

Upland and Wetland Ecological Systems in Colorado, Wyoming, South Dakota, Nebraska, and Kansas

Report and Map to the National Gap Analysis Program



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Citation:

Comer, P., S. Menard, M. Tuffly, K. Kindscher, R. Rondeau, G. Jones, G. Steinuaer, R. Schneider, and D. Ode. 2003. *Upland and Wetland Ecological Systems in Colorado, Wyoming, South Dakota, Nebraska, and Kansas. Report and Map to the National Gap Analysis Program.* (U.S. Geological Survey, Department of Interior). NatureServe, Arlington, Virginia. 18 pp. plus appendices.

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Funding for this report was provided by a grant from the National Gap Analysis Program in partnership with U.S. Forest Service Region 2.

Cover Photo:

Western Great Plains Sandhill Shrubland System in the foreground (with *Schizacharium scoparium* and *Artemisia filifolia*) with the Kansas Red Hills and Central Mixedgrass Prairie System in the distance. Photo © S. Menard.

Inset picture is of Rocky Mountain Subalpine Dry-Mesic Spruce-fir Forest and Woodland and Rocky Mountain Aspen Forest and Woodland Systems in foreground with Rocky Mountain Alpine Bedrock and Scree System in the distance. Maroon Bells Wilderness, Colorado. Photo © P. Comer.

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UPLAND AND WETLAND ECOLOGICAL SYSTEMS IN COLORADO, WYOMING,
SOUTH DAKOTA, NEBRASKA, AND KANSAS:
REPORT AND MAP TO THE NATIONAL GAP ANALYSIS PROGRAM

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Abstract

NatureServe has worked with the National Gap Analysis Program to map existing vegetation using the U.S. National Vegetation Classification (USNVC) classification standard at the alliance level. Many state and regional GAP programs have needed to develop map units at scales that are intermediate between the alliance level and formation level. Since the USNVC provides no intermediate scale, ad-hoc map units have been developed in each state effort, impeding the ability to create consistent regional maps. Ecological systems present an alternative and consistent method to develop “meso-scale” vegetation-based units across a region. Ecological systems are linked to the USNVC and are defined as groups of plant associations from one or more USNVC alliances that occur together on a given landscape due to similarities in ecological dynamics, underlying environmental features, and/or environmental gradients. A study was initiated in the USFS Region 2 to classify and map ecological systems in that region, linking them to the original landcover maps created by five state GAP programs. This regional effort builds directly on national classification efforts, so units developed for this project are already part of a consistent national classification of ecological systems. The original maps were grouped to create a regional coverage and then, in many instances, combined with ancillary spatial data (ecoregions, elevation, landform, National Land Cover Data, hydrography, soils, etc.), recoded to reflect 61 upland and wetland ecological systems attributed to this region. Results from this study indicate that using ecological systems could help regionalize GAP maps such that they could be more easily used for modeling vertebrate habitat ranges.

Introduction

The Gap Analysis Program (GAP) represents one of the most comprehensive efforts to map vegetation across the United States. This information is used extensively as a basis for conservation decisions, wildlife habitat models, landscape management, etc. The USDA Forest Service’s Rocky Mountain Region (USFS Region 2) is in the process of developing species assessments in order to improve the management of species in the region. USFS Region 2 requires regionally consistent and detailed distribution information for land cover and a select group of species for five states (SD, KS, NE, WY, and CO) in order to develop better species assessments. These assessments are important to the Species Conservation Project developed by the USFS to evaluate species viability at varied temporal and spatial scales (Blakenshift *et al.* 2001). This information, along with models of species’ habitats, can be used in management plans for USFS properties in this region. Specifically, USFS Region 2 needs to provide biologists with models that merge data from Gap Analysis programs with other animal models for them to aid USFS Species Assessments for 15 select species out of approximately 280 species from the USFS sensitive species list. These assessments will then provide managers with a better understanding of the ecology of the selected species and their potential response to environmental change (Blakenshift *et al.* 2001).

To develop consistent animal models, scientists first need a consistent landcover across the region. The available GAP landcover information lacks consistency across the 5 states to develop an ecologically meaningful land cover map. The individual state maps were completed using various classifications and mapping techniques. The GAP Analysis Program now uses the U.S. National Vegetation Classification (USNVC) as a classification standard for mapping existing vegetation for each state. The USNVC was originally developed by The Nature Conservancy, subsequently adopted in modified form by the Federal Geographic Data Committee as a standard for reporting vegetation information among federal agencies, and now managed by NatureServe and other partners (FGDC 1997, Grossman *et al.* 1998, NatureServe 2003a). The goals of the Gap Analysis Program include mapping vegetation using the alliance level of the USNVC using comparable methods across all states.

The USNVC, provides a hierarchical classification structure that allows for varying levels of floristic and physiognomic detail, but depending on the local circumstances, mapping protocols can easily permit designations of mapping mosaics that are “ad-hoc” or overly driven by observed patterns in available imagery. Many alliances 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 some alliances to be indistinguishable using remotely sensed imagery at a given area. The reasons for this vary

but common examples are that species that differentiate similar alliances occur beneath a dense canopy of trees or shrubs, that differential species had very similar signatures when the imagery was acquired, or, in some cases, that the scale of the alliances is below the standard minimum mapping unit. In these situations the mapping team must find other ways to define map units. To maintain a standard classification, the mapping team may consider using higher and/or finer levels of the USNVC hierarchy as map units. USNVC units at upper levels of the hierarchy, such as Formation, are driven primarily by vegetation physiognomy, rather than considerations of spatial scales and ecological variables, whereas the USNVC association unit (floristic unit finer than alliance) is typically mappable at scales of around 1:24,000 or larger and often corresponds to ecological factors at that scale. It is more difficult to identify typical spatial scales and ecological patterns for the mid-level units. So the higher levels of the USNVC hierarchy do not necessarily provide suitable classification units for mapping at “coarser” (smaller) scales. Thus, in cases where alliances are difficult to map directly, state GAP programs in this region have used a variety of methods to derive map units, from mapping associations (finer than alliances) to aggregating alliances into ad-hoc sets of coarser units that can encompass different upper physiognomic units. In addition, the minimum mapping unit used by different GAP states varies across this region. These issues led to the different states in the study region utilizing different ways of combining alliances. This leads to potential problems when crosswalking map units across state borders to derive a regionally consistent map, which also can lead to problems in developing consistent maps that predict distributions of vertebrate species across a region. NatureServe has developed a new standard method of describing and delineating vegetation communities across the landscape called ecological systems (NatureServe 2003b). This new classification focuses on the ecological and spatial relations among the types, rather than just vegetation like the USNVC. This approach will provide GAP and the USFS Region 2 the necessary tools to link wildlife models across state boundaries.

Ecological systems are groups of plant associations from one or more alliance that 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). Plant association refers to the finest classification unit as defined by the National Vegetation Classification (USNVC) (Grossman *et al.* 1998, Jennings *et al.* 2003, NatureServe 2003a), which nest under alliances used as the GAP standard for mapping. 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). Thus, ecological systems may take two forms similar in scope and concept to compositional groups and ecological complexes, units already being used by GAP that explicitly relate alliances to specific map units (Pearlstine *et al.* 1998). Because ecological systems are defined with a strong emphasis on environmental settings and dynamics, they should provide a more practical and ecologically meaningful goal for mapping at regional scales where alliance-scale mapping is not feasible (Menard and Lauer 2000). NatureServe is dedicated to the mapping of ecological systems in a consistent manner across the United States. This ecological systems layer will provide a consistent level classification of ecological units with biological and conservation utility that is necessary for many biological, ecological, conservation and resource management applications. It will also provide intuitive or widely understood concepts for grouping vegetation types that managers and other users can more readily understand.

Ecological systems can allow for useful integration and scaling among species because many animal and plant species are likely restricted to one or several ecological systems. More mobile vertebrates that use a wider variety of ecological systems typically require specific habitat components with multiple ecological system units. Because systems are directly tied to environmental conditions, features and processes, these units will be highly correlated to other variables such as topography and climate that can be used to develop wildlife habitat relationship models (WHRM). These models link patterns of known habitat use by animal species with maps of existing vegetation and can be stratified according ancillary data such as landform, soil, hydrogeomorphology, and climate to model habitat changes across a region. Thus systems could provide a way to “regionalize” these maps while still maintaining conservation units that are ecologically meaningful and can be successfully used to model habitats of specific species. NatureServe is currently working toward a first-draft classification of terrestrial ecological systems across North and South America. This document is focused on those types occurring within the states of Colorado, Kansas, Nebraska, South Dakota, and Wyoming.

In order to develop the regional map, NatureServe worked with GAP and Natural Heritage Programs to create an ecologically based land cover system for the region using ecological systems units, which are linked the USNVC (the FGDC standard for mapping vegetation communities). Once this system was established, the current GAP maps for the five states can be attributed based on this new classification and used to create a regional land coverage of vegetation communities. This involves compiling existing state GAP land cover data and classification systems to determine how units were could be attributed to individual USNVC alliances (where feasible) and to NatureServe's ecological systems. Using GAP data and ancillary spatial data, the original maps were grouped to create a regional coverage and recoded to reflect upland and wetland ecological systems attributed to this region. Thus, the objectives of this study were specifically to 1) develop a classification for upland and wetland terrestrial ecological systems for the region, 2) create a regional land cover map of ecological systems using the existing state GAP maps for CO, WY, SD, NE, and NatureServe expertise, and 3) provide a map of USNVC alliances where they could be confidently mapped from the original GAP data.

Methods

Development of Ecological Systems

Ecological systems were developed to describe surficial terrestrial environments, encompassing both *upland* and *wetland* areas where rooted and non-vascular vegetation may be used to recognize and describe each type. Only "natural" or "near-natural," units (i.e., those that appear to be unmodified or only marginally impacted by human activities) were considered part of this classification. This is to provide a framework for describing ecological composition, structure, and function that has existed with minimal human influence under climatic regimes of recent millennia. Ecological system units developed for this project were defined as part of a national classification effort, so the resulting units of this project are already standardized nationally. Detailed discussion on the conceptual basis, methods of classification, and discussion of numerous applications for terrestrial ecological systems can be found in A Working Classification of Terrestrial Ecological Systems in the Conterminous United States (NatureServe 2003b).

Ecological systems for the five-state region were developed using both "top-down" and "bottom-up" approaches. Initially sub-continental landscapes reflecting both climate and biogeographic history, modified from Bailey (1996 and 1997) at the Division scale were used to geographically bound the systems and reflect broad similarities in climate such as, humidity and seasonality (e.g. Mediterranean vs. dry continental vs. humid oceanic). Regional patterns of climate, physiography, disturbance regimes, and biogeographic history that are well described by each Division are therefore utilized to characterize the likely composition of each ecological system. Divisions in the study area include the Inter-Mountain Basins, the Western Great Plains, the Eastern Great Plains, and the Rocky Mountains (Figure 1). A "Rocky Mountain" ecological system type is predominantly found (>80% of it's total range) within the Rocky Mountain Division.

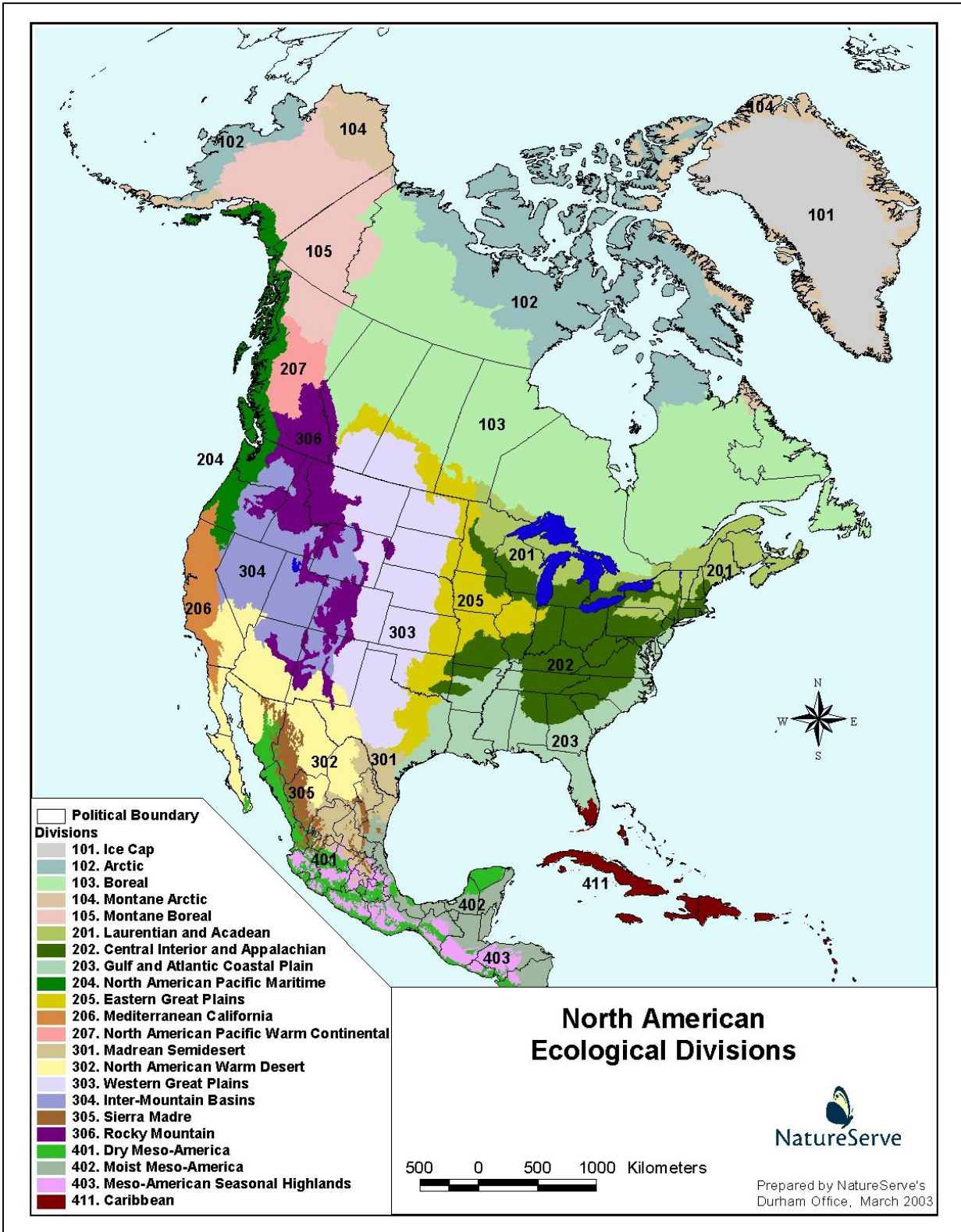


Figure 1. Ecological Divisions of North America used in organization and nomenclature of NatureServe Ecological Systems (from NatureServe 2003b).

A “Southern Rocky Mountain” ecological system type is limited in distribution to southern portions of the broader Rocky Mountain Division. In these cases, The Nature Conservancy ecoregions (Groves *et al.* 2002) were often used to more explicitly bind the ecological system geographically in this region (Figure 2). 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.

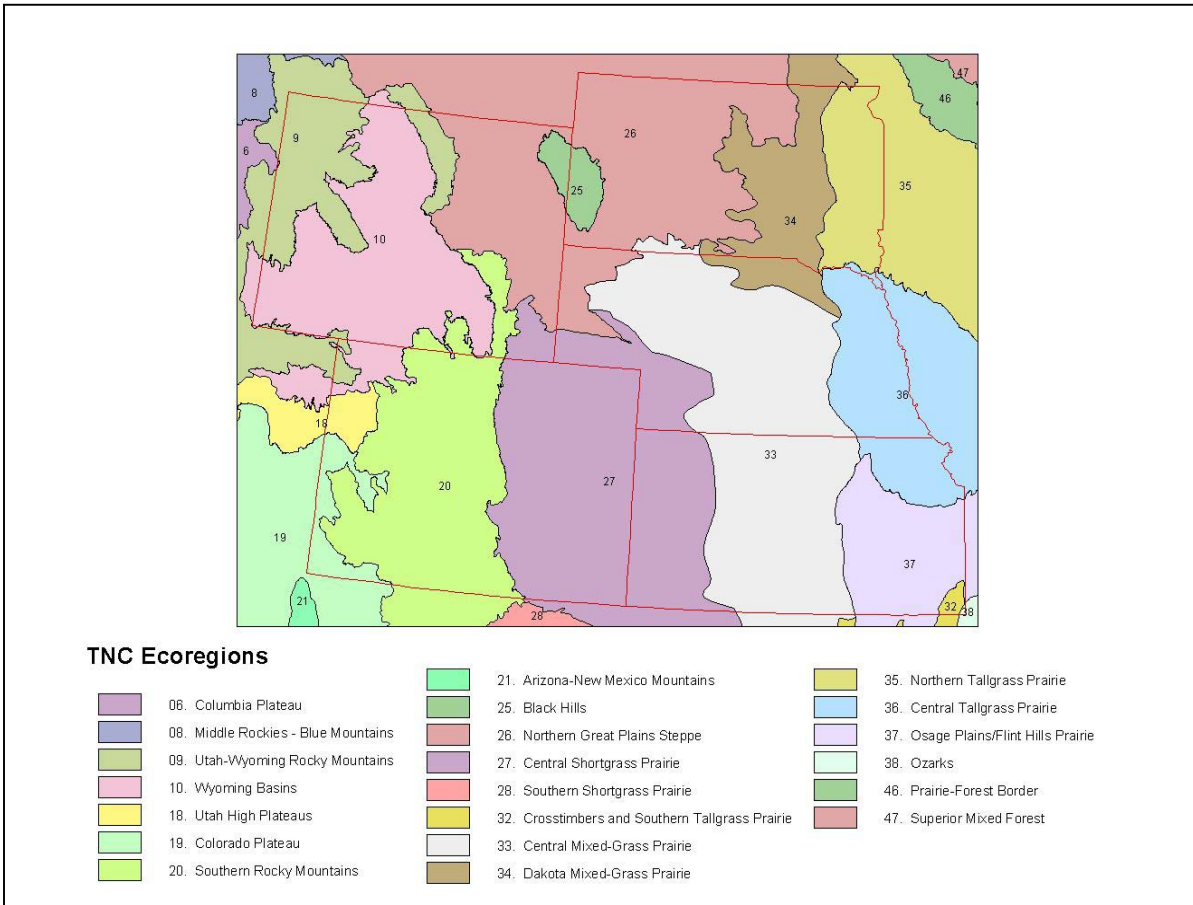


Figure 2: The Nature Conservancy ecoregions found within the five-state region (after Groves *et al.* 2002).

In this study, USNVC associations and alliances were 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 along with similar ecological processes, substrates, and/or environmental gradients. Within the context of biogeographic and bioclimatic factors, ecological composition, structure, and function in upland and wetland systems are strongly influenced by factors determined by local physiography, landform, and surface substrate. Some environmental variables are described through existing, standard classifications, which were used as diagnostic classifiers for ecological systems. Practical hydrogeomorphic classes are established for describing all wetland circumstances (Brinson 1993), and other factors such as landforms and specialized soil chemistry were used as needed to further subdivide both wetland and upland systems. Similarly, a characteristic disturbance regime provided distinctions among 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 flow direction (Brinson 1993; Cowardin 1977). Finally, vegetative composition provided significant distinctions among systems with the turnover of species composition through space used as a primary means of differentiating ecosystem types. Associations and/or alliances that consistently co-occur on the landscape helped define biotic components of each ecological system type.

Ecological systems were then defined as groups of USNVC associations that share similar ecological processes, substrates, and/or environmental gradients. These criteria were first used at a coarse scale to further subdivide ecological systems. This “top-down” approach was then used in combination with more detailed knowledge about USNVC associations and their more specific environmental requirements (i.e. “bottom-up” approach). Figure 3 demonstrates this process of starting with broad characteristics and then integrating more precise characteristics at lower levels with specific examples of montane ecological systems in the Rocky Mountains.

General stratifier	<i>UPLAND, MAINLY FOREST AND WOODLAND</i>									
Global Life Zone	Montane									
Local Life Zone	Subalpine			Upper Montane			Lower Montane/Foothill			
Landscape Position	High Ridges			Upper slopes/Plateaus			Lower Slopes			
Primary disturbance regime	Windthrow (frequent) Fire (infrequent, potentially stand replacing) Avalanche			Fire (frequent, potentially stand replacing)		Fire (infrequent)	Fire (frequent, ground-fire)			
Landform/ Topography	Ridge Tops, Side Slopes		High Rolling terrain	Toe Slopes /North Aspects	Side Slopes	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	
Composition System Definition	Rocky Mountain Subalpine Lumber Pine – Bristlecone Pine Woodland	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland		Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest And Woodland	Rocky Mountain Aspen Forest And Woodland	Rocky Mountain Montane Mesic Mixed Conifer Forest	Rocky Mountain Ponderosa Pine Woodland	Rocky Mountain Pinyon – Juniper Woodland	Rocky Mountain Ponderosa Pine Savanna Rocky Mountain Juniper Savanna

Figure 3. Sample decision matrix for classification of selected forest and woodland ecological systems in the Rocky Mountain Division.

Appendix A details the primary and secondary ecological and geographic criteria that could be used to define ecological systems. Ecological systems were named according to the Division or TNC ecoregion for the majority of their range, dominant vegetative physiognomy and composition, and/or specific environmental setting.

Map creation

The GAP programs from these five states all used TM imagery to develop their landcover maps (Table 1). The Wyoming and Colorado map efforts used a similar map classification to each other, but had never linked map classes the USNVC alliances. More explicit attempts were made at that linkage for the states of Kansas, Nebraska, and South Dakota. Across all of these states, very few of these map classes could be mapped directly as USNVC alliances (Figure 4). This is due to the limitations of recognizing alliance level units as mentioned above. When multiple state maps are combined, even fewer map classes could be said to reflect alliance-level classification units consistently across the entire study area. These 17 single NVC alliance landcover classes result from a direct recoding of component state Gap cover types.

Table 1: Source Table for original state GAP landcover data and maps for the five states.

Data	Source
GAP for Colorado	Schrupp, D.L., W.A. Reiners, T.G. Thompson, L.E. O'Brien, J.A. Kindler, M.B. Wunder, J.F. Lowsky, J.C. Buoy, L. Satcowitz, A.L. Cade, J.D. Stark, K.L. Driese, T.W. Owens, S.J. Russo, And F. D'Erchia. 2000. Colorado Gap Analysis Program: A Geographic Approach to Planning for Biological Diversity – Final Report. U.S. Geological Survey Biological Resources Division Gap Analysis Program, And Colorado Division Of Wildlife. Denver, CO.
GAP for Kansas	Egbert, Stephen; Peterson, Dana, Steward, Aimee; Lauver, Chris; Blodgett, Clayton; Price, Kevin; and Martinko, Edward. 2001. "The Kansas Gap Land Cover Map." Kansas Biological Survey Report No. 98.
GAP for Nebraska	Henebry, G., B. Putz, J. Fischer, J. Wolf, and J. Merchant. 2003. Land cover map of Nebraska. Under final review.
GAP for South Dakota	Smith, V. J., J. A. Jenks, C. Berry, Jr., C. J. Kopplin, and D. M. Fecske. Expected publication 2003. The South Dakota Gap Analysis Project final report. U. S. Department of the Interior, U. S. Geological Survey, Reston, Virginia, USA.
GAP for Wyoming	Merrill, E.H., W.A. Reiners, R.W. Marrs, S.H. Anderson, T.W. Kohley, M.E. Herdendorf, K.L. Driese. 1996. Wyoming Gap Analysis: A Geographic Analysis of Biodiversity - Final Report, U.S.G.S. Biological Resources Division. Wyoming Cooperative Fish and Wildlife Research Unit and University of Wyoming, Laramie, WY.

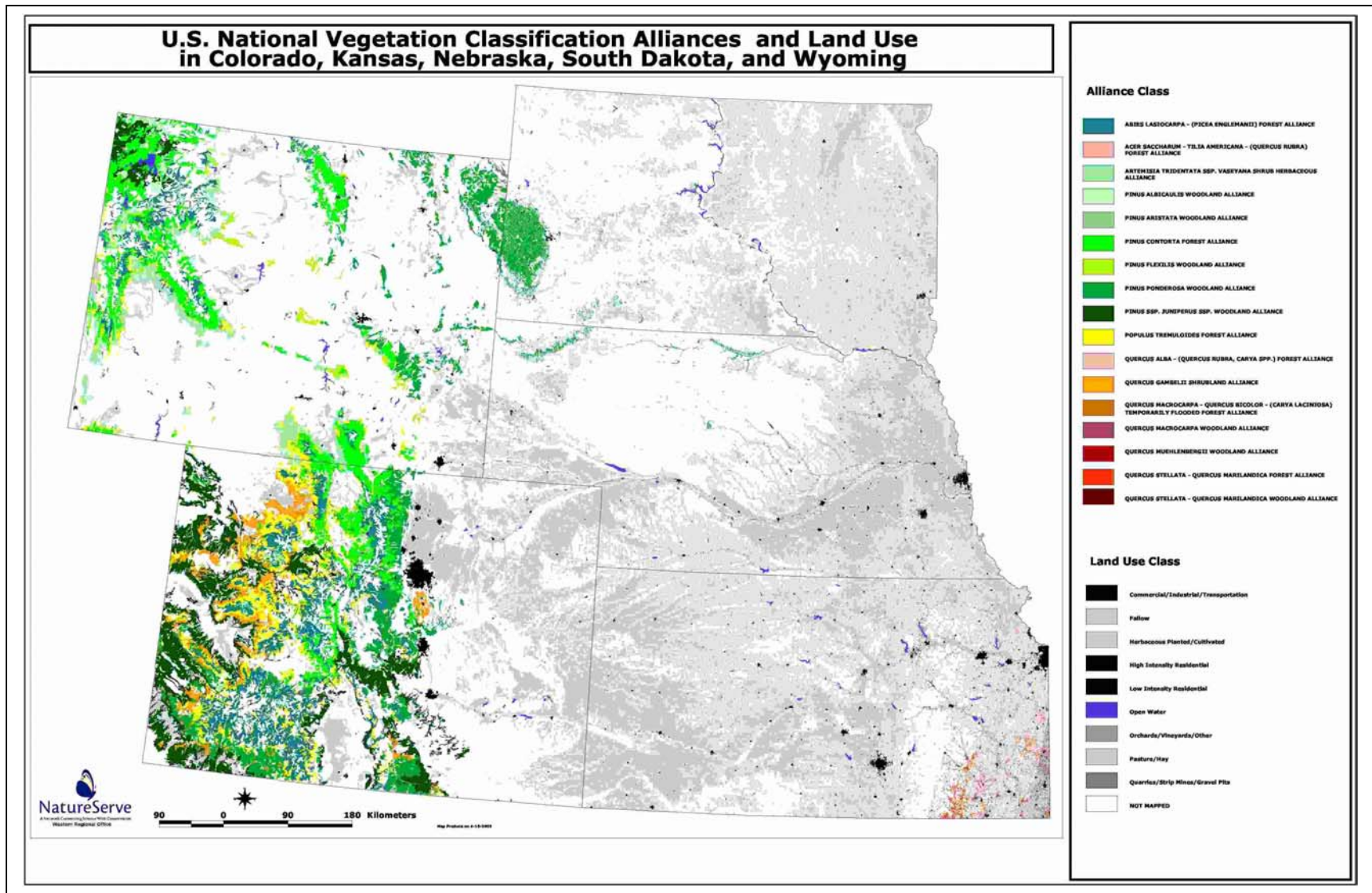


Figure 4. Alliance-scale units mapped across CO, KS, NE, SD, and WY (see Table 6 in Appendix B for metadata).

A number of original Gap cover types matched directly with the concepts of the ecological systems units, and thus, those types were recoded directly to ecological systems. In the cases where the ecological systems were not easily delineated using the original GAP landcover data, ancillary data were used to develop the boundaries of individual ecological systems (Table 2). As examples, elevation data were used to distinguish montane from all lower elevation grassland system types where no distinction was made in original Gap data. USGS 1:100k Surface Water Information Management System hydrography database was combined with other data to separate several riparian systems that were generally below the minimum map unit size for several state's original Gap data. A 150m buffer was created around the stream networks. Natural vegetation classes from the National Land Cover data set (NLCD) (developed at 30 m pixel resolution) occurring within the 150m buffer were coded as a floodplain system type.. Digital elevation models also were used to further delineate riparian systems distributions (e.g. subalpine vs. montane vs. low elevation riparian systems types). Data from the recent regional-wide sagebrush mapping effort (Comer *et al.* 2002) were used to help delineate sagebrush-dominated systems. In addition to that map, which was derived in part from original Gap data, the herbaceous class from the National Land Cover data set was used to help distinguish graminoid-dominated sagebrush steppe from more dense sagebrush shrublands (Table 2).

Table 2: Ancillary data and sources used to develop and map ecological systems.

Data	Source	Description
Digital Elevation Model (DEM) for CO, KS, NE, SD, and WY.	USGS (www.usgs.gov) provide @ 82 m resolution from Univ. Wyoming	Elevation Data for Colorado
National Land Cover Data (NLCD)	USGS (www.usgs.gov)	Land Cover Data for the entire United States
Hydrography	ESRI (www.esri.com)	Streams, Creeks, and Rivers
State Boundaries	ESRI (www.esri.com)	Boundaries for all 5 states (CO, KS, NE, SD, WY)
The Nature Conservancy's Ecoregions	Groves, C.R., D.B. Jensen, L.L. Valutis, K.H. Redford, M.L. Shaffer, J.M. Scott, J.V. Baumgartner, J.V. Higgins, M.W. Beck, and M.G. Anderson. 2002. Planning for biodiversity conservation: putting conservation science into practice. <i>Bioscience</i> 52:499-512.	Ecoregion Boundaries for the United States and adjacent Canada and Mexico
Sagebrush Map across the InterMountain West	Comer, P., J. Kagan, M. Heiner, & C. Tobalske. 2002. Sagebrush Vegetation in the Western United States. Map 1: 2,000,000 scale. Compact Disc with metadata for the USGS Forest and Rangeland Ecosystems Science Center, Boise, Idaho. The Nature Conservancy. Boulder CO, USA.	10 sagebrush vegetation types from eastern WA, OR, and CA, through CO, WY, and MT using multiple regional data sets.

A systems division map from NatureServe was used to bound system types found solely within the Intermountain Basin, Rocky Mountain, Western Great Plains and Eastern Great Plains Divisions (Figure 1). For systems restricted primarily to an individual ecoregion, TNC ecoregions (Grove *et al.* 2000) were used to further delineate those systems (Figure 2). Appendix B outlines the full set of decisions used to link the original GAP landcover units to the new ecological systems classification (for complete FGDC metadata, see Appendix C). Raster and vector versions of this map were created using a 100 ha minimum mapping unit (mmu) for matrix ecological systems and a 30-meter mmu for small and large patch types.

Results

Ecological Systems

A total of 91 wetland and upland ecological systems were identified within the five-state region. Out of the 91 ecological systems, 61 were linked to the original classes in the original GAP land cover maps. Some systems could not be mapped directly based on the original GAP data even with the addition of the ancillary data. Some systems were too small to depict at this scale and were not included in the regional map. Others could not be consistently distinguished into individual systems across the multi-state area. For example, Western Great Plains Riparian Woodland and Shrubland, and Western Great Plains Floodplain were not separated into two distinct map classes. State GAP maps did not differentiate these types, and the vegetation in these two systems is very similar. More detailed hydrography and vegetation data would be required to consistently distinguish these two types.. The defining factors distinguishing them include “flashiness” of the water flow, size of the floodplain and abundance of the vegetation.. Thus, two riparian/floodplain complexes of systems were created to attribute systems that could not be separated into individual types. The new regional vegetation map based on ecological systems was created employing these new assignments of ecological systems and system complexes (Figure 5).

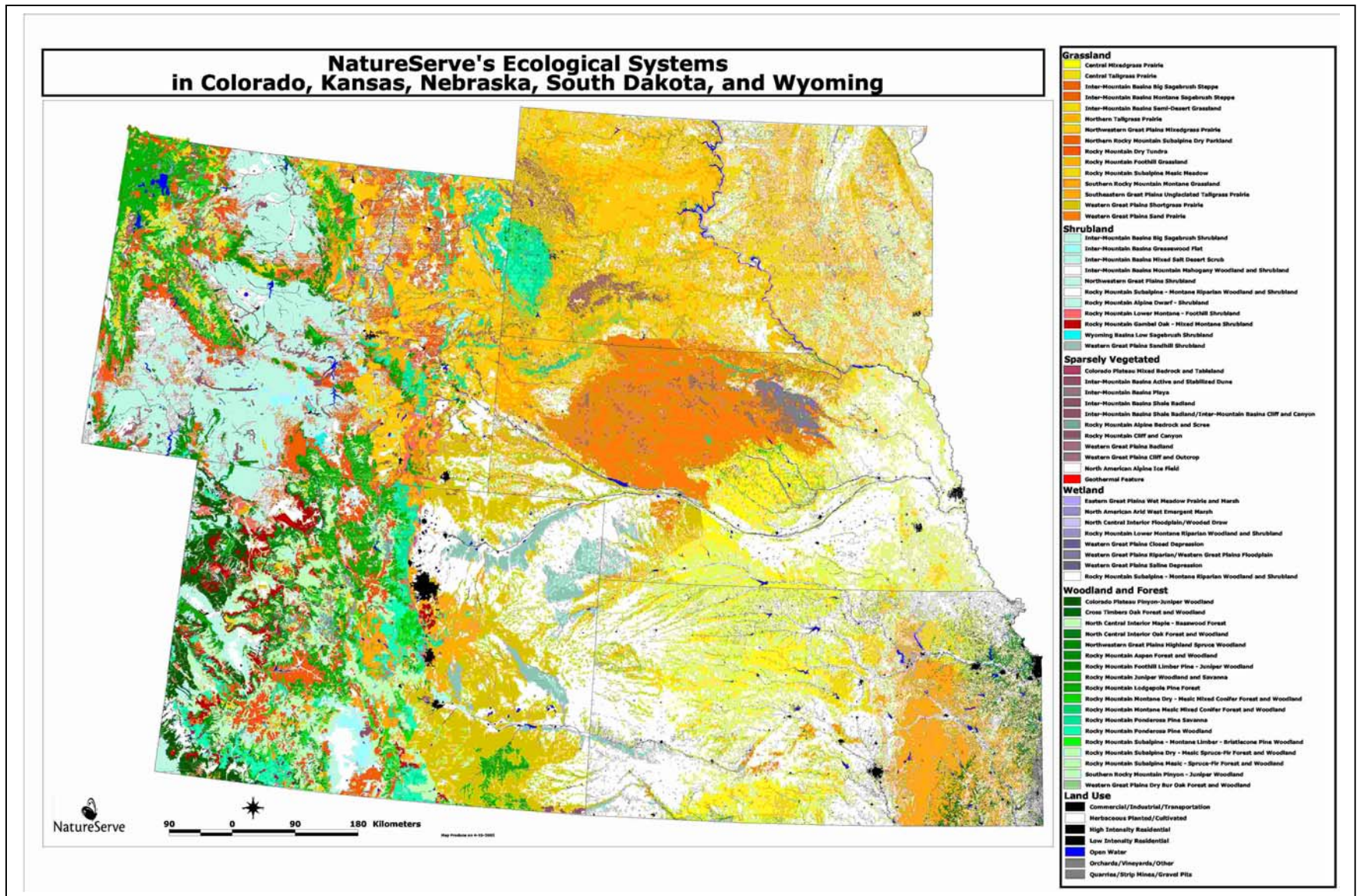


Figure 5. Terrestrial ecological system-scale units mapped comprehensively across CO, KS, NE, SD, and WY.

Appendix B shows the scheme used to assign GAP classes to systems level classes by state and the linkage between the original state GAP map and the new ecological system classification. The number of USNVC alliances related to a particular ecological system ranged from four to over 20. Cultural vegetation and land use classes were standardized to across the five states to categories established for the National Land Cover Data set.

Appendix D contains more detailed descriptions of the individual ecological systems attributed to the five states along with a list of the USNVC alliances related to each system. Each system description contains a list of the specific criteria that distinguish that particular system along with a summary that includes information about the environmental setting, vegetative structure and composition, and dynamic processes. Specific criteria used to define and describe systems varied but could include biogeography, total floristic composition, physiognomy (vertical structure), spatial pattern (horizontal structure), physical environment (e.g. soil type), chemical variables (e.g. pH, salinity), and prevailing dynamic processes (e.g. fire, flooding). Wetland systems were typically defined with more weight given to hydrologic and flooding regimes and thus the component USNVC alliances and associations used to define systems do not necessarily share physiognomic or floristic characteristics. In contrast, upland systems tended towards broad patterns in vegetative physiognomy that were more constant over larger areas and diagnostic of environmental and ecological processes. Also included with each system description is the spatial scale and pattern of that particular system (matrix, large patch, small patch or linear; Table 3).

Table 3. Categories for patch types used to describe ecological systems (from NatureServe 2003b).

Patch Type	Definition
Matrix	Ecological Systems that form extensive and contiguous cover, occur on the most extensive landforms, and typically have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g. <5%) of the total occurrence. In undisturbed conditions, typical occurrences range in size from 2,000 to 10,000s ha.
Large Patch	Ecological Systems that form large areas of interrupted cover and typically have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large proportion of the overall occurrence (e.g. >20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions, typical occurrences range from 50-2,000 ha.
Small patch	Ecological Systems that form small, discrete areas of vegetation cover typically limited in distribution by localized environmental features. In undisturbed conditions, typical occurrences range from 1-50 ha.
Linear	Ecological Systems that occur as linear strips. They are often ecotonal between terrestrial and aquatic ecosystems. In undisturbed conditions, typical occurrences range in linear distance from 0.5 to 100 km.

There are circumstances where an ecological system forms the matrix within one part of its range, but then occurs as a “large patch” type in another part of its range. This likely results in differing dynamics of climate and related disturbance processes – and interactions with other systems – that vary in ways that are unique to each system type. For example, a mixedgrass prairie system may form the matrix of the Great Plains where landscape-scale fire regimes have historically been supported by regional climate. But the adjacent Wyoming Basins might support the same grassland system, but there it occurs as patches within a matrix of sagebrush shrublands.

Map Creation

The map created with this project represents the first region-wide map of ecological systems based on a recoding of state GAP maps. Although detailed analyses of the distribution of ecological systems was not part of this study, results show broad patterns of vegetation across the region. Areas influenced by human activity such as CRP land, agriculture, and heavily disturbed forests primarily dominate the vegetation of the Great Plains with the Rocky Mountains and Inter-Mountain Basin areas showing a higher percentage of natural areas. This reflects the agricultural potential, actual land use history, and the relative amount of public lands in those regions. Natural ecological systems demonstrate the distribution of the natural vegetation, which comprises approximately 67.6% of the area, and reflect biogeographic regions (Table 4). The majority of the Great Plains is comprised of matrix prairie systems ranging from tallgrass prairie in the east to shortgrass and mixedgrass prairie in the west. These matrix and large patch systems typify the difference between the Eastern Great Plains Division where tallgrass prairie is the characteristic vegetation, and the Western Great Plains Division, which has thinner, drier soils and thus is distinguished by mixedgrass and shortgrass prairies along with dry shrublands. The most predominant systems in the montane areas are forests and woodlands, with the Inter-Mountain Basin areas containing a high proportion of sagebrush and other shrubland systems. Elevation is key in delineating the changes in ecological system types across the montane portion of the study region.

While no formal accuracy assessment was completed on this map product because the project was intended as a process to aggregate existing data sets Thus the user should look to accuracy measures of the component map data sets as an indication of the systems map accuracy.

Table 4: Summary of Ecological Systems and Landcover types within study region including the number of hectares and the percentage of the total area encompassed by a given system or landuse type.

Ecological Systems & Landuse	Hectares	Percent Area
Central Mixedgrass Prairie	6716283	5.9
Central Tallgrass Prairie	1015318	0.9
Colorado Plateau Mixed Bedrock and Tableland	181	0.0
Cross Timbers Oak Forest and Woodland	64504	0.1
Herbaceous Planted/Cultivated	36111724	31.8
Inter-Mountain Basins Active and Stabilized Dune	103840	0.1
Inter-Mountain Basins Big Sagebrush Shrubland	7429765	6.5
Inter-Mountain Basins Greasewood Flat	561602	0.5
Inter-Mountain Basins Mixed Salt Desert Scrub	2480696	2.2
Inter-Mountain Basins Montane Sagebrush Steppe	1598502	1.4
Inter-Mountain Basins Playa	12749	0.0
Inter-Mountain Basins Semi-Desert Grassland	3390	0.0
Wyoming Basins Low Sagebrush Shrubland	48010	0.0
North American Alpine Ice Field	2525	0.0
North American Arid West Emergent Marsh	128301	0.1
Eastern Great Plains Wet Meadow Prairie and Marsh	138843	0.1
North Central Interior Oak Forest and Woodland	101490	0.1
North Central Interior Floodplain/Wooded Draw	771987	0.7
North Central Interior Maple - Basswood Forest	765	0.0
Northern Rocky Mountain Subalpine Dry Parkland	80733	0.1
Northern Tallgrass Prairie	591649	0.5
Northwestern Great Plains Highland Spruce Woodland	5636	0.0

Northwestern Great Plains Mixedgrass Prairie	12220552	10.8
Northwestern Great Plains Shrubland	2335	0.0
Open Water	592579	0.5
Quarries/Strip Mines/Gravel Pits	115369	0.1
Rocky Mountain Alpine Bedrock and Scree	452195	0.4
Rocky Mountain Alpine Dwarf - Shrubland	125084	0.1
Rocky Mountain Aspen Forest and Woodland	1251465	1.1
Rocky Mountain Cliff and Canyon	306814	0.3
Rocky Mountain Dry Tundra	530192	0.5
Rocky Mountain Foothill Grassland	1176265	1.0
Rocky Mountain Gambel Oak - Mixed Montane Shrubland	907732	0.8
Rocky Mountain Juniper Woodland and Savanna	230368	0.2
Rocky Mountain Lodgepole Pine Forest	2341527	2.1
Rocky Mountain Lower Montane - Foothill Shrubland	304374	0.3
Rocky Mountain Montane Dry - Mesic Mixed Conifer Forest and Woodland	921354	0.8
Southern Rocky Mountain Pinyon - Juniper Woodland	797289	0.7
Rocky Mountain Ponderosa Pine Savanna	657101	0.6
Rocky Mountain Ponderosa Pine Woodland	1952322	1.7
Rocky Mountain Subalpine Dry - Mesic Spruce-Fir Forest and Woodland	1855748	1.6
Rocky Mountain Subalpine - Montane Limber - Bristlecone Pine Woodland	24092	0.0
Rocky Mountain Subalpine Mesic Meadow	884960	0.8
Southeastern Great Plains Unglaciaded Tallgrass Prairie	2671636	2.4
Western Great Plains Badland	252448	0.2
Western Great Plains Cliff and Outcrop	119464	0.1
Western Great Plains Closed Depression	817203	0.7
Western Great Plains Dry Bur Oak Forest and Woodland	133743	0.1
Western Great Plains Riparian/Western Great Plains Floodplain	1488930	1.3
Western Great Plains Saline Depression	2828	0.0
Western Great Plains Sand Prairie	4664280	4.1
Western Great Plains Sandhill Shrubland	1469718	1.3
Western Great Plains Shortgrass Prairie	7038758	6.2
Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	40598	0.0
Southern Rocky Mountain Montane Grassland	994749	0.9
Inter-Mountain Basins Big Sagebrush Steppe	2433038	2.1
Rocky Mountain Subalpine - Montane Riparian Woodland and Shrubland	71	0.0
Rocky Mountain Foothill Limber Pine - Juniper Woodland	891358	0.8
Colorado Plateau Pinyon-Juniper Woodland	1801185	1.6
Geothermal Feature	1539	0.0
Inter-Mountain Basins Cliff and Canyon	190036	0.2
Inter-Mountain Basins Shale Badland	85185	0.1
Rocky Mountain Subalpine Mesic - Spruce-Fir Forest and Woodland	48164	0.0
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	15566	0.0
Rocky Mountain Subalpine - Montane Riparian Woodland	746197	0.7

Rocky Mountain Lower Montane Foothill Riparian Woodland and Shrubland	848753	0.7
Developed	694583	0.6
Rocky Mountain Subalpine-Montane Riparian Shrubland	475655	0.4
Total	113543893	100.0

Discussion

Ecological systems currently being developed by NatureServe demonstrate a viable alternative to using USNVC alliances and ad hoc, uneven lumping of alliances. State GAP programs use TM imagery and other ancillary data to develop their map of USNVC alliances, but it has been found difficult to distinguish individual alliances using remotely sensed data. Simply recoding the original Kansas Vegetation Map from USNVC alliances to ecological systems increased the accuracy of the landcover by approximately 2% (Menard *et al.* 2002). Although the accuracy increased just slightly, this does suggest that ecological systems would provide a more accurate approach to GAP vegetation maps along with a standardized set of map classes. If ecological systems were used to classify the original TM imagery, it would likely increase the accuracy of the natural vegetation layer even further (Menard *et al.* 2002).

Experience in land cover mapping at regional and national scales indicates the degree of challenge in achieving thematic and spatial consistency. Mappers may successfully map individual alliances in one portion of its range, but find it far more difficult in another part of the range. This can result from any number of factors, but commonly includes the fact that other spectrally similar types may occur in just a portion of the range of the original type. So success in one state does not guarantee success everywhere. This problem is not unique to alliance-scale map units, but the advantages of mapping at a consistent, somewhat more broadly defined ecological system scale in individual states is multiplied when the mapping effort is regional or national in scope.

As mentioned above, a terrestrial ecological system is defined as a group of plant associations 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. Knowledge of environmental variation, dynamic processes, and resulting compositional variation can be used to qualitatively characterize system types that typically occur in patches ranging from 2,000 on up to 10,000s of hectares including small patch, large patch and matrix systems. Further analysis of more local-scale patterns nested within the region's natural matrix clarifies the diversity of potential patch and linear system types, and similar evaluations of composition and correlated abiotic attributes may be used to differentiate system types. Spatial patterns 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. In valleys and canyons in Colorado, dense mixed-conifer forests occur on north-facing side slopes across "montane" elevations, and more open woodlands and shrublands often occupy discontinuous patches along drier south-facing slopes. In each of these settings USNVC alliances co-occur due to controlling factors in the environment. Ecological systems are defined at a temporal scale that allows for both successional changes and disturbance regimes in each classification unit. 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. Thus ancillary data sources such as the USGS 1:100k Surface Water Information Management System hydrology database and knowledge about the dynamics of the region can aid in identifying systems such as wetlands that are not obviously apparent in TM imagery and also would help model the distribution of these systems across the landscape.

Regionalizing these states using ecological systems alleviates some of the current issues with differences among the states. The wildlife habitat models developed for this region and based on these maps will likely be more consistent and cover the range of each species more completely. Likewise, the environmental data used to develop ecological systems will further relate to species requirements beyond

vegetation and help refine range models even further. Finally, because ecological systems are directly linked to the USNVC hierarchy, these units would still be FGDC compliant and allow for state and regional GAP programs to map USNVC alliances or associations where possible while maintaining a comprehensive ecological system layer.

Acknowledgements

The authors would like to thank the USGS-GAP Analysis Project and the USFS region 2 for providing funding for this project. Thanks also to state GAP programs for providing their landcover data and maps and to National GAP, in particular Kevin Gergely and Mike Jennings. In addition, we would like to recognize the natural heritage programs in the Great Plains and Rocky Mountains (North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Montana, Wyoming, Colorado, Missouri, Minnesota, Iowa, and New Mexico) and thank them for providing comments concerning the development of ecological systems in this region.

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Appendix A:

Diagnostic classifiers used to develop ecological systems (from NatureServe 2003).

Diagnostic Classifiers for Terrestrial Ecological Systems				
	CRITERIA	PRIMARY VALUES	SECONDARY VALUES	DESCRIPTION (also: Source/Literature)
GENERAL STRATIFIERS				
NATURALNESS				
	NATURAL/NEAR-NATURAL			
	PLANTED/CULTIVATED			
PREDOMINANT EDAPHIC CONDITION				
	WETLAND			
	UPLAND			
NATURAL VEGETATED UPLANDS				
FIRST TIER - GENERAL CLASSIFIERS				
	LIFE ZONES			thresholds vary by global bioclimatic zone: Polar, Boreal/Austral, Temperate, Mediterranean, Tropical (see Rivas-Martinez et al. 1999. <i>Itinera Geobotanica</i> 12:5-316)
		ALPINE	thermotype belts: Athermic, Cryoro-	
		MONTANE	thermotype belts: Oro-, Supra-, Meso-	
		LOWLAND	thermotype belts: Thermo-, Infra-	
		User defined		
	MAJOR PHYSIOGNOMY			FGDC 1997
		FOREST AND WOODLAND (TREE)		
		SHRUBLAND (SEMI-DESERT, CHAPPARAL, ETC.) (SHRUB)		
		GRASSLAND, SAVANNA, STEPPE (HERBACEOUS)		
		MOSS/LICHEN (NON-VASCULAR)		
	LANDFORMS			
		USER DEFINED (E.G. CANYON BOTTOM, CLIFF FACE, BADLANDS, ETC.)		
	TOPOGRAPHY			
		HIGH RIDGE/UPPER SLOPE		
		HIGH-LOW SLOPE		
		TOESLOPE/BOTTOM/VALLEY		
		OTHER		
	SPECIALIZED SUBSTRATES			

		CLIFF		
		TALUS		
		DUNE		
		ROCK OUTCROPS/BARRENS/GLADES		
		TUFA		
		PLAYA LAKE BED		
		OTHER		
SECOND TIER - SPECIFIC CLASSIFIERS				
	<i>SUBSTRATE</i>			
	GLACIAL HISTORY			
		GLACIATED		
		UNGLACIATED		
		PERIGLACIAL		
	SOIL FERTILITY			NRCS
		EUTROPHIC		
		MESOTROPHIC		
		OLIGOTROPHIC		
	SOIL PH			
		ALKALINE		NRCS
		CIRCUMNEUTRAL		
		ACIDIC		
	SPECIALIZED SUBSTRATE CHEMISTRY			
		USER DEFINED (E.G. SERPENTINE, ETC.)		
	SOIL DEPTH			NRCS
		VERY SHALLOW (<15 cm) (<30)		
		SHALLOW (15-100 cm) (30 - 100)		
		DEEP (>100 cm)		
	SOIL ORGANIC MATTER			NRCS
		ORGANIC PEAT(> 40 cm)		
		MUCK		
		MINERAL: W/ A HORIZON> 10 CM		
		MINERAL: W/ A HORIZON <10 CM		
	SOIL TEXTURE			NRCS
		SAND (sand, loamy sand)		
		LOAM (loam, sandy loam, sandy clay loam)		
		SILT (silt, silt loam)		
		CLAY (clay, clay loam, sandy clay, silty clay, silty clay loam)		
	SOIL MOISTURE			NRCS

		AQUIC		
		ARIDIC		
		UDIC		
		USTIC		
		XERIC		
	SUBSTRATE CONSOLIDATION			
		CONSOLIDATED		
		UNCONSOLIDATED		
		OTHER		
	<i>DISTURBANCE</i>			
	RETURN INTERVAL	VERY SHORT (<1-6 YRS)	Periodicity/nonrandom	
		SHORT (7-12 YRS)	Periodicity/irregular	
		INTERMEDIATE (13-25 YRS)	Periodicity/polycyclic	
		LONG (26-100 YRS)	Seasonality/Spring	
		VERY LONG (>100 YRS)	Seasonality/Summer	
			Seasonality/Fall	
			Seasonality/Winter	
	FIRE INTENSITY/SPATIAL CHARACTER	PATCH/HIGH INTENSITY		High= stand replacement >70% mortality, soil surface effects, increased stand homogeneity (Buckner & Turrill 1999. Peine John D. 1999).
		PATCH/MEDIUM INTENSITY		Medium = partial stand replacement (30-70% mortality, moderate soil surface effects, increasing stand heterogeneity
		PATCH/LOW INTENSITY		Low = e.g. forest underburns w/ <30% mortality, negligible soil surface effects, no impact on stand heterogeneity
		LANDSCAPE/HIGH INTENSITY		Patch: Relatively small and/or discontinuous. In natural conditions, typical size ranges from 1-2,000 ha.
		LANDSCAPE/MEDIUM INTENSITY		Landscape: Generally large and continuous (>2,000 ha)
		LANDSCAPE/LOW INTENSITY		
	GRAZING INTENSITY/SPATIAL CHARACTER	PATCH/HIGH INTENSITY		
		PATCH/MEDIUM INTENSITY		
		PATCH/LOW INTENSITY		
		LANDSCAPE/HIGH INTENSITY		
		LANDSCAPE/MEDIUM INTENSITY		
		LANDSCAPE/LOW INTENSITY		
	MASS MOVEMENT TYPE	FLOOD SCOURING		

		LANDSLIDE		
		AVALANCHE		
		LAVA FLOW		
	WIND INTENSITY/SPATIAL CHARACTER	PATCH/HIGH INTENSITY		
		PATCH/MEDIUM INTENSITY		
		PATCH/LOW INTENSITY		
		LANDSCAPE/HIGH INTENSITY		
		LANDSCAPE/MEDIUM INTENSITY		
		LANDSCAPE/LOW INTENSITY		
	OTHER	USER DEFINED		
	LIFE FORM			
		NVCS categories		FGDC
	MICROCLIMATE			Climatic gradients within a division, or specialized microclimate, e.g. cold air drainages.
		USER DEFINED		
THIRD TIER - SPATIAL/TEMPORAL				
	GEOGRAPHIC SCALE AND PATTERN			
		LINEAR		
		SMALL PATCH		
		LARGE PATCH		
		MATRIX		
	JUXTAPOSITION			
		USER DEFINED		
	TEMPORAL PERSISTENCE			
		SHORT - 50-100 YRS		
		MODERATE - 100-500 YRS		
		LONG - > 500 YRS		
NATURAL VEGETATED WETLANDS				
FIRST TIER - GENERAL CLASSIFIERS				
	HYDROGEOMORPHIC UNITS			BRINSON et al. 1993
		SEEPAGE-FED SLOPING (SEEPAGE FLOW)		
			MINERAL	
			PEATY	
		EXTENSIVE WET FLAT(SHEET FLOW, SEEPAGE FLOW)		

		DEPRESSIONAL (RAINWATER, LOCAL SHEET FLOW)		
			LAKESHORE (COULD BE FRINGE)	
			POND	
			VERNAL POOL	
		RIVERINE / ALLUVIAL (STREAM FLOW)		
			OPTIONAL (COWARDIN HYDROLOGY)	
			OPTIONAL (BLACKWATER, BROWNWATER)	
		TIDAL / ESTUARINE (TIDAL FLOW, FRINGE)		
			FRESHWATER	
			HALINE	
			OLIGOHALINE	
SECOND TIER - SPECIFIC CLASSIFIERS				
	LANDFORM/TOPOGRAPHY/ SPECIAL SUBSTRATES			
		USER DEFINED		
	<i>SUBSTRATE</i>			
	AQUATIC TROPHIC STATUS			
		EUTROPHIC		
		MESOTROPHIC		
		OLIGOTROPHIC		
	WATER ACIDITY			
		ALKALINE		
		CIRCUMNEUTRAL		
		ACIDIC		
	SPECIALIZED WATER CHEMISTRY			
		USER DEFINED (E.G SERPENTINE, ETC.)		
	WATER DEPTH			
		SHALLOW (<15 CM)		
		DEEP (>15 CM)		
	SOIL ORGANIC MATTER			NRCS
		PEAT (> 40 CM PEAT)		
		MUCK		
	SUBSOIL TEXTURE			NRCS
		SAND		
		LOAM		
		SILT		

		CLAY		
	SUBSOIL STRUCTURE	USER DEFINED (E.G HARDPAN, CALLICHE, ETC.)		
	SOIL MOISTURE REGIME	SATURATED	PERIODICITY/SEASONALITY	
	SUBSTRATE TEXTURE			NRCS
		CONSOLIDATED		
		UNCONSOLIDATED		
		OTHER		
	<i>DISTURBANCE</i>			
	FLOODING RETURN INTERVAL			
		INTERMITTENT	Periodicity/nonrandom	
		SHORT (<5 YRS)	Periodicity/irregular	
		INTERMEDIATE (5-25 YRS)	Periodicity/polycyclic	
		LONG (>25 YRS)	Seasonality/Spring	
		OTHER	Seasonality/Summer	
			Seasonality/Fall	
			Seasonality/Winter	
	HYDROPERIOD	<24 HOURS		
		1-29 DAYS		
		30-180 DAYS		
		>180 DAYS		
	LIFE FORM			
		NVCS categories		FGDC
THIRD TIER - SPATIAL/TEMPORAL				
	GEOGRAPHIC SCALE AND PATTERN			
		LINEAR		
		SMALL PATCH		
		LARGE PATCH		
		MATRIX		
	JUXTAPOSITION			
		USER DEFINED		
	TEMPORAL PERSISTENCE			
		SHORT - 50-100 YRS		
		MODERATE - 100-500 YRS		
		LONG -> 500 YRS		

Appendix B:
Metadata Tables for Ecological Systems Map and Mapping Decision Rules

Table 1: Metadata for Ecological Systems Map and mapping decision rules for the landcover of the state of Colorado.

Original GAP Landcover	Final Ecological System/Land Use	Descriptive Step
Barren Lands	Rocky Mountain Cliff and Canyon	In the Southern Rocky Mountains Ecoregion
Barren Lands	Western Great Plains Cliff and Outcrop	In the Central Shortgrass Ecoregion
Barren Lands	Inter-Mountain Basins Shale Badland	Where the Geology type is "Shale"
Dryland Crops	Herbaceous Planted/Cultivated	Direct Conversion
Irrigated Crops	Herbaceous Planted/Cultivated	Direct Conversion
Confined Livestock Feeding	Herbaceous Planted/Cultivated	Direct Conversion
Orchard/Horticulture	Herbaceous Planted/Cultivated	Direct Conversion
Wyoming Big Sage	Inter-Mountain Basins Big Sagebrush Steppe	NLCD = "Herbaceous Upland"
Big Sagebrush Shrubland	Inter-Mountain Basins Big Sagebrush Steppe	NLCD = "Herbaceous Upland"
Greasewood Fans & Flats	Inter-Mountain Basins Greasewood Flat	Direct Conversion
Desert Shrub	Inter-Mountain Basins Mixed Salt Desert Scrub	Direct Conversion
Saltbrush Fans & Flats	Inter-Mountain Basins Mixed Salt Desert Scrub	Direct Conversion
Mountain Big Sage	Inter-Mountain Basins Montane Sagebrush Steppe	Direct Conversion
Unvegetated Playa	Inter-Mountain Basins Playa	Direct Conversion
Grass/Forb Dominated	North American Arid West Emergent Marsh	Direct Conversion
Open Water - Lakes	Open Water	Direct Conversion
Strip Mines/Quarries	Quarries/Strip Mines/Gravel Pits	Direct Conversion
Bare Ground Tundra	Rocky Mountain Alpine Bedrock and Scree	Direct Conversion
Prostrate Shrub Tundra	Rocky Mountain Alpine Dwarf - Shrubland	Direct Conversion
Aspen Forest	Rocky Mountain Aspen Forest and Woodland	Direct Conversion
Exposed Rock	Western Great Plains Cliff and Outcrop	Area within this polygon includes exposed cliff and outcrop of the Pawnee Buttes in CO. It was coded to CES303.665, Western Great Plains Cliff and Outcrop.
Mixed Tundra	Rocky Mountain Dry Tundra	Direct Conversion
Meadow Tundra	Rocky Mountain Dry Tundra	Direct Conversion
Foothill/Mountain Grassland	Southern Rocky Mountain Montane Grassland	Above 2200 Meters
Midgrass Prairie	Southern Rocky Mountain Montane Grassland	Above 2200 Meters
Midgrass Prairie	Southern Rocky Mountain Montane Grassland	In the Southern Rocky Mountain Ecoregion above 2200 meters in elevation
Tallgrass Prairie	Southern Rocky Mountain Montane Grassland	Above 2200 Meters

Mesic Upland Shrub	Rocky Mountain Gambel Oak - Mixed Montane Shrubland	Direct Conversion
Deciduous Oak	Rocky Mountain Gambel Oak - Mixed Montane Shrubland	Direct Conversion
Juniper	Rocky Mountain Foothill Limber Pine - Juniper Woodland	In the Wyoming Basins Ecoregion
Juniper	Rocky Mountain Foothill Limber Pine - Juniper Woodland	Below 2400 Meters
Lodgepole Pine	Rocky Mountain Lodgepole Pine Forest	Direct Conversion
Lodgepole Pine--	Rocky Mountain Lodgepole Pine Forest	Direct Conversion
Xeric Upland Shrub	Rocky Mountain Lower Montane - Foothill Shrubland	Direct Conversion
Bitterbrush Shrub	Rocky Mountain Lower Montane - Foothill Shrubland	Direct Conversion
Douglas Fir	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	Where the aspect is North and slopes greater than 24 degrees and slope position: medium or low or lowest
White Fir	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	Where the aspect is North and slopes greater than 24 degrees and slope position: medium or low or lowest
Mixed Conifer	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	Where the aspect is North and slopes greater than 24 degrees and slope position: medium or low or lowest
Pinyon-Juniper	Colorado Plateau Pinyon-Juniper Woodland	West of the Continental Divide
Ponderosa Pine/Lodgepole	Rocky Mountain Ponderosa Pine Savanna	NLCD = "Herbaceous Upland"
Mixed Forest--General	Rocky Mountain Ponderosa Pine Savanna	NLCD = "Herbaceous Upland"
Spruce-Fir	Rocky Mountain Subalpine Mesic - Spruce-Fir Forest and Woodland	Where the aspect is North and slopes greater than 24 degrees and slope position: medium or low or lowest
Spruce-Fir--Clearcut/Logged	Rocky Mountain Subalpine Mesic - Spruce-Fir Forest and Woodland	Where the aspect is North and slopes greater than 24 degrees and slope position: medium or low or lowest
Limber Pine	Rocky Mountain Subalpine - Montane Limber - Bristlecone	Direct Conversion
Rocky Mountain Bristlecone	Rocky Mountain Subalpine - Montane Limber - Bristlecone	Direct Conversion
Subalpine Meadow	Rocky Mountain Subalpine Mesic Meadow	Direct Conversion
Sand Dune Complex	Inter-Mountain Basins Active and Stabilized Dune	In the Southern Rockies Ecoregion
Sand Dune Complex	Western Great Plains Sandhill Shrubland	This portion of extreme western KS and southwest NE
Sand Dune Complex	Inter-Mountain Basins Active and Stabilized Dune	In the Southern Rockies Ecoregion
Sand Dune Complex	Western Great Plains Sandhill Shrubland	This portion of extreme western KS and southwest NE
Sandy Areas	Inter-Mountain Basins Active and Stabilized Dune	In the Southern Rockies Ecoregion
Sandy Areas	Western Great Plains Sandhill Shrubland	This portion of extreme western KS and southwest NE
Shortgrass Prairie	Western Great Plains Shortgrass Prairie	Direct Conversion
Blue Spruce	Rocky Mountain Montane Mesic Mixed Conifer Forest and	Direct Conversion
Disturbed Shrubland	Southern Rocky Mountain Pinyon - Juniper Woodland	East of Continental Divide
Forested Wetlands	Western Great Plains Riparian/Western Great Plains	East of Continental Divide
Shrub Dominated Wetlands	Western Great Plains Riparian/Western Great Plains	East of Continental Divide

Urban	Developed	Direct Conversion
Many Types	Rocky Mountain Subalpine - Montane Riparian Woodland	With a 50 meter buffer around all streams and above 2400 meters in elevation and where NLCD types are "Deciduous Forest", "Evergreen Forest", or "Mixed Forest"
Many Types	Rocky Mountain Lower Montane Foothill Riparian Woodland and Shrubland	With a 50 meter buffer around all streams between 1650 and 2400 meters in elevation and where NLCD types are "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"
Many Types	Rocky Mountain Subalpine-Montane Riparian Shrubland	With a 50 meter buffer around all streams above 2400 meters in elevation and where NLCD types are: "Shrubland", "Grassland/Herbaceous", "Woody Wetland", "Emergent Herbaceous Wetlands"
Many Types	Western Great Plains Riparian/Western Great Plains Floodplain	With a 150 meter buffer around all streams and west of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies and below 1650 meters in elevation and where NLCD types are: "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"
Many Types	Inter-Mountain Basins Montane Sagebrush Steppe	In the Sagebrush Stitch data set where it is "Low Sagebrush", "Mountain Big Sagebrush" or "Silver Sagebrush"
Many Types	Inter-Mountain Basins Big Sagebrush Shrubland	In the Sagebrush Stitch data set "Wyoming & Basins Big sagebrush"
Many Types	Wyoming Basins Low Sagebrush Shrubland	In the Sagebrush Stitch data set where it is "Black Sagebrush"
Many Types	Rocky Mountain Cliff and Canyon	In the Utah Wyoming Rockies ecoregion or the Southern Rockies Ecoregion on all slope aspects, and on slopes greater than 35 degrees and where slope positions are Highest, High, or medium

Table 2: Metadata for Ecological Systems Map and mapping decision rules for the landcover of the state of Wyoming.

Original GAP Landcover	Final Ecological Systems/Land Use	Descriptive Step
Dry-land crops	Herbaceous Planted/Cultivated	Direct Conversion
Irrigated crops	Herbaceous Planted/Cultivated	Direct Conversion
Active sand dunes	Inter-Mountain Basins Active and Stabilized Dune	Direct Conversion
Vegetated dunes	Inter-Mountain Basins Active and Stabilized Dune	Direct Conversion
Wyoming big sagebrush	Inter-Mountain Basins Big Sagebrush Steppe	NLCD = "Herbaceous Upland"
Basin big sagebrush	Inter-Mountain Basins Big Sagebrush Steppe	NLCD = "Herbaceous Upland"
Greasewood fans and flats	Inter-Mountain Basins Greasewood Flat	Direct Conversion
Desert shrub	Inter-Mountain Basins Mixed Salt Desert Scrub	Direct Conversion
Saltbush fans and flats	Inter-Mountain Basins Mixed Salt Desert Scrub	Direct Conversion
Mountain big sagebrush	Inter-Mountain Basins Montane Sagebrush Steppe	Direct Conversion
Unvegetated playa	Inter-Mountain Basins Playa	Direct Conversion
Great Basin foothills	Northern Rocky Mountain Subalpine Dry Parkland	Above 2200 Meters
Black sagebrush steppe	Wyoming Basins Low Sagebrush Shrubland	Direct Conversion
Permanent snow	North American Alpine Ice Field	Direct Conversion
Grass-dominated wetland	North American Arid West Emergent Marsh	Direct Conversion
Whitebark pine	Northern Rocky Mountain Subalpine Dry Parkland	Direct Conversion
Mixed grass prairie	Western Great Plains Shortgrass Prairie	In the Central Short Grass Ecoregion
Mixed grass prairie	Southern Rocky Mountain Montane Grassland	Above 2200 meters in elevation
Mixed grass prairie	Rocky Mountain Foothill Grassland	Below 2200 meters within the Southern Rocky Mountain or the Central Shortgrass Ecoregion
Open water	Open Water	Direct Conversion
Surface mining operations	Quarries/Strip Mines/Gravel Pits	Direct Conversion
Alpine exposed rock/soil	Rocky Mountain Alpine Bedrock and Scree	Direct Conversion
Aspen forest	Rocky Mountain Aspen Forest and Woodland	Direct Conversion
Meadow tundra	Rocky Mountain Dry Tundra	Direct Conversion
Mesic upland shrub	Rocky Mountain Gambel Oak - Mixed Montane Shrubland	Direct Conversion
Juniper woodland	Rocky Mountain Foothill Limber Pine - Juniper Woodland	Below 2400 Meters
Lodgepole pine	Rocky Mountain Lodgepole Pine Forest	Direct Conversion
Burned conifer	Rocky Mountain Lodgepole Pine Forest	Direct Conversion
Bitterbrush shrub steppe	Rocky Mountain Lower Montane - Foothill Shrubland	Direct Conversion

Douglas fir	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	Where the aspect is North and slopes greater than 24 degrees and slope position: medium or low or lowest
Clearcut conifer	Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland	Where the aspect is North and slopes greater than 24 degrees and slope position: medium or low or lowest
Ponderosa pine	Rocky Mountain Ponderosa Pine Savanna	NLCD = "Herbaceous Upland"
Spruce-fir	Rocky Mountain Subalpine Mesic - Spruce-Fir Forest and Woodland	Where the aspect is North and slopes greater than 24 degrees and slope position: medium or low or lowest
Subalpine meadow	Rocky Mountain Subalpine Mesic Meadow	Direct Conversion
Bur oak woodland	Western Great Plains Riparian/Western Great Plains	Direct Conversion
Grass-dominated riparian	Western Great Plains Riparian/Western Great Plains	Direct Conversion
Short grass prairie	Rocky Mountain Foothill Grassland	In the Central Shortgrass Ecoregion
Limber pine and woodland	Rocky Mountain Foothill Limber Pine - Juniper Woodland	Direct Conversion
Basin exposed rock/soil	Geothermal Feature	In extreme Northwest part of the state
Basin exposed rock/soil	Western Great Plains Cliff and Outcrop	In the Central Shortgrass Prairie or the Northern Great Plains Steppe Ecoregion
Xeric upland shrub	Rocky Mountain Lower Montane - Foothill Shrubland	Not in Utah Wyoming Rockies Ecoregion
Forest-dominated riparian	Rocky Mountain Lower Montane Foothill Riparian	Direct Conversion
Shrub-dominated riparian	Rocky Mountain Lower Montane Foothill Riparian	Direct Conversion
Human settlements	Developed	Direct Conversion
Many Types	Inter-Mountain Basins Montane Sagebrush Steppe	In the Sagebrush Stitch data set where it is "Low Sagebrush", "Mountain Big Sagebrush" or "Silver Sagebrush"
Many Types	Inter-Mountain Basins Big Sagebrush Shrubland	In the Sagebrush Stitch data set where it is "Wyoming & Basins Big sagebrush"
Many Types	Wyoming Basins Low Sagebrush Shrubland	In the Sagebrush Stitch data set where it is " Black sagebrush"
Many Types	Rocky Mountain Cliff and Canyon	In the Utah Wyoming Rockies ecoregion or the Southern Rockies Ecoregion on all slope aspects, and on slopes greater than 35 degrees and where slope positions are Highest, High, or medium
Many Types	Rocky Mountain Subalpine - Montane Riparian Woodland	With a 50 meter buffer around all streams and above 2400 meters in elevation and where NLCD types are "Deciduous Forest", "Evergreen Forest", or "Mixed Forest"

Many Types	Rocky Mountain Lower Montane Foothill Riparian Woodland and Shrubland	With a 50 meter buffer around all streams between 1650 and 2400 meters in elevation and where NLCD types are "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"
Many Types	Rocky Mountain Subalpine-Montane Riparian Shrubland	With a 50 meter buffer around all streams above 2400 meters in elevation and where NLCD types are: "Shrubland", "Grassland/Herbaceous", "Woody Wetland", "Emergent Herbaceous Wetlands"
Many Types	Western Great Plains Riparian/Western Great Plains Floodplain	With a 150 meter buffer around all streams and west of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies and below 1650 meters in elevation and where NLCD types are: "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"

Table 3: Metadata for Ecological Systems Map and mapping decision rules for the landcover of the state of Kansas.

Original GAP Landcover	Final Ecological Systems/Land Use	Descriptive Step
Western Wheatgrass Prairie	Central Mixedgrass Prairie	Direct Conversion
Mixed Prairie	Central Mixedgrass Prairie	Direct Conversion
Mixed Prairie - Disturbed	Central Mixedgrass Prairie	Direct Conversion
Tallgrass Prairie	Southeastern Great Plains Unglaciaded Tallgrass Prairie	In the Flint Hills Ecoregion
Post Oak - Blackjack Oak Forest	Cross Timbers Oak Forest and Woodland	Direct Conversion
Post Oak - Blackjack Oak Woodland	Cross Timbers Oak Forest and Woodland	Direct Conversion
Non-Native Grassland	Herbaceous Planted/Cultivated	Direct Conversion
CRP (Conservation Reserve Program)	Herbaceous Planted/Cultivated	Direct Conversion
Cultivated Land	Herbaceous Planted/Cultivated	Direct Conversion
Evergreen Forest - Disturbed Land	Herbaceous Planted/Cultivated	Direct Conversion
Weedy Upland	Herbaceous Planted/Cultivated	Direct Conversion
Oak - Hickory Forest	North Central Interior Oak Forest and Woodland	Direct Conversion
Pecan Floodplain Forest	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Ash - Elm - Hackberry Floodplain Forest	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Cottonwood Floodplain Forest	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Mixed Oak Floodplain Forest	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Bur Oak Floodplain Woodland	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies

Mixed Oak Ravine Woodland	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Cottonwood Floodplain Woodland	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Buttonbush (Swamp) Shrubland	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Low or Wet Prairie	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Maple Floodplain Forest	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Maple - Basswood Forest	North Central Interior Maple - Basswood Forest	Direct Conversion
Water	Open Water	Direct Conversion
Deciduous Forest - Mined Land	Quarries/Strip Mines/Gravel Pits	Direct Conversion
Sandstone Glade/Prairie	Southeastern Great Plains Unglaciaded Tallgrass Prairie	Direct Conversion
Grass Playa Lake	Western Great Plains Closed Depression	Direct Conversion
Spikerush Playa Lake	Western Great Plains Closed Depression	Direct Conversion
Playa Lake	Western Great Plains Closed Depression	Direct Conversion
Freshwater Marsh	Western Great Plains Closed Depression	Direct Conversion
Cattail Marsh	Western Great Plains Closed Depression	Direct Conversion
Forb Playa Lake	Western Great Plains Closed Depression	Direct Conversion
Weedy Marsh	Western Great Plains Closed Depression	Direct Conversion
Deciduous Woodland	Western Great Plains Dry Bur Oak Forest and Woodland	Direct Conversion
Willow Shrubland	North Central Interior Floodplain/Wooded Draw	within the Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Bulrush Marsh	North Central Interior Floodplain/Wooded Draw	within the Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies

Salt Cedar or Tamarisk Shrubland	North Central Interior Floodplain/Wooded Draw	within the Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Alkali Sacaton Prairie	Western Great Plains Saline Depression	Direct Conversion
Salt Marsh/Prairie	Western Great Plains Saline Depression	Direct Conversion
Sand Prairie	Western Great Plains Sand Prairie	Direct Conversion
Sandsage Shrubland	Western Great Plains Sandhill Shrubland	Direct Conversion
Shortgrass Prairie	Western Great Plains Shortgrass Prairie	Direct Conversion
Urban Areas	Developed	Direct Conversion
Many Types	Western Great Plains Riparian/Western Great Plains Floodplain	With a 150 meter buffer around all streams and west of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies and below 1650 meters in elevation and where NLCD types are: "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"
Many Types	North Central Interior Floodplain/Wooded Draw	With a 150 meter buffer around all streams and with in the Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies and below 1650 meters in elevation and where NLCD types are: "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"

Table 4: Metadata for Ecological Systems Map and mapping decision rules for the landcover of the state of South Dakota.

Original GAP Landcover	Final Ecological Systems/Land Use	Descriptive Step
High Cover Grassland	Northwestern Great Plains Mixedgrass Prairie	In the Northern Great Plans Steppe
High Cover Grassland	Northern Tallgrass Prairie	In the Northern Tallgrass Ecoregion
High Cover Grassland	Central Tallgrass Prairie	Central Tallgrass Ecoregion
High Cover Grassland	Northwestern Great Plains Mixedgrass Prairie	Natural grasslands within this polygon, as well as within the Northern Great Plains Steppe ecoregion were coded to CES303.674, Northwestern Great Plains Mixed Grass Prairie
Moderate Cover Grassland	Northwestern Great Plains Mixedgrass Prairie	In the Northern Great Plans Steppe
Moderate Cover Grassland	Northern Tallgrass Prairie	In the Northern Tallgrass Ecoregion
Moderate Cover Grassland	Central Tallgrass Prairie	Central Tallgrass Ecoregion
Moderate Cover Grassland	Northwestern Great Plains Mixedgrass Prairie	Natural grasslands within this polygon, as well as within the Northern Great Plains Steppe ecoregion were coded to CES303.674, Northwestern Great Plains Mixed Grass Prairie
Idle Grassland	Northwestern Great Plains Mixedgrass Prairie	In the Northern Great Plans Steppe
Idle Grassland	Northern Tallgrass Prairie	In the Northern Tallgrass Ecoregion
Idle Grassland	Central Tallgrass Prairie	Central Tallgrass Ecoregion
Idle Grassland	Northwestern Great Plains Mixedgrass Prairie	Natural grasslands within this polygon, as well as within the Northern Great Plains Steppe ecoregion were coded to CES303.674, Northwestern Great Plains Mixed Grass Prairie
Pastureland	Northwestern Great Plains Mixedgrass Prairie	In the Northern Great Plans Steppe
Pastureland	Northern Tallgrass Prairie	In the Northern Tallgrass Ecoregion
Pastureland	Central Tallgrass Prairie	Central Tallgrass Ecoregion
Pastureland	Northwestern Great Plains Mixedgrass Prairie	Natural grasslands within this polygon, as well as within the Northern Great Plains Steppe ecoregion were coded to CES303.674, Northwestern Great Plains Mixed Grass Prairie
Agriculture	Herbaceous Planted/Cultivated	Direct Conversion
Hayland	Herbaceous Planted/Cultivated	Direct Conversion
Semipermanent Wetlands	Eastern Great Plains Wet Meadow Prairie and Marsh	In the Northern Tallgrass Ecoregion
Seasonal Wetlands	Eastern Great Plains Wet Meadow Prairie and Marsh	In the Northern Tallgrass Ecoregion
Permanent Wetlands	Eastern Great Plains Wet Meadow Prairie and Marsh	In the Northern Tallgrass Ecoregion

Deciduous Trees	Western Great Plains Dry Bur Oak Forest and Woodland	Direct Conversion
Deciduous Woodland	Western Great Plains Dry Bur Oak Forest and Woodland	Direct Conversion
White Spruce	Northwestern Great Plains Highland Spruce Woodland	Direct Conversion
Low Cover Grassland	Northwestern Great Plains Mixedgrass Prairie	Direct Conversion
Creeping Juniper Dwarf-shrubland	Northwestern Great Plains Shrubland	Direct Conversion
Water	Open Water	Direct Conversion
Mines and Quarries	Quarries/Strip Mines/Gravel Pits	Direct Conversion
Mesic Shrubland	Rocky Mountain Gambel Oak - Mixed Montane Shrubland	Direct Conversion
Deciduous Shrubland	Rocky Mountain Gambel Oak - Mixed Montane Shrubland	Direct Conversion
Xeric Shrubland	Rocky Mountain Lower Montane - Foothill Shrubland	Direct Conversion
Ponderosa Pine	Rocky Mountain Ponderosa Pine Savanna	NLCD = "Herbaceous Upland"
Burned Pine	Rocky Mountain Ponderosa Pine Savanna	NLCD = "Herbaceous Upland"
Vegetated Badlands	Western Great Plains Badland	Direct Conversion
Unvegetated Badlands	Western Great Plains Badland	Direct Conversion
Barren Land	Western Great Plains Badland	Direct Conversion
Eastern Red Cedar	Western Great Plains Cliff and Outcrop	Direct Conversion
Temporary Wetlands	Eastern Great Plains Wet Meadow Prairie and Marsh	With in the Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Bur Oak Forest	Rocky Mountain Aspen Forest and Woodland	Above 1500 meters in elevation
Cottonwood	North Central Interior Floodplain/Wooded Draw	With in the Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Riverine Wetlands	North Central Interior Floodplain/Wooded Draw	With in the Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Sand Hills Sparse Vegetation	Western Great Plains Sand Prairie	Direct Conversion
Sand Hills High Cover	Western Great Plains Sand Prairie	Direct Conversion
Shale Barren Slope Sparse	Inter-Mountain Basins Shale Badland	Direct Conversion
Low Density Development	Developed	Direct Conversion
High Density Development	Developed	Direct Conversion
Towns	Developed	Direct Conversion

Many Types	Inter-Mountain Basins Montane Sagebrush Steppe	In the Sagebrush Stitch data set where it is "Low Sagebrush", "Mountain Big Sagebrush" or "Silver Sagebrush"
Many Types	Rocky Mountain Lower Montane Foothill Riparian Woodland and Shrubland	With a 50 meter buffer around all streams between 1650 and 2400 meters in elevation and where NLCD types are "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"
Many Types	Western Great Plains Riparian/Western Great Plains Floodplain	With a 150 meter buffer around all streams and west of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies and below 1650 meters in elevation and where NLCD types are: "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"
Many Types	North Central Interior Floodplain/Wooded Draw	With a 150 meter buffer around all streams and with in the Northern Tall Grass Prairie, Central Tall Grass Parries, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies and below 1650 meters in elevation and where NLCD types are: "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody
Many Types	Western Great Plains Sand Prairie	Area within this polygon from both NE and SD includes sandy soils from STATSGO where grassland types were recoded to CES303.670, Western Great Plains Sand Prairie.

Table 5: Metadata for Ecological Systems Map and mapping decision rules for the landcover of the state of Nebraska.

Original GAP Landcover	Final Ecological Systems/Land Use	Descriptive Step
Little Bluestem-Grama Mixedgrass Prairie	Northwestern Great Plains Mixedgrass Prairie	In the Northern Great Plains Steppe Ecoregion
Little Bluestem-Grama Mixedgrass Prairie	Western Great Plains Shortgrass Prairie	In the Central Short Grass Ecoregion
Little Bluestem-Grama Mixedgrass Prairie	Northwestern Great Plains Mixedgrass Prairie	Natural grasslands within this polygon, as well as within the Northern Great Plains Steppe ecoregion were coded to CES303.674, Northwestern Great Plains Mixed Grass Prairie
Western Wheatgrass Mixedgrass Prairie	Northwestern Great Plains Mixedgrass Prairie	In the Northern Great Plains Steppe Ecoregion
Western Wheatgrass Mixedgrass Prairie	Western Great Plains Shortgrass Prairie	In the Central Short Grass Ecoregion
Western Wheatgrass Mixedgrass Prairie	Northwestern Great Plains Mixedgrass Prairie	Natural grasslands within this polygon, as well as within the Northern Great Plains Steppe ecoregion were coded to CES303.674, Northwestern Great Plains Mixed Grass Prairie
Western Mixedgrass Prairie	Northwestern Great Plains Mixedgrass Prairie	In the Northern Great Plains Steppe Ecoregion
Western Mixedgrass Prairie	Western Great Plains Shortgrass Prairie	In the Central Short Grass Ecoregion
Western Mixedgrass Prairie	Northwestern Great Plains Mixedgrass Prairie	Natural grasslands within this polygon, as well as within the Northern Great Plains Steppe ecoregion were coded to CES303.674, Northwestern Great Plains Mixed Grass Prairie
Upland Tallgrass Prairie	Central Tallgrass Prairie	Direct Conversion
Agricultural Fields	Herbaceous Planted/Cultivated	Direct Conversion
Fallow Agricultural Fields	Herbaceous Planted/Cultivated	Direct Conversion
Deciduous Forest/Woodland	Western Great Plains Dry Bur Oak Forest and Woodland	In the Dakota Mixed Grass Ecoregion or the Northern Great Plains Steppe Ecoregion, or the Black Hills
Deciduous Forest/Woodland	Western Great Plains Dry Bur Oak Forest and Woodland	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies

Riparian Shrubland	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Riparian Woodland	Western Great Plains Riparian/Western Great Plains Floodplain	West of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairies, Crosstimbers and Southern Tall Grass Prairies
Open Water	Open Water	Direct Conversion
Evergreen Forest/Woodland	North Central Interior Floodplain/Wooded Draw	This area of includes juniper woodland in NE that was combined with CES202.046
Evergreen Forest/Woodland	Rocky Mountain Foothill Limber Pine - Juniper Woodland	Below 2400 Meters
Ponderosa Pine	Rocky Mountain Ponderosa Pine Savanna	Direct Conversion
Barren/Sand/Outcrop	Western Great Plains Cliff and Outcrop	Direct Conversion
Lowland Tallgrass Prairie	Eastern Great Plains Wet Meadow Prairie and Marsh	With in the Northern Tall Grass Prairie, Central Tall Grass Parries, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Aquatic Bed Wetland	Eastern Great Plains Wet Meadow Prairie and Marsh	With in the Northern Tall Grass Prairie, Central Tall Grass Parries, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Emergent Wetland	Eastern Great Plains Wet Meadow Prairie and Marsh	With in the Northern Tall Grass Prairie, Central Tall Grass Parries, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies
Sandhills Upland Prairie	Western Great Plains Sandhill Shrubland	This portion of extreme western KS and southwest NE includes mosaic of sand prairie (CES303.670) and sand hill shrubland (CES303.671). However, in CO original MMU application makes cross-border differences impossible to reconcile. Within this polygon, all sand prairie areas in KS were combined with sandhill shrubland.
Sandsage Shrubland	Western Great Plains Sandhill Shrubland	Direct Conversion
Low Intensity Residential	Developed	Direct Conversion
Commercial/Industrial/Transportation	Developed	Direct Conversion

Many Types	Western Great Plains Riparian/Western Great Plains Floodplain	With a 150 meter buffer around all streams and west of (Dry Line) which is west of Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies and below 1650 meters in elevation and where NLCD types are: "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody Wetland" or "Emergent Herbaceous Wetlands"
Many Types	North Central Interior Floodplain/Wooded Draw	With a 150 meter buffer around all streams and with in the Northern Tall Grass Prairie, Central Tall Grass Prairies, Flint Hills Prairie, Crosstimbers and Southern Tall Grass Prairies and below 1650 meters in elevation and where NLCD types are: "Deciduous Forest" or "Evergreen Forest" or "Mixed Forest" or "Shrubland" or "Grassland/Herbaceous" or "Woody
Many Types	Western Great Plains Sand Prairie	Area within this polygon from both NE and SD includes sandy soils from STATSGO where grassland types were recoded to CES303.670, Western Great Plains Sand Prairie.

Table 6: Metadata of mapping decision rules for the USNVC Alliances and Land Use Classes that could be mapped directly using original GAP landcover data within the 5-state region.

STATE	Original GAP Landcover	NVC Alliance & Land Use Class
Colorado	Agricultural Fields	Herbaceous Planted/Cultivated
Colorado	Aspen type	POPULUS TREMULOIDES FOREST ALLIANCE
Colorado	Commercial/Industrial/Transportation	Commercial/Industrial/Transportation
Colorado	Confined Livestock Feeding	Pasture/Hay
Colorado	Cultivated Land	Herbaceous Planted/Cultivated
Colorado	Deciduous oak type	QUERCUS GAMBELII SHRUBLAND ALLIANCE
Colorado	Dry land crops type	Herbaceous Planted/Cultivated
Colorado	Fallow Agricultural Fields	Fallow
Colorado	Irrigated crop type	Herbaceous Planted/Cultivated
Colorado	Limber pine type	PINUS FLEXILIS WOODLAND ALLIANCE
Colorado	Lodgepole pine clearcut type	PINUS CONTORTA FOREST ALLIANCE
Colorado	Lodgepole pine type	PINUS CONTORTA FOREST ALLIANCE
Colorado	Low Intensity Residential	Low Intensity Residential
Colorado	Mining operations type	Quarries/Strip Mines/Gravel Pits
Colorado	Mountain big sagebrush type	ARTEMISIA TRIDENTATA SSP. VASEYANA SHRUB HERBACEOUS ALLIANCE
Colorado	Open Water type	Open Water
Colorado	Orchard, Horticultural type	Orchards/Vineyards/Other
Colorado	Ponderosa pine type	PINUS PONDEROSA WOODLAND ALLIANCE
Colorado	Rocky Mountain bristlecone pine type	PINUS ARISTATA WOODLAND ALLIANCE
Colorado	Spruce - fir type	ABIES LASIOCARPA - (PICEA ENGLEMANII) FOREST ALLIANCE
Colorado	Urban or Built-up land	High Intensity Residential
Kansas	Water	Open Water
Kansas	Cultivated Land	Herbaceous Planted/Cultivated
Kansas	Deciduous Forest-Mined Land	Quarries/Strip Mines/Gravel Pits
Kansas	Urban Areas	High Intensity Residential
Kansas	Bur Oak Floodplain Woodland	QUERCUS MACROCARPA WOODLAND ALLIANCE
Kansas	Maple-Basswood Forest	ACER SACCHARUM - TILIA AMERICANA - (QUERCUS RUBRA) FOREST ALLIANCE
Kansas	Mixed Oak Floodplain Forest	QUERCUS MACROCARPA - QUERCUS BICOLOR - (CARYA LACINIOSA) TEMPORARILY FLOODED FOREST ALLIANCE
Kansas	Mixed Oak Ravine Woodland	QUERCUS MUEHLENBERGII WOODLAND ALLIANCE

Kansas	Oak-Hickory Forest	QUERCUS ALBA - (QUERCUS RUBRA, CARYA SPP.) FOREST ALLIANCE
Kansas	Post Oak-Blackjack Oak Forest	QUERCUS STELLATA - QUERCUS MARILANDICA FOREST ALLIANCE
Kansas	Post Oak-Blackjack Oak Woodland	QUERCUS STELLATA - QUERCUS MARILANDICA WOODLAND ALLIANCE
Kansas	CRP (Conservation Reserve Program)	Fallow
Nebraska	Open Water	Open Water
Nebraska	Agricultural Fields	Herbaceous Planted/Cultivated
Nebraska	Urban Areas	High Intensity Residential
Nebraska	Commercial/Industrial/Transportation	Commercial/Industrial/Transportation
Nebraska	Fallow Agricultural Fields	Fallow
Nebraska	Low Intensity Residential	Low Intensity Residential
Nebraska	Ponderosa Pine	PINUS PONDEROSA WOODLAND ALLIANCE
South Dakota	Water	Open Water
South Dakota	Agriculture	Herbaceous Planted/Cultivated
South Dakota	Mines and Quarries	Quarries/Strip Mines/Gravel Pits
South Dakota	High Density Development	High Intensity Residential
South Dakota	Commercial/Industrial/Transportation	Commercial/Industrial/Transportation
South Dakota	Low Density Development	Low Intensity Residential
South Dakota	Towns	Low Intensity Residential
South Dakota	Ponderosa Pine Forest	PINUS PONDEROSA WOODLAND ALLIANCE
South Dakota	Hayland	Pasture/Hay
Wyoming	Open water	Open Water
Wyoming	Mountain big sagebrush	ARTEMISIA TRIDENTATA SSP. VASEYANA SHRUB HERBACEOUS ALLIANCE
Wyoming	Dry land crops	Herbaceous Planted/Cultivated
Wyoming	Irrigated crop	Herbaceous Planted/Cultivated
Wyoming	Aspen forest	POPULUS TREMULOIDES FOREST ALLIANCE
Wyoming	Lodgepole pine	PINUS CONTORTA FOREST ALLIANCE
Wyoming	clearcut conifer	PINUS CONTORTA FOREST ALLIANCE
Wyoming	Limber pine	PINUS FLEXILIS WOODLAND ALLIANCE
Wyoming	Whitebark pine	PINUS ALBICAULIS WOODLAND ALLIANCE
Wyoming	Human settlements	High Intensity Residential
Wyoming	Ponderosa pine	PINUS PONDEROSA WOODLAND ALLIANCE
Wyoming	Spruce - fir	ABIES LASIOCARPA - (PICEA ENGLEMANII) FOREST ALLIANCE

Appendix C:

FDGC Compliant Metadata for Ecological Systems Map

Frequently-anticipated questions:

- [What does this data set describe?](#)
 1. [How should this data set be cited?](#)
 2. [What geographic area does the data set cover?](#)
 3. [What does it look like?](#)
 4. [Does the data set describe conditions during a particular time period?](#)
 5. [What is the general form of this data set?](#)
 6. [How does the data set represent geographic features?](#)
 7. [How does the data set describe geographic features?](#)
- [Who produced the data set?](#)
 1. [Who are the originators of the data set?](#)
 2. [Who also contributed to the data set?](#)
 3. [To whom should users address questions about the data?](#)
- [Why was the data set created?](#)
- [How was the data set created?](#)
 1. [From what previous works were the data drawn?](#)
 2. [How were the data generated, processed, and modified?](#)
 3. [What similar or related data should the user be aware of?](#)
- [How reliable are the data; what problems remain in the data set?](#)
 1. [How well have the observations been checked?](#)
 2. [How accurate are the geographic locations?](#)
 3. [How accurate are the heights or depths?](#)
 4. [Where are the gaps in the data? What is missing?](#)
 5. [How consistent are the relationships among the data, including topology?](#)
- [How can someone get a copy of the data set?](#)
 1. [Are there legal restrictions on access or use of the data?](#)
 2. [Who distributes the data?](#)
 3. [What's the catalog number I need to order this data set?](#)
 4. [What legal disclaimers am I supposed to read?](#)
 5. [How can I download or order the data?](#)
- [Who wrote the metadata?](#)

What does this data set describe?

Title: r2_fin_4

Abstract:

Ecological Systems for Colorado, Kansas, Nebraska, South Dakota, and Wyoming as described by NatureServe.

1. How should this data set be cited?

NatureServe, 10-16-2003, r2_fin_4.

Online Links:

- o \\CALIFORNIA\GIS_Workarea\region2\export\aifiles\r2_fin_4

Other_Citation_Details:

Comer, P., S. Menard, M. Tuffly, K. Kindscher, R. Rondeau, G. Jones, G. Steinaer, and D. Ode. 2003. Upland and Wetland Ecological Systems in Colorado, Wyoming, South Dakota, Nebraska, and Kansas. Report and map (10 hectare minimum map unit) to the National Gap Analysis Program. Dept. of Interior USGS. NatureServe. ___ pp. plus appendices.

2. What geographic area does the data set cover?

West_Bounding_Coordinate: -124.526302

East_Bounding_Coordinate: -84.572593

North_Bounding_Coordinate: 52.649075

South_Bounding_Coordinate: 26.903866

3. What does it look like?

(JPEG)

JPG graphic

4. Does the data set describe conditions during a particular time period?

Calendar_Date: 1910

Time_of_Day: 4:00 PM

Currentness_Reference: publication date

5. What is the general form of this data set?

Geospatial_Data_Presentation_Form: raster digital data

6. How does the data set represent geographic features?

a. How are geographic features stored in the data set?

This is a Raster data set. It contains the following raster data types:

- Dimensions 87770 x 95305 x 1, type Grid Cell

b. What coordinate system is used to represent geographic features?

The map projection used is Albers Conical Equal Area.

Projection parameters:

Standard_Parallel: 29.500000
Standard_Parallel: 45.500000
Longitude_of_Central_Meridian: -96.000000
Latitude_of_Projection_Origin: 23.000000
False_Easting: 0.000000
False_Northing: 0.000000

Planar coordinates are encoded using row and column
Abcissae (x-coordinates) are specified to the nearest 30.000000
Ordinates (y-coordinates) are specified to the nearest 30.000000
Planar coordinates are specified in meters

The horizontal datum used is North American Datum of 1927.
The ellipsoid used is Clarke 1866.
The semi-major axis of the ellipsoid used is 6378206.400000.
The flattening of the ellipsoid used is 1/294.978698.

Vertical_Coordinate_System_Definition:

Altitude_System_Definition:
Altitude_Datum_Name: National Geodetic Vertical Datum of 1929
Altitude_Distance_Units: meters

7. How does the data set describe geographic features?

r2_fin_4

ObjectID

Internal feature number. (Source: ESRI)

Sequential unique whole numbers that are automatically generated.

value

Identification key for MS Access Database (Source: NatureServe)

Formal codeset	
Codeset Name:	LC_ID
Codeset Source:	NatureServe

Count

Cell count per Value (Source: ESRI)

Sequential unique whole numbers that are automatically generated.

Eco_sys_name

Ecological System Name (Source: NatureServe)

Formal codeset	
Codeset Name:	LC_ID
Codeset Source:	NatureServe

Who produced the data set?

1. **Who are the originators of the data set?** (may include formal authors, digital compilers, and editors)
 - o NatureServe
2. **Who also contributed to the data set?**

NatureServe

3. **To whom should users address questions about the data?**

Michael Tuffly
NatureServe
Ecologist/GIS Analyst
2400 Spruce Street Suite 201
Boulder, Colorado 80302
USA

(303) 541-0331 (voice)
(303) 449-4328 (FAX)
mike_tuffly@natureserve.org

Hours_of_Service: 8:00 AM - 5:00 PM MST

Why was the data set created?

These data were developed from existing GAP data from Colorado, Kansas, Nebraska, South Dakota, and Wyoming coupled with ancillary data. These data show the Ecological Systems and were developed for the United States Forest Service Region 2.

How was the data set created?

1. **From what previous works were the data drawn?**

Colorado GAP data (source 1 of 12)

Schrupp, D.L., W.A. Reiners, T.G. Thompson, L., 2000, Colorado Gap Analysis Program: A Geographic Approach to Planning for Biological Diversity - Final Report. U.S. Geological Survey Biological Resources Division Gap Analysis Program, And Colorado Division Of Wildlife. Denver, CO.

Type_of_Source_Media: paper

South Dakota GAP data (source 2 of 12)

Smith, V. J., J. A. Jenks, C. Berry, Jr.,, Expected publication 2003, The South Dakota Gap Analysis Project final report. U. S. Department of the Interior, U. S. Geological Survey, Reston, Virginia, USA..

Type_of_Source_Media: paper

Wyoming GAP Data (source 3 of 12)

Merrill, E.H., W.A. Reiners, R.W. Marrs, S.H. , 1996, A Geographic Analysis of Biodiversity - Final Report, U.S.G.S. Biological Resources Division. Wyoming Cooperative Fish and Wildlife Research Unit and University of Wyoming, Laramie, WY.

Type_of_Source_Media: paper

DEMS (source 4 of 12)

USGS, Unknown, Digital Elevation Models.

Other_Citation_Details:

The Digital Elevation Models for all 5 states were give to NatureServe by the University of Wyoming. All the DEMS were in 82.3 meter cell size.

Type_of_Source_Media: online

NLCD (source 5 of 12)

USGS, National Land Cover Data (NLCD).

Online Links:

- <http://edcwww.cr.usgs.gov/programs/lccp/natl/landcover.html>

Type_of_Source_Media: online

Rivers (source 6 of 12)

Environmetal Systems Reserach Institute, Hydrography.

Other_Citation_Details:

see the directory labeled a_metadata for the metadata on the hydrography. Files are labeled corivers.shp.xml (for Colorado), wyivers.shp.xml (for Wyoming), ksivers.shp.xml (for Kansas), sdrivers.shp.xml (for South Dakota), nerivers.shp.xml (for Nebraska).

Type_of_Source_Media: CD-ROM

State Boundaries (source 7 of 12)

Environmental Systems Research Institute, State Boundaries.

Other_Citation_Details:

see the directory labeled a_metadata for the metadata on the State Boundaries. File is labeled states.shp.xml

Type_of_Source_Media: CD-ROM

TNC EcoRegions (source 8 of 12)

Conservancy, The Nature , National Ecological Ecoregions.

Other_Citation_Details:

see the directory labeled a_metadata for the metadata on the National Ecological Ecoregions. File is labeled eco2000b.shp.xml

Type_of_Source_Media: disc

Sagebrush Mapping (source 9 of 12)

NatureServe and The Nature Conservancy, SageBrush Mapping.

Other_Citation_Details:

see the directory labeled a_metadata for the metadata on the State Boundaries. File is labeled sagesitch_meta.txt

Type_of_Source_Media: CD-ROM

Final Report on the Project (source 10 of 12)

Comer, P., S. Menard, M. Tuffly, K. Kindsc, Unknown, Upland and Wetland Ecological Systems in Colorado, Wyoming, South Dakota, Nebraska, and Kansas.

Type_of_Source_Media: paper

Kansas GAP Data (source 11 of 12)

Egbert, Stephen; D. Peterson; A. Steward; C. Lau, 2001, The Kansas Gap Land Cover Map.

Type_of_Source_Media: paper

Nebraska GAP (source 12 of 12)

Henebry, G., Putz, J. Fischer, J. Wolf, and , October 2001, Land Cover Map of Nebraska.

Type_of_Source_Media: paper

2. **How were the data generated, processed, and modified?**

Date: 1909 (process 1 of 4)

All of the 5 State GAP data were downloaded from

ftp://ftp.gap.uidaho.edu/outgoing/jennings/GAP_FSR2_STATES.zip Author of the raw GAP data is Michael Jennings [jennings@uidaho.edu]

Person who carried out this activity:

Michael Jennings
USGS/BRD/Gap Analysis Program
530 S. Asbury St., Suite 1
Moscow, ID 83843
USA

(303) 541-0331 (voice)
(303) 449-4328 (FAX)
mike_tuffly@natureserve.org

Hours_of_Service: M - F 8:00 AM - 5:00 PM MT

Data sources used in this process:

- all 5 state GAP data

(process 2 of 4)

A minimum map unit of 100 Hectares was applied to all classes

Date: 1910 (process 3 of 4)

The GAP Landuse Names were reclassified using the parameters outlined in Metadata_tables_final.mdb. Note that Metadata_tables_final.mdb is a Microsoft Access database. The Metadata_tables_final.mdb file is contained in the a_metadata directory as an additional file. If this file is not included please contact the Contact person for a copy.

Person who carried out this activity:

Michael Tuffly
NatureServe
Ecologist/GIS Analyst

(303) 444-1060 (voice)
(303) 449-4328 (FAX)
mike_tuffly@natureserve.org

(process 4 of 4)

After classifying the data a Minimum Mapping unit (MMU) of 100 Hectares was reapplied to all data. Classes that have a MMU of 0 (see metadata Metadata_tables_final.mdb) were added back into the final GRID product.

3. **What similar or related data should the user be aware of?**
-

How reliable are the data; what problems remain in the data set?

1. **How well have the observations been checked?**
2. **How accurate are the geographic locations?**

Unknown

3. **How accurate are the heights or depths?**
 4. **Where are the gaps in the data? What is missing?**
 5. **How consistent are the relationships among the observations, including topology?**
-

How can someone get a copy of the data set?

Are there legal restrictions on access or use of the data?

Access_Constraints: None

Use_Constraints:

follow the minimum mapping unit of 100 Hectares for some classes and 0.09 Hectares for other classes.

1. **Who distributes the data set?** (Distributor 1 of 1)

Michael Tuffly
NatureServe
Ecologist/GIS Analyst

(303) 444 1060 (voice)
(303) 449 4328 (FAX)
mike_tuffly@natureserve.org

Hours_of_Service: M-F 8:00AM - 5:00 PM MST

2. **What's the catalog number I need to order this data set?**

Downloadable Data

3. **What legal disclaimers am I supposed to read?**
4. **How can I download or order the data?**
 - o **Availability in digital form:**

Data format: Size: 200.035

- **Cost to order the data:**
-

Who wrote the metadata?

Dates:

Last modified: 13-Nov-2003

Last Reviewed: 16-Oct-2003

To be reviewed: N/A

Metadata author:

Michael Tuffly
NatureServe
Ecologist/GIS Analyst
2400 Spruce Street Suite 201
Boulder, Colorado 80302.
USA

(303) 541 0331 (voice)

(303) 449-4328 (FAX)

mike_tuffly@natureserve.org

Metadata standard:

FGDC Content Standards for Digital Geospatial Metadata (FGDC-STD-001-1998)

Metadata extensions used:

- <http://www.esri.com/metadata/esriprof80.html>
-

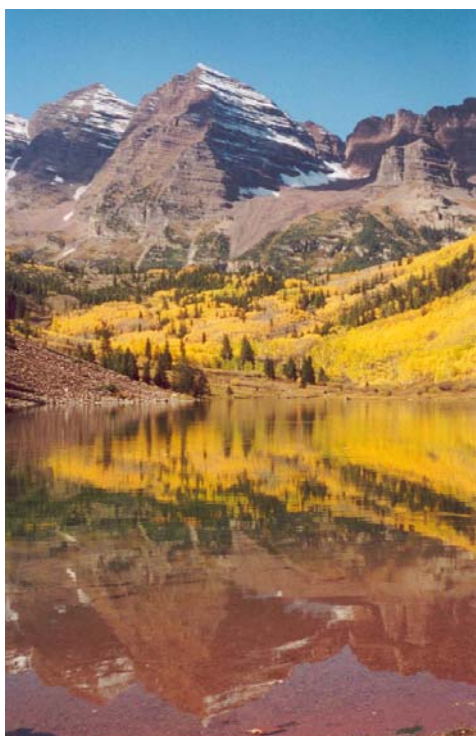
Generated by [mp](#) version 2.7.33 on Thu Nov 13 13:38:17 2003

Appendix D:
Descriptions of Ecological Systems Identified for CO, WY, KS, NE, and SD



Spring view of the Central Great Plains Mixedgrass Prairie Ecological System. This site is from Horse Thief Canyon, which is found in the Dakota Sandstone, Smoky Hills Physiographic Province in Ellsworth County, Kansas. *Photo © S. Menard.*

Southeastern Great Plains Unglaci-ated Tallgrass Prairie System--landscape dominated by tallgrass prairie (*Andropogon gerardii* and *Schizacharium scoparium*) with scattered trees in the ravines. This site is from the Flint Hills of Kansas. *Photo © S. Menard.*



Rocky Mountain Alpine Bedrock and Scree, Rocky Mountain Subalpine Dry-Mesic Spruce-fir Forest and Woodland, and Rocky Mountain Aspen Forest and Woodland Systems, above Maroon Lake in the Maroon Bells Wilderness, Colorado. *Photo © P. Comer.*

**INTERNATIONAL ECOLOGICAL
CLASSIFICATION STANDARD:**

**TERRESTRIAL ECOLOGICAL SYSTEMS
OF THE UNITED STATES**

US Forest Service Region 2 Subset

Updated October 2003

by

NatureServe

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

This subset of the Terrestrial Ecological Systems of The United States covers ecological systems attributed to the states of SD, NE, KS, WY, and MT. 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 Shannon Menard (shannon_menard@natureserve.org).



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Arlington, VA 22209

These data are extracted from:

NatureServe. 2003. International Ecological Classification Standard: Terrestrial Ecological Systems. NatureServe Central Databases. NatureServe, Arlington, VA.

This document may be generally cited as follows:

NatureServe¹. 2003. International Ecological Classification Standard: Terrestrial Ecological Systems of the United States, US Forest Service Region 2 Subset (updated October 2003). NatureServe Central Databases. NatureServe, Arlington, VA and Minneapolis, MN.

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, Query 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-Departamento 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.

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Executive Summary to Ecological Systems Report

This report presents work conducted to classify and describe terrestrial ecological systems in the coterminous United States and adjacent portions of coastal British Columbia and southern Alaska. A terrestrial ecological system is 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 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 system units are intended to provide “meso-scale” classification units for applications to resource management and conservation. They may serve as practical units on their own or in combination with classification units defined at different conceptual and spatial scales.

Here we define upland and wetland ecological system units emphasizing the “natural” portions of the landscape. We have not defined units for human-dominated areas. The temporal scale or bounds we have chosen integrate typical successional dynamics into the concept of each unit. The spatial characteristics of ecological systems vary on the ground, but all fall into several recognizable and repeatable categories. With these temporal and spatial scales bounding the concept of ecological systems, we may then integrate multiple ecological factors – or *diagnostic classifiers* – to define each classification unit.

Multiple environmental factors are evaluated and combined in different ways to explain the spatial co-occurrence of vegetation associations. Continent-scaled climate, as well as broad patterns in phytogeography, are reflected in Ecological Division units that spatial frame the classification at subcontinental scales. We integrated bioclimatic categories to consistently characterize life zone concepts (e.g. ‘maritime,’ ‘lowland,’ ‘montane,’ ‘subalpine,’ ‘alpine’) in appropriate context from arctic through tropical latitudes. Within the context of biogeographic and bioclimatic factors, ecological composition, structure, and function is strongly influenced by factors determined by local physiography, landform, and surface substrate. Some environmental variables are described through existing, standard classifications (e.g. soil and hydrogeomorphology) and serve as excellent diagnostic classifiers for ecological systems. Many dynamic processes are also sufficiently understood and described to serve as diagnostic classifiers. The recurrent juxtaposition of recognizable vegetation communities provides an additional criterion for multi-factor classification. While biotic turnover, or beta diversity, is a primary consideration in distinguishing among similar ecological system units, the relative abundance of vegetation can also be an important consideration.

Ecological classification ideally proceeds through several phases, including qualitative description, quantitative data gathering, analysis, and field-testing; all in a continual process of refinement. Our approach presented here is qualitative and rule-based, setting the stage for subsequent quantitative work, as well as the development of dichotomous keys and maps. We relied on available interpretations of vegetation and ecosystem patterns across the study area. And we reviewed associations of the IVC/NVC in order to help define the limits of systems concepts. Thus our approach draws extensively on the existing literature available to us. In recent years we have also tested how well a systems approach could facilitate mapping of ecological patterns at intermediate-scales across the landscape. These tests have led to the rule sets and protocols presented here.

This project resulted in the identification and description of 599 upland and wetland ecological system types within the project area. They represent the full range of natural variation, with some 381 types (63%) being uplands, 183 types (31%) being wetland, and 35 types (6%) being complexes of uplands and wetlands. Looking at prevailing vegetation physiognomy, and not counting upland/wetland complexes, some 322 types (54%) are predominantly forest, woodland, and/or shrubland, and some 166 types (28%) are predominantly herbaceous, savanna, or shrub steppe. Seventy-four types (12%) are sparsely vegetated

or “barren.” All information for this classification is stored in a database, allowing for numerous queries of information on each type.

Terrestrial ecological system units provide practical, systematically defined groupings of plant associations, forming the basis of mapping terrestrial communities and ecosystems at multiple scales of spatial and thematic resolution. Applications of ecological systems include their use as units for conservation assessment, ecological inventory, mapping, land management, ecological monitoring, and species habitat modeling. NatureServe will facilitate on-going development and refinement of this classification as part of an International Ecological Classification Standard.

Ecological System Descriptions

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CES202.046 NORTH-CENTRAL INTERIOR DRY-MESIC OAK FOREST AND WOODLAND

Division 202, Forest and Woodland

Spatial Scale & Pattern: Large Patch**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland**Diagnostic Classifiers:** Forest and Woodland (Treed), Udic, F-Patch/Low Intensity, Quercus - Carya**Non-Diagnostic Classifiers:** Footslope, Glaciated uplands, Kame moraine, Lakeplain, Moraine, Temperate [Temperate Continental], Mesotrophic Soil, Loam Soil Texture

Concept Summary: This system is found throughout the glaciated regions of the Midwest, typically in gently rolling landscapes. It can occur on uplands within the prairie matrix and near floodplains, or on rolling glacial moraines and among kettle-kame topography. Soils are typically well-drained Mollisols or Alfisols that range from loamy to sandy loam in texture. Historically, this type was quite extensive in Michigan, Indiana, Illinois, Missouri, Iowa, Wisconsin, and Minnesota. Well over 700,000 hectares likely occurred in southern Michigan alone ca. 1800. It is distinct from other forested systems within the region by a dry-mesic edaphic condition that is transitional between dry oak forests and woodlands and mesic hardwood forests, such as maple-basswood forests. Forest cover can range from dense to moderately open canopy, and there is commonly a dense shrub layer. Fire-resistant oak species, in particular *Quercus macrocarpa*, *Quercus rubra*, and/or *Quercus alba*, dominate the overstory. *Carya* spp., including *Carya ovata*, *Carya cordiformis*, and *Carya alba* (= *Carya tomentosa*) are diagnostic in portions of the range of this system. Depending on range of distribution, and overstory canopy density, the understory may include species such as *Corylus americana*, *Amelanchier* spp., *Maianthemum stellatum*, *Caulophyllum thalictroides*, *Laportea canadensis*, *Trillium grandiflorum*, *Aralia nudicaulis*, and *Urtica dioica*. Occasionally, prairie grasses such as *Andropogon gerardii* and *Panicum virgatum* may be present. Fire constitutes the main natural process for this type and likely maintained a more open canopy structure to support oak regeneration. Historic fire frequency was likely highest in the prairie-forest border areas. Fire suppression may account for the more closed oak forest examples of this system with the more mesic understory. It likely has allowed for other associates such as *Acer saccharum*, *Celtis occidentalis*, *Liriodendron tulipifera*, *Ostrya virginiana*, and *Juglans nigra* to become more prevalent, especially in upland areas along floodplains. Extensive conversion for agriculture has fragmented these systems. Continued fire suppression has also resulted in succession to mesic hardwoods, such that in many locations, no oak species are regenerating. Remaining large areas of this system are likely under considerable pressure due to conversion to agriculture, pastureland, and urban development.

DISTRIBUTION**Range:** Found throughout the glaciated regions of the Midwest.**Ecological Divisions:** 202, 205**TNC Ecoregions:** 35:C, 36:C, 44:?, 45:C, 46:C, 47:?, 48:C**Subnations/Nations:** IA:c, IL:c, IN:c, KS:c, MI:c, MN:c, MO:c, ND:c, NE:c, OH:c, SD:p, WI:c**CONCEPT****Alliances:**

- ACER SACCHARUM - TILIA AMERICANA - (QUERCUS RUBRA) FOREST ALLIANCE (A.220)
- QUERCUS ALBA - (QUERCUS RUBRA, CARYA SPP.) FOREST ALLIANCE (A.239)
- QUERCUS ALBA - (QUERCUS VELUTINA) WOODLAND ALLIANCE (A.612)
- QUERCUS MACROCARPA - QUERCUS (ALBA, ELLIPSOIDALIS, VELUTINA) WOODLAND ALLIANCE (A.619)
- QUERCUS MACROCARPA FOREST ALLIANCE (A.245)
- QUERCUS MACROCARPA WOODLAND ALLIANCE (A.620)
- QUERCUS MUEHLENBERGII - (ACER SACCHARUM) FOREST ALLIANCE (A.1912)
- QUERCUS RUBRA - (ACER SACCHARUM) FOREST ALLIANCE (A.251)

SOURCES**References:** Abrams 1992, Archambault et al. 1989, Archambault et al. 1990, Comer and Albert 1997, Comer et al. 1995a, MNNHP 1993**Last updated:** 17 Apr 2003**Concept Author:** P. Comer, K. Kindscher, S. Menard, D. Faber-Langendoen**Stakeholders:** MCS**LeadResp:** MCS**CES202.696 NORTH-CENTRAL INTERIOR MAPLE-BASSWOOD FOREST**

Division 202, Forest and Woodland

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Sideslope, Toeslope/Valley Bottom, Mesotrophic Soil, Deep Soil, Loam Soil Texture

Concept Summary: This system is primarily found in the prairie forest border region of Minnesota, Wisconsin and Iowa, but can range north into northern Minnesota and Wisconsin and south to southern Illinois and eastern Kansas. This forest system is distinguished by underlying mesic soils and the predominance of mesic deciduous species forming a moderately dense to dense canopy. Examples of this system occur on valley slopes and bottoms often with northern or eastern aspects. Soils are moderately well-drained, fertile, and moderate to deep loams that have developed from glacial till or loess parent material. *Acer saccharum* typifies this system with *Tilia americana*, *Quercus rubra*, and *Ostrya virginiana* often occurring as common associates. The dense canopy allows for a rich mixture of shrub and herbaceous species in the understory. Examples of common herbaceous species include *Anemone quinquefolia*, *Adiantum pedatum*, *Arisaema triphyllum*, and *Sanicula* spp. Dynamic processes such as wind and fire can impact this system over long return cycles, however, the most immediate threats to remaining examples of this system are grazing and conversion to agriculture.

DISTRIBUTION

Range: This system ranges from Minnesota and Wisconsin south to eastern Kansas and Nebraska and southeast to Illinois and possibly western Indiana.

Ecological Divisions: 202, 205

TNC Ecoregions: 36:C, 37:?, 38:?, 45:C, 46:C, 47:C, 48:C

Subnations/Nations: IA:c, IL:c, IN:p, KS:c, MI:p, MN:c, MO:c, NE:c, WI:c

CONCEPT

Alliances:

- ACER SACCHARUM - TILIA AMERICANA - (QUERCUS RUBRA) FOREST ALLIANCE (A.220)
- QUERCUS RUBRA - (ACER SACCHARUM) FOREST ALLIANCE (A.251)

Environment: This system is found primarily on mesic soils that are moderately well-drained and fertile. These are mostly moderate to deep loams that have developed from glacial till or loess. This system occurs primarily on valley slopes and bottoms often with northern or eastern aspects.

Vegetation: Mesic deciduous trees form a moderately dense to dense canopy in examples of this system. *Acer saccharum* is the most common tree species forming the majority of the canopy and sapling layers. Common associates include *Tilia americana*, *Quercus rubra*, and *Ostrya virginiana*. The understory contains a rich mixture of shrub and herbaceous species such as *Anemone quinquefolia*, *Adiantum pedatum*, *Arisaema triphyllum*, and *Sanicula* spp.

Dynamics: Wind and fire can impact this system over long return intervals. Small gap development and replacement due to tree death is more frequent than more catastrophic fire or wind. The greatest impacts on this system are due to conversion to agriculture, logging and grazing.

SOURCES

References: Barbour and Billings 1988

Last updated: 07 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS

LeadResp: MCS

CES202.699 NORTH-CENTRAL INTERIOR QUARTZITE GLADE

Division 202, Forest and Woodland

Spatial Scale & Pattern: Small Patch

Classification Confidence: low

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Woody-Herbaceous, Cliff (Landform), Ridge/Summit/Upper Slope, Metamorphic Rock [Quartzite], Very Shallow Soil

Concept Summary: This system is found within the driftless region of Wisconsin and along outcrops of Sioux Quartzite in Minnesota and South Dakota. It is found on steep slopes that overlay quartzite, rhyolite or sandstone bedrock with occasional fractures. Soils are typically thin silt loams and acidic. This system includes a mosaic of rocky outcrops that are sparsely vegetated with scattered succulents to woodland glades. The glades are dominated by *Quercus alba* or *Carya ovata* with an understory of herbaceous species such as *Carex pensylvanica*, *Antennaria plantaginifolia*, *Solidago ulmifolia*, and others. Drought strongly influences this system, although deer browsing and fire, at least historically, may also play a role in keeping the glade structure, especially in the Baraboo Hills.

Comments: This system may not hold together as a system separate from a larger, surrounding system. In addition, those stands in Minnesota and South Dakota may not be the same system type as those in Wisconsin. Further review is needed.

DISTRIBUTION

Range: This is found in a very restricted area within Minnesota and South Dakota along outcrops of Sioux Quartzite and on quartzite, rhyolite or sandstone outcrops in the Baraboo Hills region of Wisconsin.

Ecological Divisions: 202, 205

TNC Ecoregions: 35:C, 46:C

Subnations/Nations: MN:c, ND:c, SD:p, WI:c

CONCEPT**Alliances:**

- QUERCUS ALBA - (QUERCUS VELUTINA) WOODLAND ALLIANCE (A.612)
- ROCK OUTCROP SPARSELY VEGETATED ALLIANCE (A.1838)

SOURCES

References: MNNHP 1993, West and Welsh 1998

Last updated: 05 Mar 2003

Concept Author: S. Menard and D. Faber-Langendoen

Stakeholders: MCS

LeadResp: MCS

CES202.708 OZARK-OUACHITA DRY-MESIC OAK FOREST

Division 202, Forest and Woodland

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Quercus - Carya

Concept Summary: This system is found throughout the Ozark and Ouachita Highlands ranging to the western edge of the Interior Low Plateau. It is the matrix system of this region and occurs on dry-mesic to mesic gentle to moderately steep slopes. Soils are typically moderately to well-drained and more fertile than those associated with oak woodlands. A closed canopy of oak species (*Quercus rubra* and *Quercus alba*) often associated with hickory species (*Carya* spp.) typify this system. *Acer saccharum* (or *Acer barbatum* to the south) may occur on more mesic examples of this system. Wind, drought, lightning, and occasional fires can influence this system.

Comments: Dry-mesic to mesic oaks were separated from dry oak (Ozark-Ouachita Dry Oak Woodland (CES202.707)) per the suggestion of Missouri. This separation may need to be further reviewed. Likewise, the distribution of this system versus the one farther north needs to be reviewed. Currently the glacial line separates the two systems.

DISTRIBUTION

Range: This system is found throughout the Ozark and Ouachita Highlands, reaching to the western Interior Low Plateau.

Ecological Divisions: 202

TNC Ecoregions: 37:P, 38:C, 39:C, 44:C, 49:P

Subnations/Nations: AR:c, IL:c, IN:c, KS:?, MO:c, OK:c

CONCEPT**Alliances:**

- ACER BARBATUM - FRAXINUS AMERICANA - (JUGLANS NIGRA) FOREST ALLIANCE (A.214)
- FAGUS GRANDIFOLIA - QUERCUS RUBRA - QUERCUS ALBA FOREST ALLIANCE (A.229)
- QUERCUS ALBA - (QUERCUS RUBRA, CARYA SPP.) FOREST ALLIANCE (A.239)
- QUERCUS FALCATA FOREST ALLIANCE (A.243)
- QUERCUS PRINUS - (QUERCUS COCCINEA, QUERCUS VELUTINA) FOREST ALLIANCE (A.248)
- QUERCUS RUBRA - (ACER SACCHARUM) FOREST ALLIANCE (A.251)
- QUERCUS VELUTINA - QUERCUS ALBA - (QUERCUS COCCINEA) FOREST ALLIANCE (A.1911)
- TSUGA CANADENSIS - LIRIODENDRON TULIPIFERA FOREST ALLIANCE (A.413)

SOURCES

References: Nelson 1985

Last updated: 31 Mar 2003

Concept Author: S. Menard

Stakeholders: MCS, SCS

LeadResp: MCS

CES202.695 NORTH-CENTRAL INTERIOR SAND AND GRAVEL TALLGRASS PRAIRIE

Division 202, Herbaceous

Spatial Scale & Pattern: Large Patch

Classification Confidence: high

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

Non-Diagnostic Classifiers: Herbaceous, Esker, Kame, Lakeplain, Moraine, Outwash plain, Outwash terrace, Glaciated, Sand Soil Texture, F-Patch/High Intensity, W-Patch/High Intensity

Concept Summary: This system is found in the northern Midwest, particularly in Minnesota, Wisconsin and Michigan and possibly ranging into Ontario. It is often found on glacial features such as kames, eskers, moraines, lakeplains (though excluding the Great Lakes lakeplain) and sandplains, and along eolian dunes. In contrast to the deeper, richer soils supporting other tallgrass systems in the region, the underlying soils in this system tend to be more shallow, sandy, rocky and/or gravelly outwash soils. Grassland species such as *Schizachyrium scoparium*, *Andropogon gerardii*, and *Bouteloua* spp., varying in cover from sparse to moderately dense, dominate this system. Woody species more tolerant of droughty conditions may be found in some examples. Fire and drought are the major dynamics influencing this system. Wind can also play a role, especially on examples found on sandplains and/or eolian dunes.

DISTRIBUTION

Range: This system is found in the northern Midwest possibly ranging into Ontario.

Ecological Divisions: 202, 205

TNC Ecoregions: 35:C, 36:P, 45:C, 46:C, 47:C, 48:C

Subnations/Nations: IA:p, IL:p, IN:p, MI:c, MN:c, MO:c, ND:p, ON:p, SD:p, WI:c

CONCEPT

Alliances:

- ANDROPOGON GERARDII - (CALAMAGROSTIS CANADENSIS, PANICUM VIRGATUM) HERBACEOUS ALLIANCE (A.1191)
- ANDROPOGON GERARDII - (SORGHASTRUM NUTANS) HERBACEOUS ALLIANCE (A.1192)
- SCHIZACHYRIUM SCOPARIUM - (SPOROBOLUS CRYPTANDRUS) HERBACEOUS ALLIANCE (A.1224)
- SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1225)
- SCHIZACHYRIUM SCOPARIUM - SORGHASTRUM NUTANS HERBACEOUS ALLIANCE (A.1198)

SOURCES

References: MNNHP 1993

Last updated: 07 Mar 2003

Concept Author: S. Menard

Stakeholders: MCS

LeadResp: MCS

CES202.701 NORTH-CENTRAL INTERIOR SHRUB SWAMP-WET MEADOW AND MARSH

Division 202, Woody Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: high

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

Non-Diagnostic Classifiers: Shrubland (Shrub-dominated), Herbaceous, Saturated Soil

Concept Summary: This system is found throughout the northern Midwest ranging into southern Canada. It is typically found on glacial potholes, river valleys, ponds, channels in glacial outwash and on lakeplains. This system contains a deep to shallow area of freshwater marsh dominated by emergent species surrounded by a zone of wet meadow. The emergent marsh zone within this system contains hydric soils flooded by water ranging from several centimeters to over 1 meter for most of the growing season. Emergent marsh species such as *Typha* spp. and *Schoenoplectus* spp. dominate the core of this system. Wet meadows can surround the emergent marsh core along wet mineral soils, or shallow peat with the water table typically just below the surface for most of the growing season. The vegetation in this zone of the system is dominated by sedges (*Carex* spp.) and grasses such as *Calamagrostis canadensis*. Shrub swamps can also be associated with the wet meadows within this system. Typical shrub species include *Cornus* spp., *Salix* spp., and/or *Cephalanthus occidentalis*. Fire originating in adjacent uplands, as well as hydrology, can influence this system. In the absence of fire, drought and/or ditching can increase the proportion of shrubs compared to the wet meadow.

DISTRIBUTION

Range: This system is found in the northern Midwest and southern Canada.

Ecological Divisions: 201, 202

TNC Ecoregions: 35:C, 36:C, 45:C, 46:C, 47:C, 48:C, 49:?

Subnations/Nations: IA:c, IL:c, IN:c, MI:c, MN:c, MO:c, ND:c, OH:c, ON:p, SD:c, WI:c

CONCEPT

Alliances:

- CALAMAGROSTIS CANADENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1400)
- CAREX (ROSTRATA, UTRICULATA) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1403)
- CAREX AQUATILIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1404)
- CAREX ATHERODES SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1396)

- CAREX LACUSTRIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1367)
- CAREX STRICTA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1397)
- CEPHALANTHUS OCCIDENTALIS SEMIPERMANENTLY FLOODED SHRUBLAND ALLIANCE (A.1011)
- CORNUS SERICEA - SALIX SPP. SEASONALLY FLOODED SHRUBLAND ALLIANCE (A.989)
- CORYLUS AMERICANA - (SPIRAEA TOMENTOSA, MALUS IOENSIS) SHRUBLAND ALLIANCE (A.897)
- SCHOENOPECTUS ACUTUS - (SCHOENOPECTUS TABERNAEMONTANI) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1443)
- SCHOENOPECTUS FLUVIATILIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1387)
- SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)
- TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCHOENOPECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1436)

SOURCES

References: Comer and Albert 1997

Last updated: 10 Mar 2003

Concept Author: S. Menard

Stakeholders: MCS, CAN

LeadResp: MCS

CES202.702 NORTH-CENTRAL INTERIOR SHRUB-GRAMINOID ALKALINE FEN

Division 202, Woody Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: high

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

Non-Diagnostic Classifiers: Shrubland (Shrub-dominated), Woody-Herbaceous, Herbaceous, Fen, Alkaline Water, Saturated Soil

Concept Summary: This fen system is found in the glaciated portions of the Midwest and southern Canada. Examples of this system can be located on level to sloping seepage areas, in pitted outwash or in kettle lakes associated with kettle-kame-moraine topography. Groundwater flows through marls and shallow peat soils typically minerotrophic and slightly alkaline. Examples of this system contain a core fen area of graminoids surrounded by shrubs and tall-shrubs with a fairly continuous sphagnum moss. Herbaceous and shrub cover is variable with little to no tree cover. Characteristic species include prairie grasses such as *Andropogon gerardii* and *Spartina pectinata* with prairie forbs and sedges, *Carex* spp. Common shrub species include *Dasiphora fruticosa* ssp. *floribunda*, *Cornus* spp., and *Salix* spp. Alterations in wetland hydrology and agricultural development can threaten examples of this system.

DISTRIBUTION

Range: This system is found in the northern Midwest and southern Canada.

Ecological Divisions: 201, 202

TNC Ecoregions: 35:C, 36:C, 45:C, 46:C, 47:C, 48:C, 49:P

Subnations/Nations: IA:c, IL:c, IN:c, MI:c, MN:c, ND:c, OH:c, ON:c, SD:c, WI:c

CONCEPT

Alliances:

- CAREX (FLAVA, HYSTERICINA, INTERIOR, STERILIS) SATURATED SHRUB HERBACEOUS ALLIANCE (A.1561)
- CAREX OLIGOSPERMA - CAREX LASIOCARPA SATURATED HERBACEOUS ALLIANCE (A.1467)
- CORNUS SERICEA - PHOTINIA MELANOCARPA - TOXICODENDRON VERNIX SATURATED SHRUBLAND ALLIANCE (A.1016)
- DASIPHORA FRUTICOSA SSP. FLORIBUNDA / CAREX (FLAVA, INTERIOR, LASIOCARPA, STERILIS) SATURATED SHRUB HERBACEOUS ALLIANCE (A.1562)
- SYMPLOCARPUS FOETIDUS - CALTHA PALUSTRIS SATURATED HERBACEOUS ALLIANCE (A.1694)
- VACCINIUM CORYMBOSUM SATURATED SHRUBLAND ALLIANCE (A.1018)

SOURCES

References: MNNHP 1993

Last updated: 10 Mar 2003

Concept Author: S. Menard

Stakeholders: MCS

LeadResp: MCS

CES202.694 NORTH-CENTRAL INTERIOR FLOODPLAIN

Division 202, Mixed Upland and Wetland

Spatial Scale & Pattern: Linear

Classification Confidence: high

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Herbaceous, Floodplain, Glaciated, Sand Soil Texture, Clay Soil Texture, Udic

Concept Summary: This system is found along rivers across the glaciated Midwest. It occurs from river's edge across the floodplain or to where it meets a wet meadow system. It can have a variety of soil types found within the floodplain from very well-drained sandy substrates to very dense clays. It is this variety of substrates and flooding that creates the mix of vegetation that includes *Acer saccharinum*, *Populus deltoides*, willows, especially *Salix nigra* in the wettest areas, and *Fraxinus pennsylvanica*, *Ulmus americana*, and *Quercus macrocarpa* in more well-drained areas. Within this system are oxbows that may support *Nelumbo lutea* and *Typha latifolia*. Understory species are mixed, but include shrubs, such as *Cornus drummondii* and *Asimina triloba* (in Kansas), sedges and grasses, which sometimes help form savanna vegetation. Flooding is the primary dynamic process, but drought, grazing, and fire have all had historical influence on this system. Federal reservoirs have had a serious and negative effect on this system, along with agriculture that has converted much of this system to drained agricultural land.

Comments: The distribution limit northward into the Great Lakes (Laurentian) region is somewhat unclear. This system is distinguished from floodplain systems northeastward, Laurentian-Acadian Floodplain Forest (CES201.587), and eastward, Central Appalachian Floodplain (CES202.608).

DISTRIBUTION

Range: This system is found along medium and large river floodplains throughout the glaciated Midwest ranging from eastern Kansas and western Missouri to western Ohio and north along the Red River basin in Minnesota.

Ecological Divisions: 202, 205

TNC Ecoregions: 35:C, 36:C, 45:C, 46:C, 47:?, 48:?

Subnations/Nations: IA:c, IL:c, IN:c, KS:c, MI:c, MN:c, MO:c, ND:c, NE:c, OH:c, SD:c, WI:c

CONCEPT

Alliances:

- ACER SACCHARINUM TEMPORARILY FLOODED FOREST ALLIANCE (A.279)
- ACER SACCHARUM - CARYA CORDIFORMIS TEMPORARILY FLOODED FOREST ALLIANCE (A.302)
- ANDROPOGON GERARDII - (SORGHASTRUM NUTANS) TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1337)
- BETULA NIGRA - (PLATANUS OCCIDENTALIS) TEMPORARILY FLOODED FOREST ALLIANCE (A.280)
- BRASENIA SCHREBERI PERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1742)
- CAREX (ROSTRATA, UTRICULATA) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1403)
- CAREX PELLITA - (CAREX NEBRASCENSIS) - SCHOENOPLECTUS SPP. SATURATED HERBACEOUS ALLIANCE (A.1466)
- CAREX PELLITA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1414)
- CAREX SPP. - PLANTAGO ERIPODA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1350)
- CAREX SPP. - TYPHA SPP. SATURATED HERBACEOUS ALLIANCE (A.1465)
- CARYA ILLINOINENSIS - (CELTIS LAEVIGATA) TEMPORARILY FLOODED FOREST ALLIANCE (A.282)
- CEPHALANTHUS OCCIDENTALIS SEMIPERMANENTLY FLOODED SHRUBLAND ALLIANCE (A.1011)
- FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) TEMPORARILY FLOODED FOREST ALLIANCE (A.308)
- FRAXINUS PENNSYLVANICA - ULMUS AMERICANA - CELTIS (OCCIDENTALIS, LAEVIGATA) TEMPORARILY FLOODED FOREST ALLIANCE (A.286)
- NELUMBO LUTEA PERMANENTLY FLOODED TEMPERATE HERBACEOUS ALLIANCE (A.1671)
- NON-TIDAL MUD FLAT SEASONALLY/TEMPORARILY FLOODED SPARSELY VEGETATED ALLIANCE (A.1878)
- NYMPHAEA ODORATA - NUPHAR SPP. PERMANENTLY FLOODED TEMPERATE HERBACEOUS ALLIANCE (A.1984)
- PINUS STROBUS - QUERCUS (ALBA, RUBRA, VELUTINA) FOREST ALLIANCE (A.401)
- PLATANUS OCCIDENTALIS - (FRAXINUS PENNSYLVANICA, CELTIS LAEVIGATA, ACER SACCHARINUM) TEMPORARILY FLOODED FOREST ALLIANCE (A.288)
- POPULUS DELTOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.290)
- POPULUS DELTOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636)
- QUERCUS ALBA - (QUERCUS RUBRA, CARYA SPP.) FOREST ALLIANCE (A.239)
- QUERCUS MACROCARPA - QUERCUS (ALBA, ELLIPSOIDALIS, VELUTINA) WOODLAND ALLIANCE (A.619)
- QUERCUS MACROCARPA - QUERCUS BICOLOR - (CARYA LACINIOSA) TEMPORARILY FLOODED FOREST ALLIANCE (A.293)
- QUERCUS MACROCARPA WOODLAND ALLIANCE (A.620)
- SALIX (EXIGUA, INTERIOR) TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.947)
- SALIX NIGRA TEMPORARILY FLOODED FOREST ALLIANCE (A.297)
- SAND FLATS TEMPORARILY FLOODED SPARSELY VEGETATED ALLIANCE (A.1864)
- SARCOBATUS VERMICULATUS SHRUB HERBACEOUS ALLIANCE (A.1535)
- SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)
- SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.961)
- TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCHOENOPLECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1436)

Environment: This ecological system occurs in floodplains of medium to large rivers. It primarily is found on alluvial soils ranging from sandy to very dense clays.

Vegetation: The variety of soil properties associated with this system can create a mixture of vegetation. *Acer saccharinum* occurs on the wetter soils of floodplains in the eastern portion of this system with *Populus deltoides* and willows, especially *Salix nigra*, occurring more in the western range of this system. *Fraxinus pennsylvanica*, *Ulmus americana*, and *Quercus macrocarpa* occur in more well-drained areas. Understory species can vary across the range of this system but can include shrubs such as *Cornus drummondii* and *Asimina triloba*, and sedge and grass species. Oxbows within this system may have species such as *Nelumbo lutea* and *Typha latifolia*.

Dynamics: This system is primarily controlled by moderately to frequent flooding. Grazing can also impact this system and can lead to decreased cover of many graminoid species in some areas.

SOURCES

Last updated: 07 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, CAN

LeadResp: MCS

CES205.682 CROSSTIMBERS OAK FOREST AND WOODLAND

Division 205, Forest and Woodland

Spatial Scale & Pattern: Matrix

Classification Confidence: high

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Sand Soil Texture, Loam Soil Texture

Concept Summary: This system is primarily found within central Texas and Oklahoma, with the northern extent reaching into southeastern Kansas. It is distinct from the surrounding prairie and coastal plain grassland regions by the higher density of tree species. The area consists of irregular plains with primarily sandy to loamy Ustalf soils that range from shallow to moderately deep. Rainfall can be moderate, but somewhat erratic, therefore moisture is often limiting during part of the growing season. Short, stunted *Quercus stellata* and *Quercus marilandica* characterize and dominate this system. Other species such as *Carya texana*, *Carya cordiformis*, *Quercus prinoides*, and *Quercus* spp. can also be present. The understory often contains species typical of the surrounding prairies, in particular, *Schizachyrium scoparium*. Shrubs such as *Rhus* spp. may also be present. Drought, grazing, and fire are the primary natural processes that affect this system. Overgrazing and conversion to agriculture, along with fire suppression, have led to the invasion of some areas by problematic brush species such as *Juniperus virginiana* and *Juniperus ashei* and *Prosopis glandulosa* further south in Texas and Oklahoma. It has also led to decreases in native grass cover allowing for annual grasses and forbs to invade.

DISTRIBUTION

Range: This system is primarily found within central Texas and Oklahoma, with the northern extent reaching into southeastern Kansas.

Ecological Divisions: 205, 303

TNC Ecoregions: 29:C, 32:C, 33:C, 40:C

Subnations/Nations: KS:c, OK:c, TX:c

CONCEPT

Alliances:

- JUNIPERUS VIRGINIANA - QUERCUS (STELLATA, VELUTINA, MARILANDICA) FOREST ALLIANCE (A.383)
- QUERCUS BUCKLEYI FOREST ALLIANCE (A.242)
- QUERCUS MUEHLENBERGII - (ACER SACCHARUM) FOREST ALLIANCE (A.1912)
- QUERCUS STELLATA - QUERCUS MARILANDICA FOREST ALLIANCE (A.253)
- QUERCUS STELLATA - QUERCUS MARILANDICA WOODLAND ALLIANCE (A.625)
- SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1225)

Environment: This system is located on irregular plains comprised of sandy to loamy Ustalf soils. These soils range from shallow to moderately deep. Rainfall can be moderate, but sporadic, leading to periods of limiting moisture.

Vegetation: This system is distinguished by the dominance of short, stunted *Quercus stellata* and *Quercus marilandica*. Other tree species such as *Carya texana*, *Carya cordiformis*, *Quercus prinoides*, and *Quercus* spp. can also be present. The understory often contains species typical of the surrounding prairies, in particular, *Schizachyrium scoparium*. Shrubs such as *Rhus* spp. may also be present.

Dynamics: Drought, grazing, and fire primarily influence this system. Overgrazing and conversion to agriculture have allowed for the invasion of eastern red cedar (*Juniperus virginiana*), Ashe juniper (*Juniperus ashei*) and mesquite (*Prosopis glandulosa*). Decreases in native grass cover associated with overgrazing can also lead to an increase in invasive annual grasses and forbs.

SOURCES**References:** Barbour and Billings 1988, Hoagland 2000, Ricketts et al. 1999**Last updated:** 05 Mar 2003**Concept Author:** S. Menard and K. Kindscher**Stakeholders:** MCS, SCS**LeadResp:** MCS**CES205.683 CENTRAL TALLGRASS PRAIRIE**

Division 205, Herbaceous

Spatial Scale & Pattern: Matrix**Classification Confidence:** high**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland**Non-Diagnostic Classifiers:** Herbaceous, Glaciated plains, Temperate, Glaciated, Deep Soil, Loam Soil Texture

Concept Summary: This system is found primarily in the Central Tallgrass Prairie Ecoregion ranging from eastern Kansas and Nebraska to northwestern Indiana. This system differs in other prairie systems to the north and south by being the most mesic with primarily deep, rich Mollisol soils. This system is dominated by tallgrass species such as *Andropogon gerardii*, *Sorghastrum nutans*, and *Panicum virgatum*. Several forb species are also associated with this system making it one of the most diverse grassland systems. As many as just under 300 herbaceous plant species could occur in this system across its range. Fire, drought, and grazing are the primary natural dynamics influencing this system and helped prevent woody species from invading. However, conversion to agriculture has been the prime disturbance since post-European settlement. The rich soils and long growing season make this an ideal location for farming row crops, and as a result very few examples of this system remain.

DISTRIBUTION**Range:** Found primarily in the Central Tallgrass Prairie ecoregion ranging from eastern Kansas and Nebraska to northwestern Indiana.**Ecological Divisions:** 205**TNC Ecoregions:** 36:C, 45:C**Subnations/Nations:** IA:c, IL:c, IN:p, KS:c, MO:c, NE:c**CONCEPT****Alliances:**

- ANDROPOGON GERARDII - (SORGHASTRUM NUTANS) HERBACEOUS ALLIANCE (A.1192)
- CORNUS DRUMMONDII SHRUBLAND ALLIANCE (A.3558)
- JUNIPERUS VIRGINIANA FOREST ALLIANCE (A.137)
- SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1225)
- SCHIZACHYRIUM SCOPARIUM - SORGHASTRUM NUTANS HERBACEOUS ALLIANCE (A.1198)

SOURCES**References:** Barbour and Billings 1988, Ricketts et al. 1999**Last updated:** 05 Mar 2003**Concept Author:** S. Menard**Stakeholders:** MCS**LeadResp:** MCS**CES205.686 NORTHERN TALLGRASS PRAIRIE**

Division 205, Herbaceous

Spatial Scale & Pattern: Matrix**Classification Confidence:** high**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland**Non-Diagnostic Classifiers:** Herbaceous, Glaciated plains, Glaciated, Deep Soil, Loam Soil Texture, F-Landscape/Low Intensity, G-Landscape/Medium Intensity

Concept Summary: This system is found primarily in the Northern Tallgrass ecoregion ranging along the Red River basin in Minnesota and the Dakotas to Lake Manitoba in Canada. It constitutes the northernmost extension of the "true" prairies. Similar to Central Tallgrass Prairie (CES205.683), this system is dominated by tallgrass species such as *Andropogon gerardii*, *Sorghastrum nutans*, and *Panicum virgatum*. However, the soils in this region are not as rich nor deep, and thus this system does not have as much species diversity as grasslands to the south. This system is often found on well-drained, drier soils and can grade into Eastern Great Plains Tallgrass Aspen Parkland (CES205.688) to the north and east. Grazing and fire influenced this system historically. Much of this system has been converted to agriculture with very few unaltered and highly fragmented examples remaining.

DISTRIBUTION

Range: Found primarily in the Northern Tallgrass ecoregion ranging along the Red River basin in Minnesota and the Dakotas to Lake Manitoba in Canada.

Ecological Divisions: 205

TNC Ecoregions: 35:C

Subnations/Nations: IA:c, MB:p, MN:c, ND:c, SD:c

CONCEPT**Alliances:**

- ANDROPOGON GERARDII - (CALAMAGROSTIS CANADENSIS, PANICUM VIRGATUM) HERBACEOUS ALLIANCE (A.1191)
- ANDROPOGON GERARDII - (SORGHASTRUM NUTANS) HERBACEOUS ALLIANCE (A.1192)
- SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1225)
- TYPHA SPP. - (SCHOENOPLECTUS SPP., JUNCUS SPP.) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1394)

SOURCES

References: Barbour and Billings 1988, Ricketts et al. 1999

Last updated: 05 Mar 2003

Concept Author: S. Menard

Stakeholders: MCS, CAN

LeadResp: MCS

CES205.685 SOUTHEASTERN GREAT PLAINS TALLGRASS PRAIRIE

Division 205, Herbaceous

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Herbaceous, Unglaciaded, Shallow Soil, F-Landscape/Medium Intensity, G-Landscape/Medium Intensity

Concept Summary: This system is found primarily within the Flint Hills of Kansas and the Osage Plains of Oklahoma; however, it can range into the Ozarks of Missouri, the Arbuckle Mountains of Oklahoma, and the Arkansas River Valley. It is distinguished from Central Tallgrass Prairie (CES205.683) by having more species with western geographic affinities and the presence of a thin soil layer over limestone beds ranging to more acidic substrates, although some areas of deeper soils are found within the region, especially on lower slopes. Because of the presence of the rocky substrate close to the surface and the rolling topography, this area is relatively unsuitable for agriculture. The Flint Hills contain one of the largest remaining, relatively intact pieces of tallgrass prairie. The vegetation in this system is typified by tallgrass species such as *Andropogon gerardii*, *Panicum virgatum*, *Schizachyrium scoparium*, and *Sorghastrum nutans* forming a dense cover. A moderate to high density of forb species such as *Oligoneuron rigidum* (= *Solidago rigida*), *Liatris punctata*, *Symphyotrichum ericoides*, *Lespedeza capitata*, and *Viola pedatifida* also occur. Areas of deeper soil, especially lower slopes along draws, slopes and terraces, can include *Baptisia alba* var. *macrophylla*, *Liatris pycnostachya*, and *Vernonia missurica*. Shrub and tree species are relatively infrequent and, if present, constitute less than 10% cover in the area. Fire and grazing constitute the major dynamic processes for this region. Although many of the native common plant species still occur, grazing does impact this region. Poor grazing practices can lead to soil erosion and invasion by cool-season grasses such as *Bromus inermis*.

Comments: This includes the Flint Hills plus prairies in Oklahoma and Missouri south of the glacial line. There may need to be further review concerning the prairies in Missouri and Oklahoma. In Arkansas, this system of prairies and associated woodlands is found in the Arkansas River Valley region of Arkansas and adjacent Oklahoma. The valley is characterized by broad, level to gently rolling uplands derived from shales and is much less rugged and more heavily impacted by Arkansas River erosional processes than the adjacent mountainous regions. The shale-derived soils associated with the prairies are thin and droughty. The combined effect of droughty soils, reduced precipitation (compared to surrounding mountainous regions), and prevailing level topography create conditions highly conducive to the ignition and spread of fires. Some extant examples of this system in Arkansas remain, but most are small and isolated, in the western edge of the region towards the Crosstimbers where precipitation and agriculture conversion were lowest (T. Foti pers. comm. 2003).

DISTRIBUTION

Range: This system is found primarily within the Flint Hills and Osage Plains, but small patches can be found in the Ozarks of Missouri, the Arbuckle Mountains of Oklahoma, and the Arkansas River Valley.

Ecological Divisions: 205

TNC Ecoregions: 32:P, 37:C, 38:P, 39:P

Subnations/Nations: AR:c, KS:c, MO:c, OK:c

CONCEPT**Alliances:**

- (JUNIPERUS VIRGINIANA) / SCHIZACHYRIUM SCOPARIUM - (BOUPELOUA CURTIPENDULA) WOODED HERBACEOUS ALLIANCE (A.1919)
- (QUERCUS STELLATA, QUERCUS MARILANDICA) / SCHIZACHYRIUM SCOPARIUM WOODED HERBACEOUS ALLIANCE (A.1920)
- ANDROPOGON GERARDII - (SORGHASTRUM NUTANS) HERBACEOUS ALLIANCE (A.1192)
- BOUPELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1244)
- JUNIPERUS ASHEI WOODLAND ALLIANCE (A.501)
- MUHLENBERGIA REVERCHONII HERBACEOUS ALLIANCE (A.1218)
- SCHIZACHYRIUM SCOPARIUM - SORGHASTRUM NUTANS HERBACEOUS ALLIANCE (A.1198)

Environment: This system is typified by the thin soil layer over limestone beds or acidic substrates such as chert or granite, although areas of deeper soils are possible along lower slopes, draws, and terraces. The topography is rolling and mostly unsuitable for agriculture.

Vegetation: Tallgrass species such as *Andropogon gerardii*, *Panicum virgatum*, *Schizachyrium scoparium*, and *Sorghastrum nutans* predominate this system and often form a dense cover. Forb species such as *Oligoneuron rigidum* (= *Solidago rigida*), *Liatris punctata*, *Symphyotrichum ericoides*, *Lespedeza capitata*, and *Viola pedatifida* can also occur. In those areas of deeper soils, *Baptisia alba* var. *macrophylla*, *Liatris pycnostachya*, and *Vernonia missurica* can also occur. Tree and shrub species are relatively infrequent and constitute less than 10% cover.

Dynamics: Fire and grazing are the prevalent dynamic processes in examples of this system. Overgrazing can lead to soil erosion and invasion of cool-season grasses. Fire suppression can lead to increased cover of woody species.

SOURCES

References: Barbour and Billings 1988, Lauver et al. 1999, Ricketts et al. 1999

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, SCS

LeadResp: MCS

CES205.687 EASTERN GREAT PLAINS WET MEADOW, PRAIRIE, AND MARSH

Division 205, Herbaceous Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Herbaceous, Depression, Shoreline

Concept Summary: This system is found along creeks and streams from Nebraska and Iowa to Illinois, and from Minnesota to Texas. It is also found along lake borders, especially in the northern extension of its range into Minnesota. It is often adjacent to a floodplain system, but is devoid of trees and riparian vegetation. It is also distinct from upland prairie systems by having more hydrology, especially associated with silty, dense clay soils that are often hydric soils, classified as Vertic Haplaquolls. The landform is usually floodplain or poorly drained, relatively level land. The vegetation is dominated by *Spartina pectinata*, *Tripsacum dactyloides*, numerous large sedges, such as *Carex frankii* and *Carex hyalinolepis*, and in wetter areas, *Eleocharis* spp. Other emergent marsh species such as *Typha* spp. can be associated with this system. Forbs can include *Helianthus grosseserratus*, *Vernonia fasciculata*, and *Physostegia virginiana*. Fire has had the primary influence on keeping these wet areas free of trees. Other dynamic processes include grazing and flooding (often in the late spring). Many areas have been converted to agricultural, but this usually requires some sort of drainage.

DISTRIBUTION

Range: This system is found throughout the northeastern Great Plains ranging from eastern Kansas to western Illinois and north into Minnesota.

Ecological Divisions: 205

TNC Ecoregions: 35:C, 36:C, 45:P, 46:P

Subnations/Nations: IA:c, IL:c, KS:c, MN:c, MO:p, ND:c, NE:c, SD:c

CONCEPT**Alliances:**

- CALAMAGROSTIS CANADENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1400)
- CAREX (ROSTRATA, UTRICULATA) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1403)
- CAREX AQUATILIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1404)
- CAREX ATHERODES SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1396)
- CAREX LACUSTRIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1367)
- CAREX PELLITA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1414)
- CAREX SPP. - PLANTAGO ERIOPODA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1350)

- CAREX STRICTA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1397)
- CORNUS SERICEA - SALIX SPP. SEASONALLY FLOODED SHRUBLAND ALLIANCE (A.989)
- CORYLUS AMERICANA - (SPIRAEA TOMENTOSA, MALUS IOENSIS) SHRUBLAND ALLIANCE (A.897)
- IMPATIENS PALLIDA - CYSTOPTERIS BULBIFERA - ADOXA MOSCHATELLINA HERBACEOUS ALLIANCE (A.1598)
- NYMPHAEA ODORATA - NUPHAR SPP. PERMANENTLY FLOODED TEMPERATE HERBACEOUS ALLIANCE (A.1984)
- POLYGONUM SPP. (SECTION PERSICARIA) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1881)
- POTAMOGETON SPP. - CERATOPHYLLUM SPP. - ELODEA SPP. PERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1754)
- SAGITTARIA LATIFOLIA SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1675)
- SCHOENOPLECTUS ACUTUS - (SCHOENOPLECTUS TABERNAEMONTANI) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1443)
- SCHOENOPLECTUS FLUVIATILIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1387)
- SCHOENOPLECTUS MARITIMUS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1444)
- SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)
- TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCHOENOPLECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1436)
- TYPHA SPP. - (SCHOENOPLECTUS SPP., JUNCUS SPP.) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1394)

Environment: This system is found primarily on silty and/or dense clay, hydric soils, usually classified as Vertic Haplaquolls. It is often found within poorly drained, relatively level areas.

Vegetation: *Spartina pectinata*, *Tripsacum dactyloides*, numerous large sedges, such as *Carex frankii* and *Carex hyalinolepis* dominate this system. In wetter areas, *Eleocharis* spp. and *Typha* spp. may be significant. Forbs such as *Helianthus grosseserratus*, *Vernonia fasciculata*, and *Physostegia virginiana* also may be common. Shrub species can be present, especially in the northern range of this system, however, they are usually insignificant compared to the prairie and meadow species.

Dynamics: Fire is the major dynamic process that helps maintain the herbaceous nature of this system and prevents trees from establishing. Grazing and periodic flooding can also influence this system.

SOURCES

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

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, CAN

LeadResp: MCS

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

Non-Diagnostic Classifiers: Montane [Montane], Montane [Lower Montane], Lowland [Foothill], Lowland [Lowland], Backwater, Drainage bottom (undifferentiated), Floodplain, Marsh, Oxbow, Pond, Temperate [Temperate Continental], Forb, Alga, Clay Subsoil Texture

Concept Summary: 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*).

DISTRIBUTION

Range: Occurs throughout much of the arid and semi-arid regions of western North America.

Ecological Divisions: 301, 302, 303, 304, 305, 306

TNC Ecoregions: 11:C, 17:C, 18:C, 19:C, 20:C, 21:C, 23:C, 24:C, 26:C, 27:C, 28:C, 29:C, 30:C, 6:C, 7:C, 8:C, 9:C

Subnations/Nations: AB:c, AZ:c, BC:c, CA:c, CO:c, ID:c, MT:c, MXBC:c, MXCH:c, MXSO:c, ND:c, NE:c, NM:c, NV:c, OK:c, OR:c, SD:c, TX:c, UT:c, WA:c, WY:c

CONCEPT

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 (CIRRHOSEA, 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)

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, SCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Mediterranean [Mediterranean Xeric-Continental], Temperate [Temperate Continental]

Concept Summary: 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.

DISTRIBUTION

Ecological Divisions: 104, 105, 204, 306

TNC Ecoregions: 20:C, 3:C, 69:C, 7:C, 70:C, 71:P, 76:C, 77:P, 78:C, 79:C, 9:C

Subnations/Nations: AB:c, AK:c, BC:c, CO:c, ID:c, MT:c, OR:c, WA:c, WY:c

CONCEPT

• California community types:

- Alpine Snowbank Margin (91.300.00)
- Alpine Snow and Ice Habitat (92.000.00)
- Alpine Snowfield (92.100.00)
- Alpine Glacier (92.200.00)

SOURCES

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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, MCS, CAN

LeadResp: WCS

CES303.957 NORTHWESTERN GREAT PLAINS HIGHLAND SPRUCE WOODLAND

Division 303, Forest and Woodland

Spatial Scale & Pattern: Large Patch

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

Diagnostic Classifiers: Temperate [Temperate Continental], *Picea glauca*

Non-Diagnostic Classifiers: Montane [Montane], Forest and Woodland (Treed), Needle-Leaved Tree

Concept Summary: This uncommon system is limited to relatively high-elevation outliers of montane environments in the northwestern Great Plains. Best known areas including this system are small portions of the Black Hills of Wyoming and South Dakota and the Cypress Upland of southern Alberta and Saskatchewan. These highland areas have a cooler climate than surrounding mixed-grass prairie. This woodland system is limited to sideslopes and depressions, likely adjoining riparian zones, where snow is well-retained. Soils vary widely from deep to quite shallow. Disturbance regimes are not well documented for this system, but likely include periodic windthrow as well as fire spreading from adjacent, lower elevation woodlands and grasslands.

DISTRIBUTION

Range: Limited to relatively high-elevation outliers of montane environments in the northwestern Great Plains. Best known areas including this system are small portions of the Black Hills of Wyoming and South Dakota and the Cypress Upland of southern Alberta and Saskatchewan.

Ecological Divisions: 303, 306

TNC Ecoregions: 25:C, 26:C

Subnations/Nations: AB:, SD:, SK:, WY:

CONCEPT

Alliances:

- PICEA GLAUCA FOREST ALLIANCE (A.167)
- PICEA GLAUCA TEMPORARILY FLOODED FOREST ALLIANCE (A.172)

SOURCES

References: ESWG 1995

Last updated: 20 Mar 2003

Concept Author: P. Comer

Stakeholders: WCS, CAN

LeadResp: WCS

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

Non-Diagnostic Classifiers: Lowland [Lowland], Forest and Woodland (Treed), F-Landscape/Medium Intensity, G-Landscape/Medium Intensity

Concept Summary: 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.

DISTRIBUTION

Range: This system is found throughout the Western Great Plains Division.

Ecological Divisions: 303

TNC Ecoregions: 26:C, 27:C, 28:C, 33:C, 34:C

Subnations/Nations: MT:p, ND:c, NE:?, SD:c

CONCEPT

Alliances:

- ACER SACCHARUM - TILIA AMERICANA - (QUERCUS RUBRA) FOREST ALLIANCE (A.220)
- POPULUS TREMULOIDES FOREST ALLIANCE (A.274)
- QUERCUS MACROCARPA FOREST ALLIANCE (A.245)
- QUERCUS MACROCARPA WOODLAND ALLIANCE (A.620)

Environment: This system is found in upland areas throughout the Division. Soils are predominately dry to mesic.

Vegetation: This system is typified by the predominance of *Quercus macrocarpa* constituting at least 10% of the vegetation cover in any given example of this system. Other species such as *Tilia americana*, *Juniperus virginiana*, and *Fraxinus* spp. may be also present. Understory vegetation can range from sparsely vegetated to more dense and usually exemplifies the surrounding prairie grassland vegetation.

Dynamics: This system is primarily driven by fire. Fire suppression within this system can lead to more closed canopies and a decrease in the cover of grass species in the understory. Grazing, conversion to agriculture, and past timber harvesting can impact this system. Overgrazing can also lead to a decrease in understory species, and timber harvesting can completely eliminate examples of this system.

SOURCES

References: Barbour and Billings 1988, Tolstead 1947

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

CES303.662 NORTHWESTERN GREAT PLAINS SHRUBLAND

Division 303, Shrubland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Shrubland (Shrub-dominated), Temperate [Temperate Continental], Ustic, G-Patch/Medium Intensity

Concept Summary: This system ranges from South Dakota into southern Canada on moderately shallow to deep fine to sandy loam soils. These sites are typically more mesic than most of the surrounding area, and this system may be located along upper terraces of rivers and streams, gently inclined slopes near breaklands, and upland sandy loam areas throughout its range. This system is dominated by shrub species such as *Amelanchier alnifolia*, *Rhus trilobata*, *Symphoricarpos* spp., *Dasiphora fruticosa* ssp. *floribunda* and dwarf-shrubs such as *Juniperus horizontalis*. Mid grasses such as *Festuca* spp., *Koeleria macrantha*, and *Pseudoroegneria spicata* and species such as *Carex filifolia* can co-occur. This system differs from Northwestern Great Plains Mixedgrass Prairie (CES303.674) in that it contains greater than 60% cover of natural shrub species. Fire and grazing constitute the primary dynamics affecting this system. Drought can also impact this system. This system may include areas of Northwestern Great Plains Mixedgrass Prairie (CES303.674) where fire suppression has allowed for a greater cover of shrub species.

Comments: This may not be a separate system from the prairie matrix. Those areas that have increased shrub cover due to fire suppression should be considered part of Northwestern Great Plains Mixedgrass Prairie (CES303.674). More information from Canada is probably needed to fully define this system.

DISTRIBUTION

Range: This system extends from South Dakota into southern Canada. The U.S. range corresponds to Bailey (1994) sections Northeast Glaciated Plains (332A), Western Glaciated Plains (332B), North Central Glaciated Plains - extreme Western part (251B), and in Canada to the Moist Mixed Grassland and Fescue Grassland.

Ecological Divisions: 303

TNC Ecoregions: 26:C, 34:C, 66:P, 67:P

Subnations/Nations: AB:?, MB:c, MT:c, ND:c, SD:c, SK:p, WY:?

CONCEPT

Alliances:

- AMELANCHIER ALNIFOLIA SHRUBLAND ALLIANCE (A.913)
- ARTEMISIA CANA SSP. CANA SHRUB HERBACEOUS ALLIANCE (A.2554)
- DASIPHORA FRUTICOSA SSP. FLORIBUNDA SHRUB HERBACEOUS ALLIANCE (A.1534)
- ELAEAGNUS COMMUTATA SHRUBLAND ALLIANCE (A.918)
- JUNIPERUS HORIZONTALIS DWARF-SHRUBLAND ALLIANCE (A.1080)
- RHUS TRILOBATA SHRUB HERBACEOUS ALLIANCE (A.1537)
- SARCOBATUS VERMICULATUS INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.1046)

Environment: Climate and growing season length for the region this system occurs are intermediate to the shortgrass regions to the west and the tallgrass regions to the east with a shorter growing season with semi-arid moisture conditions. This system occurs on sites more mesic than most of the surrounding area such as upper river terraces, gently inclined slopes, and upland sandy areas. Soils range from shallow to deep and fine to sandy loams.

Vegetation: This system is dominated by shrub and dwarf-shrub species such as *Amelanchier alnifolia*, *Rhus trilobata*, *Symphoricarpos* spp. *Dasiphora fruticosa* ssp. *floribunda*, and *Juniperus horizontalis*. Mid grasses such as *Festuca* spp., *Koeleria macrantha*, and *Pseudoroegneria spicata* can also occur. This system differs from Northwestern Great Plains Mixedgrass Prairie (CES303.674) in that it contains greater than 60% cover of natural shrub species.

Dynamics: Fire and grazing constitute the primary dynamics affecting this system. Drought can also impact this system. Conversion to agriculture can impact this system, and its range has probably been decreased by human activities.

SOURCES

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, CAN, WCS

LeadResp: MCS

CES303.671 WESTERN GREAT PLAINS SANDHILL SHRUBLAND

Division 303, Shrubland

Spatial Scale & Pattern: Large Patch

Classification Confidence: high

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

Non-Diagnostic Classifiers: Shrubland (Shrub-dominated), Sand Soil Texture, Ustic, F-Landscape/Medium Intensity, G-Landscape/Medium Intensity

Concept Summary: This system is found mostly in south-central areas of the Western Great Plains Division ranging from the Nebraska Sandhill region south to central Texas, although some examples may reach as far north as the Badlands of South Dakota. The climate is semi-arid to arid for much of the region in which this system occurs. This system is found on somewhat excessively to excessively well-drained, deep sandy soils that are often associated with dune systems and ancient floodplains. In some areas, this system may actually occur as a result of overgrazing in Western Great Plains Tallgrass Prairie (CES303.673) or Western Great Plains Sand Prairie (CES303.670). This system is characterized by a sparse to moderately dense woody layer dominated by *Artemisia filifolia*. Associated species can vary with geography, precipitation, disturbance and soil texture. Several graminoid species such as *Andropogon hallii*, *Schizachyrium scoparium*, *Sporobolus cryptandrus*, *Calamovilfa gigantea*, *Hesperostipa comata*, and *Bouteloua* spp. can be connected with this system. Other shrub species may also be present including *Yucca glauca*, *Prosopis glandulosa*, *Rhus trilobata*, and *Prunus angustifolia*. In the southern range of this system, *Quercus havardii* may also be present and represents one succession pathway that develops over time following a disturbance. *Quercus havardii* is able to resprout following a fire and thus may persist for long periods of time once established. Fire and grazing are the most important dynamic processes for this type, although drought stress can impact this system significantly in some areas. Overgrazing can lead to decreasing dominance of some of the grass species such as *Andropogon hallii*, *Calamovilfa gigantea*, and *Schizachyrium scoparium*.

Comments: This system may overlap in concept with Crosstimbers Southern Xeric Sandhill (CES205.897).

DISTRIBUTION

Range: This system is found primarily within the south-central areas of the Western Great Plains Division ranging from the Nebraska Sandhills south into central Texas. However, examples of this system can be found as far north as the Badlands in South Dakota.

Ecological Divisions: 303

TNC Ecoregions: 26:C, 27:C, 28:C, 33:C

Subnations/Nations: CO:c, KS:c, NE:c, OK:c, TX:?

CONCEPT

Alliances:

- ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE (A.816)
- PRUNUS ANGUSTIFOLIA SHRUBLAND ALLIANCE (A.1884)
- QUERCUS HAVARDII SHRUBLAND ALLIANCE (A.780)

Environment: This system is found primarily in semi-arid to arid areas of the Western Great Plains Division. It occurs on somewhat excessively to excessively well-drained and deep sandy soils. This system is often found associated with dune systems and/or ancient floodplains but may occur in soils derived from sandstone residuum.

Vegetation: This system is distinguished by a sparse to a moderately dense shrub layer dominated by *Artemisia filifolia*. Graminoid species such as *Andropogon hallii*, *Schizachyrium scoparium*, *Sporobolus cryptandrus*, *Calamovilfa gigantea*, *Hesperostipa comata*, and *Bouteloua* spp. can also be found within this system. Other shrub species such as *Yucca glauca*, *Rhus trilobata*, and *Prunus angustifolia* may be present. *Quercus havardii* and *Prosopis glandulosa* may also be present in the southern extent of this system.

Dynamics: Fire and grazing constitute the most important processes impacting this system. Drought stress can also influence this system in some areas.

SOURCES

References: Ramaley 1939b, Sims et al. 1976, Tolstead 1942

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

CES303.659 CENTRAL MIXEDGRASS PRAIRIE

Division 303, Herbaceous

Spatial Scale & Pattern: Matrix

Classification Confidence: high

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

Non-Diagnostic Classifiers: Lowland [Lowland], Herbaceous, Temperate [Temperate Continental], Shallow Soil, Loam Soil Texture, Silt Soil Texture, Ustic, F-Landscape/Medium Intensity, G-Landscape/High Intensity, Graminoid

Concept Summary: 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.

DISTRIBUTION

Range: This system is found throughout the central and southern areas of the Western Great Plains ranging from southern South Dakota into northern Texas.

Ecological Divisions: 303

TNC Ecoregions: 27:P, 28:P, 29:C, 32:C, 33:C, 37:P

Subnations/Nations: CO:c, KS:c, NE:c, OK:c, SD:c, TX:c

CONCEPT

Alliances:

- (COMPLEX)
- ARTEMISIA TRIDENTATA SSP. WYOMINGENSIS SHRUB HERBACEOUS ALLIANCE (A.1527)
- CORNUS DRUMMONDII SHRUBLAND ALLIANCE (A.3558)
- CYNODON DACTYLON HERBACEOUS ALLIANCE (A.1279)
- HESPEROSTIPA COMATA - BOUTELOUA GRACILIS HERBACEOUS ALLIANCE (A.1234)
- HESPEROSTIPA CURTISETA - ELYMUS LANCEOLATUS HERBACEOUS ALLIANCE (A.3523)
- JUNIPERUS VIRGINIANA FOREST ALLIANCE (A.137)
- KRASCHENINNIKOVIA LANATA DWARF-SHRUB HERBACEOUS ALLIANCE (A.1565)
- PASCOPYRUM SMITHII HERBACEOUS ALLIANCE (A.1232)
- PLEURAPHIS MUTICA HERBACEOUS ALLIANCE (A.1249)
- POA PALUSTRIS SEMI-NATURAL SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1409)
- POA PRATENSIS SEMI-NATURAL HERBACEOUS ALLIANCE (A.3562)
- QUERCUS MACROCARPA WOODED MEDIUM-TALL HERBACEOUS ALLIANCE (A.1505)
- SARCOBATUS VERMICULATUS INTERMITTENTLY FLOODED SPARSELY VEGETATED ALLIANCE (A.1877)
- SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1225)
- YUCCA GLAUCA SHRUB HERBACEOUS ALLIANCE (A.1540)

Environment: Differences in topography and soil characteristics also occur across the range of this system. It is often characterized by rolling to extremely hilly landscapes with soils developed from loess, shale, limestone or sandstone parent material. Mollisol soils are most prevalent and range from silt loams and silty clay loams with sandy loams possible on the western edge of the range. The Red Hills region of Kansas and Oklahoma, which contains examples of this system, contains somewhat unique soil characteristics and has developed from a diversity of sources including red shale, red clay, sandy shale, siltstone, or sandstone. These soils have developed a characteristic reddish color from the primary material. These soils can consist of silt, loam, or clay and can have textures ranging from a fine sandy loam to a more clayey surface.

Vegetation: This system contains elements from both Western Great Plains Shortgrass Prairie (CES303.672) and Western Great Plains Tallgrass Prairie (CES303.673). This system typically contains 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*. Isolated patches of *Quercus macrocarpa* also can occur.

Dynamics: Fire and grazing are the primary processes occurring within the system. The diversity in this mixedgrass system likely reflects both the short- and long-term responses of the vegetation to these often concurrent disturbance regimes. Fire suppression and overgrazing can lead to the invasion of this system by woody species such as *Juniperus virginiana* and *Pinus ponderosa*. Likewise, fire suppression may lead to a more closed canopy of bur oak.

SOURCES

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

Last updated: 05 Mar 2003

Stakeholders: MCS

Concept Author: S. Menard and K. Kindscher

LeadResp: MCS

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

Non-Diagnostic Classifiers: Herbaceous, Glaciated, Shallow Soil, Loam Soil Texture

Concept Summary: 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.

DISTRIBUTION

Range: This system extends from northern Nebraska into southern Canada. The U.S. range corresponds to Bailey et al. (1994) sections 331D, 331E, 331F (mostly) 331G, 332A, 332B, and perhaps minor extensions in to 251B, and in Canada to the Moist Mixed Grassland and Fescue Grassland.

Ecological Divisions: 205, 303

TNC Ecoregions: 26:C, 34:C, 66:P, 67:C

Subnations/Nations: AB:p, MB:c, MT:c, ND:c, NE:c, SD:c, SK:c, WY:c

CONCEPT

Alliances:

- (COMPLEX)
- (CIRSIMUM ARVENSE, EUPHORBIA ESULA, MELILOTUS SPP.) - MIXED FORBS HERBACEOUS ALLIANCE (A.3564)
- AGROPYRON CRISTATUM SEMI-NATURAL HERBACEOUS ALLIANCE (A.3563)
- AMELANCHIER ALNIFOLIA SHRUBLAND ALLIANCE (A.913)
- ARTEMISIA CANA SSP. CANA SHRUB HERBACEOUS ALLIANCE (A.2554)
- ARTEMISIA TRIDENTATA SHRUB HERBACEOUS ALLIANCE (A.1521)
- ARTEMISIA TRIDENTATA SSP. VASEYANA SHRUB HERBACEOUS ALLIANCE (A.1526)
- BETULA PUMILA - (SALIX SPP.) SATURATED SHRUBLAND ALLIANCE (A.1021)
- DASIPHORA FRUTICOSA SSP. FLORIBUNDA SHRUB HERBACEOUS ALLIANCE (A.1534)
- ELAEAGNUS COMMUTATA SHRUBLAND ALLIANCE (A.918)
- ELEOCHARIS PALUSTRIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1422)
- FESTUCA ALTAICA HERBACEOUS ALLIANCE (A.1250)
- FESTUCA CAMPESTRIS HERBACEOUS ALLIANCE (A.1255)
- FESTUCA IDAHOENSIS HERBACEOUS ALLIANCE (A.1251)
- HESPEROSTIPA COMATA - BOUTELOUA GRACILIS HERBACEOUS ALLIANCE (A.1234)
- HESPEROSTIPA NEOMEXICANA HERBACEOUS ALLIANCE (A.1272)
- JUNIPERUS HORIZONTALIS DWARF-SHRUBLAND ALLIANCE (A.1080)
- PASCOPYRUM SMITHII HERBACEOUS ALLIANCE (A.1232)
- POA PALUSTRIS SEMI-NATURAL SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1409)
- POA PRATENSIS SEMI-NATURAL HERBACEOUS ALLIANCE (A.3562)
- PSEUDOROEGNERIA SPICATA - BOUTELOUA GRACILIS HERBACEOUS ALLIANCE (A.1239)
- PSEUDOROEGNERIA SPICATA HERBACEOUS ALLIANCE (A.1265)
- SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1225)
- SCHIZACHYRIUM SCOPARIUM BUNCH HERBACEOUS ALLIANCE (A.1266)
- SCHIZACHYRIUM SCOPARIUM HERBACEOUS ALLIANCE (A.1240)
- SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.961)

Environment: Climate and growing season length for the region this system occurs are intermediate to the shortgrass regions to the west and the tallgrass regions to the east with a shorter growing season and cooler climate compared to the range of Central Mixedgrass Prairie (CES303.659). Moisture conditions are semi-arid. This system occurs on loamy glacial tills and clay to clay-loam soils with rolling to broken topography.

Vegetation: This system contains greater than 50% cover of natural, cool-season grasses such as *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). Cool-season exotics such as *Poa pratensis* and *Bromus inermis* can increase in dominance with fire suppression and over-grazing. Likewise, shrub species such as *Juniperus virginiana* can also increase in dominance with fire suppression.

Dynamics: Fire and grazing constitute the primary dynamics affecting this system. Drought can also impact this system. Fire suppression and heavy grazing cause cool-season exotics such as *Poa pratensis* and *Bromus inermis* to increase in dominance. Conversion to agriculture also impacts this system and an estimated 75% percent of the region where this system occurs has been heavily altered. Only few remnant patches have escaped conversion to agriculture.

SOURCES

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

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS, CAN

LeadResp: MCS

CES303.670 WESTERN GREAT PLAINS SAND PRAIRIE

Division 303, Herbaceous

Spatial Scale & Pattern: Large Patch**Classification Confidence:** high**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland**Non-Diagnostic Classifiers:** Lowland [Lowland], Herbaceous, Sand Soil Texture, Ustic, G-Landscape/Low Intensity, W-Patch/High Intensity

Concept Summary: The sand prairies constitute a very unique system within the Western Great Plains. These sand prairies are often considered part of the tallgrass regions in the Western Great Plains, but can contain elements from both Western Great Plains Shortgrass Prairie (CES303.672) and Central Mixedgrass Prairie (CES303.659). The largest expanse of sand prairies (approximately 5 million ha) can be found in the Sandhills of north-central Nebraska and southwestern South Dakota. These areas are relatively intact. The primary use of this system has been grazing (not cultivation), and areas such as the Nebraska Sandhills can experience less degeneration than other prairie systems. Although greater than 90% of the Sandhills region is privately owned, the known fragility of the soils and the cautions used by ranchers to avoid poor grazing practices have allowed for fewer significant changes in the vegetation of the Sandhills compared to other grassland systems. The distribution, species richness and productivity of plant species within the sand prairie ecological system is controlled primarily by environmental conditions, in particular the temporal and spatial distribution of soil moisture and topography. Soils in the sand prairies can be relatively undeveloped and are highly permeable. Soil texture and drainage along with a species' rooting morphology, photosynthetic physiology, and mechanisms to avoid transpiration loss are highly important in determining the composition and distribution of communities/associations within the sand prairies. Another important aspect of soils in the sand prairies is their susceptibility to wind erosion. Blowouts and sand draws are some of the unique wind-driven disturbances in the sand prairies, particularly the Nebraska Sandhills, which can profoundly impact vegetation composition and succession within this system. Graminoid species dominate the sand prairies, although relative dominance can change due to impacts of wind disturbance. *Andropogon hallii* and *Calamovilfa longifolia* are the most common species, but other grass and forb species such as *Hesperostipa comata*, *Carex inops ssp. heliophila*, and *Panicum virgatum* may be present. Patches of *Quercus havardii* can also occur within this system in the southern Great Plains. Fire and grazing constitute the other major dynamic processes that can influence this system.

DISTRIBUTION

Range: This system is found throughout the Western Great Plains Division. The largest and most intact example of this system is found within the Sandhills region of Nebraska and South Dakota.

Ecological Divisions: 303**TNC Ecoregions:** 26:C, 27:C, 28:C, 33:C, 34:C**Subnations/Nations:** CO:p, KS:c, MT:p, ND:c, NE:c, NM:?, OK:p, SD:c, TX:?, WY:p**CONCEPT****Alliances:**

- ANDROPOGON GERARDII - (CALAMAGROSTIS CANADENSIS, PANICUM VIRGATUM) HERBACEOUS ALLIANCE (A.1191)
- ANDROPOGON HALLII HERBACEOUS ALLIANCE (A.1193)
- ARTEMISIA CANA SSP. CANA SHRUB HERBACEOUS ALLIANCE (A.2554)
- BETULA OCCIDENTALIS SHRUBLAND ALLIANCE (A.914)
- CALAMOVILFA LONGIFOLIA HERBACEOUS ALLIANCE (A.1201)
- CAREX PELLITA - (CAREX NEBRASCENSIS) - SCHOENOPLECTUS SPP. SATURATED HERBACEOUS ALLIANCE (A.1466)
- QUERCUS HAVARDII SHRUBLAND ALLIANCE (A.780)
- SCHIZACHYRIUM SCOPARIUM - (SPOROBOLUS CRYPTANDRUS) HERBACEOUS ALLIANCE (A.1224)
- YUCCA GLAUCA SHRUB HERBACEOUS ALLIANCE (A.1540)

Environment: This tallgrass system is found primarily on sandy and sandy loam soils that can be relatively undeveloped and highly permeable as compared to Western Great Plains Tallgrass Prairie (CES303.673), which occurs on deeper loams. This system is usually found in areas with a rolling topography and can occur on ridges, midslopes and/or lowland areas within a region. It often occurs on moving sand dunes, especially within the Sandhill region of Nebraska and South Dakota.

Vegetation: This system is distinguished by the dominance of *Andropogon hallii* and *Calamovilfa longifolia*. Other species such as *Hesperostipa comata*, *Carex inops ssp. heliophila*, and *Panicum virgatum* may be present. In the southern range of this system, patches of *Quercus havardii* can also occur. *Pentstemon haydenii* is endemic to the sand prairie system and of special conservation concern because of its probable decline due to grazing and fire suppression.

Dynamics: The distribution, species richness and productivity of plant species within the sand prairie ecological system is controlled primarily by environmental conditions, in particular the temporal and spatial distribution of soil moisture and topography. Another important aspect of this system is its susceptibility to wind erosion. Blowouts and sand draws are some of the unique wind-driven disturbances in the sand prairies, particularly the Nebraska Sandhills, which can profoundly impact vegetation composition and succession within this system. Fire and grazing constitute the other major disturbances that can

influence this system. Overgrazing, fire and trampling that leads to the removal of vegetation within those areas susceptible to blowouts can either instigate a blowout or perpetuate one already occurring. Overgrazing can also lead to significant erosion.

SOURCES

References: Barbour and Billings 1988, Tolstead 1942

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

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

Non-Diagnostic Classifiers: Herbaceous, Loam Soil Texture, Ustic, F-Landscape/Low Intensity

Concept Summary: 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.

DISTRIBUTION

Range: 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).

Ecological Divisions: 303

TNC Ecoregions: 26:P, 27:C, 28:C, 33:P

Subnations/Nations: CO:c, KS:c, NE:c, NM:c, OK:c, TX:c, WY:c

CONCEPT

Alliances:

- (COMPLEX)
- ARISTIDA PURPUREA HERBACEOUS ALLIANCE (A.2570)
- BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1244)
- BOUTELOUA ERIPODA HERBACEOUS ALLIANCE (A.1284)
- BOUTELOUA GRACILIS HERBACEOUS ALLIANCE (A.1282)
- BOUTELOUA HIRSUTA HERBACEOUS ALLIANCE (A.1285)
- HESPEROSTIPA NEOMEXICANA HERBACEOUS ALLIANCE (A.1272)
- YUCCA GLAUCA SHRUB HERBACEOUS ALLIANCE (A.1540)

Environment: This system is located on primarily flat to rolling uplands. Soils typically are loamy and ustic and range from sandy to clayey.

Vegetation: This system spans a wide range and thus there can be some differences in the relative dominance of some species from north to south and from east to west. This system is primarily dominated by *Bouteloua* spp. throughout its range

with associated graminoid species such as *Buchloe dactyloides*, *Hesperostipa comata*, *Koeleria macrantha* (= *Koeleria cristata*), *Pascopyrum smithii* (= *Agropyron smithii*), and *Sporobolus cryptandrus*. Shrub species such as *Artemisia filifolia* and *Artemisia tridentata* can be present.

Dynamics: Fire and grazing constitute the primary processes impacting this system. However, fire is less important in this system compared to other Western Great Plains prairie systems, especially in the western portion of its range. Previous comments in the literature citing *Opuntia* spp. increasing with overgrazing may not be borne out by more recent research (R. Rondeau pers. com.). Conversion to agriculture and pastureland with the subsequent irrigation has degraded and extirpated this system in some areas of its range.

SOURCES

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

Last updated: 21 Aug 2003

Stakeholders: MCS, WCS

Concept Author: S. Menard and K. Kindscher

LeadResp: MCS

CES303.673 WESTERN GREAT PLAINS TALLGRASS PRAIRIE

Division 303, Herbaceous

Spatial Scale & Pattern: Small Patch

Classification Confidence: high

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

Non-Diagnostic Classifiers: Herbaceous, Deep Soil, Loam Soil Texture, Ustic, F-Patch/Low Intensity, G-Patch/Medium Intensity

Concept Summary: This system can be found throughout the Western Great Plains Division. It is found primarily in areas where soil characteristics allow for mesic conditions more typical of the Eastern Great Plains Division and thus are able to sustain tallgrass species. This system may be small patches interspersed within Northwestern Great Plains Mixedgrass Prairie (CES303.674) or Western Great Plains Shortgrass Prairie (CES303.672) and may also be associated with upland terraces above a floodplain system where these more mesic conditions persist. Soils are primarily loamy Mollisols that are moderately deep and rich. Those areas that contain more sandy soils should be considered part of Western Great Plains Sand Prairie (CES303.670). This system is dominated primarily by *Andropogon gerardii* and may also include *Sorghastrum nutans*, *Schizachyrium scoparium*, *Pascopyrum smithii*, *Hesperostipa spartea*, and *Sporobolus heterolepis*. *Andropogon gerardii* often dominates the lowland regions, although *Pascopyrum smithii* can be prolific if conditions are favorable. Forbs in varying density may also be present. The primary dynamics for this system include fire, climate and grazing. Fire suppression in these areas has allowed for the invasion of woody species such as *Juniperus virginiana* and *Prunus* spp. Grazing also has contributed to these changes and likewise led to a decrease of this system as overgrazing favors shortgrass and mixedgrass systems. Conversion to agriculture likewise has probably decreased the range of this system. Thus, this system likely only occurs in small patches and in scattered locations throughout the division. Large-patch occurrences are mostly isolated to slopes and swales of rolling uplands where either grazing or cultivation are more problematic.

DISTRIBUTION

Range: This system occurs throughout the Western Great Plains Division, however, grazing and conversion to agriculture have likely decreased its natural range.

Ecological Divisions: 303

TNC Ecoregions: 26:C, 27:C, 28:?, 33:C, 34:C

Subnations/Nations: CO:p, KS:c, MT:p, ND:c, NE:c, OK:c, TX:?

CONCEPT

Alliances:

- ANDROPOGON GERARDII - (SORGHASTRUM NUTANS) HERBACEOUS ALLIANCE (A.1192)
- CORNUS DRUMMONDII SHRUBLAND ALLIANCE (A.3558)
- QUERCUS FUSIFORMIS WOODLAND ALLIANCE (A.477)
- SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)

Environment: This system is found primarily on loam, moderately deep, and rich Mollisols throughout the Western Great Plains Division. These soils tend to be more mesic and deep than the majority of soils within the Western Great Plains and are more typical of the Eastern Great Plains Division.

Vegetation: The mesic, deep soils allow for dominance by *Andropogon gerardii*. Other species such as *Sorghastrum nutans*, *Schizachyrium scoparium*, *Pascopyrum smithii*, *Hesperostipa spartea*, and *Sporobolus heterolepis* can also be present. In more lowland areas, *Pascopyrum smithii* can become more prevalent. Fire suppression can lead to the invasion of these areas by woody species such as *Juniperus virginiana* and *Prunus* spp.

Dynamics: Fire, climate and grazing constitute the primary dynamic processes impacting this system. Fire suppression can allow for the invasion of woody species such as *Juniperus virginiana* and *Prunus* spp. into the prairie matrix. Overgrazing tends to favor shortgrass and mixedgrass species and can cause the conversion of this system to the Western Great Plains shortgrass or mixedgrass systems. Also, invasion by introduced species such as *Bromus inermis* can become more severe as grazing pressure increases. Likewise, conversion to agriculture has degraded or extirpated many examples of this system.

SOURCES

References: Barbour and Billings 1988, Weaver 1954

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

CES303.676 NORTHWESTERN GREAT PLAINS FLOODPLAIN

Division 303, Woody Wetland

Spatial Scale & Pattern: Linear

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Floodplain, Riverine / Alluvial, Long (>25 yrs) Flooding Interval

Concept Summary: This system is found in the floodplains of medium and large rivers of the northwestern Great Plains ranging from the Dakotas Mixedgrass Prairie east through the Northern Great Plains Steppe north into Canada. Alluvial soils and periodic, intermediate flooding (every 5-25 years) typify this system. Dominate 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 balsamifera ssp. trichocarpa*, *Populus deltoides*, and *Salix* spp. Grass cover underneath the trees is an important part of this system and is a mix of cool-season graminoid species, including *Carex pellita* (= *Carex lanuginosa*), *Panicum virgatum*, *Schizachyrium scoparium*, and *Elymus lanceolatus*. This system is 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.

DISTRIBUTION

Range: This system is found in the Northwestern Great Plains through southern Canada.

Ecological Divisions: 205, 303

TNC Ecoregions: 26:C, 34:C, 66:P, 67:P

Subnations/Nations: AB:p, MB:c, MT:c, ND:c, NE:c, SD:c, SK:c, WY:c

CONCEPT

Alliances:

- CAREX NEBRASCENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1417)
- CORNUS SERICEA TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.968)
- FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) TEMPORARILY FLOODED FOREST ALLIANCE (A.308)
- POPULUS DELTOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.290)
- POPULUS DELTOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636)
- SALIX (EXIGUA, INTERIOR) TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.947)
- SALIX PLANIFOLIA SEASONALLY FLOODED SHRUBLAND ALLIANCE (A.1008)
- SAND FLATS TEMPORARILY FLOODED SPARSELY VEGETATED ALLIANCE (A.1864)
- SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)
- SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.961)
- TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCHOENOPLECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1436)
- TYPHA SPP. - (SCHOENOPLECTUS SPP., JUNCUS SPP.) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1394)

SOURCES

Last updated: 10 Mar 2003

Concept Author: S. Menard, K. Kindscher, NatureServe Western Ecology Team

Stakeholders: MCS, CAN, WCS

LeadResp: MCS

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Herbaceous, Floodplain, Riverine / Alluvial, Deep (>15 cm) Water, Long (>25 yrs) Flooding Interval

Concept Summary: 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.

DISTRIBUTION

Range: This system is found along major river floodplains in the southern and central portions of the Western Great Plains division.

Ecological Divisions: 205, 303

TNC Ecoregions: 27:C, 28:C, 29:P, 32:C, 33:C, 37:C

Subnations/Nations: CO:c, KS:c, NE:c, OK:c, SD:c, TX:p

CONCEPT

Alliances:

- CAREX NEBRASCENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1417)
- CELTIS LAEVIGATA - ULMUS CRASSIFOLIA TEMPORARILY FLOODED FOREST ALLIANCE (A.283)
- COBBLE/GRAVEL SHORE SPARSELY VEGETATED ALLIANCE (A.1850)
- ERICAMERIA NAUSEOSA SHRUBLAND ALLIANCE (A.835)
- FRAXINUS PENNSYLVANICA - ULMUS AMERICANA - CELTIS (OCCIDENTALIS, LAEVIGATA) TEMPORARILY FLOODED FOREST ALLIANCE (A.286)
- JUGLANS MICROCARPA TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.945)
- JUSTICIA AMERICANA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1657)
- PANICUM VIRGATUM TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1343)
- PLATANUS OCCIDENTALIS - (BETULA NIGRA, SALIX SPP.) TEMPORARILY FLOODED WOODLAND ALLIANCE (A.633)
- PLATANUS OCCIDENTALIS - (FRAXINUS PENNSYLVANICA, CELTIS LAEVIGATA, ACER SACCHARINUM) TEMPORARILY FLOODED FOREST ALLIANCE (A.288)
- POPULUS DELTOIDES SSP. WISLIZENI TEMPORARILY FLOODED FOREST ALLIANCE (A.312)
- POPULUS DELTOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.290)
- POPULUS DELTOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636)
- SALIX (EXIGUA, INTERIOR) TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.947)
- SALIX NIGRA TEMPORARILY FLOODED FOREST ALLIANCE (A.297)
- SAND FLATS TEMPORARILY FLOODED SPARSELY VEGETATED ALLIANCE (A.1864)
- SCHOENOPLECTUS PUNGENS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1433)
- SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)
- SPOROBOLUS AIROIDES HERBACEOUS ALLIANCE (A.1267)
- SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.961)
- TAXODIUM DISTICHUM - (PLATANUS OCCIDENTALIS) TEMPORARILY FLOODED FOREST ALLIANCE (A.298)
- TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCHOENOPLECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1436)
- TYPHA SPP. - (SCHOENOPLECTUS SPP., JUNCUS SPP.) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1394)

Environment: This system is found primarily along floodplains of medium and large rivers. Soils are primarily alluvial and range from sandy to dense clays.

Vegetation: Dominant woody species occurring within this system include *Populus deltoides* and *Salix* spp. Understory species constitute an important component of this system and include a mixture of tallgrass prairie species such as including *Panicum virgatum* and *Andropogon gerardii*. Sparsely vegetated areas such as gravel and sand flats are also included within this system.

Dynamics: Periodic and intermediate flooding (i.e., every 5-25 years) constitutes the major process influencing this system. Grazing and conversion to agriculture can significantly impact this system and can lead to the degradation or extirpation of the majority of prairie and wet meadow communities from this system.

SOURCES**References:** Lauver et al. 1999, Steinauer and Rolfsmeier 2000**Last updated:** 05 Mar 2003**Concept Author:** S. Menard and K. Kindscher**Stakeholders:** MCS, SCS, WCS**LeadResp:** MCS**CES303.675 NORTHWESTERN GREAT PLAINS OPEN FRESHWATER DEPRESSION**

Division 303, Herbaceous Wetland

Spatial Scale & Pattern: Small Patch**Classification Confidence:** medium**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Wetland**Non-Diagnostic Classifiers:** Herbaceous, Depression, Depressional, Saturated Soil

Concept Summary: This system is composed of lowland depressions and also occurs along lake borders that have more open basins and a permanent water source through most of the year except during exceptional drought years. These areas are distinct from Western Great Plains Closed Depression Wetland (CES303.666) by having a large watershed and/or significant connection to the groundwater table. Some of the specific communities will also be found in the floodplain system and should not be considered a separate system in that case. These types should also not be considered a separate system if they are occurring in lowland areas of the prairie matrix only because of an exceptional wet year. A variety of species are part of this system, including *Typha* spp. and *Schoenoplectus* spp. The system includes submergent and emergent marshes, and associated wet meadows and wet prairies. These types can also drift into stream margins that are more permanently wet and linked directly to basin via groundwater flow from/into the pond or lake.

Comments: This system occurs widely throughout the western Great Plains, but in the arid shortgrass region, it is replaced by North American Arid West Emergent Marsh (CES300.729). Open and emergent marshes may be a separate system from wet meadows and wet prairies.

DISTRIBUTION**Range:** This system can occur throughout the northwestern Great Plains Division, but not in the arid shortgrass region.**Ecological Divisions:** 205, 303**TNC Ecoregions:** 26:C, 33:C, 34:C, 37:?, 66:P, 67:P**Subnations/Nations:** KS:c, MT:c, ND:c, NE:c, OK:c, SD:c, WY:c**CONCEPT****Alliances:**

- ALNUS INCANA SEASONALLY FLOODED SHRUBLAND ALLIANCE (A.986)
- BETULA OCCIDENTALIS SEASONALLY FLOODED SHRUBLAND ALLIANCE (A.996)
- CAREX (ROSTRATA, UTRICULATA) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1403)
- CAREX AQUATILIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1404)
- CAREX ATHERODES SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1396)
- CAREX NEBRASCENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1417)
- CAREX PELLITA - (CAREX NEBRASCENSIS) - SCHOENOPLECTUS SPP. SATURATED HERBACEOUS ALLIANCE (A.1466)
- CAREX PELLITA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1414)
- CAREX SPP. - PLANTAGO ERIPODA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1350)
- CAREX SPP. - TYPHA SPP. SATURATED HERBACEOUS ALLIANCE (A.1465)
- CAREX SPP. SATURATED HERBACEOUS ALLIANCE (A.1455)
- CAREX STRICTA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1397)
- CORNUS SERICEA - SALIX SPP. SEASONALLY FLOODED SHRUBLAND ALLIANCE (A.989)
- ELEOCHARIS PALUSTRIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1422)
- ELEOCHARIS PALUSTRIS TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1342)
- GLYCERIA BOREALIS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1445)
- JUNCUS BALTICUS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1374)
- PASCOPYRUM SMITHII TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1354)
- PHALARIS ARUNDINACEA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1381)
- POLYGONUM SPP. - ECHINOCHLOA SPP. TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1348)
- POLYGONUM SPP. (SECTION PERSICARIA) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1881)
- POTAMOGETON RICHARDSONII PERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1765)
- POTAMOGETON SPP. - CERATOPHYLLUM SPP. - ELODEA SPP. PERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1754)
- SAGITTARIA LATIFOLIA SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1675)
- SCHOENOPLECTUS ACUTUS - (SCHOENOPLECTUS TABERNAEMONTANI) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1443)
- SCOLOCHLOA FESTUCACEA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1401)
- SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)

- STUCKENIA PECTINATA PERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1764)
- TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCHOENOPLECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1436)
- TYPHA SPP. - (SCHOENOPLECTUS SPP., JUNCUS SPP.) SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1394)

Environment: This system is found within lowland depressions and along lakes that have more permanent water sources throughout the year. These areas typically have a large watershed and are connected to the groundwater sources. Examples may also drift into stream margins that are more permanently wet and linked to a basin via groundwater flow from/into a pond or lake. Those areas that are found within larger prairie matrix that are only lowland or wet because of an exceptional wet year are not part of this system.

Vegetation: Many species can be associated with this system with *Typha* spp. and *Schoenoplectus* spp. being common.

Dynamics: Hydrology is the primary process influencing this system. Grazing and conversion to agriculture can significantly impact the hydrology and species composition of this system.

SOURCES

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

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

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

Non-Diagnostic Classifiers: Lowland [Lowland], Herbaceous, Depression, Playa, Clay Subsoil Texture, Impermeable Layer, Saturated Soil

Concept Summary: 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*, *Symphytotrichum subulatum* (= *Aster subulatus*), and *Polygonum pennsylvanicum* (= *Polygonum bicorne*) 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.

DISTRIBUTION

Range: This system can be found throughout the eastern portion of the Western Great Plains Division, however, it is most prevalent in the central states of Nebraska, Kansas and Oklahoma.

Ecological Divisions: 205, 303

TNC Ecoregions: 27:C, 28:C, 32:P, 33:C

Subnations/Nations: CO:p, KS:c, NE:c, NM:?, OK:c, TX:c

CONCEPT

Alliances:

- ELEOCHARIS PALUSTRIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1422)
- ELEOCHARIS PALUSTRIS TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1342)
- HETERANTHERA LIMOSA PERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1744)
- HORDEUM JUBATUM TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1358)
- PANICUM OBTUSUM HERBACEOUS ALLIANCE (A.1238)
- PASCOPYRUM SMITHII HERBACEOUS ALLIANCE (A.1232)
- PASCOPYRUM SMITHII INTERMITTENTLY FLOODED HERBACEOUS ALLIANCE (A.1328)
- PASCOPYRUM SMITHII TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1354)
- PLEURAPHIS MUTICA INTERMITTENTLY FLOODED HERBACEOUS ALLIANCE (A.1330)
- POLYGONUM SPP. - ECHINOCHLOA SPP. TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1348)
- SARCOBATUS VERMICULATUS INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.1046)
- SCHOENOPLECTUS AMERICANUS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1432)

• SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)

Environment: This system is typified by upland depressional basins with an impermeable layer such as dense clay, hydric soils. Rainwater and runoff primarily recharge this system and it is rarely linked to outside groundwater sources.

Vegetation: Species richness varies considerably among individual examples of this system. Commonly, *Eleocharis* spp., *Hordeum jubatum*, along with *Coreopsis tinctoria*, *Symphyotrichum subulatum* (= *Aster subulatus*), and *Polygonum pennsylvanicum* (= *Polygonum bicorne*) are found in the wetter and deeper depression. Shallower depressions in rangelands commonly contain *Pascopyrum smithii* and *Buchloe dactyloides*.

Dynamics: Hydrological changes, grazing and conversion to agriculture are the primary processes influencing this system.

SOURCES

References: Hoagland 2000, Lauver et al. 1999

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

CES303.669 WESTERN GREAT PLAINS SALINE DEPRESSION WETLAND

Division 303, Herbaceous Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Herbaceous, Depression, Saline Water Chemistry

Concept Summary: This system is very similar to Northwestern Great Plains Open Freshwater Depression (CES303.675) and Western Great Plains Closed Depression Wetland (CES303.666). However, strongly saline soils cause both the shallow lakes and depressions and the surrounding areas to be more brackish. 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*, *Sporobolus airoides*, and *Hordeum jubatum*. During exceptionally wet years, an increase in precipitation can dilute the salt concentration in the soils of some of 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.

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

DISTRIBUTION

Range: This system can occur throughout the Western Great Plains, but is likely more prevalent in the south-central portions of the division.

Ecological Divisions: 303

TNC Ecoregions: 26:?, 27:C, 28:C, 33:C, 34:?

Subnations/Nations: CO:c, KS:c, MT:p, ND:c, NE:c, NM:c, OK:c, SD:c, WY:c

CONCEPT**Alliances:**

- CAREX SPP. - PLANTAGO ERIPODA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1350)
- DISTICHLIS SPICATA - (HORDEUM JUBATUM) TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1341)
- DISTICHLIS SPICATA INTERMITTENTLY FLOODED HERBACEOUS ALLIANCE (A.1332)
- HORDEUM JUBATUM TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1358)
- PASCOPYRUM SMITHII TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1354)
- 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 SHRUB HERBACEOUS ALLIANCE (A.1535)
- SCHOENOPECTUS AMERICANUS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1432)
- SCHOENOPECTUS MARITIMUS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1444)
- SCHOENOPECTUS PUNGENS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1433)
- SCOLOCHLOA FESTUCACEA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1401)
- SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1347)
- SPOROBOLUS AIROIDES HERBACEOUS ALLIANCE (A.1267)
- STUCKENIA PECTINATA PERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1764)
- TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCHOENOPECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1436)

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*, *Sporobolus airoides*, and *Hordeum jubatum* 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.

SOURCES

References: Hoagland 2000, Lauver et al. 1999, Steinauer and Rolfmeier 2000

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

CES303.661 GREAT PLAINS PRAIRIE POTHOLE

Division 303, Mixed Upland and Wetland

Spatial Scale & Pattern: Large Patch

Classification Confidence: high

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

Non-Diagnostic Classifiers: Lowland [Lowland], Herbaceous, Pothole, Temperate [Temperate Continental]

Concept Summary: The prairie pothole system is found primarily in glaciated northern Great Plains of the United States and Canada, and is dominated by depression wetlands formed by glaciers scraping the landscape during the Pleistocene era. This system is typified by several classes of wetlands distinguished by changes in topography, soils and hydrology. Many of the basins within this system are closed basins and receive irregular inputs of water from their surroundings (groundwater and precipitation), and export water as groundwater. Hydrology of the potholes is complex. Precipitation and runoff from snowmelt are often the principal water sources, with groundwater inflow secondary. Evapotranspiration is the major water loss, with seepage loss secondary. Most of the wetlands and lakes contain water that is alkaline (pH >7.4). The concentration of dissolved solids in these waters ranges from fresh to extremely saline. The flora and vegetation of this system is a function of the topography, water regime, and salinity. In addition, because of periodic droughts and wet periods, many wetlands within this system may undergo vegetation cycles. This system includes elements of emergent marshes and wet, sedge meadows that develop into a pattern of concentric rings. This system is responsible for a significant percentage of the annual production of many economically important waterfowl in North America and houses more than 50% of North American's migratory waterfowl with several species reliant on this system for breeding and feeding. Much of the original extent of this system has been converted to agriculture and only approximately 40-50% of the system remains undrained.

Comments: More data from Canada is needed to really define this system completely.

DISTRIBUTION

Range: This system can be found throughout the northern Great Plains ranging from central Iowa northeast to southern Saskatchewan and Alberta. It encompasses approximately 870,000 km² with approximately 80% of its range in southern Canada. It is also prevalent in North Dakota, South Dakota, and northern Minnesota.

Ecological Divisions: 205, 303

TNC Ecoregions: 34:C, 35:C, 66:P, 67:P

Subnations/Nations: AB:p, IA:?, MB:c, MN:c, ND:c, SD:c, SK:c

CONCEPT

Alliances:

- (COMPLEX)
- CAREX OLIGOSPERMA - CAREX LASIOCARPA SATURATED HERBACEOUS ALLIANCE (A.1467)
- SCHOENOPLECTUS ACUTUS - (SCHOENOPLECTUS TABERNAEMONTANI) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1443)
- SCHOENOPLECTUS MARITIMUS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1444)

Environment: This system is dominated by closed basins, potholes, that receive irregular inputs of water from the surroundings and export water as groundwater. The climate for the range of this system is characterized by mid-continental temperature and precipitation extremes. Snowmelt in the spring typically fills many of the potholes in examples of this system. The region in the range of this system is distinguished by a thin mantle of glacial drift with overlying stratified sedimentary rocks of the Mesozoic and Cenozoic ages; these form a glacial landscape of end moraines, stagnation moraines, outwash plains and lakeplains. The glacial drift ranges 30 to 120 m thick and forms steep to slight local relief with fine-grained, silty to clayey soils. Limestone, sandstone, and shales predominant, and highly mineralized water can discharge from these rocks. The hydrology of this system is complex with salinity ranging from fresh to saline, and chemical

characteristics varying seasonally and annually. Precipitation and snowmelt are the primary water sources with evapotranspiration being the source of major water loss.

Vegetation: The vegetation within this system is highly influenced by hydrology, salinity and dynamics. Potholes found within this system can vary in depth and duration, which will determine the local gradient of species. Likewise, plant species found within individual potholes of this system will be strongly influenced by periodic drought and wet periods. Deeper potholes with standing water throughout most of the year have a central zone of submersed aquatic vegetation. Potholes that dry during droughty times can have central zones dominated by either tall emergents or mid-height emergents depending on the depth of the marsh. Wet meadow species such as grasses, forbs and sedges can be found in potholes that are only flooded briefly in the spring. All of these types of potholes can be found within an example of this system. Grazing, draining, and mowing of this system can influence the distribution of these types of potholes and plant species within this system.

Dynamics: Flooding is the primary natural dynamic influencing this system. Snowmelt in the spring often floods this system and can cause the prominent potholes within the system to overflow. Greater than normal precipitation can flood out emergent vegetation and/or increase herbivory by animal species such as muskrats. This system can undergo periodic wet and droughty periods that can cause shifts in the vegetation. Vegetation zones are evident around the wet potholes throughout this system, and each zone responds to changing environmental conditions. Draining and conversion to agriculture can also significantly impact this system. Much of the original extent of this system has been converted to cropland, and many remaining examples are under pressure to be drained.

SOURCES

References: Johnson et al. 1987, Kantrud et al. 1989

Last updated: 05 Mar 2003

Concept Author: S. Menard

Stakeholders: MCS, CAN

LeadResp: MCS

CES303.677 NORTHWESTERN GREAT PLAINS RIPARIAN

Division 303, Mixed Upland and Wetland

Spatial Scale & Pattern: Linear

Classification Confidence: low

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed)

Concept Summary: This system is found in the riparian areas of medium and small rivers and streams throughout the northwestern Great Plains. It is likely most common in the Northern Great Plains Steppe. These are found on alluvial soils in highly variable landscape settings, from deep cut ravines to wide, braided streambeds. Hydrologically, these tend to be more flashy with less developed floodplain than on larger rivers, and typically dry down completely for some portion of the year. Dominant vegetation shares much with generally drier portions of larger floodplain systems downstream, but overall abundance of vegetation is generally lower. Communities within this system range from riparian forests and shrublands to gravel/sand flats. Dominant species include *Populus deltoides*, *Populus balsamifera ssp. trichocarpa*, *Salix* spp., *Artemisia cana ssp. cana*, and *Pascopyrum smithii*. 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.

DISTRIBUTION

Range: Throughout the northwestern Great Plains.

Ecological Divisions: 205, 303

TNC Ecoregions: 26:C, 34:C, 66:P, 67:P

Subnations/Nations: AB:p, MB:c, MT:c, ND:c, NE:c, SD:p, SK:c, WY:?

CONCEPT

Alliances:

- ARTEMISIA CANA TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.843)
- ARTEMISIA TRIDENTATA SSP. WYOMINGENSIS SHRUBLAND ALLIANCE (A.832)
- PASCOPYRUM SMITHII HERBACEOUS ALLIANCE (A.1232)

SOURCES

Last updated: 26 Mar 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, CAN, MCS

LeadResp: WCS

CES303.956 WESTERN GREAT PLAINS RIPARIAN WOODLAND AND SHRUBLAND

Division 303, Mixed Upland and Wetland

Spatial Scale & Pattern: Linear**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland, Wetland**Diagnostic Classifiers:** Woody-Herbaceous, Very Short Disturbance Interval, Flood Scouring, Riparian Mosaic, Riverine / Alluvial**Non-Diagnostic Classifiers:** Lowland [Lowland], Forest and Woodland (Treed), Shrubland (Shrub-dominated), Alluvial fan, Arroyo, Floodplain, Fluvial, Toeslope/Valley Bottom, Temperate [Temperate Xeric], Broad-Leaved Deciduous Tree, Broad-Leaved Deciduous Shrub, Evergreen Sclerophyllous Shrub, Graminoid, Intermittent Flooding, Short (<5 yrs) Flooding Interval**Concept Summary:** This system is found in the riparian areas of medium and small rivers and streams throughout the Western Great Plains. It is likely most common in the Central Shortgrass Prairie and Northern Great Plains Steppe, but extends west into the Wyoming Basins. These are found on alluvial soils in highly variable landscape settings, from deep cut ravines to wide, braided streambeds. Hydrologically, these tend to be more flashy with less developed floodplain than on larger rivers, and typically dry down completely for some portion of the year. Dominant vegetation shares much with generally drier portions of larger floodplain systems downstream, but overall abundance of vegetation is generally lower. Communities within this system range from riparian forests and shrublands to gravel/sand flats. Dominant species include *Populus deltoides*, *Salix* spp., *Artemisia cana* ssp. *cana*, *Pascopyrum smithii*, *Sporobolus cryptandrus*, and *Schizachyrium scoparium*. These areas are often subjected to heavy grazing and/or agriculture and can be heavily degraded. *Tamarix* spp. and less desirable grasses and forbs can invade degraded examples up through central Colorado. Another factor is that groundwater depletion and lack of fire have created additional species changes.**DISTRIBUTION****Range:** Riparian areas of medium and small rivers and streams throughout the Western Great Plains. It is likely most common in the Central Shortgrass Prairie and Northern Great Plains Steppe, but extends west into the Wyoming Basins.**Ecological Divisions:** 303, 304**TNC Ecoregions:** 10:P, 26:C, 27:C, 28:P**Subnations/Nations:** CO:, MT:, NM:, WY:**CONCEPT****Alliances:**

- ARTEMISIA CANA TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.843)
- COBBLE/GRAVEL SHORE SPARSELY VEGETATED ALLIANCE (A.1850)
- POPULUS DELTOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636)
- SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.961)

SOURCES**Last updated:** 20 Mar 2003**Concept Author:** P. Comer, G. Kittel**Stakeholders:** WCS, CAN**LeadResp:** WCS**CES303.680 WESTERN GREAT PLAINS WOODED DRAW AND RAVINE**

Division 303, Mixed Upland and Wetland

Spatial Scale & Pattern: Linear**Classification Confidence:** medium**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland, Wetland**Non-Diagnostic Classifiers:** Forest and Woodland (Treed), Draw, Ravine, G-Patch/Medium Intensity**Concept Summary:** This system is typically found associated with permanent or ephemeral streams and small rivers and may occur on steep northern slopes or within canyon bottoms that do not experience periodic flooding, although soil moisture and topography allow greater than normal moisture conditions compared to the surrounding areas. *Fraxinus* spp. and *Ulmus rubra* and *Ulmus americana* typically dominate this system, although in some areas of the western Great Plains steppe province, *Juniperus* spp. can dominate the canopy. In south-central portions of the Great Plains, *Quercus macrocarpa* can also be present. This system was often subjected to heavy grazing and trampling by both domestic animals and wildlife and can be heavily degraded in some areas. In addition, exotic species such as *Ulmus pumila* and *Elaeagnus angustifolia* can invade these systems.**Comments:** More information from the broader division and from the Rocky Mountain division will be needed to determine if those areas dominated by ash and elm should be separated from areas dominated by *Juniperus scopulorum*. Those areas dominated by *Juniperus* are typically found in the Badlands and the western portions of North Dakota and Nebraska, and

should probably be described based on data from the Great Plains Steppe or Rocky Mountain division. However, *Juniperus* can occur in stands with elm and ash in Nebraska and North Dakota.

DISTRIBUTION

Range: This system is found throughout the Western Great Plains Division.

Ecological Divisions: 205, 303

TNC Ecoregions: 26:C, 27:C, 28:P, 33:C, 34:C, 37:C

Subnations/Nations: CO:c, KS:c, MT:c, ND:c, NE:c, OK:c, SD:c, TX:p

CONCEPT

Alliances:

- CAREX NEBRASCENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1417)
- CORNUS DRUMMONDII SHRUBLAND ALLIANCE (A.3558)
- CORNUS SERICEA - SALIX SPP. SEASONALLY FLOODED SHRUBLAND ALLIANCE (A.989)
- CORNUS SERICEA TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.968)
- CRATAEGUS (DOUGLASII, SUCCULENTA) TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.954)
- FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) FOREST ALLIANCE (A.259)
- FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) TEMPORARILY FLOODED FOREST ALLIANCE (A.308)
- FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) WOODLAND ALLIANCE (A.629)
- FRAXINUS PENNSYLVANICA - ULMUS AMERICANA - CELTIS (OCCIDENTALIS, LAEVIGATA) TEMPORARILY FLOODED FOREST ALLIANCE (A.286)
- JUNIPERUS SCOPULORUM WOODLAND ALLIANCE (A.506)
- POPULUS DELTOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.290)
- POPULUS DELTOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE (A.636)
- PRUNUS VIRGINIANA SHRUBLAND ALLIANCE (A.919)
- QUERCUS MACROCARPA WOODLAND ALLIANCE (A.620)
- ROSA WOODSII TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.959)
- SHEPHERDIA ARGENTEA TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.960)
- SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.961)

Environment: This system is associated with permanent or ephemeral streams and small rivers. It also can occur on steep northern slopes or within canyon bottoms that do not experience periodic flooding. Soils are primarily wet to mesic, and more dissected topography allows for greater than normal moisture conditions. This system is most often associated with smaller rivers and/or temporary streams.

Vegetation: Species composition of this system can vary across the range of this system. *Fraxinus* spp. and *Ulmus* spp. typically dominate this system. In some western areas of the Great Plains Division, *Juniperus* spp. can dominate, and in the south-central portion of the division, *Quercus macrocarpa* can also be important. Exotic species such as *Ulmus pumila* and *Elaeagnus angustifolia* can be present in degraded examples of this system.

Dynamics: Fire can influence this system, however, grazing is the most prevalent dynamic process influencing this system. Overgrazing can heavily degrade this system and allow for the invasion of exotic species.

SOURCES

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

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

Non-Diagnostic Classifiers: Badlands, Badland, Temperate [Temperate Continental], Ustic, Flood Scouring, W-Patch/High Intensity

Concept Summary: 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.

DISTRIBUTION

Range: This system ranges throughout the northern Great Plains region of the United States and Canada. Some of the best and well known examples occur in North and South Dakota.

Ecological Divisions: 303

TNC Ecoregions: 26:C, 34:P, 66:?, 67:P

Subnations/Nations: MB:?, MT:c, ND:c, NE:c, SD:c

CONCEPT**Alliances:**

- (COMPLEX)
- ARENARIA HOOKERI BARRENS HERBACEOUS ALLIANCE (A.1642)
- ARTEMISIA LONGIFOLIA SPARSELY VEGETATED ALLIANCE (A.1874)
- ERIOGONUM PAUCIFLORUM SPARSELY VEGETATED ALLIANCE (A.3565)
- LARGE ERODING BLUFFS SPARSELY VEGETATED ALLIANCE (A.1875)
- PASCOPYRUM SMITHII TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1354)
- SARCOBATUS VERMICULATUS INTERMITTENTLY FLOODED SHRUBLAND ALLIANCE (A.1046)
- SARCOBATUS VERMICULATUS SHRUBLAND ALLIANCE (A.1041)
- SHEPHERDIA ARGENTEA TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.960)

Environment: A combination of factors such as elevation, rainfall, carving action of streams and parent material can contribute to the development of this system. This system is primarily a type of mature dissection with finely textured drainage pattern and steep slopes. This system contains extremely dry and easily erodible, consolidated clayey soils with bands of sandstone or isolated consolidates. This system is found within an arid to semi-arid climate with infrequent, but torrential, rains that cause erosion.

Vegetation: Vegetation in this system is limited by the climate and soils of this system and often is less than 10% cover. Scattered individuals of *Grindelia squarrosa*, *Gutierrezia sarothrae*, or *Eriogonum* spp. and/or patches of *Artemisia* spp. may occur.

Dynamics: This system contains highly erodible soils that can be strongly influenced by infrequent, but often torrential, rains.

SOURCES

References: Von Loh et al. 1999

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS, CAN

LeadResp: MCS

CES303.664 WESTERN GREAT PLAINS CANYON

Division 303, Barren

Spatial Scale & Pattern: Small Patch

Classification Confidence: high

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

Non-Diagnostic Classifiers: Canyon, Very Shallow Soil, Flood Scouring

Concept Summary: This system occurs primarily along springbranch and dry canyons. Soils can range from deep loams to alluvial to sandy. Examples of this system are found primarily in the southern portion of the Great Plains, but can range as far north as the Niobrara and North Platte rivers in Nebraska. Vegetation varies both regionally and locally depending on latitude, aspect, slope position and substrate and can range from riparian vegetation to xeric or mesic woodlands. Rock outcrops with sparse vegetation are also common. Dominant tree species include *Quercus* spp., *Populus deltoides*, *Betula papyrifera*, *Fraxinus pennsylvanica*, *Ulmus rubra*, *Pinus ponderosa*, and *Juniperus* spp.; shrub species may be present as well. This system can grade into in areas dominated by *Pinus* spp. This system often contains elements of other systems such as Western Great Plains Cliff and Outcrop (CES303.665) and Northwestern Great Plains Shrubland (CES303.662), but unique geology and dynamics bring these together to form this canyon system. Occasionally, fens may occur in canyon bottom seeps.

DISTRIBUTION

Range: This system occurs along springbranch and dry canyons in the southern portion of the Western Great Plains, ranging as far north as the Niobrara and North Platte rivers in Nebraska.

Ecological Divisions: 303

TNC Ecoregions: 28:C, 29:C, 33:C

Subnations/Nations: CO:c, KS:c, NE:c, OK:p, TX:c

CONCEPT**Alliances:**

- ACER GRANDIDENTATUM - QUERCUS BUCKLEYI - QUERCUS MUEHLENBERGII FOREST ALLIANCE (A.215)
- ADIANTUM CAPILLUS-VENERIS SATURATED HERBACEOUS ALLIANCE (A.1683)
- AGROSTIS STOLONIFERA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1405)
- BETULA PAPYRIFERA FOREST ALLIANCE (A.267)
- BUDDLEJA RACEMOSA - UNGNADIA SPECIOSA SHRUBLAND ALLIANCE (A.894)
- CAREX PELLITA - (CAREX NEBRASCENSIS) - SCHOENOPLECTUS SPP. SATURATED HERBACEOUS ALLIANCE (A.1466)
- PSEUDOTSUGA MENZIESII WOODLAND ALLIANCE (A.552)
- QUERCUS GAMBELII SHRUBLAND ALLIANCE (A.920)
- QUERCUS MUEHLENBERGII - (ACER SACCHARUM) FOREST ALLIANCE (A.1912)

Vegetation: Vegetation can vary regionally and locally with latitude, aspect, slope position and substrate. It can range from riparian to mesic to xeric woodlands. Several tree species such as *Quercus* spp., *Populus deltoides*, *Betula papyrifera*, *Fraxinus pennsylvanica*, *Ulmus rubra*, and *Pinus ponderosa* and shrub species such as *Juniperus* spp. can occur within this system. Cover of these species can range from less than 10% on rock outcrops to greater than 60%.

SOURCES

References: Steinauer and Rolfsmeier 2000

Last updated: 05 Mar 2003

Concept Author: S. Menard and K. Kindscher

Stakeholders: MCS, WCS

LeadResp: MCS

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

Non-Diagnostic Classifiers: Cliff (Landform), Very Shallow Soil, Ustic, Flood Scouring, W-Patch/High Intensity

Concept Summary: 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.

DISTRIBUTION

Range: This system ranges throughout the Western Great Plains Division from northern Texas to southern Canada.

Ecological Divisions: 303

TNC Ecoregions: 26:C, 27:C, 28:C, 29:C, 33:C, 37:P, 66:P, 67:P

Subnations/Nations: CO:c, KS:c, MB:p, MT:c, ND:c, NE:c, NM:c, OK:c, TX:c

CONCEPT**Alliances:**

- ADIANTUM CAPILLUS-VENERIS SATURATED HERBACEOUS ALLIANCE (A.1683)
- ARENARIA HOOKERI BARRENS HERBACEOUS ALLIANCE (A.1642)
- ARTEMISIA LONGIFOLIA SPARSELY VEGETATED ALLIANCE (A.1874)
- LESQUERELLA (GORDONII, OVALIFOLIA) HERBACEOUS ALLIANCE (A.1619)
- OPEN CLIFF SPARSELY VEGETATED ALLIANCE (A.1836)
- ROCK OUTCROP SPARSELY VEGETATED ALLIANCE (A.1838)
- SEDUM NUTTALLIANUM SPARSELY VEGETATED ALLIANCE (A.1846)

Environment: This system includes cliff and outcrops throughout the Western Great Plains Division with substrate ranging from sandstone to limestone. Areas of shelves, cracks, and crevices accumulated materials and allow soils to develop enough to support more vegetation.

Vegetation: Short shrubs and mixedgrass species dominate the vegetation of this system. Common species include *Rhus trilobata*, *Artemisia longifolia*, *Bouteloua curtipendula* and *Bouteloua gracilis*, and *Calamovilfa longifolia*, although species can vary somewhat with substrate and exposure.

Dynamics: Drought and wind erosion are the major influences affecting this system.

SOURCES

Last updated: 05 Mar 2003**Concept Author:** S. Menard and K. Kindscher**Stakeholders:** MCS, WCS**LeadResp:** MCS**CES304.767 COLORADO PLATEAU PINYON-JUNIPER WOODLAND**

Division 304, Forest and Woodland

Spatial Scale & Pattern: Matrix**Classification Confidence:** medium**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland**Diagnostic Classifiers:** Montane [Lower Montane], Lowland [Foothill], Mesa, Ridge/Summit/Upper Slope, Sedimentary Rock, Temperate [Temperate Xeric], Aridic, *Pinus edulis*, *Juniperus osteosperma***Non-Diagnostic Classifiers:** Forest and Woodland (Treed), Foothill(s), Piedmont, Plateau, Sideslope, Alkaline Soil, Long Disturbance Interval, F-Patch/Medium Intensity

Concept Summary: This ecological system occurs on dry mountains and foothills of the Colorado Plateau region from the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim. It is typically found at lower elevations ranging from 1500-2440 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. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. *Pinus edulis* and/or *Juniperus osteosperma* dominate the tree canopy. *Juniperus scopulorum* may codominate or replace *Juniperus osteosperma* at higher elevations. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Arctostaphylos patula*, *Artemisia tridentata*, *Cercocarpus intricatus*, *Cercocarpus montanus*, *Coleogyne ramosissima*, *Purshia stansburiana*, *Purshia tridentata*, *Quercus gambelii*, *Bouteloua gracilis*, *Pleuraphis jamesii*, or *Poa fendleriana*. This system occurs at higher elevations than Great Basin Pinyon-Juniper Woodland (CES304.773) and Colorado Plateau shrubland systems where sympatric.

DISTRIBUTION

Range: Occurs on dry mountains and foothills of the Colorado Plateau region from the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim. It is typically found at lower elevations ranging from 1500-2440 m.**Ecological Divisions:** 304, 306**TNC Ecoregions:** 18:C, 19:C, 20:?**Subnations/Nations:** AZ:c, CO:c, NM:c, UT:c

CONCEPT

Alliances:

- JUNIPERUS OSTEOSPERMA WOODED HERBACEOUS ALLIANCE (A.1502)
- JUNIPERUS OSTEOSPERMA WOODED SHRUBLAND ALLIANCE (A.2541)
- JUNIPERUS OSTEOSPERMA WOODLAND ALLIANCE (A.536)
- PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516)
- PINUS EDULIS FOREST ALLIANCE (A.135)

SOURCES

References: Baker and Kennedy 1985, Stuever and Hayden 1997a, Tuhy et al. 2002, West et al. 1998**Last updated:** 20 Feb 2003**Concept Author:** NatureServe Western Ecology Team**Stakeholders:** WCS**LeadResp:** WCS**CES304.776 INTER-MOUNTAIN BASINS ASPEN-MIXED CONIFER FOREST AND WOODLAND**

Division 304, Forest and Woodland

Spatial Scale & Pattern: Matrix**Classification Confidence:** low**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**Non-Diagnostic Classifiers:** Montane [Upper Montane], Montane [Montane], Montane [Lower Montane], Sideslope, Toeslope/Valley Bottom, Temperate [Temperate Continental]

Concept Summary: This ecological system occurs on montane slopes and plateaus in Utah, eastern Nevada, southern Idaho and western Wyoming. 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*, *Picea engelmannii*, *Picea pungens*, *Pinus contorta*, *Pinus flexilis*, 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 *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.

DISTRIBUTION

Range: Occurs on montane slopes and plateaus in Utah, eastern Nevada, southern Idaho and western Wyoming. Elevations range from 1700 to 2800 m.

Ecological Divisions: 304, 306?

TNC Ecoregions: 11:C, 18:C, 19:P, 6:C, 9:C

Subnations/Nations: ID:c, NV:c, UT:c, WY:c

CONCEPT

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 FLEXILIS - POPULUS TREMULOIDES FOREST ALLIANCE (A.425)
- PINUS PONDEROSA - POPULUS TREMULOIDES FOREST ALLIANCE (A.399)
- POPULUS TREMULOIDES - PSEUDOTSUGA MENZIESII FOREST ALLIANCE (A.426)

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 *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 Systems: 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, DeByle and Winokur 1985, DeVelice et al. 1986, Henderson et al. 1977, Mueggler 1988, Tuhy et al. 2002, Youngblood and Mauk 1985, Youngblood and Mueggler 1981

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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*

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Shrubland (Shrub-dominated), Foothill(s), Piedmont, Plateau, Ridge/Summit/Upper Slope, Sideslope, Temperate [Temperate Continental], Long Disturbance Interval, F-Patch/Medium Intensity

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 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.

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.

Ecological Divisions: 206?, 304, 306

TNC Ecoregions: 10:P, 11:C, 12:C, 6:P, 9:C

Subnations/Nations: CA:c, ID:?, MT:c, NV:c, OR:?, UT:c, WY:c

CONCEPT

Alliances:

- CERCOCARPUS LEDIFOLIUS SHRUBLAND ALLIANCE (A.828)
- CERCOCARPUS LEDIFOLIUS WOODLAND ALLIANCE (A.586)

SOURCES

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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

CES304.763 COLORADO PLATEAU BLACKBRUSH-MORMON-TEA 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], Shrubland (Shrub-dominated), Temperate [Temperate Xeric], Aridic

Non-Diagnostic Classifiers: Ridge/Summit/Upper Slope, Sideslope, Alkaline Soil, Sand Soil Texture, Very Long Disturbance Interval, F-Patch/High Intensity

Concept Summary: This ecological system occurs in the Colorado Plateau on benchlands, colluvial slopes, pediments or bajadas. Elevation ranges from 560-1600 m. Substrates are shallow, typically calcareous, non-saline and gravelly or sandy soils over sandstone or limestone bedrock, caliche or limestone alluvium. It also occurs in deeper soils on sandy plains where it may have invaded desert grasslands. The vegetation is characterized by an extensive open shrublands dominated by *Coleogyne ramosissima* often with *Ephedra viridis*, *Ephedra torreyana*, or *Grayia spinosa*. Sandy portions may include *Artemisia filifolia* as codominant. The herbaceous layer is sparse and composed of graminoids such as *Achnatherum hymenoides*, *Pleuraphis jamesii*, or *Sporobolus cryptandrus*.

DISTRIBUTION

Range: Occurs in the Colorado Plateau on benchlands, colluvial slopes, pediments or bajadas. Elevation ranges from 560-1600 m.

Ecological Divisions: 304

TNC Ecoregions: 18:C, 19:C

Subnations/Nations: AZ:c, CO:c, NM:c, UT:c

CONCEPT

Alliances:

- ACHNATHERUM HYMENOIDES SHRUB HERBACEOUS ALLIANCE (A.1543)
- ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE (A.816)
- BOUTELOUA ERIPODA XEROMORPHIC SHRUB HERBACEOUS ALLIANCE (A.1553)
- COLEOZYNE RAMOSISSIMA SHRUBLAND ALLIANCE (A.874)
- EPHEDRA NEVADENSIS - EPHEDRA VIRIDIS SHRUBLAND ALLIANCE (A.856)
- EPHEDRA NEVADENSIS SHRUBLAND ALLIANCE (A.857)
- EPHEDRA VIRIDIS SHRUBLAND ALLIANCE (A.858)

Environment: This ecological system typically occurs on gentle to steep, bouldery or rocky slopes of mountains, canyons, and mesas with varying aspects. This system is an evergreen, microphyllous desert scrub with succulents, half-shrubs, and scattered deciduous shrubs typically found at elevations ranging from 580 to 1600 m. (1903-5249 feet). This shrubland system occurs in an arid to semi-arid climate with annual precipitation in the form of summer monsoons and winter storms averaging approximately 20 cm. Soils are highly variable and parent materials may include shale, sandstone, limestone, quartzites, and igneous rocks. Soils are generally coarse-textured, often rocky, shallow and well-drained. Effective soil moisture appears to be primarily controlled by regolith depth and position in relation to the water table. This brushland system occupies most sites where regolith is uniformly shallow. In association with blackbrush (*Coleogyne ramosissima*) sites, the soil moisture is concentrated on top of impermeable bedrock at a shallow depth. This perching effect allows for gradual uptake of moisture by the plants roots (Loope and West 1979). This permits growth of plants with more mesic habitat requirements (Warren et al. 1982). On sites with deep soil, blackbrush may occur in almost pure occurrences with only a few associated species (Warren et al. 1982). Dark-colored cryptogamic soil crusts, composed of lichens, mosses, fungi, and algae, are often present in this system in fairly undisturbed areas. Sandy soils may have more cryptogamic crusts than clayish or silty soil surfaces.

Vegetation: This ecological system is dominated by sparse to moderately dense shrubs. Dominant shrubs include *Coleogyne ramosissima*, *Ephedra nevadensis*, and *Ephedra viridis* (which may codominate with *Grayia spinosa*, *Salvia dorrii*, and *Lycium andersonii*). There is usually a sparse herbaceous layer with some perennial grasses and forbs. Annual grasses and forbs are present seasonally. Some characteristic species associated with this system include the shrubs *Gutierrezia sarothrae*, *Chrysothamnus viscidiflorus*, *Yucca baccata*, and *Krameria grayi*, succulents such as *Ferocactus cylindraceus* (= *Ferocactus acanthodes*), *Opuntia* spp., *Echinocereus* spp., *Echinocactus* spp., and *Agave* spp., the graminoid *Pleuraphis rigida*, and perennial forbs such as *Machaeranthera pinnatifida* and *Sphaeralcea ambigua*.

Dynamics: Fire does not appear to play a role in maintenance of shrublands within this system. Topographic breaks dissect the landscape, and isolated pockets of vegetation are separated by rock walls or steep canyons. Blackbrush is fire-intolerant (Loope and West 1979). Following fires, these communities are often colonized by non-native grasses, which serve to encourage recurrent fires and delay shrub regeneration (IVC 1999). In shallow regolith situations, secondary succession, in the sense of site preparation by seral plants, may not occur at all (Loope and West 1979).

SPATIAL CHARACTERISTICS

Adjacent Ecological Systems: Adjacent vegetation often includes *Atriplex* dominated shrubland communities and upland areas of pinyon-juniper woodlands. Grasslands dominated by *Pleuraphis jamesii*, *Hesperostipa comata*, and *Achnatherum hymenoides* also occur.

SOURCES

References: Loope and West 1979, Tuhy and MacMahon 1988, Tuhy et al. 2002, Warren et al. 1982, West 1983d

Last updated: 20 Feb 2003

Stakeholders: WCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

CES304.762 COLORADO PLATEAU MIXED 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: Montane [Lower Montane], Lowland [Foothill], Shrubland (Shrub-dominated), Ridge/Summit/Upper Slope, Temperate [Temperate Xeric], Aridic

Non-Diagnostic Classifiers: Alkaline Soil

Concept Summary: This ecological system occurs in the Colorado Plateau, Tavaputs Plateau and Uinta Basin in canyons, gravelly draws, hilltops, and dry flats at elevations generally below 1800 m. Soils are often rocky, shallow, and alkaline. This type extends across northern New Mexico into the southern Great Plains on limestone hills. It includes open shrublands and steppe dominated by *Artemisia nova* or *Artemisia bigelovii* sometimes with *Artemisia tridentata ssp. wyomingensis* codominant. Semi-arid grasses such as *Achnatherum hymenoides*, *Aristida purpurea*, *Bouteloua gracilis*, *Hesperostipa comata*, *Pleuraphis jamesii*, or *Poa fendleriana* are often present and may form a graminoid layer with over 25% cover.

DISTRIBUTION

Range: Occurs in the Colorado Plateau, Tavaputs Plateau and Uinta Basin in canyons, gravelly draws, hilltops, and dry flats at elevations generally below 1800 m.

Ecological Divisions: 303, 304

TNC Ecoregions: 18:C, 19:C, 20:C, 27:C, 28:C

Subnations/Nations: AZ:c, CO:c, NM:c

CONCEPT

Alliances:

- ARTEMISIA BIGELOVII SHRUBLAND ALLIANCE (A.1103)
- ARTEMISIA NOVA SHRUBLAND ALLIANCE (A.1105)
- BOUTELOUA ERIOPODA DWARF-SHRUB HERBACEOUS ALLIANCE (A.1570)
- BOUTELOUA GRACILIS DWARF-SHRUB HERBACEOUS ALLIANCE (A.1571)

SOURCES

References: Brown 1982, Dick-Peddie 1993, Francis 1986

Last updated: 20 Feb 2003

Stakeholders: WCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

CES304.766 COLORADO PLATEAU PINYON-JUNIPER SHRUBLAND

Division 304, Shrubland

Spatial Scale & Pattern: Matrix

Classification Confidence: low

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

Diagnostic Classifiers: Lowland [Foothill], Mesa, Ridge/Summit/Upper Slope, Sedimentary Rock, Temperate [Temperate Xeric], Aridic, *Pinus edulis*, *Juniperus osteosperma*

Non-Diagnostic Classifiers: Shrubland (Shrub-dominated), Foothill(s), Sideslope, Alkaline Soil, Long Disturbance Interval, F-Patch/Medium Intensity

Concept Summary: This ecological system is characteristic of the rocky mesa tops and slopes on the Colorado Plateau, but these stunted tree shrublands may extend further upslope along the low-elevation margins of taller pinyon-juniper woodlands. Sites are drier than Colorado Plateau Pinyon-Juniper Woodland (CES304.767). Substrates are shallow/rocky soils at lower elevations (1200-2000 m). Sparse examples of the system grade into Colorado Plateau Mixed Bedrock Canyon and Tableland (CES304.765). The vegetation is dominated by dwarfed (usually <3 m tall) *Pinus edulis* and/or *Juniperus osteosperma* trees forming extensive tall shrublands in the region along low-elevation margins of pinyon-juniper woodlands. Other shrubs, if present, may include *Artemisia nova*, *Artemisia tridentata ssp. wyomingensis*, *Chrysothamnus viscidiflorus*, or *Coleogyne ramosissima*. Herbaceous layers are sparse to moderately dense and typically composed of xeric graminoids.

DISTRIBUTION

Range: Rocky mesa tops and slopes on the Colorado Plateau.

Ecological Divisions: 304, 306?

TNC Ecoregions: 18:C, 19:C, 20:?

Subnations/Nations: AZ:c, CO:c, NM:c, UT:c

CONCEPT

Alliances:

- JUNIPERUS OSTEOSPERMA WOODLAND ALLIANCE (A.536)
- PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516)

SOURCES

References: Tuhy et al. 2002, West et al. 1998

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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*

Non-Diagnostic Classifiers: Alluvial plain, Plain, Temperate [Temperate Continental], Alkaline Soil, Xeromorphic Shrub

Concept Summary: This ecological system occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains and foothills between 1500-2300 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*.

DISTRIBUTION

Range: Occurs throughout much of the western U.S., typically in broad basins between mountain ranges, plains and foothills between 1500-2300 m elevation.

Ecological Divisions: 303, 304, 306

TNC Ecoregions: 10:C, 11:C, 18:C, 19:C, 20:C, 26:C, 27:C, 4:C, 6:C, 8:C, 9:C

Subnations/Nations: CA:c, CO:c, ID:c, MT:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

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. 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)

• California community types:

- Big Sagebrush - Desert Snowberry (35.110.04)
- Big Sagebrush - Antelope Bitterbrush (35.110.07)
- Antelope Bitterbrush Scrub (35.200.00)
- Antelope Bitterbrush - Big Sagebrush - Horesebush (35.200.01)
- Antelope Bitterbrush - Big Sagebrush / Indian Ricegrass (35.200.02)
- Antelope Bitterbrush - Big Sagebrush - Round-leaf Snowberry (35.200.03)
- Antelope Bitterbrush / Nelson's Needlegrass (35.200.04)
- Antelope Bitterbrush / Sulphur-flower Buckwheat (35.200.05)
- Rubber Rabbitbrush Scrub (35.310.00)
- Parry Rabbitbrush Dwarf Scrub (35.320.00)
- Needle-leaved Rabbitbrush (35.330.00)
- Blackstem Rabbitbrush (35.340.00)

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

CES304.783 INTER-MOUNTAIN BASINS MAT SALTBUSH SHRUBLAND

Division 304, Shrubland

Spatial Scale & Pattern: Matrix

Classification Confidence: low

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, Dwarf-Shrub, Atriplex spp.

Non-Diagnostic Classifiers: Basin floor, Temperate [Temperate Continental], Oligotrophic Soil

Concept Summary: This ecological system occurs on gentle slopes and rolling plains in the northern Colorado Plateau and Uinta Basin on Mancos Shale and arid, wind-swept basins and plains across parts of Wyoming. Substrates are shallow, typically saline, alkaline, fine-textured soils developed from shale or alluvium and may be associated with shale badlands. Infiltration rate is typically low. These landscapes that typically support dwarf-shrublands composed of relatively pure stands of *Atriplex* spp. such as *Atriplex corrugata* or *Atriplex gardneri*. Other dominant or codominant dwarf-shrubs may include *Artemisia longifolia*, *Artemisia pedatifida*, or *Picrothamnus desertorum*, sometimes with a mix of other low shrubs such as *Krascheninnikovia lanata* or *Tetradymia spinosa*. *Atriplex confertifolia* or *Atriplex canescens* may be present, but do not codominate. The herbaceous layer is typically sparse. Scattered perennial forbs occur, such as *Xylorhiza glabriuscula* and *Sphaeralcea grossulariifolia*, and the perennial grasses *Achnatherum hymenoides*, *Bouteloua gracilis*, *Elymus elymoides*, *Elymus lanceolatus* ssp. *lanceolatus*, *Pascopyrum smithii*, or *Sporobolus airoides* may dominate the herbaceous layer. In less saline areas, there may be inclusions grasslands dominated by *Hesperostipa comata*, *Leymus salinus*, *Pascopyrum smithii*, or *Pseudoroegneria spicata*. In Wyoming and possibly elsewhere, inclusions of non-saline, gravelly barrens or rock outcrops dominated by cushion plants such as *Arenaria hookeri* and *Phlox hoodii* without dwarf-shrubs may be present. Annuals are seasonally present and may include *Eriogonum inflatum*, *Plantago tweedyi*, and the introduced annual grass *Bromus tectorum*.

DISTRIBUTION

Range: Occurs on gentle slopes and rolling plains in the northern Colorado Plateau and Uinta Basin on Mancos Shale and arid, wind-swept basins and plains across parts of Wyoming.

Ecological Divisions: 304

TNC Ecoregions: 10:C, 19:C

Subnations/Nations: AZ:c, CO:c, NM:c, UT:c, WY:c

CONCEPT**Alliances:**

- ATRIPLEX CORRUGATA DWARF-SHRUBLAND ALLIANCE (A.1109)
- ATRIPLEX CUNEATA SHRUBLAND ALLIANCE (A.871)
- ATRIPLEX GARDNERI DWARF-SHRUBLAND ALLIANCE (A.1110)

Environment: This ecological system occurs on gentle slopes and rolling plains in the northern Colorado Plateau and Uinta Basin on Mancos Shale and arid, wind-swept plains and basins across parts of Wyoming. Substrates are shallow, typically saline, alkaline, fine-textured soils developed from shale or alluvium and may be associated with shale badlands. Infiltration

rate is typically low. In Wyoming and possibly elsewhere inclusions of non-saline, gravelly barrens or rock outcrops may be present.

Vegetation: This ecological system typically supports dwarf-shrublands composed of relatively pure stands of *Atriplex* spp. such as *Atriplex corrugata* or *Atriplex gardneri*. Other dominant or codominant dwarf-shrub may include *Artemisia longifolia*, *Artemisia pedatifida*, or *Picrothamnus desertorum*, sometimes with a mix of other low shrubs such as *Krascheninnikovia lanata*, or *Tetradymia spinosa*. *Atriplex confertifolia* or *Atriplex canescens* may be present, but do not codominate. The herbaceous layer is typically sparse. Scattered perennial forbs occur, such as *Xylorhiza glabriuscula* and *Sphaeralcea grossulariifolia*, and the perennial grasses *Achnatherum hymenoides*, *Bouteloua gracilis*, *Elymus elymoides*, *Elymus lanceolatus ssp. lanceolatus*, *Pascopyrum smithii*, or *Sporobolus airoides* may dominate the herbaceous layer. In less saline areas, there may be inclusions grasslands dominated by *Hesperostipa comata*, *Leymus salinus*, *Pascopyrum smithii*, or *Pseudoroegneria spicata*. In Wyoming and possibly elsewhere, vegetation dominated by cushion plants such as *Arenaria hookeri*, *Phlox hoodii* without dwarf-shrubs may be present and occur on inclusions of non-saline, gravelly barrens or rock outcrops. Annuals are seasonally present and may include *Eriogonum inflatum*, *Plantago tweedyi*, and the introduced annual grass *Bromus tectorum*.

SOURCES

References: Branson et al. 1976, Knight 1994, Potter et al. 1985, Welsh 1957

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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.

Non-Diagnostic Classifiers: Basin floor, Temperate [Temperate Continental], Oligotrophic Soil

Concept Summary: 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*. Various forbs are also present.

DISTRIBUTION

Range: Intermountain western U.S., extending in limited distribution into the southern Great Plains.

Ecological Divisions: 303, 304, 306

TNC Ecoregions: 10:C, 11:C, 18:C, 19:C, 20:C, 21:C, 26:C, 27:C, 28:C, 4:?, 6:C, 8:?, 9:C

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

CONCEPT

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)
- PICTROTHAMNUS DESERTORUM SHRUBLAND ALLIANCE (A.1128)
- PLEURAPHIS JAMESII SHRUB HERBACEOUS ALLIANCE (A.1532)

• California community types:

- Fourwing Saltbush Scrub (36.310.00)
- Fourwing Saltbush (36.310.01)
- Shadscale - Fourwing Saltbush (36.320.06)
- Shadscale - Winter Fat (36.320.08)
- Spinescale Scrub (36.350.00)
- Great Valley Spinescale Scrub (36.351.00)
- Winter Fat dwarf scrub (36.500.00)

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*, *Psoralea 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* spp., *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).

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Shrubland (Shrub-dominated), Moss/Lichen (Nonvascular), Temperate [Temperate Continental], Aridic, Very Short Disturbance Interval, Broad-Leaved Shrub, Dwarf-Shrub, Semi-Shrub

Concept Summary: 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.

DISTRIBUTION

Range: Intermountain western U.S.

Ecological Divisions: 304, 306

TNC Ecoregions: 10:C, 11:C, 12:?, 18:C, 19:C, 20:C, 21:C, 6:P, 9:C

Subnations/Nations: AZ:c, CA:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, UT:c, WA:?, WY:c

CONCEPT

Alliances:

- ACHNATHERUM HYMENOIDES HERBACEOUS ALLIANCE (A.1262)
- ARTEMISIA BIGELOVII SHRUBLAND ALLIANCE (A.1103)
- ARTEMISIA PEDATIFIDA SHRUBLAND ALLIANCE (A.1127)
- ARTEMISIA PYGMAEA SHRUBLAND ALLIANCE (A.1106)
- ATRIPLEX CORRUGATA DWARF-SHRUBLAND ALLIANCE (A.1109)
- ATRIPLEX CUNEATA SHRUBLAND ALLIANCE (A.871)

- ATRIPLEX GARDNERI DWARF-SHRUBLAND ALLIANCE (A.1110)
- ATRIPLEX OBOVATA DWARF-SHRUBLAND ALLIANCE (A.1108)
- ERIOGONUM CORYMBOSUM DWARF-SHRUBLAND ALLIANCE (A.1126)
- LEYMUS SALINUS SSP. SALMONIS SPARSELY VEGETATED ALLIANCE (A.1258)
- PAINTED DESERT SPARSELY VEGETATED ALLIANCE (A.2545)
- PSEUDOROEGNERIA SPICATA SPARSELY VEGETATED ALLIANCE (A.1876)

SOURCES

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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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.

Non-Diagnostic Classifiers: Temperate [Temperate Continental], Alkaline Soil, Dwarf-Shrub

Concept Summary: 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.

DISTRIBUTION

Range: Throughout the basins of central and southern Wyoming.

Ecological Divisions: 304

TNC Ecoregions: 10:C

Subnations/Nations: CO:c, MT:c, WY:c

CONCEPT**Alliances:**

- ARTEMISIA NOVA SHRUBLAND ALLIANCE (A.1105)
- ARTEMISIA TRIPARTITA SSP. RUPICOLA SHRUB HERBACEOUS ALLIANCE (A.2556)

SOURCES

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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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*

Non-Diagnostic Classifiers: Lowland [Foothill], Woody-Herbaceous, Plain, Plateau, Sideslope, Temperate [Temperate Continental], Alkaline Soil, Forb, Graminoid

Concept Summary: 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.

DISTRIBUTION

Range: Occurs throughout much of the Columbia Plateau and northern Great Basin and Wyoming, and is found at slightly higher elevations further south.

Ecological Divisions: 304, 306

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

Subnations/Nations: CA:c, CO:c, ID:c, MT:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

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 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 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.

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

CES304.782 INTER-MOUNTAIN BASINS JUNIPER SAVANNA

Division 304, Steppe/Savanna

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Lowland [Foothill], Lowland [Lowland], Woody-Herbaceous, Ridge/Summit/Upper Slope, Sideslope, Toeslope/Valley Bottom, Calcareous

Concept Summary: This widespread ecological system occupies dry foothills and sandsheets of western Colorado, central 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 and plateaus, often on dry, rocky areas. The vegetation is typically open savanna, although there may be inclusions of more dense juniper woodlands. This savanna is dominated by *Juniperus osteosperma* trees with high cover of perennial bunch grasses and forbs, with *Bouteloua gracilis* and *Pleuraphis jamesii* being most common. Species of *Artemisia* are also commonly present. Pinyon trees are typically not present because sites are outside the ecological or geographic range of *Pinus edulis* and *Pinus monophylla*.

DISTRIBUTION

Range: Western Colorado, central Utah, west into the Great Basin of Nevada and southern Idaho at lower elevations, ranging from 1500-2300 m.

Ecological Divisions: 304, 306

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

Subnations/Nations: AZ:c, CA:c, CO:c, ID:c, NV:c, OR:c, UT:c, WY:c

CONCEPT**Alliances:**

- JUNIPERUS OSTEOSPERMA WOODED HERBACEOUS ALLIANCE (A.1502)
- JUNIPERUS OSTEOSPERMA WOODLAND ALLIANCE (A.536)
- JUNIPERUS SCOPULORUM WOODLAND ALLIANCE (A.506)

SOURCES

References: Knight 1994, Tuhy et al. 2002

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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

Non-Diagnostic Classifiers: Mountainside, Mountain valley, Plateau, Sideslope, Toeslope/Valley Bottom, Temperate [Temperate Continental], Long Disturbance Interval, F-Patch/Medium Intensity, Broad-Leaved Evergreen Shrub, Graminoid, Bunch grasses, *Artemisia tridentata* ssp. *vaseyana*

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. 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.

DISTRIBUTION

Range: 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.

Ecological Divisions: 304, 306

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

Subnations/Nations: AZ:?, CA:c, CO:c, ID:c, MT:c, NM:c, NV:p, OR:c, UT:c, WA:c, WY:c

CONCEPT**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 CANA (SSP. BOLANDERI, SSP. VISCIDULA) SHRUB HERBACEOUS ALLIANCE (A.1531)
- ARTEMISIA CANA (SSP. BOLANDERI, SSP. VISCIDULA) SHRUBLAND ALLIANCE (A.2557)
- 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)
- SYMPHORICARPOS OREOPHILUS SHRUBLAND ALLIANCE (A.2530)

• **California community types:**

- Wright's Buckwheat Dwarf Scrub (32.041.00)
- Big Sagebrush - Rubber Rabbitbrush (35.110.01)
- Low Sagebrush / Mono Clover (35.120.01)
- Low Sagebrush / Stemless Haplopappus (35.120.02)
- Rothrock Sagebrush Scrub (35.140.00)
- Rothrock Sagebrush / Heretic Penstemon (35.140.01)
- Rothrock Sagebrush / Mountain Monardella (35.140.02)
- Silver Sagebrush Scrub (35.150.00)

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.

SOURCES

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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, MCS

LeadResp: WCS

CES304.788 INTER-MOUNTAIN BASINS SEMI-DESERT SHRUB-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 [Foothill], Lowland [Lowland], Woody-Herbaceous, Temperate [Temperate Xeric], Alkaline Soil, Aridic, Very Short Disturbance Interval, G-Landscape/High Intensity, Graminoid

Non-Diagnostic Classifiers: Mechanical Disturbance, Broad-Leaved Evergreen Shrub, Xeromorphic Shrub, Thorn Shrub, Evergreen Sclerophyllous Shrub, Succulent Shrub, Dwarf-Shrub, Forb, Short (50-100 yrs) Persistence

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. This semi-arid shrub-steppe is typically dominated by graminoids (>25% cover) with an open shrub layer, but may include sparse shrublands without a strong graminoid layer. Characteristic grasses include *Achnatherum hymenoides*, *Bouteloua gracilis*, *Distichlis spicata*, *Hesperostipa comata*, *Pleuraphis jamesii*, *Poa secunda*, and *Sporobolus airoides*. The woody layer is often a mixture of shrubs and dwarf-shrubs. Characteristic species include *Atriplex canescens*, *Artemisia filifolia*, *Chrysothamnus Greenei*, *Chrysothamnus viscidiflorus*, *Ephedra cutleri*, *Ephedra nevadensis*, *Ephedra torreyana*, *Ephedra viridis*, *Ericameria nauseosa*, *Gutierrezia sarothrae*, and *Krascheninnikovia lanata*. *Artemisia tridentata* may be present but does not dominate. 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 occurrences.

DISTRIBUTION

Range: Occurs throughout the Intermountain western U.S., typically at lower elevations.

Ecological Divisions: 304

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

Subnations/Nations: AZ:c, CA:c, CO:c, ID:c, MT:p, NM:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

Alliances:

- ACHNATHERUM HYMENOIDES SHRUB HERBACEOUS ALLIANCE (A.1543)
- ACHNATHERUM SPECIOSUM SHRUB HERBACEOUS ALLIANCE (A.1549)
- ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE (A.816)
- BOUTELOUA ERIOPODA MICROPHYLOUS 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 SHRUB HERBACEOUS ALLIANCE (A.1524)
- EPHEDRA NEVADENSIS SHRUBLAND ALLIANCE (A.857)
- EPHEDRA TORREYANA SHRUBLAND ALLIANCE (A.2572)
- ERICAMERIA NAUSEOSA SHRUB SHORT HERBACEOUS ALLIANCE (A.1546)
- ERICAMERIA NAUSEOSA SHRUBLAND ALLIANCE (A.835)
- ERICAMERIA PARRYI SHRUBLAND ALLIANCE (A.818)
- GRAYIA SPINOSA SHRUBLAND ALLIANCE (A.1038)
- GUTIERREZIA SAROTHRAE DWARF-SHRUBLAND ALLIANCE (A.2528)
- KRASCHENINNIKOVIA LANATA DWARF-SHRUB HERBACEOUS ALLIANCE (A.1565)
- KRASCHENINNIKOVIA LANATA DWARF-SHRUBLAND ALLIANCE (A.1104)
- PLEURAPHIS JAMESII SHRUB HERBACEOUS ALLIANCE (A.1532)
- PLEURAPHIS RIGIDA / GUTIERREZIA SAROTHRAE SHRUB HERBACEOUS ALLIANCE (A.1529)
- POLIOMINTHA INCANA SHRUBLAND ALLIANCE (A.862)
- SPHAEROMERIA ARGENTEA HERBACEOUS ALLIANCE (A.1654)

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*.

SOURCES

References: Branson et al. 1976, Hanson 1929, Hironaka et al. 1983, Tuhy et al. 2002

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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

Non-Diagnostic Classifiers: Intermediate Disturbance Interval, F-Landscape/Medium Intensity, G-Landscape/Low Intensity, Forb, Moderate (100-500 yrs) Persistence

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) 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*.

DISTRIBUTION

Range: Occurs throughout the Intermountain western U.S. on dry plains and mesas, at approximately 1450 to 2320 m (4750-7610 feet) in elevation.

Ecological Divisions: 304, 306

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

Subnations/Nations: AZ:c, CA:c, CO:c, ID:c, MT:p, NM:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

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)
- 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 MONTANA HERBACEOUS ALLIANCE (A.1260)
- PLEURAPHIS JAMESII HERBACEOUS ALLIANCE (A.1287)
- PLEURAPHIS JAMESII SHRUB HERBACEOUS ALLIANCE (A.1532)
- 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 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)

• **California community types:**

- Needle-and-thread (41.130.00)
- Great Basin Grassland (41.300.00)
- Little Galleta Grassland (41.610.00)
- Little Galleta - California Buckwheat (41.610.01)
- Little Galleta - Anderson's Wolfberry (41.610.02)
- Little Galleta - Nevada Ephedra (41.610.03)

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.

SOURCES

References: 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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

CES304.764 COLORADO PLATEAU HANGING GARDEN

Division 304, Herbaceous Wetland

Spatial Scale & Pattern: Small Patch**Classification Confidence:** medium**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Wetland**Diagnostic Classifiers:** Montane [Montane], Montane [Lower Montane], Cliff (Landform), Cliff (Substrate), Sedimentary Rock, Temperate [Temperate Xeric], Forb, Graminoid, Fern, Seepage-Fed Sloping, Saturated Soil**Non-Diagnostic Classifiers:** Herbaceous

Concept Summary: Hanging gardens in the Colorado Plateau region are surrounded by an arid environment and associated with canyon country. These highly localized environments include canyonlands with perennial water sources (seeps) forming pocketed wetlands and draping vegetation across wet cliff faces. Three main garden types exist: alcove, terrace, or windowblind. Each is determined by the nature of the geological formation and the presence or absence of joint systems. They tend to occur at all exposures of the canyon walls, but they are always shaded for much to most of each day. Temperature and humidity are relatively stable compared to the surrounding environment. Most hanging gardens are dominated by herbaceous plants, and a number of these are endemic to this region. Common species include *Adiantum capillus-veneris*, *Adiantum pedatum*, *Mimulus eastwoodiae*, *Mimulus guttatus*, *Sullivantia hapemanii*, *Cirsium rydbergii*, and several species of *Aquilegia*.

DISTRIBUTION**Range:** Colorado Plateau.**Ecological Divisions:** 304**TNC Ecoregions:** 19:C**Subnations/Nations:** AZ:c, CO:c, UT:c**CONCEPT****Alliances:**

- AQUILEGIA MICRANTHA SATURATED HANGING GARDEN HERBACEOUS ALLIANCE (A.2506)

Environment: Hanging gardens in the Colorado Plateau ecoregion are surrounded by an arid environment and associated with canyon country. Annual precipitation is low and varies from 5 to 14 inches. While mean annual temperatures are high, extreme temperatures are probably more important than means to the survival of plants. Summer temperatures greater than 100 degrees F are common. Complexity of the plant community within a hanging garden is a function of the quantity and quality of water, developmental aspects, and accessibility of plant species to it. They tend to occur at all exposures of the canyon walls, but they are always shaded for much to most of each day. Temperature and humidity are relatively stable compared to the surrounding environment. They vary in size, aspect, exposure to the elements, water quantity and quality, number of bedding planes, and amount of light received. Water quality, in some degree, controls the kinds of plants in hanging gardens. Quality of water is dictated by the nature of the formations through which the water passes. Water is often drinkable quality, however, water may be saline or laden with calcium, which results in tufa deposits in the gardens. Generally, however, water from the gardens is potable.

In the Colorado Plateau region, three main garden types exist: alcove, terrace, or windowblind. Each is determined by the nature of the geological formation and the presence or absence of joint systems. In general, the hanging gardens are the result of the ancient swales or valleys in a sand dune-swale system that developed between the Cretaceous and Pennsylvanian periods (65-310 mya). Massive sandstones seem to be best suited for alcove development coincidental with garden formation, some better than others. The formations with greatest development are the Navajo and Entrada, both of them cross-bedded, massive formations composed of wind-blown sand and containing ancient pond bottoms that serve as impervious bedding planes. The Wingate Formation lacks significant hanging gardens. The sands of formations suitable for hanging garden development were deposited mainly on lands, as dunes with interdunal valleys. The interdunal valleys were often the sites of lakes, whose bottoms were made impervious by accumulations of dust and other fine particles. Turned to stone, the ancient lake and pond basins continue to exist within the strata. Water percolating through the porous rock encounters the ancient bedding planes, still impervious and capable of holding water. When filled to overflowing, these bedding planes carry the water downward to the next bedding plane beneath or to another impervious stratum at the base of the formation. Joint systems within the rock act as passageways for water. Where the joint systems are exposed along canyon walls the water flows over the moist surfaces.

In the Utah High Plateaus, the hanging garden ecological system is associated with springs, seeps and waterfalls. The waterfall vegetation grows in the cracks behind and beside the waterfall and is best described as hanging gardens. In the seeps adjacent to waterfalls and in the splash zones at the base of waterfalls, the substrate is saturated during most of the

growing season. The vegetation is continually wet, at least near the bases of the plants, and water can very commonly be seen dripping from leaves, exposed roots and old stems. Suitable growing sites are limited on the steep rock walls such that each of the available ledges has an abundance of plants which grow on it. Most of the hanging gardens in the Utah High Plateaus are associated with calcareous shales of the Green River Formation. Although large occurrences of hanging gardens are primarily associated with waterfalls, smaller occurrences occur along cliff seeps above the streams, especially in the Roan Plateau area.

Vegetation: The vegetation of hanging gardens is often comprised of few species, although the diversity of vegetation is much greater in the gardens on the Colorado Plateau versus those of the Utah High Plateaus. The vegetation may overlap with the nearby riparian vegetation, but there are a series of species that are unique to hanging gardens (Welsh 1989). Several species of algae are restricted to these hanging gardens. The classic alcove type of hanging garden in the Canyonlands of southeastern Utah consists of an overhanging back wall, a vaulted face wall, a detrital slope, and a plunge basin. The back and face walls support clinging plants of *Adiantum capillus-veneris*, *Primula specuicola*, *Mimulus eastwoodiae*, *Petrophyton caespitosum*, and several other species. The wet, sandy detritus supports *Carex aurea*, *Aquilegia micrantha*, *Calamagrostis scopulorum*, *Epipactis gigantea*, *Perityle specuicola*, *Dichanthelium acuminatum* (= *Panicum acuminatum*), *Cirsium rydbergii*, and *Zigadenus vaginatus*. A fringing margin of *Cercis canadensis* var. *texensis* (= *Cercis occidentalis*), *Celtis laevigata* var. *reticulata* (= *Celtis reticulata*), and *Quercus gambelii* often occurs outward from the footslope where the plants tend to conceal the alcove base. The outer and drier edges support grasses typical of the prairies and plains of the western U.S. In the Utah High Plateaus gardens, the dominants are usually *Sullivantia hapemanii* var. *purpusii* and *Aquilegia barnebyi* with *Mimulus guttatus* common.

Variation in hanging garden vegetation varies from canyon to canyon as well as separate alcoves within a canyon. The vegetation of hanging gardens generally has some common species that are found at most of the hanging gardens, e.g., *Maianthemum stellatum*, *Adiantum capillus-veneris*, *Adiantum pedatum*, and *Mimulus* spp. But numerous endemics occur of which some may be represented by just one or two sites. The following species are endemic to hanging gardens of the Colorado Plateau region: *Aquilegia micrantha*, *Carex curatorum*, *Cirsium rydbergii*, *Erigeron kachinensis* (one occurrence outside of hanging gardens in the Abajo Mountains), *Erigeron sionis*, *Erigeron zothecinus*, *Platanthera zothecina* (= *Habenaria zothecina*), *Mimulus eastwoodiae*, *Perityle specuicola*, and *Primula specuicola*.

SOURCES

References: Malanson 1980, Malanson 1982, Malanson and Kay 1980, Romme et al. 1993, Tuhy et al. 2002, Welsh 1989, Welsh and Toft 1981

Last updated: 20 Feb 2003

Stakeholders: WCS

Concept Author: NatureServe Western Ecology Team; R. Rondeau

LeadResp: WCS

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

Non-Diagnostic Classifiers: Alluvial flat, Alluvial plain, Alluvial terrace, Temperate [Temperate Continental], Saline Substrate Chemistry, *Sarcobatus vermiculatus*, Riverine / Alluvial, Deep (>15 cm) Water

Concept Summary: 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.

DISTRIBUTION

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

Ecological Divisions: 303, 304

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

Subnations/Nations: AZ:c, CA:c, CO:c, ID:c, MT:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT**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)

California community types:

- Greasewood - Shadscale (36.320.01)
- Greasewood - Saltgrass (41.200.03)

SOURCES

References: Knight 1994, West 1983b

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, MCS

LeadResp: WCS

CES304.765 COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND

Division 304, Barren

Spatial Scale & Pattern: Matrix

Classification Confidence: low

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

Diagnostic Classifiers: Montane [Lower Montane], Lowland [Foothill], Shrubland (Shrub-dominated), Ridge/Summit/Upper Slope, Sedimentary Rock, Temperate [Temperate Xeric], Alkaline Soil, Aridic

Non-Diagnostic Classifiers: Moss/Lichen (Nonvascular), Cliff (Substrate), Talus (Substrate)

Concept Summary: The distribution of this ecological system is centered on the Colorado Plateau where it is comprised of barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and open tablelands of predominantly sedimentary rocks, such as sandstone, shale, and limestone. Some eroding shale layers similar to Inter-Mountain Basins Shale Badland (CES304.789) may be interbedded between the harder rocks. The vegetation is characterized by very open tree canopy or scattered trees and shrubs with a sparse herbaceous layer. Common species includes *Pinus edulis*, *Pinus ponderosa*, *Juniperus* spp., *Cercocarpus intricatus*, and other short-shrub and herbaceous species, utilizing moisture from cracks and pockets where soil accumulates.

Comments: Geographically restricted and distinct from the related, but broader Inter-Mountain Basins Cliff and Canyon (CES304.779). Shale areas are not extensive as in shale badlands.

DISTRIBUTION

Range: Colorado Plateau.

Ecological Divisions: 304

TNC Ecoregions: 18:C, 19:C, 20:?

Subnations/Nations: AZ:c, CO:c, NM:c, UT:c

CONCEPT**Alliances:**

- CERCOCARPUS INTRICATUS SPARSELY VEGETATED ALLIANCE (A.2543)
- CERCOCARPUS MONTANUS SPARSELY VEGETATED ALLIANCE (A.2544)
- EPHEDRA TORREYANA SPARSELY VEGETATED ALLIANCE (A.2571)
- JUNIPERUS OSTEOSPERMA WOODLAND ALLIANCE (A.536)
- PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516)
- SANDSTONE SPARSELY VEGETATED ALLIANCE (A.2568)
- WOODED BEDROCK SPARSELY VEGETATED ALLIANCE (A.2546)

Environment: This system includes limestone escarpments and plateaus occurring in a relatively narrow band of unvegetated or sparsely vegetated badlands formed by the red beds of Claron (Wasatch) Formation along the eastern edge of the Pausaugunt Plateau (Bryce Canyon) and the western edge of the Markagunt Plateau (Cedar Breaks National Monument)

(Graybosch and Buchanan 1983). It includes areas of which often 90% of the exposed surface consists of barren rock. It forms, or includes, areas of fixed bedrock forming the vertical or near-vertical parts on the plateau faces. The rocks forming such areas are predominantly limestone-capped plateaus. These areas are highly erodible and form the basic scenic structure of Bryce Canyon and Cedar Breaks national parks. The area is generally too steep to allow any significant soil development. Scattered plants obtain a precarious foothold in the crevices of the rocks. Knolls may form at the base of the cliffs.

This ecological system also includes sandstone and shale escarpments, which form, or include, areas of fixed bedrock forming the vertical or near-vertical parts of canyon walls and plateau faces. The scenic cliffs of the East Tavaputs area, e.g., the Book Cliffs are excellent examples of this. The rocks forming such areas are dominantly sandstone and shale with some limestone and marlstone. These areas are unstable and rocks are frequently rolling down onto the talus slopes below (often forming Inter-Mountain Basins Shale Badland (CES304.789)). The area is generally too steep to allow any significant soil development. Scattered plants obtain a precarious foothold in the crevices of the rocks. Knolls may form at the base of the cliffs. The larger drainages (e.g., East Fork Parachute Creek) plunge several hundred feet at this escarpment, which creates scenic and lush hanging gardens. Many of these escarpments are over 1000 feet in height and provide excellent habitat for cliff-nesting birds such as peregrine falcons and golden eagles.

The Claron limestone, a Tertiary deposit, is divisible into Red Eocene beds and White Oligocene beds, which differ somewhat in presence or absence of pigmentation in the form of iron and manganese oxides, and in amounts of sand and conglomerates in the limestone (Graybosch and Buchanan 1983). The Claron Formation is characterized by a rapid rate of erosion, largely a function of creep resulting from winter freeze-thaw activity and wash away by summer thunderstorm runoff (Graybosch and Buchanan 1983). Freeze-thaw cycles are most pronounced on south-facing slopes. Soil development is limited. Infiltration rates are low and runoff high.

Vegetation: For the most part, this system is sparsely vegetated. Small patches of scattered trees and shrubs may occur. These small vegetated patches are usually dominated by conifer trees, and may include *Abies concolor*, *Juniperus scopulorum*, *Picea pungens*, *Pinus flexilis*, *Pinus longaeva*, *Pinus ponderosa*, and *Pseudotsuga menziesii*. If a shrub layer exists it may include *Acer glabrum*, *Amelanchier utahensis*, *Arctostaphylos patula*, *Ceanothus martinii*, *Cercocarpus montanus*, *Cercocarpus intricatus*, *Juniperus communis*, *Mahonia repens*, *Purshia tridentata*, *Ribes cereum*, and *Gutierrezia sarothrae*. Grasses and forbs, if present, may include *Astragalus kentrophyta*, *Cirsium arizonicum*, *Clematis columbiana*, *Leymus salinus*, *Eriogonum panguicense*, *Achnatherum hymenoides*, and *Linum kingii*.

This ecological system is noted for its high rate of endemic species of forbs, especially in Bryce Canyon. Nine of the eleven endemic species occur in the *Pinus longaeva* community, three are found in the *Pinus ponderosa* - *Arctostaphylos patula* plant association, and two occur in the mixed conifer type. Species that occur only in the *Pinus longaeva* type have the narrowest geographic distributions, although *Eriogonum panguicense* var. *panguicense* is an exception (Graybosch and Buchanan 1983). Within Bryce Canyon, most of these endemics are restricted to the Claron Formation (Graybosch and Buchanan 1983). The majority of endemic species found in southern Utah are restricted to substrates derived from a specific geologic formation (Welsh 1979). Welsh notes that most of these taxa are found in areas of exposed parent material. The distribution of endemic species in Utah is not a random one; fine-textured substrates support more species than coarser ones, and desert and foothill vegetation is richer in endemic species than montane communities (Welsh 1978, 1979).

Dynamics: This ecological system has a naturally high rate of erosion. Fires are infrequent and not an important ecological process.

SOURCES

References: Graybosch and Buchanan 1983, Shute and West 1977, Thorne Ecological Institute 1973a

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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

Non-Diagnostic Classifiers: Lowland [Lowland], Shrubland (Shrub-dominated), Woody-Herbaceous, Dune (undifferentiated)

Concept Summary: 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*, *Psoraleum lanceolatum*, *Purshia tridentata*, *Sporobolus airoides*, *Tetradymia tetrameres*, or *Tiquilia* spp.

DISTRIBUTION

Range: Occurs in the Intermountain basins.

Ecological Divisions: 304

TNC Ecoregions: 10:C, 11:C, 19:C, 6:C

Subnations/Nations: AZ:c, MT:c, NM:p, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

Alliances:

- ACHNATHERUM HYMENOIDES HERBACEOUS ALLIANCE (A.1262)
- ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE (A.816)
- ELYMUS LANCEOLATUS HERBACEOUS ALLIANCE (A.1242)
- 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)
- REDFIELDIA FLEXUOSA HERBACEOUS ALLIANCE (A.2505)
- ROCK OUTCROP SPARSELY VEGETATED ALLIANCE (A.1838)
- SARCOBATUS VERMICULATUS SHRUBLAND ALLIANCE (A.1041)
- TETRADYMIA TETRAMERES SPARSELY VEGETATED ALLIANCE (A.2525)

SOURCES

References: Bowers 1982, Knight 1994

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Upper Montane], Montane [Montane], Montane [Lower Montane], Lowland [Foothill], Lowland [Lowland], Canyon, Rockfall avalanche, Ridge/Summit/Upper Slope, Sideslope, Toeslope/Valley Bottom, Sedimentary Rock, Metamorphic Rock, Igneous Rock, Temperate [Temperate Continental], Very Shallow Soil

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 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.

DISTRIBUTION

Ecological Divisions: 304

TNC Ecoregions: 11:C, 18:C, 4:?, 6:C

Subnations/Nations: CA:c, ID:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

Alliances:

- CERCOCARPUS INTRICATUS SPARSELY VEGETATED ALLIANCE (A.2543)

- CERCOCARPUS MONTANUS SPARSELY VEGETATED ALLIANCE (A.2544)
- CRATAEGUS RIVULARIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.2597)
- GLOSSOPETALON SPINESCENS SHRUBLAND ALLIANCE (A.1032)
- JUNIPERUS OSTEOSPERMA WOODLAND ALLIANCE (A.536)
- LEYMUS SALINUS SSP. SALMONIS SPARSELY VEGETATED ALLIANCE (A.1258)
- PINUS MONOPHYLLA - (JUNIPERUS OSTEOSPERMA) WOODLAND ALLIANCE (A.543)
- WOODED BEDROCK SPARSELY VEGETATED ALLIANCE (A.2546)

SOURCES**References:** Knight 1994**Last updated:** 20 Feb 2003**Concept Author:** NatureServe Western Ecology Team**Stakeholders:** WCS, MCS**LeadResp:** WCS**CES304.781 INTER-MOUNTAIN BASINS GREASEWOOD WASH**

Division 304, Barren

Spatial Scale & Pattern: Linear**Classification Confidence:** medium**Required Classifiers:** Natural/Semi-natural, Non-vegetated (<10% vasc.), Upland, Wetland**Diagnostic Classifiers:** Lowland [Lowland], Shrubland (Shrub-dominated), Wash, Toeslope/Valley Bottom, Alkaline Soil, Xeromorphic Shrub, Sarcobatus vermiculatus, Riverine / Alluvial**Non-Diagnostic Classifiers:** Temperate [Temperate Continental], Saline Substrate Chemistry, Deep (>15 cm) Water

Concept Summary: This barren and sparsely vegetated (generally <10% plant cover) ecological system is restricted to intermittently flooded streambeds lined with *Sarcobatus vermiculatus* and/or *Artemisia cana ssp. cana* in more northern and mesic stands. Shrubs often 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 southwest Great Plains.

Comments: Compare with Inter-Mountain Basins Greasewood Flat (CES304.780); should it include nonsparse shrublands?**DISTRIBUTION****Ecological Divisions:** 303, 304, 306**TNC Ecoregions:** 10:C, 11:C, 19:C, 20:C, 26:C, 4:C, 6:C, 8:C, 9:C**Subnations/Nations:** AZ:c, CA:c, CO:c, ID:c, MT:c, NV:c, OR:c, UT:c, WA:c, WY:c**CONCEPT****Alliances:**

- DISTICHLIS SPICATA INTERMITTENTLY FLOODED HERBACEOUS ALLIANCE (A.1332)
- HORDEUM BRACHYANTHERUM TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.2585)
- 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)

• California community types:

- Greasewood Scrub (36.400.00)

SOURCES**References:** Knight 1994, West 1983b**Last updated:** 20 Feb 2003**Concept Author:** NatureServe Western Ecology Team**Stakeholders:** WCS, MCS**LeadResp:** WCS**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

Non-Diagnostic Classifiers: Shrubland (Shrub-dominated), Herbaceous, Dwarf-Shrub, Forb, Graminoid, Clay Subsoil Texture

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 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.

DISTRIBUTION

Range: Intermountain western U.S.

Ecological Divisions: 304

TNC Ecoregions: 10:C, 11:C, 19:C, 6:C

Subnations/Nations: CA:c, CO:c, ID:c, NV:c, OR:c, UT:c, WA:p, WY:c

CONCEPT

Alliances:

- (SARCOCORNIA UTAHENSIS) - (ARTHROCNEUM 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)
- GRAYIA SPINOSA SHRUBLAND ALLIANCE (A.1038)
- 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)

SOURCES

References: Knight 1994, Nachlinger et al. 2001

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Cirque headwall, Glaciated uplands, Moraine, Mountainside, Temperate [Temperate Continental], Glaciated, Mesotrophic Soil, Shallow Soil, Ustic

Concept Summary: 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.

DISTRIBUTION

Range: Northern Rocky Mountains.

Ecological Divisions: 204, 306

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

Subnations/Nations: AB:c, BC:c, ID:p, MT:c, WA:c, WY:c

CONCEPT

Alliances:

- ABIES LASIOPARPA - PINUS ALBICAULIS WOODLAND ALLIANCE (A.560)
- ABIES LASIOPARPA FOREST ALLIANCE (A.168)
- ABIES LASIOPARPA KRUMMHOLZ SHRUBLAND ALLIANCE (A.811)
- PINUS ALBICAULIS FOREST ALLIANCE (A.132)
- PINUS ALBICAULIS WOODLAND ALLIANCE (A.531)

SOURCES

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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, CAN

LeadResp: WCS

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*

Non-Diagnostic Classifiers: Montane [Upper Montane], Montane [Montane], Temperate [Temperate Continental], Mesotrophic Soil, Shallow Soil, Mineral: W/ A-Horizon <10 cm, Ustic

Concept Summary: 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.

DISTRIBUTION

Range: 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.

Ecological Divisions: 204, 206, 304, 306

TNC Ecoregions: 1:P, 11:C, 12:P, 18:C, 19:C, 20:C, 21:P, 25:C, 3:C, 4:P, 5:P, 7:C, 8:C, 81:P, 9:C

Subnations/Nations: AB:c, AZ:c, BC:c, CA:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, SD:c, UT:c, WA:c, WY:c

CONCEPT

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). Secondly, 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*, *Heraclium 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).

SOURCES

References: Bartos and Cambell 1998, 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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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*

Non-Diagnostic Classifiers: Montane [Lower Montane], Escarpment, Hillslope bedrock outcrop, Ridgetop bedrock outcrop, Ridge/Summit/Upper Slope, Sideslope, Temperate [Temperate Continental], Loam Soil Texture

Concept Summary: 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.

DISTRIBUTION

Range: 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.

Ecological Divisions: 303, 306

TNC Ecoregions: 10:C, 20:C, 25:P, 26:C, 27:C, 8:C, 9:C

Subnations/Nations: CO:c, MT:c, ND:p, SD:p, WY:c

CONCEPT

Alliances:

- JUNIPERUS OSTEOSPERMA WOODLAND ALLIANCE (A.536)
- JUNIPERUS SCOPULORUM TEMPORARILY FLOODED WOODLAND ALLIANCE (A.563)
- JUNIPERUS SCOPULORUM WOODLAND ALLIANCE (A.506)
- KRASCHENINNIKOVIA LANATA DWARF-SHRUBLAND ALLIANCE (A.1104)
- PINUS FLEXILIS WOODLAND ALLIANCE (A.540)

SOURCES

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

Last updated: 20 Mar 2003

Concept Author: G. Jones, K. Schulz

Stakeholders: WCS, CAN

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Upper Montane], Montane [Montane], Forest and Woodland (Treed), Sideslope, Toeslope/Valley Bottom, Temperate [Temperate Continental]

Concept Summary: 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.

DISTRIBUTION

Range: Upper montane to subalpine elevations of the Rocky Mountains, Intermountain region, and north into the Canadian Rockies.

Ecological Divisions: 304, 306

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

Subnations/Nations: AB:c, BC:c, CO:c, ID:c, MT:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT**Alliances:**

- CEANOTHUS VELUTINUS SHRUBLAND ALLIANCE (A.787)
- 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.

SOURCES

References: Alexander 1986, Alexander et al. 1987, 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, 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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Ridge/Summit/Upper Slope, Sideslope, Temperate [Temperate Continental], Mesotrophic Soil, Shallow Soil, Mineral: W/ A-Horizon <10 cm

Concept Summary: 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.

DISTRIBUTION

Range: Occurs throughout the southern Rockies, north and west into Utah, Nevada, western Wyoming and Idaho.

Ecological Divisions: 304, 306

TNC Ecoregions: 11:C, 18:C, 19:C, 20:C, 21:C, 26:C, 6:C, 68:C, 7:C, 8:C, 9:C

Subnations/Nations: AB:p, AZ:c, BC:p, CO:c, ID:c, MT:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

Alliances:

- ABIES CONCOLOR FOREST ALLIANCE (A.152)
- ABIES CONCOLOR WOODLAND ALLIANCE (A.553)
- PICEA PUNGENS FOREST ALLIANCE (A.165)
- PICEA PUNGENS WOODLAND ALLIANCE (A.557)
- 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)

Vegetation: This highly variable ecological system is comprised of mixed conifer forests at montane elevations throughout the Intermountain region. The four main alliances in this system are found on slightly different, but intermingled, biophysical environments: *Abies concolor* dominates at higher, colder locations; *Picea pungens* represents mesic conditions; *Pseudotsuga menziesii* dominates intermediate zones. As many as seven conifers can be found growing in the same occurrences, with the successful reproduction of the diagnostic species determining the association type. Common conifers include *Pinus ponderosa*, *Pinus flexilis*, *Abies lasiocarpa* var. *lasiocarpa*, *Abies lasiocarpa* var. *arizonica*, *Juniperus scopulorum*, and *Picea engelmannii*. *Populus tremuloides* is often present as intermingled individuals in remnant aspen clones, or in adjacent patches. The composition and structure of overstory is dependent upon the temperature and moisture relationships of the site, and the successional status of the occurrence (DeVelice et al. 1986, Muldavin et al. 1996).

A number of cold-deciduous shrub and graminoid species are found in many occurrences (e.g., *Arctostaphylos uva-ursi*, *Mahonia repens*, *Paxistima myrsinites*, *Symphoricarpos oreophilus*, *Jamesia americana*, *Quercus gambelii*, and *Festuca arizonica*). Other important species include *Acer glabrum*, *Acer grandidentatum*, *Amelanchier alnifolia*, *Arctostaphylos patula*, *Holodiscus dumosus*, *Jamesia americana*, *Juniperus communis*, *Physocarpus monogynus*, *Quercus arizonica*, *Quercus rugosa*, *Quercus X pauciloba*, *Quercus hypoleucoides*, *Robinia neomexicana*, *Rubus parviflorus*, and *Vaccinium myrtilloides*. Where soil moisture is favorable, the herbaceous layer may be quite diverse, including graminoids *Bromus ciliatus* (= *Bromus canadensis*), *Calamagrostis rubescens*, *Carex geyeri*, *Carex rossii*, *Carex siccata* (= *Carex foenea*), *Festuca occidentalis*, *Koeleria macrantha*, *Muhlenbergia montana*, *Muhlenbergia virescens*, *Poa fendleriana*, *Pseudoroegneria spicata*, and forbs *Achillea millefolium*, *Arnica cordifolia*, *Erigeron eximius*, *Fragaria virginiana*, *Linnaea borealis*, *Luzula parviflora*, *Osmorhiza berteroi*, *Packera cardamine* (= *Senecio cardamine*), *Thalictrum occidentale*, *Thalictrum fendleri*, *Thermopsis rhombifolia*, *Viola adunca*, and species of many other genera, including *Lathyrus*, *Penstemon*, *Lupinus*, *Vicia*, *Arenaria*, *Galium*, and others.

Dynamics: Forests in this ecological system represent the gamut of fire tolerance. Formerly, *Abies concolor* in the Utah High Plateaus were restricted to rather moist or less fire-prone areas by frequent ground fires. These areas experienced mixed fire severities, with patches of crowning in which all trees are killed, intermingled with patches of underburn in which larger *Abies concolor* survived (www.fs.fed.us/database/feis/). With fire suppression, *Abies concolor* has vigorously colonized many sites formerly occupied by open *Pinus ponderosa* woodlands. These invasions have dramatically changed the fuel load and potential behavior of fire in these forests. In particular, the potential for high-intensity crown fires on drier sites now codominated by *Pinus ponderosa* and *Abies concolor* has increased. Increased landscape connectivity, in terms of fuel loadings and crown closure, has also increased the potential size of crown fires.

Pseudotsuga menziesii forests are the only true 'fire-tolerant' occurrences in this ecological system. *Pseudotsuga menziesii* forests were probably subject to a moderate-severity fire regime in presettlement times, with fire-return intervals of 30-100 years. Many of the important tree species in these forests are fire-adapted (*Populus tremuloides*, *Pinus ponderosa*, *Pinus contorta*) (Pfister et al. 1977), and fire-induced reproduction of *Pinus ponderosa* can result in its continued codominance in *Pseudotsuga menziesii* forests (Steele et al. 1981). Seeds of the shrub *Ceanothus velutinus* can remain dormant in forest occurrences for 200 years (Steele et al. 1981) and germinate abundantly after fire, competitively suppressing conifer seedlings. Successional relationships in this system are complex. *Pseudotsuga menziesii* is less shade-tolerant than many northern or montane trees such as *Tsuga heterophylla*, *Abies concolor*, *Picea engelmannii*, and seedlings compete poorly in deep shade. At drier locales, seedlings may be favored by moderate shading, such as by a canopy of *Pinus ponderosa*, which helps to minimize drought stress. In some locations, much of these forests have been logged or burned during European settlement, and present-day occurrences are second-growth forests dating from fire, logging, or other occurrence-replacing disturbances (Mauk and Henderson 1984, Chappell et al. 1997).

Picea pungens is a slow-growing, long-lived tree which regenerates from seed (Burns and Honkala 1990a). Seedlings are shallow-rooted and require perennially moist soils for establishment and optimal growth. *Picea pungens* is intermediate in shade tolerance, being somewhat more tolerant than *Pinus ponderosa* or *Pseudotsuga menziesii*, and less tolerant than *Abies lasiocarpa* or *Picea engelmannii*. It forms late-seral occurrences in the subhumid regions of the Utah High Plateaus. It is common for these forests to be heavily disturbed by grazing or fire.

In general, fire suppression has led to the encroachment of more shade-tolerant, less fire-tolerant species (e.g., climax) into occurrences and an attendant increase in landscape homogeneity and connectivity (from a fuels perspective). This has increased the lethality and potential size of fires.

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Montane], Montane [Lower Montane], Temperate [Temperate Continental], Shallow Soil, Mineral: W/ A-Horizon <10 cm, Moderate (100-500 yrs) Persistence

Concept Summary: 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.

DISTRIBUTION

Range: 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.

Ecological Divisions: 304, 306

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

Subnations/Nations: AB:p, AZ:c, BC:p, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

Alliances:

- ABIES CONCOLOR FOREST ALLIANCE (A.152)
- ABIES CONCOLOR WOODLAND ALLIANCE (A.553)
- PICEA PUNGENS FOREST ALLIANCE (A.165)
- PICEA PUNGENS TEMPORARILY FLOODED WOODLAND ALLIANCE (A.567)
- PICEA PUNGENS WOODLAND ALLIANCE (A.557)
- PSEUDOTSUGA MENZIESII FOREST ALLIANCE (A.157)
- PSEUDOTSUGA MENZIESII TEMPORARILY FLOODED WOODLAND ALLIANCE (A.568)

SOURCES

References: Alexander et al. 1984a, Alexander et al. 1984b, Alexander et al. 1987, Boyce 1977, Bunin 1975c, Comer et al. 2002, Cooper et al. 1987, DeVelice et al. 1986, 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, Komarkova et al. 1988b, Mauk and Henderson 1984, Moir and Ludwig 1979, Nachlinger et al. 2001, Neely et al. 2001, Pfister 1972, Tuhy et al. 2002, Youngblood and Mauk 1985

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Montane], Montane [Lower Montane], Forest and Woodland (Treed), Temperate [Temperate Continental], Circumneutral Soil, F-Landscape/Low Intensity, Short (50-100 yrs) Persistence

Concept Summary: 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.

DISTRIBUTION

Range: Throughout the cordillera of the Rocky Mountains, Colorado Plateau region, west into scattered locations in the Great Basin, and north into southern British Columbia.

Ecological Divisions: 204, 303, 304, 306

TNC Ecoregions: 10:C, 11:C, 18:C, 19:C, 20:C, 21:C, 25:C, 26:?, 33:?, 4:C, 6:C, 68:C, 7:C, 8:C, 9:C

Subnations/Nations: AB:c, AZ:c, BC:c, CO:c, ID:c, MT:c, ND:c, NE:?, NM:c, NV:c, OR:c, SD:c, UT:c, WA:c, WY:c

CONCEPT**Alliances:**

- PINUS PONDEROSA FOREST ALLIANCE (A.124)
- PINUS PONDEROSA WOODLAND ALLIANCE (A.530)

Environment: This ecological system within the region occurs at the lower treeline/ecotone between grassland or shrubland and more mesic coniferous forests typically in warm, dry, exposed sites at elevations ranging from 1980-2800 m. (6500-9200 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 igneous, metamorphic, and sedimentary material derived soils, including basalt, basaltic, andesitic flows, intrusive granitoids and porphyrites, and tuffs (Youngblood and Mauk 1985). Characteristic soil features include good aeration and drainage, coarse textures, circumneutral to slightly acid 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. *Pinus ponderosa* / *Arctostaphylos patula* represents the extreme with typically a high percentage of rock and bare soil present.

Precipitation generally contributes 25-60 cm annually to this system, mostly through winter storms and some monsoonal summer rains. Typically a seasonal drought period occurs throughout this system as well. Fire plays an important role in maintaining the characteristics of these open canopy woodlands. However, soil infertility and drought may contribute significantly in some areas as well.

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 (5-15 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 crown fires, 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).

Mehl (1992) states the following: "Where fire has been present, occurrences will be climax and contain groups of large, old trees with little understory vegetation or down woody material and few occurring dead trees. The age difference of the groups of trees would be large. Where fire is less frequent there will also be smaller size trees in the understory giving the occurrence some structure with various canopy layers. Dead, down material will be present in varying amounts along with some occurring dead trees. In both cases the large old trees will have irregular open, large branched crowns. The bark will be lighter in color, almost yellow, thick and some will like have basal fire scars."

Grace's warbler, 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).

SOURCES

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, Rondeau 2001, Tuhy et al. 2002, Youngblood and Mauk 1985

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Montane], Ridge/Summit/Upper Slope, Sideslope, Temperate [Temperate Continental], Mesotrophic Soil, Shallow Soil, Mineral: W/ A-Horizon >10 cm, W-Patch/Medium Intensity, W-Landscape/Low Intensity

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 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.

DISTRIBUTION

Range: Cascades and Rocky Mountains from southern British Columbia east into Alberta, south into New Mexico and the Intermountain region.

Ecological Divisions: 304, 306

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

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

CONCEPT

Alliances:

- ABIES LASIOCARPA FOREST ALLIANCE (A.168)
- ABIES LASIOCARPA KRUMMHOLZ SHRUBLAND ALLIANCE (A.811)
- ABIES LASIOCARPA WOODLAND ALLIANCE (A.559)
- PICEA ENGELMANNII FOREST ALLIANCE (A.164)
- PICEA ENGELMANNII SEASONALLY FLOODED FOREST ALLIANCE (A.191)
- PICEA ENGELMANNII TEMPORARILY FLOODED FOREST ALLIANCE (A.179)

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.

SOURCES

References: Alexander and Ronco 1987, Alexander et al. 1984a, Alexander et al. 1987, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Cooper et al. 1987, Daubenmire and Daubenmire 1968, DeVelice et al. 1986, 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, 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, Steele and Geier-Hayes 1995, Steele et al. 1981, Tuhy et al. 2002, Youngblood and Mauk 1985

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Montane], Sideslope, Toeslope/Valley Bottom, Temperate [Temperate Continental], Mesotrophic Soil, Shallow Soil, Mineral: W/ A-Horizon >10 cm

Concept Summary: 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 empetrififormis*, 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.

DISTRIBUTION

Range: High elevations of the Rocky Mountains.

Ecological Divisions: 204, 304, 306

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

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

CONCEPT

Alliances:

- ABIES LASIOCARPA - POPULUS TREMULOIDES FOREST ALLIANCE (A.422)
- ABIES LASIOCARPA FOREST ALLIANCE (A.168)
- ABIES LASIOCARPA KRUMMHOLZ SHRUBLAND ALLIANCE (A.811)
- ABIES LASIOCARPA SEASONALLY FLOODED FOREST ALLIANCE (A.190)
- ABIES LASIOCARPA WOODLAND ALLIANCE (A.559)
- PICEA ENGELMANNII FOREST ALLIANCE (A.164)

SOURCES

References: Alexander and Ronco 1987, Alexander et al. 1984a, Alexander et al. 1987, Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, Cooper et al. 1987, Daubenmire and Daubenmire 1968, DeVelice et al. 1986, 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, 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, Steele and Geier-Hayes 1995, Steele et al. 1981, Tuhy et al. 2002, Youngblood and Mauk 1985

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

CE306.819 ROCKY MOUNTAIN SUBALPINE-MONTANE LIMBER-BRISTLECONE PINE 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: 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

Non-Diagnostic Classifiers: Montane [Upper Montane], Montane [Montane], Montane [Lower Montane], Forest and Woodland (Treed), Temperate [Temperate Continental], Alkaline Soil, Moderate (100-500 yrs) Persistence

Concept Summary: This ecological system occurs throughout the Rocky Mountains on dry, rocky ridges and slopes near upper treeline above the matrix spruce-fir forest. It extends down to the lower montane in the central and northern Rocky Mountains, particularly along the Front Range north into Canada. 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 and northern New Mexico. In the northern Rockies, *Pinus albicaulis* is found in some occurrences. 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. This foothill system 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.

DISTRIBUTION

Range: Occurs throughout the Rocky Mountains on dry, rocky ridges and slopes near upper treeline.

Ecological Divisions: 303, 306

TNC Ecoregions: 20:C, 21:C, 26:C, 68:P, 7:C, 8:C, 9:C

Subnations/Nations: AB:c, BC:c, CO:c, ID:c, MT:c, NM:c, OR:c, UT:c, WA:c, WY:c

CONCEPT

Alliances:

- PINUS ALBICAULIS FOREST ALLIANCE (A.132)
- PINUS ALBICAULIS WOODLAND ALLIANCE (A.531)
- 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)

SOURCES

References: Brunstein and Yamaguchi 1992, Canadian Rockies Ecoregional Plan 2002, Knight 1994, Lanner and Vander Wall 1980, Neely et al. 2001, Ranne et al. 1997

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, CAN

LeadResp: WCS

CES306.835 SOUTHERN ROCKY MOUNTAIN PINYON-JUNIPER WOODLAND

Division 306, Forest and Woodland

Spatial Scale & Pattern: Matrix

Classification Confidence: medium

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

Diagnostic Classifiers: Forest and Woodland (Treed), Very Shallow Soil, Shallow Soil, Mineral: W/ A-Horizon <10 cm, Aridic, Long Disturbance Interval, Needle-Leaved Tree, *Pinus edulis*, *Juniperus monosperma*

Non-Diagnostic Classifiers: Lowland [Foothill], Butte, Escarpment, Foothill(s), Midslope, Ridge, Temperate [Temperate Continental], Unglaciaded, F-Patch/Medium Intensity, F-Landscape/Medium Intensity

Concept Summary: This southern Rocky Mountain ecological system occurs on dry mountains and foothills in southern Colorado, in mountains and plateaus of northern New Mexico and Arizona, and extends out onto breaks in the Great Plains. 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. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. *Pinus edulis* and/or *Juniperus monosperma* dominate the tree canopy. *Juniperus scopulorum* may codominate or replace *Juniperus monosperma* at higher elevations. In transitional areas along the Mogollon Rim *Juniperus deppeana* becomes common. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Artemisia tridentata*, *Cercocarpus montanus*, *Quercus gambelii*, *Achnatherum scribneri*, *Bouteloua gracilis*, *Festuca arizonica*, or *Pleuraphis jamesii*.

DISTRIBUTION

Range: Occurs on dry mountains and foothills in southern Colorado, in mountains and plateaus of northern New Mexico and Arizona, and extends out onto breaks in the Great Plains.

Ecological Divisions: 303, 304, 306

TNC Ecoregions: 19:C, 20:C, 21:C, 22:P, 27:C, 28:C

Subnations/Nations: AZ:c, CO:c, NM:c, UT:c

CONCEPT

Alliances:

- JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504)
- PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516)
- PINUS EDULIS FOREST ALLIANCE (A.135)

SOURCES

References: Alexander 1981, Barbour and Billings 1988, Blackburn and Tueller 1970, Bradley et al. 1992, Dwyer and Pieper 1967, Eager 1999, Erdman 1962, Hess and Wasser 1982, Ladyman and Muldavin 1996, Mehl 1992, Muldavin et al. 1992, Muldavin et al. 1996, Neely et al. 2001, Powell 1988b

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS

LeadResp: WCS

CES306.810 ROCKY MOUNTAIN ALPINE DWARF-SHRUBLAND

Division 306, Shrubland

Spatial Scale & Pattern: Large Patch**Classification Confidence:** medium**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**Non-Diagnostic Classifiers:** Shrubland (Shrub-dominated), Temperate [Temperate Continental], Mineral: W/ A-Horizon >10 cm, Bryophyte

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 2250 m in southeastern British Columbia. This system occurs in areas of level or concave glacial topography, with late-lying snow, and sub-irrigation 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 tufts of graminoids and scattered forbs occur. *Dryas octopetala* or *Dryas integrifolia* communities are included here, although they occur on more wind-swept and drier sites than the heath communities. Within these communities *Cassiope mertensiana*, *Dryas integrifolia*, *Dryas octopetala*, *Salix arctica*, *Salix reticulata*, 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 alpigenuus*), *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: 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 2250 m in southeastern British Columbia.

Ecological Divisions: 304, 306**TNC Ecoregions:** 11:C, 19:C, 20:C, 21:C, 4:P, 68:P, 7:C, 8:C, 9:C**Subnations/Nations:** AB:c, BC:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, UT:c, WA:c, WY:c**CONCEPT****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 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, SCOPARIUM) DWARF-SHRUBLAND ALLIANCE (A.1114)

SOURCES

References: Bamberg 1961, Bamberg and Major 1968, Canadian Rockies Ecoregional Plan 2002, Cooper et al. 1997, Komarkova 1976, Meidinger and Pojar 1991, Neely et al. 2001, Willard 1963

Last updated: 20 Feb 2003**Stakeholders:** WCS, CAN**Concept Author:** NatureServe Western Ecology Team**LeadResp:** WCS**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

Non-Diagnostic Classifiers: Montane [Montane], Montane [Lower Montane], Lowland [Foothill], Ridge/Summit/Upper Slope, Sideslope, Temperate [Temperate Continental], F-Patch/Medium Intensity, F-Landscape/Medium Intensity, Short (50-100 yrs) Persistence

Concept Summary: 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.

DISTRIBUTION

Range: 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.

Ecological Divisions: 304, 306

TNC Ecoregions: 10:P, 18:C, 19:C, 20:C, 21:C

Subnations/Nations: AZ:c, CO:c, NM:c, UT:c, WY:p

CONCEPT

Alliances:

- AMELANCHIER ALNIFOLIA SHRUBLAND ALLIANCE (A.913)
- AMELANCHIER UTAHENSIS SHRUBLAND ALLIANCE (A.916)
- ARCTOSTAPHYLOS PATULA SHRUBLAND ALLIANCE (A.788)
- JUNIPERUS SCOPULORUM WOODLAND ALLIANCE (A.506)
- QUERCUS GAMBELII SHRUBLAND ALLIANCE (A.920)

Environment: This ecological system typically occupies the lower slope positions of the foothill and lower montane zones. They may occur on level to steep slopes, cliffs, escarpments, rimrock slopes, rocky outcrops, and scree slopes. Climate is semi-arid and characterized by mostly hot-dry summers with mild to cold winters and annual precipitation of 25 to 70 cm. Precipitation mostly occurs as winter snows but may also consist of some late summer rains. Soils are typically poorly developed, rocky to very rocky, and well-drained. Parent materials include alluvium, colluvium, and residuum derived from igneous, metamorphic, or sedimentary rocks such as granite, gneiss, limestone, quartz, monzonite, rhyolite, sandstone, schist, and shale. Although this is a shrub-dominated system, some trees may be present. In older occurrences, or occurrences on mesic sites, some of the shrubs may acquire tree-like sizes. Adjacent communities often include woodlands or forests of *Abies concolor*, *Pinus ponderosa*, *Pseudotsuga menziesii*, or *Populus tremuloides* at higher elevations, and *Pinus edulis* and *Juniperus osteosperma* on the lower and adjacent elevations. Shrublands of *Artemisia tridentata* or grasslands of *Festuca* sp., *Stipa* sp., or *Pseudoroegneria* sp. may also be present at the lower elevations.

Vegetation: Vegetation types in this system may occur as sparse to dense shrublands composed of moderate to tall shrubs. Occurrences may be multi-layered, with some short shrubby species occurring in the understory of the dominant overstory species. In many occurrences of this system, the canopy is dominated by the broad-leaved deciduous shrub *Quercus gambelii*, which occasionally reaches small tree size. Occurrences can range from dense thickets with little understory to relatively mesic mixed-shrublands with a rich understory of shrubs, grasses and forbs. These shrubs often have a patchy distribution with grass growing in between. Scattered trees are occasionally present in stands and typically include species of *Pinus* or *Juniperus*. Characteristic shrubs that may co-occur, or be singularly dominant, include *Amelanchier alnifolia*, *Amelanchier utahensis*, *Arctostaphylos patula*, *Artemisia tridentata*, *Cercocarpus montanus*, *Ptelea trifoliata*, *Prunus virginiana*, *Purshia stansburiana*, *Robinia neomexicana*, *Rosa* spp., *Symphoricarpos oreophilus*, and *Symphoricarpos rotundifolius*. The herbaceous layer is sparse to moderately dense, ranging from 1-40% cover. Perennial graminoids are the most abundant species, particularly *Bouteloua curtipendula*, *Bouteloua eriopoda*, *Bouteloua gracilis*, *Aristida* spp., *Carex inops*, *Carex geyeri*, *Elymus arizonicus*, *Eragrostis* spp., *Festuca* spp., *Koeleria macrantha*, *Muhlenbergia* spp., and *Stipa* spp. Many forb and fern species can occur, but none have much cover. Commonly present forbs include *Achillea millefolium*, *Artemisia* spp., *Geranium* spp., *Maianthemum stellatum*, *Thalictrum fendleri*, and *Vicia americana*. Ferns include species of

Cheilanthes and *Woodsia*. Annual grasses and forbs are seasonally present, and weedy annuals are often present, at least seasonally.

Dynamics: Fire typically plays an important role in this system, causing die-back of the dominant shrub species in some areas, promoting stump sprouting of the dominant shrubs in other areas, and controlling the invasion of trees into the shrubland system. Natural fires typically result in a system with a mosaic of dense shrub clusters and openings dominated by herbaceous species. In some instances these associations may be seral to the adjacent *Pinus ponderosa*, *Abies concolor*, and *Pseudotsuga menziesii* woodlands and forests. Ream (1964) noted that on many sites in Utah, Gambel oak may be successional and replaced by bigtooth maple (*Acer grandidentatum*).

SOURCES

References: Christensen 1955, Comer et al. 2002, Johnston and Hendzel 1985, 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

Last updated: 20 Feb 2003

Stakeholders: WCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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]

Non-Diagnostic Classifiers: Canyon, Colluvial slope, Foothill(s), Gulch, Midslope, Ridge, Temperate [Temperate Continental], Mineral: W/ A-Horizon <10 cm, Short (50-100 yrs) Persistence

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 cereu*, *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.

Ecological Divisions: 303, 306

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

Subnations/Nations: CO:c, MT:p, NE:?, NM:c, SD:c, WY:c

CONCEPT

Alliances:

- ARTEMISIA FRIGIDA SHRUBLAND ALLIANCE (A.2565)
- ARTEMISIA NOVA SHRUB HERBACEOUS ALLIANCE (A.1567)
- CERCOARPUS MONTANUS SHRUB HERBACEOUS ALLIANCE (A.1538)
- CERCOARPUS MONTANUS SHRUBLAND ALLIANCE (A.896)
- ELAEAGNUS COMMUTATA SHRUBLAND ALLIANCE (A.918)
- ELAEAGNUS COMMUTATA TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.956)
- 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)
- SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE (A.961)

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Montane], Montane [Lower Montane], Lowland [Foothill], Temperate [Temperate Continental], Mineral: W/ A-Horizon <10 cm, Sand Soil Texture, Short (50-100 yrs) Persistence

Concept Summary: 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*.

DISTRIBUTION

Range: 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.

Ecological Divisions: 303, 304, 306

TNC Ecoregions: 20:C, 21:C, 25:C, 26:C, 33:C, 6:C, 68:C, 8:C

Subnations/Nations: AZ:c, BC:c, CO:c, ID:p, MT:p, NE:c, NM:c, NV:p, OR:c, SD:c, UT:p, WA:c, WY:c

CONCEPT

Alliances:

- PINUS PONDEROSA FOREST ALLIANCE (A.124)
- PINUS PONDEROSA WOODED TALL HERBACEOUS ALLIANCE (A.1488)
- PINUS PONDEROSA WOODLAND ALLIANCE (A.530)

Other Comments: The Pine Escarpment regions of northwestern and central Nebraska are included within this system. In that region, examples of the system can range from open canopies with grassy understories to more closed canopies. Included within these areas are also several rocky outcrops, which probably should be included within the system as they are often intermingled with the savanna. The more closed-canopy examples may be more similar to Rocky Mountain Ponderosa Pine Woodland (CES306.827), and thus these areas could fit that system as well. Further review is needed to determine if the Pine Escarpment regions in Nebraska should be considered a separate system from the Rocky Mountain ponderosa pine systems.

SOURCES

References: Mehl 1992, Meidinger and Pojar 1991

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

CES306.834 SOUTHERN ROCKY MOUNTAIN JUNIPER WOODLAND AND SAVANNA

Division 306, Steppe/Savanna

Spatial Scale & Pattern: Large Patch**Classification Confidence:** medium**Required Classifiers:** Natural/Semi-natural, Vegetated (>10% vasc.), Upland**Diagnostic Classifiers:** Lowland [Foothill], Woody-Herbaceous, Shallow Soil, Mineral: W/ A-Horizon <10 cm, Aridic, Needle-Leaved Tree, Graminoid, *Juniperus monosperma* & grasses**Non-Diagnostic Classifiers:** Lowland [Lowland], Temperate [Temperate Continental], Unglaciated, Intermediate Disturbance Interval, Moderate (100-500 yrs) Persistence

Concept Summary: This ecological system occupies the lower and warmest elevations growing from 1370 to 1830 m in a semi-arid climate, primarily along the east and south slopes of the southern Rockies and Arizona-New Mexico mountains. It is best represented just below the lower elevational range of ponderosa pine and often intermingles with grasslands and shrublands. This system is best described as a savanna that has widely spaced mature (>150 years old) juniper trees and occasionally *Pinus edulis*. *Juniperus monosperma* and *Juniperus scopulorum* are the dominant tall shrubs or scattered short trees, though there may be inclusions of more dense juniper woodlands. Graminoid species are similar to those found in Western Great Plains Shortgrass Prairie (CES303.672), with *Bouteloua gracilis* and *Pleuraphis jamesii* being most common. In addition, succulents such as species of *Yucca* and *Opuntia* are typically present.

DISTRIBUTION

Range: Occupies the lower and warmest elevations growing from 1370 to 1830 m in a semi-arid climate, primarily along the east and south slopes of the southern Rockies and Arizona-New Mexico mountains.

Ecological Divisions: 303, 304, 306**TNC Ecoregions:** 19:C, 20:C, 21:C, 27:C**Subnations/Nations:** AZ:c, CO:c, NM:c, UT:c**CONCEPT****Alliances:**

- JUNIPERUS MONOSPERMA WOODLAND ALLIANCE (A.504)
- JUNIPERUS SCOPULORUM WOODLAND ALLIANCE (A.506)

SOURCES

References: Anderson et al. 1985, Barnes 1987, Bassett et al. 1987, Blackburn and Tueller 1970, Dwyer and Pieper 1967, Eager 1999, Fitzhugh et al. 1987, Francis 1986, Gehlbach 1967, Ladyman and Muldavin 1996, Larson and Moir 1986, Larson and Moir 1987, Mehl 1992, Neely et al. 2001, Rogers 1950, Wright and Bailey 1982

Last updated: 20 Feb 2003**Stakeholders:** WCS**Concept Author:** NatureServe Western Ecology Team**LeadResp:** WCS**CES306.836 NORTHERN 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, Loam Soil Texture, Silt Soil Texture, Ustic, Graminoid, Cool-season bunch grasses**Non-Diagnostic Classifiers:** Montane [Montane], Montane [Lower Montane], Temperate [Temperate Continental], Mesotrophic Soil, Shallow Soil, Short Disturbance Interval, F-Patch/Low Intensity, Moderate (100-500 yrs) Persistence

Concept Summary: This ecological system of the northern Rocky Mountains is found at montane elevation in the mountains of northeastern Wyoming, and Montana west through Idaho into the Blue Mountains of Oregon and north into the Okanagan, and the Canadian Rockies. These dry grasslands are small meadows to large open parks surrounded by conifer trees but lack tree cover within them. Generally, the soil textures are much finer, and soils are often deeper under grasslands than in the neighboring forests. These northern montane grasslands represent a shift in precipitation regime from summer monsoons and cold snowy winters found in the southern Rockies, to predominantly dry summers and winter rains. 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. Occurrences have a moderately dense graminoid layer of cool-season, medium-tall bunch grasses, dominated by *Festuca campestris*, *Pseudoroegneria spicata*, *Festuca idahoensis*, *Leymus cinereus*, *Elymus trachycaulus*, *Bromus inermis* ssp. *pumpellianus* (= *Bromus pumpellianus*), *Achnatherum richardsonii* (= *Stipa richardsonii*), *Achnatherum occidentale* (= *Stipa occidentalis*), *Koeleria macrantha*, and other graminoids such as *Carex filifolia* and *Danthonia intermedia*. Common associated forbs include *Geum triflorum*, *Galium boreale*, *Campanula rotundifolia*, *Antennaria microphylla*, *Geranium viscosissimum*, and *Potentilla gracilis*. Shrub cover is generally nonexistent, but can be adjacent in neighboring wetlands or riparian areas.

DISTRIBUTION

Range: Found at montane elevation in the mountains of northeastern Wyoming, and Montana west through Idaho into the Blue Mountains of Oregon and north into the Okanagan, and the Canadian Rockies.

Ecological Divisions: 204, 306

TNC Ecoregions: 6:C, 68:C, 7:C, 8:C, 9:C

Subnations/Nations: AB:c, BC:c, ID:c, MT:c, OR:c, UT:c, WA:c, WY:c

CONCEPT**Alliances:**

- CAREX HOODII HERBACEOUS ALLIANCE (A.1253)
- DASIPHORA FRUTICOSA SSP. FLORIBUNDA SHRUB HERBACEOUS ALLIANCE (A.1534)
- 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)
- LEYMUS CINEREUS HERBACEOUS ALLIANCE (A.1204)
- LEYMUS SALINUS SSP. SALMONIS SPARSELY VEGETATED ALLIANCE (A.1258)
- PSEUDOROEGNERIA SPICATA HERBACEOUS ALLIANCE (A.1265)

Dynamics: *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 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*).

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Marriott 2000, McLean 1970, Meidinger and Pojar 1991, Mueggler and Harris 1969, Mueggler and Stewart 1980, Tisdale 1947, Tisdale 1982

Last updated: 02 Mar 2003

Stakeholders: WCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

CES306.806 NORTHERN ROCKY MOUNTAIN SUBALPINE DRY GRASSLAND

Division 306, Herbaceous

Spatial Scale & Pattern: Large Patch

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Temperate [Temperate Continental], Mineral: W/ A-Horizon <10 cm, F-Patch/Low Intensity

Concept Summary: This is a 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 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*, *Trisetum spicatum*, *Fragaria virginiana*, and *Chamerion angustifolium* (= *Epilobium angustifolium*). This system is similar to Northern Rocky Mountain Montane Grassland (CES306.836), but is found at higher elevations, and is more often composed of *Festuca* spp. and *Stipa* spp.

DISTRIBUTION

Range: It is most extensive in the Canadian Rockies portion of the Rocky Mountain cordillera, extending south into western Montana, eastern Washington and Idaho.

Ecological Divisions: 306**TNC Ecoregions:** 4:P, 68:C, 7:C, 8:C, 9:P**Subnations/Nations:** AB:c, BC:c, ID:c, MT:c, OR:c, WA:c, WY:p**CONCEPT****Alliances:**

- FESTUCA CAMPESTRIS HERBACEOUS ALLIANCE (A.1255)
- FESTUCA IDAHOENSIS HERBACEOUS ALLIANCE (A.1251)
- FESTUCA VIRIDULA HERBACEOUS ALLIANCE (A.1257)
- PHLEUM ALPINUM HERBACEOUS ALLIANCE (A.1310)

SOURCES**References:** Canadian Rockies Ecoregional Plan 2002, Cooper et al. 1995**Last updated:** 20 Feb 2003**Concept Author:** NatureServe Western Ecology Team**Stakeholders:** WCS, CAN**LeadResp:** WCS**CES306.811 ROCKY MOUNTAIN ALPINE FELL-FIELD**

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], 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**Non-Diagnostic Classifiers:** Patterned ground (undifferentiated), Saddle, Temperate [Temperate Continental], Glaciated, Ustic, W-Landscape/Medium Intensity

Concept Summary: This ecological system is found discontinuously at alpine elevations throughout the Rocky Mountains, west into the mountainous areas of the Great Basin. 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. Plants cover is 15-50%, while exposed rocks make up the rest. Fell-fields are usually within or adjacent to alpine tundra dry meadows.

DISTRIBUTION**Range:** Found discontinuously at alpine elevations throughout the Rocky Mountains, west into the mountainous areas of the Great Basin.**Ecological Divisions:** 304, 306**TNC Ecoregions:** 11:C, 20:C, 21:C, 68:P, 7:C, 8:C, 9:C**Subnations/Nations:** AB:c, BC:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, UT:c, WA:c, WY:c**CONCEPT****Alliances:**

- GEUM ROSSII HERBACEOUS ALLIANCE (A.1645)
- 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)

SOURCES**References:** Bamberg 1961, Bamberg and Major 1968, Canadian Rockies Ecoregional Plan 2002, Cooper et al. 1997, Komarkova 1976, Meidinger and Pojar 1991, Neely et al. 2001, Willard 1963**Last updated:** 20 Feb 2003**Concept Author:** NatureServe Western Ecology Team**Stakeholders:** WCS, CAN**LeadResp:** WCS

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**Non-Diagnostic Classifiers:** Herbaceous, Temperate [Temperate Continental], Glaciated, Periglacial, Long (>500 yrs) Persistence

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. 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.

DISTRIBUTION**Range:** Occurs above upper timberline throughout the Rocky Mountain cordillera, including alpine areas of ranges in Utah and Nevada, and north into Canada.**Ecological Divisions:** 306**TNC Ecoregions:** 11:C, 20:C, 21:C, 68:C, 7:C, 8:C, 9:C**Subnations/Nations:** AB:c, AZ:c, BC:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, UT:c, WA:c, WY:c**CONCEPT****Alliances:**

- 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 DURIOUSCULA 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 SICCATATA HERBACEOUS ALLIANCE (A.1298)
- CAREX VERNACULA HERBACEOUS ALLIANCE (A.1309)
- CIRSIUM SCOPULORUM HERBACEOUS ALLIANCE (A.1608)
- 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 HERBACEOUS ALLIANCE (A.1632)
- SIBBALDIA PROCUMBENS HERBACEOUS ALLIANCE (A.1635)
- TRIFOLIUM DASYPHYLLUM HERBACEOUS ALLIANCE (A.1637)
- TRIFOLIUM PARRYI HERBACEOUS ALLIANCE (A.1638)

SOURCES**References:** Baker 1980a, Bamberg 1961, Bamberg and Major 1968, Canadian Rockies Ecoregional Plan 2002, Cooper et al. 1997, Komarkova 1976, Meidinger and Pojar 1991, Neely et al. 2001, Willard 1963**Last updated:** 20 Feb 2003**Concept Author:** NatureServe Western Ecology Team**Stakeholders:** WCS, CAN**LeadResp:** WCS

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**Non-Diagnostic Classifiers:** Herbaceous, Temperate [Temperate Continental], Short (50-100 yrs) Persistence

Concept Summary: 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.**DISTRIBUTION**

Range: Rocky Mountains between 1600-2200 m in elevation extending 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.

Ecological Divisions: 303, 306**TNC Ecoregions:** 10:C, 20:C, 21:C, 24:C, 25:P, 26:P, 27:C, 28:P**Subnations/Nations:** AZ:?, CO:c, NM:c, SD:p, TX:?, WY:c**CONCEPT****Alliances:**

- ANDROPOGON GERARDII - (SORGHASTRUM NUTANS) HERBACEOUS ALLIANCE (A.1192)
- BOUTELOUA GRACILIS HERBACEOUS ALLIANCE (A.1282)
- BOUTELOUA HIRSUTA HERBACEOUS ALLIANCE (A.1285)
- HESPEROSTIPA COMATA - BOUTELOUA GRACILIS HERBACEOUS ALLIANCE (A.1234)
- HESPEROSTIPA COMATA BUNCH HERBACEOUS ALLIANCE (A.1270)
- HESPEROSTIPA NEOMEXICANA HERBACEOUS ALLIANCE (A.1272)
- NASSELLA VIRIDULA HERBACEOUS ALLIANCE (A.1261)
- POLIOMINTHA INCANA SHRUBLAND ALLIANCE (A.862)
- PSEUDOROEGNERIA SPICATA HERBACEOUS ALLIANCE (A.1265)
- SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE (A.1225)
- SCHIZACHYRIUM SCOPARIUM BUNCH HERBACEOUS ALLIANCE (A.1266)
- YUCCA GLAUCA SHRUB HERBACEOUS ALLIANCE (A.1540)

SOURCES**References:** Hess and Wasser 1982, Neely et al. 2001**Last updated:** 20 Feb 2003**Concept Author:** NatureServe Western Ecology Team**Stakeholders:** WCS**LeadResp:** WCS**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

Non-Diagnostic Classifiers: Sideslope, Temperate [Temperate Continental], Shallow Soil, Mineral: W/ A-Horizon >10 cm, W-Patch/Medium Intensity, W-Landscape/Medium Intensity

Concept Summary: 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.

DISTRIBUTION

Range: Rocky Mountains.

Ecological Divisions: 304, 306

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

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

CONCEPT

Alliances:

- AGASTACHE URTICIFOLIA HERBACEOUS ALLIANCE (A.1602)
- ANTENNARIA MICROPHYLLA HERBACEOUS ALLIANCE (A.1623)
- DESCHAMPSIA CAESPITOSA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1408)
- DESCHAMPSIA CAESPITOSA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1355)
- GEUM ROSSII HERBACEOUS ALLIANCE (A.1645)
- 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)
- MERTENSIA CILIATA HERBACEOUS ALLIANCE (A.1606)
- PHLEUM ALPINUM HERBACEOUS ALLIANCE (A.1310)
- TRIFOLIUM DASYPHYLLUM HERBACEOUS ALLIANCE (A.1637)
- TRIFOLIUM PARRYI HERBACEOUS ALLIANCE (A.1638)
- WYETHIA AMPLEXICAULIS HERBACEOUS ALLIANCE (A.1607)

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Montane], Montane [Lower Montane], Sideslope, Temperate [Temperate Continental], Shallow Soil, F-Patch/Low Intensity, Moderate (100-500 yrs) Persistence

Concept Summary: 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.

DISTRIBUTION

Range: Occurs between 2200-3000 m in the Colorado Rockies.

Ecological Divisions: 304, 306

TNC Ecoregions: 18:C, 19:C, 20:C, 21:C

Subnations/Nations: AZ:c, CO:c, NM:c, UT:c, WY:c

CONCEPT

Alliances:

- AGROSTIS VARIABILIS HERBACEOUS ALLIANCE (A.1318)
- BROMUS INERMIS SEMI-NATURAL HERBACEOUS ALLIANCE (A.3561)
- CAREX HOODII HERBACEOUS ALLIANCE (A.1253)
- DANTHONIA INTERMEDIA HERBACEOUS ALLIANCE (A.1315)
- DANTHONIA PARRYI HERBACEOUS ALLIANCE (A.1316)
- DESCHAMPSIA CAESPITOSA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1408)
- FESTUCA ARIZONICA HERBACEOUS ALLIANCE (A.1245)
- FESTUCA CAMPESTRIS HERBACEOUS ALLIANCE (A.1255)
- FESTUCA IDAHOENSIS ALPINE HERBACEOUS ALLIANCE (A.1313)
- FESTUCA IDAHOENSIS HERBACEOUS ALLIANCE (A.1251)
- FESTUCA THURBERI HERBACEOUS ALLIANCE (A.1256)
- FESTUCA VIRIDULA HERBACEOUS ALLIANCE (A.1257)
- LEYMUS CINEREUS HERBACEOUS ALLIANCE (A.1204)
- LEYMUS SALINUS SSP. SALMONIS SPARSELY VEGETATED ALLIANCE (A.1258)
- MUHLENBERGIA FILICULMIS HERBACEOUS ALLIANCE (A.1288)
- MUHLENBERGIA MONTANA HERBACEOUS ALLIANCE (A.1260)
- PASCOPYRUM SMITHII HERBACEOUS ALLIANCE (A.1232)
- POA FENDLERIANA INTERMITTENTLY FLOODED HERBACEOUS ALLIANCE (A.1336)
- PSEUDOROEGNERIA SPICATA HERBACEOUS ALLIANCE (A.1265)

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

CES306.803 NORTHERN ROCKY MOUNTAIN CONIFER SWAMP

Division 306, Woody Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Forest and Woodland (Treed), Mineral: W/ A-Horizon <10 cm, Seepage-Fed Sloping [Mineral], Depressional, Saturated Soil

Non-Diagnostic Classifiers: Montane, Bench, Toeslope, Valley bottom, Temperate [Temperate Continental], Needle-Leaved Tree

Concept Summary: This 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. Soils are never organic, but are mineral. Stands generally occupy sites on benches, toeslopes or valley bottoms along mountain streams. Associations present include wetland phases of *Abies grandis*, *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*, *Gymnocarpium dryopteris*, *Equisetum arvense*, *Senecio triangularis*, *Mitella breweri*, *Mitella pentandra*, *Streptopus amplexifolius*, and *Calamagrostis canadensis*.

Comments: May need to split out calcareous cedar (*Thuja plicata*) swamps from the other conifer swamps- needs more review.

DISTRIBUTION

Range: Occurs in the northern Rocky Mountains from northwestern Wyoming north into the Canadian Rockies and west into eastern Oregon and Washington.

Ecological Divisions: 306

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

Subnations/Nations: AB:c, BC:c, MT:c, OR:c, WA:c, WY:p

CONCEPT**Alliances:**

- ABIES GRANDIS TEMPORARILY FLOODED FOREST ALLIANCE (A.176)
- 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 FOREST ALLIANCE (A.145)
- TSUGA HETEROPHYLLA SATURATED FOREST ALLIANCE (A.203)
- TSUGA HETEROPHYLLA TEMPORARILY FLOODED FOREST ALLIANCE (A.174)

SOURCES

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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, CAN

LeadResp: WCS

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

Non-Diagnostic Classifiers: Forest and Woodland (Treed), Shrubland (Shrub-dominated), Braided channel or stream, Drainage bottom (undifferentiated), Floodplain, Stream terrace (undifferentiated), Valley bottom, Temperate [Temperate Continental], Circumneutral Water

Concept Summary: 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.

DISTRIBUTION

Range: Found throughout the Rocky Mountain region within a broad elevation range from approximately 900 to 2800 m.

Ecological Divisions: 304, 306

TNC Ecoregions: 11:C, 18:C, 19:C, 20:C, 21:C, 25:C, 6:P, 8:C, 9:C

Subnations/Nations: AZ:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, SD:c, UT:c, WY:c

CONCEPT**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)
- EQUISETUM (ARVENSE, VARIEGATUM) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.3539)
- 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)
- 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).

SOURCES

References: Baker 1989a, Baker 1989b, Comer et al. 2002, Crowe and Clausnitzer 1997, Daubenmire 1952, Kittel et al. 1999b, Kovalchik 1987, 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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Lower Montane], Alluvial terrace, Drainage bottom (undifferentiated), Erosional stream terrace, Floodplain, Stream terrace (undifferentiated), Valley bottom, Temperate [Temperate Continental], Mineral: W/ A-Horizon <10 cm, Circumneutral Water

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 geeyeriana*, *Salix monticola*, *Salix planifolia*, and *Salix wolfii*. Generally the upland vegetation surrounding these riparian systems are of either conifer or aspen forests.

DISTRIBUTION

Range: 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.

Ecological Divisions: 304, 306

TNC Ecoregions: 11:C, 18:C, 19:C, 20:C, 21:C, 25:C, 6:P, 68:C, 7:C, 8:C, 9:C

Subnations/Nations: AB:c, AZ:c, BC:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, SD:c, UT:c, WA:c, WY:c

CONCEPT

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 SHRUBLAND 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)

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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

Non-Diagnostic Classifiers: Montane [Lower Montane], Drainage bottom (undifferentiated), Floodplain, Stream terrace (undifferentiated), Valley bottom, Temperate [Temperate Continental], Needle-Leaved Tree, Broad-Leaved Deciduous Tree, Circumneutral Water

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. 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*.

DISTRIBUTION

Range: 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.

Ecological Divisions: 204, 304, 306

TNC Ecoregions: 11:C, 18:C, 19:C, 20:C, 21:C, 25:C, 4:P, 6:P, 68:C, 7:C, 8:C, 9:C

Subnations/Nations: AB:c, AZ:c, BC:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, SD:c, UT:c, WA:c, WY:c

CONCEPT

Alliances:

- ABIES CONCOLOR FOREST ALLIANCE (A.152)
- 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)
- POPULUS TREMULOIDES FOREST ALLIANCE (A.274)
- POPULUS TREMULOIDES SEASONALLY FLOODED FOREST ALLIANCE (A.340)
- POPULUS TREMULOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.300)

SOURCES

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

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, MCS

LeadResp: WCS

CES306.812 ROCKY MOUNTAIN ALPINE-MONTANE WET MEADOW

Division 306, Herbaceous Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Alpine/AltiAndino [Alpine/AltiAndino], Montane [Upper Montane], Herbaceous, Graminoid, Seepage-Fed Sloping [Mineral], Depressional [Lakeshore], Depressional [Pond]

Non-Diagnostic Classifiers: Montane [Montane], Temperate [Temperate Continental], Mineral: W/ A-Horizon >10 cm, Mineral: W/ A-Horizon <10 cm, Forb, Mesotrophic Water, Saturated Soil

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.

DISTRIBUTION

Range: Found throughout the Rocky Mountains and Intermountain regions, ranging in elevation from montane to alpine (1000-3600 m).

Ecological Divisions: 304, 306

TNC Ecoregions: 11:C, 18:C, 19:C, 20:C, 21:C, 22:P, 25:C, 68:C, 7:C, 8:C, 9:C

Subnations/Nations: AB:c, AZ:c, BC:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, SD:c, UT:c, WA:c, WY:c

CONCEPT**Alliances:**

- AGROSTIS SCABRA TEMPORARILY FLOODED HERBACEOUS ALLIANCE (A.1351)
- AGROSTIS STOLONIFERA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1405)
- 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 ARAPAHOENSIS HERBACEOUS ALLIANCE (A.1319)
- CAREX DOUGLASII HERBACEOUS ALLIANCE (A.1286)
- CAREX DURIUSCULA HERBACEOUS ALLIANCE (A.1283)
- CAREX LASIOCARPA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1415)
- CAREX LIMOSA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1416)
- 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. PSEUDOSCIPOIDEA HERBACEOUS ALLIANCE (A.1306)
- CAREX SCOPULORUM SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1420)
- CAREX SIMULATA SATURATED HERBACEOUS ALLIANCE (A.1469)
- 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)
- DESCHAMPسيا CAESPITOSA SATURATED HERBACEOUS ALLIANCE (A.1456)
- DESCHAMPسيا CAESPITOSA SEASONALLY FLOODED HERBACEOUS ALLIANCE (A.1408)
- DESCHAMPسيا 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) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.3539)
- EQUISETUM FLUVIATILE SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE (A.1678)
- 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)

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.

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Comer et al. 2002, 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, Sanderson and Kettler 1996, Tuhy et al. 2002

Last updated: 20 Feb 2003

Concept Author: NatureServe Western Ecology Team

Stakeholders: WCS, CAN, MCS

LeadResp: WCS

CES306.831 ROCKY MOUNTAIN SUBALPINE-MONTANE FEN

Division 306, Herbaceous Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Diagnostic Classifiers: Moss/Lichen (Nonvascular), Organic Peat (>40 cm), Graminoid, Bryophyte, Seepage-Fed Sloping [Peaty], Extreme (Mineral) Rich & Iron-Rich, Saturated Soil

Non-Diagnostic Classifiers: Montane [Upper Montane], Montane [Montane], Montane [Lower Montane], Temperate [Temperate Continental], Depressional [Pond], Shallow (<15 cm) Water

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.

DISTRIBUTION

Range: Occurs infrequently throughout the Rocky Mountains from Colorado north into Canada.

Ecological Divisions: 304, 306

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

Subnations/Nations: AB:c, AZ:p, BC:c, CO:c, ID:c, MT:c, NV:p, OR:c, UT:c, WA:c, WY:p

CONCEPT**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)
- DULICHIMUM 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 is 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).

SOURCES

References: Canadian Rockies Ecoregional Plan 2002, Cooper 1986b, Cooper and Sanderson 1997, Neely et al. 2001, Rondeau 2001, Windell et al. 1986

Last updated: 20 Feb 2003

Stakeholders: WCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

CES306.801 NORTHERN ROCKY MOUNTAIN AVALANCHE CHUTE SHRUBLAND

Division 306, Mixed Upland and Wetland

Spatial Scale & Pattern: Small Patch

Classification Confidence: medium

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

Non-Diagnostic Classifiers: Montane [Upper Montane], Montane [Montane], Temperate [Temperate Continental], Forb, Seepage-Fed Sloping [Mineral]

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.

Ecological Divisions: 306

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

Subnations/Nations: AB:c, BC:c, CO:p, MT:c, OR:?, WA:p, WY:c

CONCEPT

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)
- POPULUS BALSAMIFERA SSP. TRICHOCARPA TEMPORARILY FLOODED FOREST ALLIANCE (A.311)
- POPULUS TREMULOIDES TEMPORARILY FLOODED FOREST ALLIANCE (A.300)

SOURCES

References: Butler 1979, Canadian Rockies Ecoregional Plan 2002

Last updated: 20 Feb 2003

Stakeholders: WCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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**Non-Diagnostic Classifiers:** Temperate [Temperate Continental], Glaciated, Unconsolidated**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.**Ecological Divisions:** 304, 306**TNC Ecoregions:** 11:C, 19:C, 20:C, 21:C, 68:C, 7:C, 8:C, 9:C**Subnations/Nations:** AB:c, AZ:c, BC:c, CO:c, ID:c, MT:c, NM:c, NV:c, OR:c, UT:c, WA:c, WY:c**CONCEPT****Alliances:**

- AQUILEGIA CAERULEA HERBACEOUS ALLIANCE (A.1603)
- CIRSIUM SCOPULORUM HERBACEOUS ALLIANCE (A.1608)
- CLAYTONIA MEGARHIZA HERBACEOUS ALLIANCE (A.1626)
- IVESIA CRYPTOCAULIS SPARSELY VEGETATED ALLIANCE (A.2513)
- POLEMONIUM VISCOSUM HERBACEOUS ALLIANCE (A.1631)
- SENECIO TARAXACOIDES HERBACEOUS ALLIANCE (A.1634)

SOURCES**References:** Canadian Rockies Ecoregional Plan 2002, Cooper et al. 1997, Komarkova 1976, Meidinger and Pojar 1991, Neely et al. 2001, Willard 1963**Last updated:** 20 Feb 2003**Stakeholders:** WCS, MCS, CAN**Concept Author:** NatureServe Western Ecology Team**LeadResp:** WCS**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**Non-Diagnostic Classifiers:** Montane [Upper Montane], Montane [Montane], Montane [Lower Montane], Lowland [Foothill], Butte, Escarpment, Temperate [Temperate Continental], Long (>500 yrs) Persistence**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 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?**DISTRIBUTION****Range:** Rocky Mountains.**Ecological Divisions:** 306**TNC Ecoregions:** 20:C, 21:C, 25:C, 68:C, 7:C, 8:C, 9:C

Subnations/Nations: AB:c, AZ:c, BC:c, CO:c, ID:c, MT:c, NM:c, OR:c, TX:c, UT:c, WA:c, WY:c

CONCEPT

Alliances:

- ABIES CONCOLOR WOODLAND ALLIANCE (A.553)
- ABIES LASIOPARPA WOODLAND ALLIANCE (A.559)
- ALETES ANISATUS HERBACEOUS ALLIANCE (A.1639)
- ATHYRIUM AMERICANUM HERBACEOUS ALLIANCE (A.1625)
- CAREX NARDINA HERBACEOUS ALLIANCE (A.1299)
- HEUCHERA BRACTEATA HERBACEOUS ALLIANCE (A.1646)
- JAMESIA AMERICANA SHRUBLAND ALLIANCE (A.2566)
- LOWLAND TALUS SPARSELY VEGETATED ALLIANCE (A.1847)
- OPEN CLIFF SPARSELY VEGETATED ALLIANCE (A.1836)
- 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)
- ROCK OUTCROP SPARSELY VEGETATED ALLIANCE (A.1838)
- RUBUS IDAEUS SSP. STRIGOSUS SHRUBLAND ALLIANCE (A.927)
- SAXIFRAGA RIVULARIS HERBACEOUS ALLIANCE (A.1633)

SOURCES

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

Last updated: 20 Feb 2003

Stakeholders: WCS, MCS, CAN

Concept Author: NatureServe Western Ecology Team

LeadResp: WCS

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