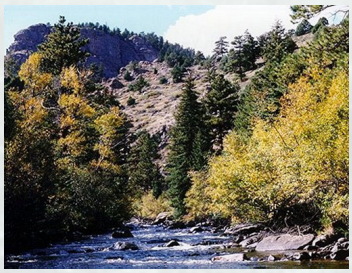

Comprehensive Statewide Wetlands Classification and Characterization

Wetland Plant Associations of Colorado

Natural Heritage Program
COLORADO

Preliminary Report
1999-2001

Colorado State University
Knowledge to Go Places

Comprehensive Statewide Wetlands Classification and Characterization

WETLAND PLANT ASSOCIATIONS OF COLORADO

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Front page photos (from top), HGM subclasses are discussed in the report:

1. Depressional (1) - Snow Mesa, Hinsdale Co. *Colorado Natural Areas Program file photo.*
2. Slope (1) - iron fen at Chattanooga, San Juan Co. *Colorado Natural Areas Program file photo.*
3. Flats (1) - Stinking Spring, Rio Blanco Co. *Colorado Natural Areas Program file photo.*
4. Riverine (3, 4) - North St. Vrain Creek, Boulder Co. *By Ron West.*
5. Riverine (5) - plains cottonwood riparian forest at Big Sandy Creek, Cheyenne Co. *By Gwen Kittel.*
6. Depressional (2, 3) - playa lake at Pawnee National Grasslands. *By Ric Hupalo.*

Background photo: Kettle Lakes Research Natural Area, Jackson Co. *By Janet Coles*

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This project was initiated with recommendations and advice of members of the Wetlands Task Force, which includes representatives from the private sector and from federal, state, and local agencies. They came together to share their expertise and offered counsel and encouragement. We thank all those who participated in those early discussions.

Ric Hupalo managed Phase I of the project and wrote the Phase I report, from which much of the Methods section for this report is taken. We appreciate all that he did to establish, structure and organize the project.

This project would not have been possible without the many landowners and managers, public, private, and tribal, who welcomed us on to their properties and provided invaluable information about their wetlands. Their cooperation made it possible to sample a broad range of Colorado's wetland resources.

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EXECUTIVE SUMMARY

The ***Comprehensive Statewide Wetlands Classification and Characterization*** (CSWCC) project is a three-year effort of the Colorado Natural Heritage Program (CNHP), in partnership with Colorado State University, and the Colorado Department of Natural Resources, Division of Wildlife (DOW) Wetlands Program to integrate previously collected data and develop a floristic classification for the wetlands of Colorado. Floristic classification and characterization of wetland types is an important step toward understanding the nature and dynamics of Colorado wetlands. It is an essential tool to help meet DOW Wetland Program goals for protecting wetland habitat and wetland-dependent wildlife. It also establishes a basis for focusing wetland research, land management, and conservation efforts where they will be most effective and beneficial.

The first phase of this project (1999-2000) integrated previously collected data, especially from the CNHP Statewide Riparian Classification (Kittel et al.1999a), CNHP wetland inventories (1995-present), and Colorado State University (Dr. D. Cooper) and grouped these 4,511 stands by hydrogeomorphic class and subclass (Hupalo et al. 2000).

This report describes the second phase of the project (2000-01) which defines plant associations within each of the hydrogeomorphic (HGM) subclasses (Colorado Geologic Survey et al. 1998) and classifies them according to the National Vegetation Classification System (USNVC). One hundred and eighty-six plant associations in four HGM classes (Depressional, Flats, Riverine and Slope) and ten HGM subclasses (D1, D2/3, D4/5, F1, S1/2, S3/4, R1, R2, R3/4, R5) are identified in this report. The CSWCC includes both native and non-native vegetation from near-pristine sites and sites that have been altered by natural or anthropogenic disturbances. This report expands the *Classification of Riparian Wetland Plant Associations of Colorado* (Kittel et al. 1999a) by identifying and describing wetland plant associations that occur outside riparian areas. For plant associations that were previously identified by Kittel et al. (1999a) or Cooper, descriptions and geographic and elevation distributions have been updated.

The list of 186 plant associations identified by the CSWCC is arranged by forest, woodland, shrubland, and herbaceous types. Each plant association is ranked and prioritized in terms of imperilment and biodiversity significance with global and state ranks when available. Fifty-five of the 186 are "unclassified," not yet ranked or incorporated into the USNVC although they appear to be valid associations. (This issue will be thoroughly reviewed during Phase III). The report also includes a table of associations by HGM group, a list of potential associations, and a sample of plant association descriptions for each HGM class.

A key to Colorado wetland plant associations and complete descriptions of all associations will be forthcoming in Phase III (2001-02).

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INTRODUCTION

A critical first step in understanding and defining the nature and dynamics of habitats across the landscape is cataloging and describing types. In order to manage, restore and protect Colorado wetlands adequately, we must know which types exist, their functions and attributes, relative frequency or rarity, and distribution across the landscape. This information is crucial to efforts to prioritize allocation of limited conservation resources. Information collected for this classification indicates that between one-third and one-half of Colorado flora occurs in wetland and riparian habitats. Preventing the loss of this valuable biodiversity is critical, particularly in the arid western United States (Dahl 2000).

The U.S. Environmental Protection Agency (EPA), pursuant to section 104 (b)(3) of the Clean Water Act, has funded projects to assess, map, characterize and classify wetland and riparian habitats in Colorado in order to improve the management of Colorado wetland resources. One of those projects, the Statewide Wetlands Strategy, is a collaborative venture among the Colorado Department of Natural Resources Division of Wildlife (DOW), EPA Region VIII, and the Colorado Natural Heritage Program (CNHP) to provide a strategy for wetlands protection and to ensure the quality of life for Coloradans. As part of the Statewide Wetlands Strategy, this classification is intended to be a tool for community-based conservation and protection of Colorado wetlands and associated biodiversity.

In 1999, CNHP, in partnership with the Colorado Department of Natural Resources DOW Wetlands Program, initiated the Statewide Wetlands Classification and Characterization project (CSWCC) as a key component of the on-going effort to define a Statewide Wetlands Strategy model for Colorado. The CSWCC project was developed with advice from a Wetlands Task Force convened by CNHP in April 1999. Attendees included representatives of federal, state, county, and city agencies and academia (Hupalo et al. 2000). This classification is an extension of research conducted by wetland scientists over the past twenty years. That work is integrated here, and new analyses are presented.

The CSWCC is a three-phase project designed to develop a tool for community-based conservation and protection of Colorado wetlands and associated biodiversity. The three phases are described below.

1. Phase I (1999-2000)
    a. Collected and synthesized existing wetland data (4,511 plots).
    b. Identified data gaps and began collection of data from underrepresented wetland types.
    c. Stratified the entire dataset into nine hydrogeomorphic (HGM) subclasses, based on hydrogeomorphic classification developed by David Cooper in 1998 (Colorado Geologic Survey et al. 1998, Hupalo et al. 2000).

2. Phase II (2000-2001)
    a. Classifies wetland vegetation according to the Unites States National Vegetation Classification System (USNVC) standard.
    b. Identifies plant associations within ten hydrogeomorphic (HGM) subclasses.

c. Compiles or revises existing plant association descriptions with known ecological and environmental data.

3. Phase III (2001-2002)
    a. Complete the characterization of the wetland plant associations.
    b. Rank and prioritize wetland plant associations in terms of imperilment and biodiversity significance according to the USNVC.
    d. Produce a key to wetland types.
    e. Collect data on poorly known wetland types such as ephemeral streams, prairie seeps, hanging gardens, and playas.

Vegetation Classification Methods: The US National Vegetation Classification System (USNVC)

The CSWCC follows the format of the USNVC (Anderson et al. 1998), the accepted national standard for all federal agencies (Maybury 1999). The USNVC: 1) is vegetation-based, 2) uses a systematic approach, 3) emphasizes natural vegetation, 4) emphasizes existing vegetation, 5) uses a combined physiognomic-floristic hierarchy, identifying vegetation units at scales practical for conservation, and 6) is appropriate for mapping at multiple scales (Grossman et al. 1998). The upper levels of the USNVC (beginning with the most inclusive) including class, subclass, group, subgroup and formation are physiognomic, based on growth form characteristics and environmental factors. The lowest levels, alliance and association, are floristic, based on dominant or diagnostic species names. The association is considered the basic unit for vegetation classification, and is the focus of this project.
(These syntaxa, e.g. alliance, are not used in accordance with the same terms in the Braun-Blanquet system or other vegetation classification schemes used around the world.)

Although the terms plant association and community have been described by numerous ecologists, no general consensus of their meaning has developed. The terms are similar, somewhat overlapping, and are often used more or less interchangeably. The USNVC defines a community as an "assemblage of species that co-occur in defined areas at certain times and that have the potential to interact with one another" (The Nature Conservancy 1999), and a plant association as a type of plant community with "definite floristic composition, uniform habitat conditions, and uniform physiognomy" (Flahault and Schroter 1910).

Vegetation classifications are necessary simplifications of the natural world, developed to facilitate understanding, planning, management, and conservation. Classifications of wetlands can be based on factors (e.g., vegetation, hydrology, landform) that are used either singly or jointly. Single factor classification systems, such as those based on vegetation, are generally easier to develop since less information is required, characteristics are less complex, and they can be tailored to specific objectives (Anderson et al. 1998). Vegetation is often chosen as the basis of a single factor system for classifying ecological systems because it generally integrates the ecological processes operating on a site or landscape more reliably and visibly than any other factor or set of factors (Mueller-Dumbois and Ellenberg 1974; Kimmins 1997).

Characterizing and tracking communities provides many potential benefits to conservation. Ecological communities represent unique sets of natural interactions among species and their

environment (Costanza et al. 1997, Daily et al. 1997). Community description and classification can be important tools for systematically characterizing the current pattern and condition of ecosystems and landscapes (Grossman et al. 1998). By protecting communities, many species not generally targeted for conservation, including those from poorly known groups such as bryophytes and invertebrates, are protected. Change over time may be more efficiently monitored in communities than in component species. Changes may be detected by monitoring composition (changes in species abundance, richness, proportions of endemics or exotics), structure (canopy features), and function (productivity, nutrient cycling, and patch dynamics) (Noss 1990, Max 1996). Community classification also provides the basis for monitoring by providing a systematic means to break the landscape continuum into recognizable units.

The Nature Conservancy and the Natural Heritage Program Network, including CNHP, use a coarse filter/fine filter approach to prioritize management and conservation efforts (The Nature Conservancy 1996). This approach involves identification and protection of plant communities (coarse filter) and rare species (fine filter). Identifying and protecting representative examples of plant communities ensures conservation of a greater number of species, biotic interactions, and ecological processes. Using communities as a coarse filter has ensured that conservation efforts are working to protect a more complete spectrum of biological diversity.

This project followed the quantitative analysis methods for classification suggested in Grossman et al. 1998. Data were stratified by hydrogeomorphic type. Ordination and cluster analysis were used to summarize the data in major groups. The summary also included the exploration of vegetation-environment relationships where such data were available. Tabular analysis was used to assign samples to plant associations. This process resulted in a floristic classification of Colorado wetland communities.

Wetland definitions

The CSWCC follows the U.S. Fish and Wildlife Service (USFWS) definition of wetlands (Cowardin et al. 1979). According to that definition wetlands are "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water." USFWS-defined wetlands must have *one or more* of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes (wetland plants); (2) the substrate is predominantly undrained hydric soil; and/or (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. The U. S. Army Corps of Engineers definition (US Army Corps of Engineers 1987), developed to define "jurisdictional" wetlands for the Clean Water Act permitting process, requires that a site have all three wetland attributes (vegetation, soil, and hydrology) to be classified as a jurisdictional wetland.

For this classification, we use the USFWS definition because it recognizes that not all wetlands are "jurisdictional" wetlands. Riparian areas in particular often do not meet all three of the wetland criteria, but should be included in wetland classification and conservation programs. Riparian areas perform many of the same functions as do wetlands, including maintenance of water quality, storage of floodwaters, and enhancement of biodiversity, especially in the western United States (National Research Council 1995).

Previous wetland and riparian classification work in Colorado

Researchers using a variety of methodologies have conducted wetland studies in scattered areas throughout Colorado and neighboring states (see summary in Kittel et al. 1999a). Dr. David Cooper has collected wetland plot data and classified wetland plant associations throughout the state for more than 15 years and contributed much of the data used for the CSWCC. Since 1994, CNHP, in cooperation with the DOW Wetlands Program, has systematically inventoried wetlands within Larimer, Routt, Summit, portions of Park, Pueblo, El Paso, Mesa, and Garfield, Rio Grande, and Conejos counties, as well as wetlands in broader watershed areas such as the San Luis Valley (Saguache and northern Alamosa counties) and the Uncompahgre River Basin (eastern Montrose and Ouray counties). Sanderson and Kettler (1996) produced a preliminary wetland vegetation classification for a portion of Colorado's western slope (based on 152 plots). Kittel et al. (1999a) completed a separate classification for riparian wetland plant associations of all major drainage basins, two National Forests, and one National Grassland. Kittel and others (1999a). analyzed research data by drainage basin rather than on a statewide basis; the report includes summaries for each basin.

Although wetlands have been studied in Colorado for many years, there has been no systematic inventory or comprehensive classification. In the absence of a comprehensive classification of Colorado wetlands, the CSWCC builds on previous studies and inventories of riparian and wetland plant associations in the state, especially those of Cooper and Kittel. Cooper has identified, described, and classified all wetland types of several regions or local areas of the state. His descriptions and classifications provide valuable resources for regional and local planners as well as conservation organizations. Kittel's (1999a) focus was on riparian sites that were "relatively undisturbed by human activity, thereby limiting the classification to plant associations native to Colorado" with the hope that these areas would serve as reference areas for management and restoration activities, as well as potential sites for land conservation.

The CSWCC is comprehensive in the sense of considering pristine and disturbed, riparian and non-riparian wetlands, and wetlands dominated by native and non-native plants. The CSWCC, however, must be considered preliminary. Although this project combines an unprecedented quantity of data from previous studies into a single, statewide classification, it should not be considered a final description of Colorado wetlands. The datasets used here do not constitute a comprehensive sample of Colorado geography or ecology. It is clear that many Colorado wetland types and localities still have not been adequately sampled. As a consequence, there are probably many plant associations that have yet to be described. In addition, some of the associations listed here will require further refinement and reclassification in order to accurately and completely describe Colorado wetlands. Therefore, this classification should be updated as more information becomes available.

STUDY AREA

The state of Colorado forms a nearly perfect rectangle, roughly between 37° and 41° north latitude and 102° and 109° west longitude. The boundaries encompass 104,247 square miles (over 66.7 million acres or 27 million hectares) of plains, foothills, mountains, plateaus and canyons. Colorado's average elevation is 6,800 feet (2,073 m). The lowest point is 3,315 feet

(1,011 m) on the Arikaree River at the Kansas border, and the highest point is Mt. Elbert at 14,431 feet (4,400 m)(Colorado State Archives 2001).

Geology and geomorphology

The following description of the geologic history of Colorado is adapted from: Benedict 1991, Mutel and Emerick 1984, and Tweto 1979. The modern landforms of Colorado are the result of millions of years of geologic processes. The products of both gradual and cataclysmic events are evident throughout the state. Colorado's oldest rocks, the Precambrian "basement" of metamorphic gneiss and schist, represent the base of long-vanished mountain ranges. Igneous intrusives such as granite and gabbro are visible in northern and central parts of Colorado. Following the Precambrian, mountain building ceased and erosion was widespread. As a result, rocks from certain geologic time periods are scarce in Colorado. The only period completely missing from the geologic record is the Silurian (410-440 million years ago). The upper Precambrian erosional surface in Colorado is generally overlain by much younger sediments.

Paleozoic era geology in Colorado is represented primarily by sedimentary formations, now exposed throughout the central and western portions of the state. Some 300 million years ago during the Pennsylvanian period, renewed tectonic activity leading to the rise of the Ancestral Rocky Mountains produced block-fault mountains and adjacent basin subsidence. Basin-deposited sediments of this period include extensive "red beds" such as the Boulder Flatirons. By the end of the Paleozoic, the Ancestral Rocky Mountains had been almost completely buried in their own erosional debris.

Beginning approximately 230 million years ago, the gradual breakup of the supercontinent of Pangaea led to renewed mountain building and the cyclic advance and retreat of inland seas. Sedimentary deposits of alluvial plains, sand dunes and both shallow and deep marine environments from this time are found throughout Colorado. The Cretaceous Pierre and Mancos formations in particular are widespread in the eastern and western non-mountain areas. Toward the end of the Mesozoic, some 70 million years ago, the Laramide Orogeny began the uplift that would result in the formation of the Southern Rocky Mountains.

Most of Colorado's current mountain ranges and drainages are a result of geologic activity during the Tertiary period, which began about 65 million years ago. The early or Paleocene part of the period witnessed the continued uplift of the Rocky Mountains as a result of the Laramide Orogeny, the emplacement of large igneous intrusions in what would become the Colorado Mineral Belt, as well as continued erosion and basin development. As Laramide activity subsided, the uplifted surface continued to erode, and extensive volcanic activity shaped the southern mountains. As the Tertiary period drew to a close, regional uplift accompanied by erosion and canyon cutting by rivers continued, and the Rio Grande Rift developed. In the last two million years, glacial cycles of the Quaternary period have further sculpted the landscape of the Southern Rocky Mountains through erosion and wind-borne deposits.

Much of Colorado falls into three primary physiographic regions: the Great Plains, Southern Rocky Mountains, and Colorado Plateau. The eastern forty percent of the state belongs to the Great Plains region, characterized by flat, high plains and rolling grasslands, rising gradually to the west to meet the foothills of the Southern Rocky Mountain ranges. The level plains are occasionally interrupted by buttes, escarpments, and larger remnants of the Eocene high plains

surface, while in the southwest parts of the region, mesas and buttes of volcanic origin mark the border with New Mexico. Stretching from the mountain foothills to the high plains escarpment between Denver and Greeley, the Colorado piedmont has been extensively eroded by the South Platte River. The highland of the Palmer Divide south of Denver separates the South Platte drainage from the other major prairie river, the Arkansas. Where the Great Plains meet the mountain front, tilted sedimentary beds form a series of hogbacks and ridges, and in the northern part of state, the mountains beyond rise quickly to the continental divide. Surface geology is largely sedimentary rocks and unconsolidated deposits including Quaternary eolian dune fields and loess, Tertiary sandstones and basalt fields, and Cretaceous shales and limestones.

The central mountainous portion of Colorado is part of the Southern Rocky Mountain region and contains a complex group of fairly well defined ranges, with more than fifty peaks greater than 14,000 feet (4,268 m) in elevation. Here the Continental Divide traces a winding path through west central Colorado, separating the state into eastern and western slopes. The northern end of the Rio Grande Rift cuts through the Southern Rocky Mountains, creating a series of large intermountain valleys. The Southern Rocky Mountains include the oldest rocks in the state, as well as extensive volcanic and sedimentary features, and are the result of alternating periods of mountain uplift and erosion during the past several hundred million years. Much of the topography we see today was formed within the last 70 million years by the most recent episodes of uplift, volcanism, erosion, and sedimentation. Mountain terrain above about 8,500 feet (2,591 m) has also been shaped by glacial activity of the past two million years.

The western-most portions of the state in the Colorado Plateau region are characterized by high plateaus, wide valleys, and rugged canyons. The Colorado River and its tributaries have carved numerous scenic canyons through a variety of sedimentary formations. Elevations range from 5,000 feet to 10,000 feet (1,524 – 3,049 m). Major features of the region include the high elevation Uncompahgre Plateau, the basalt-capped Battlement Mesa and Grand Mesa, the eroded sandstone canyons of the Paradox and San Juan Basins, and the extensive Tertiary shales of the Piceance Basin and Roan Plateau. Extreme northwestern Colorado also includes a portion of the Wyoming Basin region where ancient tributaries of the Yampa River have deeply dissected much of the high elevation terrain.

Climate

Elevation and topography are major factors influencing climate in Colorado. The climate is generally dry, due in part to the mid-latitude position in the continental interior. Annual precipitation in Colorado ranges from eight inches to over 60 inches (20 – 152 cm) with a statewide average of around 17 inches (43cm) (Daly and Taylor 1998). The San Luis Valley is the driest area of the state; areas receiving the most precipitation are the higher elevations of the Front Range, Park Range, West Elk, and San Juan Mountains. There are several different patterns of annual precipitation influencing the development of native vegetation. The eastern plains area tends to receive the majority of precipitation in the spring. The northern mountains have the heaviest precipitation in the winter months. For the southern mountains, the monsoons of late summer also provide a large portion of annual precipitation. Much of the remainder of the state lacks a dominant precipitation season.

Hydrology

Six major rivers have headwaters in the mountains of Colorado. On the western slope, the Colorado River and the major tributaries the White, Yampa, Gunnison, Dolores and San Juan flow toward the Gulf of California. On the eastern slope, the North Platte, South Platte, Arkansas, and Republican rivers are part of the Mississippi drainage which, with the Rio Grande River, eventually empties into the Gulf of Mexico.

All or part of four major aquifer systems are present in Colorado: the Colorado Plateau, Rio Grande, High Plains, and Denver Basin. Precipitation falling on the land surface in Colorado either flows directly into streams and rivers as runoff, or infiltrates the soil and underlying aquifers and moves laterally to discharge into rivers and streams as baseflow. Surficial aquifers occur primarily at shallow depth in unconsolidated sediments along parts of major river valleys. With the exception of the South Platte and Arkansas River drainages, individual stream-valley aquifers are usually small and unconnected to aquifers in other valleys or to distant aquifers in the same valley. Only in the valleys of eastern Colorado are the aquifers large and continuous enough to form a major aquifer. For a detailed description of the hydrology of Colorado, see the U. S. Geologic Survey Ground Water Atlas of the United States for Arizona, Colorado, New Mexico and Utah (Robson and Banta 1995).

Although there are few large natural lakes in Colorado, there are numerous small bodies of water in mountain areas. Many small natural lakes have been augmented by dams or diversions. Reservoirs and irrigation ditches are also common, especially on the eastern plains and in the San Luis Valley. Streams originating in the Southern Rockies usually flow year-round. Lower order streams in the non-mountainous areas of the state are often intermittent, flowing only during spring snowmelt or with local direct run-off.

On the predominantly dry eastern plains, wetlands occur along drainages and in shallow depressions with at least periodically wet soils. Most naturally-occurring wetlands are in the Southern Rocky Mountain region where higher precipitation and varied geomorphology support a wide variety of wetlands on slopes, in ponds and shallow depressions, and along streams. The often saline or alkaline wetlands of the western plateaus and canyons occur along river terraces and floodplains, or in a variety of seeps, springs, and marshes.

Vegetation

The eastern plains are dominated by grasslands, primarily shortgrass prairie. Especially in the northern plains, many native grasslands have been replaced by cereal crops. Large areas of stabilized sand dunes support shrubby grasslands. Trees are fairly rare on the plains, and in pre-settlement times would have been confined to riparian corridors, mesic draws, and higher buttes. The highly variable topography of the Southern Rocky Mountains supports a diversity of vegetation. Mountainous areas are chiefly characterized by coniferous woodlands and forests of ponderosa pine, Douglas-fir, Englemann spruce, and subalpine fir, interspersed with stands of aspen, grasslands and meadows, and mountain shrublands. The highest elevations are dominated by a variety of alpine tundra communities. The western plateaus and canyons are characterized by shrublands of sagebrush and saltbush. Bunchgrass grasslands and piñon-juniper woodlands are also common.

Land ownership, management and uses

More than 27 million acres (10.9 million hectares, or approximately 40%) of the 66.7 million acres within Colorado borders are in public ownership (Colorado GAP Project 1993). Public lands are concentrated in the western half of the state. Primary land managers for public lands in Colorado are the USDA Forest Service, administering more than 14 million acres (5.7 million hectares), the U. S. Bureau of Land Management administering more than eight million acres (3.2 million hectares), and the State of Colorado, with more than three million acres (1.2 million hectares) (Colorado GAP Project 1993). Throughout Colorado, valley bottoms and riparian areas are likely to be privately owned except at higher elevations.

The availability of water is often the driving factor in determining land use. Most relatively flat areas in the state are used for agriculture. The Great Plains are dominated by dry and irrigated farming and livestock grazing. In the mountains and western plateaus ranching, mining, timber harvest, and irrigated crops in valleys are common land uses.

CLASSIFICATION METHODS

Data sources and preparation

This classification is based on floristic data from samples collected in 4,511 vegetation stands throughout Colorado (Appendix A). All researchers who contributed data had the common goal of sampling homogenous stands of vegetation for the purpose of community classification. However, the scope of sampling and sampling methodology varied between researchers. Studies ranged from extensive inventories of primary watersheds to intensive studies of particular wetland complexes, and plot size and species abundance scales differed among studies. Although the lack of standardized field methods may contribute to unexplainable variation in the data, the additional error is an acceptable trade-off for the greatly increased representation of vegetation samples.

Taxa not identified to species were removed from the dataset. Each species was assigned a unique code. Species nomenclature (with the exception of willows) follows Kartesz (Kartesz and Kartesz 1980), as reported and updated in the PLANTS database (USDA NRCS). The nomenclature of willows follows (Dorn 1997). The binomial names are cross-referenced in the database to the nomenclature of the regional floras (Weber and Wittmann 1996a, Weber and Wittmann 1996b). In some cases, common names are regionally recognized names rather than Kartesz and Kartesz names.

The combined data matrix was 4,511 sampling units by 1,267 species. Species abundance is represented by percent cover, ranging from zero to 100 percent. Accidental species, defined as species occurring in only one sampling unit and having a cover value of less than ten percent, were considered ecological noise and were removed from the data prior to analyses. This strategy avoided removing species that were rare but contributed significant cover in at least one sampling unit, this type of outlier may constitute unusual associations and were inspected in subsequent analyses. Removal of 148 accidental species reduced the number of species to 1,119.

A relational database (Access 97 Relational Database) was created to relate the stand data to environmental data (e.g. elevation) and to provide summary statistics. This database was used to generate datasets for analyses.

Treatment of large datasets

Large datasets are usually heterogeneous if they represent large geographic areas or many types of vegetation. In such cases, treatment of all the data in a single ordination or in classification can be ineffective since many calculations would be based on sampling units sharing no species (Van der Maarel et al. 1987). It is not always apparent which hierarchical clustering or ordination program options provide optimum (ecologically interpretable) results when dealing with thousands of sampling units (Van der Maarel et al. 1987). Local communities, represented by a small number of sampling units, may be masked by the greater variation occurring across a geographic region (Van der Maarel et al. 1987).

With large sets of floristic data, it is often necessary to break the analysis into several stages to produce satisfactory results (Kent and Coker 1992). Van der Maarel et al. (1987) suggest stratification prior to ordination or hierarchical clustering of large datasets to increase

interpretability of the results. They suggest two ways of stratifying datasets. If clear local subsets of large heterogeneous areas exist, they can be used as grouping units. Allen and Peet (1990). Alternatively, if all or most of the plant communities of an area are included, samples may be grouped by vegetation type. In some circumstances, another alternative to stratification is to sub-sample the data to produce an initial classification and allocate the remaining sampling units to these groups (Kent and Coker 1992).

For this classification, a variation of the first approach was used. The dependence of wetland types upon hydrologic regime and geomorphic setting and processes suggested the use of hydrogeomorphic (HGM) classes as a means of stratification. A framework of regional hydrogeomorphic subclasses proposed by Cooper (Colorado Geologic Survey et al. 1998) was used for data stratification. The HGM approach focuses on geomorphic, physical, and chemical features of wetland ecosystems, and acknowledges that plant communities are often indicative of the hydrogeomorphic forces affecting an ecosystem (Brinson 1993).

HGM as a basis for stratification

As part of a multi-discipline collaboration to characterize wetlands of Colorado, Cooper (Colorado Geologic Survey et al. 1998) investigated the relationship between hydrogeomorphic attributes and the wetland vegetation of Colorado. His work synthesized environmental data derived from field data sheets and various USGS resource maps, based on location, for 3,625 sampling units within Colorado. The variables coarsely described elevation, latitude, longitude, soil texture, soil organic content, channel gradient, type of bedrock, surficial geology, stream order, inundation frequency, soil moisture, water source, and hydrologic disturbance.

The environmental and floristic datasets were analyzed together using the direct gradient analysis technique of Canonical Correspondence Analysis (CCA) (ter Braak 1986). CCA results in the simultaneous ordination of samples and species in the same space, as well as allowing the direct plotting of the environmental variables as vectors in the ordination diagram. Because this technique requires that ordination axes be expressed in terms of the environmental variables used, meaningful interpretation of CCA plots depends upon the assumption that those environmental variables included are, in fact, ecologically important. For a useful discussion of Correspondence Analysis methods see Palmer 1993.

Cooper concluded that the first axis represented a gradient from high elevation, glaciated landscapes and peat soils to coarse-textured soils, alluvial landscapes with high stream order. The second axis was interpreted as an inundation duration gradient. This work resulted in the definition of 15 preliminary HGM subclasses in four classes (River, Slope, Depression, and Flat) and common or diagnostic plant species for each subclass (Table 1). The 99 plant species associated with the HGM subclasses formed the basis for stratifying the sampling units (Appendix B).

Table 1. Preliminary HGM subclasses as described by Cooper (Colorado Geologic Survey et al. 1998).

HGM Subclass	Description	Common Species
Depressional 1	Mid-to-high elevation basins with peat soils and lake fringes with or without peat soils.	*Carex utriculata*
Depressional 2	Permanently or semi-permanently flooded low elevation basins, including reservoir and pond margin wetlands as well as marshes.	*Typha* spp., *Scirpus* spp.
Depressional 3	Seasonally flooded low elevation basins that are dry for long periods.	*Eleocharis palustris*
Depressional 4	Temporarily flooded low elevation basins flooded for short periods in the spring and early summer.	*Polygonum lapathifolium*
Depressional 5	Intermittently flooded low elevation basins that are not flooded annually or are largely barren of vegetation.	*Xanthium strumarium*
Flats 1	Middle to low elevation sites on mineral saline soil (due to evaporation) with a seasonal high water table near the ground surface and occasionally shallow standing water.	*Suaeda calceoliformis, Puccinellia nuttalliana, Sarcobatus vermiculatus*
Riverine 1	Steep gradient low order streams and springs on coarse-textured substrate. Very common in the subalpine zone.	*Mertensia ciliata, Senecio triangularis, Glyceria striata*
Riverine 2	Moderate gradient, low to middle order streams on coarse and fine-textured substrates. Typically dominated by willow thickets and may contain beaver pond complexes.	S*alix monticola, Salix boothii, Heracleum maximum*
Riverine 3	Moderate gradient, middle elevation reaches of small and mid-order streams.	*Picea pungens, Populus angustifolia, Alnus incana* ssp. *tenuifolia*
Riverine 4	Stream reaches on larger rivers in low elevation canyons in the foothills and plateaus. Generally steep gradient and coarse soils.	*Acer negundo* var. *interius*
Riverine 5	Low elevation floodplains on mid-to-high order streams with fine-textured substrate and usually a perennial flow.	*Populus deltoides, Salix amygdaloides*
Slope 1	Alpine and subalpine fens and wet meadows on saturated non-calcareous substrates.	*Carex aquatilis* var. *stans, Carex scopulorum*
Slope 2	Subalpine and montane fens and wet meadows on saturated calcareous substrates.	*Eleocharis quinqueflora, Kobresia simpliciuscula, Carex simulata*
Slope 3	Wet meadows at middle elevations in the mountain ecoregion with a seasonal high water table near the ground surface.	*Juncus balticus* var. *montanus*
Slope 4	Low elevation meadows with a seasonal high water table near the ground surface. May occur on floodplains or near springs.	*Carex nebrascensis*

Stratification: Methods for assignment of sampling units to HGM subclasses

Several HGM subclasses from Cooper's CCA analysis (Colorado Geologic Survey et al. 1998) were grouped to simplify the stratification of the comprehensive classification dataset. These were subclasses that had few diagnostic species, or cases where the subclass boundaries were not necessarily clear. The stratification framework is based on nine HGM subclasses, which stratifies the data into groups associated with nine broad ecological settings: Depressional 1, Depressional 2/3, Depressional 4/5, Flat 1, Riverine 1/2, Riverine 3/4, Riverine 5, Slope 1/2, and Slope 3/4. A combination of classification and ordination techniques was used to assign sampling units to the nine hydrogeomorphic subclasses representing the range of hydrogeomorphic conditions in wetlands of Colorado (Figure 1, page 15). Stratification was based on the 99 plant species Cooper (Colorado Geologic Survey et al.1998) reported as common or diagnostic of the HGM subclasses (Appendix B).

Cluster analysis was used to aggregate the sampling units into floristically similar groups. Indicator Species Analysis (ISA) (Dufrêne and Legendre 1997) was applied to the clustering

results to identify species indicative of the clustering hierarchy. This information was in turn compared with the 99 characteristic species identified by Cooper (Colorado Geologic Survey et al. 1998) and allocations to the nine HGM groups were made accordingly.

Cluster analysis is a method of identifying groups of samples in a dataset. For this classification the groups are floristically similar assemblages of plots. The clustering method used works in an agglomerative manner, initially treating each sample unit as its own group, and proceeding to combine samples into larger and larger groups. This joining method produces a hierarchy of groups which contain smaller groups and are in turn part of larger groups.

Ward's method of minimum variance joining, as implemented in PC-ORD 4 (McCune and Mefford 1999) was used to cluster the sampling units. Euclidean distance, the default distance measure for Ward's method in PC-ORD, was used for the analysis. In this algorithm, joining is based on the two cluster groups whose fusion results in the smallest increase in variance, relative to the variances within each cluster taken separately (Ludwig and Reynolds 1988).

An output option of the clustering program provided a record of group membership for each sampling unit in the upper 200 levels of clustering. This information was then used to create the group membership matrix necessary for Indicator Species Analysis (ISA). Indicator Species Analysis was applied to only the first 90 levels of the clustering (see Hupalo et al. 2000 for further details).

Once group membership has been determined, the next step is to characterize the differences between groups in an ecologically meaningful way, such as by species composition. In order to assign the groups produced by the cluster analysis to the correct HGM subclasses, species characteristic of those groups must be identified. Indicator Species Analysis (Dufrêne and Legendre 1997) is a technique to identify the species or species assemblage that characterize a group of sampling units. The objective of ISA is to identify species that have high fidelity to a particular group and thus are good indicators of that group. A good indicator species occurs with high relative abundance and high frequency in its own group, and at the same time does not occur in other groups. The indicator species identified by ISA were used as an aid to assigning a group of plots to an HGM group with the same characteristic species.

ISA (McCune and Mefford 1999) was conducted on all clusters for each of the upper 90 levels of the cluster analysis, and mass assignments of sampling units to HGM subclasses were based on the results. Following the work of Dufrêne and Legendre (1997), species having an Indicator Value (IV) of 25 or greater and a p-value of 0.05 or less were retained. This selected species present in at least 50% of the sampling units in one subclass and with relative abundance in that subclass (average percent cover) of 50% or greater. Assignments were made by comparing (visually matching species names) the Indicator Species of a group at a given cluster level with the HGM subclass diagnostic and common species identified by CCA analysis in Cooper (Colorado Geologic Survey et al. 1998).

After the assignment of groups to HGM subclasses, the subclasses were inspected for obviously misclassified plots. These types of outliers are not necessarily poor data, but they may have an extreme influence on multivariate analyses. Misclassification may result from sampling units which cross ecotones and therefore have non-homogenous vegetation. Sampling units from semiaquatic communities (e.g. dominated by *Nuphar luteum* and some *Potamogeton* and

Sparganium species) or regionally isolated, monocultural species (*Carex vesicaria*) were also outliers. Some plots were permanently removed (poor sampling units) and others were temporarily removed (unusual communities) from the data. The stand composition of each questionable plot, or group of plots, was evaluated by querying the relational database. Then a decision was made to leave the sampling unit(s), move the sampling unit(s) to a different HGM subclass, or remove the sampling unit(s) from the dataset.

Verification: Assessing the effectiveness of stratification

Once groups have been identified, the next step is to determine their validity. Two questions are of interest: 1) Are the groups significantly different? and 2) if so, how are they different? In order to address the first question, the non-parametric Multi-response Permutation Procedure (MRPP) comparison test was used. This procedure gives an indication of how clumped the original groups are compared to arbitrary groups produced by reassigning the samples. To address the second question, Indicator Species Analysis was reapplied to the sampling units, now grouped by nine HGM subclasses. This was done to determine whether the new set of Indicator Species made sense from ecological and hydrogeomorphic points of view, had good separation between groups, and compared well with the characteristic species that Cooper (Colorado Geologic Survey et al. 1998) identified.

MRPP tests the hypothesis that samples within a group are clumped in multivariate space. This hypothesis is evaluated by reassigning the original group memberships (permutation), and calculating the degree to which the original group is more clumped than groups of randomly assigned samples. MRPP detects concentration within *a priori* groups, a similar purpose to the one-way analysis of variance *F* test, but with fewer statistical assumptions about the data (Zimmerman et al. 1985). The test was applied to the subclasses as an overall comparison, rather than as pair-wise comparisons. The test statistic "T" is a descriptor of the within-group homogeneity of the real data compared to the amount of homogeneity expected by chance, indicating the degree of separation between the groups.

MRPP was implemented in PC-ORD 4 (McCune and Mefford 1999), using rank transformed Sorensen distances. The Sorensen distance metric was chosen for MRPP because it retains more sensitivity in heterogeneous datasets and gives less weight to outliers, compared to Euclidean distance (McCune and Mefford 1999). A rank transformation was applied to help correct the loss of sensitivity of distance measures as community heterogeneity increases (McCune and Mefford 1999). Applying the test to rank transformed distances changes the null hypothesis from "average within-group distance no smaller than expected by chance" to "no difference in average within-group rank of distances" (McCune and Mefford 1999).

Indicator Species Analysis was used to evaluate the degree of separation of characteristic species between the individual HGM subclasses. Group membership was according to one of nine HGM subclasses (Subclass R1/2 was later divided, resulting in a total of ten subclasses). In some respects this provides more ecological insight than conducting pair-wise comparisons with MRPP and avoids Type I error and test power issues associated with non-independent multiple comparisons. If good separation existed between the nine groups, then a species maximum Indicator Value would be expected to be statistically significant and have a considerably higher value than in the other subclasses. Secondly, subclass Indicator Species should agree with the characteristic species of Cooper (Colorado Geologic Survey et al. 1998).

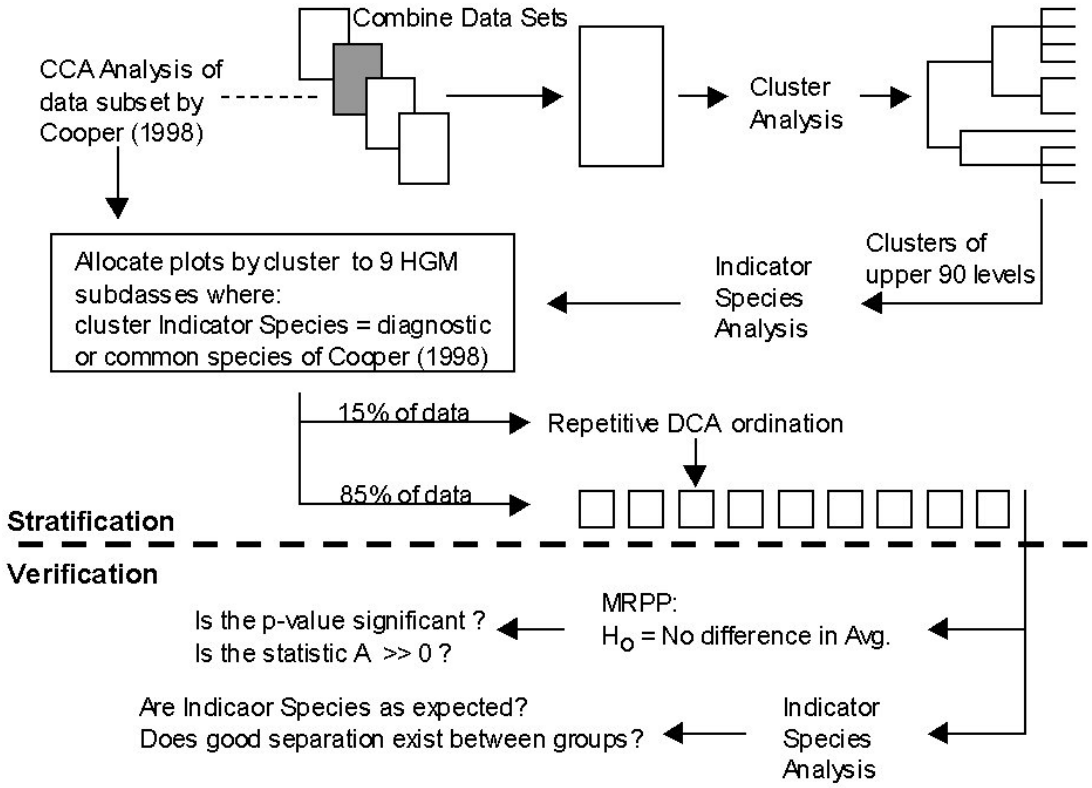

Figure 1. Outline of stratification and verification process.

Mass assignment of sampling units to HGM subclasses based on the ISA summary table resulted in the stratification of 80% of the sampling units. A second cluster analysis and ISA applied to the upper 15 levels of the cluster resulted in assignment of an additional 5% of the sampling units (see Figure 1).

The remaining 15% of unassigned sampling units were assigned based on repetitive ordination with DCA, following the example of Peet (1980). DCA revealed that the remaining sampling units were generally weedy and associated with alkaline flat and lower altitude riverine (R3, 4 and R5) subclasses. High beta diversity sometimes produced an undesirable arch effect in the ordination (Kent and Coker 1992). Because of the arch distortion, the composition of sampling units patterns was always inspected to avoid allocating dissimilar sampling units (from opposing tails of the arch). Less than 2% of the dataset remained unassigned to one of the nine subclasses following these ordinations. Unassigned sampling units, outliers, and sampling units from semi-aquatic communities were excluded from further analyses. Overall, 4,335 sampling units of the 4,511 sampling units were allocated to HGM subclasses.

Separate outlier analyses (chi-square and Sorensen distances) and DCA ordination was conducted on each HGM subclass as a final quality control on the stratification process. A small number (< 50 sampling units) of reallocations were made. These were cases where sampling units greatly influenced the ordination and were usually much more than two standard deviations from the group average distance using either distance measure.

The upper section of Table 2 shows the average within-group rank distance for each HGM subclass from the MRPP analysis. This statistic is a measure of the internal heterogeneity of the nine groups of sampling units. For example, the Depressional (1) subclass is comprised of species-poor stands dominated by *Carex utriculata*, reflected by the very low average distance for the group. The magnitude of the average within-group rank distances is related to the group heterogeneity, not necessarily sample size. For example, Flats 1 is one of the smaller groups but exhibits one of the higher amounts of internal variability, which supports Cooper's (Colorado Geologic Survey et al. 1998) assertion that the mineral soil flats subclass (Flats 1) should be subdivided when more data are available.

In addressing the question of whether the groups produced by the cluster analysis are different, the MRPP results reported in Table 2 indicate that the stratification was effective, in that overall the average within-group ranked distances were significantly different ($T = -1071.597$; $p<<0.001$). This is not surprising, given that the groups were largely defined by cluster analysis, a procedure which maximizes variability among groups and minimizes it within groups. With such a large sample size even a slight overall difference between groups should be detectable. It is of more interest to know whether the differences are ecologically significant, that is, to know which variables are accounting for among-group differences.

Table 3 lists all species from the analysis that had an Indicator Value greater than twenty percent and p-values < 0.05 in a Monte Carlo test of significance of the observed maximum IV, and the HGM subclasses to which they belong. The left section of Table 3 shows the HGM subclass and the maximum Indicator Value of each Indicator Species. The center section shows the Monte Carlo test results, based on 250 permutations with randomized data. The mean IV scores obtained from 250 calculations on randomized data provide a benchmark to compare with IV scores for the real (observed) data. The right section of the table shows the observed Indicator Values in each HGM subclass. The ISA shows there is a strong correspondence with the characteristic species that Cooper (Colorado Geologic Survey et al. 1998) delimited, and a large difference between a species maximum IV and the IV achieved in the other subclasses.

The species listed in Table 3 are ecologically explainable and their Indicator Values show good separation among the nine groups. Values greater than twenty percent (rather than the twenty-five percent stratification criterion) are given to better illustrate the characteristic plant assemblages. Figure 2 shows the location of the sampling units, coded by HGM subclass affiliation, that were used in the wetland community classification.

Table 2. MRPP statistics for rank transformed Sorensen distance matrix.

HGM Subclass	Avg. Ranked Distance	N
Depression 1	0.004	123
Riverine 1,2	0.203	775
Riverine 5	0.283	462
Slope 3,4	0.284	393
Riverine 3,4	0.311	1130
Slope 12	0.312	713
Flats 1	0.362	131
Depression 4,5	0.404	125
Depression 2,3	0.410	483
Test Statistic	**Value**	
Test statistic: T =	-1071.597	
Observed delta =	0.293	
Expected delta =	0.500	
Variance of delta =	3.73E-08	
Skewness of delta =	-0.269	
Chance-corrected within-group agreement, A =	0.414	
Probability of a smaller or equal delta, p <	1.00E-09	

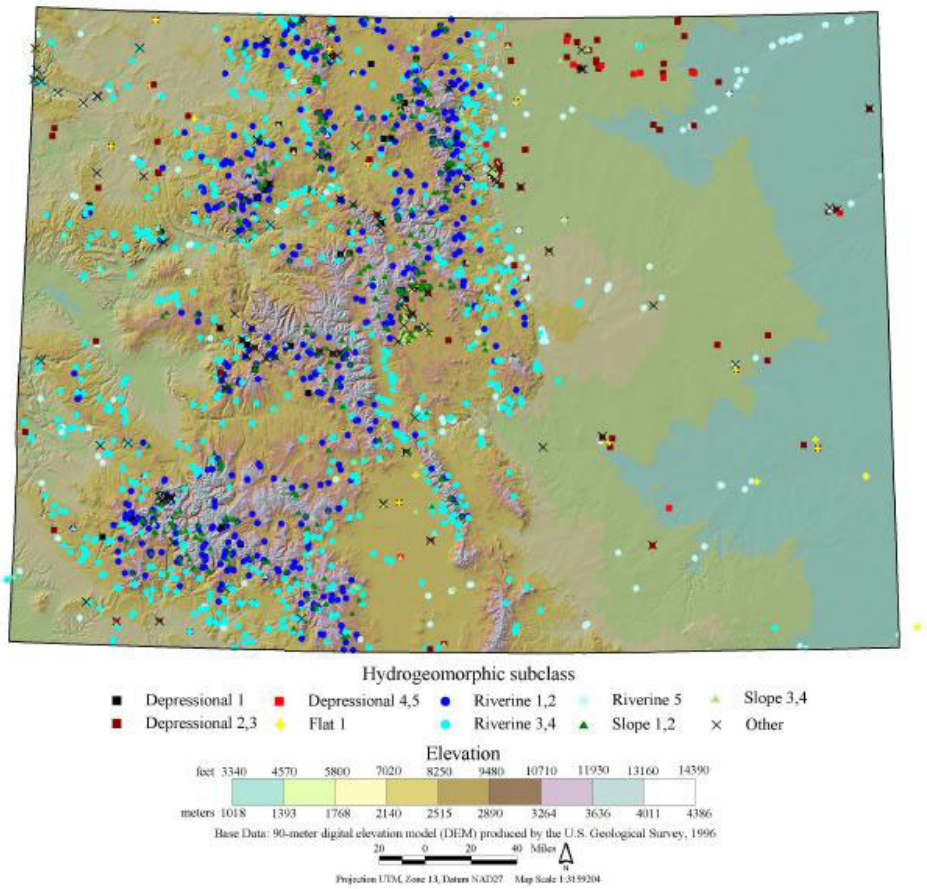

Figure 2. Map of Colorado with sampling unit locations delimited by HGM subclass. From Hupalo et al. 2000.

Table 3. Indicator Species Analysis on HGM subclass membership.

Max observed Indicator Value (IV) by HGM subclass			IV stats for randomized groups 250 permutations			Number of sampling units and observed Indicator Value for each HGM Subclass								
						D 1	**D 2,3**	**D 4,5**	**F 1**	**R 1,2**	**R 3,4**	**R 5**	**S 1,2**	**S 3,4**
Spp ID	**Group**	**Max IV**	**Mean**	**S.Dev**	**p-value**	N= 123	483	125	131	775	1130	462	713	393
CARUTR	D 1	88	2.5	0.57	0.004	88	0	0	0	1	0	0	1	0
ELEPAL	D 2,3	41	2.3	0.61	0.004	0	41	3	0	0	0	0	0	0
SCHPUN	D 2,3	25	1.3	0.44	0.004	0	25	0	1	0	0	1	0	0
TYPLAT	D 2,3	24	1	0.37	0.004	0	24	0	0	0	0	0	0	0
ECHCRU	D 4,5	37	1	0.46	0.004	0	0	37	0	0	0	0	0	0
XANSTR	D 4,5	30	1.2	0.5	0.004	0	0	30	0	0	0	1	0	0
PERLAP	D 4,5	29	0.9	0.48	0.004	0	0	29	0	0	0	0	0	0
POLARE	D 4,5	26	0.6	0.32	0.004	0	0	26	0	0	0	0	0	0
DISSTR	F 1	55	1	0.38	0.004	0	0	0	55	0	0	0	0	0
PUCAIR	F 1	26	0.6	0.36	0.004	0	0	0	26	0	0	0	0	0
SALMON	R 1,2	39	2.7	0.56	0.004	0	0	0	0	39	1	0	1	0
MERCIL	R 1,2	39	3.3	0.64	0.004	0	0	0	0	39	3	0	3	0
CALCAN	R 1,2	33	3.3	0.68	0.004	0	0	0	0	33	2	0	4	0
CARCOR	R 1,2	32	2.9	0.64	0.004	0	0	0	0	32	1	0	4	0
SALDRU	R 1,2	26	1.9	0.47	0.004	0	0	0	0	26	2	0	0	0
PICENG	R 1,2	26	2	0.47	0.004	0	0	0	0	26	1	0	1	0
DISINV	R 1,2	22	2.5	0.56	0.004	0	0	0	0	22	9	0	0	0
SENTRI	R 1,2	22	2.5	0.65	0.004	0	0	0	0	22	1	0	6	0
HERSPH	R 1,2	22	2.8	0.67	0.004	0	0	0	0	22	12	0	0	0
ALNINC	R 3,4	37	2.7	0.55	0.004	0	0	0	0	3	37	0	0	0
POPANG	R 3,4	30	2.1	0.57	0.004	0	0	0	0	0	30	1	0	0
ROSWOO	R 3,4	30	2.7	0.61	0.004	0	0	0	0	1	30	2	0	0
MAISTE	R 3,4	24	2.6	0.66	0.004	0	0	0	0	5	23	0	0	0
SWISER	R 3,4	24	1.7	0.49	0.004	0	0	0	0	0	23	0	0	0
SALEXI	R 5	54	2.5	0.62	0.004	0	0	0	0	0	1	54	0	0
POPDEL	R 5	38	1.5	0.4	0.004	0	0	0	0	0	0	38	0	0
CARAQU	S 12	43	3.1	0.62	0.004	5	0	0	0	3	0	0	43	0
SALPLA	S 12	37	2	0.52	0.004	0	0	0	0	1	0	0	36	0
PSYLEP	S 12	35	2	0.52	0.004	0	0	0	0	1	0	0	35	0
PEDGRO	S 12	25	1.9	0.53	0.004	0	0	0	0	2	0	0	25	1
CLERHO	S 12	25	1.5	0.52	0.004	0	0	0	0	1	0	0	25	0
JUNARC	S 3,4	56	3.1	0.66	0.004	0	0	0	0	0	0	1	0	56
DESCES	S 3,4	23	2.7	0.68	0.004	0	0	0	0	1	0	0	9	23
ARGANS	S 3,4	21	1.2	0.39	0.004	0	0	0	0	0	0	0	0	21

From Hupalo et al. 2000. CARUTR - *Carex utriculata,* ELEPAL - *Eleocharis palustris,* SCHPUN - *Schoenoplectus pungens,* TYPLAT - *Typha latifolia,* ECHCRU - *Echinochloa crus-galli,* XANSTR - *Xanthium strumarium,* PERLAP - *Polygonum lapathifolium,* POLARE - *Polygonum arenastrum,* DISSTR - *Distichlis spicata,* PUCAIR - *Puccinellia nuttalliana,* SALMON - *Salix monticola,* MERCIL - *Mertensia ciliata,* CALCAN - *Calamagrostis canadensis,* CARCOR - *Cardamine cordifolia,* SALDRU - *Salix drummondiana,* PICENG - *Picea engelmannii,* DISINV - *Lonicera involucrata,* SENTRI - *Senecio triangularis,* HERSPH - *Heracleum maximum,* ALNINC - *Alnus incana ssp. tenuifolia,* POPANG - *Populus angustifolia,* ROSWOO - *Rosa woodsii,* MAISTE - *Maianthemum stellatum,* SWISER - *Cornus sericea ssp. sericea,* SALEXI - *Salix exigua,* POPDEL - *Populus deltoides,* CARAQU - *Carex aquatilis var. stans,* SALPAL - *Salix planifolia,* PSYLEP - *Caltha leptosepala ssp. leptosepala,* PEDGRO - *Pedicularis groenlandica,* CLERHO - *Rhodiola rhodanthum,* JUNARC - *Juncus arcticus,* DESCES - *Deschampsia cespitosa ssp. cespitosa,* ARGANS - *Argentina anserina.*

Tabular Analysis and identification of associations

Once samples had been allocated to HGM subgroups, tabular analysis was used to identify plant associations. Techniques were based on the procedures suggested by Mueller-Dombois and Ellenberg (1974) for classifying vegetation by tabular comparison. These methods, although dating from the days before high-speed computing, have the advantage of allowing an ecologist to examine and compare large amounts of raw data in a meaningful format, and subsequently to construct a detailed mental picture of the entire range of plant associations and variation present in the data.

For each HGM group, a raw data matrix was constructed from the database by importing the data in list form to PC-ORD, and saving the working matrix as a spreadsheet file. The total number of species in the matrix was restricted to 250 due to limitations of the spreadsheet program used (Microsoft Excel). For most groups, species occurring in fewer than five plots were omitted from the table.

The resulting data matrix, in spreadsheet form, was used to calculate the degree of constancy for each species. Both absolute constancy (number of plots in which the species occurs) and percent constancy (number of plots in which the species occurs/total number of plots) were calculated. The matrix could then be sorted by either of these scores.

Percent constancy was used to examine the data for differential species. Good differential species are generally those which occur in the mid-range of constancy (e.g. 10-60%), and are thus useful in differentiating between groups of plots. The selected range of species, together with plot identification information, was extracted to a new matrix. In this "partial table" species columns were rearranged (ordinated) to group species which have similar distribution among a series of plots together, giving a first approximation of community associations present in the HGM subgroup. The ordinated partial table was used in conjunction with expert knowledge of state and regional ecologists to assign samples to an association type.

Because some existing associations may be underrepresented in this dataset, the plots for which species had been omitted in order to fit the matrix into the spreadsheet were reexamined for possible relevance as distinct associations. Discussions with state and regional experts in wetland and riparian community types helped clarify the existence and extent of data gaps. The information was synthesized into the plant association descriptions presented in this report.

CLASSIFICATION RESULTS

Wetlands constitute only a small part of the landscape in the arid environment of Colorado. Yet they occur in a variety of forms, and their importance in maintaining natural diversity, wildlife, scenic beauty, and water quality is well-established (Cooper 1993, Sanderson and Kettler 1996, Windell et. al. 1986).

Wetlands are dynamic systems. They may change over time with changing environmental conditions. Wetland plant communities may transition into wetter open water communities or into drier upland communities. Although we may easily recognize wetlands, it is more difficult to assign a precise definition to the term wetland (see p. 3). In general terms, wetlands are areas where saturation with water is the dominant factor governing soil development and determining the nature of the plants and animals that live in the soil and on the soil surface (Cowardin et al. 1979).

The seasonality of the water, the duration and depth of inundation, the water chemistry and source of the water supporting the wetland, and the vegetation and soil characteristics are some of the factors that influence wetland types. When conditions at a particular site change, the wetland changes as well. Under stable conditions, some wetlands may persist relatively unchanged for long periods (e.g. fens with peat soils more than 10,000 years old). In other types, natural dynamic processes such as flooding or successional processes such as in-filling of depressions, produce changes in wetlands over time.

Wetlands are also vulnerable to disturbance, degradation, or destruction when used for agriculture, water or other natural resource development, residential or road construction, or recreation. Dahl (2000) estimated that 50% of the wetlands in Colorado have been lost or degraded since 1980. Cooper (Colorado Geologic Survey et al. 1998) estimated that up to 90% of some wetland types may have been lost or degraded.

In Colorado, four main types of wetlands are commonly recognized: riparian lands, wet meadows, marshes, and peatlands (Jones and Cooper 1993, Colorado Geologic Survey et al. 1998). Landscape diversity, which is a result of regional and local variation in geologic substrate, geomorphology, elevation, and precipitation, creates conditions for a diversity of wetland types within these four categories. These types include seeps, springs, marshes, playas, fens, carrs, wet meadows, mineral flats, and streamside forests, woodlands, and shrublands.

This classification begins the effort to assimilate results of years of research to produce a comprehensive guide describing the variety of wetlands in Colorado, documenting distribution across the state, and evaluating relative natural heritage value. We identify plant associations by physiognomic group (forest, woodland, shrubland, herbaceous) and floristic composition according to the USNVC standard (Table 4). We also describe wetland types by hydrogeomorphic class and subclass based on hydrology, position on the landscape, and sustaining processes (Table 5). Many of the plant associations listed here were originally identified in earlier work, especially by Kittel et al. (1999a) and in numerous works by Cooper. This preliminary report focuses on major wetland plant associations, but also lists a number of provisional or potentially rare types that may occur. A total of 186 major plant associations and 26 potential types were identified (Table 6). Descriptions of several plant associations from each

HGM class are included in the Plant Association Description section. (page 48). Many of these descriptions have been updated by adding new plot information to Kittel's original descriptions. Plant associations for HGM subclasses R2 and R3/4 are from Kittel et al. (1999a); more classification work is needed before final associations are defined for these groups. Phase III of this project will include a key to plant associations and descriptions of all major wetland plant associations.

Of the 186 plant associations presented here, 55 are listed as "unclassified." This means that they are legitimate associations, based on the number of sampled stands and the opinion of the authors, but that they are not yet listed in the USNVC classification. About half of the unclassified types were identified in Kittel et al. 1999a. Of the unclassified types identified in Kittel's riparian classification (1999a), most are forest or woodland types, a few are willow and other shrub types, and one is an herbaceous association. In contrast, most of the remaining unclassified associations (those not previously identified in the USNVC classification or Kittel's riparian classification) are herbaceous types. *Salix amygdaloides* is the only tree-dominated woodland type in this group. *Salix amygdaloides* has generally been considered part of *Populus deltoides* associations in Colorado. *Salix amygdaloides* associations are not common, but they do occur (five stands in our sample) and were probably more common in the past before exotic species and development altered their natural habitat. About one-fourth of the newly identified associations are dominated by exotic species, including *Tamarix ramosissima* (tamarisk or saltcedar), a common shrub or small tree in the R5 HGM subclass. Other exotic, dominant species include three forbs of drawdown zones or other disturbed areas around ponds (*Xanthium strumarium* (cockleburr), *Polygonum lapathifolia* (curly knotweed), and *Polygonum arenastrum* (oval-leaf knotweed), and one very common grass, *Agrostis gigantea* (redtop).

Wetlands by Hydrogeomorphic class and subclass

In 1998, as part of a multi-disciplinary effort (Colorado Geological Survey et al.), Cooper investigated the relationship between geomorphology, wetland vegetation, and wetland functions, and produced a first approximation of hydrogeomorphic classes and subclasses for Colorado wetlands. He described four hydrogeomorphic classes in Colorado: riverine, slope, depression, and mineral soil flats. Within a geographic region, HGM wetland classes are further subdivided into subclasses. A subclass includes all those wetlands that have essentially the same characteristics and perform the same functions. Riparian areas, loosely defined as streamside vegetation communities, may include depressional, slope, or mineral flats associations as well as riverine associations. Position on the landscape and the source of the water supporting the wetland are the critical factors distinguishing the four types. Table 5 lists plant associations by hydrogeomorphic (HGM) group.

We used the HGM system to stratify our original dataset, and below we present a review of our results by HGM class and subclass. The HGM classification groups wetland types that have similar characteristics and perform similar functions; it can be used to assist land managers to develop functional evaluations as well as to identify the wetlands under their jurisdiction. Class and subclass descriptions follow Cooper (Colorado Geologic Survey et al. 1998) and include information derived from the data analysis for this classification. The original stratification of the classification dataset combined several of Cooper's original 15 HGM subclasses into nine subclasses to simplify analysis (see Methods). During the process of identifying plant associations, we were able to separate one of the combined subclasses, R1/2 into the component

R1 and R2 subclasses. Several subclasses are still combinations of Cooper's original set. For example, D2/3 combines the Depressional 2 and Depressional 3 subclasses. In general, and partly because indicator species were used to define HGM subclasses, most plant associations occur in only one subclass. However, there are several associations that occur in two or even three subclasses.

Mineral Soil Flats Wetlands

Mineral Soil Flats occur on relatively flat ground and are supported by precipitation and surface runoff.

Flats Subclass 1 (F1)

Cooper (Colorado Geologic Survey et al. 1998) describes one Mineral Soil Flats subclass (F1), but suggests that this type may need to be divided when more data are available. Mineral soil flats occasionally have standing water and more frequently have a seasonally high water table. Soils are often saline due to evaporation of water containing high concentrations of dissolved solutes. Geomorphic setting includes flat sites or shallow basins. In Colorado, mineral soil flats are especially common in South Park and the San Luis Valley, and are also found on the eastern plains, along the Front Range, in North Park, and at lower elevations on the western slope. Elevations of sampled stands range from 3,820 to 9,000 feet (1,164 – 2,744 m). Sixteen plant associations were identified in the Mineral Soil Flats subclass. One temporarily flooded woodland association (*Populus deltoides / Distichlis spicata*), five intermittently flooded shrubland associations and nine herbaceous associations (semi-permanently, seasonally, or intermittently flooded) were identified from mineral flats. All are dominated by native plant species that are tolerant of saline and alkaline soils.

Depressional Wetlands

We combined Cooper's five depressional subclasses into three groups: D1, D2/3, and D4/5. Depressional wetlands occur in shallow or deeper depressions and are supported by the water filling the depression.

Depressional Subclass 1 (D1)

Depressional wetlands in subclass 1 occur in mid-to-high elevation basins with peat soils and lake fringes with or without peat soils (Colorado Geologic Survey et al. 1998). Cooper also suggests that basin peatland and lake fringe types are functionally different and should be separated into different subclasses when sufficient data are available. CSWCC data included stands from the Front Range, South Park, the Park Range, and areas around Crested Butte and Telluride (6,880 – 10,400 feet, 2,097 – 3,170 m). We identified two seasonally flooded herbaceous wetland types in this subclass: *Carex utriculata,* and *Carex aquatilis-Carex utriculata.* The *Carex utriculata* type is by far the most common and widespread; the *Carex aquatilis – Carex utriculata* association is probably also common in the state but occurred in fewer than ten stands in our sample.

Depressional Subclasses 2 and 3 (D2/3)

Depressional wetlands in subclasses 2 and 3 are usually found at lower elevations and are permanently or semi-permanently flooded. The subclass includes reservoir and pond margins as well as marshes (Cooper 1993) and includes cattail, bulrush and other tall reed, sedge, grass, and rush-dominated herbaceous vegetation. In our sample, this type was common along the Front

Range and in the San Luis Valley. Stands also occurred in North and South parks; a few occurred at higher elevations near Crested Butte and Telluride and in the Yampa, Green, and Animas drainages on the western slope. Stands were found between 3,950 and 9,800 feet (1,204 – 2,988 m). We identified 14 plant associations in this subclass. All are herbaceous and able to tolerate saturated soils (seasonally, temporarily or semipermanently flooded). All but one (*Bidens cernua,* a forb) of these associations are dominated by native graminoid species.

Depressional Subclasses 4 and 5 (D4/5)

Depressional wetlands in subclasses 4 and 5 occur in low elevation basins that are temporarily or intermittently flooded. Subclass 5 wetlands may be flooded very occasionally, sometimes only once every five to ten years as in the case of playa lakes. Perennial vegetation may be poorly developed and the depression bottom may be barren. This type may include abandoned beaver ponds, small irrigation ponds and playa lakes. In our sample, D4/5 wetlands were found in the same areas of the state as D2/3 wetlands, except that none were located in South Park. They occurred between 4500 and 9700 feet (1,372 – 2,957 m), but were uncommon above 7,500 feet (2,286 m). We identified 12 plant associations in the Depressional 4/5 subclass. All are dominated by forbs or graminoids, about one-third of which are non-native plants.

Slope Wetlands

We group Cooper's four subclasses of slope wetlands into two types here, S1/2 and S3/4. Slope wetlands occur on gentle to moderate slopes and are supported by groundwater.

Slope Subclasses 1 and 2 (S1/2)

Slope wetlands in subclass 1 are alpine and subalpine fens and wet meadows on non-calcareous substrates. Subclass 2 wetlands are subalpine and montane fens and wet meadows on calcareous substrates. Both types may be dominated by woody or herbaceous species and may have organic or mineral soils. Wetlands in slope subclass 1 are very common and widespread in mountainous regions of the state. Slope 2 wetlands are much less common and are known mainly from the meadows and fens in South Park. Wetlands in these two subclasses occurred in our dataset between 8,600 (2,622 m) and 11,800 feet (3,597 m). We identified 37 plant associations in these two subclasses. One seasonally flooded type is dominated by conifers (*Abies lasiocarpa-Picea engelmannii/Carex aquatilis*). Sixteen are seasonally or temporarily flooded willow shrublands dominated by species of *Salix.* Subshrubs dominate one association (*Kalmia polifolia-Gaultheria humifusa*), and graminoids and one forb (*Caltha leptosepala*) dominate the remainder. Two uncommon wetland types occur in this subclass: extreme rich fens and iron fens. Extreme rich fens currently are documented from South Park in Colorado (Cooper 1996, Sanderson and March1996). The water supporting extreme rich fens is rich in calcium, magnesium, and other minerals and plant nutrients. Probably because of these unusual conditions, extreme rich fens in South Park support at least two rare plant communities, fourteen rare plants and nine rare invertebrates (Sanderson and March 1996). Iron fens occur in the Colorado mineral belt. Waters supporting these fens have high concentrations of iron. Only a limited suite of plants can grow in the acid conditions of these fens.

Slope Subclasses 3 and 4 (S3/4)

The Slope 3 subclass includes wet meadows at middle elevations in the mountains with a seasonally high water table and dominated by herbaceous plants. Slope 4 wetlands occur at lower elevations, but also have a seasonally high water table supporting herbaceous or

occasionally shrub associations. They may occur on floodplains or at springs and may be supported by irrigation. They are widespread throughout the state. Stands in our dataset occurred between 4,950 and 10,600 feet (1,509 – 3,232 m). We identified 16 plant associations in the Slope 3/4 subclass. Most are seasonally or temporarily flooded and dominated by graminoid species. Two are temporarily flooded shrubland types.

Riverine Wetlands

Riverine wetlands occur along rivers and streams. Stream flow is the main source of water maintaining the riverine wetland vegetation. Riverine wetlands are important for flood control, maintaining water quality, stabilizing stream banks, and providing habitat for fish and other wildlife (Hansen et al. 1988, Brinson et al. 1981). Riparian areas are used extensively for domestic livestock grazing, gravel mining, recreation, transportation and residential development.

We were not able to complete the analysis of all riverine subclasses for this preliminary report. A more complete analysis, especially for riverine subclasses 2, 3, and 4, will be available in the final report. Associations and descriptions of riverine wetlands are from Kittel et al. 1999a with updates for subclasses R1 and R5.

Riverine Subclass 1 (R1)

Wetlands in subclass R1 typically occur along steep-gradient, low-order streams and springs on coarse-textured substrate. They are especially common in the subalpine zone, but also occur on the plains (Colorado Geologic Survey et al.1998). Stands used for this classification came from studies on the Front Range, from subalpine sites around Telluride and Crested Butte, from the alpine tundra of the central mountains, the Gunnison, Colorado, San Miguel, and Dolores river basins. A few stands were from South Park. Elevation of stands ranged from 7,700 to 12,000 feet (2,347 – 3,658 m). Nine R1 plant associations were identified, mostly subalpine types. The vegetation at the headwaters of streams at lower elevations apparently have received less attention. Plant associations described for Riverine 1 wetlands include one conifer type (*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*), five shrubland types, three graminoid-dominated types and one forb-dominated type.

Riverine Subclass 2 (R2)

R2 wetlands occur along middle elevation, moderate gradient, low- to mid- order streams on coarse and fine-textured substrates. They may contain beaver pond complexes. Preliminary analysis of this group identified 29 plant associations including coniferous and deciduous forests, shrublands, and herbaceous types. Stands occur between 6,100 and 12,000 feet (1,860 – 3,658 m) but are most common between 7,500 and 11,000 feet (2,286 – 3,354 m).

Riverine Subclasses 3 and 4 (R3/4)

Subclass R3 wetlands occur on middle elevation reaches of small and mid-order streams. They are often dominated by tall shrubs and trees. R4 wetlands occupy lower elevation canyons in the foothills and plateaus along larger rivers. These wetland sites have coarser soils and steeper gradients than subclass R5. We have not analyzed these two subclasses, therefore, types listed in Tables 4 and 5 are from Kittel et al. (1999a).

Riverine Subclass 5 (R5)

Subclass R5 wetlands typically occur on low elevation floodplains of mid- to high-order streams with fine-textured substrate and usually perennial, but occasionally intermittent, flow. In this dataset, stands in this subclass occurred mostly on the eastern plains, along the Front Range, the Animas drainage, and along the lower Yampa River on the western slope. Associations in this subclass are most common below 7,000 feet (2,134 m) but may occur up to 9,000 feet (2,744 m). Thirty plant associations were identified in the R5 subclass. They are dominated by shrublands, grasslands or deciduous woodlands.

Further research needed

This preliminary classification lists many of the major wetland types in Colorado, but it should not be considered complete. More research is needed to finish the classification of some HGM subclasses, especially those in the riverine class. Some of the associations listed here may be combinations of several associations that may require further analysis and separation. In addition, although our dataset was large, it covers only a certain range of the habitats and geographic areas of the state. Many areas have not been surveyed and new wetland associations will likely be discovered when they are. Some wetland types that were underrepresented in our data are: alpine tundra wetlands, playa lakes, intermittent streams, iron fens, hanging gardens, and Colorado Plateau seeps. Plant associations dominated by semiaquatic plants were not included in this classification.

A number of potential plant associations were identified on the basis of only one or two plots each (Table 6). Although these associations were uncommon in our dataset, many of them are expected to be more common across the landscape. More information on these types will help clarify whether they are actually rare or have not yet been well-documented.

The HGM classes and subclasses for Colorado were identified recently and have been minimally tested, reviewed, and used by wetland scientists. Some subclass descriptions will need revision as more information becomes available. There is also a need to describe the functions performed by wetlands of the different HGM classes and subclasses. Some of the associations identified here were well documented in our data for one subclass, but also occurred in a few stands in other HGM subclasses. More work is needed to identify whether those associations actually belong in more than one subclass.

COLORADO WETLAND PLANT ASSOCIATIONS

Table 4. Colorado Wetland Plant Associations by physiognomic group.

* Association not yet classified within USNVC. Only associations with an Elcode beginning with CEGL are classified by USNVC.
** May also be in R3/4

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
FORESTS					
CEGL000255	ABIES CONCOLOR – (PICEA PUNGENS) – POPULUS ANGUSTIFOLIA / ACER GLABRUM FOREST	WHITE FIR – (BLUE SPRUCE) – NARROWLEAF COTTONWOOD / ROCKY MOUNTAIN MAPLE	G2	S2	R3/4
CRFEXXXXX7	ABIES LASIOCARPA – PICEA ENGELMANNII – POPULUS ANGUSTIFOLIA / LONICERA INVOLUCRATA FOREST	SUBALPINE FIR – ENGELMANN SPRUCE – NARROWLEAF COTTONWOOD / TWINBERRY HONEYSUCKLE FOREST	G4	S3	R3/4
CRFFABLA0B	ABIES LASIOCARPA – PICEA ENGELMANNII / RIBES SPP. FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / CURRANT SPP. FOREST	G5	S3	R2
CRFEABLA0B	ABIES LASIOCARPA – PICEA ENGELMANNII / ALNUS INCANA FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / THINLEAF ALDER FOREST	G5	S5	R2
CRFEABLA0A	ABIES LASIOCARPA – PICEA ENGELMANNII / CALAMAGROSTIS CANADENSIS FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / BLUEJOINT REEDGRASS FOREST	G5	S3	R2
CRFCABLA0I	ABIES LASIOCARPA – PICEA ENGELMANNII / CAREX AQUATILIS FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / WATER SEDGE FOREST	G3	S3	R2 S1/2
CRFFPIEN0A	ABIES LASIOCARPA – PICEA ENGELMANNII / EQUISETUM ARVENSE FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / FIELD HORSETAIL FOREST	G5	S2	R2
CRFEABLA0B	ABIES LASIOCARPA – PICEA ENGELMANNII / MERTENSIA CILIATA FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / TALL FRINGED BLUEBELLS FOREST	G5	S5	R2
CRFEABLA0F	ABIES LASIOCARPA – PICEA ENGELMANNII / SALIX DRUMMONDIANA FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / DRUMMOND WILLOW FOREST	G5	S4	R2
CWFDACNE2F	ACER NEGUNDO – POPULUS ANGUSTIFOLIA / CELTIS RETICULATA FOREST	BOXELDER – NARROWLEAF COTTONWOOD / NETLEAF HACKBERRY FOREST	G1Q	S1Q	R3/4
CEGL000627	ACER NEGUNDO – POPULUS ANGUSTIFOLIA / CORNUS SERICEA FOREST	BOXELDER – NARROWLEAF COTTONWOOD / RED-OSIER DOGWOOD FOREST	G2	S2	R2
CEGL000625	ACER NEGUNDO / CORNUS SERICEA FOREST	BOXELDER / RED-OSIER DOGWOOD FOREST	G3?	S2	R3/4

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CEGL000628	ACER NEGUNDO / PRUNUS VIRGINIANA FOREST	BOXELDER / CHOKECHERRY FOREST	G3	S2	R3/4
CEGL002643	POPULUS ANGUSTIFOLIA SAND DUNE FOREST	NARROWLEAF COTTONWOOD SAND DUNE FOREST	G1	S1	R3/4
CEGL000678	POPULUS DELTOIDES SSP. MONILIFERA / MUHLENBERGIA ASPERFOLIA FOREST	PLAINS COTTONWOOD / ALKALI MUHLY FOREST	G2Q	S1Q	R5
CEGL001150	POPULUS TREMULOIDES / ALNUS INCANA SSP. TENUIFOLIA FOREST	QUAKING ASPEN / THINLEAF ALDER FOREST	G3	S3	R3/4
CEGL002650	POPULUS TREMULOIDES / BETULA OCCIDENTALIS FOREST	QUAKING ASPEN / WATER BIRCH FOREST	G3	S2	R3/4
CEGL000582	POPULUS TREMULOIDES / CORNUS SERICEA FOREST	QUAKING ASPEN / RED-OSIER DOGWOOD FOREST	G4	S2S3	R3/4
CEGL000618	POPULUS TREMULOIDES / TALL FORB FOREST	QUAKING ASPEN / TALL FORB FOREST	G5	S5	R2
CEGL000563	POPULUS TREMULOIDES / ACER GLABRUM FOREST	QUAKING ASPEN / ROCKY MOUNTAIN MAPLE FOREST	G1G2	S1S2	R2
CEGL000452	PSEUDOTSUGA MENZIESII / QUERCUS GAMBELII FOREST	DOUGLAS-FIR / GAMBEL OAK FOREST	G5	S4	R3/4
CEGL000462	PSEUDOTSUGA MENZIESII / SYMPHORICARPOS OREOPHILUS FOREST	DOUGLAS-FIR / MOUNTAIN SNOWBERRY FOREST	G5	S4	R3/4
WOODLANDS					
CEGL000936	ACER NEGUNDO / BETULA OCCIDENTALIS WOODLAND	BOXELDER / WATER BIRCH WOODLAND	G1G2	S1	R3/4
CEGL000746	JUNIPERUS SCOPULORUM / CORNUS SERICEA WOODLAND	ROCKY MOUNTAIN JUNIPER / RED-OSIER DOGWOOD WOODLAND	G4	S2	R3/4
CEGL000894	PICEA PUNGENS / ALNUS INCANA SSP. TENUIFOLIA WOODLAND	BLUE SPRUCE / THINLEAF ALDER WOODLAND	G3	S3	R3/4
CEGL002637	PICEA PUNGENS / BETULA OCCIDENTALIS WOODLAND	BLUE SPRUCE / WATER BIRCH WOODLAND	G2	S2	R2
CEGL000388	PICEA PUNGENS / CORNUS SERICEA WOODLAND	BLUE SPRUCE / RED-OSIER DOGWOOD WOODLAND	G4	S2	R3/4
CEGL000389	PICEA PUNGENS / EQUISETUM ARVENSE WOODLAND	BLUE SPRUCE / FIELD HORSETAIL WOODLAND	G3?	S2?	R3/4

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CEGL002638	PINUS PONDEROSA / ALNUS INCANA SSP. TENUIFOLIA WOODLAND	PONDEROSA PINE / THINLEAF ALDER WOODLAND	G2	S2	R3/4
CEGL002640	POPULUS ANGUSTIFOLIA – JUNIPERUS SCOPULORUM WOODLAND	NARROWLEAF COTTONWOOD – ROCKY MOUNTAIN JUNIPER WOODLAND	G2G3	S2	R3/4
CEGL000934	POPULUS ANGUSTIFOLIA – PICEA PUNGENS / ALNUS INCANA WOODLAND	NARROWLEAF COTTONWOOD – BLUE SPRUCE / THINLEAF ALDER WOODLAND	G3	S3	R2
CEGL002641	POPULUS ANGUSTIFOLIA – PSEUDOTSUGA MENZIESII WOODLAND	NARROWLEAF COTTONWOOD – DOUGLAS-FIR WOODLAND	G3	S2	R3/4
CEGL002642	POPULUS ANGUSTIFOLIA / ALNUS INCANA SSP. TENUIFOLIA WOODLAND	NARROWLEAF COTTONWOOD / THINLEAF ALDER WOODLAND	G3	S3	R3/4
CEGL000648	POPULUS ANGUSTIFOLIA / BETULA OCCIDENTALIS WOODLAND	NARROWLEAF COTTONWOOD / WATER BIRCH WOODLAND	G3	S2	R3/4
CEGL002664	POPULUS ANGUSTIFOLIA / CORNUS SERICEA WOODLAND	NARROWLEAF COTTONWOOD / RED-OSIER DOGWOOD WOODLAND	G4	S3	R3/4
CEGL002644	POPULUS ANGUSTIFOLIA / CRATAEGUS RIVULARIS WOODLAND	NARROWLEAF COTTONWOOD / RIVER HAWTHORN WOODLAND	G2?	S2?	R3/4
CEGL000651	POPULUS ANGUSTIFOLIA / PRUNUS VIRGINIANA WOODLAND	NARROWLEAF COTTONWOOD / CHOKECHERRY WOODLAND	G2Q	S1	R5
CEGL000652	POPULUS ANGUSTIFOLIA / RHUS TRILOBATA WOODLAND	NARROWLEAF COTTONWOOD / SKUNKBUSH SUMAC WOODLAND	G3	S3	R3/4
CEGL002645	POPULUS ANGUSTIFOLIA / MIXED SALIX (MONTICOLA, DRUMMONDIANA, LUCIDA) WOODLAND	NARROWLEAF COTTONWOOD / MIXED WILLOW (ROCKY MOUNTAIN WILLOW, DRUMMOND WILLOW, WHIPLASH WILLOW) WOODLAND	G3	S3	R3/4
CEGL002646	POPULUS ANGUSTIFOLIA / SALIX DRUMMONDIANA – ACER GLABRUM WOODLAND	NARROWLEAF COTTONWOOD / DRUMMOND WILLOW – ROCKY MOUNTAIN MAPLE WOODLAND	G2?	S1?	R3/4
CEGL000654	POPULUS ANGUSTIFOLIA / SALIX EXIGUA WOODLAND	NARROWLEAF COTTONWOOD / SANDBAR WILLOW WOODLAND	G4	S4	R5
CEGL002647	POPULUS ANGUSTIFOLIA / SALIX IRRORATA WOODLAND	NARROWLEAF COTTONWOOD / BLUESTEM WILLOW WOODLAND	G2	S2	R3/4
CEGL000655	POPULUS ANGUSTIFOLIA / SALIX LIGULIFOLIA – SHEPHERDIA ARGENTEA WOODLAND	NARROWLEAF COTTONWOOD / STRAPLEAF WILLOW – SILVER BUFFALOBERRY WOODLAND	G1	S1	R3/4
CEGL002648	POPULUS ANGUSTIFOLIA / SYMPHORICARPOS ALBUS WOODLAND	NARROWLEAF COTTONWOOD / COMMON SNOWBERRY WOODLAND	G2Q	S2Q	R3/4

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CCNHPXXXX3	POPULUS ANGUSTIFOLIA / SALIX LUCIDA VAR. CAUDATA WOODLAND	NARROWLEAF COTTONWOOD / GREENLEAF WILLOW WOODLAND	G1Q	S1Q	R3/4
CRFAPOBA0A	POPULUS BALSAMIFERA WOODLAND	BALSAM POPLAR WOODLAND	GU	SU	R2
CPFAPODE3A	POPULUS DELTOIDES – (SALIX AMYGDALOIDES) / SALIX EXIGUA WOODLAND	COTTONWOOD – (PEACHLEAF WILLOW) / SANDBAR WILLOW WOODLAND	G3,G4	S3	R5
CCNHPXXX19	POPULUS DELTOIDES / PASCOPYRUM SMITHII – PANICUM OBTUSUM WOODLAND	COTTONWOOD / WESTERN WHEATGRASS – VINE MESQUITE WOODLAND	G1,G2Q	S1,S2Q	R5
CCNHPXXX18	POPULUS DELTOIDES / SPOROBOLUS CRYPTANDRUS WOODLAND	COTTONWOOD / SAND DROPSEED WOODLAND	G1G2Q	S1S2Q	R5
CEGL002649	POPULUS DELTOIDES SSP. MONILIFERA / CAREX PELLITA WOODLAND	PLAINS COTTONWOOD / WOOLLY SEDGE WOODLAND	G1G2	S1	R5
CEGL001454	POPULUS DELTOIDES SSP. MONILIFERA / PANICUM VIRGATUM – SCHIZACHYRIUM SCOPARIUM WOODLAND	PLAINS COTTONWOOD / SWITCHGRASS – LITTLE BLUESTEM WOODLAND	G1G2	S1	R5
CPFDPODE3G	POPULUS DELTOIDES SSP. MONILIFERA / PRUNUS VIRGINIANA WOODLAND	PLAINS COTTONWOOD / CHOKECHERRY WOODLAND	G1Q	S1Q	R5
CEGL000940	POPULUS DELTOIDES SSP. WISLIZENII / RHUS TRILOBATA WOODLAND	RIO GRANDE COTTONWOOD / SKUNKBUSH SUMAC WOODLAND	G2	S2	R3/4
	POPULUS DELTOIDES / BROMUS INERMIS WOODLAND	PLAINS COTTONWOOD / SMOOTH BROME WOODLAND	*	*	R5
CEGL000939	POPULUS DELTOIDES / DISTICHLIS SPICATA WOODLAND	PLAINS COTTONWOOD / INLAND SALTGRASS WOODLAND	GU	S1?	R5
	POPULUS DELTOIDES / SPARTINA PECTINATA WOODLAND	PLAINS COTTONWOOD / PRAIRIE CORDGRASS WOODLAND	G1G2	S1	R5
CCNHPXXX16	POPULUS DELTOIDES / SPOROBOLUS AIROIDES WOODLAND	PLAINS COTTONWOOD / ALKALI SACATON WOODLAND	G2Q	S2Q	R5
CCNHPXXX17	POPULUS DELTOIDES / SPOROBOLUS ASPER WOODLAND	PLAINS COTTONWOOD / DROPSEED WOODLAND	G1Q	S1Q	R5
CEGL000660	POPULUS DELTOIDES / SYMPHORICARPOS OCCIDENTALIS WOODLAND	PLAINS COTTONWOOD / WESTERN SNOWBERRY WOODLAND	G2G3	S2	R5
CEGL000944	POPULUS FREMONTII / SALIX GOODINGII WOODLAND	FREMONT COTTONWOOD – GOODDING WILLOW WOODLAND	G2	S1	R5

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CEGL002639	PSEUDOTSUGA MENZIESII / BETULA OCCIDENTALIS WOODLAND	DOUGLAS-FIR / WATER BIRCH WOODLAND	G3?	S3	R3/4
CRFEPSME0A	PSEUDOTSUGA MENZIESII / CORNUS SERICEA WOODLAND	DOUGLAS-FIR / RED-OSIER DOGWOOD WOODLAND	G4	S2	R3/4
CEGL000947	SALIX AMYGDALOIDES WOODLAND	PEACHLEAF WILLOW WOODLAND	G3	SU	R5
SHRUBLANDS					
CEGL001147	ALNUS INCANA / MESIC FORB SHRUBLAND	THINLEAF ALDER / MESIC FORB SHRUBLAND	G3,G4Q	S3	R2
CEGL00145	ALNUS INCANA SSP. TENUIFOLIA – CORNUS SERICEA SHRUBLAND	THINLEAF ALDER – RED-OSIER DOGWOOD SHRUBLAND	G3,G4	S3	R3/4
CEGL002651	ALNUS INCANA SSP. TENUIFOLIA – SALIX (MONTICOLA, LUCIDA, LIGULIFOLIA) SHRUBLAND	THINLEAF ALDER – WILLOW (ROCKY MOUNTAIN WILLOW, WHIPLASH WILLOW, STRAPLEAF WILLOW) SHRUBLAND	G3	S3	R3/4
CEGL002652	ALNUS INCANA SSP. TENUIFOLIA – SALIX DRUMMONDIANA SHRUBLAND	THINLEAF ALDER – DRUMMOND WILLOW SHRUBLAND	G3	S3	R3/4
CEGL001146	ALNUS INCANA SSP. TENUIFOLIA / EQUISETUM ARVENSE SHRUBLAND	THINLEAF ALDER / FIELD HORSETAIL SHRUBLAND	G3?	S3	R3/4
CEGL001148	ALNUS INCANA / MESIC GRAMINOID SHRUBLAND	THINLEAF ALDER / MESIC GRAMINOID SHRUBLAND	G5Q	S3	R2
CEGL001016	ARTEMISIA TRIDENTATA SSP. TRIDENTATA / LEYMUS CINEREUS SHRUBLAND	BIG SAGEBRUSH / BASIN WILDRYE SHRUBLAND	G2,G3	S1	R3/4
CCNHPXXX23	BACCHARIS SALICINA SHRUBLAND	GREAT PLAINS FALSE WILLOW	G2Q	S2Q	R5
CEGL002653	BETULA GLANDULOSA (BETULA NANA) / MESIC FORB – MESIC GRAMINOID SHRUBLAND	SWAMP BIRCH / MESIC FORB – MESIC GRAMINOID SHRUBLAND	G3,G4	S3	R1 R2
CEGL001162	BETULA OCCIDENTALIS / MESIC FORB SHRUBLAND	WATER BIRCH / MESIC FORB SHRUBLAND	G3	S2	R3/4
CEGL001085	CELTIS LAEVIGATA VAR. RETICULATA / PSEUDOROEGNERIA SPICATA WOODLAND	NETLEAF HACKBERRY / BLUEBUNCH WHEATGRASS WOODLAND	G2G3	S1S2	R3/4
	CHRYSOTHAMNUS VISCIDIFLORUS / DISTICHLIS SPICATA SHRUBLAND	GREEN RABBITBRUSH / INLAND SALTGRASS SHRUBLAND	*	*	F1 R5
CEGL001165	CORNUS SERICEA SHRUBLAND	RED-OSIER DOGWOOD SHRUBLAND	G4Q	S3	R3/4

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CWFAPSME1A	CORYLUS CORNUTA SHRUBLAND	BEAKED HAZELNUT SHRUBLAND	G3	S1	R3/4
CRSACRRI0A	CRATAEGUS RIVULARIS SHRUBLAND	RIVER HAWTHORN SHRUBLAND	G2Q	S2Q	R2? R3/4
CEGL001107	DASIPHORA (PENTAPHYLLOIDES) FLORIBUNDA / DESCHAMPSIA CESPITOSA SHRUBLAND	SHRUBBY-CINQUEFOIL / TUFTED HAIRGRASS SHRUBLAND	G4	S3S4	S3/4
	DASIPHORA (PENTAFYLLOIDES) FLORIBUNDA / JUNCUS BALTICUS VAR. MONTANUS SHRUBLAND	SHRUBBY CINQUEFOIL / MOUNTAIN RUSH SHRUBLAND	*	*	S3/4
CEGL001168	FORESTIERA PUBESCENS SHRUBLAND	WILD-PRIVET SHRUBLAND	G1G2	S1	R3/4
CWFEFRAN0A	FRAXINUS ANOMALA / QUERCUS GAMBELII SHRUBLAND	SINGLELEAF ASH / GAMBEL OAK SHRUBLAND	GUQ	S1Q	R3/4
	KALMIA POLIFOLIA – GAULTHERIA HUMIFUSA SHRUBLAND	BOG LAUREL – ALPINE SPICYWINTERGREEN SHRUBLAND	*	*	S1/2
CEGL001108	PRUNUS VIRGINIANA – (PRUNUS AMERICANA) SHRUBLAND	CHOKECHERRY – (AMERICAN PLUM) SHRUBLAND	G4Q	S3	R3/4
CWSEQUGA0B	QUERCUS GAMBELII / SYMPHORICARPOS SPP. SHRUBLAND	GAMBEL OAK / SNOWBERRY SPP. SHRUBLAND	G5	S3,S4	R3/4
CWSFRHTR0A	RHUS TRILOBATA SHRUBLAND	SKUNKBUSH SUMAC SHRUBLAND	G2	S2	R3/4
CEGL001174	SALIX BEBBIANA / MESIC GRAMINOID SHRUBLAND	BEBB WILLOW / MESIC GRAMINOIDS SHRUBLAND	G3?	S2	R2
CEGL001178	SALIX BOOTHII / CAREX UTRICULATA SHRUBLAND	BOOTH WILLOW / BEAKED SEDGE SHRUBLAND	G4	S3	R3/4
CEGL001180	SALIX BOOTHII / MESIC FORB SHRUBLAND	BOOTH WILLOW / MESIC FORB SHRUBLAND	G3	S3	R2
CEGL001/244	SALIX BRACHYCARPA / CAREX AQUATILIS SHRUBLAND	BARRENGROUND WILLOW / WATER SEDGE SHRUBLAND	G2G3	S2,S3	R3/4 S1/2
CEGL001135	SALIX BRACHYCARPA / MESIC FORB SHRUBLAND	BARRENGROUND WILLOW / MESIC FORB SHRUBLAND	G4	S4	R3/4 S1/2
	SALIX CANDIDA / TRIGLOCHIN MARITIMUM SHRUBLAND	SAGELEAF WILLOW / SEASIDE ARROWGRASS SHRUBLAND	*	*	S1/2

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CEGL002667	SALIX DRUMMONDIANA / CALAMAGROSTIS CANADENSIS SHRUBLAND	DRUMMOND WILLOW / BLUEJOINT REEDGRASS SHRUBLAND	G3	S3	R2
CEGL001192	SALIX DRUMMONDIANA / MESIC FORB SHRUBLAND	DRUMMOND WILLOW / MESIC FORB SHRUBLAND	G4	S4	R2
CRWASABR0C	SALIX DRUMMONDIANA / CAREX AQUATILIS SHRUBLAND	DRUMMOND WILLOW / WATER SEDGE SHRUBLAND	G2G3	S2S3	R3/4
CEGL002655	SALIX EXIGUA – SALIX LIGULIFOLIA SHRUBLAND	SANDBAR WILLOW – STRAPLEAF WILLOW SHRUBLAND	G2G3	S2S3	R5
CEGL001/200	SALIX EXIGUA / BARREN GROUND SHRUBLAND	SANDBAR WILLOW / BARREN GROUND SHRUBLAND	G5	S5	R5
CEGL001/203	SALIX EXIGUA / MESIC GRAMINOID SHRUBLAND	SANDBAR WILLOW / MESIC GRAMINOID SHRUBLAND	G5	S5	R5
CEGL001/247	SALIX GEYERIANA – SALIX MONTICOLA / CALAMAGROSTIS CANADENSIS SHRUBLAND	GEYER WILLOW – ROCKY MOUNTIAN WILLOW / BLUEJOINT REEDGRASS SHRUBLAND	G3	S3	R2
CEGL001/223	SALIX GEYERIANA – SALIX MONTICOLA / MESIC FORB SHRUBLAND	GEYER WILLOW – ROCKY MOUNTAIN WILLOW / MESIC FORB SHRUBLAND	G3	S3	R2
CEGL001/205	SALIX GEYERIANA / CALAMAGROSTIS CANADENSIS SHRUBLAND	GEYER WILLOW / BLUEJOINT REEDGRASS SHRUBLAND	G5	S3	R3/4
CEGL001/206	SALIX GEYERIANA / CAREX AQUATILIS SHRUBLAND	GEYER WILLOW / WATER SEDGE SHRUBLAND	G3	S3	R3/4
CEGL001/207	SALIX GEYERIANA / CAREX UTRICULATA SHRUBLAND	GEYER WILLOW / BEAKED SEDGE SHRUBLAND	G5	S3	R3/4
CEGL002666	SALIX GEYERIANA / MESIC FORB SHRUBLAND	GEYER WILLOW / MESIC FORB SHRUBLAND	G3	S3	R2
CRWASALU1A	SALIX LASIANDRA (VAR. CAUDATA OR VAR. LASIANDRA) SHRUBLAND	WHIPLASH WILLOW SHRUBLAND	G3Q	S2,S3	R3/4
CEGL001/218	SALIX LIGULIFOLIA (=SALIX ERIOCEPHALA VAR. LIGULIFOLIA) SHRUBLAND	STRAPLEAF WILLOW SHRUBLAND	G2G3	S2S3	R3/4
CEGL001/222	SALIX MONTICOLA / CALAMAGROSTIS CANADENSIS SHRUBLAND	ROCKY MOUNTAIN WILLOW / BLUEJOINT REEDGRASS SHRUBLAND	G3	S3	R2
CEGL002656	SALIX MONTICOLA / CAREX AQUATILIS SHRUBLAND	ROCKY MOUNTAIN WILLOW / WATER SEDGE SHRUBLAND	G3	S3	R2

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CEGL002658	SALIX MONTICOLA / MESIC FORB SHRUBLAND	ROCKY MOUNTAIN WILLOW / MESIC FORB SHRUBLAND	G3	S3	R2
CEGL002659	SALIX MONTICOLA / MESIC GRAMINOID SHRUBLAND	ROCKY MOUNTAIN WILLOW / MESIC GRAMINOID SHRUBLAND	G3	S3	R3/4
CEGL001/225	SALIX PLANIFOLIA / CALAMAGROSTIS CANADENSIS SHRUBLAND	PLANELEAF WILLOW / BLUEJOINT REEDGRASS SHRUBLAND	G3	S3	R1 R3/4 S1/2
CEGL002665	SALIX PLANIFOLIA / CALTHA LEPTOSEPALA SHRUBLAND	PLANELEAF WILLOW / WHITE MARSH-MARIGOLD SHRUBLAND	G4	S4	R3/4 S1/2
CEGL001/227	SALIX PLANIFOLIA / CAREX AQUATILIS SHRUBLAND	PLANELEAF WILLOW / WATER SEDGE SHRUBLAND	G5	S4	R3/4 S1/2
CCNHPXXX26	SALIX PLANIFOLIA / MESIC FORB SHRUBLAND	PLANELEAF WILLOW / MESIC FORB SHRUBLAND	G4	S4	R2 S1/2
CRWASAWO0C	SALIX WOLFII / CALAMAGROSTIS CANADENSIS SHRUBLAND	WOLF WILLOW / BLUEJOINT REEDGRASS SHRUBLAND	G3	S2,S3	R1 **
CEGL001/234	SALIX WOLFII / CAREX AQUATILIS SHRUBLAND	WOLF WILLOW / WATER SEDGE SHRUBLAND	G4	S3	R1 S1/2 **
CEGL001/237	SALIX WOLFII / CAREX UTRICULATA SHRUBLAND	WOLF WILLOW / BEAKED SEDGE SHRUBLAND	G4	S3	R1 S1/2 **
CEGL001/240	SALIX WOLFII / MESIC FORB SHRUBLAND	WOLF WILLOW / MESIC FORB SHRUBLAND	G3	S3	R1 S1/2**
	SARCOBATUS VERMICULATUS / BARE GROUND SHRUBLAND	BLACK GREASEWOOD / BARE GROUND SHRUBLAND	*	*	F1
CEGL001363	SARCOBATUS VERMICULATUS / DISTICHLIS SPICATA SHRUBLAND	BLACK GREASEWOOD / INLAND SALTGRASS SHRUBLAND	G4	S1	F1 **
CEGL001368	SARCOBATUS VERMICULATUS / SPOROBOLUS AIROIDES SPARSE VEGETATION	BLACK GREASEWOOD / ALKALI SACATON SPARSE VEGETATION	*	*	F1
CEGL001370	SARCOBATUS VERMICULATUS / SUAEDA MOQUINII (CALCEOLIFORMIS) SHRUBLAND	BLACK GREASEWOOD / PURSH SEEPWEED SHRUBLAND	*	*	F1
CEGL0011/28	SHEPHERDIA ARGENTEA SHRUBLAND	SILVER BUFFALOBERRY SHRUBLAND	G3G4	S1	R3/4
CEGL001131	SYMPHORICARPOS OCCIDENTALIS SHRUBLAND	WESTERN SNOWBERRY SHRUBLAND	G4G5	S3	R5

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
	TAMARIX RAMOSISSIMA SHRUBLAND	SALTCEDAR SHRUBLAND	*	*	R5

HERBACEOUS VEGETATION

	AGROSTIS GIGANTEA HERBACEOUS VEGETATION	BLACK BENTGRASS HERBACEOUS VEGETATION	*	*	S3/4
	ALOPECURUS AEQUALIS HERBACEOUS VEGETATION	SHORTAWN FOXTAIL HERBACEOUS VEGETATION	*	*	D4/5
CPWAANGE0A CEGL001464?	ANDROPOGON GERARDII / SORGHASTRUM NUTANS-(SPARTINA PECTINATA) HERBACEOUS VEGETATION	BIG BLUESTEM / YELLOW INDIANGRASS – PRAIRIE CORDGRASS HERBACEOUS VEGETATION	G2	S1,S2	R5
	BIDENS CERNUA HERBACEOUS VEGETATION	NODDING BEGGARTICK HERBACEOUS VEGETATION	*	*	D2/3
CCNHPXXX22	BOTHRIOCHLOA SPRINGFIELDII HERBACEOUS VEGETATION	SPRINGFIELD'S BEARDGRASS HERBACEOUS VEGETATION	G1,G2Q	S1,S2Q	R5**
CEGL001559	CALAMAGROSTIS CANADENSIS WESTERN HERBACEOUS VEGETATION	BLUEJOINT REEDGRASS WESTERN HERBACEOUS VEGETATION	G4	S4	R1, R2
CEGL001954	CALTHA LEPTOSEPALA HERBACEOUS VEGETATION	WHITE MARSH-MARIGOLD HERBACEOUS VEGETATION	G4	S4	S1/2**
CEGL002662	CARDAMINE CORDIFOLIA – MERTENSIA CILIATA – SENECIO TRIANGULARIS HERBACEOUS VEGETATION	LARGE MOUNTAIN BITTERCRESS – MOUNTAIN BLUEBELLS – ARROWLEAF RAGWORT HERBACEOUS VEGETATION	G4	S4	R1
CEGL001803	CAREX AQUATILIS – CAREX UTRICULATA HERBACEOUS VEGETATION	WATER SEDGE – BEAKED SEDGE HERBACEOUS VEGETATION	G4	S4	D1 S1/2/3/4?
CEGL001802	CAREX AQUATILIS HERBACEOUS VEGETATION	WATER SEDGE HERBACEOUS VEGETATION	G5	S4	S1/2
CEGL001804	CAREX AQUATILIS – PEDICULARIS GROENLANDICA HERBACEOUS VEGETATION	WATER SEDGE – ELEPHANTHEAD LOUSEWORT HERBACEOUS VEGETATION	GU	SU	S1/2
CEGL001872	CAREX CAPILLARIS – POLYGONUM VIVIPARUM HERBACEOUS VEGETATION	HAIR SEDGE – SERPENT-GRASS HERBACEOUS VEGETATION	GU	SU	S1/2
CEGL001876	CAREX ILLOTA HERBACEOUS VEGETATION	SMALL-HEAD SEDGE HERBACEOUS VEGETATION	GUQ	S1?	S1/2
CEGL001972	CAREX MICROPTERA HERBACEOUS VEGETATION	SMALLWING SEDGE HERBACEOUS VEGETATION	G4	S2?	S1/2 **

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CEGL001813	CAREX NEBRASCENSIS HERBACEOUS VEGETATION	NEBRASKA SEDGE HERBACEOUS VEGETATION	G4	S3	D2/3 S3/4 **
CEGL001818	CAREX NIGRICANS – JUNCUS DRUMMONDII HERBACEOUS VEGETATION	BLACK ALPINE SEDGE – DRUMMOND RUSH HERBACEOUS VEGETATION	GU	SU	S1/2
CEGL001809	CAREX PELLITA (LANUGINOSA) HERBACEOUS VEGETATION	WOOLLY SEDGE HERBACEOUS VEGETATION	G3	S3	D2/3 S3/4 **
CEGL002660	CAREX PRAEGRACILIS HERBACEOUS VEGETATION	CLUSTERED FIELD SEDGE HERBACEOUS VEGETATION	G3G4	S2	R3/4 S3/4
CEGL001769	CAREX SAXATILIS HERBACEOUS VEGETATION	RUSSET SEDGE HERBACEOUS VEGETATION	G3	S2	S1/2 **
CEGL001823	CAREX SCOPULORUM – CALTHA LEPTOSEPALA HERBACEOUS VEGETATION	MOUNTAIN SEDGE – WHITE MARSH-MARIGOLD HERBACEOUS VEGETATION	G4	S4	S1/2 **
CEGL001825	CAREX SIMULATA HERBACEOUS VEGETATION	ANALOGUE SEDGE HERBACEOUS VEGETATION	G4	S3	S1/2 **
CEGL001562	CAREX UTRICULATA HERBACEOUS VEGETATION	BEAKED SEDGE HERBACEOUS VEGETATION	G5	S4	D1 S3/4**
CEGL001868	CAREX VERNACULA HERBACEOUS VEGETATION	NATIVE SEDGE HERBACEOUS VEGETATION	GU	SU	R3/4
CEGL002661	CAREX VESICARIA HERBACEOUS VEGETATION	INFLATED SEDGE HERBACEOUS VEGETATION	G4Q	S1	R3/4
CEGL001599	DESCHAMPSIA CESPITOSA HERBACEOUS VEGETATION	TUFTED HAIRGRASS HERBACEOUS VEGETATION	G4?	S4	S3/4 **
CEGL001770	DISTICHLIS SPICATA HERBACEOUS VEGETATION	INLAND SALTGRASS HERBACEOUS VEGETATION	G5	S3	F1 R3/4
	ECHINOCHLOA CRUS-GALLI HERBACEOUS VEGETATION	BARNYARDGRASS HERBACEOUS VEGETATION	*	*	D4/5
CEGL001832	ELEOCHARIS ACICULARIS HERBACEOUS VEGETATION	NEEDLE SPIKERUSH HERBACEOUS VEGETATION	G4?	S3S4	D4/5
CEGL001833	ELEOCHARIS PALUSTRIS HERBACEOUS VEGETATION	MARSH SPIKERUSH HERBACEOUS VEGETATION	G5	S4	D2/3 **
CEGL001836	ELEOCHARIS QUINQUEFLORA HERBACEOUS VEGETATION	FEW-FLOWER SPIKERUSH HERBACEOUS VEGETATION	G4	S3S4	S1/2 **

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
	GLAUX MARITIMA HERBACEOUS VEGETATION	SEA MILKWORT HERBACEOUS VEGETATION	*	*	F1
	GLYCERIA GRANDIS HERBACEOUS VEGETATION	AMERICAN MANNAGRASS HERBACEOUS VEGETATION	*	*	D2/3
	GLYCERIA STRIATA HERBACEOUS VEGETATION	FOWL MANNAGRASS HERBACEOUS VEGETATION	*	*	R2
	GLYCERIA STRIATA-MIMULUS GUTTATUS-EPILOBIUM LACTIFLORUM HERBACEOUS VEGETATION	FOWL MANNAGRAS – SEEP MONKEYFLOWER – MILKFLOWER WILLOWHERB HERBACEOUS VEGETATION	*	*	R1
CEGL001798	HORDEUM (CRITESION) JUBATUM HERBACEOUS VEGETATION	FOXTAIL BARLEY HERBACEOUS VEGETATION	G2,G4	S1	D2/3 D4/5
CEGL001838	JUNCUS BALTICUS VAR. MONTANUS HERBACEOUS VEGETATION	MOUNTAIN RUSH HERBACEOUS VEGETATION	G5	S5	R3/4
	JUNCUS BALTICUS VAR. MONTANUS – ARGENTINA ANSERINA HERBACEOUS VEGETATION	MOUNTAIN RUSH – SILVERWEED CINQUEFOIL HERBACEOUS VEGETATION	*	*	S3/4
	JUNCUS BALTICUS VAR. MONTANUS - CAREX PRAEGRACILIS HERBACEOUS VEGETATION	MOUNTAIN RUSH – CLUSTERED FIELD SEDGE HERBACEOUS VEGETATION	*	*	S3/4
	JUNCUS BALTICUS VAR. MONTANUS - DESCHAMPSIA CESPITOSA HERBACEOUS VEGETATION	MOUNTAIN RUSH – TUFTED HAIRGRASS HERBACEOUS VEGETATION	*	*	S3/4
	JUNCUS BLATICUS VAR. MONTANUS – POA PRATENSIS HERBACEOUS VEGETATION	MOUNTAIN RUSH – KENTUCKY BLUEGRASS HERBACEOUS VEGETATION	*	*	S3/4
CEGL002900	KOBRESIA MYOSUROIDES – THALICTRUM ALPINUM HERBACEOUS VEGETATION	PACIFIC BOG SEDGE – ALPINE MEADOWRUE HERBACEOUS VEGETATION	G2	S1	S1/2
	KOBRESIA SIMPLICIUSCULA – TRICHOPHORUM PUMILUM	SIMPLE BOG SEDGE – ROLLAND'S BULRUSH	G2?	S1	S1/2
CEGL001779	MUHLENBERGIA ASPERIFOLIA HERBACEOUS VEGETATION	ALKALI MUHLY HERBACEOUS VEGETATION	GU	SU	F1 R5
CEGL001573	PANICUM OBTUSUM – BUCHLOE DACTYLOIDES HERBACEOUS VEGETATION	VINE-MESQUITE – BUFFALO GRASS HERBACEOUS VEGETATION	G?Q	S1S2	R5
CEGL001578	PASCOPYRUM SMITHII – BOUTELOUA GRACILIS HERBACEOUS VEGETATION	WESTERN WHEATGRASS – BLUE GRAMA HERBACEOUS VEGETATION	G5	S4	R5
	PASCOPYRUM SMITHII – (BUCHLOE DACTYLOIDES) – AMBROSIA LINEARIS – RATIBIDA TAGETES HERBACEOUS VEGETATION	WESTERN WHEATGRASS – (BUFFALO GRASS) – PLAINS AMBROSIA – CONEFLOWER HERBACEOUS VEGETATION	*	*	R5

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
	PHALARIS ARUNDINACEA WESTERN HERBACEOUS VEGETATION	REED CANARYGRASS WESTERN HERBACEOUS VEGETATION	G5	*	D2/3
CEGL001475	PHRAGMITES AUSTRALIS HERBACEOUS VEGETATION	COMMON REED HERBACEOUS VEGETATION	G4	S3	R5
	POLYGONUM ARENASTRUM HERBACEOUS VEGETATION	OVAL-LEAF KNOTWEED HERBACEOUS VEGETATION	*	*	D4/5
	POLYGONUM LAPATHIFOLIUM HERBACEOUS VEGETATION	CURLY KNOTWEED HERBACEOUS VEGETATION	*	*	D4/5
CEGL001799	PUCCINELLIA NUTTALLIANA (AIROIDES) HERBACEOUS VEGETATION	NUTTALL'S ALKALIGRASS HERBACEOUS VEGETATION	G3	S1	F1
CPWDSCTA0A	SCHOENOPLECTUS ACUTUS VAR ACUTUS – SCHOENOPLECTUS TABERNAEMONTANI HERBACEOUS VEGETATION	HARDSTEM BULRUSH – SOFTSTEM BULRUSH HERBACEOUS VEGETATION	G3	S2,S3	D2/3
CEGL001843	SCHOENOPLECTUS MARITIMUS HERBACEOUS VEGETATION	COSMOPOLITAN BULRUSH HERBACEOUS VEGETATION	G4	S2	F1
CEGL001587	SCHOENOPLECTUS PUNGENS HERBACEOUS VEGETATION	THREESQUARE BULRUSH HERBACEOUS VEGETATION	G3G4	S3	D2/3
	SCIRPUS NEVADENSIS HERBACEOUS VEGETATION	NEVADA BULRUSH HERBACEOUS VEGETATION	G4	S2	F1
	SCIRPUS PALLIDUS HERBACEOUS VEGETATION	CLOAKED BULRUSH HERBACEOUS VEGETATION	*	*	D2/3
CEGL001588	SPARTINA GRACILIS HERBACEOUS VEGETATION	ALKALI CORDGRASS HERBACEOUS VEGETATION	GU	SU	F1
CEGL001476	SPARTINA PECTINATA WESTERN HERBACEOUS VEGETATION	PRAIRIE CORDGRASS WESTERN HERBACEOUS VEGETATION	G3?	S1	R3/4
CEGL001685	SPOROBOLUS AIROIDES SOUTHERN PLAINS HERBACEOUS VEGETATION	ALKALI SACATON SOUTHERN PLAINS HERBACEOUS VEGETATION	G3Q	S3	F1 / R5
	SUAEDA CALCEOLIFORMIS HERBACEOUS VEGETATION	PURSH SEEPWEED HERBACEOUS VEGETATION	*	*	F1
	TRIGLOCHIN MARITIMUM HERBACEOUS VEGETATION	SEASIDE ARROWGRASS HERBACEOUS VEGETATION	*	*	F1
	TRIGLOCHIN MARITIMUM – TRIGLOCHIN PALUSTRIS HERBACEOUS VEGETATION	SEASIDE ARROWGRASS – MEADOW ARROWGRASS HERBACEOUS VEGETATION	*	*	S1/2

Element Code	Scientific Name	Common Name	G Rank	S Rank	HGM group
CPWDTYAN0A	TYPHA ANGUSTIFOLIA – TYPHA LATIFOLIA HERBACEOUS VEGETATION	CATTAIL HERBACEOUS VEGETATION	G5	S3	D2/3
	VERONICA CATENATA – JUNCUS BUFONIUS HERBACEOUS VEGETATION	SPEEDWELL – TOAD RUSH HERBACEOUS VEGETATION	*	*	D4/5
	XANTHIUM STRUMARIUM HERBACEOUS VEGETATION	ROUGH COCKLEBURR HERBACEOUS VEGETATION	*	*	D4/5

Table 5. Wetland Plant Associations of Colorado by HGM group

Only associations with an Elcode beginning with CEGL are classified by USNVC.

Element Code	Scientific Name	Common Name
FLATS 1		
	CHRYSOTHAMNUS VISCIDIFLORUS / DISTICHLIS SPICATA SHRUBLAND	GREEN RABBITBRUSH / INLAND SALTGRASS HERBACEOUS VEGETATION
CEGL001770	DISTICHLIS SPICATA HERBACEOUS VEGETATION	INLAND SALTGRASS HERBACEOUS VEGETATION
	GLAUX MARITIMA HERBACEOUS VEGETATION	SEA MILKWORT HERBACEOUS VEGETATION
CEGL001779	MUHLENBERGIA ASPERIFOLIA HERBACEOUS VEGETATION	ALKALI MUHLY HERBACEOUS VEGETATION
CEGL001799	PUCCINELLIA NUTTALLIANA (AIROIDES) HERBACEOUS VEGETATION	NUTTALL'S ALKALIGRASS HERBACEOUS VEGETATION
	SARCOBUTUS VERMICULATUS / BARE GROUND SHRUBLAND	BLACK GREASEWOOD / BARE GROUND SHRUBLAND
CEGL001363	SARCOBATUS VERMICULATUS / DISTICHLIS SPICATA SHRUBLAND	BLACK GREASEWOOD / INLAND SALTGRASS SHRUBLAND
CEGL001368	SARCOBATUS VERMICULATUS / SPOROBOLUS AIROIDES SPARSE VEGETATION	BLACK GREASEWOOD / ALKALI SACATON SPARSE VEGETATION
CEGL001370	SARCOBATUS VERMICULATUS / SUAEDA MOQUINII (CALCEOLIFORMIS) SHRUBLAND	BLACK GREASEWOOD / SHRUBBY SEEPWEED SHRUBLAND
CEGL001843	SCHOENOPLECTUS MARITIMUS HERBACEOUS VEGETATION	COSMOPOLITAN BULRUSH HERBACEOUS VEGETATION
	SCIRPUS NEVADENSIS HERBACEOUS VEGETATION	NEVADA BULRUSH HERBACEOUS VEGETATION
CEGL001588	SPARTINA GRACILIS HERBACEOUS VEGETATION	ALKALI CORDGRASS HERBACEOUS VEGETATION
CEGL001685	SPOROBOLUS AIROIDES SOUTHERN PLAINS HERBACEOUS VEGETATION	ALKALI SACATON SOUTHERN PLAINS HERBACEOUS VEGETATION
	SUAEDA CALCEOLIFORMIS HERBACEOUS VEGETATION	PURSH SEEPWEED HERBACEOUS VEGETATION
	TRIGLOCHIN MARITIMUM HERBACEOUS VEGETATION	SEASIDE ARROWGRASS HERBACEOUS VEGETATION
DEPRESSIONAL 1		
CEGL001803	CAREX AQUATILIS – CAREX UTRICULATA HERBACEOUS VEGETATION	WATER SEDGE – BEAKED SEDGE HERBACEOUS VEGETATION
CEGL001562	CAREX UTRICULATA HERBACEOUS VEGEATION	BEAKED SEDGE HERBACEOUS VEGETATION
DEPRESSIONAL 2 and 3		

Element Code	Scientific Name	Common Name
	BIDENS CERNUA HERBACEOUS VEGETATION	NODDING BEGGARTICK HERBACEOUS VEGETATION
CEGL001813	CAREX NEBRASCENSIS HERBACEOUS VEGETATION	NEBRASKA SEDGE HERBACEOUS VEGETATION
CEGL001809	CAREX PELLITA (LANUGINOSA) HERBACEOUS VEGETATION	WOOLLY SEDGE HERBACEOUS VEGETATION
CEGL001833	ELEOCHARIS PALUSTRIS HERBACEOUS VEGETATION	MARSH SPIKERUSH HERBACEOUS VEGETATION
	GLYCERIA GRANDIS HERBACEOUS VEGETATION	AMERICAN MANNAGRASS HERBACEOUS VEGETATION
CEGL001798	HORDEUM (CRITESION) JUBATUM HERBACEOUS VEGETATION	FOXTAIL BARLEY HERBACEOUS VEGETATION
	PHALARIS ARUNDINACEA WESTERN HERBACEOUS VEGETATION	REED CANARY GRASS WESTERN HERBACEOUS VEGETATION
CPWDSCTAQA	SCHOENOPLECTUS ACUTUS – SCHOENOPLECTUS TABERNAEMONTANI HERBACEOUS VEGETATION	HARDSTEM BULRUSH – SOFTSTEM BULRUSH HERBACEOUS VEGETATION
CEGL001587	SCHOENOPLECTUS PUNGENS HERBACEOUS VEGETATION	THREESQUARE BULRUSH HERBACEOUS VEGETATION
	SCIRPUS PALLIDUS HERBACEOUS VEGETATION	CLOAKED BULRUSH HERBACEOUS VEGETATION
CPWDTYAN0A	TYPHA ANGUSTIFOLIA – TYPHA LATIFOLIA HERBACEOUS VEGETATION	CATTAIL HERBACEOUS VEGETATION
DEPRESSIONAL 4 and 5		
	ALOPECURUS AEQUALIS HERBACEOUS VEGETATION	SHORTAWN FOXTAIL HERBACEOUS VEGETATION
	ECHINOCHLOA CRUS-GALLI HERBACEOUS VEGETATION	BARNYARDGRASS HERBACEOUS VEGETATION
CEGL001832	ELEOCHARIS ACICULARIS HERBACEOUS VEGETATION	NEEDLE SPIKERUSH HERBACEOUS VEGETATION
CEGL001798	HORDEUM (CRITESION) JUBATUM HERBACEOUS VEGETATION	FOXTAIL BARLEY HERBACEOUS VEGETATION
	PASCOPYRUM SMITHII – (BUCHLOE DACTYLOIDES) – AMBROSIA LINEARIS – RATIBIDA TAGETES HERBACEOUS VEGETATION	WESTERN WHEATGRASS – (BUFFALO GRASS) – PLAINS AMBROSIA – CONEFLOWER HERBACEOUS VEGETATION
	POLYGONUM ARENASTRUM HERBACEOUS VEGETATION	OVALLEAF KNOTWEED HERBACEOUS VEGETATION
	POLYGONUM LAPATHIFOLIUM HERBACEOUS VEGETATION	SMARTWEED HERBACEOUS VEGETATION
	VERONICA CATENATA – JUNCUS BUFONIUS HERBACEOUS VEGETATION	SPEEDWELL – TOAD RUSH HERBACEOUS VEGETATION
	XANTHIUM STRUMARIUM HERBACEOUS VEGETATION	ROUGH COCKLEBURR HERBACEOUS VEGETATION
SLOPE 1 and 2		
	ABIES LASIOCARPA – PICEA ENGELMANII / CAREX AQUATILIS FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / WATER SEDGE FOREST
CEGL001954	CALTHA LEPTOSEPALA HERBACEOUS VEGETATION	WHITE MARSH-MARIGOLD HERBACEOUS VEGETATION
CEGL001803	CAREX AQUATILIS – CAREX UTRICULATA HERBACEOUS VEGETATION	WATER SEDGE – BEAKED SEDGE HERBACEOUS VEGETATION

Element Code	Scientific Name	Common Name
CEGL001802	CAREX AQUATILIS HERBACEOUS VEGETATION	WATER SEDGE HERBACEOUS VEGETATION
CEGL001804	CAREX AQUATILIS – PEDICULARIS GROENLANDICA HERBACEOUS VEGETATION	WATER SEDGE – ELEPHANTHEAD LOUSEWORT HERBACEOUS VEGETATION
CEGL001872	CAREX CAPILLARIS – POLYGONUM VIVIPARUM HERBACEOUS VEGETATION	HAIR SEDGE – SERPENT-GRASS HERBACEOUS VEGETATION
CEGL001876	CAREX ILLOTA HERBACEOUS VEGETATION	SMALL-HEAD SEDGE HERBACEOUS VEGETATION
CEGL001972	CAREX MICROPTERA HERBACEOUS VEGETATION	SMALL-WING SEDGE HERBACEOUS VEGETATION
CEGL001818	CAREX NIGRICANS – JUNCUS DRUMMONDII HERBACEOUS VEGETATION	BLACK ALPINE SEDGE – DRUMMOND RUSH HERBACEOUS VEGETATION
CEGL001769	CAREX SAXATILIS HERBACEOUS VEGETATION	RUSSET SEDGE HERBACEOUS VEGETATION
CEGL001823	CAREX SCOPULORUM – CALTHA LEPTOSEPALA HERBACEOUS VEGETATION	MOUNTAIN SEDGE – WHITE MARSH-MARIGOLD HERBACEOUS VEGETATION
CEGL001825	CAREX SIMULATA HERBACEOUS VEGETATION	ANALOGUE SEDGE HERBACEOUS VEGETATION
CEGL001836	ELEOCHARIS QUINQUEFLORA HERBACEOUS VEGETATION	FEW-FLOWER SPIKERUSH HERBACEOUS VEGETATION
	KALMIA POLIFOLIA – GAULTHERIA HUMIFUSA SHRUBLAND	ALPINE LAUREL / ALPINE SPICYWINTERGREEN SHRUBLAND
CEGL002900	KOBRESIA MYOSUROIDES – THALICTRUM ALPINUM HERBACEOUS VEGETATION	PACIFIC BOG SEDGE – ALPINE MEADOWRUE HERBACEOUS VEGETATION
	KOBRESIA SIMPLICIUSCULA -TRICHOPHORUM PUMILUM HERBACEOUS VEGETATION	SIMPLE BOG SEDGE HERBACEOUS VEGETATION
CEGL001244	SALIX BRACHYCARPA – CAREX AQUATILIS SHRUBLAND	BARRENGROUND WILLOW – WATER SEDGE SHRUBLAND
CEGL001135	SALIX BRACHYCARPA – MESIC FORB SHRUBLAND	BARRENGROUND WILLOW – MESIC FORB SHRUBLAND
	SALIX CANDIDA – TRIGLOCHIN MARITIMUM SHRUBLAND	SAGELEAF WILLOW – SEASIDE ARROWGRASS SHRUBLAND
CEGL001225	SALIX PLANIFOLIA – CALAMAGROSTIS CANADENSIS SHRUBLAND	PLANELEAF WILLOW – BLUEJOINT REEDGRASS SHRUBLAND
CEGL002665	SALIX PLANIFOLIA – CALTHA LEPTOSEPALA SHRUBLAND	PLANELEAF WILLOW – WHITE MARSH MARIGOLD SHRUBLAND
CEGL001277	SALIX PLANIFOLIA – CAREX AQUATILIS SHRUBLAND	PLANELEAF WILLOW – WATER SEDGE SHRUBLAND
CCNHP22226	SALIX PLANIFOLIA – MESIC FORB SHRUBLAND	PLANELEAF WILLOW – MESIC FORB SHRUBLAND
CEGL001234	SALIX WOLFII – CAREX AQUATILIS SHRUBLAND	WOLF WILLOW – WATER SEDGE SHRUBLAND
CEGL001240	SALIX WOLFII – MESIC FORB SHRUBLAND	WOLF WILLOW – MESIC FORB SHRUBLAND
	TRIGLOCHIN MARITIMUM -TRIGLOCHIN PALUSTRIS HERBACEOUS VEGETATION	SEASIDE ARROWGRASS / MEADOW ARROWGRASS HERBACEOUS VEGETATION

SLOPE 3 and 4

	AGROSTIS GIGANTEA HERBACEOUS VEGETATION	BLACK BENTGRASS HERBACEOUS VEGETATION
CEGL001803	CAREX AQUATILIS – CAREX UTRICULATA HERBACEOUS VEGETATION	WATER SEDGE – BEAKED SEDGE HERBACEOUS VEGETATION
CEGL001813	CAREX NEBRASCENSIS HERBACEOUS VEGETATION	NEBRASKA SEDGE HERBACEOUS VEGETATION

Element Code	Scientific Name	Common Name
CEGL001809	CAREX PELLITA (CAREX LANUGINOSA) HERBACEOUS VEGETATION	WOOLLY SEDGE HERBACEOUS VEGETATION
CEGL002660	CAREX PRAEGRACILIS HERBACEOUS VEGETATION	CLUSTERED FIELD SEDGE HERBACEOUS VEGETATION
CRWCCARO64	CAREX UTRICULATA HERBACEOUS VEGETATION	BEAKED SEDGE HERBACEOUS VEGETATION
CEGL001107	DASIPHORA (PENTAPHYLLOIDES) FLORIBUNDA / DESCHAMPSIA CESPITOSA SHRUBLAND	SHRUBBY CINQUEFOIL / TUFTED HAIRGRASS SHRUBLAND
	DASIPHORA (PENTAPHYLLOIDES) FLORIBUNDA / JUNCUS BALTICUS VAR. MONTANUS SHRUBLAND	SHRUBBY CINQUEFOIL / MOUNTAIN RUSH SHRUBLAND
CEGL001599	DESCHAMPSIA CESPITOSA HERBACEOUS VEGETATION	TUFTED HAIRGRASS HERBACEOUS VEGETATION
CEGL001838	JUNCUS BALTICUS VAR. MONTANUS HERBACEOUS VEGETATION	MOUNTAIN RUSH HERBACEOUS VEGETATION
	JUNCUS BALTICUS VAR. MONTANUS – ARGENTINA ANSERINA HERBACEOUS VEGETATION	MOUNTAIN RUSH – SILVERWEED CINQUEFOIL HERBACEOUS VEGETATION
	JUNCUS BALTICUS VAR. MONTANUS – CAREX PRAEGRACILIS HERBACEOUS VEGETATION	MOUNTAIN RUSH – CLUSTERED FIELD SEDGE HERBACEOUS VEGETATION
	JUNCUS BALTICUS VAR. MONTANUS – DESCHAMPSIA CESPITOSA	MOUNTAIN RUSH – TUFTED HAIRGRASS HERBACEOUS VEGETATION
	JUNCUS BALTICUS VAR. MONTANUS – POA PRATENSIS HERBACEOUS VEGETATION	MOUNTAIN RUSH – KENTUCKY BLUEGRASS HERBACEOUS VEGETATION
RIVERINE 1		
CEGL002653	BETULA GLANDULOSA (NANA) / MESIC FORB – MESIC GRAMINOID SHRUBLAND	WATER BIRCH / MESIC FORB SHRUBLAND
CEGL001559	CALAMAGROSTIS CANADENSIS WESTERN HERBACEOUS VEGETATION	BLUEJOINT REEDGRASS WESTERN HERBACEOUS VEGETATION
CEGL002662	CARDAMINE CORDIFOLIA – MERTENSIA CILIATA – SENECIO TRIANGULARIS HERBACEOUS VEGETATION	HEARTLEAF BITTERCRESS – TALL FRINGED BLUEBELLS – ARROWLEAF RAGWORT HERBACEOUS VEGETATION
	GLYCERIA STRIATA – MIMULUS GUTTATUS –EPILOBIUM LACTIFLORUM HERBACEOUS VEGETATION	FOWL MANNAGRASS – MONKEYFLOWER – MILKFLOWER WILLOWHERB HERBACEOUS VEGETATION
CEGL001225	SALIX PLANIFOLIA / CALAMAGROSTIS CANADENSIS SHRUBLAND	PLANELEAF WILLOW / BLUEJOINT REEDGRASS SHRUBLAND
CRWASAWO0C	SALIX WOLFII / CALAMAGROSTIS CANADENSIS SHRUBLAND	WOLF WILLOW / BLUEJOINT REEDGRASS SHRUBLAND
CEGL001234	SALIX WOLFII / CAREX AQUATILIS SHRUBLAND	WOLF WILLOW / WATER SEDGE SHRUBLAND
CEGL001237	SALIX WOLFII / CAREX UTRICULATA SHRUBLAND	WOLF WILLOW / BEAKED SEDGE SHRUBLAND
CEGL001240	SALIX WOLFII / MESIC FORB SHRUBLAND	WOLF WILLOW / MESIC FORB SHRUBLAND
RIVERINE 2		

Element Code	Scientific Name	Common Name
CRFFABLA0B	ABIES LASIOCARPA – PICEA ENGELMANNII / RIBES SPP. FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / CURRANT SPP. FOREST
CRFEABLA0B	ABIES LASIOCARPA – PICEA ENGELMANNII / ALNUS INCANA FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / THINLEAF ALDER FOREST
CRFEABLA0A	ABIES LASIOCARPA – PICEA ENGELMANNII / CALAMAGROSTIS CANADENSIS FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / BLUEJOINT REEDGRASS FOREST
CRFCABLA0I	ABIES LASIOCARPA – PICEA ENGELMANNII / CAREX AQUATILIS FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / WATER SEDGE FOREST
CRFFPIEN0A	ABIES LASIOCARPA – PICEA ENGELMANNII / EQUISETUM ARVENSE FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / FIELD HORSETAIL FOREST
CRFEABLA0B	ABIES LASIOCARPA – PICEA ENGELMANNII / MERTENSIA CILIATA FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / TALL FRINGED BLUEBELLS FOREST
CRFEABLA0F	ABIES LASIOCARPA – PICEA ENGELMANNII / SALIX DRUMMONDIANA FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / DRUMMOND WILLOW FOREST
CEGL000627	ACER NEGUNDO – POPULUS ANGUSTIFOLIA / CORNUS SERICEA FOREST	BOXELDER – NARROWLEAF COTTONWOOD / RED-OSIER DOGWOOD FOREST
CEGL001147	ALNUS INCANA / MESIC FORB SHRUBLAND	THINLEAF ALDER / MESIC FORB SHRUBLAND
CEGL001148	ALNUS INCANA / MESIC GRAMINOID SHRUBLAND	THINLEAF ALDER / MESIC GRAMINOID SHRUBLAND
CEGL002653	BETULA GLANDULOSA (BETULA NANA) / MESIC FORB – MESIC GRAMINOID SHRUBLAND	SWAMP BIRCH / MESIC FORB – MESIC GRAMINOID SHRUBLAND
CEGL001559	CALAMAGROSTIS CANADENSIS WESTERN HERBACEOUS VEGETATION	BLUEJOINT REEDGRASS WESTERN HERBACEOUS VEGETATION
CRSACRRI0A	CRATAEGUS RIVULARIS SHRUBLAND	RIVER HAWTHORN SHRUBLAND
	GLYCERIA STRIATA HERBACEOUS VEGETATION	FOWL MANNAGRASS HERBACEOUS VEGETATION
CEGL002637	PICEA PUNGENS / BETULA OCCIDENTALIS WOODLAND	BLUE SPRUCE / WATER BIRCH WOODLAND
CEGL000934	POPULUS ANGUSTIFOLIA – PICEA PUNGENS / ALNUS INCANA WOODLAND	NARROWLEAF COTTONWOOD – BLUE SPRUCE / THINLEAF ALDER WOODLAND
CRFAPOBA0A	POPULUS BALSAMIFERA WOODLAND	BALSAM POPLAR WOODLAND
CEGL000563	POPULUS TREMULOIDES / ACER GLABRUM FOREST	QUAKING ASPEN / ROCKY MOUNTAIN MAPLE FOREST
CEGL000618	POPULUS TREMULOIDES / TALL FORBS FOREST	QUAKING ASPEN / TALL FORBS FOREST
CEGL001174	SALIX BEBBIANA / MESIC GRAMINOID SHRUBLAND	BEBB WILLOW / MESIC GRAMINOIDS SHRUBLAND
CEGL001180	SALIX BOOTHII / MESIC FORB SHRUBLAND	BOOTH WILLOW / MESIC FORB SHRUBLAND
CEGL002667	SALIX DRUMMONDIANA / CALAMAGROSTIS CANADENSIS SHRUBLAND	DRUMMOND WILLOW / BLUEJOINT REEDGRASS SHRUBLAND
CEGL001192	SALIX DRUMMONDIANA / MESIC FORB SHRUBLAND	DRUMMOND WILLOW / MESIC FORB SHRUBLAND
CEGL001247	SALIX GEYERIANA – SALIX MONTICOLA / CALAMAGROSTIS CANADENSIS SHRUBLAND	GEYER WILLOW – MOUNTIAN WILLOW / BLUEJOINT REEDGRASS SHRUBLAND
CEGL001223	SALIX GEYERIANA – SALIX MONTICOLA / MESIC FORB SHRUBLAND	GEYER WILLOW – ROCKY MOUNTAIN WILLOW / MESIC FORB SHRUBLAND
CEGL002666	SALIX GEYERIANA / MESIC FORB SHRUBLAND	GEYER WILLOW / MESIC FORB SHRUBLAND
CEGL001222	SALIX MONTICOLA / CALAMAGROSTIS CANADENSIS SHRUBLAND	ROCKY MOUNTAIN WILLOW / BLUEJOINT REEDGRASS SHRUBLAND

Element Code	Scientific Name	Common Name
CEGL002656	SALIX MONTICOLA / CAREX AQUATILIS SHRUBLAND	ROCKY MOUNTAIN WILLOW / WATER SEDGE SHRUBLAND
CEGL002658	SALIX MONTICOLA / MESIC FORB SHRUBLAND	ROCKY MOUNTAIN WILLOW / MESIC FORB SHRUBLAND
CCNHPXXX26	SALIX PLANIFOLIA / MESIC FORB	PLANELEAF WILLOW / MESIC FORB SHRUBLAND

RIVERINE 3 and 4

CEGL000255	ABIES CONCOLOR – (PICEA PUNGENS) – POPULUS ANGUSTIFOLIA / ACER GLABRUM FOREST	WHITE FIR – (BLUE SPRUCE) – NARROWLEAF COTTONWOOD / ROCKY MOUNTAIN MAPLE FOREST
CRFEXXXXX7	ABIES LASIOCARPA – PICEA ENGELMANNII – POPULUS ANGUSTIFOLIA / LONICERA INVOLUCRATA FOREST	SUBALPINE FIR – ENGELMANN SPRUCE / NARROWLEAF COTTONWOOD / TWINBERRY HONEYSUCKLE FOREST
CWFDACNE2F	ACER NEGUNDO – POPULUS ANGUSTIFOLIA / CELTIS RETICULATA FOREST	BOXELDER – NARROWLEAF COTTONWOOD / NETLEAF HACKBERRY FOREST
CEGL000936	ACER NEGUNDO / BETULA OCCIDENTALIS WOODLAND	BOXELDER / WATER BIRCH WOODLAND
CEGL000625	ACER NEGUNDO / CORNUS SERICEA FOREST	BOXELDER / RED-OSIER DOGWOOD FOREST
CEGL000628	ACER NEGUNDO / PRUNUS VIRGINIANA FOREST	BOXELDER / CHOKECHERRY FOREST
CEGL00145	ALNUS INCANA SSP. TENUIFOLIA – CORNUS SERICEA SHRUBLAND	THINLEAF ALDER / RED-OSIER DOGWOOD SHRUBLAND
CEGL002651	ALNUS INCANA SSP. TENUIFOLIA – SALIX (MONTICOLA, LUCIDA, LIGULIFOLIA) SHRUBLAND	THINLEAF ALDER – WILLOW (ROCKY MOUNTAIN WILLOW, WHIPLASH WILLOW, STRAPLEAF WILLOW) SHRUBLAND
CEGL002652	ALNUS INCANA SSP. TENUIFOLIA – SALIX DRUMMONDIANA	THINLEAF ALDER – DRUMMOND WILLOW SHRUBLAND
CEGL001146	ALNUS INCANA SSP. TENUIFOLIA / EQUISETUM ARVENSE SHRUBLAND	THINLEAF ALDER / FIELD HORSETAIL SHRUBLAND
CEGL001016	ARTEMISIA TRIDENTATA SSP. TRIDENTATA / LEYMUS CINEREUS SHRUBLAND	BIG SAGEBRUSH / BASIN WILDRYE SHRUBLAND
CEGL001162	BETULA OCCIDENTALIS / MESIC FORB SHRUBLAND	WATER BIRCH / MESIC FORB SHRUBLAND
CCNHPXXX22	BOTHRIOCHLOA SPRINGFIELDII HERBACEOUS VEGETATION	SPRINGFIELD'S BEARDGRASS HERBACEOUS VEGETATION
CEGL002660	CAREX PRAEGRACILIS HERBACEOUS VEGETATION	CLUSTERED FIELD SEDGE HERBACEOUS VEGETATION
CEGL001868	CAREX VERNACULA HERBACEOUS VEGETATION	NATIVE SEDGE HERBACEOUS VEGETATION
CEGL002661	CAREX VESICARIA HERBACEOUS VEGETATION	INFLATED SEDGE HERBACEOUS VEGETATION
CEGL001085	CELTIS LAEVIGATA VAR. RETICULATA / PSEUDOROEGNERIA SPICATA SHRUBLAND	NETLEAF HACKBERRY / BLUEBUNCH WHEATGRASS WOODLAND
CEGL001165	CORNUS SERICEA SHRUBLAND	RED-OSIER DOGWOOD SHRUBLAND
CWFAPSME1A	CORYLUS CORNUTA SHRUBLAND	BEAKED HAZELNUT SHRUBLAND
CRSACRRI0A	CRATAEGUS RIVULARIS SHRUBLAND	RIVER HAWTHORN SHRUBLAND
CEGL001770	DISTICHLIS SPICATA HERBACEOUS VEGETATION	INLAND SALTGRASS HERBACEOUS VEGETATION
CEGL001168	FORESTIERA PUBESCENS SHRUBLAND	WILD-PRIVET SHRUBLAND

Element Code	Scientific Name	Common Name
CWFEFRAN0A	FRAXINUS ANOMALA / QUERCUS GAMBELII SHRUBLAND	SINGLELEAF ASH / GAMBEL OAK WOODLAND
CEGL001838	JUNCUS BALTICUS VAR. MONTANUS HERBACEOUS VEGETATION	MOUNTAIN RUSH HERBACEOUS VEGETATION
CEGL000746	JUNIPERUS SCOPULORUM / CORNUS SERICEA WOODLAND	ROCKY MOUNTAIN JUNIPER / RED-OSIER DOGWOOD WOODLAND
CEGL000894	PICEA PUNGENS / ALNUS INCANA SSP. TENUIFOLIA WOODLAND	BLUE SPRUCE / THINLEAF ALDER WOODLAND
CEGL000388	PICEA PUNGENS / CORNUS SERICEA WOODLAND	BLUE SPRUCE / RED-OSIER DOGWOOD WOODLAND
CEGL000389	PICEA PUNGENS / EQUISETUM ARVENSE WOODLAND	BLUE SPRUCE / FIELD HORSETAIL WOODLAND
CEGL002638	PINUS PONDEROSA/ ALNUS INCANA SSP. TENUIFOLIA	PONDEROSA PINE / THINLEAF ALDER WOODLAND
CEGL002640	POPULUS ANGUSTIFOLIA – JUNIPERUS SCOPULORUM WOODLAND	NARROWLEAF COTTONWOOD – ROCKY MOUNTAIN JUNIPER WOODLAND
CEGL002641	POPULUS ANGUSTIFOLIA – PSEUDOTSUGA MENZIESII WOODLAND	NARROWLEAF COTTONWOOD – DOUGLAS-FIR WOODLAND
CEGL002642	POPULUS ANGUSTIFOLIA / ALNUS INCANA SSP. TENUIFOLIA WOODLAND	NARROWLEAF COTTONWOOD / THINLEAF ALDER WOODLAND
CEGL000648	POPULUS ANGUSTIFOLIA / BETULA OCCIDENTALIS WOODLAND	NARROWLEAF COTTONWOOD / WATER BIRCH WOODLAND
CEGL002664	POPULUS ANGUSTIFOLIA / CORNUS SERICEA WOODLAND	NARROWLEAF COTTONWOOD / RED-OSIER DOGWOOD WOODLAND
CEGL002644	POPULUS ANGUSTIFOLIA / CRATAEGUS RIVULARIS WOODLAND	NARROWLEAF COTTONWOOD / RIVER HAWTHORN WOODLAND
CEGL000652	POPULUS ANGUSTIFOLIA / RHUS TRILOBATA WOODLAND	NARROWLEAF COTTONWOOD / SKUNKBUSH SUMAC WOODLAND
CEGL002645	POPULUS ANGUSTIFOLIA / MIXED SALIX (MONTICOLA, DRUMMONDIANA, LUCIDA) WOODLAND	NARROWLEAF COTTONWOOD / (ROCKY MOUNTAIN WILLOW, DRUMMOND WILLOW, WHIPLASH WILLOW) WOODLAND
CEGL002646	POPULUS ANGUSTIFOLIA / SALIX DRUMMONDIANA – ACER GLABRUM WOODLAND	NARROWLEAF COTTONWOOD / DRUMMOND WILLOW – ROCKY MOUNTAIN MAPLE WOODLAND
CEGL002647	POPULUS ANGUSTIFOLIA / SALIX IRRORATA WOODLAND	NARROWLEAF COTTONWOOD / BLUESTEM WILLOW WOODLAND
CEGL000655	POPULUS ANGUSTIFOLIA / SALIX LIGULIFOLIA – SHEPHERDIA ARGENTEA WOODLAND	NARROWLEAF COTTONWOOD / STRAPLEAF WILLOW – SILVER BUFFALOBERRY WOODLAND
CCNHPXXXX3	POPULUS ANGUSTIFOLIA / SALIX LUCIDA VAR. CAUDATA FOREST	NARROWLEAF COTTONWOOD / GREENLEAF WILLOW FOREST
CEGL002648	POPULUS ANGUSTIFOLIA / SYMPHORICARPOS ALBUS WOODLAND	NARROWLEAF COTTONWOOD / COMMON SNOWBERRY WOODLAND
CEGL002643	POPULUS ANGUSTIFOLIA SAND DUNE FOREST	NARROWLEAF COTTONWOOD SAND DUNE FOREST
CEGL000940	POPULUS DELTOIDES SSP. WISLIZENII / RHUS TRILOBATA	RIO GRANDE COTTONWOOD / SKUNKBUSH SUMAC WOODLAND
CEGL001150	POPULUS TREMULOIDES / ALNUS INCANA SSP. TENUIFOLIA	QUAKING ASPEN / THINLEAF ALDER FOREST
CEGL002650	POPULUS TREMULOIDES / BETULA OCCIDENTALIS FOREST	QUAKING ASPEN / WATER BIRCH FOREST
CEGL000582	POPULUS TREMULOIDES / CORNUS SERICEA FOREST	QUAKING ASPEN / RED-OSIER DOGWOOD FOREST
CEGL001108	PRUNUS VIRGINIANA – (PRUNUS AMERICANA) SHRUBLAND	CHOKECHERRY – (AMERICAN PLUM) SHRUBLAND
CEGL002639	PSEUDOTSUGA MENZIESII / BETULA OCCIDENTALIS WOODLAND	DOUGLAS-FIR / WATER BIRCH WOODLAND
CRFEPSME0A	PSEUDOTSUGA MENZIESII / CORNUS SERICEA WOODLAND	DOUGLAS-FIR / RED-OSIER DOGWOOD

Element Code	Scientific Name	Common Name
CEGL000452	PSEUDOTSUGA MENZIESII / QUERCUS GAMBELII FOREST	DOUGLAS-FIR / GAMBEL OAK FOREST
CEGL000462	PSEUDOTSUGA MENZIESII / SYMPHORICARPOS OREOPHILUS FOREST	DOUGLAS-FIR / MOUNTAIN SNOWBERRY FOREST
CWSEQUGA0B	QUERCUS GAMBELII – SYMPHORICARPOS SPP. SHRUBLAND	GAMBEL OAK – SNOWBERRY SHRUBLAND
CWSFRHTR0A	RHUS TRILOBATA SHRUBLAND	THREELEAF SUMAC SHRUBLAND
CEGL001178	SALIX BOOTHII / CAREX UTRICULATA SHRUBLAND	BOOTH WILLOW / BEAKED SEDGE SHRUBLAND
CEGL001244	SALIX BRACHYCARPA / CAREX AQUATILIS SHRUBLAND	BARRENGROUND WILLOW / WATER SEDGE SHRUBLAND
CEGL001135	SALIX BRACHYCARPA / MESIC FORB SHRUBLAND	BARRENGROUND WILLOW / MESIC FORB SHRUBLAND
CRWASABR0C	SALIX DRUMMONDIANA / CAREX AQUATILIS	DRUMMOND WILLOW / WATER SEDGE
CEGL001205	SALIX GEYERIANA / CALAMAGROSTIS CANADENSIS SHRUBLAND	GEYER WILLOW / BLUEJOINT REEDGRASS SHRUBLAND
CEGL001206	SALIX GEYERIANA / CAREX AQUATILIS SHRUBLAND	GEYER WILLOW / WATER SEDGE SHRUBLAND
CEGL001207	SALIX GEYERIANA / CAREX UTRICULATA SHRUBLAND	GEYER WILLOW / BEAKED SEDGE SHRUBLAND
CRWASALU1A	SALIX LASIANDRA (VAR. CAUDATA OR VAR. LASIANDRA) SHRUBLAND	WHIPLASH WILLOW SHRUBLAND
CEGL001218	SALIX LIGULIFOLIA (=SALIX ERIOCEPHALA VAR. LIGULIFOLIA) SHRUBLAND	STRAPLEAF WILLOW SHRUBLAND
CEGL002659	SALIX MONTICOLA / MESIC GRAMINOID SHRUBLAND	ROCKY MOUNTAIN WILLOW / MESIC GRAMINOID SHRUBLAND
CEGL001225	SALIX PLANIFOLIA / CALAMAGROSTIS CANADENSIS SHRUBLAND	PLANELEAF WILLOW / BLUEJOINT REEDGRASS SHRUBLAND
CEGL002665	SALIX PLANIFOLIA / CALTHA LEPTOSEPALA SHRUBLAND	PLANELEAF WILLOW / WHITE MARSH-MARIGOLD SHRUBLAND
CEGL001227	SALIX PLANIFOLIA / CAREX AQUATILIS SHRUBLAND	PLANELEAF WILLOW / WATER SEDGE SHRUBLAND
CRWASAWO0C	SALIX WOLFII / CALAMAGROSTIS CANADENSIS SHRUBLAND	WOLF WILLOW / BLUEJOINT REEDGRASS SHRUBLAND
CEGL001128	SHEPHERDIA ARGENTEA SHRUBLAND	SILVER BUFFALOBERRY SHRUBLAND
CEGL001476	SPARTINA PECTINATA WESTERN HERBACEOUS VEGETATION	PRAIRIE CORDGRASS WESTERN HERBACEOUS VEGETATION

RIVERINE 5

CPWAANGE0A	ANDROPOGON GERARDII – SORGHASTRUM NUTANS – (SPARTINA PECTINATA) HERBACEOUS VEGETATION	BIG BLUESTEM – YELLOW INDIANGRASS – PRAIRIE CORDGRASS HERBACEOUS VEGETATION
CCNHPXXX23	BACCHARIS SALICINA SHRUBLAND	GREAT PLAINS FALSEWILLOW SHRUBLAND
CCNHPXXX22	BOTHRIOCHLOA SPRINGFIELDII HERBACEOUS VEGETATION	SPRINGFIELD'S BEARDGRASS HERBACEOUS VEGETATION
	CHRYSOTHAMNUS VISCIDIFLORUS / DISTICHLIS SPICATA SHRUBLAND	GREEN RABBITBRUSH / INLAND SALTGRASS SHRUBLAND
CEGL001779	MUHLENBERGIA ASPERIFOLIA HERBACEOUS VEGETATION	ALKALI MUHLY HERBACEOUS VEGETATION
CEGL001573	PANICUM OBTUSUM – BUCHLOE DACTYLOIDES HERBACEOUS VEGETATION	VINE-MESQUITE – BUFFALO GRASS HERBACEOUS VEGETATION

Element Code	Scientific Name	Common Name
CEGL001578	PASCOPYRUM SMITHII – BOUTELOUA GRACILIS HERBACEOUS VEGETATION	WESTERN WHEATGRASS – BLUE GRAMA HERBACEOUS VEGETATION
CEGL001475	PHRAGMITES AUSTRALIS HERBACEOUS VEGETATION	COMMON REED HERBACEOUS VEGETATION
CEGL000651	POPULUS ANGUSTIFOLIA / PRUNUS VIRGINIANA WOODLAND	NARROWLEAF COTTONWOOD / CHOKECHERRY WOODLAND
CEGL000654	POPULUS ANGUSTIFOLIA / SALIX EXIGUA WOODLAND	NARROWLEAF COTTONWOOD / SANDBAR WILLOW WOODLAND
CCNHPXXX19	POPULUS DELTOIDES / PASCOPYRON SMITHII – PANICUM OBTUSUM WOODLAND	COTTONWOOD / WESTERN WHEATGRASS – VINE MESQUITE WOODLAND
CCNHPXXX18	POPULUS DELTOIDES / SPOROBOLUS CRYPTANDRUS WOODLAND	COTTONWOOD / SAND DROPSEED WOODLAND
	POPULUS DELTOIDES / BROMUS INERMIS WOODLAND	COTTONWOOD / SMOOTH BROME WOODLAND
CEGL000939	POPULUS DELTOIDES/ DISTICHLIS SPICATA WOODLAND	COTTONWOOD / INLAND SALTGRASS WOODLAND
CPFAPODE3A	POPULUS DELTOIDES – (SALIX AMYGDALOIDES) / SALIX EXIGUA WOODLAND	COTTONWOOD – (PEACHLEAF WILLOW) / SANDBAR WILLOW WOODLAND
CEGL002649	POPULUS DELTOIDES SSP. MONILIFERA / CAREX PELLITA (CAREX LANUGINOSA) WOODLAND	PLAINS COTTONWOOD / WOOLLY SEDGE WOODLAND
CEGL000678	POPULUS DELTOIDES SSP. MONILIFERA / MUHLENBERGIA ASPERFOLIA FOREST	PLAINS COTTONWOOD / ALKALI MUHLY FOREST
CEGL001454	POPULUS DELTOIDES SSP. MONILIFERA / PANICUM VIRGATUM – SCHIZACHYRIUM SCOPARIUM WOODLAND	PLAINS COTTONWOOD / SWITCHGRASS – LITTLE BLUESTEM WOODLAND
CPFDPODE3G	POPULUS DELTOIDES SSP. MONILIFERA/ PRUNUS VIRGINIANA WOODLAND	PLAINS COTTONWOOD / CHOKECHERRY WOODLAND
CEGL000944	POPULUS FREMONTII / SALIX GOODINGII WOODLAND	FREMONT COTTONWOOD / GOODDING'S WILLOW WOODLAND
	POPULUS DELTOIDES/ SPARTINA PECTINATA WOODLAND	COTTONWOOD / PRAIRIE CORDGRASS WOODLAND
CCNHPXXX16	POPULUS DELTOIDES / SPOROBOLUS AIROIDES WOODLAND	COTTONWOOD / ALKALI SACATON WOODLAND
CCNHPXXX17	POPULUS DELTOIDES / SPOROBOLUS ASPER WOODLAND	COTTONWOOD / HARSH DROPSEED WOODLAND
CEGL000660	POPULUS DELTOIDES / SYMPHORICARPOS OCCIDENTALIS WOODLAND	COTTONWOOD / WESTERN SNOWBERRY WOODLAND
CEGL000947	SALIX AMYGDALOIDES WOODLAND	PEACHLEAF WILLOW WOODLAND
CEGL001200	SALIX EXIGUA / BARREN GROUND SHRUBLAND	SANDBAR WILLOW / BARREN GROUND SHRUBLAND
CEGL002655	SALIX EXIGUA – SALIX LIGULIFOLIA SHRUBLAND	SANDBAR WILLOW – STRAPLEAF WILLOW SHRUBLAND
CEGL001203	SALIX EXIGUA / MESIC GRAMINOID SHRUBLAND	SANDBAR WILLOW / MESIC GRAMINOID SHRUBLAND
CEGL001131	SYMPHORICARPOS OCCIDENTALIS SHRUBLAND	WESTERN SNOWBERRY SHRUBLAND
	TAMARIX RAMOSISSIMA SHRUBLAND	SALTCEDAR SHRUBLAND

Table 6. Potential associations which need more data.

SCIENTIFIC NAME	COMMON NAME	HGM GROUP	# PLOTS
AQUILEGIA MICRANTHA – MIMULUS EASTWOODIAE	MANCOS COLUMBINE – EASTWOOD'S MONKEYFLOWER	S3/4	
CALAMAGROSTIS SCOPULORUM	DITCH REEDGRASS		
CALAMAGROSTIS STRICTA	SLIMSTEM REEDGRASS	S3/4	2
CAREX CANESCENS	SILVERY SEDGE	S1/2	2
CAREX DIANDRA	LESSER PANICLED SEDGE	D1	2
CAREX MICROGLOCHIN	FEWSEEDED BOG SEDGE	S1/2	1
CAREX NEBRASCENSIS-CATABROSA AQUATICA	NEBRASKA SEDGE – WATER WHORLGRASS	S3/4	1
CAREX SCIRPOIDEA	NORTHERN SINGLESPIKE SEDGE	S1/2	3
DESCHAMPSIA CESPITOSA-GEUM ROSSII	TUFTED HAIRGRASS - ROSS' AVENS	S3/4	2
DESCHAMPSIA CESPITOSA-LIGUSTICUM SPP.	TUFTED HAIRGRASS - LICORICE-ROOT	S3/4	1
ELAEAGNUS ANGUSTIFOLIA	RUSSIAN OLIVE	R3/4/5	
ELEOCHARIS ROSTELLATA	BEAKED SPIKERUSH	S3/4	
ERIGERON PEREGRINUS – ARNICA MOLLIS	SUBALPINE FLEABANE – HAIRY ARNICA	S1/2	2
GLYCERIA BOREALIS	SMALL FLOATING MANNAGRASS	D2/3	
GLYCERIA ELATA	FOWL MANNAGRASS	D2/3	
EQUISETUM HYEMALE	SCOURINGRUSH HORSETAIL	R5	7
JUNCUS ALPINUS	NORTHERN GREEN RUSH	S1/2	2
LEERSIA ORYZOIDES	RICE CUTGRASS	D2/3	3
MENYANTHES TRIFOLIATA	BUCKBEAN		
MUHLENBERGIA FILIFORMIS	PULLUP MUHLY	S3/4	4
MUHLENBERGIA RICHARDSONII	RICHARDSON MUHLY	S3/4	1
POPULUS DELTOIDES / ELYMUS LANCEOLATA	PLAINS COTTONWOOD / STREAMBANK WHEATGRASS	R5	4
POPULUS DELTOIDES SSP. WISLIZENII / SALIX EXIGUA	RIO GRANDE COTTONWOOD / SANDBAR WILLOW	R3/4/5	
SALICORNIA RUBRA	RED SWAMPFIRE	F1	4
SALIX EXIGUA / EQUISETUM HYEMALE	SANDBAR WILLOW / SCOURINGRUSH HORSETAIL		
SAXIFRAGA ODONTOLOMA	BROOK SAXIFRAGE	R1	7
SCIRPUS MICROCARPUS	PANICLED BULRUSH	D2/3	1
SPARGANIUM ANGUSTIFOLIUM	NARROWLEAF BUR-REED	D2/3	2
SPARGANIUM MINIMUM	SMALL BUR-REED	D2/3	1
TYPHA DOMINGENSIS	SOUTHERN CATTAIL	D2/3	
VERBENA BRACTEATA	BIGBRACT VERBENA	D4/5	3
VERONICA ANAGALLIS-AQUATICA	WATER SPEEDWELL	R1	1

Mineral Soil Flats Wetlands

Amphiscirpus nevadensis Herbaceous Vegetation
Sarcobatus vermiculatus – Bare ground Shrubland
Sporobolus airoides Herbaceous Vegetation

Sarcobatus vermiculatus – Bare ground Shrubland

Sporobolus airoides Herbaceous Vegetation

Amphiscirpus nevadensis Herbaceous Vegetation

Nevada Bulrush Herbaceous Vegetation

NVCS Alliance: Unclassified
Elcode:
Global rank/State rank: G4
Ranking comments: Currently documented from fewer than 20 locations. More work is needed to establish the rank.
HGM class: F1
Distribution: CA UT WY NE CO ND to WA and Saskatchewan, British Columbia, and Argentina. In the San Luis Valley and South and North parks in Colorado.
Elevation Range in Colorado: 7645-8995 feet (2330-2742 m)

General Description

Amphiscirpus nevadensis is an association of moist to seasonally flooded alkaline meadows in desert and semidesert regions in Canada and the northwestern United States (Cronquist 1977).

Vegetation Description

In North and South Park sites, the *Amphiscirpus nevadensis* association tends to be monotypic (30-40% cover) with sparse coverage (< 5%) by other species such as *Hordeum jubatum* (foxtail barley), *Distichlis spicata* (inland saltgrass), *Puccinellia nuttalliana* (Nuttall's alkaligrass) and *Glaux maritima* (sea milkwort).

Species diversity in the San Luis Valley sites is higher. *Amphiscirpus nevadensis* provides 10 to 80% cover; other species include *Juncus balticus* var. *montanus* (mountain rush, up to 5%), *Spartina gracilis* (alkali cordgrass, up to 10%), *Schoenoplectus pungens* (common threesquare <5%), and *Hordeum jubatum* (<10%). Forb cover is minimal.

Ecological processes

The *Amphiscirpus nevadensis* association always occurs on saline soils and can tolerate a range of moisture conditions. Stands in the San Luis Valley tend to occur on drier sites than those in South Park. In the San Luis Valley this association is typically found above the zone of *Juncus balticus* var. *montanus* where soils are periodically saturated, but flooding is rare; in South Park stands have seasonal standing water. Soils in South Park stands have extremely high salinity and stands have low species diversity.

Status and management

There is very little information available about this association.

Comments

Amphiscirpus nevadensis is superficially similar to *Scirpus pungens*, but the achenes of each are distinctive (Cronquist et al. 1977).

Representative Plots: NP24, SP102, SV-105, SV113, SV-126, SV-127, SV-134, SV-145, SV-147, SV-152, SV-18, SV-19

Sarcobatus vermiculatus – Bare ground Shrubland

Greasewood – Bare Ground Shrubland

NVCS Alliance: *Sarcobatus vermiculatus* Intermittently Flooded Shrubland
Elcode:
Global rank/State rank: To be determined
Ranking comments: This community currently is documented only from the San Luis Valley in Colorado.
HGM class: F1
Distribution: Colorado, San Luis Valley.
Elevation Range in Colorado: 7500-7650 feet (2286-2332 m)

General Description

Sarcobatus vermiculatus is a long-lived deciduous shrub. Stands are scattered throughout western Colorado and are extensive in the San Luis Valley. This association of almost pure greasewood with very little understory has been documented only from the San Luis Valley. Cooper and Severn (1992) describe this association as occurring where the water table is close to the soil surface for much of the growing season and where soil salinity is very high. The community typically has an open canopy and much bare ground with a hard crusty surface and a deposit of salts during the dry season.

Vegetation Description

Sarcobatus vermiculatus typically forms an open community with 10-25% cover. Bare ground makes up most of the understory, but there may be sparse cover of *Spartina gracilis* (alkali cordgrass <5%). One stand also had 3% cover of *Cleome multicaulis* (slender spiderflower).

Ecological processes

Sarcobatus vermiculatus shrublands are long-lived and self perpetuating. *Sarcobatus vermiculatus is* classified as a phreatophyte, rooting to a depth of permanent soil water, thereby avoiding some of the effects of drought (Ganskopp 1986, Romo et al. 1989). The species can also withstand some flooding, up to 40-42 days before any visible effects are apparent (Ganskopp 1986). *Sarcobatus vermiculatus* accumulates sodium (up to 9.5%) in its leaves, and increases soil salinity over time from salts leaching out of shed leaves. Seedlings can survive under parent shrubs, despite high levels of salinity. Seeds germinate during spring runoff when surface moisture dilutes salinity (Knight 1994).

Sarcobatus vermiculatus may occur as a band of vegetation around a salt flat or depression. This visible zonation is caused by the relative tolerances to soil salinity and depth to groundwater of the dominant species. Soil characteristics may also play a role in the mosaic of shrub species on the landscape. In the Big Horn desert in Wyoming, *Sarcobatus vermiculatus* occurs on siltier soils than *Atriplex confertifolia* (shadscale) or *Artemisia* spp. (sagebrush), but not as clayey as that occupied by *Pascopyrum smithii* (western wheatgrass) (Knight 1994).

In the San Luis Valley, a large playa lake ecosystem supports extensive stands of *Sarcobatus vermiculatus* shrublands. The playas are ephemeral to perennial shallow lakes, depending on the variation in the annual precipitation (driven by snowmelt runoff). Adjacent vegetation types are successive rings of *Distichlis spicata* (inland saltgrass), *Juncus balticus* (arctic rush), and *Eleocharis palustris* (common spikerush), in that order, between the *Sarcobatus vermiculatus* and the open water of the playa lakes.

Status and management

Sarcobatus vermiculatus has a wide distribution throughout North America. It can be found in Washington, Oregon, the Dakotas, Wyoming, Colorado, New Mexico, Utah, and Texas. Greasewood cover may increase with grazing. If consumed in large amounts greasewood can be poisonous to livestock because of high oxalate concentrations in the foliage.

Groundwater pumping is one of the greatest threats to the biodiversity of the Closed Basin of the San Luis Valley. Surface water impoundments and diversions present an equally widespread and allied threat. The playa lake ecosystems of the San Luis Valley floor depend upon a complex interaction of surface and groundwater sources which undergo characteristic seasonal and inter-annual fluctuations. Extensive wetlands have developed where sources of fresh surface water, such as creeks or springs, build on the shallow water table to create seasonal groundwater mounds. Preliminary work has shown that not only are hydrologic dynamics in the valley complex, but that the differing water sources vary widely in water quality (Cooper and Severn 1992). Wetland vegetation is strongly affected by water salinities, and valley wetlands have developed unique floristic patterns based on the quantity and quality of water they receive. Water uses which perturb the timing or magnitude of surface flows, or affect the water table, have the potential to negatively affect valley bottom wetlands. Even minor changes in the water depth or duration of inundation in the wetland basins can have profound effects on soil salinities, and consequently, on wetland vegetation. Cooper and Severn (1992) observed that the entire range of soil moisture and salinity, and associated plant communities, from permanently saturated wetland to saline flat to rain-rinsed upland, occurred over an elevation gradient of only 5 to 8 feet. Wetland dependent fauna, such as nesting water birds, amphibians, or invertebrates may be affected by even brief fluctuations in wetland hydrology.

The confusing array of past, present, and anticipated hydrologic disturbances make it exceedingly difficult to accurately estimate management needs and viability potential for the rare plants, animals, and plant communities at many valley bottom sites. Although information needs are immense, independent research has been minimal to date (Cooper and Severn 1992). Effective management will require a much better understanding of the hydrologic connections between surface, shallow, and deep groundwater resources of the Closed Basin, and how they vary in time and space.

Comments

Sarko is from the Greek word for flesh, and batos from the Greek word for bramble, which describes the succulent leaves and the thorny branches of the greasewood plant.

Representative stands: SV-20 SV-27

This description is updated from Kittel et al. 1999a.

Sporobolus airoides Herbaceous Vegetation

Alkali Sacaton Herbaceous Vegetation

NVCS Alliance: Unclassified
Elcode:
Global rank/State rank: G3Q/S3
Ranking comments: This association is known from the Colorado western slope and eastern plains, where it occurs in small but frequent patches (Steve Kettler,TNC, *personal communication*). It is highly threatened by improper livestock grazing and stream flow alterations.
HGM class: F1/R5
Distribution: Kansas (Steve Kettler, *personal communication*), New Mexico (Esteban Muldavin, New Mexico Natural Heritage Program *personal communication*), Utah (Jim Von Loh, Engineering-Environmental Management, *personal communication*), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997). In Colorado, the association occurs in the Arkansas River Basin (Johnston 1987), in South Park, and the San Luis Valley (Cooper and Severn 1992) and in the San Miguel/Dolores River Basin in western Colorado (Kittel and Lederer 1993).
Elevation Range in Colorado: 5120-8826 ft. (1561-2691 m)

General Description

This plant association occurs on alkaline or saline soils in mineral flats on floodplains (F1) and on sandy stream banks (R5). The *Sporobolus airoides* (alkali sacaton) plant association of Baker (1984) is synonymous with the Colorado *Sporobolus airoides* plant association. The same type also occurs in New Mexico as *Sporobolus airoides – Bouteloua gracilis* (blue grama) (Esteban Muldavin, New Mexico Natural Heritage Program, *personal communication*). A closely related community, the *Sporobolus airoides* / *Elytrigia smithii* (alkali sacaton/western wheatgrass) plant association, from Kansas, Oklahoma, Colorado, and New Mexico (Johnston 1987), has species not found in the Colorado *Sporobolus airoides* plant association.

Vegetation Description

Riverine stands are characterized by 20-54% cover of a dense stand of *Sporobolus airoides* lining and overhanging the stream bank. Riverine stands may also include the grasses *Sporobolus cryptandrus* (sand dropseed 2%) and *Bouteloua gracilis* (3%) and a few woody species with less than 5% cover, including *Populus angustifolia* (narrowleaf cottonwood), *Fraxinus anomala* (singleleaf ash), *Rhus trilobata* (skunkbush sumac), *Amelanchier alnifolia* (Saskatoon serviceberry), and *Salix exigua* (sandbar willow). Forb cover is minor.

On mineral flats, stands occur on soils with a high water table that rarely or never have standing water and where conditions are too salty for non-halophytes. Cover of *Sporobolus airoides* may be as much as 100%. Other grass species that may be present include: *Pascopyrum smithii* (western wheatgrass 1-5%), *Schizachyrium scoparium* (little bluestem 10%), *Distichlis spicata* (inland saltgrass 10%), *Hordeum jubatum* (foxtail barley 5%), *Spartina gracilis* (alkali cordgrass 3%), and *Juncus balticus* ssp. *montanus* (mountain rush 1-5%).

Ecological processes

The riverine type of this association is an early-seral community that occurs on floodplains with moderately saline soils (Aldous and Shantz 1924 [as cited in Johnston 1987]). The intermittent flood regime affects soil moisture and salinity and can alter species composition. Sudden increases in salinity may result in a decrease in cover of *Sporobolus airoides*. With no change in salinity, this plant association will form hummocks that accumulate sand. Gradually the sites will decrease in salinity and moisture and invasion by other grasses will follow (Unger 1974 [as cited in Johnston 1987]). Soils are non-saline to moderately saline to usually alkaline.

There is very little information on the ecological processes maintaining the mineral soil flats type.

Status and management

Very little management information is available. However, *Sporobolus airoides* is considered to be of poor to good forage value for livestock (Stubbendieck et al. 1982). *Distichlis spicata* often increases in this association with heavy grazing (Steve Kettler, *personal communication*), or with an increase in soil salinity.

Comments

Representative stands: LA25, SP107, SP30, SV-42, SV-70, SV-98, 91NL22, 98GK34

This description is adapted from Kittel et al. 1999a.

Depressional Wetlands

Bidens cernua Herbaceous Vegetation
Carex pellita (*lanuginosa*) Herbaceous Vegetation
Carex nebrascensis Herbaceous Vegetation
Hordeum (Critesion) jubatum Herbaceous Vegetation
Pascopyrum smithii – (Buchloe dactyloides) – Ambrosia linearis – Ratibida tagetes Herbaceous Vegetation

Carex nebrascensis herbaceous vegetation

Pascopyrum smithii – (Buchloe dactyloides) – Ambrosia linearis – Ratibida tagetes Herbaceous Vegetation

Bidens cernua Herbaceous Vegetation

Nodding Beggartick Herbaceous Vegetation

NVCS Alliance: Unclassified seasonally flooded herbaceous vegetation
Elcode:
Global rank/State rank: To be determined.
Ranking comments: Documented from six plots at Cherry Creek Reservoir (Cooper and Cottrell 1989) and two stands on the western slope (Sanderson and Kettler 1996) and is expected to be much more common.
HGM class: D2/3
Distribution: *Bidens cernua* occurs in most states of the U. S. The association is not described in the NVCS.
Elevation: 6000-7500 feet (1829-2286 m)

General Description

Bidens cernua (nodding beggartick) is a tall, rapid growing, obligate wetland annual forb that occurs in Colorado in muddy swales and on pond margins on the plains and in the intermountain basins (Weber and Wittmann 2001). Stands typically occur on clayey or sandy wet loams (Sanderson and Kettler 1996). Soils are generally saturated from occasional to seasonal inundation. Sites tend to be oxygen rich (Cooper and Cottrell 1989).

Vegetation Description

Bidens cernua often occurs in a near monoculture, making up 20-98% of the cover of documented stands. *Hordeum jubatum* (foxtail barley) makes up 62.5% of the cover in one plot. In all other stands associated species provide less than 15% of the cover. *Eleocharis palustris* (common spikerush) is one of the more common associates (2.5-15%). Typically the vegetation varies widely from site to site with the graminoids *Typha latifolia* (broadleaf cattail), *Schoenoplectus pungens* (common threesquare), *Scirpus lacustris* hard/softstem bulrush), and *Glyceria grandis* (American mannagrass) being possible associates. Forbs generally makes up less than 5% of the vegetation cover of these stands. Aquatic plants such as *Sagittaria cuneata* (arumleaf arrowhead) , *Myriophyllum sibiricum* (shortspike watermilfoil), and *Lemna* spp. (duckweed) may occur (Sanderson and Kettler 1996).

Ecological processes

The *Bidens cernua* association is an adventitious type occurring on disturbed edges of ponds, lakes, and back reaches of rivers (Sanderson and Kettler 1996). On wet soils other adventitious species may be found with *Bidens*; in standing water a variety of native aquatic plants may co-occur (Sanderson and Kettler 1996).

Status and management

Bidens cernua lives a short life and has no resprout ability. It has a slow after-harvest regrowth rate, low fire tolerances, low drought tolerance, and low salinity tolerance. It has a low forage value.

Sanderson and Kettler (1996) suggest that this association may indicate excessive trampling of the shoreline or eutrophication of the pond, lake, or stream.

Comments

According to Sanderson and Kettler (1996), this plant arrived relatively recently to the Colorado western slope. It is listed as an invasive weed by *Weeds of Nebraska and the Great Plains* (Stubbendieck et al.. 1994) and *Weeds of the West* (Whitson et al. 1996).

Representative Plots: CH394, CH431, CH241, CH438, CH247, CH270, CH263, JS94-13A, JS94-21A

Carex pellita (*lanuginosa*) Herbaceous Vegetation

Woolly Sedge Herbaceous Vegetation

NVCS Alliance: *Carex pellita* Seasonally Flooded Herbaceous Vegetation
Elcode: CEGL001809
Global rank/State rank: G3/S3
Ranking comments: In Colorado, this community has increased in abundance along regulated rivers on the western slope and may have decreased in abundance on streams on the eastern plains. Few pristine high quality stands are known.
HGM class: D2/3 and S3/4
Distribution: Oregon east to South Dakota and Montana south to Colorado and Kansas.
In Colorado: Gunnison (Kittel et al. 1995), South Platte (Kittel et al. 1996, Kittel et al. 1997), and Rio Grande River Basins, Lodore Canyon of the Green River (Cooper 1995), in the San Luis Valley (Cooper and Severn 1992) and South Park (Cooper 1990), and the Front Range (Cooper and Cottrell 1990).
Elevation Range in Colorado: 4640-8826 ft (1415-2690 m).

General Description

Carex pellita (*lanuginosa*) is a distinctive wetland-indicator sedge that forms small- to-medium-sized meadows. It occurs in both slope and depressional hydrogeomorphic subclasses, with most of the sampled stands in the D2/3 subclass and only three stands in the S3/4 subclass. It occurs in depressions and swales on the margins of springs, lakes, or stream channels where soils are saturated or seasonally flooded. On the eastern plains of Colorado, it can occur under the canopy of plains cottonwood trees, forming the *Populus deltoides ssp. monilifera / Carex lanuginosa* (plains cottonwood / woolly sedge) plant association.

Where this association occurs along streams, the channels tend to be sinuous with a moderate gradient (Rosgen's Channel Type: C4, C6). Soils are deep silt loams to clays. Mottling often occurs throughout the soil profile.

Closely related communities include two *Carex lanuginosa – Scirpus* spp. (woolly sedge – bulrush) plant associations and the *Carex lanuginosa – Spartina pectinata* (woolly sedge – prairie cordgrass) plant association reported from North and South Dakota, Nebraska, and Kansas (Faber-Langendoen 1996).

Vegetation Description

This plant association is characterized by 30-98% cover of *Carex pellita* (woolly sedge). The most common additional graminoid species is *Deschampsia cespitosa* (tufted hairgrass 1-30%). *Eleocharis palustris* (spikerush)*, Calamagrostis stricta* (slimstem reedgrass), and *Phleum pratense* (timothy) also occur. Other grasses may be present and a variety of sedges and rushes provide less than 5% cover each. Forb cover is generally minor and may include *Trifolium repens* (white clover 25%), *Argentina anserina* (silverweed cinquefoil 3-20%), and *Mentha arvensis* (field mint 40%).

Ecological processes

The *Carex pellita* plant association appears to be a fairly stable community because of the strongly rhizomatous roots and well developed soils (Padgett et al. 1989). In Montana, the *Carex lanuginosa* plant association can be associated with large amounts of *Carex lasiocarpa* (slender sedge). With season-long grazing, *Carex lanuginosa* decreases in abundance, shifting dominance towards *Poa pratensis* (Kentucky bluegrass). In Colorado, stands of *Carex pellita* that occur on stream banks with a consistent water table depth and heavy, cohesive clay soils, appear stable and long-lived as long as the water table remains at current levels.

Status and management

Carex pellita (woolly sedge) is highly palatable to most livestock when young. Overuse of this plant association may result in the increase of *Poa pratensis* (Kentucky bluegrass) and compaction of saturated soils. Periods of rest from livestock grazing are necessary in order to maintain the vigor of this association. Due to its long, creeping rhizomes, *Carex pellita* is an effective stream bank stabilizer and is resistant to fire damage (Hansen et al. 1988). Stands dominated by this species can have high primary production and support aquatic insect populations when inundated. Stands provide important nesting habitat and cover for waterfowl.

Comments

The NVCS and the USDA Plants Database combine *Carex lanuginosa* with *Carex lasiocarpa* into the species *Carex pellita*.

Representative plots: D2/3: 94JB38, 97MD20, 95LS13, B33, CH147, SP28 LA4-42-59 FR27 KP2-4 L28
S3/4: R5B, SV-91-22

This description is updated from Kittel et al. 1999a.

Carex nebrascensis Herbaceous Vegetation

Nebraska Sedge Herbaceous Vegetation

NVCS Alliance: *Carex nebrascensis* Seasonally Flooded Herbaceous
Elcode: CEGL001813
Global rank/State rank: G4/S3
Ranking comments: This is a common community documented from many western states though it may be quite rare in parts of its range, especially at the periphery. In Colorado, this is a common but declining association. It is threatened by improper livestock grazing, stream flow alterations and heavy recreational use.
HGM class: D2/3 and S3/4
Distribution: This plant association occurs in Nevada (Manning and Padgett 1995), Montana (Hansen et al.1995), Idaho, Wyoming (Youngblood et al.1985, Jones and Walford 1995), Utah (Padgett et al. 1989), New Mexico (Durkin et al.1994, Durkin et al. 1995, Bourgeron and Engelking 1994), and Colorado (Johnston 1987, Cooper and Cottrell 1990, CNHP 1997).
Elevation Range in Colorado: D2/3: 4300-6300 ft.(1310-1920 m) S3/4: 5100-9600 ft. (1555-2925 m)

General Description

Carex nebrascensis (Nebraska sedge) is a widespread species and generally forms small-to-medium-size meadows. It forms an open wetland meadow occurring along the margins of stream banks, lakes and seeps. The soils are generally saturated for much of the growing season and are subject to compaction by livestock.

In Colorado *Carex nebrascensis* occurs in at least two HGM subclasses, D2/3 and S3/4, and may also occur in the R3/4 subclass. *Carex nebrascensis* depressional wetlands (D2/3) are documented from the Front Range, the South Platte drainage, and the eastern plains. Slope wetlands of this type are found in the same areas and also occur in the Yampa and Rio Grande river basins, North and South parks, and near Telluride.

This association is restricted to saturated soils and seasonally flooded sites near springs, floodplains bordering ponds, or pools adjacent to stream channels. Streams that were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996) were low-gradient (0.5-0.75%), moderately narrow, and had sinuous channels (C6, F6) or were very narrow with sinuous channels (E6). Soils in this association are heavy clays and silty clay loams with high organic matter content. Anoxic conditions often occur within eight inches (20 cm) of the surface either in the form of a gleyed layer or abundant mottling.

Vegetation Description

Carex nebrascensis contributes the dominant cover (10-80%). A wide variety of other graminoids and forbs may be present, depending on the elevation and wetness of the site, such as *Carex utriculata* (beaked sedge), with 70% cover in one stand. All associated species have a constancy of 33% or less, with the exception of *Poa pratensis* (Kentucky bluegrass), with 50% constancy. Other graminoids species that can be abundant (10-40% cover) include *Eleocharis palustris* (common spikerush), *Carex praegracilis* (clustered field sedge), and *Scirpus pungens* (threesquare bulrush). Forb cover is generally low, but can be high in moist locations. Common forb species include *Ranunculus cymbalaria* (buttercup), *Mentha arvensis* (field mint), *Mimulus glabratus* (monkey flower), and *Melilotus officinalis* (sweetclover). In one very wet site, *Potamogeton* sp. (pondweed) was abundant, with 34% cover.

Ecological processes

In Montana, the *Carex nebrascensis* type is considered a grazing-disclimax. Under season-long grazing, *Carex nebrascensis* increases in abundance, replacing former dominant species (Hansen et al. 1995). However, under extreme grazing conditions and a resulting drop in the water table, *Juncus balticus* (Baltic rush) or *Poa*

pratensis (Kentucky bluegrass) can eventually replace *Carex nebrascensis*. In Nevada, sites dominated by *Carex nebrascensis* are considered the Potential Natural Community (Manning and Padgett 1995), which appears to be the case in undisturbed stands in Colorado.

Status and management

Carex nebrascensis is highly palatable to livestock in the spring and early summer when stems and leaves are tender. Forage production in this association is high and grazing pressure can be heavy. However, *Carex nebrascensis* can usually tolerate heavy grazing due to its rhizomatous growth. Since the saturated soils of this association are easily compacted by livestock in the spring and early summer, late season grazing is recommended in order to prevent trampling damage to plants and to allow for regrowth (Hansen et al. 1995). On the Rio Grande National Forest in south-central Colorado, livestock disperse more readily in the spring, and tend to concentrate on the wetter sites in the late summer, so less damage occurs with spring and summer grazing on this association (Dean Erhard, Forest Ecologist, *personal communication*).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel down cutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water table across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers may want to consider maintaining beavers rather than removing them (Hansen et al. 1995).

According to Hansen et al. (1995), *Carex nebrascensis* is well-suited to prescribed burning, but livestock need to be removed for a year prior to burning to build up root reserves. Fire will reduce litter accumulation and temporarily increase plant productivity. Fire apparently does not shift the species composition away from dominance by *Carex nebrascensis*.

Comments

Adjacent riparian vegetation may be dominated by *Populus angustifolia* (narrowleaf cottonwood) forests. *Salix exigua* (sandbar willow), *Salix lasiandra* ssp. *lasiandra* (Pacific willow), and *Salix boothii* (Booth willow) shrublands, and *Carex praegracilis* (clustered field sedge), *Carex utriculata* (beaked sedge), and *Scirpus lacustris* (softstem bulrush) meadows occur in adjacent riparian areas.

Adjacent upland vegetation may be *Pinus edulis – Juniperus* spp. (pinyon pine-juniper) and *Quercus gambelii* (Gambel oak) woodlands, *Sarcobatus vermiculatus* (greasewood) and *Artemisia tridentata* (big sagebrush) shrublands, or *Bouteloua gracilis* (blue grama) short-grass prairies occur on adjacent hill slopes.

More work is needed to determine the status of *Carex nebrascensis* wetlands in the Riverine 3/4 HGM subclass.

Representative stands:
S3/4: 90MR40, 90MR82, 95GK02, 97BG24, 97MD18, 95LS01, B3, CH206, CH211, CH222, CH246, CH279, CH290, CH309, CH377, CH389, CH426, CH446, CH60, CH64, CH95, FR24, FR28, FR34, FR68, LA54, NP26, R6B, SP121, SP32, T9, T38, VG-28, VG-9, VG-22, VG-43

D2/3: 92NL47, 95LS05, 99RH61, A98, A192, B38, B117, B134, B99, CH30, CH53, CH54, CH55, CH216, LA48

This description is updated from Kittel et al. 1999a.

Hordeum (Critesion) jubatum Herbaceous Vegetation

Foxtail Barley Herbaceous Vegetation

NVCS Alliance: *Hordeum (Critesion) jubatum* Temporarily Flooded Herbaceous
Elcode: CEGL001798
Global rank/State rank: G2G4/S1
Ranking comments: This association is documented from eight stands in Colorado, but is known to be much more common in the state.
HGM class: D2/3 and D4/5
Distribution: This association is found across the northern and western Great Plains and documented in Colorado (Cooper and Cottrell 1989), Montana, North Dakota, and possibly in South Dakota and Saskatchewan.
Elevation Range in Colorado: 5435-6000 ft. (1657 - 1829 m)

General Description

Hordeum jubatum (foxtail barley) is a perennial native grass of wet meadows. Stands are common in Colorado but are rarely reported in the literature. They are documented only from one playa on the eastern plains and from Cherry Creek near Denver (Cooper and Cottrell 1989). These documented sites are low elevation shallow basins that may be either seasonally to permanently flooded (the D2/3 HGM subclass) or intermittently to temporarily flooded (D4/5). D4/5 basins tend to be nearly flat; D2/3 basins typically are deeper and *Hordeum jubatum* occurs on the edges of, or in the drawdown zone of, ponds. Soils are fine to coarse and poorly to very poorly drained. Soil salinity is variable. The soil surface may be covered with white salt crusts with moderately to strongly saline soils (Hansen et al. 1995).

Vegetation Description

Vegetation in *Hordeum jubatum* meadows is sparse to dense with *Hordeum jubatum* making up 12 to 85% of documented stands. Associated species rarely contribute more than 15% cover. Species composition is highly variable between stands, reflecting the moisture and soil differences between sites. The vegetation of D2/3 and D4/5 stands is similar, but D2/3 stands tend to have more species adapted to wetter conditions. Both types may have an assortment of weedy annual or perennial forbs and graminoids. *Eleocharis palustris* (common spikerush 2.5-15%) is one of the more constant species occurring in five stands, and several species of *Polygonum* (knotweed) may be present.

Wetter sites adjacent to *Hordeum jubatum* stands are often open water. Surrounding uplands can be dominated by a variety of grasslands or shrublands (The Nature Conservancy 1999).

Ecological processes

Hordeum jubatum is a common, short-lived pioneer species. It may represent a seral stage that will be taken over by more permanent grasses (Hansen et al. 1989) as conditions change. It is moderately salt tolerant and can densely colonize areas disturbed by flooding along drainages, around playas, and more permanent ponds. Often around playas, this association occupies a zone of intermediate salinity between halophytic vegetation dominated by *Distichlis spicata* (inland saltgrass), *Puccinellia airoides* (Nuttall's alkaligrass), or *Salicornia rubra* (red swampfire), and non-saline mesic prairie vegetation dominated by *Pascopyrum smithii* (western wheatgrass), *Poa* spp. (bluegrass), or *Elymus* spp (wild rye). Vegetation cover, species composition, and soil salinity, as well as the direction of succession of this type, depend on the amount and timing of precipitation and flooding. (The Nature Conservancy 1999).

Status and management

Because it harbors wheat rust and blackstem rust, *Hordeum jubatum* can indirectly affect the development of field crops. (Manitoba Agriculture)

Comments

Hordeum jubatum can be a pest in agricultural fields, and for that reason, it is listed as a weed by Stubbendieck et al. 1994 and Whitson et al. 1996. It is, however, a native pioneer species and serves an important function by colonizing disturbed sites.

Representative stands:
D2/3: CH160 CH400 CH421
D4/5: CH70 CH158 CH170 CH443 99RH30A

Pascopyrum smithii – (*Buchloe dactyloides*) – Ambrosia linearis – Ratibida tagetes Herbaceous Vegetation

Western Wheatgrass – (Buffalograss) – Plains Ambrosia – Coneflower Herbaceous Vegetation

NVCS Alliance: *Pascopyrum smithii* Temporarily Flooded
Elcode:
Global rank/State rank: G3/S3
Ranking comments: This association occurs in the best known playa habitat for the globally vulnerable plains ambrosia.
HGM class: D4/5
Distribution: In Colorado, this association is found on the eastern plains, especially in El Paso County.
Elevation Range in Colorado: 5315-6070 ft. (1620 to 1850 m)

General Description

This association occurs in small flat-bottomed depressions, isolated from drainage channels, on Colorado's eastern plains. These basins are dry for long periods, sometimes several years at a time. They are occasionally filled by storm runoff. Once filled the playas may retain water for days, weeks, or occasionally for several months at a time. Playas are on the dry end of the wetland spectrum and may be considered by some not to be wetlands. Certainly the vegetation is not always typical of wetlands. In these stands soils in playa bottoms are fine-textured sandy clay, silty clay or clay with 5-10% mottles.

Vegetation Description

In wet years *Pascopyrum smithii* typically dominates these playas; in drier years *Buchloe dactyloides* is more common and may withstand inundation for more than five weeks (Porterfield 1945). The vegetation in the playas generally occurs in bands where the outermost rim often supports the highest density of plains ambrosia and coneflower. Other plants growing in the playas include *Carex eleocharis* ssp. *stenophylla* (a dry land sedge), *Verbena bracteata* (prostrate vervain), *Phyla cuneifolia* (wedgeleaf), *Rorippa sinuata* (spreading yellow cress), *Thelesperma megapotamicum* and *T. filifolium* (greenthread), *Grindelia squarrosa* (curly-cup gumweed), and *Salsola iberica* (Russian-thistle). In the playas that remain wet the longest, there may be a small bare ground portion in the center with very sparse cover that could include western wheatgrass, *Eleocharis palustris* and *E. acicularis* (spikerush), *Chenopodium* sp. (goosefoot), or weedy annuals.

Ecological processes

Playas provide heterogeneity in broad expanses of shortgrass prairie and provide for the needs of a wide range of animal species (Knopf 1996, Hoagland and Collins 1997). Other factors affecting grassland environmental and compositional heterogeneity include fire, soils, grazing, and prairie dogs. Fire management, reduced numbers of prairie dogs, and replacement of bison by cattle have reduced heterogeneity in many areas. Playas may serve as the primary source of heterogeneity in the region (Hoagland and Collins 1997). Floral diversity and instability is increased by the ephemeral water source in playas. This in turn can increase faunal diversity (Haukos and Smith 1997). These areas also serve as breeding grounds for some bird species.

Status and management

Known occurrences are within privately owned land or land leased from the State Land Board for grazing or farming. Many playas have been planted to crops. Historically, grazing has been the dominant land use in the area, varying in intensity from light to heavy. Increasingly, grazing lands are being subdivided and sold as 35-acre or larger parcels and residential development is progressing rapidly, mostly in the form of mobile homes on small plots.

Grazing regimes that maintain the natural mosaic nature of the shortgrass prairie should be

encouraged. Introduction of additional pet animals (primarily dogs and cats) with increased residential development may negatively impact shortgrass prairie birds dependent on the playa area for breeding or brood rearing.

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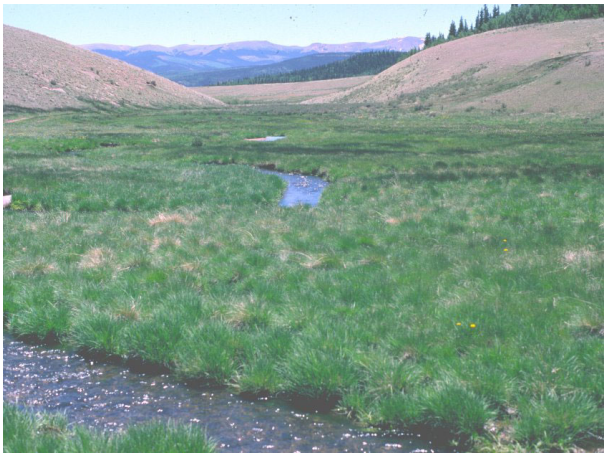
Representative stands:
99RH03, 99RH32B, 99RH34A

Updated from Doyle et al. 2001.

Slope Wetlands

Carex microptera Herbaceous Vegetation
Deschampsia cespitosa Herbaceous Vegetation
Kobresia myosuroides – Thalictrum alpinum Herbaceous Vegetation
Triglochin maritima – Triglochin palustre Herbaceous Vegetation



Deschampsia cespitosa Herbaceous Vegetation

Carex microptera Herbaceous Vegetation

Kobresia myosuroides – Thalictrum alpinum Herbaceous Vegetation

Carex microptera Herbaceous Vegetation

Smallwing Sedge Herbaceous Vegetation

NVCS Alliance: *Carex microptera* Seasonally Flooded Herbaceous
Elcode: CEGL001792
Global rank/State rank: G4/S2?
Ranking comments: This is a common community throughout its range. It is apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery. In Colorado, this community is suspected to be common, but has not been well documented.
HGM class: S1/2
Distribution: This plant association occurs in Canada (Hermann 1970), Nevada and eastern California (Manning and Padgett 1995), Utah (Padgett et al. 1989), eastern Idaho and western Wyoming (Youngblood et al.1985), Montana (Hansen et al. 1988), and Colorado. In Colorado, this plant association probably has a wide distribution throughout the state, but is overlooked due to the relatively small size of the dominant plant. It has been documented along the Cache la Poudre River in north central Colorado (Kittel 1994) and in the San Juan National Forest in southwestern Colorado (Richard et al. 1996).
Elevation Range in Colorado: 9300-10,200 ft. (2800-3100 m).

General Description

This plant association typically forms small meadows on fine-textured, mesic soils. *Carex microptera* typically dominates the association, but other graminoids are usually present and forb cover is minor.

This community is typically associated with meadows and stream terraces in wide, 350-500 feet (100-150 m), low-gradient valleys with narrow and sinuous stream channels (Rosgen 1996, Channel Type E3). It also occurs near beaver dams and marshes. Soil textures range from fine, stratified alluvial material to clay with a thin organic layer on the surface.

The *Carex microptera* (smallwing sedge) community types documented from Nevada, California (Manning and Padgett 1995), Montana (Hansen et al. 1988), Utah (Padgett et al. 1989), Idaho and Wyoming (Youngblood et al. 1985) are synonymous with the Colorado *Carex microptera* plant association. The *Carex microptera – Deschampsia cespitosa* (smallwing sedge – tufted hairgrass) plant association documented from Idaho and Wyoming (Johnston 1987) is a closely related community, although the Colorado *Carex microptera* plant association contains only small amounts of *Deschampsia cespitosa* (tufted hairgrass).

Vegetation Description

Carex microptera (smallwing sedge) forms a dense graminoid layer with 50-70% cover. Other graminoid species typically have less than 1% cover and include *Juncus triglumis* (threehulled rush), *Juncus castaneus* (chestnut rush), *Juncus biglumis* (twoflowered rush), *Deschampsia cespitosa* (tufted hairgrass), *Carex utriculata* (beaked sedge), *Carex saxatilis* (rock sedge) and other sedge species. Forb cover is usually not more than 20%, and is more commonly less than 5%. Common forb species include *Rhodiola integrifolia* (ledge stonecrop), *Polygonum viviparum* (alpine bistort), *Gentiana algida* (whitish gentian), *Artemisia scopulorum* (alpine sagebrush), *Pedicularis groenlandica* (elephanthead lousewort), *Packera pseudaurea* (groundsel), *Epilobium hornemannii* (willowherb), and *Senecio triangularis* (arrowleaf groundsel).

Ecological processes

Little is known about the successional status of this plant association, but it appears to be a stable community on moist to wet sites along streams, and is closely related to the *Deschampsia cespitosa* type (Hermann 1970, Padgett et al. 1989).

Status and management

Carex microptera is moderately palatable to livestock and is sensitive to grazing (Cronquist et al. 1977). A history of heavy grazing may be responsible for the relatively small stands that *Carex microptera* forms. The presence of this sedge in grazing-disturbed areas may indicate that it is an increaser species with livestock use (Hansen et al. 1988). However, according to Padgett et al. (1989), because *Carex microptera* grows in bunches, it is more susceptible to degradation from heavy grazing compared to rhizomatous, sod-forming sedges such as *Carex aquatilis* (water sedge). The fine-textured soils of this association are also susceptible to compaction from livestock and heavy machinery. Heavy grazing may result in the conversion of this association to a drier type such as *Poa pratensis* (Kentucky bluegrass) (Padgett et al. 1989). *Carex microptera* may be useful for stabilizing stream banks and revegetating wet meadows since it is an effective soil-binder (Hansen et al. 1988).

Comments

This plant association often occurs next to *Salix drummondiana* (Drummond willow) shrublands at montane elevations and adjacent to *Salix planifolia* (planeleaf willow) shrublands in the higher, subalpine elevations.

At higher elevations, *Abies lasiocarpa - Picea engelmannii* (subalpine fir-Engelmann spruce) and *Populus tremuloides* (quaking aspen) forests occur on adjacent hillslopes. At lower elevations, *Pinus ponderosa* (ponderosa pine) forests occur on adjacent hillslopes (Padgett et al. 1989).

Representative Plots: 95CR20, 95CR24, T43 K207, K208, K259, K281, K544, CB33-88

This description is updated from Kittel et al. 1999a.

Deschampsia cespitosa Herbaceous Vegetation

Tufted Hairgrass Herbaceous Vegetation

NVCS Alliance: *Deschampsia cespitosa* Seasonally Flooded Herbaceous
Elcode: CEGL001599
Global rank/State rank: G4/S4
Ranking comments: This common association is well documented throughout its range. It is common in Colorado, although few pristine stands have been documented. It is highly threatened by improper livestock grazing, invasion by non-native species, and reduced fire frequency.
HGM class: S3/4
Distribution: This plant association occurs in Oregon, Washington (Franklin and Dyrness 1973 [as cited in Hansen *et al.* 1995]), Nevada (Manning and Padgett 1995), Montana (Hansen et al. 1995, Cooper et al. 1997), Idaho, Wyoming (Youngblood et al. 1985, Girard et al. 1995), Utah (Padgett et al. 1989), and Colorado (Johnston 1987). In Colorado this association has been documented from the White River Basin (Kittel et al. 1994), the Colorado River Basin (Sanderson and Kettler 1996), and the Routt, San Juan, and Rio Grande National Forests (Kettler and McMullen 1996, Richard et al. 1996, Kittel et al.1999b), the Front Range (Cooper and Cottrell 1990), Crested Butte (Cooper 1993), the San Luis Valley (Cooper and Severn 1992) .
Elevation Range in Colorado: 7950-10,240 ft. (2420-3120 m).

General Description

This association is characterized by uniform to patchy cover of *Deschampsia cespitosa* (tufted hairgrass) with minor cover of other graminoids and forbs. This dense, bunch-grass meadow association occurs in broad, nearly flat valley bottoms of glaciated valleys and on well-drained ridges and hummocks adjacent to low to moderate gradient streams. It is found in openings of willow carrs and coniferous forests in subalpine regions across Colorado. It occurs on sites with a moderately high water table and other environmental conditions similar to the *Carex aquatilis* (water sedge) and *Carex utriculata* (beaked sedge) plant associations. Drier phases of this association grow on gentle slopes above the valley floor.

Soils have a shallow to deep organic layer over stratified sandy or silty loams and loamy sands. Mottles and/or gleying may be present below 50 inches (20 cm).

The following eight community types are considered synonymous with the Colorado *Deschampsia cespitosa* plant association: *1) Deschampsia cespitosa* (tufted hairgrass) community types documented from Nevada (Manning and Padgett 1995), Montana (Hansen et al. 1995), Utah (Padgett et al. 1989), Idaho, and Wyoming (Youngblood et al. 1985); *2) Deschampsia-Carex* spp. from Oregon, Montana, Idaho, Utah, Wyoming, and Colorado (Johnston 1987, Kittel et al. 1994, Richard et al. 1996); 3) *Deschampsia cespitosa – Carex aquatilis* (tufted hairgrass - water sedge) from the Routt National Forest (Kettler and McMullen 1996); 4) *Deschampsia cespitosa – Carex nebrascensis* (tufted hairgrass - Nebraska sedge) wet montane meadow from Colorado and Wyoming (USDA Soil Conservation Service 1978); 5) *Deschampsia cespitosa – Caltha leptosepala* (tufted hairgrass – white marsh marigold) from Colorado (Johnston 1987, Sanderson and Kettler 1996) and Montana (Cooper et al. 1997); 6) *Deschampsia cespitosa – Mertensia ciliata* (tufted hairgrass – tall fringed bluebells) from Colorado; *7) Deschampsia cespitosa* – mesic forb and 8) *Deschampsia cespitosa / Senecio sphaerocephalus* (tufted hairgrass / ballhead groundsel) from Wyoming (Girard et al. 1995). All of the above associations occupy wetland or mesic habitats. Not included are the grassland or dry *Deschampsia cespitosa* plant associations that are also described in the literature.

Vegetation Description

This plant association is a meadow dominated by *Deschampsia cespitosa* (25-60%). Other herbaceous species are often numerous and highly variable from stand to stand. Other graminoids that occur are: *Carex microptera* (smallwing sedge 1-40%), *Carex aquatilis* var. *stans* (water sedge 1- 25%), *Hordeum (Critesion*) *jubatum* or *brachyantherum* (meadow barley 3-15%), and *Agrostis gigantea* (redtop), *Agrostis scabra* (rough bent grass*), Poa pratensis (*Kentucky bluegrass*), Carex scopulorum* (mountain sedge*)*, and C*arex illota*, (sheep sedge), all usually with less than 5% cover. In South Park *Triglochin* spp. (1-20%) and *Juncus balticus* var. *montanus* (mountain rush 10-30%) are more common. Forbs include *Argentina anserina (*silverweed cinquefoil 5-10%), *Polygonum bistortoides* (American bistort <5%), and *Aster foliaceus* (alpine leafy-bract aster <5%). Occasionally a few shrubs may be present, especially *Salix monticola* (Rocky Mountain willow 2-15%), *Pentaphylloides floribunda* (shrubby cinquefoil), or *Salix planifolia* (planeleaf willow).

Ecological processes

The *Deschampsia cespitosa* plant association can continue to occupy sites indefinitely under relatively stable conditions (Manning and Padgett 1995). *Deschampsia cespitosa* occurs along a broad moisture gradient from mesic and dry-mesic environments to those that are very wet (Padgett et al. 1989). As sites become drier, *Deschampsia cespitosa* cover gradually decreases and *Dasiphora* (*Pentaphylloides*) *floribunda* (shrubby cinquefoil) cover may increase on sites with well-drained soils. In contrast, if a site becomes wetter, *Carex* (sedge) species may become dominant (Girard et al.1995).

The absence of native increaser species such as *Juncus balticus* and exotic species such as *Poa pratensis* and *Taraxacum officinale* (dandelion) may indicate low disturbance conditions (Padgett et al. 1989). As disturbance levels increase, *Poa pratensis* may replace *Deschampsia cespitosa*. Many subalpine areas now dominated by *Poa pratensis* may have supported *Deschampsia cespitosa* communities in the past (Padgett et al. 1989). *Deschampsia cespitosa* is relatively resistant to fire. However, with repeated burning, rhizomatous species such as *Poa pratensis* may be favored. Livestock grazing should be deferred immediately after burning in order to protect the young, palatable regrowth (Hansen et al. 1995).

Status and management

Deschampsia cespitosa is highly palatable to livestock and is, therefore, subject to heavy grazing pressure. To maintain vigor and prevent damage to soils and vegetation, grazing should be deferred until soils dry, and grazing levels should be light to moderate. On moderately disturbed sites, livestock grazing should take place after surface soils have dried and after maturation of the seed heads. On more severely disturbed sites, intensive rehabilitation is required when there is a high cover of exotic and increaser species. Rest periods from grazing are necessary in order to provide time for plant regrowth (Hansen et al. 1995). *Deschampsia cespitosa* can be relatively resistant to extensive trampling (Rich McEldowney, Colorado State University Range Ecosystem Science graduate student, *personal communication*). On the Rio Grande National Forest, *Deschampsia cespitosa* has been observed to increase for a time under moderate to heavy grazing, but then become reduced and eventually replaced by *Poa pratensis* (Dean Erhard, Forest Ecologist, *personal communication*). Sheep grazing in the alpine areas of Montana appear to increase the abundance of *Poa pratensis* and *Juncus balticus* in moist and wet sites, indicating these areas are most susceptible to alteration of species composition from grazing (Cooper et al. 1997).

Comments

This association may also occur in HGM type R3/4. More work is needed to completely classify R3/4 types.

Representative plots: VG-27, CB92-53-42-43, FR197-189, 94A571, JS94-39, JS94-27

This description is updated from Kittel et al. 1999a.

Kobresia myosuroides – Thalictrum alpinum Herbaceous Vegetation

Bellardi Bog Sedge – Alpine Meadowrue Herbaceous Vegetation

NVCS Alliance: *Kobresia myosuroides - Thalictrum alpinum* Saturated Herbaceous
Elcode: CEGL002900
Global rank/State rank: G2/S1
Ranking comments: The association is known from 15 occurrences in extreme rich fens in South Park in central Colorado. Threats are related to rapid development in the area, and include: residential development, fragmentation, hydrology modifications, grazing, haying (exotic plant introduction), and peat mining.
HGM class: S1/2
Distribution: This association is limited to the geographical region of South Park in central Colorado due to the specific hydrologic and chemical gradient needed to support the extreme rich fen communities.
Elevation Range in Colorado: 9440-9760 ft. (2875-2975 m).

General Description

This plant association is found in extreme rich fens in the high-elevation intermountain valley of South Park, Colorado.

Vegetation Description

This association is characterized by *Kobresia myosuroides* (5-60% cover) and *Thalictrum alpinum* (5-60% cover) occurring on hummocks often up to 50 cm. tall in the drier end of the hydrologic gradient of the fen. The presence of *Thalictrum alpinum* at 100% constancy in the community separates this association from the *Kobresia myosuroides*-dominated alpine communities. Associated plant species occurring in at least half of the plots include *Salix brachycarpa* (barrenground willow 10-30%), *Ptilagrostis porteri* (=*Ptilagrostis mongholica* ssp. *porteri,* Porter's false needlegrass 7-10%), *Juncus balticus var. montanus* (mountain rush 5-25%), *Kobresia simpliciuscula* (simple bog sedge 5-60%) *Polygonum viviparum* (alpine bistort 1-10%), *Deschampsia cespitosa* (tufted hairgrass; 1-10%) *Muhlenbergia filiformis* (pullup muhly 1-25%), *Dasiphora floribunda* (shrubby cinquefoil; 1-20%), *Carex aquatilis* (water sedge 1-15%), and *Carex capillaris* (hairlike sedge 1-5%).

Ecological processes

Extreme rich fens are small-patch communities confined to specific environments defined by ground water discharge, soil chemistry, and peat accumulation of at least 40 cm. Fens form at low points in the landscape at or near slopes where ground water intercepts the soil surface. The water chemistry is distinct in that it contains high levels of calcium and magnesium.

Saturated soils in the fens and the cool climate in South Park produce the conditions necessary for the formation of layers of peat in the fens. The rate of peat accumulation in extreme rich fens is even slower than in the rich and intermediate fens found in other parts of the state. While rich fens accumulate 10 to 16 inches of peat in one thousand years, the extreme rich fens of South Park accumulate only 4.3 inches in one thousand years (Sanderson and March 1996).

Status and management

The fens in South Park which support this association are currently threatened by residential development that may lead to fragmentation and physical alteration of fens and riparian vegetation as well as alteration of the hydrology that supports the wetlands. Approximately twenty percent of the wetlands in South Park have been drained or mined for their peat (Sanderson and March 1996). Further peat mining and water diversion are serious potential threats.

Comments

Extreme rich fens also support a number of rare plants and insects, including regional endemics.

Representative plots: SP135, SP210, SP217, SP222, SP236, SP252, SP50, SP201, SP216, SP153, SP244, SP253, SP168, SP12, SP211, SP16

Triglochin maritima – Triglochin palustre Herbaceous Vegetation

Seaside Arrowgrass – Marsh Arrowgrass Herbaceous Vegetation

NVCS Alliance: *Triglochin maritima* Semipermanently Flooded Herbaceous
Elcode:
Global rank/State rank: Not ranked
Ranking comments: Newly described association currently documented only from Colorado. Similar associations are likely from other states.
HGM class: S1/2
Distribution: Documented from high-elevation intermountain parks in Colorado and one plot on the western slope (Jim Von Loh, *personal communication*).
Elevation Range in Colorado: 8900-9400 ft (2700-2865 m)

General Description

This association occurs at calcareous springs in extreme rich fens. These habitats are flooded throughout the growing season in most years. Soils remain saturated even if the water table drops below the surface during periods of drought. This saturation permits the development of organic peat. Soils are poorly drained, deep, saline and alkaline, often derived from calcareous marls or limestone.

The association may also occur in other HGM subclasses. Similar associations with *Triglochin maritima* as a diagnostic species have been described from the Dakotas, Canada, eastern US, and Florida.

Vegetation Description

This association is characterized by a sparse to moderately dense herbaceous layer dominated by rhizomatous perennial graminoids

In general, vegetation is dominated by *Triglochin maritima*, with average cover of 35% (range 5-70%). *Triglochin palustre* often co-occurs or substitutes for *T. maritima* with an average cover of 21% (range 1-60%). *Schoenoplectus maritimus* (cosmopolitan bulrush) or *Eleocharis palustris* (common spikerush) may also occur with greater than 10% cover.

Other species which may occur with greater than 5% cover include: *Puccinellia nuttalliana* (Nuttall's alkaligrass), *Pedicularis groenlandica* (elephanthead lousewort), *Ranunculus cymbalaria* (alkali buttercup), *Schoenoplectus acutus* var. *acutus / S. tabernaemontani* (hardstem bulrush – softstem bulrush), *Salicornia rubra* (red swampfire) and *Salix candida* (sageleaf willow).

Generally, vegetation height, cover, and species diversity tend to vary inversely with salinity.

Ecological processes

Cover and species composition is primarily determined by soil salinity, which in turn is dependent on the amount and timing of precipitation and flooding. Flooding saturates the soil and dilutes growth-inhibiting salt concentrations, allowing the growth of less salt tolerant species. Conversely, as soils dry, salts are concentrated and precipitate on the soil surface. This process may result in the stratification of species abundance by salt tolerance in some sites. Hummocks formed by soil accumulation may also support less salt-tolerant species.

Status and management

There is very little information available about this association.

Representative Plots: HC107, HC18, HC26, HC53, HC58, HC61, HC74, HC82, HC95, SP105, SP106, SP109, SP189, SP237, SP239, SP44, SP51, SP60, SP7

Riverine Wetlands

Populus angustifolia / Alnus incana ssp. *tenuifolia* Woodland
Salix drummondiana / Carex aquatilis Shrubland
Salix drummondiana / Mesic Forb Shrubland
Salix monticola / Calamagrostis canadensis Shrubland
Salix monticola / Carex aquatilis Shrubland
Spartina pectinata Western Herbaceous Vegetation
Tamarix ramosissima Shrubland

Populus angustifolia / Alnus incana ssp. *tenuifolia* Woodland

Salix drummondiana / Carex aquatilis Shrubland

Salix monticola / Calamagrostis canadensis Shrubland

Tamarix ramosissima Shrubland

Populus angustifolia / Alnus incana ssp. *tenuifolia* Woodland

Narrowleaf Cottonwood / Thinleaf Alder Woodland

NVCS Alliance: *Populus angustifolia* Temporarily Flooded Woodland
Elcode: CEGL002642
Global rank/State rank: G3/S3
Ranking comments: This association is documented from New Mexico and Colorado. It is expected to occur throughout the range of *Populus angustifolia* in the Rocky Mountains. In Colorado, this is a common community along montane streams, but few high quality examples exist. This association is highly threatened by improper livestock grazing, development and stream flow alterations.
HGM class: R3/4
Distribution: This plant association occurs in New Mexico (Durkin et al. 1994) and Colorado (Colorado Natural Heritage Program 1997). In Colorado, it occurs on the western slope in the Yampa, Gunnison, and San Miguel River basins, and the San Juan and Rio Grande National Forests (Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1999b, Colorado Natural Heritage Program 1997, Richard et al. 1996). It also occurs along the Front Range in the Arkansas and South Platte River Basins (Kittel et al.1996, Kittel et al.1997).
Elevation Range in Colorado: 6200-8900 ft. (1900-2700 m).

General Description

This plant association occurs on active floodplains in narrow to broad valleys. It forms a narrow, dense band along stream banks and benches. Some of the stands have signs of recent flooding. Stream gradient and channel width are highly variable. Some sites occur along steep, narrow reaches with little sinuosity (Rosgen's Channel Type: A2-A4). Other sites occur along low gradient, moderately sinuous, broad channel reaches (Channel Type: B2-B5), low gradient, highly sinuous reaches (Channel Type: C3, C4), or very narrow and highly sinuous stream sections (Channel Types: E5, E6) (Rosgen 1996).

Vegetation Description

The dominance of *Populus angustifolia* and *Alnus incana* are the key diagnostic characteristics of this plant association. Several other tree and shrub species may be present, but none equal the abundance of the diagnostic species. The overstory is an open to dense canopy of *Populus angustifolia*, which is always present, if sometimes only as sapling-sized individuals (83% frequency as mature trees with 5-89% cover, 23% frequency as saplings with 3-20% cover, and 17% frequency as seedlings with 1-6% cover). Other tree species that may be present include: *Pseudotsuga menziesii* (Douglas-fir 3-12% cover), *Juniperus scopulorum* (Rocky Mountain juniper 1-10%), *Populus tremuloides* (quaking aspen 3-48%), *Pinus ponderosa* (ponderosa pine 3-13%), *Populus acuminata* (lance-leaved cottonwood 48%), *Abies concolor* (white fir 7%), or *Picea pungens* (Colorado blue spruce 4%).

The shrub understory is dominated by a dense band of *Alnus incana* ssp. *tenuifolia* (5-89% cover) lining the stream bank. A variety of other shrubs may be present, intermingling with the alder but always less than the total alder cover. Other shrub species include: *Salix bebbiana* (Bebb willow 1-10% cover), *Salix monticola* (mountain willow 1-14%), *Salix drummondiana* (Drummond willow; 3-35%), *Salix eriocephala* var. *ligulifolia* (strapleaf willow 1-17%), *Salix lucida* var. *caudata* (whiplash willow 8-25%), *Salix exigua* (sandbar willow 1-32%), *Cornus sericea* (red-osier dogwood 1-31%), *Rosa woodsii* (Wood's rose), *Acer glabrum* (Rocky Mountain maple 1-10%), and *Betula occidentalis* (river birch 3-10%).

The herbaceous undergrowth is generally sparse. Herbaceous species include: *Poa pratensis* (Kentucky bluegrass 1-29%), *Taraxacum officinale* (dandelion 1-18%), *Equisetum arvense* (field horsetail 1-18%), *Rudbeckia laciniata* (coneflower 1-20%), *Heracleum maximum* (cow parsnip 1-12%), *Maianthemum stellatum* (false Solomon's seal 1-12%), *Trifolium repens* (sweet clover 1-48%), *Calamagrostis canadensis* (bluejoint reedgrass 1-17%), *Oxypolis fendleri*

(cowbane 1-11%), *Cardamine cordifolia* (bittercress 1-22%), *Carex rossii* (Ross sedge 3-90%), *Carex praegracilis* (field sedge 1-30%), and *Carex nebrascensis* (Nebraska sedge 70%).

Ecological processes

The *Populus angustifolia /Alnus incana* plant association is considered a mid-seral community (not the youngest and not the oldest stands of cottonwoods within a reach). In the San Luis Valley, stands have high diversity of shrubs, with many willow species also present, although alder is the clear dominant shrub, forming the bulk of the biomass in the understory. With time and without flooding disturbance, the *Populus angustifolia /Alnus incana* stands may become dominated by invading conifers from adjacent upslope communities such as *Pseudotsuga menziesii* (Douglas-fir), *Juniperus scopulorum* (Rocky Mountain juniper), or *Picea engelmannii* (Engelmann spruce).

Landowners and managers should understand that cottonwood woodlands grow within a continually changing alluvial environment due to the ebb and flow of the river. Riparian vegetation is constantly being "re-set" by flooding disturbance. Cottonwood communities are early, mid- or late seral, depending on the age class of the trees and the associated species of the stand. Cottonwoods, however, do not reach a climax stage as defined by Daubenmire (1952). Mature cottonwood stands 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.

The process of cottonwood regeneration is dependent on flooding disturbance. Periodic flooding allows cottonwood seedlings to germinate and become established on newly deposited, moist sandbars. If not damaged by floods in subsequent years, seedlings trap sediment as they grow larger. Each year the surface accumulates small amounts of flood-born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a very large flood, excessive browsing from wildlife or livestock (including beaver), fire, or channel modifications (such as channel straightening or bank revetment), the young, shrubby cottonwoods may grow into a mature riparian forest. At the same time, natural river processes of bank erosion, deposition and channel migration continue, creating fresh, new surfaces for cottonwood establishment. This results in a dynamic patchwork of different age classes, plant associations and habitats (The Nature Conservancy 1996).

As cottonwoods mature, other tree species may become established. If the land surface is subject to reworking by the river, the successional processes will start over with erosion and subsequent flooding deposition. If the land surface is not subject to alluvial processes, for example, a high terrace, the cottonwoods will be replaced by upland shrub and/or tree species that may comprise the climatic climax plant association for that area.

Alnus incana ssp. *tenuifolia* (thinleaf alder) is also adapted to thrive on the floodplain environment. It is one of the first species to establish on fluvial or glacial deposits and even on placer mining spoils (Viereck 1970, Van Cleve et al. 1971, Chapin et al. 1994, and Hansen et al. 1989). Following establishment, young stands of *Alnus incana* are continually flooded. As stands mature, the stems can slow flood waters and trap sediment. Fine-textured sediments accumulate on top of the coarser alluvial material and the land surface eventually rises above annual flood levels. Flooding is then less frequent and soils begin to develop (Padgett et al. 1989).

Alnus incana is shade-intolerant (Viereck 1970, Chapin et al. 1994), and many mature stands in Colorado are restricted to stream bank edges, possibly because these are the only sites where light can penetrate the neighboring overstory canopy. *Alnus incana* usually occurs on high-gradient streams and is thought to require well-aerated water (Hansen et al. 1988, Padgett et al. 1989).

Alnus incana is a nitrogen fixer and increases ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder ranges from 16-150 kg/ha/yr, as much as 150 times the annual atmospheric deposition over the same area (Binkley 1986). Nitrogen rich alder detritus

speeds soil development and bank stability. It also provides an important source of nutrients for aquatic invertebrates.

Status and management

Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alteration to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows and reduce flooding frequency and magnitude. This results in fewer flood events that provide conditions for cottonwood stand regeneration. Without periodic disturbance by flooding, riparian areas become dominated by late-seral communities. These late-seral communities are dominated by more upland species, such as conifers in montane areas or other, more drought tolerant species in the foothill and plains environments.

Forage productivity for this plant association is high and very palatable to livestock. Cottonwood seedlings and saplings and the nitrogen-rich *Alnus incana* leaves are frequently browsed by cattle. Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage. Cottonwood dominated riparian areas in Colorado are best grazed moderately for short periods during the growing season or solely during the winter season. This maintains high forage quality and quantity (Hansen et al. 1995).

Alnus incana is an excellent stream bank stabilizer because of its rhizomatous roots. Young stands can re-sprout after flood damage or fire and can tolerate a short duration of standing water (Hansen et al. 1995). In addition, alder provides overbank shading, and nutrient inputs, important for fish and benthic macroinvertebrates. Experimental plantings of *Alnus incana* suggest that planting stem cuttings may not be a successful restoration technique. It appears that planting a portion of the rhizome or micorhizae may be necessary for alder to establish (Jim Von Loh, *personal communication*).

Comments

In narrow canyons, the *Populus angustifolia/ Alnus incana* plant association is often the only community along stream banks. Along wider stream reaches, this association is adjacent to stands of *Pseudotsuga menziesii*, *Populus angustifolia*, and *Quercus gambelii* (Gambel oak). Younger *Populus angustifolia* stands often occur on adjacent point bars and fresh alluvial deposits. *Carex utriculata* (beaked sedge) meadows or *Alnus incana*, *Betula occidentalis* (water birch), or *Salix* (willow) shrublands occur on the floodplain.

At lower elevations, adjacent south-facing slopes have *Pinus edulis – Juniperus monosperma* (pinyon pine – one-seed juniper) woodlands. North-facing slopes often have mixed conifer – *Populus tremuloides* forests or thick to scattered stands of *Pseudotsuga menziesii* and *Quercus gambelii.* At higher elevations, *Pseudotsuga menziesii* – mixed conifer forests or barren talus are on adjacent slopes.

Representative stands:
Yampa River Basin: 90MR66, 90MR74, 90MR77, 90MR81; Gunnison River Basin: 94JB09, 94MD20, 94MD21, 94RR13, 94RR23, 94RR50; San Juan National Forest: 93C032, 93C051, 93C211, 93C162, 94MS12, 94DR33, 95CR45, 95CR55, 95CR56, 95CR57, 95CR58; Rio Grande Basin: 95RG28, 95RG40, 97BG11, 97EV21, 97EV25, 97GK09, 97MD06, 97MD17; Arkansas River Basin (95AM11, 95AM46, 95AM51, 95RR03; South Platte River Basin: 96LS04, 96LS25, 96GK48, 96AM17, 96AM19 (Colorado Natural Heritage Program 1997).

This description is adapted from Kittel et al.1999a.

Salix drummondiana / Carex aquatilis Shrubland

Drummond Willow / Water Sedge Shrubland

NVCS Alliance: *Salix drummondiana* Temporarily Flooded Shrubland
Elcode: CRWASABR0C
Global rank/State rank: G2/G3
Ranking comments: This association is not well documented, but is expected to be widespread in Rocky Mountain states. Only two stands have been documented in Colorado. It is highly threatened by stream flow alterations, improper livestock grazing and heavy recreational use.
HGM class: R3/4
Distribution: This association occurs in Colorado (CNHP 1997) in the South Platte and North Platte River basins (Kittel et al. 1997, Kittel et al. 1999a).
Elevation Range in Colorado: 10,460 ft. (3190 m).

General Description

Salix drummondiana (Drummond willow) typically becomes the dominant willow on floodplains of high-gradient streams in narrow, V-shaped valleys. The stream channel at sampled stands was steep and incised (Rosgen's Channel Type: G4).

Vegetation Description

Salix drummondiana forms a thick band of tall (5-8 feet, 1.5-2.5 m) shrubs overhanging the stream channel with 36-42% cover. Other shrubs that may be present include: *Salix monticola* (Rocky Mountain willow; 12-16%), *Dasiphora* (*Pentaphylloides*) *floribunda* (shrubby cinquefoil 10%), and *Cornus sericea* (red-osier dogwood 5%). The undergrowth is a thick carpet of grasses, grass-like plants and forbs including: *Carex aquatilis* (water sedge 20%), *Carex utriculata* (beaked sedge 2%), *Carex microptera* (smallwing sedge 1%), *Conioselinum scopulorum* (hemlock parsley 1-10%), *Equisetum arvense* (field scouring rush 10%), *Fragaria virginiana* (wild strawberry 6%), and *Senecio triangularis* (arrowleaf groundsel 3%).

Ecological processes

The *Salix drummondiana / Carex aquatilis* plant association is early- to mid-seral. *Salix drummondiana* is a prolific seed producer and one of the first to colonize coarse-textured cobble bars and recently scoured alluvial surfaces. *Salix drummondiana* is flexible and can tolerate most flood events. With time, fine-textured particles are deposited on the alluvial surface, raising the ground level above the annual flood stage. These fine-textured particles along with litter develop into more nutrient-rich soils. If the site remains close to the water table, but is not heavily disturbed by flooding (no scouring), grasses and grass-like plants will become established. The presence of *Carex aquatilis* and other sedge species is a good indication of a wet-mesic and stable site. Over time, this association may become dominated by conifer trees (Padgett et al. 1989, Kittel et al. 1997).

Status and management

Salix drummondiana is highly palatable to livestock and wildlife (Kovalchik 1987). *Carex* (sedge) species are also heavily utilized by livestock in narrow riparian areas in mid- to high-elevation rangelands. Overgrazing by livestock can dry sites, increase non-native grass cover, and result in decreased vigor of willow root structure and eventually eliminate them from the site. The wet and often saturated soils of this plant association are also vulnerable to compaction by livestock and heavy equipment. In order to maintain productivity and vigor of the plants and prevent damage to the soils, livestock grazing should be deferred until soils dry (Hansen et al. 1995).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest

periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen et al. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel downcutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers may want to consider maintaining beavers rather than removing them (Hansen et al. 1995).

Burning of this plant association temporarily increases the productivity of *Carex aquatilis* and *Carex utriculata*. However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2 to 3 years after to prevent livestock from consuming young, palatable regrowth. Prescribed burning is also an effective method of rejuvenating decadent stands of willows. The willow species in this plant association vigorously sprout following quick, hot fires. Slow burning fires can actually damage the plants. (Hansen et al. 1995).

Salix drummondiana, Carex aquatilis, and *Carex utriculata* are all effective stream bank stabilizers. *Carex aquatilis* and *Carex utriculata* hold stream banks with their dense network of rhizomatous roots. *Salix drummondiana* can be grown from nursery cuttings and then transplanted. Cuttings should be taken in the spring from dormant, 2 to 4 year-old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear 10-15 days after planting if conditions are right (Hansen et al. 1995).

Comments

Riparian vegetation adjacent to this stand includes *Carex utriculata* meadows, and *Picea pungens* (Colorado blue spruce) woodlands occur within the same riparian mosaic. Uplands are *Pinus contorta* (lodgepole pine) and *Populus tremuloides* (quaking aspen) forests occur on adjacent hillslopes.

We expect that further classification of this group may identify other stands of this association.

Representative plots: 96AM49 98LT22

This description is adapted from Kittel et al.1999a.

Salix drummondiana / Mesic Forb Shrubland

Drummond Willow / Mesic Forb Shrubland

NVCS Alliance: *Salix drummondiana* Temporarily Flooded Shrubland
Elcode: CEGL001192
Global rank/State rank: G4/S4
Ranking comments: A common association usually found in small and often narrow riparian habitats. In Colorado, over 40 stands have been documented and additional stands are expected to occur. In many areas it is threatened by improper livestock grazing, stream flow alterations, and heavy recreational use.
HGM class: R2
Distribution: Known from Colorado (CNHP 1997), and expected in Wyoming (Youngblood et al. 1985), Utah (Padgett et al. 1989) and Nevada (Manning and Padgett 1995).
In Colorado it occurs throughout the western slope and in montane regions along the Front Range (Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1996, Richard et al. 1996, Rondeau et al. 1997, Cooper and Cottrell 1990, Phillips 1977).
Elevation Range in Colorado: *7500-11,300 ft (2400-3500 m)*

General Description

The *Salix drummondiana* / mesic forb (Drummond willow / mesic forb) plant association is most common on relatively steep streams, typically forming a narrow band along stream banks, 5-25 feet (1.5-7.5 m) wide. This association is characterized by the closed to partially open canopy of *Salix drummondiana* and a thick understory of a variety of forb species.

This plant association is found in a variety of habitats. It occurs in narrow, V-shaped valleys as a dense, narrow band along high gradient (1-41%) streams (Rosgen's Channel Type: A1-A3) and as large willow carrs in broad valleys, 150-1000 feet wide (50-300 m), along low gradient (1-3%), moderately sinuous streams (Rosgen's Channel Type: B1-B4). It is also located along broad, highly sinuous streams (Rosgen's Channel Type: C3-C5) and broad, actively downcutting channels (Rosgen's Channel Type: F6). See Rosgen 1996 for stream classification descriptions. This association also occurs near seeps.

Soils range from deep sandy loams and sandy clay loams with no coarse fragments to shallow silty clay loams and sandy clay loams over coarse, angular cobbles. Soils in the Colorado River Basin classify as typic and oxyaquic Cryorthents, pachic and typic Cryofluvents, histic and typic Cryaquents, and pachic and typic Cryoborolls.

The *Salix drummondiana / Mertensia ciliata* (Drummond willow / tall fringed bluebells) (Cooper and Cottrell 1990) and the *Salix drummondiana – Salix monticola* (Drummond willow – Rocky Mountain willow) community type (Phillips 1977) are synonymous with the Colorado *Salix drummondiana* /mesic forb. Closely related communities include: the *Salix boothii* / mesic forb (Booth willow / mesic forb) community type (Padgett et al. 1989) which includes stands dominated by *Salix drummondiana*, the *Salix boothii* / *Smilacina stellata* (Booth willow / false Solomon's seal) community type (Youngblood et al. 1985), which also includes stands dominated by *Salix drummondiana*, and the *Salix drummondiana* community type (Manning and Padgett 1995), which does not appear to have any significant forb undergrowth.

Vegetation Description

Salix drummondiana forms an open to closed, narrow canopy of tall shrubs lining the stream bank with 20-98% cover. Other shrub species may be present with cover equal to but not exceeding that of *Salix drummondiana*. At upper elevations *Salix brachycarpa* (barrenground willow 1-3%) and *Salix planifolia* (planeleaf willow 2-37%) may be present. At lower elevations, other shrubs such as *Lonicera involucrata* (honeysuckle 1-30%), *Alnus incana*

(thinleaf alder 1-21%), *Salix monticola* (Rocky Mountain willow 1-40%), *Salix bebbiana* (Bebb willow 1-21%), and *Salix eriocephala* var. *ligulifolia* (strapleaf willow 10-13%) may be present.

Mature trees may be present as a few individuals scattered through the shrubland or as canopy from an adjacent forested association. Tree species that may be present include: *Picea engelmannii* (Engelmann spruce 1-30%), *Abies lasiocarpa* (subalpine fir 1-10%), *Populus angustifolia* (narrowleaf cottonwood 1-20%), and *Populus tremuloides* (quaking aspen 1-75%). Stands with a real canopy of aspen are currently included in this association, although a *Populus tremuloides / Salix drummondiana* type may be split out at later date.

The herbaceous undergrowth may be sparse or richly diverse. In general, total forb cover exceeds that of graminoid cover, and no single species is dominant. Forb species include: *Mertensia ciliata* (tall fringed bluebells 1-44%), *Heracleum lanatum* (cowparsnip 1-40%), *Cardamine cordifolia* (heartleaf bittercress 1-40%), *Oxypolis fendleri* (cowbane 11-23%), *Hydrophyllum fendleri* (waterleaf 1-17%), *Saxifraga odontoloma* (brook saxifrage 1-34%), and *Delphinium barbeyi* (delphinium 1-30%). Graminoid species include: *Carex utriculata* (beaked sedge 1-29%), *Equisetum arvense* (field horsetail 1-40%), and *Calamagrostis canadensis* (bluejoint reedgrass 0.1-30%).

Ecological processes

The *Salix drummondiana* / mesic forb plant association is often an early colonizer of first-order, boulder-strewn, steep streams. This association could be an early-seral stage of the *Abies lasiocarpa – Picea engelmannii* (subalpine fir - Engelmann spruce) plant association which also occurs along steep streams and alternates with the willow carrs. In wider valleys, this plant association occurs as a broad willow carr on well-developed soils near seeps or downstream from beaver dams, where it appears to be a stable community.

Status and management

Salix drummondiana is highly palatable to livestock and wildlife (Kovalchik 1987). Season-long grazing can reduce native forb cover and increase the abundance of non-native grasses including *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop). Continued heavy grazing and browsing may weaken the root systems of *Salix drummondiana* (Padgett et al. 1989).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen et al. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel downcutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers may want to consider maintaining beavers rather than removing them (Hansen et al. 1995).

Prescribed burning in this association is an effective method of rejuvenating decadent stands of the associated willow species. The willows will vigorously sprout following fire, especially in wetter stands. Quick, hot fires produce more sprouts than slower fires (Hansen et al. 1995). *Salix drummondiana* is useful for revegetating stream banks. See Hansen et al. 1995 for more information.

Representative Plots: CB123 FR138 T84 TE20 JS94-22B

This description is updated from Kittel et al. *1999a.*

Salix monticola / Calamagrostis canadensis Shrubland

Rocky Mountain Willow / Bluejoint Reedgrass Shrubland

NVCS Alliance: *Salix monticola* Temporarily Flooded Shrubland
Elcode: CEGL001222
Global rank/State rank: G3/S3
Ranking comments: Known only from 22 documented locations in Colorado. Additional stands are expected to exist. Threatened by improper livestock grazing, inappropriate stream flow alterations, and heavy recreation.
HGM class: R2
Distribution: Colorado Front Range (Cooper and Cottrell 1990), north-central Colorado, the Crested Butte region (Cooper 1993), the Colorado and South Platte River Basins (Kittel et al. 1994, Sanderson and Kettler 1996, Kittel et al. 1997).
Elevation Range in Colorado: 8300-9700 ft (2500-2960 m)

General Description

The *Salix monticola / Calamagrostis canadensis* (Rocky Mountain willow / bluejoint reedgrass) plant association is a tall shrubland with an open to closed canopy of willows and a lush carpet of grasses. It occurs along broad floodplains and narrow streams in the montane and upper montane elevations. Near monotypic stands of *Salix monticola* are diagnostic for this association. Other willow species may be intermixed, but the bulk of the canopy is made up of *Salix monticola*. Forbs and mesic graminoids make up the undergrowth and *Calamagrostis canadensis* is always present but may not have a high cover.

Salix monticola appears to be at the center of its distribution in Colorado, where it frequently forms large thickets with few other willow species present. Literature from Utah, Wyoming, Montana, Idaho, Nevada, and Oregon indicates that *Salix monticola* loses importance north and west of Colorado, where *Salix monticola* mixes with other *Salix* species. For example, in central and eastern Utah, *Salix monticola* dominated stands are infrequent and due to structural and ecological similarities, are included in *Salix boothii* (Booth willow) associations (Padgett et al. 1989), and in Idaho, *Salix monticola* also has a limited distribution and largely associates with other *Salix* (willow) species (Brunsfield and Johnson 1985).

This plant association occurs on narrow to wide, 100-1,000 feet (30-300 m) wide, low-gradient (2-3.5%) valley bottoms and floodplains. In wider valleys, large stands of this association occur between meanders and at the edges of beaver ponds. Stream channels are steep and narrow (Rosgen's Channel Type: A4), moderately steep and wide (B4), wide and sinuous (C3, C4), or braided from beaver activity (D6) (Rosgen 1996).

Soils are finely textured sandy clays to silty clay loams, often saturated to within 10 inches (30 cm) of the surface. Soils can also be silty loams over sand and coarse sand. Mottling often occurs at 5-15 inches (20-40 cm) depth. Soils in the Colorado River Basin classify as Fluventic Cryoborolls and Oxyaquic Cryorthents.

Vegetation Description

This plant association has a closed, mixed canopy of willows with *Salix monticola* being the dominant or matrix willow with 10-90% cover. Other willows that may be present include: *Salix drummondiana* (Drummond willow 2-60%), *Salix wolfii* (Wolf willow 1-60%), *Salix geyeriana* (Geyer willow 1-80%), and *Salix boothii* (Booth willow 10%).

Calamagrostis canadensis (bluejoint reedgrass) forms an open to dense graminoid layer with 5-69% cover. Other graminoids that may be present include: *Carex aquatilis* (water sedge 1-90%), *Carex utriculata* (beaked sedge 1-95%), *Carex microptera* (small-wing sedge 1-19%), *Deschampsia cespitosa* (tufted hairgrass) (2-15%), and *Glyceria grandis* (mannagrass 6%).

Total forb cover ranges from 10-50%. Forb cover is diverse, but many species have less than 5% cover. Forb species include *Cardamine cordifolia* (heartleaf bittercress), *Geranium richardsonii* (Richardson geranium), *Mertensia ciliata* (tall fringed bluebells), *Oxypolis fendleri* (cowbane), *Geum macrophyllum* (large-leaved avens), *Solidago canadensis* (goldenrod), *Senecio bigelovii* (Bigelow groundsel), and *Galium boreale* (northern bedstraw).

Ecological processes

Salix monticola dominated plant associations appear to be long-lived and stable. They occur on mesic sites that support a diversity of graminoids and forbs. *Salix monticola* appears to grow only where the water table does not drop below 3 feet (1 m) of the surface. It appears to be limited to cold, wet environments in broad valley bottoms at high elevations. Due to the colder environments, organic matter builds up in the soils, and it is likely that succession to other associations is slow (Padgett et al. 1989). The presence of dying conifer trees in these associations may indicate a rise in the water table. A higher water table allows for the increase in cover of *Calamagrostis canadensis* and the conversion from a conifer/*Calamagrostis canadensis* type to a *Salix* spp./*Calamagrostis canadensis* type (Padgett et al. 1989).

Carex utriculata, *Carex aquatilis* and *Calamagrostis canadensis* are common dominant undergrowth of several *Salix* plant associations. These three graminoids indicate different micro-environments, generally separating out along a moisture gradient related to the depth of the water table, and can represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channels with the shallowest water tables. *Carex aquatilis* occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* and *Carex aquatilis* (Cooper 1986).

Changes in the physical environment, brought on by flooding or other disturbance, can initiate successional shifts in species composition. Sediment deposition on the floodplain raises the surface higher above the water table (Cooper 1986). As aggradation, or build up, of the floodplain proceeds, the site becomes drier and the dominant graminoid understory changes. Thus *Carex aquatilis* dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* dominated stands.

Fire can stimulate production of willows, increasing available browse species for wildlife and livestock (Hansen et al. 1995). *Calamagrostis canadensis* is an aggressive invader of moist, burned sites due to its propagation from seeds and rhizomes. Prescribed burning can also aid in rejuvenating decadent stands of willows. Quick, hot fires result in more sprouts, while slow fires damage the willows and result in fewer sprouts. Care should be taken when burning this association near stream banks due to the excellent erosion protection it provides (Hansen et al. 1995).

Both *Salix monticola* and *Calamagrostis canadensis* are valuable species for stabilizing or rehabilitating stream banks. *Calamagrostis canadensis* is valuable due to its propagation from rhizomes. *Salix monticola* can probably be grown and transplanted from nursery cuttings in the same manner as *Salix geyeriana.* Cuttings should be taken in the spring from dormant, 2-4 year old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear 10-15 days after planting if conditions are right (Hansen. et al. 1995).

Status and management

The forage value of *Calamagrostis canadensis* is highest when foliage is young. With high grazing pressure, the production of *Calamagrostis canadensis* will decrease (Hansen et al. 1995, Girard et al. 1995). The soils of this plant association are susceptible to compaction by livestock due to saturated conditions throughout much of the growing season. Season-long grazing can cause increases in less desirable species, and cause valuable native species to be eliminated from the site. Improper grazing can open the

willow canopy which increases the solar input, dries surface soils, and causes stream bank damage. Accelerated erosion from hoof action can precipitate stream bank damage, and significant streambed down cutting. In time, the water table may be lowered and the site becomes drier, supporting less productive, non-obligate riparian communities.

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for the basic biological requirements for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen et al. 1995).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel downcutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water table across the floodplain and provided year-round saturated soils. Plant establishment and sediment build-up behind beaver dams, along with plant reproduction, raises the channel bed and creates a wetland environment. Land managers may want to consider maintaining beavers rather than removing them (Hansen et al. 1995).

Salix monticola can be grown from cuttings using direct transfer from parent plant to the ground (Jim Von Loh, *personal communication*).

Comments

Adjacent riparian vegetation includes *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests and mesic forb plant associations along steep, narrow reaches. *Salix drummondiana* (Drummond willow) shrublands occur on broad floodplains. *Carex aquatilis*, *Carex utriculata* and *Deschampsia cespitosa* meadows also occur on adjacent floodplains.

At higher elevations, *Abies lasiocarpa - Picea engelmannii* (subalpine fir - Engelmann spruce) and *Pinus contorta* (lodgepole pine) forests and *Populus tremuloides* (quaking aspen) woodlands occur on adjacent hillslopes. At lower elevations, *Pinus ponderosa* (ponderosa pine) and *Pseudotsuga menziesii* (Douglas-fir) forests occur on adjacent hillslopes.

Representative plots: CB131-169 FR21 SP226 T132

This description is updated from Kittel et al. 1999a.

Salix monticola / Carex aquatilis Shrubland

Rocky Mountain Willow / Water Sedge Shrubland

NVCS Alliance: *Salix monticola* Temporarily Flooded Shrubland
Elcode: CEGL002656
Global rank/State rank: G3/S3
Ranking comments: This association is known only from Colorado, where it is documented at only five locations, although additional stands are expected to occur. This association is threatened by improper livestock grazing, inappropriate stream flow alterations, and heavy recreation use.
HGM class: R2
Distribution: This plant association is a minor type known to occur in the Yampa (Kittel and Lederer 1993), South Platte (Kittel et al. 1997), Rio Grande/Closed (Kittel et al. 1999), and the Arkansas River basins (Kittel et al. 1999), and in the San Juan National Forest (Richard et al. 1996).
Elevation Range in Colorado: 6600-9600 ft (2040-2930 m).

General Description

The *Salix monticola/Carex aquatilis* (Rocky Mountain willow / water sedge) plant association is a tall, deciduous shrubland with a fairly open willow canopy and thick carpet of grasses and sedges in the undergrowth. It occurs on open floodplains, often forming a continuous canopy across the valley floor. The undergrowth is dominated by patches of *Carex aquatilis*. Although *Carex utriculata* (beaked sedge) and *Calamagrostis canadensis* (bluejoint reedgrass) are often also present, *Carex aquatilis* is either the clear dominant or is most consistently present throughout the stand. It is this dominance of *Carex aquatilis* which distinguishes this association from the *Salix monticola / Carex utriculata* and *Salix monticola / Calamagrostis canadensis* associations.

Salix monticola appears to be at the center of its distribution in Colorado, where it frequently forms large thickets with few other willow species present. Literature from Utah, Wyoming, Montana, Idaho, Nevada and Oregon indicate that *Salix monticola* looses importance north and west of Colorado, where *Salix monticola* mixes with other *Salix* species. For example, in central and eastern Utah, *Salix monticola* dominated stands are infrequent and due to structural and ecological similarities are included in *Salix boothii* (Booth willow) associations (Padgett et al. 1989), and in Idaho, *Salix monticola* also has a limited distribution and largely associates with other *Salix* species (Brunsfield and Johnson 1985).

This plant association occurs in narrow valleys on coarse-textured stream banks. Stream channels are narrow and highly sinuous (Rosgen's Channel Type: D6E4) or braided by beaver activity (Rosgen's Channel Type: D6).

Soils are sandy clay loams to sandy loams with layers of gravel and organic matter. Mottles appear at 8 inches (20 cm) depth.

Vegetation Description

This plant association forms a tall, willow carr dominated by 15-88 % cover of *Salix monticola*. *Salix monticola* is the "matrix" shrub, the species with the highest abundance, even though other willow species may have a higher combined canopy cover. Other shrubs that may be present include: *Salix bebbiana* (Bebb willow 7-17%), *Salix drummondiana* (Drummond willow 1-40%), *Cornus sericea* (red-osier dogwood 70%), and *Lonicera involucrata* (honeysuckle 1%).

The herbaceous undergrowth is dominated by *Carex aquatilis* with 10-50% cover. Other graminoid and forb species cover is low due to shading and flood disturbance. Stands with abundant *Carex utriculata* or *Calamagrostis canadensis* may indicate a transitional stage to another *Salix monticola* association.

Ecological processes

Salix monticola dominated plant associations appear to be long-lived and stable. They occur on mesic sites that support a diversity of graminoids

and forbs. *Salix monticola* appears to grow only where the water table does not drop below 3 feet (1 m) of the surface. It appears to be limited to cold, wet environments in broad valley bottoms at high elevations. Due to the colder environments, organic matter builds up in the soils, and it is likely that succession to other associations is slow (Padgett et al. 1989). The presence of dying conifer trees in these associations may indicate a rise in the water table. A higher water table allows for the increase in cover of *Calamagrostis canadensis* (bluejoint reedgrass) and the conversion from a conifer/*Calamagrostis canadensis* type to a *Salix* spp./*Calamagrostis canadensis* type (Padgett et al. 1989).

Carex utriculata, *Carex aquatilis* and *Calamagrostis canadensis* are common dominant undergrowth of several *Salix* plant associations. These three graminoids indicate different micro-environments, generally separating out along a moisture gradient related to the depth of the water table, and can represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channels with the shallowest water tables. *Carex aquatilis* occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* and *Carex aquatilis* (Cooper 1986).

Changes in the physical environment, brought on by flooding or other disturbance, can initiate successional shifts in species composition. Sediment deposition on the floodplain raises the surface higher above the water table (Cooper 1986). As aggradation, or build up, of the floodplain proceeds, the site becomes drier and the dominant graminoid understory changes. Thus *Carex aquatilis* dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* dominated stands.

Status and management

Salix monticola appears to be less tolerant of browsing pressure than other tall montane willow species. It responds to heavy browsing pressure in the same way that *Salix geyeriana* (Geyer willow) does; it forms the classic "mushroom" shape with over-browsing by deer or cattle (Hansen et al. 1995). *Carex* (sedge) species can be heavily grazed by livestock in narrow riparian areas in mid-elevation rangelands. Improper grazing by livestock in this plant association can dry sites, increase non-native cover, and reduce the vigor of willow root structure. The wet and often saturated soils of this plant association are also vulnerable to compaction by livestock and heavy equipment. In order to maintain productivity and vigor of the plants and prevent damage to the soils, livestock grazing should be deferred until soils dry (Hansen et al. 1995).

Deferred and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association. Rest periods are recommended in order to provide time for plant establishment. Late summer and fall grazing is not recommended because willow species are vulnerable to pruning damage due to limited regrowth at the end of the growing season (Hansen et al. 1995, Kovalchik and Elmore 1992).

Beaver activity in the vicinity of this plant association is important for maintaining the health of the riparian ecosystem. Beaver dams abate channel downcutting, bank erosion, and downstream movement of sediment. Beaver dams raise the water table across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers may want to consider maintaining beavers rather than removing them (Hansen et al. 1995).

According to Hansen et al. (1995), burning of this plant association temporarily increases the productivity of *Carex aquatilis*. However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 years after in order to prevent livestock from consuming young, palatable regrowth. Prescribed burning is also an effective method of rejuvenating decadent stands of willows. The willow species in this plant association vigorously sprout following quick, hot fires. Slow burning fires can actually damage the plants. (Hansen et al.1995).

Both *Salix monticola* and *Carex aquatilis* are effective stream bank stabilizers. *Carex aquatilis*

holds stream banks with its dense network of rhizomatous roots. *Salix monticola* can be grown from cuttings using direct transfer from the parent plant to the ground (Jim Von Loh, *personal communication*). Cuttings should be taken in the spring from dormant, 2-4 year-old wood. Cuttings should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter. Roots and shoots should appear 10-15 days after planting if conditions are right (Hansen et al.1995).

Comments

Picea pungens (Colorado blue spruce) and *Populus angustifolia* (narrowleaf cottonwood) forests and *Alnus incana* (thinleaf alder) shrublands occur in adjacent riparian areas.

At higher elevations, *Abies lasiocarpa - Picea engelmannii* (subalpine fir - Engelmann spruce) forests, *Populus tremuloides* (quaking aspen) woodlands occur on adjacent hill slopes. At lower elevations, *Pinus ponderosa* (ponderosa pine) forests and *Quercus gambelii* (Gambel oak) scrub occur on adjacent hillslopes.

Representative Plots: CB60 FR62 T103-109-91 TE16-41-45-61-63-78

This description is updated from Kittel et al. 1999a.

Spartina pectinata Western Herbaceous Vegetation

Prairie Cordgrass Western Herbaceous Vegetation

NVCS Alliance: *Spartina pectinata* Temporarily Flooded Herbaceous
Elcode: CEGL001476
Global rank/State rank: G3/S2
Ranking comments: This association once formed large wet meadows on the South Platte River. It is now restricted to smaller tributaries. It is documented from the South Platte floodplain and moist floodplain meadows on the eastern plains. It is highly threatened by stream flow alterations, agricultural conversions, development, and improper livestock grazing.
HGM class: R5
Distribution: This association occurs in Montana (Hansen et al. 1988), Nebraska (Weaver 1965), Wyoming (Jones and Walford 1995, Johnston 1987), Colorado (CNHP 1997), and North Dakota (Jim Von Loh, *personal communication*). In Colorado, the *Spartina pectinata* plant association is found along the South Platte and Arikaree rivers and tributaries in the northeastern corner of the state (Kittel et al. 1996, CNHP 1997). It also occurs along the Front Range and in the Yampa Valley. Large stands south of Denver are now threatened by housing and golf course developments (Steve Kettler, *personal communication*).
Elevation Range in Colorado: 3370-5807 ft. (1030-1770 m)

General Description

Spartina pectinata (prairie cordgrass) is a tall, robust native grass of poorly drained soils. Stands occur in low swales and overflow areas of large river floodplains and on moist swales on the plains. Habitats are generally on low gradient streams with alluvial or colluvial surface geology. Most documented stands in Colorado are in the Riverine 5 HGM group; one is in the Depressional 2/3 type. Kittel et al. (1999a) described this association from a stand on a large meandering river with a mostly sand bed, which was classified C6 according to the Rosgen Classification of Natural Rivers (Rosgen 1996).

Vegetation Description

Spartina pectinata often forms nearly monotypic stands (60-100% cover). Other vegetation is often sparse and highly variable from site to site. Other graminoids that may be present include: *Panicum virgatum* (switchgrass 1-30%), *Phalaris arundinacea* (reed canarygrass 2-25%), *Schoenoplectus pungens* (common threesquare 5%), and *Juncus balticus var. montanus* (mountain rush 25%). The exotic weed, *Cirsium arvense* (Canadian thistle 1-20%), occurs in about half the stands, indicating slight to chronic disturbance.

Ecological processes

Spartina pectinata is tolerant of sediment deposition, alkaline soils, and high water tables, but does not tolerate prolonged flooding (USDA NRCS 2001). It has sharp-pointed shoots that push their way upward through a foot of new soil (Weaver 1965). On the South Platte River floodplain, *Spartina pectinata* appears to be an early colonizer of the fresh sediments deposited by the 1995 flood.

Status and management

Stands of *Spartina pectinata* have high production rates, however the rough-edged leaves make for poor forage quality, and the plant is not readily eaten by livestock or wildlife. Its tall height and thick growth provide shade and cover for wildlife and certain bird species (Hansen et al. 1988). Accessible stands can make excellent hay if cut two or three times each growing season, thereby reducing forage coarseness (Weaver 1965, Hansen et al. 1988), but cutting more than once per season may reduce vigor (USDA NRCS 2001). The vigorous rhizomes and dense stands of *Spartina pectinata* make this an excellent and effective erosion control species.

Comments

Stands of *Populus deltoides* (plains cottonwood) occur on the adjacent, slightly raised floodplain ridges. *Typha angustifolia* (cattail) stands occur in adjacent, wetter areas.

Upland slopes have mostly *Bouteloua curtipendula* (side-oats grama) shortgrass prairie, pasture lands, and cultivated fields.

Representative stands: Y93, Y110, Y50, B141, B144, B24, B28, B67, B73, 95LS28, BR3, BR

This description is updated from Kittel et al. 1999a.

Tamarix ramosissima Shrubland

Saltcedar Shrubland

NVCS Alliance: Unclassified
Elcode: PDCPR030G0
Global rank/State rank: To be determined
Ranking comments:
HGM class: R5
Distribution: This plant association is known from Arizona, California, Colorado, New Mexico, Nevada, Texas, and Utah where it is becoming increasingly common in riparian zones.
Elevation Range in Colorado: 5289-6490 ft. (1612-1978 m)

General Description

Tamarix ramosissima is a small deciduous shrub or tree that was introduced from Eurasia and is now widespread in the United States. It is extremely adaptive, becomes established in disturbed areas, and often displaces native vegetation. It is tolerant of environmental extremes and is very long-lived.

Vegetation Description

Tamarix ramosissima often occurs as a near monoculture (15-98% cover). In some stands, however, understory species have as much or more cover than *Tamarix ramosissima*. Abundant understory species include *Elymus lanceolatus* (wild rye 63%) and *Phalaris arundinacea* (reed canarygrass 38%), *Bromus tectorum* (cheatgrass 10 – 90%), and *Chrysothamnus viscidiflorus* (green rabbitbrush 3-62%). Other species that may occur are *Hordeum jubatum* (foxtail barley 1-5%), *Distichlis spicata* (inland saltgrass 3 –15%), and *Sporobolus airoides* (alkali sacaton 3- 30%)

Ecological processes

Tamarix ramosissima pioneers on newly exposed point bars and islands with little understory vegetation present. The species also invades grasslands dominated by inland saltgrass and alkali sacaton (Jim Von Loh, *personal communication*). Seedlings grow slowly and are susceptible to shading. The plant is considered to be a facultative phreatophyte that can draw from groundwater, but as time goes on and the plant establishes, it no longer needs ground water to survive. *Tamarix* is extremely aggressive, tenacious, and persistent once established.

Status and management

Tamarix ramosissima is a non-native weed that invades streamsides and sometimes pond margins. It serves as habitat for non-native and generalist native wildlife species. The plant is usually controlled with herbicides, cutting, and burning, although it may resprout from the base following fire (Jim Von Loh, *personal communication*). The USDA has proposed the release of two species of insects to control the weed. Testing is currently in progress.

Comments

Many agencies and private representatives on Colorado's western slope are currently engaged in a concerted effort to remove *Tamarix ramosissima* from western waterways.

Representative stands: A175, A179, A3, A79, A107, AB17, AB18, AB13, AB21, AB22, AB24, GR34, 98BG35

LITERATURE CITED

Access 97 Relational Database Ver. SR-2. Microsoft Corporation, Seattle, WA.

Allen, R. B. and R. K. Peet. 1990. Gradient analysis of forests of the Sangre de Cristo Range, Colorado. *Canadian Journal of Botany* 68: 193-201.

Anderson, M., P. Bourgeron, M. T Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, K. Gallyoun, K. Goodin, D. H. Grossman, S. Landall, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, L. Sneddon, and A. S. Weakley. 1998. *International Classification of Ecological Communities: Terrestrial Vegetation for the United States. Volume II*. Arlington, VA: The Nature Conservancy.

Baker, W.L. 1984. A preliminary classification of the natural vegetation of Colorado. *Great Basin Naturalist* 44(4):647-676.

Benedict, A.D. 1991. *A Sierra Club Naturalist's Guide, The Southern Rockies*. Sierra Club Books. San Francisco, CA.

Binkley, D. 1986. *Forest Nutrition Management*. John Wiley & Sons, Inc., New York, NY.

Bourgeron, P.S. and L.D. Engelking, eds. 1994. A preliminary vegetation classification of the western United States. Western heritage Task Force, The Nature Conservancy, Boulder, CO.

Brinson, M. M. 1993. *A Hydrogeomorphic Classification for Wetlands*, Technical Report WRP-DE-4. U.S. Army Corps of Engineers Waterways Experimental Station, Vicksburg, MS.

Brinson, M.M., B. Swift, R. Plantico, and J. Barclay. 1981. Riparian ecosystems: their ecology and status. U.S. Fish and Wildlife Service, FWS/OBS-81/17.

Brunsfield, S.J. and F.D. Johnson. 1985. *Field Guide to the Willows of East-Central Idaho*. Forest, Wildlife and Range Experiment Station Bulletin No. 39. University of Idaho, Moscow, ID.

Chapin,F.S., III, L.R. Walker, C.L. Fastie, and L.C. Sharman. 1994. Mechanisms of primary succession following deglaciation at Glacier Bay, Alaska. *Ecological Monographs* 64(2):149-175.

Colorado GAP Project. 1993. Colorado Land Ownership 500K (Polygon). US Department of the Interior, Fish and Wildlife Service, National Ecology Research Center in cooperation with the Bureau of Land Management, Colorado State Office, Geosciences Team. Fort Collins, CO.

Colorado Geologic Survey, Colorado Department of Natural Resources, Colorado School of Mines, Division of Environmental Science and Engineering, Colorado State University, Department of Earth Resources. 1998. *Characterization and Functional Assessment of*

Reference Wetlands in Colorado. Report submitted to the Colorado Department of Natural Resources and the U. S. Environmental Protection Agency, Region VIII.

Colorado Natural Heritage Program (CNHP). 1997. *Colorado's Natural Heritage: Rare and Imperiled Animals, Plants, and Natural Communities*. Volume 3, No. 1. Colorado Natural Heritage Program, Fort Collins, CO.

Colorado State Archives. 2001. *Colorful Colorado Geography*. http://www.archives.state.co.us/arcgeog.html. Colorado State Archives. Denver, CO.

Cooper, D.J. 1986. Ecological studies of wetland vegetation Cross Creek Valley, Holy Cross Wilderness Area, Sawatch Range, Colorado. Holy Cross Wilderness Defense Fund, Technical Report #2.

Cooper, D.J. 1990. Ecological studies of wetlands in South Park, Colorado: Classification, functional analysis, rare species inventory, and the effects of removing irrigation. Unpublished report prepared for EPA Region VIII and Park County, CO.

Cooper, D.J. 1993. Wetlands of the Crested Butte region: Mapping, functional evaluation and hydrologic regime. Unpublished report for the Town of Crested Butte and EPA Region VIII.

Cooper, D.J. 1995. An analysis of wetland impacts in the Telluride Mountain Village. Unpublished Report to the U.S. Dept. of Justice.

Cooper, D. J. 1998. "Classification of Colorado's Wetlands for Use in HGM Functional Assessment: A First Approximation." *Characterization and Functional Assessment of Reference Wetlands in Colorado*, CO Department of Natural Resources, Colorado Geological Survey - Division of Minerals and Geology, Denver, CO 80203.

Cooper, D.J. and T. Cottrell. 1989. An ecological characterization and functional evaluation of wetlands in the Cherry Creek basin: Cherry Creek reservoir upstream to Frantown. Unpublished report for EPA Region VIII and Park County, CO.

Cooper, D.J. and T. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Unpublished report prepared for The Nature Conservancy, Boulder, CO.

Cooper, D.J. and D. Gilbert. 1990. An ecological characterization and functional evaluation of wetlands in the Telluride region of Colorado. Unpublished report for EPA Region VIII.

Cooper, D.J. and C. Severn. 1992. Wetlands of the San Luis Valley, Colorado: An ecological study and analysis of the hydrologic regime, soil chemistry, vegetation and the potential effects of a water table drawdown. Unpublished report for CDOW, USFWS and Rio Grande Water Conservation District.

Cooper, S.V., P. Lesica, and D. Page-Dumroese. 1997. Plant Community classification for Alpine Vegetation on the Geaverhead National Forest, Montana. USDA Forest service General Technical Report INT-362. Intermountain Research Station, Ogden, UT.

Costanza R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387: 253-60.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. *Classification of wetlands and deepwater habitats of the United States*, U. S. Department of the Interior, Fish and Wildlife Services, Office of Biological Services, Washington D.C.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren. 1977. Intermountain Flora, Vol.6. Columbia University Press, New York, NY. 584 pp.

Dahl T.E. 2000. Status and Trends of Wetlands in the Conterminous United States 1986-1997. U.S. Department of the Interior, Fish and Wildlife Service, Washington D.C. 82 pp.

Daily, G. C., S. Alexander, P. R. Ehrlich, L. Goulder, J. Lubchenco, P. A. Matson, H. A. Mooney, S. Postel, S. H. Schneider, D. Tilman, and G. M. Woodwell. 1997. Ecosystem services: benefits supplied to human societies by natural ecosystems. *Issues in Ecology 2* Spring.

Daly, C. and G. Taylor. 1998. *Colorado Average Monthly or Annual Precipitation (Raster*). Water and Climate Center of the Natural Resources Conservation Service. Portland, OR.

Daubenmire, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. *Ecological Monographs* 22:301-330.

Dorn, R. D. 1997. *Rocky Mountain Region Willow Identification Field Guide, R2-RR-97-01*. Denver, CO: USDA, US Forest Service.

Dufrêne, M. and P. Legendre. 1997. Species assemblages and indicator species: The need for a flexible asymmetrical approach. *Ecological Monographs* 67: 3: 345-66.

Durkin, P., M. Bradley, E. Muldavin, and P. Mehlhop. 1994. A riparian/wetland vegetation community classification of New Mexico: Pecos River Basin, vol. 1. Report submitted to the New Mexico Environment Department, Surface Water Quality Bureau. New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, NM.

Durkin, P., M. Bradley, S.E. Carr, E. Muldavin, and P. Mehlhop. 1995. Riparian/wetland vegetation communities of the Rio Grande: a classification and site evaluation. Report submitted to the New Mexico Environment Department, Surface Water quality Bureau. New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, NM.

Erhard, D. Rio Grande National Forest. Monte Vista, CO. *Personal communication.*

Faber-Langendoen, D., ed. 1996. Midwest regional community classification. Conservation Science Department, Midwest Region, The Nature Conservancy, Minneapolis, MN.

Flahault, C. and C. Schroter. 1910. Rapport sur la nomenclature phytogeographique. Proceedings of the Third International Botanical Congress, Brussels 1:131-164.

Ganskopp, D.C. 1986. Tolerances of sagebrush, rabbitbrush, and greasewood to elevated water tables. *J. Range Manage*. 39:334-337.

Girard, M., D.L. Wheeler, and S.B. Mills. 1995. *Classification of riparian communities on the Bighorn National Forest*. USDA Forest Service draft manuscript. Rocky Mountain Region, Lakewood, CO.

Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. *International Classification of Ecological Communities: Terrestrial Vegetation of the United States. The National Vegetation Classification System: Development, Status, and Applications. Volume I.* Arlington, VA: The Nature Conservancy.

Hansen, P.L., S.W. Chadde, and R.D. Pfister. 1988. *Riparian Dominance Types of Montana*. Montana forest and Conservation Experimental Station Miscellaneous Publication No. 49. University of Montana, Missoula, MT.

Hansen, P., R. Pfister, K. Boggs, J. Pierce, and S. Chadde. 1989. Classification and management of riparian sites in central and eastern Montana. Draft version 1. Montana Riparian Association, University of Montana, Missoula, MT.

Hansen, P.L., R.D. Pfister, K. Boggs, B.J. Cook, J. Joy, and D.L. Hinckley. 1995. *Classification and Management of Montana's Riparian and Wetland Sites*. Montana Forest and Conservation Experiment Station Miscellaneous Publication No. 54. The University of Montana, Missoula, MT.

Haukos, D.A. and L.M. Smith. 1997. *Common Flora of the Playa Lakes.* Lubbock, TX:University of Texas Tech University Press. 196pp.

Hermann, F.J. 1970. *Manual of the Carices of the Rocky Mountains and Colorado Basin*. USDA Forest Service Agricultural Handbook No. 374. 398pp.

Hoagland, B.W. and Collins, S. W. 1997. Heterogeneity in shortgrass prairie vegetation: the role of playa lakes. *Journal of Vegetation Science* 8:277-286.

Hupalo, R., D.Culver, and G. Doyle. 2000. Comprehensive Statewide Wetlands Classification and Characterization. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Johnston, B.C. 1987. Plant Associations of Region Two. 4th ed. USDA Forest Service R2-ECOL-87-02. Rocky Mountain Region, Lakewood, CO.

Jones, G. and G.M. Walford. 1995. *Major riparian vegetation types of eastern Wyoming*. Report submitted to the Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database (The Nature Conservancy), Laramie, WY.

Jones, K. and D. Cooper. 1993. Wetlands of Colorado. Report prepared for the Colorado

Division of Wildlife and the U.S. Environmental Protection Agency.

Kartesz, J. T. and R. Kartesz. 1980. *A Synonymized Checklist of the Vascular Flora of the United States, Canada and Greenland*. Chapel Hill, NC: University of North Carolina Press.

Kent, M. and P. Coker. 1992. *Vegetation Description and Analysis: A Practical Approach*. 1st ed. Boca Raton, FL: CRC Press, Inc.

Kettler, S. The Nature Conservancy, Boulder, CO. *Personal communication.*

Kettler, S. and A. McMullen. 1996. Routt National Forest riparian vegetation classification. Report submitted to Routt National Forest. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kimmins, J. P. 1997. *Forest Ecology: A Foundation for Sustainable Management.* Second ed. Upper Saddle River, NJ: Prentice Hall.

Kittel, G.M. and N.D. Lederer. 1993. *A Preliminary Classification of the Riparian Vegetation of the Yampa and San Miguel/Dolores River Basins*. Report submitted to the Colorado Department of Health and the Environmental Protection Agency, Region VIII. The Nature Conservancy, Boulder, CO.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River Basins, Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G., R. Rondeau, and S. Kettler. 1995. *A Classification of the Riparian Vegetation of the Gunnison River Basin, Colorado*. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G., R.J. Rondeau, and A. McMullen. 1996. *A Classification of the Riparian Vegetation of the lower South Platte and parts of the upper Arkansas River Basins, Colorado.* Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO

Kittel, G., VanWie, and M. Damm. 1997. *A Classification of the riparian vegetation of the South Platte River Basin (and part of the Republican River Basin), Colorado.* Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO

Kittel, G. M., E. VanWie, M. Damm, R. Rondeau, S. Kettler, A. McMullen, and J. Sanderson. 1999a. *A Classification of Riparian Wetland Plant Associations of Colorado: User Guide to the Classification Project*. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G. E., VanWie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999b. A classification of riparian plant associations of the Rio Grande and Closed Basin Watersheds, Colorado. *A Classification of Riparian Plant Associations of the Rio Grade and Closed Basin Watersheds, Colorado* . Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Knight, D.H. 1994. Mountains and Plains: The Ecology of Wyoming Landscapes. Yale University Press: New Haven and London. 338pp.

Knopf, F.L. 1996. Prairie Legacies-Birds. Pages 135-148 *in Prairie Conservation: Preserving North America's Most Endangered Ecosystem* (F.B. Samson and F.L. Knopf, Eds.). Island Press. Washington, D.C.

Kovalchik, B.L. 1987. Riparian Zone Associations, Deschutes, Ochoco, Fremont, and Winema National Forests. USDA Forest Service R6-ECOL-TP-279-87. Pacific Northwest Region, Bend, OR.

Kovalchik, B.L. and W. Elmore. 1992. Effects of cattle grazing systems on willow-dominated plant associations in central Oregon. *In* W.P. Clary, E.D. McArthur, D. Bedunah, and C.L. Wambolt, compilers. *Proceedings-Symposium on Ecology and Management of Riparian Shrub Communities*. USDA Forest Service General Technical Report INT-289. Intermountain Research Station, Ogden, UT.

Ludwig, J.A. and J.F. Reynolds. 1988. *Statistical Ecology*. New York: John Wiley and Sons.

Manitoba Agriculture - Weeds in Crop Production: abstract & images. UC Davis, IPM: abstract & images. Weed Science Society of America: website.

Manning, M.E. and W.G. Padgett. 1995. Riparian Community Type Classification for Humbolt and Tiyabe National Forest, Nevada and Eastern California. USDA Forest Service R4-ECOL-95-01. Intermountain Region, Ogden, UT.

Max, T. A., J. Schreuder, J. W. Hazard, D. D. Oswald, J. Teply, and J. Alegria. 1996. *The Pacific Northwest Region Vegetation and Inventory Monitoring System*, U.S. Forest Service Research Paper PNW-RP-493. Pacific Northwest Research Station, Portland, OR.

Maybury, K. P. editor. 1999. *Seeing the Forest and the Trees: Ecological classification for Conservation.* Arlington, VA: The Nature Conservancy.

McCune, B., and M. J. Mefford. 1999. PC-ORD. Multivariate Analysis of Ecological Data, ver. 4. MjM Software Design. Gleneden Beach, OR.

Mueller-Dumbois, D. and H. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*. New York, NY: John Wiley & Sons.

Muldavin, E. New Mexico Natural Heritage Program. Albuquerque, New Mexico. *Personal communication*.

Mutel, C.F. and J.C. Emerick. 1984. *From Grassland to Glacier : the Natural History of*

Colorado. Johnson Books, Boulder, CO.

National Research Council. 1995. Wetlands: Characteristics and Boundaries. Washington, DC: National Academy Press.

Noss, R. F. 1990. Indicators for monitoring biodiversity: A hierarchical approach. *Conservation Biology* 4: 355-64.

Padgett, W.G., A.P. Youngblood, and A.H. Winward. 1989. *Riparian Community Type Classification of Utah and Southeastern Idaho*. USDA Forest Service R4-ECOL-89-01. Intermountain Region, Ogden, UT.

Palmer, M.W. 1993. Putting Things in Even Better Order: The Advantages of Canonical Correspondence Analysis. *Ecology* 74:2215-2230.

Peet, R. K. 1980. Ordination as a tool for analyzing complex datasets. *Vegetatio* 42: 171-74.

Phillips, C.M. 1977. Willow carrs of the upper Laramie River Valley, Colorado. Thesis. Colorado State University, Ft. Collins, CO.

Porterfield, H. G. 1945. Survival of buffalo grass following submersion in playas. *Ecology* 26:98-100.

Richard, C., G. Kittel, and S. Kettler. 1996. A Classification of the Riparian Vegetation of the San Juan National Forest. Draft 1 to be submitted to the San Juan National Forest. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Robson, S.G., and E.R. Banta. 1995. *Groundwater Atlas of the United States, Segment 2 – Arizona, Colorado, New Mexico, and Utah. U.S. Geological Survey Hydrologic Investigations Atlas 730-C,* 32p. Available online at http://capp.water.usgs.gov/gwa/ch-c/index.html.

Romo, J.T. and M.R. Hafferkamp. 1989. Water relations of Artemisia tridentata ssp. wyomingensis and Sarcobatus vermiculatus in the steppe of southeastern Oregon. *Amer. Midl. Natur.* 121:155-164.

Rondeau, R.J., M.B. Wunder, A. Meredith, C.A. Pague, and S. Spackman. 1997. *Biological survey of Naval Oil Shale Reserve No. 1 (NOSR-1).* Report submitted to the Department of Energy. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Sanderson, J. and M. March. 1996. *Extreme Rich Fens of South Park, Colorado: their distribution, identification, and natural heritage significance*. Report submitted to Park County, the Colorado Department of Natural Resources, and the U.S. Environmental Protection Agency. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Sanderson, J. and S. Kettler. 1996. *A preliminary wetland vegetation classification for a portion of Colorado's west slope*, The Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Stubbendieck, J., S.L. Hatch and K.J. Kjar. 1982. *North American Range Plants*. 2nd ed. University of Nebraska Press, Lincoln, NE.

Stubbendieck, J., G.Y. Friisoe, & M.R. Bolick. 1994. *Weeds of Nebraska and the Great Plains*. Nebraska Department of Agriculture, Bureau of Plant Industry. Lincoln, Nebraska. 589pp.

ter Braak, C. J. F. 1986. Canonical Correspondence Analysis: a new eigenvector technique for multivariate direct gradient analysis. *Ecology* 67: 1167-79.

The Nature Conservancy. 1996. *Conservation by Design: A Framework for Mission Success*. Arlington, VA: The Nature Conservancy.

The Nature Conservancy. 1999. An Alliance Level Classification of Vegetation of the Coterminous Western United States. Submitted to the University of Idaho, Cooperative Fish and Wildlife Research Unit.

Tweto, O. 1979. Geologic Map of Colorado. U.S. Geological Survey, Denver, CO.

Unger, I.A. 1974. Halophyte communities of Park County, Colorado. *Bulletin of the Torrey Botanical Club* 101(3)145-152.

US Army Corps of Engineers. 1987. *Wetlands Definition Manual.* Technical Report Y-87-1. Environmental Laboratory, Vicksburg, MS.

USDA.- NRCS. "The PLANTS database." Web page. Available at National Plant Data Center, Baton Rouge, LA. http://plants.usda.gov/plants/index.html.

USDA Soil Conservation Service. 1984. Rountree big bluestem and Rumsey indiangrass. Program Aid Number 1350. USDA Soil Conservation Service, Washington, DC.

USGS. 2001. *The USGS-NPS Vegetation Mapping Program.* http://biology.usgs.gov/npsveg/index.html

Van Cleve, K., L.A. Viereck, and R.L. Schlentner. 1971.Accumulation of nitrogen in alder (*Alnus*) ecosystems near Fairbanks, Alaska. *Arctic and Alpine Research* 3(2):101-114.

Van der Maarel, E., I. Espejel, and P. Moreno-Casasola. 1987. Two-step vegetation analysis based on very large datasets. *Vegetatio* 68: 139-43.

Viereck. L.A. 1970. Forest succession and soil development adjacent to the Chena River in interior Alaska. *Arctic and Alpine Research* 2(1):1-26.

Von Loh, J. Engineering-Environment Management. Littleton, CO. *Personal communication.*

Weaver, J.E. 1965. *Native Vegetation of Nebraska*. Lincoln, NE:University of Nebraska Press,.

Weber, W. A. and R. C. Wittmann. 1996a. *Colorado Flora: Western Slope*. 2nd ed. Niwot, CO: University Press of Colorado.

Weber, W. A., and R. C. Wittmann. 1996b. *Colorado Flora: Eastern Slope*. 2nd ed. Niwot, CO: University Press of Colorado.

Weber, W.A, and R.C. Wittmann. 2001a. *Colorado Flora: Western Slope.* 3rd ed. Niwot, CO: University Press of Colorado.

Weber, W.A, and R.C. Wittmann. 2001b. *Colorado Flora: Eastern Slope.* 3rd ed. Niwot, CO: University Press of Colorado.

Whitson, T.D. (Ed.) et al. 1996. *Weeds of the West*. Western Society of Weed Science in cooperation with Cooperative Extension Services, University of Wyoming. Laramie, Wyoming. 630pp.

Wilson, E.O. 1988. *Biodiversity*. National Academy Press, Washington, D.C.

Windell, J.T., B.E. Willard, D.J. Cooper, SQ. Foster, C.F. Knud-Hansen, L.P. Rink, and G.N.Kiladis. 1986. *An ecological characterization of Rocky Mountain montane and subalpine wetlands*. U.S. Fish and Wildlife Serv. Biol. Rep. 86(11). 298 pp.

Youngblood, A.P., W.G. Padgett, and A.H. Winward. 1985. *Riparian Community Type Classification of Eastern Idaho-Western Wyoming*. USDA Forest Service R4-ECOL-85-01. Intermountain Region, Ogden, UT.

Zimmerman, G. M., H. Goetz, and P. W. Mielke Jr. 1985. Use of an improved statistical method for group comparisons to study effects of prairie fire. *Ecology* 66: 2: 606-11.

APPENDIX A – DATA SOURCES

Two of the data sources below are compilations from the results of other studies. Therefore, the table lists both data sources, the original sources indented below the compiled source. Not all data of Cooper (Colorado Geologic Survey et al. 1998) was used in current analysis. For example, sampling units that did not have spatial coordinates and sampling units from Kittel's studies.

Source	**Location**
Cooper 1998 (n= 2376)	
Cooper 1986	Cross Creek Valley
Cooper 1987	E-470 Beltway - E of Denver
Cooper 1988	Boulder Valley and Bonny Reservoir
Cooper 1990	South Park
Cooper 1993	Crested Butte area
Cooper 1995	Telluride Mt. Village
Cooper 1995	Yampa River canyon, Green River - Lodore Canyon and Whirlpool Split
Cooper 1996	High Creek Fen, South Park
Cooper and Cottrell 1988	Rollinsville area
Cooper and Cottrell 1989	Cherry Creek - SE Denver
Cooper and Cottrell 1990	Northern CO Front Range
Cooper and Gilbert 1990	Telluride region
Cooper and Merritt 1996	Park Range, North Park
Cooper and Severn 1992	San Luis Valley
Komarkova 1979	Front Range alpine
McKee et al. 1995	Animas and La Plata rivers
Merritt 1996	Larimer County plains
Merritt 1997	Green River, Allen Bottom, Yampa River, Deer Lodge Park
Kittel et al. 1999a (n= 1925)	
Kettler and McMullen 1996	Routt National Forest
Kittel and Lederer 1993	San Miguel, Dolores, and Yampa river basins
Kittel et al. 1994	Colorado River basin and White River basin
Kittel et al. 1995	Gunnison River basin
Kittel et al. 1996	Arkansas River basin
Kittel et al. 1997	South Platte River basin
Kittel et al. 1999a	Lower San Juan River and North Platte River basins
Kittel et al. 1999b	Rio Grande and Closed basins, Rio Grande National Forest
Richard et al. 1996	San Juan National Forest
Sanderson and Kettler 1996 (n= 1/20)	Central Colorado West Slope
Hupalo 1999 unpublished[a] (n= 90)	East slope alpine and plains

a: Unpublished data collected in 1999 for this project, methods are documented below the data source listing.

Data Sources:

Cooper, D.J. 1986. Ecological studies of wetland vegetation Cross Creek Valley, Holy Cross Wilderness Area, Sawatch Range, Colorado. Holy Cross Wilderness Defense Fund, Technical Report #2.

Cooper, D.J. 1987. Wetlands, vegetation and soils along the proposed E-470 Beltway. Unpublished report for the E-470 Partnership.

Cooper, D.J. 1988. Advanced identification of wetlands in the City of Boulder Comprehensive Planning Area. City of Boulder and EPA Region VIII.

Cooper, D.J. 1990. Ecological studies of wetlands in South Park, Colorado: Classification, functional analysis, rare species inventory, and the effects of removing irrigation. Unpublished report prepared for EPA Region VIII and Park County, Colorado.

Cooper, D.J. 1993. Wetlands of the Crested Butte region: Mapping, functional evaluation and hydrologic regime. Unpublished report for the Town of Crested Butte and EPA Region VIII.

Cooper, D.J. 1995. An analysis of wetland impacts in the Telluride Mountain Village. Unpublished Report to the U.S. Dept. of Justice.

Cooper, D.J. 1996. Water and soil chemistry, floristics and phytosociology of the extreme rich High Creek fen, in South Park, Colorado, U.S.A. *Canadian Journal of Botany* 74:1801-1811.

Cooper, D. J. 1998. "Classification of Colorado's Wetlands for Use in HGM Functional Assessment: A First Approximation." *Characterization and Functional Assessment of Reference Wetlands in Colorado*, CO Department of Natural Resources, Colorado Geological Survey - Division of Minerals and Geology, Denver, CO 80203.

Cooper, D.J. and T. Cottrell. 1988. Wetland finding and description of wetlands State Highway 119 - Blackhawk to the Boulder County Line. Unpublished report Colorado Dept. of Transportation by Daniel, Mann, Johnson and Mendenhall, Inc.

Cooper, D.J. and T. Cottrell. 1989. An ecological characterization and functional evaluation of wetlands in the Cherry Creek basin: Cherry Creek reservoir upstream to Frantown. Unpublished report for EPA Region VIII and Park County, Colorado.

Cooper, D.J. and T. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Unpublished report prepared for The Nature Conservancy, Boulder, Colorado.

Cooper, D.J. and D. Gilbert. 1990. An ecological characterization and functional evaluation of wetlands in the Telluride region of Colorado. Unpublished report for EPA Region VIII.

Cooper, D.J. and C. Severn. 1992. Wetlands of the San Luis Valley, Colorado: An ecological study and analysis of the hydrologic regime, soil chemistry, vegetation and the potential effects of a water table drawdown. Unpublished report for CDOW, USFWS and Rio Grande Water Conservation District.

Kettler, S. and A. McMullen. 1996. Routt National Forest riparian vegetation classification. Report submitted to Routt National Forest. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G.M. and N.D. Lederer. 1993. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores River Basins. Report submitted to the Colorado Department of Health and the Environmental Protection Agency, Region VIII. The Nature Conservancy's Colorado Program, Boulder, CO.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River Basins, Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G., R. Rondeau, and S. Kettler. 1995. A classification of the riparian vegetation of the Gunnison River Basin, Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G., R.J. Rondeau, and A. McMullen. 1996. A classification of the riparian vegetation of the lower South Platte and parts of the upper Arkansas River Basins, Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G., E. VanWie, and M. Damm. 1997. A classification of the riparian vegetation of the South Platte River Basin (and part of the Republican River Basin), Colorado. Report submitted to the Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, G. M., E. VanWie, M. Dam, R. Rondeau, S. Kettler, A. McMullen, and J. Sanderson. 1999a. *A Classification of Riparian Wetland Plant Associations of Colorado: User Guide to the Classification Project*, Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Kittel, Gwen M., Erika VanWie, Mary Damm, Renée Rondeau, Steve Kettler, and John Sanderson. 1999b. A Classification of Riparian Plant Associations of the Rio Grande and Closed Basin Watersheds, Colorado. Prepared for: The Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII Denver, Colorado. The Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Komarkova, V. 1979. Alpine vegetation of the Indian Peaks Area. J. Cramer, Vaduz, Germany.

McKee, J.P., D.E. Salas, and K. Willie. 1995. Animas - LaPlata Project wetland / riparian vegetation communities: Classification and inventory. Technical Service Center. U.S. Bureau of Reclamation. Denver, CO.

Merrit, D. M. 1997. Riparian vegetation and geomorphic features on regulated and unregulated rivers: Green and Yampa, NW Colorado. Unpublished thesis, Colorado State University. Fort Collins, CO.

Richard, C., G. Kittel, and S. Kettler. 1996. A classification of the riparian vegetation of the San Juan National Forest. Draft 1 to be submitted to the San Juan National Forest. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Sanderson, John and Steve Kettler 1996. A Preliminary Wetland Vegetation Classification for a portion of Colorado's West Slope, CNHP Research Report No. 13. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, Colorado 80523.

APPENDIX B – HGM INDICATOR SPECIES

Listed are the ninety-nine common and diagnostic species delimited by Cooper (Colorado Geologic Survey et al. 1998, Figure 7) for each of 15 HGM subclasses. The subclasses are defined in Table 1 of the report.

SppID	Scientific Name	Common Name	HGM
AGRGIG	*Agrostis gigantea*	redtop	R4
ALNINC	*Alnus incana ssp. tenuifolia*	thinleaf alder	R3
ALOAEQ	*Alopecurus aequalis*	shortawn foxtail	D2
AMPNEV	*Scirpus nevadensis*	Nevada bulrush	F1
ARGANS	*Argentina anserina*	silverweed cinquefoil	S3
BECSYZ	*Beckmannia syzigachne*	American sloughgrass	D3
BOLMAR	*Schoenoplectus maritimus*	cosmopolitan bulrush	F1
BROINE	*Bromus inermis ssp. inermis var. inermis*	smooth brome	R4
CALCAN	*Calamagrostis canadensis*	bluejoint reedgrass	R1
CALSTR	*Calamagrostis stricta*	slimstem reedgrass	S3
CARAQU	*Carex aquatilis var. stans*	water sedge	S1
CARCOR	*Cardamine cordifolia*	heartleaf bittercress	R1
CAREMO	*Carex emoryi*	Emory's sedge	R5
CARLAN	*Carex pellita*	woolly sedge	R4
CARLIM	*Carex limosa*	mud sedge	D1
CARNEB	*Carex nebrascensis*	Nebraska sedge	S4
CARNIG	*Carex nigricans*	black alpine sedge	S1
CARSCO	*Carex scopulorum*	mountain sedge	S1
CARSIM	*Carex simulata*	analogue sedge	S2
CARUTR	*Carex utriculata*	beaked sedge	D1
CHERUB	*Chenopodium chenopodioides*	low goosefoot	D5
CHRLIN	*Chrysothamnus linifolius*	spearleaf rabbitbrush	R5
CORCOR	*Corylus cornuta*	beaked hazelnut	R4
CRIJUB	*Hordeum jubatum ssp. jubatum*	foxtail barley	R4
DESCES	*Deschampsia cespitosa*	tufted hairgrass	S3
DISSTR	*Distichlis spicata*	inland saltgrass	F1
ELEANG	*Elaeagnus angustifolia*	Russian olive	R5
ELEOBT	*Eleocharis engelmannii*	Engelmann spikerush	D4
ELEPAL	*Eleocharis palustris*	common spikerush	D3
ELEQUI	*Eleocharis quinqueflora*	fewflower spikerush	S2
ELEROS	*Eleocharis rostellata*	beaked spikerush	D4
EPICIL	*Epilobium ciliatum ssp. glandulosum*	fringed willowherb	D2
EQUARV	*Equisetum arvense*	field horsetail	R3
GEUMAC	*Geum macrophyllum var. perincisum*	largeleaf avens	R2
GLAMAR	*Glaux maritima*	sea milkwort	F1
GLYGRA	*Glyceria grandis*	American mannagrass	D2
GLYSTR	*Glyceria striata*	fowl mannagrass	R1
GNAULI	*Gnaphalium uliginosum*	marsh cudweed	D4
HERSPH	*Heracleum maximum*	common cowparsnip	R2
HIPVUL	*Hippuris vulgaris*	common mare's-tail	D1
JUNARC	*Juncus balticus var. montanus*	mountain rush	S3
JUNBUF	*Juncus bufonius*	toad rush	D4
JUNTOR	*Juncus torreyi*	Torrey's rush	R4
KOBMYO	*Kobresia myosuroides*	Bellardi bog sedge	S2
KOBSIM	*Kobresia simpliciuscula*	simple bog sedge	S2
LEMMIN	*Lemna minor*	common duckweed	D2
LOBSIP	*Lobelia siphilitica*	great blue lobelia	D3
LYCAME	*Lycopus americanus*	American water horehound	R5

SppID	Scientific Name	Common Name	HGM
MENTRI	*Menyanthes trifoliata*	buckbean	D1
MERCIL	*Mertensia ciliata*	tall fringed bluebells	R1
MIMGUT	*Mimulus guttatus*	seep monkeyflower	R1
NEGACE	*Acer negundo var. interius*	boxelder	R4
OXYFEN	*Oxypolis fendleri*	Fendler's cowbane	R1
PEDCRE	*Pedicularis crenulata*	meadow lousewort	S3
PEDGRO	*Pedicularis groenlandica*	elephanthead lousewort	S1
PENFLO	*Dasiphora floribunda*	shrubby cinquefoil	S3
PERLAP	*Polygonum lapathifolium*	curlytop knotweed	D4
PHAARU	*Phalaris arundinacea*	reed canarygrass	D3
PHRAUS	*Phragmites australis*	common reed	R5
PICPUN	*Picea pungens*	blue spruce	R3
POAPRA	*Poa pratensis*	Kentucky bluegrass	R3
POPANG	*Populus angustifolia*	narrowleaf cottonwood	R3
POPDEL	*Populus deltoides*	eastern cottonwood	R5
PSYLEP	*Caltha leptosepala ssp. leptosepala*	white marsh marigold	S1
PUCAIR	*Puccinellia nuttalliana*	Nuttall's alkaligrass	F1
RANREP	*Ranunculus flammula var. filiformis*	greater creeping spearwort	F1
RHUARO	*Rhus trilobata var. trilobata*	skunkbush sumac	R5
ROSWOO	*Rosa woodsii*	Woods' rose	R3
RUDAMP	*Rudbeckia laciniata var. ampla*	cutleaf coneflower	R3
SAGLAT	*Sagittaria latifolia*	broadleaf arrowhead	D2
SALAMY	*Salix amygdaloides*	peachleaf willow	R5
SALBOO	*Salix boothii*	Booth willow	R2
SALCAN	*Salix candida*	sageleaf willow	S2
SALEXI	*Salix exigua*	narrowleaf willow	R5
SALFRA	*Salix fragilis*	crack willow	R5
SALGEY	*Salix geyeriana*	Geyer willow	R2
SALIRR	*Salix irrorata*	dewystem willow	R4
SALLIG	*Salix ligulifolia*	strapleaf willow	R3
SALMON	*Salix monticola*	Rocky Mountain willow	R2
SALPLA	*Salix planifolia*	planeleaf willow	S1
SARVER	*Sarcobatus vermiculatus*	greasewood	F1
SCHLAC	*Schoenoplectus acutus var. acutus / tabernaemontani*	hardstem bulrush / softstem bulrush	D2
SCIPAL	*Scirpus pallidus*	cloaked bulrush	D2
SENTRI	*Senecio triangularis*	arrowleaf ragwort	S1
SPAEUR	*Sparganium eurycarpum*	broadfruit bur-reed	D2
SPAGRA	*Spartina gracilis*	alkali cordgrass	R5
SPAPEC	*Spartina pectinata*	prairie cordgrass	R5
SPEMED	*Spergularia maritima*	media sandspurry	F1
SPOAIR	*Sporobolus airoides*	alkali sacaton	F1
SUACAL	*Suaeda calceoliformis*	Pursh seepweed	F1
SWISER	*Cornus sericea ssp. sericea*	red-osier dogwood	R3
TAMRAM	*Tamarix ramosissima*	saltcedar	R5
THAALP	*Thalictrum alpinum*	alpine meadow-rue	S2
TRIMAR	*Triglochin maritimum*	seaside arrowgrass	S2
TRIPAL	*Triglochin palustre*	marsh arrowgrass	S2
TYPANG	*Typha angustifolia*	narrowleaf cattail	D2
TYPLAT	*Typha latifolia*	broadleaf cattail	D2
VITRIP	*Vitis riparia*	riverbank grape	R5
XANSTR	*Xanthium strumarium*	rough cockleburr	D5

APPENDIX C:
The Natural Heritage Network Ranking System

Just as ancient artifacts and historic buildings represent our cultural heritage, a diversity of plant and animal species and their habitats represent our "natural heritage." Colorado's natural heritage encompasses a wide variety of ecosystems from tallgrass prairie and shortgrass high plains to alpine cirques and rugged peaks, from canyon lands and sagebrush deserts to dense subalpine spruce-fir forests and wide-open tundra.

These widely diversified habitats are determined by water availability, temperature extremes, altitude, geologic history, and land use history. The species that inhabit each of these ecosystems have adapted to the specific set of conditions found there. But, because human influence today touches every part of the Colorado environment, we are responsible for understanding our impacts and carefully planning our actions to ensure our natural heritage persists for future generations.

Some generalist species, like house finches, have flourished over the last century, having adapted to habitats altered by humans. However, many other species are specialized to survive in vulnerable Colorado habitats; among them are Pikes Peak spring parsley (a wildflower), the Arkansas darter (a fish), and the Pawnee montane skipper (a butterfly). These species have special requirements for survival that may be threatened by incompatible land management practices and competition from non-native species. Many of these species have become imperiled not only in Colorado, but also throughout their range of distribution, some existing in fewer than five populations in the entire world. The decline of these specialized species often indicates disruptions that could permanently alter entire ecosystems. Thus, recognition of rare and imperiled species is crucial to preserving Colorado's diverse natural heritage.
Colorado is inhabited by some 800 vertebrate species and subspecies, and tens of thousands of invertebrate species. In addition, the state has approximately 4,300 species of plants and more than 450 recognized plant communities that represent terrestrial and wetland ecosystems. It is this rich natural heritage that has provided the basis for Colorado's diverse economy. Some components of this heritage have always been rare, while others have become imperiled with human-induced changes in the landscape. This decline in biological diversity is a global trend resulting from human population growth, land development, and subsequent habitat loss. Globally, the loss in species diversity has become so rapid and severe that Wilson (1988) has compared the phenomenon to the great natural catastrophes at the end of the Paleozoic and Mesozoic eras.

The need to address this loss in biological diversity has been recognized for decades in the scientific community. However, many conservation efforts made in this country were not based upon preserving biological diversity; instead, they primarily focused on preserving game animals, striking scenery, and locally favorite open spaces. To address the absence of a methodical, scientifically based approach to preserving biological diversity, Dr. Robert Jenkins of The Nature Conservancy pioneered the Natural Heritage Methodology in the early '70s. Recognizing that rare and imperiled species are more likely to become extinct than common ones, the Natural Heritage Methodology ranks species according to their rarity or degree of imperilment. The ranking system is scientifically based upon the number of known locations of the species as well as its biology and known threats. By ranking the relative rareness or

imperilment of a species, the quality of its populations, and the importance of associated conservation sites, the methodology can facilitate the prioritization of conservation efforts so the most rare and imperiled species may be preserved first. As the scientific community began to realize that plant communities are as important as individual species, this methodology has also been applied to ranking and preserving rare plant communities, and the best examples of common communities.

The Natural Heritage Methodology is used by Natural Heritage Programs throughout North, Central, and South America, forming an international database network. The 85 Natural Heritage Network data centers are located in each of the 50 U.S. states, five provinces of Canada, and 13 countries in South and Central America and the Caribbean. This network enables scientists to monitor the status of species from a state, national, and global perspective. Information collected by the Natural Heritage Programs can provide a means to protect species before the need for legal endangerment status arises. It can also enable conservationists and natural resource managers to make informed, objective decisions in prioritizing and focusing conservation efforts.

What is Biological Diversity?

Protecting biological diversity has become an important management issue for many natural resource professionals. Biological diversity at its most basic level includes the full range of species on Earth, from single-celled species such as bacteria and protists through the multicellular kingdoms of plants and animals. At finer levels of organization, biological diversity includes the genetic variation within species, both among geographically separated populations and among individuals within a single population. On a wider scale, diversity includes variations in the biological communities in which species live, the ecosystems in which communities exist, and the interactions between these levels. All levels are necessary for the continued survival of species and plant communities, and all are important for the well being of humans. It stands to reason that biological diversity should be of concern to all people.

The biological diversity of an area can be described at four levels:

1. **Genetic Diversity** — the genetic variation within a population and among populations of a plant or animal species. The genetic makeup of a species varies between populations within its geographic range. Loss of a population results in a loss of genetic diversity for that species and a reduction of total biological diversity for the region. Once lost, this unique genetic information cannot be reclaimed.

2. **Species Diversity** — the total number and abundance of plant and animal species and subspecies in an area.

3. **Community Diversity** — the variety of plant communities within an area that represent the range of species relationships and inter-dependence. These communities may be diagnostic or even restricted to an area. It is within communities that all life dwells.

4. **Landscape Diversity** — the type, condition, pattern, and connectedness of natural communities. A landscape consisting of a mosaic of natural communities may contain one multifaceted ecosystem, such as a wetland ecosystem. A landscape also may contain several

distinct ecosystems, such as a riparian corridor meandering through shortgrass prairie. Fragmentation of landscapes, loss of connections and migratory corridors, and loss of natural communities all result in a loss of biological diversity for a region. Humans and the results of their activities are integral parts of most landscapes.

The conservation of biological diversity must include all levels of diversity: genetic, species, community, and landscape. Each level is dependent on the other levels and inextricably linked. In addition, and all too often omitted, humans are also closely linked to all levels of this hierarchy. We at the Colorado Natural Heritage Program believe that a healthy natural environment and a healthy human environment go hand in hand, and that recognition of the most imperiled species is an important step in comprehensive conservation planning.

Colorado's Natural Heritage Program

To place this document in context, it is useful to understand the history and functions of the Colorado Natural Heritage Program (CNHP).

CNHP is the state's primary comprehensive biological diversity data center, gathering information and field observations to help develop statewide conservation priorities. After operating in the Colorado Division of Parks and Outdoor Recreation for 14 years, the Program was relocated to the University of Colorado Museum in 1992, and to the College of Natural Resources at Colorado State University in 1994, where it has operated ever since.
The multi-disciplinary team of scientists, planners, and information managers at CNHP gathers comprehensive information on the rare, threatened, and endangered species and significant plant communities of Colorado. Life history, status, and locational data are incorporated into a continually updated data system. Sources include published and unpublished literature, museum and herbaria labels, and field surveys conducted by knowledgeable naturalists, experts, agency personnel, and our own staff of botanists, ecologists, and zoologists.

The Biological and Conservation Data System (BCD), developed by The Nature Conservancy, is used by all natural heritage programs to house data about imperiled species. These data include taxonomic group, global and state rarity rank, federal and state legal status, observation source, observation date, county, township, range, watershed, and other relevant facts and observations. CNHP also uses the Biological Diversity Tracking System (BIOTICS) for digitizing and mapping occurrences of rare plants, animals, and plant communities. These rare species and plant communities are referred to as **elements of natural diversity** or simply **elements**.

Concentrating on site-specific data for each element enables CNHP to evaluate the significance of each location for the conservation of biological diversity in Colorado and in the nation. By using species imperilment ranks and quality ratings for each location, priorities can be established to guide conservation action. A continually updated locational database and priority-setting system such as that maintained by CNHP provides an effective, proactive land-planning tool.

To assist in biological diversity conservation efforts, CNHP scientists strive to answer questions such as:

- What species and ecological communities exist in the area of interest?

- Which are at greatest risk of extinction or are otherwise significant from a conservation perspective?
- What are their biological and ecological characteristics, and where precisely are these priority species or communities found?
- What is their condition at these locations, and what processes or activities are sustaining or threatening them?
- Where are the most important sites to protect?
- Who owns or manages those places deemed most important to protect, and what is threatening those places?
- What actions are needed for the protection of those sites and the significant elements of biological diversity they contain?
- How can we measure our progress toward conservation goals?

CNHP has effective working relationships with several state and federal agencies, including the Colorado Department of Natural Resources, the Colorado Division of Wildlife, the Bureau of Land Management, and the U.S. Forest Service. Numerous local governments and private entities, such as consulting firms, educators, landowners, county commissioners, and non-profit organizations, also work closely with CNHP. Use of the data by many different individuals and organizations encourages a proactive approach to conservation, thereby reducing the potential for conflict.

The Natural Heritage Ranking System

Key to the functioning of Natural Heritage Programs is the concept of setting priorities for information gathering and inventory. The number of possible facts and observations that can be gathered about the natural world is essentially limitless. The financial and human resources available to gather such information are not. Because biological inventories tend to be woefully underfunded, there is a premium on devising systems that are both effective in providing information that meets users' needs and efficient in gathering that information. The cornerstone of heritage inventories is the use of a ranking system to achieve these twin objectives of effectiveness and efficiency.

Ranking species and ecological communities according to their imperilment status provides guidance for where natural heritage programs should focus their information-gathering activities. For species deemed secure, only general information needs to be maintained by natural heritage programs. Fortunately, the more common and secure species constitute the majority of most groups of organisms. On the other hand, for those species that are by their nature rare or otherwise threatened, more detailed information is needed. Because of these species' very rarity, gathering comprehensive and detailed population data on them is possible, even if difficult. Gathering similarly comprehensive information on more abundant species would pose a far greater challenge.

To determine the status of species within Colorado, CNHP gathers information on plants, animals, and plant communities. Each of these elements of natural diversity is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). This

factor is weighted more heavily than other factors because an element found in one place is more imperiled than something found in twenty-one places. Also of importance is the size of the geographic range, the number of individuals, trends in population and distribution, identifiable threats, and the number of already protected occurrences.

Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State or S-rank) and the element's imperilment over its entire range (its Global or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. For example, the lynx, which is thought to be secure in northern North America but is known from fewer than 5 current locations in Colorado, is ranked G5S1 (globally secure, but critically imperiled in this state). The Rocky Mountain Columbine (*Aquilegia saximontana*), which is known only in Colorado from about 30 locations, is ranked a G3S3 (vulnerable both in the state and globally, since it only occurs in Colorado and then in small numbers). Further, a tiger beetle that is only known from one location in the world at the Great Sand Dunes National Monument is ranked G1S1 (critically imperiled both in the state and globally, because it exists in a single location). CNHP actively collects, maps, and electronically processes specific occurrence information for animal and plant species considered from extremely imperiled to vulnerable in the state (S1 - S3). Several factors, such as rarity, evolutionary distinctiveness, and endemism (restrictiveness of habitat), contribute to the conservation priority of each species. Certain species are "watchlisted," meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted. A complete description of each of the Natural Heritage ranks is provided in Table 2.

This single rank system works readily for all species except those that are migratory. Animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding, and resident species. As noted in Table 2, ranks followed by a "B," for example S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N," for example S4N, refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

Table C - 1. Definition of Natural Heritage Imperilment Ranks

Global imperilment ranks are based on the range-wide status of a species. State imperilment ranks are based on the status of a species in an individual state. State and Global ranks are denoted with an "S" or a "G" respectively, followed by a number or letter. **These ranks should not be interpreted as legal designations.**

G/S1	***Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction.***
G/S2	***Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.***
G/S3	***Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).***
G/S4	***Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.***
G/S5	***Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery.***
G/SX	***Presumed extinct globally, or extirpated within the state.***
G#?	***Indicates uncertainty about an assigned global rank.***
G/SU	***Unable to assign rank due to lack of available information.***
GQ	***Indicates uncertainty about taxonomic status.***
G/SH	***Historically known, but usually not verified for an extended period of time.***
G#T#	***Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.***
S#B	***Refers to the breeding season imperilment of elements that are not permanent residents.***
S#N	***Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used.***
SZ	***Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably identified, mapped, and protected.***
SA	***Accidental in the state.***
SR	***Reported to occur in the state but unverified.***
S?	***Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.***

Note: Where two numbers appear in a state or global rank (for example, S2S3), the rank of the element is unclear but likely within the stated range.

Legal Designations

Natural Heritage imperilment ranks should not be interpreted as legal designations. Although most species protected under state or federal endangered species laws are extremely rare, not all rare species receive legal protection. Legal status is designated by either the U.S. Fish and Wildlife Service under the Endangered Species Act or by the Colorado Division of Wildlife under Colorado Statutes 33-2-105 Article 2. In addition, the U.S. Forest Service recognizes some species as "Sensitive," as does the Bureau of Land Management. Table 3 defines the special status assigned by these agencies and provides a key to abbreviations used by CNHP.

Candidate species for listing as endangered or threatened under the Endangered Species Act are indicated with a "C". While obsolete legal status codes (Category 2 and 3) are no longer used, CNHP will continue to maintain them in its Biological and Conservation Data system for reference.

Table C-2. Federal and State Agency Special Designations.

Federal Status:
1. U.S. Fish and Wildlife Service (58 Federal Register 51147, 1993) and (61 Federal Register 7598, 1996)

LE Listed Endangered: defined as a species, subspecies, or variety in danger of extinction throughout all or a significant portion of its range.

E(S/A) Endangered: treated as endangered due to similarity of appearance with listed species.

LT Listed Threatened: defined as a species, subspecies, or variety likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

P Proposed: taxa formally proposed for listing as Endangered or Threatened (a proposal has been published in the Federal Register, but not a final rule).

C Candidate: taxa for which substantial biological information exists on file to support proposals to list them as endangered or threatened, but no proposal has been published yet in the Federal Register.

2. U.S. Forest Service (Forest Service Manual 2670.5) (noted by the Forest Service as "S")

FS Sensitive: those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by:

- Significant current or predicted downward trends in population numbers or density.
- Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

3. Bureau of Land Management (BLM Manual 6840.06D) (noted by BLM as "S")

BLM Sensitive: those species found on public lands, designated by a State Director, that could easily become endangered or extinct in a state. The protection provided for sensitive species is the same as that provided for C (candidate) species.

State Status:
The Colorado Division of Wildlife has developed categories of imperilment for nongame species (refer to the Colorado Division of Wildlife's Chapter 10 – Nongame Wildlife of the Wildlife Commission's regulations). The categories being used and the associated CNHP codes are provided below.

E Endangered: those species or subspecies of native wildlife whose prospects for survival or recruitment within this state are in jeopardy, as determined by the Commission.

T Threatened: those species or subspecies of native wildlife which, as determined by the Commission, are not in immediate jeopardy of extinction but are vulnerable because they exist in such small numbers, are so extremely restricted in their range, or are experiencing such low recruitment or survival that they may become extinct.

SC Special Concern: those species or subspecies of native wildlife that have been removed from the state threatened or endangered list within the last five years; are proposed for federal listing (or are a federal listing "candidate species") and are not already state listed; have experienced, based on the best available data, a downward trend in numbers or distribution lasting at least five years that may lead to an endangered or threatened status; or are otherwise determined to be vulnerable in Colorado.

Element Occurrence Ranking

Actual locations of elements, whether they are single organisms, populations, or plant communities, are referred to as **element occurrences**. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. To prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the ecological quality of the occurrences whenever sufficient information is available. This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful. The EO-Rank is based on three factors:

> Size – a measure of the area or abundance of the element's occurrence, relative to other known, and/or presumed viable, examples. Takes into account factors such as area of occupancy, population abundance, population density, population fluctuation, and minimum dynamic area (which is the area needed to ensure survival or re-establishment of an element after natural disturbance).
>
> Condition/Quality – an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence. This includes factors such as reproduction, age structure, biological composition (such as the presence of exotic versus native species), structure (for example, canopy, understory, and ground cover in a forest community), and biotic interactions (such as levels of competition, predation, and disease).
>
> Landscape Context – an integrated measure of two factors: the dominant environmental regimes and processes that establish and maintain the element, and connectivity. *Dominant environmental regimes and processes* include herbivory, hydrologic and water chemistry regimes (surface and groundwater), geomorphic processes, climatic regimes (temperature and precipitation), fire regimes, and many kinds of natural disturbances. *Connectivity* includes such factors as a species having access to habitats and resources needed for life cycle completion, fragmentation of ecological communities and systems, and the ability of the species to respond to environmental change through dispersal, migration, or re-colonization.

Each of these factors is rated on a scale of A through D, with A representing an excellent grade and D representing a poor grade. These grades are then averaged to determine an appropriate EO-Rank for the occurrence. If not enough information is available to rank an element occurrence, an EO-Rank of E is assigned. EO-Ranks and their definitions are as follows:

EO Rank	Description
A	excellent estimated viability
B	good estimated viability
C	fair estimated viability
D	poor estimated viability
E	verified extant (viability not assessed)
H	historical
F	failed to find
X	extirpated