUR OAK FOREST AND WOODLAND

Division 303, Forest and Woodland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Concept: This system is dominated by *Quercus macrocarpa* and is found in upland areas throughout the Western Great Plains. Other species such as *Tilia americana*, *Juniperus virginiana*, and *Fraxinus* spp. may be present. The herbaceous layer can vary from sparsely to moderately vegetated. Historically, higher cover of grass species occurred as these stands were more open due to more frequent fires. Few good examples of this system likely remain because of past timber harvesting and heavy grazing.

Comments: Stands of bur oak can also be included within Central Mixedgrass Prairie (CES303.659); however, that system would only include small patches or single trees protected by fire. Any stands of bur oak or more substantial woodlands should be included within this system.

References: Barbour and Billings 1988, Tolstead 1947

CES303.678 WESTERN GREAT PLAINS FLOODPLAIN

Division 303, Woody Wetland

Spatial Scale & Pattern: Linear

Classification Confidence: medium

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

Concept: This system is found in the floodplains of medium and large rivers of the Western Great Plains. Alluvial soils and periodic, intermediate flooding (every 5-25 years) typify this system. Dominant communities within this system range from floodplain forests to wet meadows to gravel/sand flats; however, they are linked by underlying soils and the flooding regime. Dominant species include *Populus deltoides* and *Salix* spp. Grass cover underneath the trees is an important part of this system and is a mix of tallgrass species, including *Panicum virgatum* and *Andropogon gerardii*. *Tamarix* spp. and less desirable grasses and forbs can invade degraded areas within the floodplains, especially in the western portion of the province. These areas are often subjected to heavy grazing and/or agriculture and can be heavily degraded. Another factor is that groundwater depletion and lack of fire have created additional species changes. In most cases, the majority of the wet meadow and prairie communities may be extremely degraded or extirpated from the system.

Comments: Need to review if there needs to be another split of this system into a Central Great Plains Floodplain system and a Southern Great Plains floodplain system. Will need to review in conjunction with Northwestern Great Plains Floodplain.

References: Lauver et al. 1999, Steinauer and Rolfsmeier 2000

CES303.672 WESTERN GREAT PLAINS SHORTGRASS PRAIRIE

Division 303, Herbaceous

Spatial Scale & Pattern: Matrix

Classification Confidence: high

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

Concept: This system is found primarily in the western half of the Western Great Plains Division east of the Rocky Mountains and ranges from the Nebraska Panhandle south into Texas and New Mexico, although some examples may reach as far north as southern Canada where it grades into Northwestern Great Plains Mixedgrass Prairie (CES303.674). This system occurs primarily on flat to rolling uplands with loamy, ustic soils ranging from sandy to clayey. In much of its range, this system forms the matrix system with *Bouteloua* spp. dominating this system. Other associated graminoids may include *Buchloe dactyloides*, *Hesperostipa comata*, *Koeleria macrantha* (= *Koeleria cristata*), *Pascopyrum smithii* (= *Agropyron smithii*), and *Sporobolus cryptandrus*. Although tallgrass and mixedgrass species may be present especially on more mesic soils, they are secondary in importance to the sod-forming short grasses. Shrub species such as *Artemisia filifolia* and *Artemisia tridentata* that dominate the Western Great Plains shrubland systems may also be present. Also, because this system spans a wide range, there can be some differences in the relative dominance of some species from north to south and from east to west. Large-scale processes such as climate, fire and grazing influence this system. In contrast to other prairie systems, fire is less important, especially in the western range of this system, because the often dry and xeric climate conditions can decrease the fuel load and thus the relative fire frequency within the system. However, historically, fires that did occur were often very expansive. Currently, fire suppression and more extensive grazing in the region have likely decreased the fire frequency even more, and it is unlikely that these processes could occur at a natural scale. A large part of the range for this system (especially in the east and near rivers) has been converted to agriculture. Areas of the central and western range have been impacted by the unsuccessful attempts to develop dryland cultivation during the Dust Bowl of the 1930s. The short grasses that dominate this system are extremely drought- and grazing-tolerant. These species evolved with drought and large herbivores and, because of their stature, are relatively resistant to overgrazing. This system in combination with the associated wetland systems represents one of the richest areas for mammals and birds. Endemic bird species to the shortgrass system may constitute one of the fastest declining bird populations.

References: Barbour and Billings 1988, Dick-Peddie 1993, Lauenroth and Milchunas 1991, Milchunas et al. 1989, Ricketts et al. 1999

CES304.794 WYOMING BASINS LOW SAGEBRUSH SHRUBLAND

Division 304, Shrubland

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

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

Concept: This ecological system is composed of sagebrush dwarf-shrublands that occur in a variety of dry habitats throughout the basins of central and southern Wyoming. *Artemisia tripartita* ssp. *rupicola*-dominated dwarf-shrublands typically occur on wind-swept ridges and south and west aspect slopes above 2135 m in central and southeastern Wyoming. Substrates are shallow, fine-textured soils. *Artemisia nova*-dominated dwarf-shrublands occur on shallow, coarse-textured, calcareous substrates at lower elevations. Other shrubs and dwarf-shrubs present may include *Purshia tridentata* 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.

References: Jones 1992b, Knight 1994, Knight et al. 1987