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

Prepared by:
Colorado Natural Heritage Program
Gwen Kittel, Erika VanWie, Mary Damm,
Renée Rondeau, Steve Kettler and John Sanderson

March, 1999

This report should be cited as:

Kittel, G., E. VanWie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999. A Classification of Riparian Plant Associations of the Rio Grande and Closed Basin Watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

For more information please contact:

Deb Mellblom, Colorado Department of Natural Resources 1313 Sherman St., Room 718, Denver, CO 80203, (303) 866-3311.

Sarah Fowler, Environmental Protection Agency, Region VII, 999 18th St., Denver CO 80202-2405, (303) 312-6312.

Colorado Natural Heritage Program, 254 General Service Building, Colorado State University, Ft. Collins, Colorado 80523. (970) 491-1309 www.cnhp.colostate.edu

ACKNOWLEDGMENTS

Financial support for this study was provided by a grant from the Environmental Protection Agency (EPA) Region VIII, through the Colorado Department of Natural Resources, with in-kind services from the Colorado Natural Heritage Program. Additional funding was provided by Rio Grande National Forest and the use of a field vehicle, the Bureau of Land Management's Colorado Office, the Bureau of Reclamation, and the Denver Water Board. We'd like to thank Karen Hamilton and Dale Vodenahl of the EPA, Doug Robotham of the Colorado Department of Natural Resources, Brenda Mitchell of the Bureau of Land Management. We'd also like to acknowledge all Riparian Task Force members for their support and technical assistance, and for making this project a success. The Riparian Task Force is a cooperative group of 14 agencies joined by a Memorandum of Understanding and dedicated to the development of a state wide riparian classification for Colorado (see Appendix 2).

We must thank several people in the valley for help with land owner contacts, maps, directions, hot food, hot showers, and a place to escape from the rain and mosquitoes. The riparian survey would not have happened with out the help of Dean Erhard (USFS), Nancy and Chuck Werner (TNC), Mike Cassel (BLM), Fred Bunch (NPS), John Koshak (San Luis Lakes), and Hobey Dixon (Adams State College). Special thanks go to the hard working field crew Marti Aitken, and Erika VanWie in 1995; Erika VanWie, Mary Damm, and Bill Grantham in 1997. They not only collected all the field data, they identified hundreds of plant specimens, fixed flat tires, broken-down vehicles, trained volunteers, dealt with rain, heat, and bugs, happily entered the data into the computer, and contributed to and edited the community descriptions in this report. A big thank you is owed to CNHP Volunteers spending many hours in the field and at the office: Carol Adair, Liz Philips, Colorado, and many others. Extra big thank you goes to the friendly and helpful landowners who gave us permission to access your beautiful ranches. I am sure I am forgetting many other wonderful individuals, it's not intentional.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

This work describes, in a systematic way, an estimated 80-90% of the riparian plant association diversity and their physical habitats within the Rio Grande and Closed Basin watersheds. This work is not a mapping of riparian areas, nor is it an assessment of the abundance of riparian types found within the study area.

In this report we present results from field surveys conducted in 1995 and 1997 in the Rio Grande and Closed Basin watersheds. We collected vegetation and environmental data from over 200 sites found along relatively undisturbed stretches of rivers and streams. We classified these stands into alliances and plant associations based on their dominate plant species, species composition, and environmental setting. Three new plant associations are described from the Closed Basin, and several high quality riparian areas were located throughout the study area.

The classification presented is part of the United States National Vegetation Classification System (USNVS), developed and maintained by The Nature Conservancy (Grossman *et al*. 1998, Anderson *et al.* 1998). This system is based on six key elements to best incorporate existing systems and information, and to best fit the needs of conservation. The classification: 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. Because many riparian plant associations can be classified as wetlands, a cross-walk of USNVC with the Cowardin *et al*.'s (1979) Classification of Wetland and Deepwater Habitats is provided (Table 3).

For each riparian plant association we describe the regional, state, and basin-wide distribution, the elevational range, stream channel type, geomorphic setting, and vegetative characteristics. A brief soil description is included. The relationship of each plant association to previously described riparian associations is also discussed. Succession and management issues are discussed where successional trends and/or land use impacts were observed, or where information was available from the literature.

This project is a cooperative effort to produce a statewide riparian classification by the Riparian Task Force, a group of state and federal government agency representatives, which in cooperation with The Nature Conservancy's Colorado Program and the Colorado Natural Heritage Program, supports the project through in-kind services, financial support, and technical assistance. The Riparian Task Force, formalized in 1993 by a Memorandum of Understanding (MOU), consists of steering and technical committees that meet once a year to review methods, results, conduct yearly planning, and to discuss the continued support of the statewide classification project.

INTRODUCTION

Riparian areas, highly threatened in Colorado, are of great importance for maintaining water quality and quantity, stabilizing stream banks, and providing habitat for fish and other wildlife species (Hansen *et al.* 1988, Brinson *et al.* 1981). Riparian areas are the biological and physical link between terrestrial and aquatic ecosystems (Youngblood *et al.* 1985). These areas are used extensively for domestic livestock grazing, gravel mining, recreational purposes, and as transportation corridors. The ecology of riparian areas and their response to various land management practices is variable and often poorly understood. Consequently, resource management and conservation decisions for many riparian areas can be far from optimal.

Our knowledge of riparian plant associations in Colorado has been both limited and fragmented. Patchy and scattered inventory work, using a variety of methodologies, has been conducted in Colorado. Areas include the Piceance Basin (Baker 1982), along the more accessible portions of the main stem of the Yampa River (by the Colorado Natural Areas Program), and the Yampa River within Dinosaur National Monument (Fisher *et al.* 1983). The Nature Conservancy has funded classification and surveys of riparian vegetation in west-central and southwestern Colorado (Baker 1986), and the northern Front Range (Cooper and Cottrell 1990). Plant community and habitat classification by the National Forests (Hess and Alexander 1986, Hess and Wasser 1982, Komarkova 1979, Komarkova *et al.* 1988, DeVelice *et al.* 1985) have not specifically focused on riparian areas. Elsewhere in the Rocky Mountain Region, riparian classification has been conducted in eastern Idaho and western Wyoming (Youngblood *et al.* 1985), eastern Wyoming (Jones 1990, Jones and Walford 1995), New Mexico (Muldavin 1992, Durkin *et al.* 1994, 1995), Montana (Hansen *et al.* 1988, 1989, 1995), Nevada (Manning and Padgett 1989, Manning and Padgett 1995), and Utah (Padgett *et al.* 1989).

This project constitutes the first state wide comprehensive riparian classification effort for Colorado. Since 1990, basin-wide, systematic riparian classification has been conducted in the Yampa and San Miguel/Dolores River basins (Kittel and Lederer 1993), the White and Colorado River basins (Kittel *et al.* 1994), the Gunnison River Basin (Kittel *et al.* 1995), on the San Juan and Routt National Forests (Richard *et al.* 1996, Kettler and McMullen 1996), and the South Platte watershed (Kittel *et al.* 1998). East of the Continental Divide, major watersheds include the South Platte and Republican, the Arkansas and Cimarron, and the Rio Grande River basins. The South Platte and Arkansas basins were divided into smaller, more manageable units or sub-basins: upper South Platte (I-25 west to the Continental Divide), lower South Platte (I-25 east to the state line) (we sampled the Republican drainage at the same time), upper Arkansas (Pueblo west to the Continental Divide), and lower Arkansas (Pueblo east to the state line, including the Cimarron River) (Figure 1). In this report, we present a classification of riparian vegetation from Rio Grande and Closed Basin watersheds.

Homogeneous stands of riparian vegetation are classified into Plant Associations based on similar floristic composition and environmental setting. The classification is part of the United States National Vegetation Classification System (USNVS), developed and maintained by The Nature Conservancy (Grossman *et al*. 1998, Anderson *et al.* 1998). The classification is based on a hierarchical physiognomic and ecological structure (Grossman *et al.* 1998). In this report, we cross-walk Alliances and Plant Associations with Wetland and Deepwater Habitats of the United States (Cowardin *et al.* 1979), and with Colorado Division of Wildlife (CDOW) GAP vegetation mapping units (CDOW 1997).

This classification is subject to peer review, field testing, and revision. As new data are collected from different basins, information will be incorporated into the classification. Information pertaining to rare or high quality occurrences of common plant associations will be incorporated into the Biological and Conservation Database of Rare and Imperiled Natural Communities, updated and maintained by the Colorado Natural Heritage Program (CNHP), and the Terrestrial Vegetation for the United States (Anderson *et al*. 1998).

This project is a cooperative effort by the Riparian Task Force, a group of state and federal government agency representatives, which in cooperation with The Nature Conservancy's Colorado Program and the Colorado Natural Heritage Program, supports the project through in-kind services, financial support, and technical assistance. The Riparian Task Force, formalized in 1993 by a Memorandum of Understanding (MOU), consists of steering and technical committees that meet once a year to review methods and results, and to discuss the continued support for the statewide classification project.

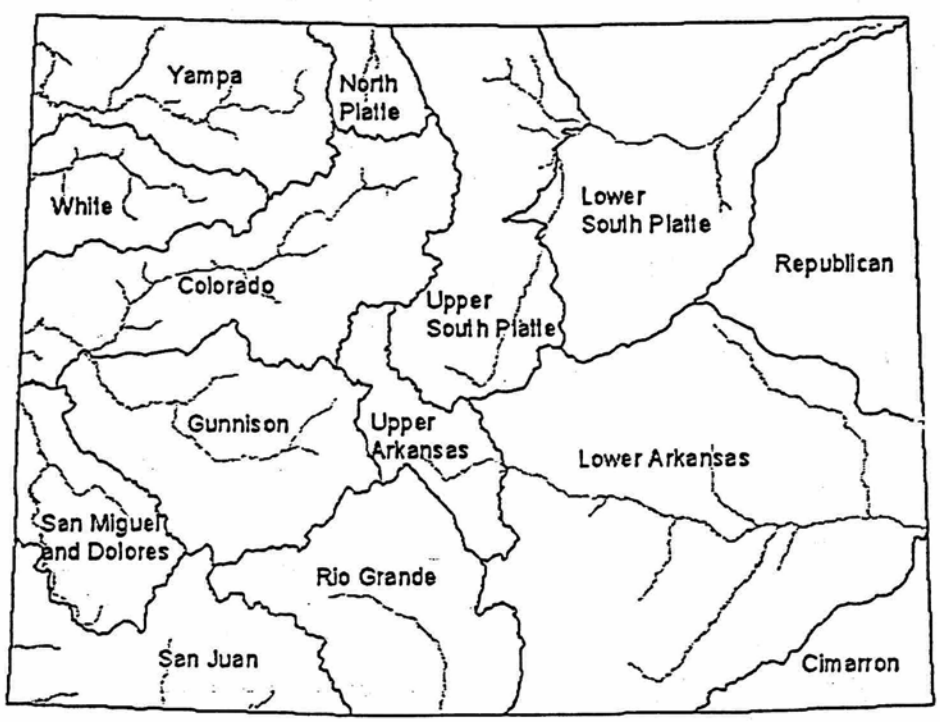


Figure 1. Map of the Major River Basins of Colorado.

STUDY AREA

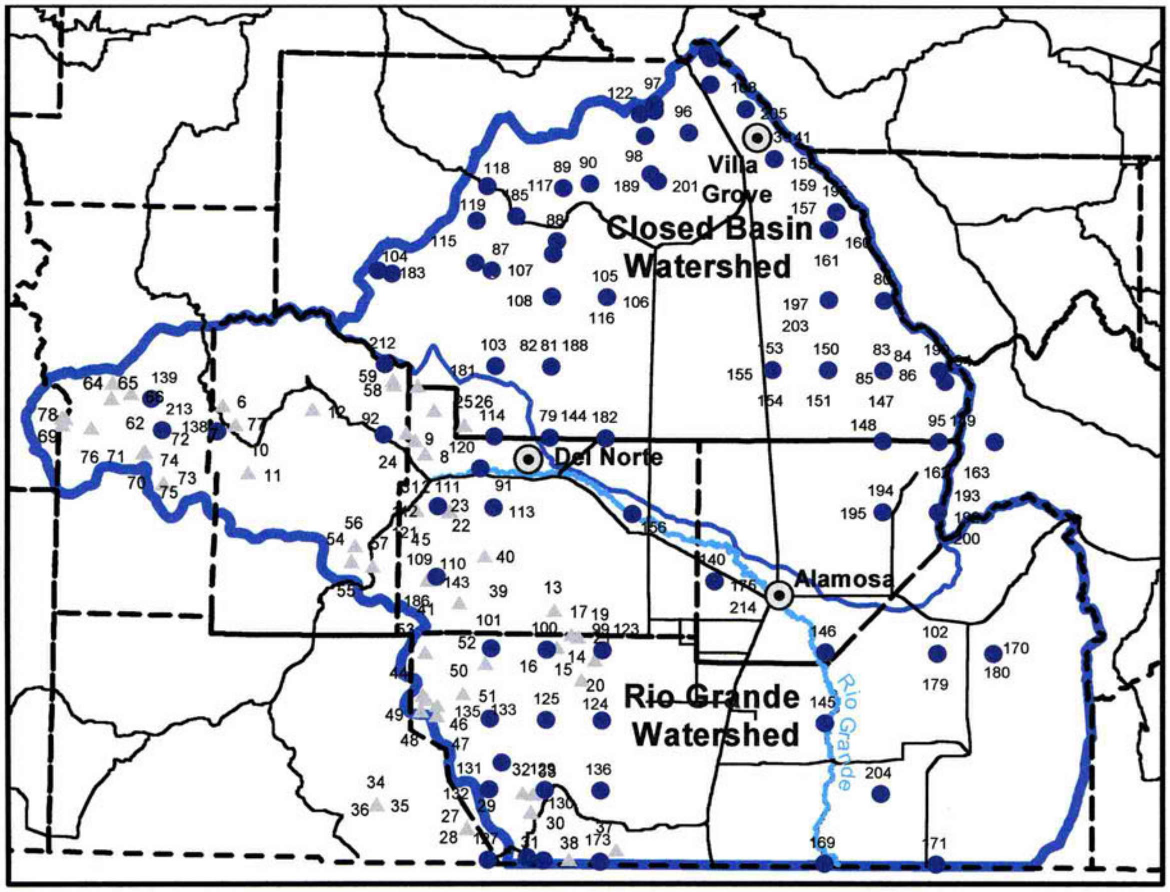
General Description

This study surveyed perennial and intermittent streams in the Rio Grande and Closed Basins watersheds in south-central Colorado, an area of approximately 7,500 square miles. The headwaters of the Rio Grande are in the San Juan Mountains in southwestern Colorado, reaching more than 13,500 feet in elevation along the Continental Divide. Several peaks reach elevations over 14,000 feet in the Sangre de Cristo Range along the northeastern boundary of the study area. The Rio Grande travels some 165 stream miles from its headwaters to the Colorado-New Mexico border (Figure 2, Table 1).

The area includes the San Luis Valley, the state's largest montane valley. It is composed of unconsolidated sediments laid down in the late Tertiary Period. The two mountain ranges on either side of the San Luis Valley are very different in origin and geology. The San Juan mountains, on the west side of the drainage, are volcanic in origin, formed during the mid-to-late Tertiary Period. The Sangre de Cristo mountains, forming the eastern boundary of the valley, are up a long, steep, narrow range, formed from faulting and upthrusting along the Rio Grande rift. An nearly imperceptible topographic divide north of Alamosa divides the valley into the Closed Basin, to the north, where no surface waters reach the Rio Grande River, and the Rio Grande watershed itself to the south. Ground-water may or may not flow between the basins. The Closed Basin part of the San Luis Valley floor houses the state's most extensive riparian/wetland complex. The surrounding foothills and mountains also contain a diverse array of riparian and upland habitats, including shortgrass prairies, foothill shrublands and woodlands, montane forests, and alpine communities.

The climate is that of a mid-continental, high mountain location. Precipitation in the San Juan and Sangre de Cristo mountains, mostly winter snowfall, averages over 50 inches at the highest elevations. The massive San Juan mountains cause a rain-shadow effect east of the Continental Divide. Consequently, the Sangre de Cristo range is drier than the San Juan range, and the San Luis Valley is a very dry high-mountain desert. The San Juan mountains have an annual precipitation of up to 50 inches in the wettest areas such as Wolf Creek Pass, Cumbres Pass, and the Conejos River uplands. Humidities are generally low in all locations.

The valley floor is very dry, receiving less than 10 inches in most areas and less than 7 inches in the center of the San Luis Basin, as it lies in the rain shadow of the San Juan Mountains. Precipitation on the valley floor includes some spring and summer rainfall (averaging 0.75 inches in May and 1.25 inches in July at Alamosa). Temperatures are generally very cold in the winter months to mild in the summer (Alamosa mean January temperature is 15° F, and 65°F in July). Mean annual potential evapotranspiration is as high as 50 inches on the valley floor, resulting in the San Luis Valley being described as a high mountain desert (Ellis *et al.* 1993).



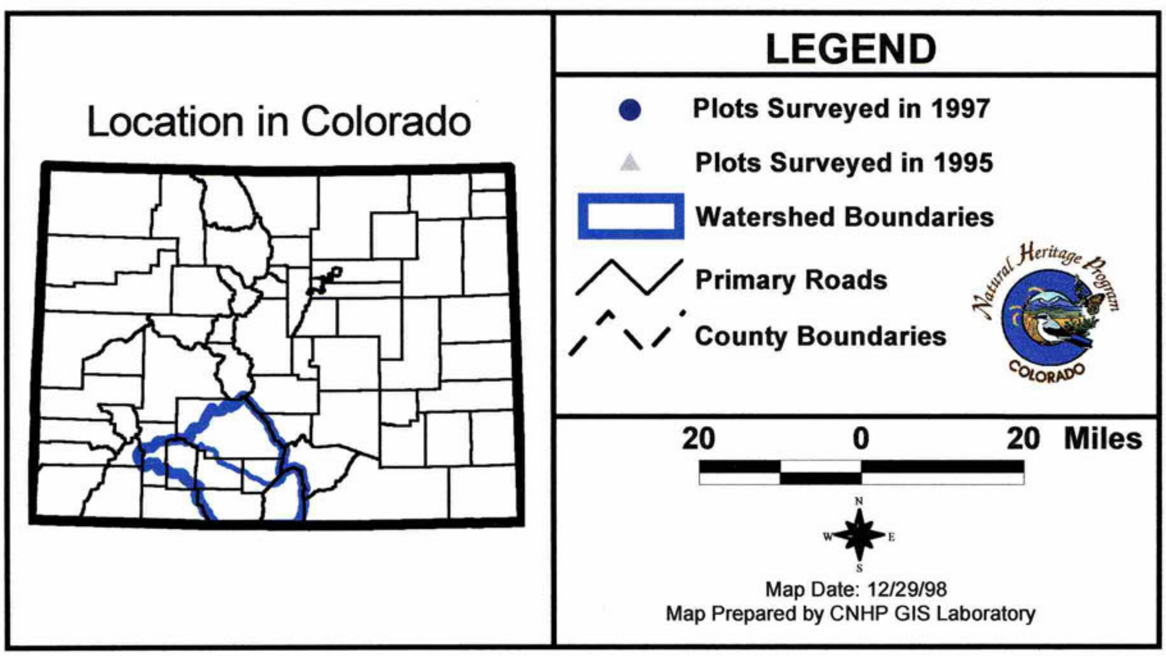


Figure 2. 1995 and 1997 Plot Locations in the Rio Grande and Closed Basin Watersheds.

Table 1. Rio Grande and Closed Basin Watershed Plot Locations, Riparian Condition Site Rank, Plant Association and Land Ownership. Private land locations are withheld to protect landowner privacy. Abbreviations used: BLM= Bureau of Land Management, CDOW= Colorado Division of Wildlife, RGNF= Rio Grande National Forest, GSNM= Great Sand Dunes National Monument, USFWS= Wildlife Refuge. Map numbers correspond to those in Figure 2 (page 4).

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance** Classification	Township, Range and Section***	Decimal Lat.	Long.	Owner
1	95RG01	South Fork Rio Grande	Rio Grande	B	Populus angustifolia Recent Alluvial Bar	T39NR3E SEC17 SE4 & T39NR3E SEC20 NE4	37.619	106.673	RGNF
2	95RG02	South Fork Rio Grande	Rio Grande	C	Populus angustifolia-Picea pungens/Alnus incana var. tenuifolia	T39NR3E SEC17 SE4 & T39NR3E SEC20 NE4	37.619	106.673	RGNF
3	95RG03	South Fork Rio Grande	Rio Grande	C	Salix monticola/Mesic Forbs	T39NR3E SEC17 SE4 & T39NR3E SEC20 NE4	37.619	106.673	RGNF
4	95RG04	South Fork Rio Grande	Rio Grande	A	Salix monticola/Calamagrostis canadensis	T39NR3E SEC17 SE4 & T39NR3E SEC20 NE4	37.619	106.673	RGNF
5	95RG05	South Fork Rio Grande	Rio Grande	B	Juncus balticus var. montanus	T39NR3E SEC17 SE4 & T39NR3E SEC20 NE4	37.619	106.673	RGNF
6	95RG06	Clear Creek	Mineral	C	Abies lasiocarpa-Picea engelmannii/Alnus incana var. tenuifolia	T41NR2W SEC20 SW4	37.797	107.115	RGNF
7	95RG07	Clear Creek	Mineral	C	Picea pungens Alliance	T41NR2W SEC20 SW4	37.797	107.115	RGNF
8	95RG08	West Alder Creek	Rio Grande	A	Alnus incana var. tenuifolia-Salix drummondiana	T40NR3E	37.719	106.656	RGNF
9	95RG09	West Alder Creek	Rio Grande	A	Alnus incana var. tenuifolia-mixed Salix species	T40NR3E	37.719	106.656	RGNF
10	95RG10	Trout Creek	Mineral	A	Populus angustifolia-Picea pungens/Alnus incana var. tenuifolia	T40NR2W SEC35 SE4	37.680	107.053	RGNF
11	95RG11	Trout Creek	Mineral	A	Alnus incana var. tenuifolia-Salix drummondiana	T40NR2W SEC35 SE4	37.680	107.053	RGNF
12	95RG12	Lower Deep Creek	Mineral	B	Glyceria spp. Alliance	T41NR1E SEC19 NW4 & T41NR1E SEC24 NE4	37.794	106.912	RGNF
13	95RG13	Rock Creek	Rio Grande	C	Abies lasiocarpa-Picea engelmannii/Alnus incana var. tenuifolia	T37NR6E SEC18 SW4 SE4/4	37.446	106.359	RGNF
14	95RG14	Alamosa River	Conejos	C	Picea pungens Alliance	T36NR6E SEC07 SW4	37.381	106.353	RGNF
15	95RG15	Alamosa River	Conejos	A	Alnus incana var. tenuifolia-Mixed Salix species	T36NR6E SEC07 SW4	37.381	106.353	RGNF
16	95RG16	Alamosa River	Conejos	C	Populus angustifolia-Picea pungens/Alnus incana var. tenuifolia	T36NR6E SEC07 SW4	37.381	106.353	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
17	95RG17	South Fork Cat Creek	Rio Grande/ Conejos	A	Juncus balticus var. montanus	T37NR6E SEC33 SE4 SW4/4 & T37NR6E SEC33 SW4 SE4/4	37.404	106.321	RGNF
18	95RG18	South Fork Cat Creek	Rio Grande/ Conejos	A	Glyceria spp. Alliance	T37NR6E SEC33 SE4 SW4/4 & T37NR6E SEC33 SW4 SE4/4	37.404	106.321	RGNF
19	95RG19	Willow Creek	Conejos	C	Pseudotsuga menziesii--Alliance	T36NR6E SEC03 NW4 NE4/4	37.399	106.305	RGNF
20	95RG20	Piedrosa Canyon	Conejos	C	Carex aquatilis-Carex utriculata	T36NR6E SEC34 SE4	37.323	106.296	RGNF
21	95RG21	Hound Dog-Rock Creek	Conejos	C	Populus angustifolia/mixed Salix species	T36NR6E SEC24 NW4 SE4/4	37.359	106.266	RGNF
22	95RG22	W. Fork Willow Creek	Rio Grande	A	Abies lasiocarpa-Picea engelmannii/Salix drummondiana	T39NR3.5E SEC13 SW4	37.618	106.599	RGNF
23	95RG23	E. Fork Willow Creek	Rio Grande	B	Salix lucida	T39NR3.5E SEC13 NW4 SE4/4	37.618	106.598	RGNF
24	95RG24	Snowedupon Creek	Mineral	B	Salix planifolia/Carex aquatilis	T40NR2E SEC25	37.756	106.699	RGNF
25	95RG25	Embargo Creek	Saguache	B	Alnus incana var. tenuifolia-Mixed Salix species	T41NR4E	37.771	106.568	RGNF
26	95RG26	Embargo Creek	Saguache	C	Populus angustifolia/Mixed Salix species	T41NR4E	37.771	106.568	RGNF
27	95RG27	Rio Chama	Archuleta	C	Populus angustifolia-Picea pungens/Alnus incana var. tenuifolia	T33NR4E SEC32 & T32NR4E SEC15	37.056	106.547	RGNF
28	95RG28	Rio Chama	Archuleta	C	Populus angustifolia/Alnus incana var. tenuifolia	T33NR4E SEC32 & T32NR4E SEC15	37.056	106.547	RGNF
29	95RG29	Rio Chama	Archuleta	B	Alnus incana var. tenuifolia-Salix drummondiana	T33NR4E SEC32 & T32NR4E SEC15	37.056	106.547	RGNF
30	95RG30	La Manga	Conejos	B	Salix planifolia/Mesic Forbs	T33NR5E	37.086	106.405	RGNF
31	95RG31	La Manga	Conejos	B	Carex aquatilis	T33NR5E	37.086	106.405	RGNF
32	95RG32	First Meadows	Conejos	B	Salix monticola/Carex aquatilis	T33NR5E	37.122	106.424	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
33	95RG33	Elk Creek	Conejos	B	Populus angustifolia-Picea pungens/Alnus incana var. tenuifolia	T33NR5E	37.119	106.401	RGNF
34	95RG34	La Manga Cr.-lower	Conejos	B	Salix planifolia/Carex aquatilis	T33NR5E SEC23	37.095	106.750	RGNF
35	95RG35	La Manga Cr.-lower	Conejos	B	Carex aquatilis	T33NR5E SEC23	37.095	106.750	RGNF
36	95RG36	La Manga Cr.-lower	Conejos	B	Salix planifolia/Caltha leptosepala	T33NR5E SEC23	37.095	106.750	RGNF
37	95RG37	Rito Hondo	Conejos	C	Alnus incana var. tenuifolia-mixed Salix species	T32NR7E SEC09 SW4 SE4/4	37.023	106.213	RGNF
38	95RG38	Rio de Los Pinos	Conejos	C	Salix monticola/Mesic Forbs	T32NR6E SEC17 SW4 SE4/4	37.005	106.319	RGNF
39	95RG39	Big Hollow-Headwaters	Rio Grande	A	Carex aquatilis	T37NR4E SEC17 NE4	37.457	106.573	RGNF
40	95RG40	West For Pinos Creek	Rio Grande	C	Populus angustifolia/Alnus incana var. tenuifolia	T38NR4E SEC14 SE4 SE4/4 & T38NR4E SEC23 NE4 SE/SW4/4	37.541	106.518	RGNF
41	95RG41	Park Creek	Rio Grande	C	Alnus incana var. tenuifolia-Salix drummondiana	T37NR3E	37.496	106.646	RGNF
42	95RG42	Beaver Creek	Rio Grande	A	Alnus incana var. tenuifolia-Cornus sericea	T39NR3E SEC20 NE4 NE4/4	37.743	106.679	RGNF
43	95RG43	West Bear Creek	Rio Grande	B	Salix planifolia/Carex aquatilis	T41NR3E	37.797	106.637	RGNF
44	95RG44	North Fork of Conejos River	Conejos	B	Cardamine cordifolia-Mertensia ciliata-Senecio triangularis	T35NR3E	37.292	106.652	RGNF
45	95RG45	North Fork Flume on the Conejos	Conejos	A	Salix planifolia/Caltha leptosepala	T35NR3E	37.285	106.643	RGNF
46	95RG46	El Rito Azul	Conejos	A/B	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T35NR3E	37.274	106.618	RGNF
47	95RG47	No Name Confluence on El Rito Azul	Conejos	A	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T35NR3E	37.256	106.620	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Decimal Long.	Owner
48	95RG48	Middle Fork of the Conejos	Conejos	B	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T35NR3E	37.263	106.656	RGNF
49	95RG49	Middle Fork of the Conejos	Conejos	A	Salix planifolia/Carex aquatilis	T35NR3E	37.263	106.656	RGNF
50	95RG50	Saddle Creek	Conejos	A	Caltha leptosepala	T35NR4E	37.296	106.561	RGNF
51	95RG51	Saddle Creek	Conejos	A	Salix planifolia/Caltha leptosepala	T35NR4E	37.296	106.561	RGNF
52	95RG52	Conejos River at Platoro	Conejos	B	Salix monticola/Mesic Forbs	T36NR4E	37.350	106.512	RGNF
53	95RG53	Treasure Creek	Conejos	A	Salix planifolia/Mesic Forbs	T36NR3E	37.368	106.647	RGNF
54	95RG54	South Fork of the Rio Grande	Mineral	A	Abies lasiocarpa-Picea engelmannii/Salix drummondiana	T38NR1E&R2E	37.526	106.817	RGNF
55	95RG55	South Fork of the Rio Grande	Mineral	A	Abies lasiocarpa-Picea engelmannii/Ribes spp.	T38NR1E&R2E	37.526	106.817	RGNF
56	95RG56	Hope Creek	Mineral	A	Abies lasiocarpa-Picea engelmannii/Salix drummondiana	Not available	37.555	106.809	RGNF
57	95RG57	Pass Creek	Mineral	B	Salix monticola/Mesic Forbs	T38NR2E	37.519	106.769	RGNF
58	95RG58	Nieve Canon Creek	Mineral	A	Salix monticola/Carex aquatilis	T42NR2E	37.840	106.729	RGNF
59	95RG59	Canon Nieve	Mineral	B	Salix planifolia/Mesic Forbs	T42NR2E	37.848	106.731	RGNF
60	95RG60	East Bellows Creek	Saguache	B	Salix planifolia/Caltha leptosepala	T42NR2E	37.838	106.676	RGNF
61	95RG61	East Bellows Creek	Saguache	B	Deschampsia cespitosa	T42NR2E	37.838	106.676	RGNF
62	95RG62	West Lost Trail Creek	San Juan	B	Salix drummondiana/Mesic Forbs	T41NR5W	37.805	107.366	RGNF
63	95RG63	West Lost Trail Creek	San Juan	B	Salix wolfii/Mesic Forbs	T41NR5W	37.805	107.366	RGNF
64	95RG64	Lost Trail Creek	San Juan	B	Salix planifolia/Carex aquatilis	T41NR4W	37.832	107.363	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
65	95RG65	Lost Trail Creek	San Juan	B	Carex aquatilis	T41NR5W	37.832	107.363	RGNF
66	95RG66	North Clear Creek	Hinsdale	B	Carex aquatilis	T41NR4W SEC16&17	37.815	107.322	RGNF
67	95RG67	North Clear Creek	Hinsdale	B	Salix planifolia/Carex aquatilis	T41NR4W	37.815	107.322	RGNF
68	95RG68	Rio Grande	Hinsdale	B-	Salix brachycarpa/Mesic Forbs	T41NR6W	37.768	107.468	RGNF
69	95RG69	Bear Creek	Hinsdale	B	Salix wolfii/Mesic Forbs	Not available	37.756	107.475	RGNF
70	95RG70	Weminuche Creek	Hinsdale	B	Salix monticola/Mesic Forbs	T40NR4W SEC22 NE4 SW4/4	37.710	107.292	RGNF
71	95RG71	Weminuche Creek	Hinsdale	B	Salix drummondiana/Mesic Forbs	T40NR4W SEC22 NE4 SW4/4	37.710	107.292	RGNF
72	95RG72	Tributary to Weminuche Creek	Hinsdale	A	Cardamine cordifolia-Mertensia ciliata-Senecio triangularis	T40NR4W SEC22 NE4 NE4/4 & T40NR4W SEC22 NE4 SE4/4	37.713	107.287	RGNF
73	95RG73	Squaw Creek	Hinsdale	B	Salix drummondiana/Mesic Forbs	Not available	37.657	107.244	RGNF
74	95RG74	Seep on Squaw Creek	Hinsdale	A	Carex utriculata	T39NR3W	37.658	107.244	RGNF
75	95RG75	Squaw Creek	Hinsdale	B	Abies lasiocarpa-Picea engelmannii/Salix drummondiana	Not available	37.657	107.244	RGNF
76	95RG76	Rio Grande	Hinsdale	C	Salix monticola/Mesic Forbs	Not available	37.753	107.410	RGNF
77	95RG77	Rio Grande	Hinsdale	A	Carex utriculata	Not available	37.764	107.085	RGNF
78	95RG78	Lost Trail Creek (Lower)	Hinsdale	B	Salix drummondiana/Mesic Forbs	T41NR4W SEC31 NW4 SE4/4	37.769	107.476	RGNF
79	97BG01	Little Garita Creek	Saguache	C	Salix bebbiana	T42NR5E	37.750	106.375	RGNF
80	97BG02	Dimick Gulch	Saguache	A	Populus angustifolia-Juniperus scopulorum	44NR12E	38.000	105.625	RGNF
81	97BG03	Cave Creek	Saguache	C	Salix monticola/Mesic Graminoids	T42N R5E	37.875	106.375	RGNF
82	97BG04	Cave Creek	Saguache	B	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T42N R4E	37.875	106.375	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
83	97BG05	Cottonwood Creek	Saguache	B	Carex aquatilis	Location withheld to respect landowner privacy.			Private
84	97BG06	Cottonwood Creek	Saguache	B	Populus angustifolia/Mesic Graminoids	Location withheld to respect landowner privacy.			Private
85	97BG07	Tributary .to Cedar Creek	Saguache	B	Populus angustifolia-Juniperus scopulorum	Location withheld to respect landowner privacy.			Private
86	97BG08	Cottonwood Creek	Saguache	A	Pseudotsuga menziesii/Betula occidentalis	Location withheld to respect landowner privacy.			Private
87	97BG09	Saguache Creek	Saguache	A	Salix monticola/Calamagrostis canadensis	T44N R3E	38.045	106.512	RGNF
88	97BG10	Houselog Creek	Saguache	C	Salix exigua/Bare Ground	T44N R5E Sec. 1 NE 1/4 NE 4/4	38.099	106.366	RGNF
89	97BG11	Jacks Creek	Saguache	B	Populus angustifolia/Alnus incana var. tenuifolia	Location withheld to respect landowner privacy.			Private
90	97BG12	Ford Creek	Saguache	B	Alnus incana var. tenuifolia/Mesic Forbs	T46N R6E Sec. 26 SE 1/4 SE4/4	38.202	106.293	BLM
91	97BG13	Rio Grande	Rio Grande	C	Salix lucida	T40N R4E Sec. 22 Se 1/4 Se 4/4	37.625	106.500	CDOW
92	97BG14	Blue Creek	Mineral	A	Carex aquatilis	T41N R2E	37.750	106.750	RGNF
93	97BG15	Nieland Creek	Saguache	A	Populus tremuloides/tall forb	T47N R9E Sec. 4 E1/4	38.250	105.875	BLM
94	97BG16	Medano Lake	Saguache	A	Salix brachycarpa/Mesic Forbs	T25S R72W Sec. 19 SW 1/4	37.856	105.486	RGNF
95	97BG17	Cold Creek	Saguache	B	Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum	T25S R73W Sec. 33 SW1/4 SE 4/4	37.750	105.500	RGNF
96	97BG18	Kelly Creek	Saguache	A	Alnus incana var. tenuifolia/Mesic Graminoids	T47N R8E Sec. 27 SE1/4 SE4/4	38.295	106.071	RGNF
97	97BG19	Squirrel Creek	Saguache	B	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T47N R7E Sec. 12 NW 1/4 SE4/4	38.343	106.149	RGNF
98	97BG20	Slaughter House Creek	Saguache	A	Populus tremuloides/Alnus incana var. tenuifolia	T47N R7E Sec. 26	38.288	106.169	RGNF
99	97BG21	North Fork Cat Creek	Rio Grande	C	Alnus incana var. tenuifolia/Mesic Graminoids	T37N R6E Sec. 29	37.375	106.250	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
100	97BG22	Silver Creek	Conejos	B	Salix monticola/Mesic Forbs	T36N R5E Sec. 5 SE1/4	37.375	106.375	RGNF
101	97BG23	Alamosa River	Conejos	C	Picea pungens Alliance	T36N R4E	37.375	106.500	RGNF
102	97BG24	Unnamed trib. of Trinchera Creek	Costilla	B	Carex nebrascensis	Location withheld to respect landowner privacy.			Private
103	97BG25	Groundhog Creek	Saguache	B	Pentaphylloides floribunda/ Deschampsia cespitosa	T42N R4E Sec. 17 SE1/4	37.875	106.500	RGNF
104	97BG26	North Fork Saguache Creek	Saguache	B	Pentaphylloides floribunda/ Deschampsia cespitosa	Not available	38.041	106.769	RGNF
105	97EV01	Mill Creek	Saguache	C	Alnus incana var. tenuifolia/Mesic Forbs	T44N R6E Sec 17	38.000	106.250	RGNF
106	97EV02	Mill Creek	Saguache	B	Populus tremuloides/Alnus incana var. tenuifolia	T45N R6E Sec 32	38.000	106.250	BLM
107	97EV03	House Log Creek	Saguache	B	Salix bebbiana	T44N R5E Sec 12 NW1/4	38.076	106.374	RGNF
108	97EV04	Hat Springs Creek	Saguache	B	Salix exigua/Mesic Graminoids	T44N R4E Sec 12 NW1/4	38.000	106.375	BLM
109	97EV05	Park Creek	Rio Grande	B	Abies lasiocarpa-Picea engelmannii/Alnus incana var. tenuifolia	T38N R3E	37.500	106.625	RGNF
110	97EV06	Rio Grande	Mineral	B	Alnus incana var. tenuifolia-Salix drummondiana	T39N R2E	37.500	106.625	RGNF
111	97EV07	Poison Gulch	Mineral	B	Salix monticola/Mesic Graminoids	T40N R3E Sec 36 S1/2	37.625	106.625	RGNF
112	97EV08	Raspberry Gulch	Mineral	B	Alnus incana var. tenuifolia/Mesic Forbs	T40N R2E Sec 26 NE1/4	37.625	106.625	RGNF
113	97EV09	Bear Creek	Rio Grande	C	Alnus incana var. tenuifolia/Mesic Forbs	T40N R3E	37.625	106.500	RGNF
114	97EV10	Baughman Creek	Saguache	C	Populus tremuloides/Alnus incana var. tenuifolia	T41N R4E	37.750	106.500	RGNF
115	97EV11	Saguache Creek	Saguache	B	Salix bebbiana	Location withheld to respect landowner privacy.			Private
116	97EV12	Houselog Creek	Saguache	C	Populus angustifolia/Mesic graminoids	T44N R6E NW1/4 NW4/4	38.000	106.250	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
117	97EV13	Jacks Creek	Saguache	A	Carex utriculata	Location withheld to respect landowner privacy.			Private
118	97EV14	East Pass Creek	Saguache	C	Salix bebbiana	T46N R4E Sec. 34 SW1/4 NW4/4	38.194	106.526	RGNF
119	97EV15	Lunders Creek	Saguache	B	Populus tremuloides/tall forb	T45N R4E Sec. 21 NW1/4 NW4/4	38.132	106.548	RGNF
120	97EV16	Rio Grande	Rio Grande	B	Populus angustifolia/Mesic graminoids	T40N R4E Sec. 22 SE1/4 SE4/4, Sec. 23 SW1/4 SW4/4, Sec. 26 NW1/4	37.693	106.531	CDOW
121	97EV17	Rio Grande	Mineral	B	Salix exigua/Mesic Graminoids (late seral)	T40N R2E Sec 11 NE1/4 NE4/4	37.625	106.625	CDOW
122	97EV18	Kerber Creek	Saguache	A	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T47N R7E Sec. 15 SE1/4 NW4/4	38.326	106.181	RGNF
123	97EV19	Cat Creek	Rio Grande	B	Cornus sericea	T37N R6E Sec. 34 SW 1/4 NE4/4	37.375	106.250	RGNF
124	97EV20	Piedrosa Creek	Conejos	A	Pseudotsuga menziesii/Cornus sericea	T35N R6E Sec. 11 NE1/4 SW4/4	37.250	106.250	RGNF
125	97EV21	Alamosa River	Rio Grande	B	Populus angustifolia/Alnus incana var. tenuifolia	T37N R4E Sec. 36 NE1/4 MW4/4	37.375	106.375	RGNF
126	97EV22	Rhodes Gulch	Conejos	C	Salix monticola/Mesic Graminoids	T36N R5E Sec. 16 NW 1/4 SW 4/4	37.375	106.375	RGNF
127	97EV23	W. Frk. Rio Chama	Archuleta	B	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T33N R4E	37.000	106.500	RGNF
128	97EV24	W. Frk. Rio Chama	Archuleta	B	Abies lasiocarpa-Picea engelmannii/Salix drummondiana	T33N R4E	37.000	106.500	RGNF
129	97EV25	Conejos River	Conejos	C	Populus angustifolia/Alnus incana var. tenuifolia	T34N R5E Sec. 29 NE 1/4, Sec. 28 NW1/4, Sec. 20 SE1/4	37.125	106.375	RGNF
130	97EV26	Conejos River	Conejos	C	Salix eriocephala var. ligulifolia	T34N R5E Sec. 29 NE 1/4, Sec. 28 NW1/4, Sec. 20 SE1/4	37.125	106.375	RGNF
131	97EV27	So. Fork Conejos River	Conejos	B	Populus angustifolia-Picea pungens/Alnus incana var. tenuifolia	T35N R4E	37.125	106.500	RGNF
132	97EV28	So. Fork Conejos River	Conejos	B	Salix eriocephala var. ligulifolia	T34N R4E Sec. 36 SW 1/4 SW4/4	37.125	106.500	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
133	97EV29	Lake Fork	Conejos	B	Salix monticola/Mesic Graminoids	T36N R4E Sec 35 NE1/4 SW4/4	37.250	106.500	RGNF
134	97EV30	Arkansas Creek	Conejos	B	Salix monticola/Mesic Forbs	T32N R5E Sec. 15 SW1/4 SW4/4, Sec 16 SE1/4 SE4/4	37.006	106.412	RGNF
135	97EV31	Rito Gato	Conejos	A	Abies lasiocarpa-Picea engelmannii/Salix drummondiana	T36N R4E Sec	37.250	106.500	RGNF
136	97EV32	unnamed branch of La Jara Creek	Conejos	A	Carex simulata fen	T35N R6E Sec 31	37.125	106.250	State
137	97EV33	Dorsey Creek	Saguache	B	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T48N R9E Sec 12	38.427	106.023	RGNF
138	97EV34	North Clear Lake	Hindsdale	B	Salix monticola/Calamagrostis canadensis	T42N R3W Sec. 36 SW 1/4 NW4/4	37.750	107.125	RGNF
139	97EV35	Mason Creek	Mineral	A	Salix planifolia/Carex aquatilis	T41N R4W Sec. 14 S1/2	37.804	107.276	RGNF
140	97EV36	Rio Grande	Rio Grande	C	Salix exigua/Mesic Graminoids	T39N R8E Sec. 34, T38N R8E Sec 2	37.500	106.000	State
141	97GK01	Yankee Creek	Saguache	C	Salix lucida	T48N R9E Sec 32	38.250	105.875	BLM/ RGNF
142	97GK02	East Pass Creek	Saguache	C	Salix geyeriana/Carex utriculata	T45N R5E Sec 7, R 4E Sec 12	37.173	106.471	BLM
143	97GK03	South Fork Rio Grande	Mineral	B	Populus angustifolia-Picea pungens/Alnus incana var. tenuifolia	T39N R2E Sec 24	37.500	106.625	RGNF
144	97GK04	Little Garita Creek	Saguache	R	Populus angustifolia-Juniperus scopulorum	T42N R5E Sec 36	37.750	106.375	RGNF
145	97GK05	Rio Grande	Alamosa	C	Salix amygdaloides Alliance	T36N 11E Sec 22	37.250	105.750	USFWS
146	97GK06	Rio Grande	Alamosa	C	Salix exigua/Mesic Graminoids	T37N R11E Sec 20	37.375	105.750	USFWS
147	97GK07	Deadman Creek	Saguache	B	Populus angustifolia-Juniperus scopulorum	Location withheld to respect landowner privacy.			Private
148	97GK08	Sand Creek	Saguache	B	Populus angustifolia/Rhus trilobata	Location withheld to respect landowner privacy.			Private
149	97GK09	Sand Creek	Saguache	B	Populus angustifolia/Alnus incana var. tenuifolia	Location withheld to respect landowner privacy.			Private

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
150	97GK10	San Luis Creek	Saguache	C	Juncus balticus var. montanus	T42N R10E Sec 22	37.875	105.750	State
151	97GK11	San Luis Creek	Saguache	C	Sarcobatus vermiculatus/Distichlis spicata	T42N R10E Sec 22	37.875	105.750	State
152	97GK12	Deadman Creek	Saguache	C	Populus angustifolia/Salix lucida var. caudata	Location withheld to respect landowner privacy.			Private
154	97GK13	Mishak Lakes	Saguache	B	Eleocharis palustris	T42N 9E Sec 4	37.875	105.875	TNC
155	97GK14	Mishak Lakes	Saguache	B	Distichlis spicata	T42N 9E Sec 4	37.875	105.875	TNC
156	97GK15	Mishak Lakes	Saguache	B	Sarcobatus vermiculatus/Distichlis spicata	T42N 9E Sec 4	37.875	105.875	TNC
157	97GK16	Rio Grande	Rio Grande	C	Populus angustifolia/Cornus sericea	Location withheld to respect landowner privacy.			Private
158	97GK17	unnamed Crk	Saguache	C	Juncus balticus var. montanus	T45N R10E Sec 1	38.125	105.750	BLM
159	97GK18	Rock Creek	Saguache	A	Carex simulata fen	Location withheld to respect landowner privacy.			Private
160	97GK19	San Luis Creek	Saguache	C	Carex simulata fen	Location withheld to respect landowner privacy.			Private
161	97GK20	Cottonwood Creek	Saguache	A	Populus tremuloides/Betula occidentalis	T45N R11E Sec 20	38.125	105.750	RGNF
162	97GK21	Cotton Creek	Saguache	B	Betula occidentalis/Mesic Forbs	T45N R11E Sec 20	38.125	105.750	RGNF
163	97GK22	Little Medano Creek	Saguache	A	Alnus incana var. tenuifolia-mixed Salix species	T26S R73W Sec 11	37.750	105.500	GSNM
164	97GK23	Medano Lake	Saguache	A	Cardamine cordifolia-Mertensia ciliata-Senecio triangularis	T25S R72W Sec 19	37.750	105.375	RGNF
165	97GK24	Sand Creek	Saguache	A	Populus angustifolia/Salix drummondiana-Acer glabrum	T25S R73W Sec 21	37.750	105.500	RGNF
166	97GK25	Sand Creek	Saguache	A	Populus angustifolia/Salix drummondiana-Acer glabrum	T25S R73W Sec 21	37.750	105.500	RGNF
167	97GK26	Sand Creek	Saguache	A	Populus angustifolia/Salix drummondiana-Acer glabrum	T25S R73W Sec 21	37.750	105.500	RGNF
168	97GK27	Sand Creek	Saguache	A	Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum	T25S R73W Sec	37.750	105.500	RGNF/ Private

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Decimal Long.	Owner
169	97GK28	Raspberry Creek (upper)	Saguache	A	Populus tremuloides/tall forb	T47N R9E Sec 11	38.338	105.942	BLM/ RGNF
170	97GK29	Rio Grande	Conejos	C	Cornus sericea	T32N R11E Sec 10	37.000	105.750	BLM
171	97GK30	Sangre de Cristo Creek	Costilla	C	Salix exigua-Salix eriocephala var. ligulifolia	T30N R12E	37.375	105.375	County/ Private
172	97GK31	Eastdale Res. No. 1	Costilla	C	Typha latifolia	Location withheld to respect landowner privacy.			Private
173	97GK32	Elk Creek	Conejos	B	Populus angustifolia-Picea pungens/Alnus incana var. tenuifolia	T33N R5E, Sec 1	37.000	106.375	RGNF
174	97GK33	Conejos River	Conejos	C	Salix lucida	T33N R6E Sec 21, 22	37.000	106.250	CDOW
175	97GK34	Conejos River	Conejos	C	Salix monticola/Calamagrostis canadensis	Location withheld to respect landowner privacy.			Private
176	97GK35	Rio Grande River	Rio Grande	C	Salix eriocephala var. ligulifolia	T35N R8E Sec 1	37.500	106.000	CDOW
177	97GK36	Beaver Lake	Conejos	C	Salix monticola/Mesic Forbs	T35N R4E Sec 21	37.250	106.375	RGNF
178	97GK37	Torisido Creek	Conejos	C	Salix monticola/Mesic Forbs	T36N R5E Sec 34	37.250	106.375	RGNF
179	97GK38	Unnamed tributary to Dorsey Creek	Saguache	B	Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	T49N R8E Sec 1	38.437	106.030	RGNF
180	97GK39	Trinchera Creek	Costilla	C	Salix exigua-Salix eriocephala var. ligulifolia	Location withheld to respect landowner privacy.			Private
181	97GK40	Sangre de Cristo Creek	Costilla	B	Salix exigua-Salix eriocephala var. ligulifolia	T30S R1S Sec	37.375	105.375	County/ Private
182	97GK41	La Garita Creek	Saguache	C	Salix monticola/Carex aquatilis	T42N R4E Sec 16	37.875	106.500	RGNF
183	97GK42	Carneo Creek	Saguache	C	Alnus incana var. tenuifolia/Mesic Graminoids	Location withheld to respect landowner privacy.			Private
184	97GK43	North Fork Saguache Creek	Saguache	C	Salix geyeriana/Mesic Forbs	T44N R2E Sec 35	38.036	106.739	RGNF
185	97MD01	Merkt Creek	Saguache	D	Juncus balticus var. montanus	T48N R9E Sec 30 SW1/4 NW4/4	38.381	106.022	BLM

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Long.	Owner
186	97MD02	Sheep Creek	Saguache	C	Salix geyeriana/Carex utriculata	T45N R5E Sec. 19 NE 1/4 SE 4/4	38.142	106.458	BLM
187	97MD03	South Fork Rio Grande	Mineral	B	Alnus incana var. tenuifolia-Salix drummondiana	T39E R2E Sec. 24 SE 1/4	37.500	106.625	RGNF
188	97MD04	Trout Creek	Rio Grande	D	Salix geyeriana/Calamagrostis canadensis	T39N R3E Sec. 7 NW 1/4 NE 4/4	37.625	106.625	RGNF
189	97MD05	Middle Fork of Carnero Creek	Saguache	C	Alnus incana var. tenuifolia/Mesic Forbs	T43N R 5E Sec. 27 SW 1/4	37.875	106.375	RGNF
190	97MD06	Little Kerber Creek	Saguache	C	Populus tremuloides/Alnus incana var. tenuifolia	T46N R7E Sec. 24 SW 1/4 SW 4/4	38.220	106.155	RGNF
191	97MD07	Deadman Creek (upper)	Saguache	A	Populus tremuloides/Acer glabrum	Location withheld to respect landowner privacy.			Private
192	97MD08	Medano Creek	Saguache	A	Alnus incana var. tenuifolia/Mesic Forbs	T26S R73W Sec 14 NW1/4 NW4/4	37.750	105.500	GSNM
193	97MD09	Medano Creek	Saguache	A	Salix exigua/Bare Ground	T27S R73W Sec. 3 NE 1/4	37.625	105.500	GSNM
194	97MD10	Medano Creek	Saguache	A	Populus angustifolia/Rhus trilobata	T27S R73W Sec. 3 NE 1/4	37.625	105.500	GSNM
195	97MD11	Sand Creek	Alamosa	A	Populus angustifolia Sand Dune Forest	Location withheld to respect landowner privacy.			Private
196	97MD12	Sand Creek	Alamosa	A	Juncus balticus var. montanus	Location withheld to respect landowner privacy.			Private
197	97MD13	Cotton Creek	Saguache	A	Abies lasiocarpa-Picea engelmannii/Salix drummondiana	T45N R11E Sec 15	38.156	105.733	RGNF
198	97MD14	Rito Alto Creek	Saguache	A	Populus tremuloides/Betula occidentalis	Location withheld to respect landowner privacy.			Private
199	97MD15	Hudson Branch	Saguache	C	Populus tremuloides/Salix drummondiana	T28S R72W Sec. 21 SE1/4	37.750	105.375	RGNF
200	97MD16	Medano Creek	Saguache	B	Populus tremuloides/Alnus incana var. tenuifolia	T25S R72W Sec 27	37.750	105.375	RGNF
201	97MD17	Medano Creek	Saguache	B	Populus angustifolia/Alnus incana var. tenuifolia	T27S R73W Sec. 2 NE 1/4	37.625	105.500	GSNM
202	97MD18	Little Kerber Creek	Saguache	B	Carex aquatilis-Carex utriculata	T46N R9E Sec 25, 36	38.207	106.140	RGNF

Table 1. Plant Association and Site Rank for Each Plot, Continued.

Map No.	Plot No.	Creek Name	County	Site Rank*	Plant Association or Alliance Classification**	Township, Range and Section***	Decimal Lat.	Decimal Long.	Owner
203	97MD19	Squirrel Creek	Saguache	B	Carex aquatilis	T47N R7E	38.332	106.149	RGNF
204	97MD20	Rio Grande	Conejos	C	Carex lanuginosa	T32N R11E Sec 10	38.000	105.750	BLM
205	97MD21	Rio Grande	Conejos	C	Salix exigua/Mesic Graminoids	T34N R11E Sec 23	37.125	105.625	BLM
206	97MD22	Raspberry Creek (lower)	Saguache	B	Quercus gambelii/Symphoricarpos rotundifolia	T47N R9E Sec 11SE1/4 SW4/4	38.338	105.942	BLM
207	97MD23	Conejos River	Conejos	C	Salix monticola/Calamagrostis canadensis	T34N R5E Sec 29 NE1/4 NE4/4	37.125	106.375	RGNF
208	97MD24	Conejos River	Conejos	C	Populus angustifolia/Salix exigua	T33N R6E Sec. 26 NE1/4	37.000	106.250	RGNF
209	97MD25	Costilla Creek @ Eastdale Res.	Costilla	C	Populus angustifolia/Mesic graminoids	Location withheld to respect landowner privacy.			Private
210	97MD26	Eastdale Reservoir No. 1	Costilla	C	Juncus balticus var. montanus	Location withheld to respect landowner privacy.			Private
211	97MD27	North Fork Rio De Los Pinos	Conejos	B	Salix geyeriana/Mesic Forbs	T32N R5E Sec 3NE1/4 NE4/4	37.000	106.375	RGNF
212	97MD28	S. Frk Conejos River	Conejos	B	Populus angustifolia/Alnus incana var. tenuifolia	T35N R4.5E Sec. 36	37.125	106.375	RGNF
213	97MD29	West Bellows Creek	Mineral	B	Salix planifolia/Carex aquatilis	T42N R2E Sec. 20	37.875	106.750	RGNF
214	97MD30	Mason Creek	Mineral	A	Salix monticola/Carex aquatilis	T41N R4W Sec. 14 S1/2	37.750	107.250	RGNF
215	97MD31	Rio Grande	Rio Grande	C	Populus angustifolia/Mesic graminoids	T39N R8E Sec. 34, T38N R8E Sec. 2	37.500	106.000	State

*Site Rank is the riparian health condition assessment. See Methods section for further information.
**Names are Plant Associations unless otherwise indicated. See Methods for explanation of hierarchical classification system used.
*** Township, Range and Section were not available for all RGNF sites because the entire forest has not been surveyed at the 1:24,000 scale on USGS topographic quad maps.

Land Use

The study area includes forested mountainous areas and the intensively irrigated and farmed San Luis valley floor. About 645,000 acres are irrigated, mostly for pasture and hay. Other major crops include barley, potatoes, sprint wheat, oats, quinoa, and vegetables. In 1990, total water use was 1,760,000 acre-feet, 988,000 from surface-water, and 774,000 from ground-water. Total consumptive use was about 1,060,000 acre-feet. About 348,000 acres are irrigated within the Closed Basin (Ellis *et al.* 1993).

The upper Rio Grande watershed is montane and alpine and lies mostly within the Rio Grande National Forest (RGNF), consisting of 1,851,792 acres. The Forest has many uses, including timber, mining, livestock grazing, water storage, and recreation. Over 577,000 acres are considered suitable for grazing. The current Forest Plan projects a capacity for livestock grazing at 143,077 head months, including sheep and cattle. The plan also projects over 800,000 people will use the forest for recreation, continued timber sales, continued locatable mineral mining, and a potential for 23 new gas and oil wells to be in place within a 10 year period (USDA 1996a).

Historic livestock grazing probably had a large influence on the composition of communities on the Rio Grande National Forest. As early as 1820, there were records of cattle being brought into the San Luis Valley. By the close of the century, and the early part of the 20th century, there were high numbers of livestock on the RGNF. Specific stocking rates could not be defined since the numbers, land area, and time periods of grazing were not specifically and clearly recorded. It appears that by 1929, stocking rates started declining dramatically due to documented overuse of the resource (USDA 1996b).

Rio Grande National Forest Stream-Channel Stability Conclusions
(From USDA 1996b)

- Historic photos document lush, extensive riparian vegetation in the 1870's, much more than photographed in the early and mid 1900's.
- Climatic records suggest a drought during the 1870's. Presently, there is a wetter climate than today in the 1870's.
- If streams supported vigorous and extensive riparian vegetation in the 1870's, they should be more capable of doing the same in the 1990's, a wetter period.
- Heavy livestock grazing in valley bottoms caused bunch grasses to die out.
- Human-caused fires burned most of the Rio Grande drainage at least once between 1870 and the mid 1900's. Fires and heavy sheep grazing around the turn of the century denuded large portions of watersheds, causing siltation, flooding, and channel erosion. These effects almost certainly pushed conditions outside the natural range of variability.
- Streams that remain unstable may not have fully recovered from past land-management abuses.
- Early mining had devastating effects on water quality. Streams still seriously impacted by mine drainage and erosion of tailings include Kerber Creek, Willow Creek, and Wightman Fork of Alamosa Creek. The conclusion that these streams are outside the natural range of variability comes from an observed lack of aquatic life and elevated pollution levels.

Stream Flow

The highest stream flows of the Rio Grande occur April through July. It is affected by reservoirs, diversions for irrigation, and trans-mountain diversions of water into the Rio Grande basin from the western slope. Five major canals divert water from the Rio Grande into the San Luis (Closed) Basin, averaging about 289,500 acre-feet per year (about 400 cubic feet/sec annual average). One canal transports pumped ground-water from the Closed Basin into the Rio Grande. This system uses about 70 wells and delivers about 17,400 acre-feet (24 cubic feet/sec annual average). The system is designed to contain 170 wells and deliver 105,000 (145 cubic feet/sec annual average) once completed into the Rio Grande (Ellis *et al.* 1993).

Hydrological Modification

Groundwater pumping is one of the greatest threats to the biodiversity of the Closed Basin. Surface water impoundments and diversions present an equally widespread and allied threat. The playa lake and riparian ecosystems of the San Luis Valley floor and surrounding foothills 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 pockets of elevated groundwater levels.

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 salinity, 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 salinity, 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.

For the last six years, the Bureau of Reclamation’s Closed Basin Project has pumped shallow groundwater out of the Closed Basin to supplement Rio Grande flows, in order to meet Colorado’s commitments to New Mexico, Texas, and Mexico under the Rio Grande Compact. Impacts from this project are purported by land owners and researchers (Cooper and Servern 1992), but not yet quantitatively described. Plans by Stockman’s Water Corporation to pump confined aquifer water from the Baca Ranch for transportation out of the basin represent a serious concern given such scientific uncertainty.

Despite considerable debate, the hydrological connections between surface, shallow and deep groundwater resources and valley bottom wetlands, remain poorly understood. 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. Management of the riparian communities presented in this report will require, therefore, not only local protection of on-site wetland elements, but secure water resources and greater understanding of how current and anticipated water uses within the watershed will affect the wetlands. For an accurate assessment of the risks to Closed Basin biodiversity posed by water development, further quantitative research linking hydrology, vegetation, and wetland fauna is imperative.

METHODS

Riparian areas are defined as the interface between the riverine aquatic ecosystem and the adjacent upland ecosystem (Gregory *et al.* 1991, Risser 1990, Knopf *et al.* 1988, Brinson *et al.* 1981). These areas are frequently flooded, or are at least seasonally saturated by a fluctuating water table, and have plant species, soils, and topography that differ considerably from those of the adjacent uplands (Elmore and Beschta 1987, Jones 1990). Riparian areas studied during this project include vegetation occurring along natural water courses, poorly drained overflow areas, and associated natural bodies of water, such as oxbow lakes. The classification focuses on perennial and intermittent (streams that were marked perennial for at least 1 mile of their length) as defined on U.S. Geological Survey 1:24,000 and 1:100,000 topographic maps.

Pre-Field Site Selection

To sample as much of the diversity within each basin as possible in one field season, we used a stratified-random approach based on the Austin and Heyligers (1989) gradsect concept. Two environmental gradients thought to influence riparian vegetation were chosen to stratify the study area. Each mile of every stream within the study area was placed within a cell-type, a combination of the two stratifying variables.

For the Rio Grande and Closed Basin watersheds, the two environmental variables used were: 1) stream order as a surrogate for basin size, channel size and stream volume (Schumm 1977, Knighton 1984), and 2) elevation as an important predictor of climate. Using USGS 1:100,000 topographic maps we denoted 1,000 ft (300 m) elevation bands from 5,000 ft (1,525 m) to over 10,000 ft (3,050 m) and first through fifth order stream classes, calculated for each mile of perennial stream using Strahler's (1952) system.
The total perennial and intermittent (streams that were marked perennial for at least 1 mile of their length) stream miles in the basin were tallied by cell type and their percentage for the basin calculated. Aerial photographs were used to eliminate areas of heavy disturbance (explained in more detail below). Over 200 one-mile long stream reaches were randomly selected in each

study area, representing all the classification cell types, weighted by their abundance in the basin. For example, if 20% of the stream miles above 10,000 ft (3,050 m) were first order streams, then 20% of the randomly selected one-mile sites would be of that type. Thus the number of sampled stream miles per cell type was representative of the basin (Figures 3 and 4).

In addition to sampling a representative selection of potential habitats, we also tried to sample riparian areas which have not been drastically altered by human activity in the sampling regime, thereby limiting the classification to plant associations native to Colorado, whose descriptions can serve as a reference point for management and restoration needs. This was not always possible, especially at lower elevations, and, of course, was subject to our own interpretation of natural and potential vs. changed vegetation due to human activities. We assumed that current wildlife populations and fire frequencies have been altered ubiquitously across the landscape and is constant "background noise" in our data set.

The term "relatively undisturbed" refers to the difference between the most altered reach to the least altered reach within the watershed, as opposed to some theoretical "pristine" criteria. In any case, by observing riparian areas systematically across the watershed and the state, we have gained a pretty good idea as to the status, condition and trend of riparian ecosystems within the study area and across Colorado.

Riparian corridors were ranked by their condition (amount of human-induced disturbance) at two scales. First, from small scale color infra-red aerial photographs (1989, 1990 NAPP 1:40,000, 1983 1:24,000) to block out obvious severely altered riparian reaches (see list of specific criteria starting on page 11). The amount of disturbance on surrounding lands can be a strong predictor of the amount of non-native species in the understory within the riparian corridor (Rondeau and Kittel 1994). Areas indicating heavy disturbance were eliminated prior to random selection of reaches for sampling.

Second, each randomly chosen reach was evaluated again for its condition in the field (mainly for the amount of grazing impact, and presence of non-native plant species, criteria that cannot be adequately assessed from small scale photographs).

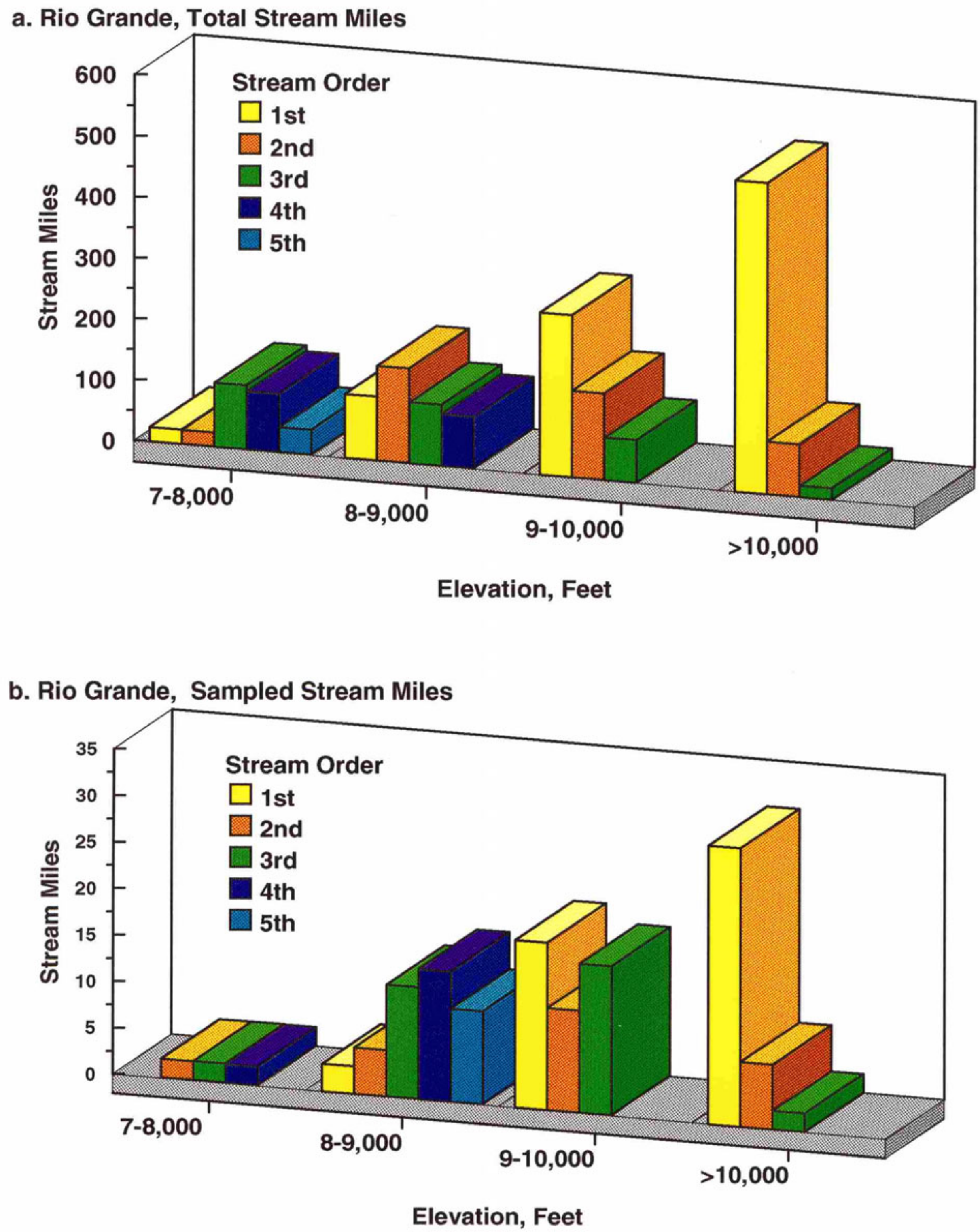
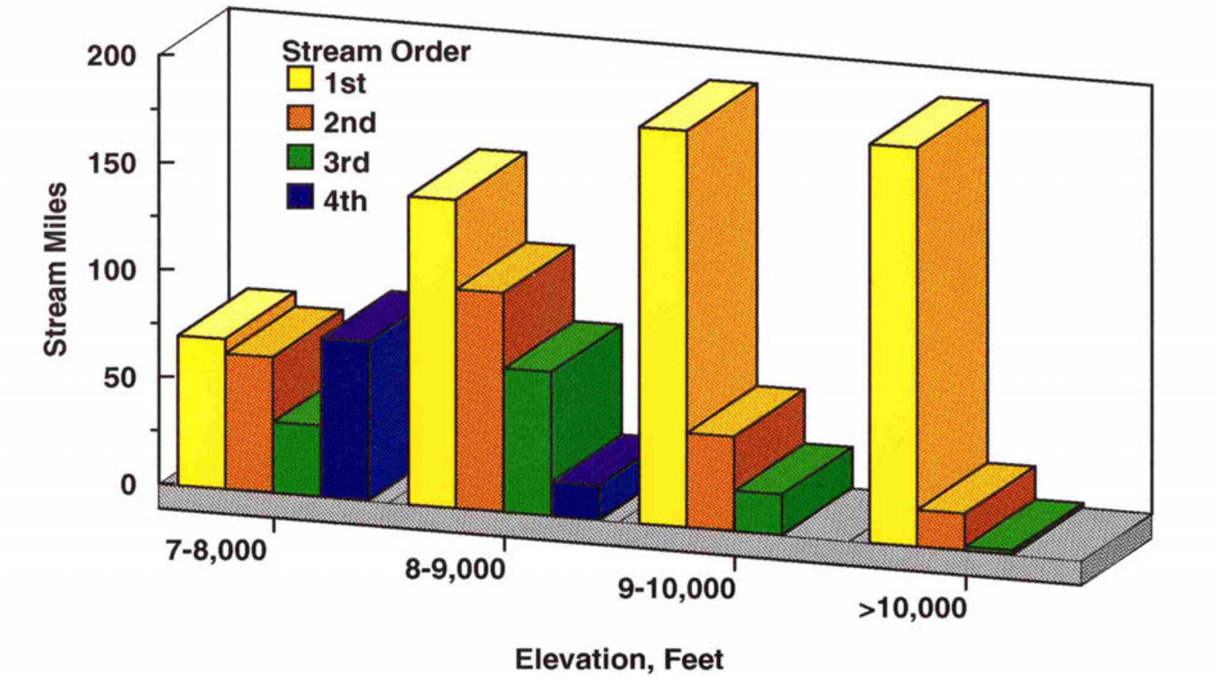


Figure 3. Total and Sampled Number of Stream Miles in the Rio Grande Watershed. a) Total stream miles stratified by elevation and stream order, b) Number of sampled stream miles by elevation and stream order.

I

a. Closed Basin, Total Stream Miles



b. Closed Basin, Sampled Stream Miles

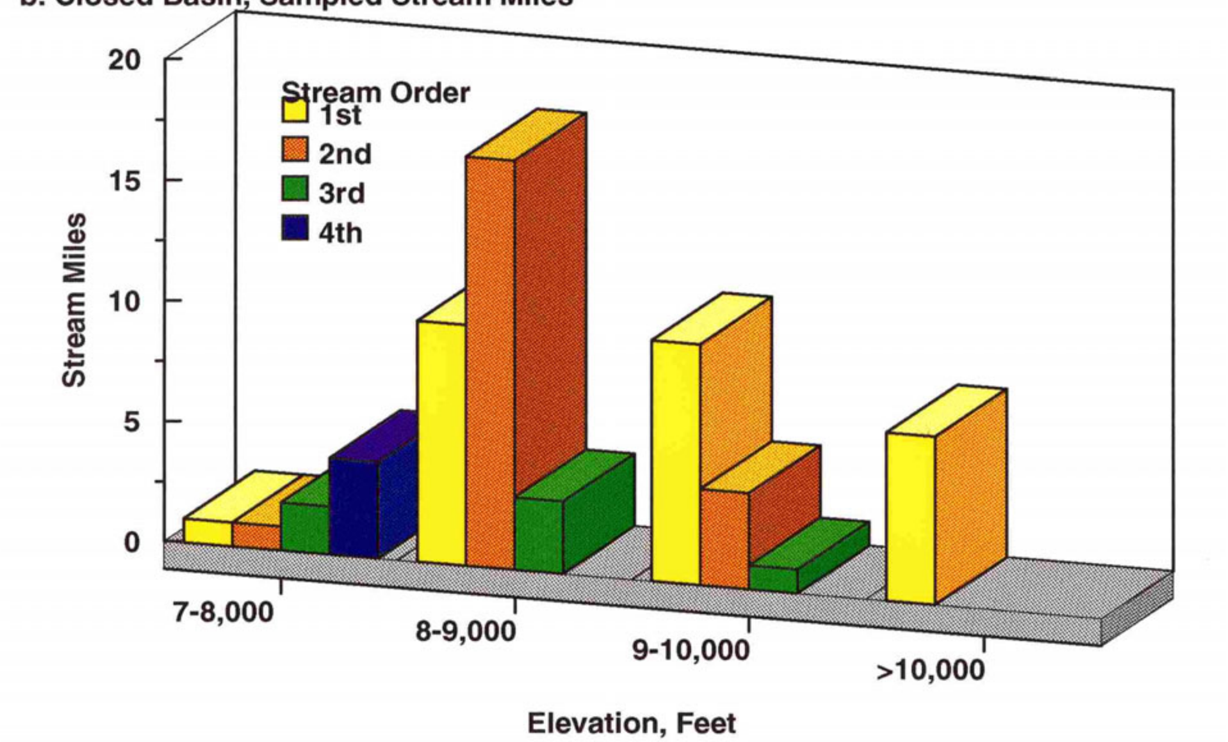


Figure 4. Total and Sampled Number of Stream Miles in the Closed Basin Watershed. a) Total stream miles stratified by elevation and stream order, b) Number of sampled stream miles by elevation and stream order.

Ariel Photograph Interpretation

Disturbance criteria used for both small (aerial photography) and large (on the ground) scale assessments were:

1. Drastic disturbance where riparian vegetation has been removed or fragmented such that less than 50% of the riparian corridor remains in tact. Signs such disturbance at small scales are: agricultural/urban conversion, constricting or encroaching irrigated fields, square-edge fields, road and railroad embankments, channelized river reaches, power line maintenance roads, within channel and floodplain gravel mining, surrounding hillslope activities such as logging, and mining, and proximity to dams and reservoirs.
2. Heavy recreational use, such as off-road vehicle use, high density camping impacts, social trails and the like.
3. Chronic heavy livestock use (improper grazing practices) where hillside trailing occurs, accelerated bank erosion/destabilization, or abundant increaser species are present; basically sites with severe improper livestock management as outlined in Valentine (1990).
4. Road maintenance activities, including grading, bridge repair/improvements, road widening, snow-removal practices that impact vegetation; channel bed re-configuration for irrigation head gates, gravel/sand mining sites, or other dumping grounds.

All riparian corridors were classified into four condition categories from the small scale (1:40,000) aerial photography assessment criteria:

1. *Excellent*-- riparian corridor and the surrounding area appear natural with no major disturbances. Within the corridor itself, the area appears unfragmented and the vegetation follows a natural pattern, and the corridor is large (>1 mile long);
2. *Good*--riparian corridor exhibits excellent vegetative cover but the surrounding area is somewhat altered, the corridor maybe large (>1 mile long) but somewhat disturbed, or the corridor smaller (<1 mile) but in excellent condition;
3. *Fair*-- the riparian corridor is fragmented, and/or the surrounding lands disturbed, the corridor may be very small (<1/4 mile long), or larger (>1 mile) but disturbed for 50% or greater of its length; and
4. *Poor*-- riparian corridor disturbed, vegetation that is sparse or highly fragmented and the surrounding land slightly to drastically altered, the area may be very small (<1/4 mile) or very large (>1 mile) with severe disturbance for >80% of its length. Deep canyons are an exception to the above criteria, as they tend to have naturally low amounts of riparian vegetation. If the surrounding land looked undisturbed, a canyon reach would be ranked "good" also.

BLM 1:100,000 topographic and land ownership maps were overlain with the aerial photographs. River miles were tallied by ownership (federal, state, private) and condition category. During field site visits, we further evaluated randomly chosen reaches for the amount of improper grazing (difficult to asses from aerial photographs) and weedy species. Sites were eliminated from sampling if they were severely degraded by improper grazing as well as if they were dominated by non-native plant species such as tamarisk or salt cedar (*Tamarix ramosissima*) or Russian-olive (*Elaeagnus angustifolia*). Areas with non-natives present, such as

Kentucky bluegrass (*Poa pratensis*), but where native flora dominated the overstory vegetation, were included in the sampling regime.

Field Data Collection

Field site visits were conducted June 1st through September 15th. Private land was accessed only with landowner permission. Each randomly chosen reach was assessed in the field for quality condition. Once a site has passed the "relatively undisturbed test" (explained in the previous section), we proceed to collected the following data at each plot:

- elevation (from 7.5 min. topographic maps)
- aspect and stream bearing
- valley floor width (from topographic maps)
- stream gradient (measured with a hand level and stadia rod)
- channel depth and width (measured at bankfull or average annual high water mark) *Bankfull stage* or *Bankfull channel* is the height of the average 1-3 year return flow, also called the average annual high water mark of the active channel (Knighton 1984, Wolman and Leopold 1957). We use this demarcation along the bank as a reference point for measuring stream channel width and depth, and the height and distance of a riparian community from the active channel.
- Stream reaches were placed into Rosgen's Stream channel classification (Rosgen 1994). This system is based on the channel width to depth ratio, available floodplain width, channel gradient and sinuosity, among other criteria.
- Hydrologic and geomorphic features (beaver dams, point bars, etc.)
- History of use (from landowner or manager) when obtainable
- Woody vegetation was quantitatively sampled for percent cover using 30-50 m long line-intercept transects, oriented parallel to the stream channel. Transects were subjectively located within a homogeneous portion of each stand to best represent the vegetation of the site.
- Herbaceous vegetation was sampled using 10-20 0.10 m^2 micro-plots, located about every third meter along the transect and 1 meter to the side, alternating sides.
- Woody and Herbaceous vegetation was measured as percent canopy cover by vascular plant species to the nearest 10% in the following cover classes: 5-15%, 16-25%, 26-35%, 36-45%, 46-55%, 56-65%, 66-75%, 76-85%, 86-95%, and >95%. Plant cover 5% or less was estimated into two categories, <1% and 1-5%.
- Total canopy cover by life-form (trees, shrubs, graminoids, and forbs). Overhead tree cover was measured along the transect using a clinometer to find the vertical intercept of the tree canopy.
- Ground cover of bare soil, litter, wood, gravel, rock, bryophyte, and non-vascular plants
- Soils were described from a single pit within each stand sampled. Pit depth varied according to the amount of coarse fragments present (average depth 70 cm). Noted from each horizon: thickness, texture, color, % mottling/gleying, matrix color, % coarse fragments, % organic matter, overall thickness, and parent material, when possible.
- Height above the active channel using a hand held level and stadia rod.

- Distance from transect to active channel (using a measuring tape or hip-chain).
- Landscape position (point bar, floodplain, abandoned channel, terrace, etc.).
- Signs of wildlife or domestic livestock utilization.
- Signs of disturbance (flooding, fire, wind throw, logging, etc.).
- Successional relationships where trends could be inferred.
- Adjacent riparian and upland vegetation.
- Reference site and plot 35 mm color slides.
- Size of occurrence mapped on 7.5 min. USGS topographic maps with aid of 9 x 9 in. 1:40,000 NAPP color infra red aerial photos.

Plant species scientific nomenclature follows Kartez (1994), except for the genera *Salix* (willows), which follows Dorn 1995. All plants not identified in the field, particularly of difficult genera such as *Salix, Carex*, and *Juncus*, were collected, pressed, and identified (to species level when possible) at the University of Colorado and Colorado State University Herbaria. Voucher specimens will be deposited at the University of Colorado Herbarium, the University of Wyoming Rocky Mountain Herbarium, and the Colorado State University Herbarium. A list of scientific plant names for the Rio Grande and Closed Basin watersheds can be found in Appendix 1.

Site Ranking Criteria

A Site Quality Rank was given to each riparian area sampled. These range from A (highest) through D (poorest) for overall riparian health and condition. In 1995 overall riparian quality was an average of the following four criteria: *Quality*--overall size, connectedness to surrounding natural ecosystems, degree of alteration; *Condition*--abundance of non-native plant species, degree of soil compaction, amount of species composition change by livestock grazing, degree of human disturbance, appropriateness of current management for riparian ecosystem health; *Viability*—are extrinsic factors necessary for long term survival of this ecosystem (*e.g.* hydrological processes, overall trend of site under current management) present?; *Defensibility*--extrinsic and intrinsic factors affecting the long term existence of the ecosystem; any known threats or site specific problems are defined; adjacent land use compatibility is included.

In 1997, riparian quality ranking criteria was revised, using the same scale (A through D) and again an average of the following criteria: *Size*—the extent of the community, now and relative to its presettlement extent. *Condition*—An integrated measure of the quality of biotic and abiotic factors (structure and processes) at the local, within site (riparian mosaic) scale, including the occurrence and the degree to which they affect the continued existence of the stand. This includes: stand age, ecological processes, species composition, and abiotic physical factors (*e.g.* stability of substrate, water quality and soil compaction); and *Landscape Context*—An integrated measure of the quality of biotic and abiotic factors at the landscape scale, structures and processes surrounding the site area including the riparian area itself. Note the adjacent land use(s), the degree of habitat fragmentation in the surrounding landscape. What hydrologic manipulation has occurred within the watershed. See Appendix 3 for examples of the 1995 and 1997 plot forms (page 3 of the forms has site ranking criteria).

For example, an **A- ranked** occurrence of a riparian plant association has no, or very few, non-native plant species present, the channel and banks are stable and show no signs of trampling or sloughing, the soils are not compacted. The association is surrounded by other riparian associations of similar quality, creating a connected, high quality mosaic. The surrounding hillslopes and areas up and down stream are in natural condition and have not been drastically altered (no dams or diversions upstream, no logging or mining up stream of adjacent hillslopes). A **B-ranked** occurrence of a riparian plant association may have all of the above `A' criteria but is very small in size, or has a higher abundance of non-native plant species present, or may be an area in high condition with surrounding land use that fragments the occurrence. A **C-ranked** occurrence is of poor condition, generally with abundant non-native plant species present and/or the area is highly fragmented, and/or the area is very small. Again surrounding land use and condition plays a role in the overall riparian occurrence rank.

Riparian areas recommended for special management or protection are examples of "A" or "B" ranked occurrences. These ecologically significant sites are valuable as reference areas for long-term research and comparison with impacted areas.

High-quality riparian areas found in the Rio Grande and Closed Basin are proposed as some of the best examples of rare or common riparian plant associations in the State. The Colorado Natural Heritage Program will be entering these areas into the Biological and Conservation Database and ranking these sites for final protection recommendation.

Data Analysis and Classification Development

Agglomerative cluster analysis was employed using Euclidean distance (a similarity index distance measure) and average clustering method to determine groups of plots with similar species abundance (Figures 4, 5 and 6)(see Ludwig and Reynolds 1988 for further explanation of this method). Plant Associations derived from the cluster analyses were compared with riparian plant association stand data and descriptions from riparian classification work in Colorado, New Mexico, Arizona, Utah, Montana, Idaho and Wyoming (Johnston 1987, Muldavin 1992, Durkin *et al*. 1994, 1995, Szaro 1989, Padgett *et al.* 1989, Hansen *et al.* 1988, 1989, and Youngblood *et al.* 1985, respectively). Associations were considered either 1) synonymous --where associations matched in species composition, constancy, average cover, environmental setting, 2) similar --when canopy structure, genera, and physical setting were similar, but species composition was different, 3) a new type not described in the literature, or 4) unclassifiable due to insufficient data.

Plant association names are based on each canopy stratum dominant and codominant plant species, characterized by high constancy (frequency of species occurrence) and high relative abundance (percent canopy cover) values. A slash separates canopy layers (e.g., tree/shrub/herb). A dash indicates co-dominance within a given canopy layer (e.g., *Populus angustifolia-Pseudotsuga menziesii*). Plant associations that appear synonymous with those in the literature (by stand table and description comparison) are given the same names. Some published names are long and awkward; we propose shorter names herein.

The United States National Vegetation Classification (or Why use Plant Association and not Community Type in the name?)

Riparian plant associations presented here are incorporated into the United States National Vegetation Classification System (USNVS), developed and maintained by The Nature Conservancy (Grossman *et al*. 1998, Anderson *et al.* 1998). This system is based on key elements to best incorporate existing systems and information, and to best fit the needs of conservation. The classification: 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 (emphasis by the author).

The classification is based on existing, relatively undisturbed (by human impacts) vegetation in all seral stages. A *plant association*, the most specific level in this hierarchical classification, is defined as "natural vegetation with definite floristic composition, uniform physiognomy, and uniform habitat" (Mueller-Dombois and Ellenberg 1974). This is *not* the same as the USDA Forest Service adopted concept of a "plant association" (Daubenmire 1952), a term reserved for only the potential climax vegetation. Plant associations in the USNVS system are defined as a product of the prevailing environmental setting (where possible, barring human influence or pre-European settlement) including past natural disturbances (such as fire, flooding, or bison grazing) and are "real, extant ... kinds of vegetation, rather than a theoretical end point that is seldom reached on most sites" (Baker 1984).

Along riparian corridors, flooding and sediment deposition and scouring, create an environment that is frequently disturbed. Thus most riparian communities are frequently set back in successional time, and the floodplain mosaic is often a series successional stages. Thus many of the plant associations described here would be equal to "community types" described by USDA Forest Service publications (*e.g.* Padgett *et al*. 1989).

The Hierarchical Physiognomic and Floristic Classification of the United States National Vegetation Classification System (USNVS) is structured as follows:

- ***Division***-- the first level in the classification system separates the Earth into either vegetated (>1%) or non-vegetated categories.
  - ***Order***-- Dominant life form (tree, shrub, dwarf shrub, herbaceous, or non-vascular).
    - ***Class***-- Relative percent canopy cover of the life form in the upper most strata during the peak of the growing season (Forest, woodland, shrubland, barrens).
      - ***Subclass***--Predominant leaf phenology of the classes defined by tree, shrub, or dwarf shrub stratum (evergreen, deciduous, mixed evergreen-deciduous), and the average vegetation height for herbaceous stratum (tall, medium, short).
        - ***Group***-- A combination of climate, leaf morphology, and leaf phenology

(*e.g. S*ubtropical drought-deciduous forest, Temperate rainforest).

- ***Subgroup***-- Separates natural/semi-natural types from the planted/cultivated types.
    - ***Formation***--Ecological groups with broadly defined environmental (e.g. hydrology) and additional physiognomic factors (*e.g.*).
        - ***Alliance***--aggregation of Plant Associations and characterized by a diagnostic species, which as a rule, occur in the dominant or uppermost stratum of the vegetation (*Picea pungens* Seasonally Saturated Alliance).
            - ***Plant Association***-- the basic floristic unit of this classification system, characterized by a diagnostic species that occur in the overstory and understory of the vegetation (e.g. *Picea pungens/Alnus incana* Seasonally Saturated Forest).

Table 3. Cross-walk of the US National Vegetation Classification (USNVC) (Grossman *et al*. 1998 and Anderson *et al*. 1998) and the Wetland and Deep Water Habitat Types of the U.S. (Cowardin *et al.* 1979).

USNVC		COWARDIN
DIVISION:	Vegetated (>1%)	
Order:	Tree Dominated	Palustrine system-Forested class
Class:	II. Open Tree Canopy (25-60%)	
Subclass:	A. Evergreen Open Tree Canopy	Needle-leaved evergreen subclass
Group:	4. Temperate or subpolar	
Subgroup:	(N). Natural/Semi-natural	
Formation:	e. Seasonally flooded/ saturated	
Floristic level	(1) Alliance	(Dominance type)
Floristic level	(2) Plant Association	
Subclass:	B. Deciduous Open Tree Canopy	Palustrine system-Forested class Broad-leaved deciduous subclass
Group:	2. Cold-deciduous	
Subgroup:	(N). Natural/Semi-natural	
Formation:	c. Seasonally flooded/ saturated	(Dominance type)
Floristic level	(1) Alliance	
Floristic level	(2) Plant Association	
Subclass:	C. Mixed evergreen-deciduous	Palustrine system-Forested class
Group:	3. Cold-deciduous	Broad-leaved deciduous subclass
Subgroup:	(N). Natural/Semi-natural	
Formation:	b. Seasonally flooded/saturated	(Dominance type)
Floristic Level	(1) Alliance	
Floristic Level	(2) Plant Association	

Table 3., Continued.

USNVC		COWARDIN
		Palustrine-Scrub-Shrub Shrubland
Order:	Shrub Dominated	
Class:	Shrubland	Deciduous--class
Subclass:	B. Deciduous Shrubs	
Group:	2. Cold-deciduous	
Subgroup:	(N). Natural/Semi-natural	
Formation:	b. Subalpine or subpolar	(Dominance type)
Floristic level	(1) Alliance	
Floristic level	(2) Plant Association	
Formation:	c. Seasonally flooded/saturated	
Floristic level	(1) Alliance	(Dominance type)
Floristic level	(2) Plant Association	
Order:	Herb/Nonvascular	Palustrine-Emergent Persistent Wetlands
Class:	Herbaceous Dominated	
Subclass:	A. Perennial graminoid (>50% relative graminoid cover)	
Group:	Temperate or subpolar grassland	
Subgroup:	(N). Natural/Semi-natural	
Formation:	k. Seasonally flooded/ saturated	
Floristic level	(1) Alliance	(Dominance type)
Floristic level	(2) Plant Association	
Subclass:	Perennial Forb vegetation (50% relative >forb cover)	Riverine System-Upper Perennial Persistent-Emergent Wetlands
Group:	2. Temperate or subpolar	
Subgroup:	(N). Natural/Semi-natural	
Formation:	e. Saturated temperate forb vegetation	(Dominance type)
Floristic level	(1) Alliance	
Floristic level	(2) Plant Association	
		Riverine System-Upper Perennial
Subclass:	Hydromorphic rooted vegetation.	Persistent-Emergent Wetlands
Group:	Temperate	
Subgroup:	(N.) Natural/Semi-natural	
Formation:	a. Non-tidal Hydromorphic rooted vegetation.	(Dominance type)
Floristic level	(1) Alliance	
Floristic level	(2) Plant Association	

RESULTS and DISCUSSION

A total of 70 plant associations were determined from over 200 sampled streams in the Rio Grande and Closed Basin watersheds (Tables 1 and 5, Figures 4, 5 and 6). This reflects the diverse array of habitats from high alpine meadows to the very unique alkaline playas on the San Luis Valley floor.

Three new and one "resurrected" plant associations were discovered in the Closed Basin. The *Populus angustifolia/Salix drummondiana-Acer glabrum* (narrowleaf cottonwood/Drummond's willow) is a new, globally rare plant association. It was discovered on one creek (Sand Creek), in a very large (over 4 continuous miles long) and pristine stand. This type has not been documented throughout the rest of Colorado. Further inventory is needed on the east flank of the Sangre de Cristo Mountains and in New Mexico.

The *Populus angustifolia* (narrowleaf) Sand Dune Forest was discovered and described in 1997. This old-seral stand of pure cottonwoods (and nothing else) grows in sand dunes adjacent to Sand creek, just west of the eastern boarder of the Great Sand Dunes National Monument. It is a unique environmental setting. Shifting, wind-blown sand dunes, flooding, and channel migration are just a few of the annual disturbances this community must tolerate to survive. The cottonwoods occur in a series of bands, each slightly younger than the next. The oldest cottonwoods had huge trunks, few branches, and were about 40 feet tall. The youngest cottonwoods were only 2 feet tall and were a product of sucker shoots from the neighboring 10-20 feet tall cottonwoods.

The *Salix exigua-Salix eriocephala* var. *ligulifolia* (coyote willow-strapleaf willow) shrubland was observed and described for the first time in 1997. It occurs along Trinchera and Sangre de Cristo Creeks in Costilla County. More stands were observed in 1998 long upper reaches of the Purgatory River, almost due east of stands located in the San Luis valley on the other side of the Sangre de Cristo Mountains.

The *Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum* (white fir-blue spruce-narrowleaf cottonwood/Rocky Mountain maple) association was previously described by Baker (1986 and 1989) from the San Juan Mountains. This association had been lumped into the diverse riparian forest type called the *Populus angustifolia-Picea pungens/Alnus incana* (narrowleaf cottonwood-blue spruce/thin leaf alder) by Kittel *et al.* (1994). However, the lack of *Alnus incana* (thinleaf alder) and consistent presence of *Abies concolor* (white fir) and *Acer glabrum* (rocky mountain maple) in the Closed Basin and San Juan stands warrant splitting the type back out. *Abies concolor* (white fir) appears to be restricted to the southern part of the state, making the "new" association a flag for biodiversity of riparian areas in that part of the state.

Excellent examples of all three can be seen on creeks draining the western flank of the Sangre de Cristo Mountains (Table 3).

Other interesting finds in the study area were: Colorado's largest and most pristine stand of *Sarcobatus vermiculatus/ Distichlis spicata* (greasewood/saltgrass) on the San Luis Valley floor; the largest and most pristine example of the *Populus angustifolia-Juniperus scopulorum* (narrowleaf cottonwood-Rocky Mountain juniper) riparian woodland along Deadman Creek on the Baca Ranch; A large example of a *Carex simulata* (analogue sedge) quaking fen along San Luis Creek in Saguache County. Only a handful of these fens occur in the state, and this one is very large and in very good condition (Table 3).

Table 4. New riparian plant associations and exemplary examples of more common riparian communities found in the Rio Grande and Closed Basin watersheds, Colorado. See Table 4 for Global and State Rank definitions. See Study Area Map (page 5) and Table 1 (page 6) for more location information and site quality rank.

Plant Associations Creek Name, County, (Plot Numbers)	Global Rank	State Rank	Owner
*Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum**	G2	S2	
Sand Creek, Saguache County (plots 97BG17 and 97GK27)			RGNF/Private
*Populus angustifolia/Salix drummondiana-Acer glabrum**	G1?	S1?	
Sand Creek, Saguache Country (plots 97GK24-26)			RGNF
Populus angustifolia Sand Dune Forest*	G1	S1	
Sand Creek, Saguache and Alamosa Counties (plot 97MD11)			Private
Salix exigua-Salix eriocephala var. *ligulifolia**	G2G3	S2S3	
Sangre de Cristo Creek, Costilla County (plots 97GK30-40)			County
Populus tremuloides/Betula occidentalis	G2G3	S2	
Rito Alto Creek, Saguache County (plot 97GK20)			RGNF
Cottonwood Creek, Saguache County (plot 97MD14)			Private
Populus angustifolia-Juniperus scopulorum	G2G3	S2	
Deadman Creek, Saguache County (plot 97GK12)			Private
Carex simulata	G4	S2	
San Luis Creek, Saguache County (plot 97GK18-19)			Private
La Jara Creek, Conejos County Plot (97EV32)			State

* New association based on 1997 data.

Table 5. Definition of Colorado Natural Heritage Program (CNHP) Global (G) and State (S) Rarity Ranks. Global ranks refer to the worldwide range a the plant, animal, or natural community (plant association). State ranks refer to the abundance with state boundaries. 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 very few remaining individuals) or because of some factor of its biology making it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (6 to 20 occurrences), or because of other factors demonstrably making 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)
G/S4	Apparently secure globally/state (>100 occurrences), though it may be quite rare in parts of its range, especially at the periphery
G/S5	Demonstrable secure globally, though it may be quite rare in parts of its range, especially at the periphery
GX	Presumed extinct.
G#?	Question mark with rank indicates there are probably more occurrences than currently documented, or there is some other question about the rank.
G/SU	Unable to assign rank due to lack of available information.
G#Q	A Q with rank indicates there is some question about taxonomic status.
G/SH	Historically known, but not verified for an extended period, usually 5 to 10 years.
G#T#	Trinomial rank (T) is used for subspecies or varieties. These species or subspecies are ranked on the same criteria as G1-G5.
S#B	Refers to the breeding season rarity of migrants.
S#N	Refers to the non-breeding season rarity of migrants; where no consistent location can be discerned for migrants or non-breeding populations.
SZ	Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably mapped and protected.
SA	Accidental in the state.
SR	Reported to occur in the state, but not verified.
S?	Question mark with rank indicates there are probably more occurrences than currently documented, or there is some other question about the rank.

Notes: Where two numbers appear in a state or global rank (e.g., S2S3), the actual rank of the element falls between the two numbers.

Table 6. Riparian Plant Associations found in the Rio Grande and Closed Basin Watersheds in 1995 and 1997.

Type and Name	CNHP Global and State Rarity Rank*
CONIFEROUS FORESTS	
1. Abies lasiocarpa-Picea engelmannii/Alnus incana	G5/S5
2. Abies lasiocarpa-Picea engelmannii/Mertensia ciliata	G5/S5
3. Abies lasiocarpa-Picea engelmannii/Salix drummondiana	G5/S4
4. Abies lasiocarpa-Picea engelmannii/Ribes spp.	G5/S3
5. Picea pungens Alliance**	
6. Pseudotsuga menziesii Alliance**	
7. Pseudotsuga menziesii/Betula occidentalis	G3?/S3
8. Pseudotsuga menziesii/Cornus sericea	G4/S2
MIXED CONIFEROUS-DECIDUOUS FORESTS	
9. Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum	G2/S2
10. Populus angustifolia-Juniperus scopulorum	G2G3/S2†
11. Populus angustifolia-Picea pungens/Alnus incana	G3/S3
DECIDUOUS FORESTS	
12. Populus angustifolia Sand Dune Forest	G1/S1
13. Populus angustifolia/Alnus incana	G3?/S3
14. Populus angustifolia/Cornus sericea	G4/S3
*15. Populus angustifolia/*Mesic Graminoids††	
16. Populus angustifolia/mixed *Salix* species	G3/S3
17. Populus angustifolia/Rhus trilobata	G3/S3
18. Populus angustifolia/Salix drummondiana-Acer glabrum	G1?/S1?
19. Populus angustifolia/Salix exigua	G4/S4
20. Populus angustifolia/Salix lucida var. *caudata*	G1Q/S1Q
21. Populus tremuloides/Acer glabrum	G2/S1S2
22. Populus tremuloides/Alnus incana	G3/S3
23. Populus tremuloides/Betula occidentalis	G2G3/S2
24. Populus tremuloides/Salix drummondiana	GU/SU
25. Populus tremuloides/Tall forbs	G5/S5
26. *Salix amygdaloides* Alliance**	
NON-WILLOW SHRUBLANDS	
27. Alnus incana/Mesic Forbs	G3G4Q/S3
28. Alnus incana/Mesic Graminoids	G5Q/S3
29. Alnus incana-Cornus sericea	G3G4/S3
30. Alnus incana-mixed *Salix* species	G3/S3
31. Alnus incana-Salix drummondiana	G3/S3
32. Betula occidentalis/Mesic Forbs	G3/S2
33. Cornus sericea	G4/S3
34. *Pentaphylloides floribunda/Deschampsia cespitosa*	G4/S3S

Table 6., Continued.

35. Quercus gambelii/Symphoricarpos oreophilus	G5/S4S3
36. Sarcobatus vermiculatus/Distichlis spicata	G4/S1
WILLOW SHRUBLANDS	
37. Salix bebbiana	G3?/S2
38. Salix brachycarpa/Mesic Forbs	G4/S4
39. Salix drummondiana/Mesic Forbs	G4/S4
40. Salix eriocephala var. *ligulifolia*	G2G3/S2S3
41. Salix exigua/Bare Ground	G5/S5
42. Salix exigua/Mesic Graminoids	G5/S5
43. Salix exigua-Salix eriocephala var. *ligulifolia*	G2G3/S2S3
44. Salix geyeriana/Calamagrostis canadensis	G5/S3
45. Salix geyeriana/Carex utriculata	G5/S3
46. Salix geyeriana/Mesic Forbs	G3/S3
47. Salix lucida (includes both subspecies) Alliance**	
48. Salix monticola/Calamagrostis canadensis	G3/S3
49. Salix monticola/Carex aquatilis	G3/S3
50. *Salix monticola*/Mesic Forbs	G3/S3
51. Salix monticola/Mesic Graminoids	G3/S3
52. Salix planifolia/Caltha leptosepala	G4/S4
53. Salix planifolia/Carex aquatilis	G5/S4
*54. Salix planifolia/*Mesic Forbs	G4/S4
55. *Salix wolfii/*Mesic Forbs	G3/S3
HERBACEOUS COMMUNITIES	
56. Caltha leptosepala	G4/S4
57. Cardamine cordifolia-Mertensia ciliata-Senecio triangularis	G4/S4
58. Carex aquatilis	G5/S4
59. Carex aquatilis-Carex utriculata	G4/S4
60. Carex lanuginosa	G3?/S3
61. Carex nebrascensis	G4/S3
62. *Carex simulata* fen	G3/S3
63. Carex utriculata	G5/S4
64. Deschampsia cespitosa	G4?/S4
65. Distichlis spicata	G5/S3
66. Eleocharis palustris	G5/S4
67. Glyceria ssp. Alliance**	
68. Juncus balticus var. *montanus*	G5/S5
69. Typha angustifolia-Typha latifolia	G5/S3

* G= Global, S= State, 1= very rare, 5= very common, ?= probably more common than is documented, Q= taxonomy is in question, type may be lumped or spilt with other types. See Table 4 for more complete CNHP Rank Definitions. **Alliances are not ranked. † Double rank indicates a range of known abundance. †† Plant association is caused by human-induced change and is not ranked by CNHP.

Figure 5. Cluster analysis dendrogram for tree dominated plots from the Rio Grande and Closed Basin watersheds. The analysis employed Euclidean Distance (a similarity measure between plot species composition) and Ward's Method to link groups (another similarity measure) of plots (See Ludwig and Reynolds 1988 for further explanation). The lower the distance, the more similar the plots. Dendrogram eventually joins all plots into one group (dotted lines, like a family tree). Various gray-colored boxes show acceptance of groupings, are labeled with plant association name or Alliance. The total number of species in the data set was reduced to those with at least 10% in one plot (from 456 species to 83 species). * indicates plot was classified into another group for environmental or other reasons.

```
                    Distance (Objective Function)
         6.000       73404.550      146803.100      220201.700    293600.200
          |-------+-------+-------+-------+-------+-------+-------+-------+
 95RG01    |Populus angustifolia Recent Alluvial Bar
 95RG55    |Abies lasiocarpa-Picea engelmannii/Ribes spp.
 97BG06    |-| Populus angustifolia/Mesic Graminoids
 97BG19    | |
*97GK05    | |
*97EV10    | |-------------|
 95RG46    | |             |
*95RG54    |||             |
 95RG47    |||             ||
 97EV18    -|              ||
 97BG04    ----|        Abies lasiocarpa-Picea engelmannii/Mertensia ciliata
 97EV23    |   |-----------||--|
 97EV33    |---|             |  |
 97GK38    |                 |  |---|
 97EV05    ----------------|Abies lasiocarpa-Picea engelmannii/Alnus incana
 95RG19    --------|-----------|   |-|
 97EV20    --------| Pseudotsuga menziesii Alliance
 95RG02    ----|-| Populus angustifolia-Picea pungens/Alnus incana
 95RG14    ----| |----------------| |----|
 95RG07    |-----| Picea pungens Alliance|
 97BG23    |                      |    |
 95RG06    |                      |    |
 95RG13    |----Abies lasiocarpa-Picea engelmannii/Alnus incana
 95RG22    |                           |          |
*95RG40    -------|   Abies lasiocarpa-Picea engelmannii/Salix drummondiana
 95RG56    -|     |-------|            |          |
 97EV24    ||-----|       |            |          |-------|
 97EV31    ||             |---------------|       |       |
 97MD13    |              |                       |       |
 97GK25    --|------------|                       |       |
 97GK26    --|     Populus angustifolia/Salix drummondiana-Acer glabrum
 97BG20    ---|-----------------------------------|       |
 97MD06    -|-|  Populus tremuloides/Alnus incana         |-------------|
 97MD16    -|                                             |             |
 97EV15    |      |--|                                    |             |
*97EV02    ------|  ||                                    |             |
 97BG15    |-|      ||   Populus tremuloides/Tall Forbs   |             |
 97GK28    | |------||-------------------------|Populus tremuloides Alliance
 97MD07    --| Populus tremuloides/Acer glabrum |-----------|             |
 97MD15    ----------|Populus tremuloides/Salix drummondiana              |
 97BG08    -----------|---- Pseudotsuga menziesii/Betula occidentalis-----|
```

Figure 5. Continued.

```
                         Distance (Objective Function)
          6.000       73404.550      146803.100      220201.700    293600.200
           |-------+-------+-------+-------+-------+-------+-------+-------+
 97GK20    ---|-------|                                                   |
 97MD14    ---|  Populus tremuloides/Betula occidentalis                  |
 95RG10    ----| Populus angustifolia-Picea pungens/Alnus incana          |
*95RG26    |--|||                                                         |
 95RG27    |  ||                                                          |
 97EV12    |  | |---| Populus angustifolia/Mesic Graminoids               |
 97MD10    ---| Populus angustifolia/Rhus trilobata                       |
 97GK16    -----| Populus angustifolia/Cornus sericea                      |
 97BG02    ---------| Populus angustifolia-Juniperus scopulorum           |
 97MD24    ------------|Populus angustifolia/Salix exigua                 |
 97GK12    -----------------| Populus angustifolia/Salix lasiandra var. caudata
 95RG33    ----| Populus angustifolia-Picea pungens/Alnus incana          |
 97EV27    |-| |--|             |      |                                |
 97GK09    | |-|  |             |      |                                |
 97MD28    | |    |-------------|      |                                |
 97MD17    --|    |  Populus angustifolia/Alnus incana                    |
 97BG11    -------|                    |                                |
 95RG16    ||    Populus angustifolia-Picea pungens/Alnus incana          |
 97GK03    ||------|                   |----|                           |
 97GK32    ||      |                   |    |                           |
 95RG28    ||  Populus angustifolia/Alnus incana                          |
 97EV25    |       |                   |    |                           |
 95RG21    | Populus angustifolia/Mixed Salix spp.                        |
 97MD25    |       |                   |    |                           |
 97MD31    ||  Populus angustifolia/Mesic Graminoids ---------------------|
 97EV16    ||      |    |              |    |
 97MD11    |||Populus angustifolia Sand Dune Forest
 97GK04    |||-----| Populus angustifolia-Juniperus scopulorum
 97GK24    -|| Populus angustifolia/Salix drummondiana-Acer glabrum
 97GK07    --|Populus angustifolia-Juniperus scopulorum
 97GK08    -------------| Populus angustifolia/Rhus trilobata
 97BG17    -----|---------------------------|
 97GK27    -----| Abies concolor-Picea pungens-Populus angustifolia/Acer
                    glabrum
```

Figure 6. Cluster Analysis Dendrogram of Riparian Plots Dominated by Shrubs from the Rio Grande and Closed Basin watersheds (see Figure 5 for brief explanation of dendrogram). * indicates the stand was placed into a different group.

```
                         Distance (Objective Function)
        83.000        89647.480      179212.000      268776.400     358340.900
          |-------+-------+-------+-------+-------+-------+-------+-------+
 95RG03    || Salix monticola/Mesic Forbs
 95RG38    ||--|
 97EV22    -|  ||
*97EV29    ----||----|
 95RG04    |    |    |
 97MD23    |----|    |--| Salix monticola/Calamagrostis canadensis
*97BG22    |         |  |
*97EV07    |         |  |------|
 97GK34    ----------|  |      |
 95RG32    -||          |      |
*97GK37    -||----------|      |
 95RG58    |-|   Salix monticola/Carex aquatilis
 97GK41    |                   |          |
 95RG70    |                   |          |
 97MD30    |-|   Salix monticola/Mesic Forbs
 97GK36    | |-----------------|          |-----------------------|
*97EV34    --|                            |                       |
 95RG62    |                              |                       |
 95RG71    |----|Salix drummondiana/Mesic Forbs                   |
 95RG73    |    |-------------------------|                       |
 95RG78    |    |                                                 |
 95RG76    -----|  Salix monticola/Mesic Forbs                    |
 95RG08    |                                                      |
 97MD03    |-|  Alnus incana-Salix drummondiana                   |
 95RG09    | |                                                    |
 95RG23    --|------||Salix lasiandra                             |
 97BG26    ---------||--| Pentaphylloides floribunda/Distichlis spicata
 97GK11    |---------|  |                                         |
 97GK15    |  Sarcobatus vermiculatus/Distichlis spicata          |
*97BG09    ------|      |  |                                      |
 97EV03    |     |------|  |                                      |
 97EV11    |-----|Salix bebbiana-|                                |
*97EV17    |               |     |                                |
 95RG37    ----|---|Alnus incana-Mixed Salix spp.                 |
 97GK01    ----|Salix lasiandra  ||                               |
 97EV26    -----|--|Salix bebbiana|                               |
 97GK33    -----|Salix lucida    ||--|                            |
 97EV14    -Salix bebbiana |     ||  |                            |
 97MD22    ----Quercus gambelii/Symphoricarpos oreophilus         |
 97BG13    ------Salix lucida-----|  ||                           |
 97EV04    -------|--------|         ||                           |
 97GK06    ---|---|   Salix exigua/Mesic Graminoids               |
 97GK39    --||   Salix exigua-Salix eriocephala var. ligulifolia |-------|
 97GK40    --|             |          | |                         |       |
 97EV28    -------|--------|          | |                         |       |
 97GK35    -------|  Salix eriocephala| | var. ligulifolia        |       |
 97BG16    ---------------------------| | Salix brachycarpa/Carex aquatilis
```

Figure 6. Continued.

```
                           Distance (Objective Function)
       83.000       89647.480      179212.000      268776.400     358340.900
         |-------+-------+-------+-------+-------+-------+-------+-------+
 95RG34     ||                          |----|                   |       |
*95RG36     ||---------|                |    |                   |       |
*95RG63     -|         | Salix monticola/Mesic Forbs             |       |
 95RG52     |-|        |-----|          |    |                   |       |
 95RG57     | |------| |     |          |    |                   |       |
 95RG68     --|Salix brachycarpa/Mesic Forbs |--|                |       |
 97BG01     ---------| Salix bebbiana        |  |                |       |
 95RG67     -|---------------|               |  |                |       |
 95RG69     -|  Salix wolfii/Mesic Forbs     |  |                |       |
 97BG10     |---|                            |  |                |       |
*97MD02     |   |-----|                      |  |                |       |
 97GK43     ----|     |----------------------|  |---|            |       |
 97EV30     -|-|      |  Salix geyeriana/Mesic Forbs |           |       |
*97GK02     || |------|                         |   |            |       |
*97MD04     |  |                                |   |            |       |
 97MD27     ---|                                |   |-----|      |       |
 97EV19     -----------|-------|                |   |     |      |       |
 97GK29     -----------|  Cornus sericea--------|   |     |      |       |
 97GK21     -------------------|Betula occidentalis/Mesic Forbs  |       |
 97EV36     ------|-------------------------------------|   |    |       |
 97GK30     -|----|   Salix exigua/Mesic Graminoids         |    |       |
 97MD09     ||                                              |    |       |
 97MD21     |                                               |    |       |
 95RG24     |                                               |    |       |
 95RG51     |                                               |-------|    |
 95RG43     |                                               |            |
*97BG03     |--|    Salix planifolia/Carex aquatilis        |            |
*95RG60     |  ||                                           |            |
 95RG64     |  ||                                           |            |
 95RG53     |--||-|                                         |            |
 95RG59     |   | |                                         |            |
 97MD29     ----| |-----|                                   |            |
 95RG30     |     |     | Salix planifolia/Caltha leptosepala            |
 95RG45     |-----|     |-----------------------------------|            |
 95RG49     |           |                                                |
*97EV35     ------------|                                                |
 95RG11     ----|-| Alnus incana-Salix drummondiana                      |
 95RG29     |---| |-----------|                                          |
 95RG41     |     |           |                                          |
 97GK22     ------| Alnus incana-Mixed Salix spp.                        |
 95RG15     -----|            |                                          |
*95RG42     ---| |---|--------|-----|                                    |
*97EV06     |  |-|   |        | Alnus incana/Mesic Forbs                 |
 97EV08     |--|     |----|   |     |                                    |
 97EV09     |        |    |   |     |                                    |
*95RG25     ---|-----|    |---|     |------------------------------------|
 97MD08     ---|          |         |
*97BG18     --------------|         |
 97BG12     ---------|              |
 97EV01     -|-----||---------------|
 97MD05     -|     ||
*97GK42     -------|
```

Figure 7. Cluster Analysis dendrogram for Herbaceous plots from the Rio Grande and Closed Basin watersheds (see Figure 5 for brief explanation of dendrogram). * indicates the plot moved to another association due to environmental data or other reasons. † indicates the plot was classified to the Alliance level only.

```
                         Distance (Objective Function)
        45.500       18069.440       36093.380       54117.320      72141.270
          |-------+-------+-------+-------+-------+-------+-------+-------+
*95RG05    |
 95RG72    |
*97MD01    ||
†95RG12    ||-|
†95RG39    || |      Cardamine cordifolia-Mertensia ciliata-Senecio
 95RG44    |  ||-----|         triangularis
†95RG18   ---||      |-|
 95RG48   ----|      | ||
 97GK13   ----------| Eleocharis palustris
 97GK14   ------------Distichlis spicata
 95RG35    |                  |---|
*95RG50    |                  |   |
 97MD19    |---|     Carex aquatilis
 97BG05    |   |--------------|   |------|
*97GK23    |   |                  |      |
 95RG61   -|--|                   |      |
 95RG66   -|         Carex simulata|     |
 97BG24   -----------------------|       |--------------|
 95RG20   -|---|                         |              |
 97EV13   -|   |--| Carex aquatilis-C. utriculata       |
 97MD18   -----|  |---------|              |            |
 97EV32   --------|         |------------|              |
 95RG74   --|------|        |                           |-------|
 97GK19   --|      |--------| Carex utriculata          |       |
 95RG77   ---------|                                    |       |
 95RG31    |------|                                     |       |
 95RG65    |      |  Carex aquatilis                    |       |---------|
 97BG14    |      |-------------------------------------|       |         |
 97BG25    |      |                                             |         |
 97GK18   -------|  Typha angustifolia-T. latifolia             |         |
 97GK31   ------------------------------------------------------|         |
 95RG17   --|---|                                                         |
 97MD26   --|   |--------|     Juncus balticus var. montanus              |
 97GK10    |-----|        |---------------------|                         |
 97MD12    |              |                     |-------------------------|
 97GK17   ---------------|     Carex lanuginosa|
 97MD20   -------------------------------------|
```

DICHOTOMOUS KEY TO THE RIPARIAN PLANT ASSOCIATIONS AND ALLIANCES OF THE RIO GRANDE AND CLOSED BASIN WATERSHEDS.

User Guide to Keys

The first step to keying out a plant association (plant community), is to delineate the individual "patch-type" within the area by its physiognomic type (tree, shrub or herbaceous dominated). Riparian areas can be complex mosaics of several plant associations, especially on broad meandering floodplains, or simple linear bands of just one plant association. You must determine what physiognomic types occur at your site BEFORE you key to individual plant associations. For example, is the river lined with a forest with a shrub understory, or is the river lined with a band of shrubs (a shrubland type) and a forested plant association behind that (a forested type). The key to Physiognomic Groups should help you make that determination.

The key to Physiognomic Groups determines the overall structure of the community (forest, shrubland, or herbaceous dominated vegetation). The Key to Groups keys to individual plant associations by its dominant species.

Cover values used in the key are averages for a stand. They should be used as guidelines rather than rules. Values found in the stand tables later in this report are based on one sample within a stand, and may not represent the typical stand-wide value. If near the cutoff between couplets, it is best to try the key in both directions. Once you arrive at an association name, go to the full association description for more information.

Key to Physiognomic Groups:

1. The stand has an overstory canopy of trees with at least 20% cover, or if less, trees have a greater canopy coverage than any combined shrub canopy component. Some riparian forest types include a narrow strip of shrubs along the stream bank with tree canopy overhead. Does the tree canopy directly overhang the shrub canopy? Are the trees and shrubs rooted in the same geomorphic landform? For example, a narrow strip of alder can have a "backdrop" of spruce and fir trees, but if you look carefully, you will see that the spruce and fir trees are rooted in the stream bank with the alders, making the stand a forested community. If the trees do not overhang the shrubs, and the trees are not rooted in the same landform, than the stand may be a shrubland community (go to 4). 2

1. The stand does not have any trees, or if trees are present, their overstory canopy is less than 20% or so, and if greater, not by much; the shrub canopy is the dominant structure of the community, and any trees present appear as isolated individuals. 4

2. The stand is purely conifers or deciduous trees. If both occur in the stand, one is clearly dominant with at least twice the canopy of the other. 3

2. The stand has a mixture of conifers and deciduous trees, either in equal proportions, or one is not less than half of the other in canopy coverage.. **Group C**

3. Conifer trees dominate the overstory canopy (if deciduous trees are present, they are less than one-half of the conifer canopy, usually <10%). .... **Group A**

3. Deciduous trees dominate (if conifers are present, they are less than one-half the deciduous canopy, usually <10%) ....**Group B**

4. The stand is dominated by shrubs, usually with a canopy cover of at least 20%. The density of shrubs ranges from very thick (a continuous canopy of overlapping or touching shrubs) to open (individual shrubs or clumps of shrubs that are evenly spaced throughout the stand). In addition, the shrubs are taller than the herbaceous layer. If the shrubs are unevenly clumped, the stand may be a mosaic of two communities. Do the same herbaceous species occur under the shrub canopy as between? Are the spaces between the shrubs smaller than the shrub clumps? If yes then it may be one plant association, if not, try keying each patch type separately. 5

4. The stand is dominated by herbaceous vegetation. If shrubs are present they are very widely spaced with less than 20% cover, or if more not by much, and are often nearly hidden by the herbaceous growth if shrubs are smaller than the herbaceous growth. .... **Group G**

5. Willows (*Salix* spp.) dominate the overstory. Other shrubs may be present, but are less than half as abundant. (Be careful here, sapling sized *Populus angustifolia* can be mistaken for willows. Look for buds with several overlapping scales, white bark, and red nodes. If *Populus angustifolia* seedlings and saplings are dominant (>20%), go to Group B.) 6

5. Other, non-willow shrubs dominate the overstory (alder, birch, shrubby cinqfoil, etc). If willows are present, they are usually less abundant than the non-willow shrub species, or may be up to equal in abundance...**Group F**

6. Shrubland with an average canopy over 1 meter (3 feet) in height, usually at montane, foothill and valley floor elevations (Tall willow shrublands) .... **Group D**

6. Shrubland with an average canopy less than 1 meter in height, typically at higher elevations, upper montane and subalpine environments (Short willow shrublands) ....**Group E**

Group A. Evergreen Riparian Forests

When determining which plant association a stand belongs to, remember to estimate the cover of each species for the **entire stand**. Percent cover values presented in the tables in this report are from single line-intercept transects, and may not adequately represent the true mean of an entire stand. Use the values in the stand tables as guidelines, not as strict cut-off values.

1. Either *Abies lasiocarpa, Picea engelmannii,* or *Pseudotsuga menziesii* are the dominant conifer(s) 2

1. *Picea pungens* is the dominant conifer. If other tree species are present they have less than half of the *Picea pungens* canopy coverage... ***Picea pungens* Alliance**

2. *Abies lasiocarpa* and/or *Picea engelmannii* are present and dominant 3

2. *Abies lasiocarpa* and *Picea engelmannii* are not present, or if so than clearly not dominant 6

3. A distinct band of *Alnus incana* and/or *Salix drummondiana* occurs along the stream bank 4

3. *Alnus incana* or *Salix drummondiana* usually absent, but if present than in such small isolated pockets that they are clearly not dominant (<10%) 5

4. *Alnus incana* is the dominant shrub along the stream bank, *Salix drummondiana* may be present, but is usually less than *Alnus incana* in abundance.. ....***Abies lasiocarpa-Picea engelmannii/Alnus incana* p.a.**

4. *Salix drummondiana* is the dominant shrub along the stream bank. If *Alnus incana* is present it is usually less abundant. (If the two shrubs occur in equal abundance, the stand is probably an elevational transition between the *Abies lasiocarpa-Picea engelmannii/Alnus incana* and the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* types) ....***Abies lasiocarpa-Picea engelmannii/Salix drummondiana* p.a.**

5. The shrub canopy is sparse to thick, and dominated by any one of several *Ribes* species............ ....***Abies lasiocarpa-Picea engelmannii/Ribes* spp. p.a.**

5. No shrubs are present, of if so they are very few and far between, comprising less than 10% cover, the stream bank is lined with thick mosses and many forb species. Dominant among the forbs is *Mertensia ciliata*, *Senecio triangularis*, or *Cardamine cordifolia*. All three forbs may be present, or any one may be present....***Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* p.a.**

6. *Pseudotsuga menziesii* is present and the dominant conifer (or at least the only tree species present. 7

6. Stand not like any of the above.................................Community is not described in this report.

7. An open to thick band of *Betula occidentalis* occurs along the stream bank (*Alnus incana* and *Cornus sericea* may be present, but are not as abundant as the birch). (If *Alnus incana* is dominant, see unclassified stands under the *Pseudotsuga menziesii* Alliance) .... ***Pseudotsuga menziesii/Betula occidentalis* p.a.**

7. A thick stand of *Cornus sericea* occurs along the bank, floodplain, or gully under the canopy of *Pseudotsuga menziesii* .... ***Pseudotsuga menziesii/Cornus sericea* p.a.**

Group B. Deciduous Dominated Forests

1. *Populus angustifolia* dominates the tree canopy with at least 20%, or is the only tree present, or with at least equal to twice the amount of any other tree present. *Populus tremuloides* and *Picea pungens* may be present in trace amounts 2

1. *Populus tremuloides, Populus deltoides,* or *Salix amygdaloides* is the dominant tree along the reach 12

2. Mature *Populus angustifolia* trees dominate the tree canopy (taller than 5 feet (1.5 m) and dbh greater than 5”, 12.6 cm)...3

2. Immature *Populus angustifolia,* mostly seedlings and saplings (less than 5 feet (1.5 m) tall, and if taller, no more than 5”, 12.6 cm dbh), dominate the stand 11

3. Shrubs create a subcanopy underneath the cottonwoods, sometimes the shrubs are confined to a narrow strip along the stream bank 4

3. No shrubs species are present, or if so than <10% cover (never dominant)..............................10

4. *Alnus incana, Cornus sericea,* or *Rhus trilobata* dominates the shrub layer..............................5

4. Willows (*Salix*) species dominated the shrub layer, other shrubs may be present in trace amounts 7

5. *Cornus sericea* is the dominate shrub present, although *Alnus incana* may be present with as much as an equal abundance to *Cornus* .... ***Populus angustifolia/Cornus sericea* p.a.**

5. C*ornus sericea* is not dominant, *Alnus incana* or *Rhus trilobata* is dominant. 6

6. *Alnus incana* lines the stream banks, some *Salix* spp. or *Betula* may be present, but in amounts less than half that of *Alnus* .... ***Populus angustifolia/Alnus incana* p.a.**

6. *Rhus trilobata* is the predominant shrub, especially away from the immediate channel edge. It can occur in widely spaced clumps under the cottonwood canopy. Little to no *Alnus incana* or *Cornus sericea* is present. *Salix exigua* may be present at the channel edge. .... ***Populus angustifolia/Rhus trilobata* p.a.**

7. Several (at least 3) willows are present in similar abundance (*Salix eriocephala*, *S. monticola*, *S. exigua,* and/or *S. lucida*), such that it is difficult to determine if any one species is the "dominant" willow... ***Populus angustifolia/*Mixed *Salix* species p.a.**

7. *Salix lucida* var. *caudata, Salix drummondiana* or *Salix exigua* is dominant 8
....

8. *Populus angustifolia* trees are mature individuals, creating a large, floodplain forest stand 9

8. *Populus angustifolia* trees are young, seedling, sapling, and pole-sized individuals, generally confined to gravel bars and immediate stream banks. *Salix exigua* is present as a dominant or co-dominant shrub (if no *Salix exigua* present, see the Populus angustifolia Recent Alluvial Bar p.a.). .... ***Populus angustifolia/Salix exigua* p.a.**

9. *Salix drummondiana* is dominant, thickly growing along the stream channel edge, and as scattered individuals on the floodplain. *Acer glabrum* is also present. Known from only one stand on the western flank of the Sangre de Cristo Mountains.. .... ***Populus angustifolia/Salix drummondiana-Acer glabrum* p.a.**

9. *Salix lucida* var. *caudata* forms a tall sub-canopy under the *Populus angustifolia*, few other shrubs are present... ***Populus angustifolia/Salix lucida* var. *caudata* p.a.**

10. Few to no shrubs are present, the undergrowth is dominated by mostly introduced hay-meadow grasses (e.g. *Poa pratensis, Agrostis stolonifera*) .... ***Populus angustifolia/*Mesic Graminoids p.a.**

10. No shrubs and no herbaceous layer is present. Substrate is pure sand and often underneath a thick litter layer of cottonwood leaves, located in or near Great Sand Dunes National Monument .... ***Populus angustifolia* Sand Dune Forest p.a.**

11. *Salix exigua* very abundant and mixed in and often of equal height with the young cottonwoods, if other shrubs present (*Alnus*, etc) then also young, but *Salix exigua* is the dominant shrub canopy component .... ***Populus angustifolia/Salix exigua* p.a.**

11. No shrub species are present, or if so, not co-dominant with the seedling and sapling cottonwoods... **See Miscellaneous *Populus angustifolia* stands**

12. *Populus tremuloides* is the dominant overstory canopy tree, mountain streams.....................13

12. *Salix amygdaloides* and/or *Populus deltoides* ssp. *wislizenii*, streams of the valley floor ....***Salix amygdaloides* Alliance**

13. Shrubs dominant the subcanopy 14

13. No shrubs or very few low scattered shrubs, stream banks lined with tall wildflower species .... ***Populus tremuloides*/Tall Forbs p.a.**

14. *Alnus incana* or *Betula occidentalis* is the dominant shrub..15

14. *Salix drummondiana* or *Acer glabrum* is the dominant shrub 16

15. *Alnus incana* dominates the shrub layer, if *Betula occidentalis* is present, it is less than half of the amount of *Alnus* cover. .... ***Populus tremuloides/Alnus incana* p.a.**

15. *Betula occidentalis* is the most abundant shrub present. If *Alnus incana* is present, it is not more abundant than *Betula*. ....***Populus tremuloides/Betula occidentalis* p.a.**

16. *Salix drummondiana* is the most abundant shrub along the stream banks, a little *Alnus* may be present.. ***Populus tremuloides/Salix drummondiana* p.a.**

16. *Acer glabrum* is the dominant shrub, if the above shrubs are present, they have less than one half the amount of *Acer* present. This community is very rare and is not restricted to stream sides; it is also found on moist north-facing slope. ....***Populus tremuloides/Acer glabrum* p.a.**

Group C. Mixed Coniferous and Deciduous Forests

1. *Abies concolor* is present and co-dominant with *Populus angustifolia*. *Picea pungens* may or may not be present. *Acer glabrum* and *Alnus incana* occur in the shrub understory ....***Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum* p.a.**

1. *Abies concolor* is not present 2

2. *Picea pungens* is present and co-dominant with *Populus angustifolia*. *Alnus incana* is usually present along the stream bank, but it can be absent, and a variety of other shrubs can be dominant in the shrub layer of this wide-spread and diverse association .... ***Populus angustifolia-Picea pungens/Alnus incana* p.a.**

2. *Picea pungens* is not present..3

3. *Juniperus scopulorum* is present and co-dominant with *Populus angustifolia*. Shrubs can be completely absent, or several species of *Ribes* may be present .... ***Populus angustifolia-Juniperus scopulorum* p.a.**

3. Conifers other than those listed above present (if *Pseudotsuga menziesii* present, try *Pseudotsuga Menziesii* plant associations) .... Community not described in this report

Group D. Tall Willow Shrublands

1. *Salix exigua* and/or *Salix eriocephala* var. *ligulifolia* (new name for *Salix lutea* and *S. ligulifolia*) is the dominant or co-dominant willows..2

1. Other willows are dominant, *Salix exigua* or *Salix eriocephala* var. *ligulifolia* may be present in the stand, but do not make up the bulk of the biomass in the stand. 5

2. *Salix exigua* is dominant, other willows, if present, have less than half the cover of *Salix exigua* 3

2. *Salix eriocephala* var. *ligulifolia* is co-dominant with *Salix exigua* or *Salix exigua* is not present or if so only in small amounts 4

3. Herbaceous growth under the *Salix exigua* canopy is low, the ground cover is mostly bare ground or alluvium (sand, cobbles, etc), grasses and forbs may be present but have a combined cover of less than 30% or so. ....***Salix exigua*/Bare Ground p.a.**

3. Herbaceous growth under *Salix exigua* canopy is at least 30% or greater. Total bare ground (or alluvium) is less than 30% or so, grasses and forbs make up most of the ground cover ....***Salix exigua*/Mesic Graminoids p.a.**

4. *Salix eriocephala* var. *ligulifolia* is co-dominant with *Salix exigua*, few other willows are present..***Salix exigua-Salix eriocephala* var. *ligulifolia* p.a.**

4. *Salix eriocephala* var. *ligulifolia* is the dominant or co-dominant willow with *Salix monticola*, or other willows, *Salix exigua* is not present or if so only in small amounts.................................... ....***Salix eriocephala* var. *ligulifolia* p.a.**

5. *Salix monticola* is the dominant, or “matrix” willow. The matrix willow is the one that comprises the bulk of the structure of a shrubland, and has highest individual cover, even though other willow species cover when combined may be greater than *Salix monticola*. 6

5. *Salix monticola* is not present, or if so, not dominant nor the matrix willow 9

6. *Calamagrostis canadensis* or *Carex aquatilis* are the dominant undergrowth herbaceous species, or if not dominant, at least have the highest cover of any other herbaceous species present in the undergrowth..7

6. Many grasses and/or forb species are present and it is impossible to assign dominance to any single herbaceous species in the undergrowth..8

7. *Calamagrostis canadensis* is dominant, or has at least the highest percent cover of all herbaceous species present in the undergrowth... ***Salix monticola/Calamagrostis canadensis*** **p.a.**

7. *Carex aquatilis* is the dominant, or has at least the highest percent cover of all herbaceous species present in the undergrowth....................................... ***Salix monticola/Carex aquatilis*** **p.a.**

8. Total cover of forb species is greater than the total graminoid cover, many species are present, no one forb species has dominance over others present, many non-native forb species may occur in the stand.. ***Salix monticola*****/Mesic Forbs p.a.**

8. Total cover of graminoid species is greater than the total forb cover, many species are present, no one graminoid species has dominance over others present, many non-native graminoids may occur in the stand... ***Salix monticola*****/Mesic Graminoids p.a.**

9. *Salix geyeriana* is the dominant or matrix willow. The matrix willow is the one that makes of the bulk of the structure of a shrubland, and has highest individual cover, even though other willow species cover when combined may be greater than *Salix geyeriana*)...............................10

9. Willow species other than *Salix geyeriana* are dominant 12

10. Total cover of forb species is greater than the total graminoid cover, many species are present, no one forb species has dominance over others present, many non-native forb species may occur in the stand ....***Salix geyeriana*****/Mesic Forbs p.a.**

10. Herbaceous undergrowth is not dominated by forbs 11

11. Herbaceous undergrowth is dominated by *Carex utriculata,* either as the only graminoid species present, or as the most abundant among several graminoid species ....
.... ***Salix geyeriana/Carex utriculata*** **p.a**.

11. Herbaceous undergrowth is dominated by *Calamagrostis canadensis,* either as the only graminoid species present, or as the most abundant among several graminoid species....................
.... ***Salix geyeriana/Calamagrostis canadensis*** **p.a.**

12. Stand is dominated by *Salix drummondiana* 13

12. Stand is dominated by other willow species 14

13. Undergrowth is dominated by numerous forb and graminoid species ....
....***Salix drummondiana*/Mesic Forbs p.a**.

13. Undergrowth is dominated by single graminoid species ....
.... Community not described in this report.

14. Stand dominated by *Salix bebbiana*, regardless of undergrowth or other associated willows ....
....***Salix bebbiana* p.a.**

14. Stand dominated by other willows...15

15. Stand dominated by *Salix lucida* (var. *caudata* or var. *lasiandra*)...........***Salix lucida* Alliance**

15. Stand dominated by other willows............................ Community not described in this report.

Group E. Short Willow Shrublands

1. Stand dominated by *Salix planifolia*. *Salix brachycarpa* or *S. wolfii* may be present, but with not more than half the cover of *Salix planifolia* 2

1. Stand dominated by *Salix brachycarpa* or *S. wolfii*. Salix planifolia may be present, but with less than half the cover of *Salix brachycarpa* or *S. wolfii* 5

2. Herbaceous undergrowth is dominated by numerous forbs...3

2. Herbaceous undergrowth is dominated by one or numerous graminoids...................................4

3. *Caltha leptosepala* is present and predominant throughout the stand, the ground is saturated to inundated for most of the growing season ....***Salix planifolia/Caltha leptosepala* p.a.**

3. Herbaceous undergrowth is dominated by numerous forbs, *Caltha leptosepala* is not present, or if so than not throughout the stand, and not one of dominant forb species, the ground is moist but not saturated to the surface for most of the growing season...
....***Salix planifolia*/Mesic Forbs p.a.**

4. Herbaceous undergrowth is dominated by graminoids and *Carex aquatilis* is the most abundant species .... ***Salix planifolia/Carex aquatilis* p.a.**

4. Herbaceous undergrowth is dominated by graminoid species other than *Carex aquatilis*............
.... Community not described in this report.

5. *Salix brachycarpa* is the dominant willow (look for glaucous layer on underneath side of leaf, underneath the pubescence). Other willows may be present, but *Salix brachycarpa* is the "matrix" willow. The matrix willow is the one that comprises the bulk of the structure of a shrubland, and has highest individual cover, even though other willow species cover when combined may be greater than *Salix brachycarpa*................***Salix brachycarpa*****/Mesic Forbs p.a.**

5. *Salix wolfii* is the dominant willow (no glaucous layer underneath the pubescence on the underneath side of the leaf). Other willows may be present, but *Salix wolfii* is the "matrix" willow. The matrix willow is the one that comprises the bulk of the structure of a shrubland, and has highest individual cover, even though other willow species cover when combined may be greater than *Salix wolfii* .... ***Salix wolfii*****/Mesic Forbs p.a.**

Group F. Non-willow Shrublands

1. Stand dominated by *Pentaphylloides floribunda* ....***Pentaphylloides floribunda/Deschampsia cespitosa* p.a**.

1. Stand dominated by other non-willows (willows may be present)..2

2. *Alnus incana* is the dominant shrub. Other shrubs may be abundant, even co-dominant (If co-dominate shrub is *Betula occidentalis*, go to 8.)...3

2. *Alnus incana* is not present, or at least not dominant (may be co-dominant)..............................7

3. One or several *Salix* species are co-dominant with *Alnus incana* 4

3. Shrubs other than willows are co-dominant, present, or *Alnus incana* is the only shrub present.. 5

4. *Salix drummondiana* is as nearly as abundant as *Alnus incana*.. ....***Alnus incana-Salix drummondiana* p.a.**

4. *Alnus incana* is co-dominant with 2 or more willow species, such that the willow combined cover is equal or nearly equal to that of *Alnus incana. Salix drummondiana,* if present, is with several other willow species of equal or greater cover......***Alnus incana/*****Mixed *Salix* species p.a.**

5. *Cornus sericea* is co-dominant with equal or near equal cover of *Alnus incana* ....***Alnus incana-Cornus sericea* p.a.**

5. Other shrubs, if present, have less than half the cover of *Alnus incana* 6

6. Herbaceous undergrowth is dominated by many forb species, mostly natives, total graminoid cover is much less than total forb cover..***Alnus incana*****/Mesic Forbs p.a**.

6. Herbaceous undergrowth is dominated by many graminoid species, may be natives or mostly introduced species, total forb cover is much less than total graminoid cover .... ***Alnus incana*/Mesic Graminoid p.a.**

7. *Cornus sericea* is the dominant shrub, often forming small isolated bands along the stream bank..***Cornus sericea* p.a.**

7. Other shrub species dominate the stand...8

8. *Betula occidentalis* is dominant or co-dominant with *Alnus incana* ......***Betula occidentalis* p.a.**

8. No *Betula, Alnus, Cornus*, or *Salix* present, or if so, in only trace amounts...............................9

9. *Quercus gambelii* lines the stream bank ....***Quercus gambelii/Symphoricarpos oreophilus* p.a.**

9. No *Quercus gambelii* present, shrublands of alkaline/ saline soils of the San Luis Valley floor 10

10. Stand dominated by *Sarcobatus vermiculatus* ....***Sarcobatus vermiculatus/Distichlis spicata* p.a.**

10 Stand not alike in all respects..................................... Community not described in this report.

Group F. Herbaceous Vegetation

1. *Carex* species dominate the herbaceous growth, in small patches or large meadows, generally one or two species are dominant...2

1. Herbaceous species other than *Carex* are dominant (grasses, spikerush, bulrushes, rushes, or forbs)..7

2. *Carex aquatilis, C. utriculata*, or *C. lanuginosa* are dominant, singly or together 3

2. *Carex simulata* or *Carex nebrascensis* are dominant 6

3. C*arex lanuginosa* is the only *Carex* species present, and often the only graminoid in the stand ....***Carex lanuginosa* p.a**.

3. *Carex aquatilis* and *Carex utriculata* are both present in near equal abundance, or one may be clearly dominant over the other, or they occur singly in monotypic stands 4

4. The two species occur in near equal abundance, and if not equal than one not less than two-thirds of the other ....*Carex aquatilis-Carex utriculata* **p.a.**

4. The two species are not equal in abundance, one species is at least two-thirds of the other, clearly more abundant than the other 5

5. *Carex aquatilis* individually has the highest cover, if *Carex utriculata* is present, it contributes not more than one third of the total cover..***Carex aquatilis* p.a.**

5. *Carex utriculata* individually has the highest cover, if *Carex aquatilis* present, it contributes not more than one third of the total cover..***Carex utriculata* p.a.**

6. *Carex simulata* present, several other *Carex* species may be present, even more abundant, substrates are deep, saturated peat, a true fen ....***Carex simulata* Fen p.a.**

6. *Carex nebrascensis* dominant, small or large stands along foothill and valley floor creeks......... .... ***Carex nebrascensis* p.a.**

7. Vegetation in or surrounding perennial or ephemeral ponds dominated by *Typha, Eleocharis*, or *Distichlis spicata* 8

7. Stands forming narrow bands or larger meadows, dominated by other graminoid or forb species than previously mentioned 10

8. Low-stature vegetation (less than 1 foot (0.5 m)), in or adjacent to shallow, usually alkaline, playa lakes or irrigated fields...9

8. Taller vegetation (1 foot (>0.5 m)), in deeper water, not usually very alkaline, dominated by *Typha latifolia*.. ***Typha angustifolia-Typha latifolia* p.a.**

9. Stands dominated by *Eleocharis palustris,* in large concentric rings surrounding playa lakes on the valley floor or narrow strips along streams of various gradients........ ***Eleocharis palustris* p.a.**

9. Stands dominated by *Distichlis spicata*, may be in concentric bands adjacent to *Eleocharis palustris* rings surrounding playa lakes, or forming large stands in low areas or playa lakes, usually on alkaline soils..***Distichlis spicata* p.a.**

10. Stands dominated by grasses or rushes (*Juncus* spp.)...11
10. Forb dominated stands 15

11. Stands dominated by *Juncus balticus*, a dark green, rhizomatous rush...................................... .... ***Juncus balticus* var. *montanus* p.a.**

11. Stands dominated by other species 13

13. Stands dominated by either *Deschampsia cespitosa* or by *Glyceria* species...........................14

13. Stands not dominated by species mentioned in this key.. .... Community not described in this report

14. Stands dominated by *Deschampsia cespitosa*, a tufted bunch grass .... ***Deschampsia cespitosa* p.a.**

14. Stands dominated by *Glyceria* species, usually in standing, non-alkaline, water .... ***Glyceria* spp. Alliance**

15. Stands dominated by forbs, a narrow band of mixed forbs, with at least one of the following three present in the stand.........***Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* p.a.**

15. Stands dominated by other forb species, not necessarily in a narrow band.............................16

16. Narrow or very broad stands dominated by *Caltha leptosepala*, with few other species present, usually on thin, saturated, organic soils ....***Caltha leptosepala* p.a.**

16. Stands dominated by forb species other than previously mentioned in this key .... Community is not described in this report

USER GUIDE to the PLANT ASSOCIATION DESCRIPTIONS

The plant association descriptions are based only on data collected by the Colorado Natural Heritage Program from 1990-1998. Other literature is cited for references to previously published association names. Species lists and environmental data from the references cited were not used to develop the plant association descriptions within this report. Stand tables that follow each description are for individual study areas (*e.g.* Rio Grande and Closed Basin watersheds, or the Lower Arkansas watershed in Colorado). The following information is provided for each plant association, unless otherwise indicated:

USNVS:	**Hierarchical position within the United States National Vegetation Classification System (Anderson 1998) (for more information, see page 30).**
COWARDIN:	**Type of Wetland according to Cowardin *et al.* 1979.**
CDOW GAP MAP:	**Vegetation Type according to the Colorado Gap Map Project (CDOW 1998).**

(The USNVS, Cowardin and CDOW GAP categories are listed only once at the beginning of each section.)

Alliance: **Name of the diagnostic species for an aggregation of plant associations, the next level above Plant Association in the USNVC.**

(The Alliance is listed only once at the beginning of each section.)

Plant Association: **Common and (*scientific*) name for the Plant Association used by Colorado Natural Heritage Program (CNHP). Naming convention is: tallest dominant canopy layer species followed by a '/' that indicates next canopy down *i.e.,* tree/shrub/herb. A dash "-" between names means the two species are co-dominant in the same canopy layer *e.g., Abies lasiocarpa-Picea engelmannii/Salix drummondiana* is a plant association with subalpine fir and Engelmann spruce as co-dominants in the overstory, and a shrub layer dominated by Drummond's willow.**

CNHP Rarity Rank: The rarity or degree of imperilment. G = Global Rank, S = State Rank, Scale: 1--5, 1 = rare, five or fewer known locations, globally imperiled, vulnerable to extinction, 5 = secure. Full rank definitions are listed in Table 4, page 36.

General Description and Comments: A short "word-picture" of the plant association and its environmental setting, and other note worthy comments of the plant association developed from CNHP data.

Recognition and Classification Problems: Notes to help readers differentiate between very similar plant associations, or notes regarding the taxonomy.

Related Literature and Synonyms: A listing of previously published vegetation types that are considered to be identical or at least include stands that are very similar to the CNHP plant association being described. The full published name, including labels used (*e.g.* "community type” or “plant association”) are reproduced exactly so they can be looked up in the original work.

Similar Communities: A list of closely aligned vegetation types, and notes about how they differ from the CNHP plant association being described. This is designed to help the reader differentiate among very similar, but not identical, types.

Regional Distribution: Known distribution throughout the ten western states and neighboring states to the east. Source: The Nature Conservancy’s Western Regional and Midwestern Vegetation Classifications (**Reid *et al.* 1998??**, Faber-Langendoen 1996).

Distribution in Colorado: Documented locations of the plant association within Colorado by watershed, and some National Forests (based on data collected by CNHP and the Colorado literature).

The following information is based on: The number of quantitative plots and a list of those plot numbers, collected by CNHP. The vegetation, site geomorphology and soil information is based on these data only. Other literature sources are not compiled in this section because the environmental data was not readily available and because of the inconsistency of data collection methods.

Elevation Range in Colorado: Range of elevations from CNHP sample points within Colorado. This may not represent the full elevation range of the plant association because the data are not based on a complete inventory.

Site Geomorphology: Physical setting of the plant association data collected by CNHP in Colorado. This section includes the Rosgen’s Stream Classification designation.

Soils: A summary of the soil data collected by CNHP in Colorado for all plots classified as this plant association. Soil family designations refer only to 1994 plots from the Colorado River Basin.

Vegetation: A summary of all CNHP plots from throughout the state. Generally it is the most dominant species found within this plant association and the range of variability in the presence and abundance of non-dominant species. The term “up to” means the species was not present in some stands. Regional differences can be explored by comparing a study area stand table with the general, statewide description.

Successional and Ecological Processes: This section is an attempt to describe the natural successional position and path of the plant association. It is based on field observations and ecological interpretations of the authors, having seen the plant association in many areas of the state in many degrees of degradation and recovery from disturbance (both natural and human-induced). It also includes what is known about the plant association (or its dominant species) from the literature.

Adjacent riparian vegetation: This section describes what riparian plant associations were located within the same mosaic, or immediately up- or downstream of the plant association being described. This information was closely observed by field researchers, and comes from CNHP plot data.

Adjacent upslope vegetation: This section lists the general surrounding non-riparian vegetation observed by field workers. It is not as specific as the adjacent riparian vegetation section, but does indicate the predominant upslope vegetation commonly observed. This information comes from CNHP plot data.

Management: This section attempts to describe the prevailing knowledge of how a plant association or its dominant plant species responds to various land practices. The information is gleaned from the literature and from CNHP researchers field observations and interpretations. Where ever possible, land use history and management practices were determined for the site sampled.

Some notes on the species tables:
The plot data presented in the species tables are based on a single sample within a given stand (see Methods, page 27). Thus the percent cover values, unfortunately, do not represent the mean of the entire stand. Please keep in mind that more plots were used to build the classification and the statewide description than just those shown in one species table. Also, remember that the plant associations were built on the quantitative vegetation data presented here *plus* additional field notes, photographs, as well as the environmental setting.

Structure of Species Table.
Table #. Percent Cover of Plant Species in Stands from the _________ watershed.

Plot Number	Plot #	Plot #	Plot #
Plant species are listed by Life Form (trees, shrubs, graminoids, forbs), then alphabetically by species. Age class is given for trees only.	Riparian Condition Rank (see Methods, page 28) A-excellent, B-good, C-poor…		
TREES (woody species with a single, defined trunk)			
Species 1—seedlings (dbh* < 12 cm, height <1.5 m)	% Canopy Cover Values		
Species 1—saplings (dbh <12 cm, height >1.5 m)			
Species 1—mature trees (dbh > 12 cm, height >1.5 m)	0% values are left blank		
Species 2			
Species 3 …			
SHRUBS (woody species with multiple trunks)			
Species 1			
Species 2			
Species 3 …			

GRAMINOIDS (Grasses and grass-like herbaceous plants, *e.g.* sedges, rushes)			
Species 1			
Species 2			
Species 3 …			
FORBS (Herbaceous broad-leaved plants, *i.e.* wildflowers)			
Species 1			
Species 2			
Species 3 …			
HORESTAILS (members of the Equisetaceae family, horsetails and scouring-rushes)			
Species 1 …			

* dbh = Diameter of the trunk at Breast Height (1.5 m above the ground)

USNVC:	I. A. 8. f. Seasonally Flooded/Saturated Temperate or Subpolar needle-leaved evergreen Closed Tree Canopy
COWARDIN: Palustrine	
CDOW GAP MAP:	61001 Forest Dominated Wetland/Riparian Type c. Mountain Coniferous Riparian

Subalpine fir (*Abies lasiocarpa*) Seasonally Flooded Forest Alliance

Subalpine fir–Engelmann spruce /thinleaf alder (*Abies lasiocarpa-Picea engelmannii /Alnus incana* ssp. *tenuifolia*) Plant Association

CNHP Rarity Rank: G5 / S5 This is a common community on first- and second-order streams in the subalpine zone in all Rocky Mountain states. In Colorado, it is a common community on first- and second-order streams above 9,000 feet in elevation. There are over 1000 miles of this type on Colorado's upper montane streams.

General Description and Comments: The *Abies lasiocarpa-Picea engelmannii/Alnus incana* (subalpine fir-Engelmann spruce/thinleaf alder) plant association occurs on heavily forested stream reaches where *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests also occur on adjacent hillslopes. Tall *Alnus incana* (thinleaf alder) and *Salix drummondiana* (Drummond willow) grow in a thick band along the edge of the stream. At lower elevations, *Alnus incana* is more abundant than *Salix drummondiana*. At mid-elevations, the two shrubs can be co-dominant. At higher elevations, *Salix drummondiana* becomes dominant and *Alnus incana* drops out, forming the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association.

Recognition and Classification Problems: The *Abies lasiocarpa-Picea engelmannii/Alnus incana* ssp. *tenuifolia-Salix drummondiana* (after Baker 1989) plant association has been split into two plant associations: the *Abies lasiocarpa-Picea engelmannii/Alnus incana* plant association, which occurs at lower elevations and has *Alnus incana* in the understory; and the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association, which occurs at higher elevations and has very little to no *Alnus incana* in the understory (Kittel *et al.* 1996). Stands with both *Alnus incana* and *Salix drummondiana* appear to be transitional between these two plant associations.

Related Literature and Synonyms: The following three community names are synonymous with the Colorado *Abies lasiocarpa-Picea engelmannii/Alnus incana* plant association: 1) *Abies lasiocarpa/Alnus incana-Salix drummondiana* (Kittel and Lederer 1993), 2) *Picea engelmannii-Abies lasiocarpa/Alnus incana*, (Kittel *et al*. 1994, Kittel *et al*. 1995), and 3) *Abies lasiocarpa-Picea engelmannii/Alnus incana* spp. *tenuifolia-Lonicera involucrata-Salix drummondiana* (Baker 1989, Kettler and McMullen 1996, Richard *et al*. 1996).

Similar Communities: Closely related communities include the *Abies lasiocarpa/Alnus incana-Cornus sericea* (subalpine fir/thinleaf alder-red-osier dogwood) plant association (Kettler and McMullen 1996), the conifer/*Cornus sericea* (red-osier dogwood) community type (Padgett *et al*. 1989, Manning and Padgett 1995), and the *Picea/Cornus stolonifera* (spruce/red-osier dogwood) community type (Youngblood *et al*. 1985). These communities have significant cover of *Cornus sericea* (red-osier dogwood) and very little *Alnus incana* (thinleaf alder). The presence of *Cornus sericea* (red-osier dogwood) in Colorado stands is considered part of the variation within the *Abies lasiocarpa-Picea engelmannii/Alnus incana* association.

Regional Distribution: This plant association occurs in Nevada (Manning and Padgett 1995), Utah (Padgett *et. al*. 1989), eastern Idaho, western Wyoming (Youngblood *et al*. 1985), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa, San Miguel/Dolores (Kittel and Lederer 1993), Gunnison (Kittel *et al*. 1995), Colorado (Kittel *et al* 1994), and South Platte River Basins (Kittel *et al.* 1996), the San Juan, Rio Grande and Routt National Forests (Richard *et al*. 1996, Kettler and McMullen 1996), and Rocky Mountain National Park (Baker 1989).

The following information is based on: a total of fifty-eight quantitative plots: fourteen from the Routt National Forest (94A617, 93K191, 93K211, 93K361, 93K412, 94A518, 94R528, 94R545, 94R556, 94R582, 94R587, 94R601, 94A602, 94R611), six from the Yampa River Basin (90MR61, 90MR62, 90MR67, 90MR75, 90MR89, 90MR112), one from the Colorado River Basin (92NL31), eleven from the Gunnison River Basin (94GK24, 94GK26, 94GK47, 94JB18, 94JB48, 94MD07, 94MD08, 94MD39, 94RR15, 94RR25, 94RR29), two from the Dolores River Basin (EO#6, EO#7), ten from the San Juan National Forest (93C531, 94MS33, 94DR51, 94MS52, 94DR54, 94MS56, 95CR05, 95CR11, 95CR12, 95CR22), three plots from the Rio Grande River Basin (95RG06, 95RG13, 97EV05), and ten plots from the South Platte River Basin (96LS06, 96AM21, 96AM22, 96AM25, 96GK09, 96LS19, 96AM04, 96LS36, 96GK44,96GK06) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7200-10,300 ft (2200-3100 m).

Site Geomorphology: This association generally occurs in narrow, 150-800 ft (40-250 m), V-shaped valleys on stream benches and banks. It usually occurs within 15-20 ft (5-6 m) of the channel edge and is rarely more than 2 ft (0.5 m) above the stream bank. Stream channels were classified according to Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow and steep (Rosgen's Channel Type: A2, A3, A4), moderately wide with a moderate gradient (Rosgen's Channel Type: B1-B6) or wide and very sinuous (C2, C3, C4).

Soils: Soils are shallow, dark-colored, loamy sands, silty loams, and sandy clay loams. There is generally high organic matter in the top 50 cm (20 inches) and mottles at 100 cm (40 inches). Soils become skeletal at 150 cm (60 inches).

Vegetation: *Picea engelmannii* (Engelmann spruce) and/or *Abies lasiocarpa* (subalpine fir) dominates the upper canopy with up to 80% cover, with *Picea engelmannii* present more often that *Abies lasiocarpa*. Other tree species occasionally present are up to 15% cover of *Populus angustifolia* (narrowleaf cottonwood), up to 20% cover each of *Picea pungens* (Colorado blue spruce) and *Pinus contorta* (lodgepole pine), and up to 1% cover of *Populus tremuloides* (aspen).

Abies concolor (white fir) is present with up to 15% cover in stands in the southwestern part of the state.

An open to dense mid-canopy of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is always present with 5-90% cover. *Salix drummondiana* (Drummond willow) can occur with up to 20% cover as a narrow band bordering the stream channel. In one stand in the Routt National Forest, *Cornus sericea* (red-osier dogwood) was present with 55% cover.

The herbaceous undergrowth is usually rich in forb species having an overall cover of 20-70%. Characteristic forb species include *Mertensia ciliata* (mountain bluebell), *Mertensia franciscana* (flagstaff bluebell), *Cardamine cordifolia* (heartleaf bittercress), *Heracleum lanatum* (cow parsnip), *Geum macrophyllum* (large-leaved avens), *Saxifraga odontoloma* (brook saxifrage), and *Geranium richardsonii* (Richardson geranium). Graminoid cover is minimal in western slope stands. In the South Platte River Basin, overall graminoid cover can be as high as 50% and include up to 25% cover of *Calamagrostis canadensis* (bluejoint reedgrass), 5-10% cover of *Carex disperma* (softleaf sedge), and up to 15% cover of *Glyceria* spp. (mannagrass). One plot had 43% cover of *Equisetum arvense* (field horsetail), indicating recent flooding disturbance.

Successional and Ecological Processes: The *Abies lasiocarpa-Picea engelmannii/Alnus incana* ssp. *tenuifolia* plant association appears to be a late-seral, or at least a long-lived, riparian community that may also represent a successional change from a deciduous-dominated overstory to a conifer-dominated overstory at lower elevations (Padgett *et al.* 1989). This successional shift may be attributed to a lack of fire in the association (Manning and Padgett 1995).

Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number of riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is slow (200 + years) and many factors can alter its path. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community (Peet 1988). Others suggest that the two species coexist in non-equilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the overstory (Aplet *et al*. 1988). Current literature suggests that the spruce-fir forest will never become a single-species dominated "climax" forest, but rather it is a perpetually changing mosaic of patches that are of different ages and composition. In addition, the successional dynamics of the forest is a complex interaction of the life history traits of spruce and fir, local site physical characteristics, and disturbance from fire, wind-throw or insect outbreak at both large (entire stand) and small (individual trees) scales.

Picea engelmannii has the potential to outlive *Abies lasiocarpa* by as much as 200 years (Aplet *et al*. 1988), but it has a much lower rate of establishment on the forest floor (Peet 1981). As the shorter-lived *Abies lasiocarpa* begin to die, a new generation of mostly *Abies lasiocarpa* seedlings establish, perpetuating a mixed stand (Peet 1981). On mesic sites, *Picea engelmannii* is faster-growing and will overtop *Abies lasiocarpa*. However, *Abies lasiocarpa* is more successful at establishing in the shade and on organic substrates (Peet 1988).

The fire frequency of *Abies lasiocarpa* and *Picea engelmannii* in moist areas is lower than on the dry upland sites (Peet 1981), but the trees in riparian areas do burn. Following a crown fire, both *Abies lasiocarpa* and *Picea engelmannii* colonize the burned area. *Picea engelmannii* establishment is greater for the first several decades, but as the ground becomes shaded, *Abies lasiocarpa* seedlings increase in abundance (Veblen *et al*. 1991).

Wind-throw and insect attack also affect the composition and age structure of *Abies lasiocarpa* and *Picea engelmannii* stands. Fallen trees, downed by wind or left as logging debris, act as hosts to the endemic spruce beetle (*Dendroctonus rufipennis*). During population surges, the beetle infests larger areas of live trees, selectively attacking and killing individuals with diameters greater than 4 inches (10 cm) (Veblen *et al*. 1991). The dead trees remain standing for years. Instead of being replaced by new seedlings, young *Abies lasiocarpa* and *Picea engelmannii* saplings are "released" from competition and grow to fill in the canopy (Veblen *et al*. 1991).

Adjacent riparian vegetation: This plant association generally is the only riparian association along a stream reach. Adjacent riparian associations can include *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests or *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce) forests along wider flood plains. Adjacent shrub-dominated associations include *Alnus incana* (thinleaf alder), *Salix boothii* (Booth willow), *Salix geyeriana* (Geyer willow), or *Salix planifolia* (planeleaf willow) shrublands. *Calamagrostis canadensis* (bluejoint reedgrass) and *Carex aquatilis* (aquatic sedge) meadows can also occur in adjacent riparian areas.

Adjacent upslope vegetation: *Picea engelmannii* (Engelmann spruce), *Abies lasiocarpa* (subalpine fir), *Picea pungens* (Colorado blue spruce), and *Populus tremuloides* (aspen) forests occur on adjacent hillsides, usually intergrading with the riparian canopy.

Management: The dense shrub layer of the *Abies lasiocarpa-Picea engelmannii/Alnus incana* (subalpine fir-Engelmann spruce/thinleaf alder) plant association may limit livestock access (Manning and Padgett 1995). *Alnus incana* is not particularly palatable to livestock, but can be damaged as animals search for more palatable forb species (Hansen *et al.* 1995).

Alnus incana is an excellent stream bank stabilizer due to its rhizomatous roots. Young stands can re-sprout after flood damage or fire and can tolerate a short duration of standing water. *Cornus sericea* (red-osier dogwood) could also be considered for stabilization projects since it quickly establishes from seed or transplanted seedlings along stream edges (Hansen *et al.* 1995).

This plant association is sensitive to timber harvesting activities due to high soil moisture content. Timber activity should be restricted. Management usually considers *Picea engelmannii* the most productive of the two species. However, consideration must be given to the uneven-aged structure and the inability of *Picea* to regenerate without providing protection for seedling survival. Small clear cuts, shelterwood, or group or individual tree selection methods should be designed to prevent seedling mortality from frost, desiccation from winter winds, sunscald, and soil movement (Youngblood and Mauk 1985).

This association is poorly suited for roads, trails, or other developments because it is so wet. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1992).

Table 7. Percent Cover of Plant Species in Stands of the *Abies lasiocarpa-Picea engelmannii/Alnus incana* ssp. *tenuifolia* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG06	95RG13	97EV05
Species name and age class/ Site Rank	C	C	B
TREES			
Abies lasiocarpa (Hook.) Nutt.--older trees		4	77
Abies lasiocarpa (Hook.) Nutt.--seedlings		3	
Picea engelmannii Parry ex Engelm.--older trees	2		
Picea engelmannii Parry ex Engelm.--seedlings	61	63	
Picea pungens Engelm.--older trees	3		
SHRUBS			
Alnus incana (L.) Moench	18	5	22
Lonicera involucrata Banks ex Spreng.	1	3	
Ribes inerme Rydb.		2	
Rosa woodsii Lindl.		1	
Salix boothii Dorn		6	
GRAMINOIDS			
Calamagrostis canadensis (Michx.) Beauv.		1	
Carex occidentalis Bailey	4		
Carex sp.		4	
Deschampsia cespitosa (L.) Beauv.		1	
Glyceria grandis S. Wats.		2	
Juncus balticus ssp. montanus Engelm.		1	
Luzula parviflora (Ehrh.) Desv.			1
Poa compressa L.			1
Poa sp.	1	2	
FORBS			
Achillea millefolium var. apicola (Rydb.) Garrett		2	
Aconitum columbianum Nutt.		1	
Aquilegia elegantula Greene	1		
Cardamine cordifolia Gray		2	
Conioselinum scopulorum (Gray) Coult. & Rose		1	
Epilobium angustifolium L.		1	
Erigeron sp.		8	
Fragaria vesca L.		2	
Fragaria virginiana Miller	1		1
Geum macrophyllum Willendow		1	
Maianthemum stellatum (L.) Link		1	
Mertensia ciliata (James ex Torr.) G. Don		1	
Oxypolis fendleri (Gray) Heller		2	1
HORESTAILS			
Equisetum sp.	1	1	1

Subalpine fir-Engelmann spruce /mountain bluebells (*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*) Plant Association

CNHP Rarity Rank: G5 / S5 This is a very common community on first- and second-order streams in the subalpine zone of all Rocky Mountain States. This community occurs in all mountain ranges and national forests in Colorado, covering more than 2000 miles in Colorado alone.

General Description and Comments: The *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* (subalpine fir-Engelmann spruce/mountain bluebells) plant association is a heavily shaded forest with no shrubs and a thick line of wildflowers lining the stream edge. *Mertensia ciliata* is nearly always present but can sometimes be absent. Other forbs can be more dominant and more consistently present include *Cardamine cordifolia* (heartleaf bittercress), *Micranthes odontoloma* (brook saxifrage), *Senecio triangularis* (arrowleaf groundsel) or cowbane(*Oxypolis fendleri*). Usually, however, there is a mix of these herbaceous species, and the association is easily recognized regardless of which forb is dominant.. A few scattered shrubs like *Salix drummondiana* (Drummond willow), *Lonicera involucrata* (honeysuckle), and *Ribes* (currant) may be present, but with less than 10% cover. At high elevations, *Vaccinium myrtillus* (Rocky Mountain whortleberry), typically an upslope species, can intergrade with this riparian plant association on the stream banks.

Related Literature and Synonyms: This association has been reported under many names. The following five communities are considered synonymous with the Colorado *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* plant association: 1) the *Picea engelmannii-Abies lasiocarpa/Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* plant association (Baker 1989), 2) the *Abies lasiocarpa/ Mertensia ciliata*) plant association (Kettler and McMullen 1996, Kittel *et al*. 1994, Kittel *et al*. 1995, Richard *et al*. 1996), 3) the *Picea engelmannii-Abies lasiocarpa/Mertensia ciliata*) plant association (Kittel and Lederer 1993), 4) the *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* plant association (Johnston 1987), and 5) the conifer/ *Aconitum columbianum* (monkshood) community type (Padgett *et al.* 1989).

Similar Communities: There are two closely related communities: 1) the *Picea engelmannii-Abies lasiocarpa/Senecio triangularis* (Engelmann spruce-subalpine fir/arrowleaf groundsel) plant association (Hess 1981, Komarkova 1986), which occurs on steep, wet hillsides, rather than in valley bottoms and 2) the *Picea*/*Galium triflorum* (spruce/fragrant bedstraw) community type(Youngblood *et al.* 1985), which has *Picea pungens* (Colorado blue spruce) as the dominate overstory, rather than *Abies lasiocarpa* and *Picea engelmannii*.

Regional Distribution: This association occurs in Montana, Utah (Padgett *et al*. 1989), New Mexico (Johnston 1987), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This common plant association is known throughout the southern Rocky Mountains of Colorado (Alexander 1981, Baker 1984, Boyce 1977, DeVelice *et al.* 1986, Dix and Richards 1976, Johnston 1987, Kettler and McMullen 1996, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et* al. 1995, Peet 1981, Richard *et* al. 1996, Steen and Dix 1974).

The following information is based on: a total of sixty-eight quantitative plots: twenty from the Routt National Forest (93K141, 93K161, 93K183, 93K312, 93K341, 93K401, 93K422, 93K431, 93K471, 93K491, 93K501, 94A529, 94R542, 94A544, 94A557, 94A572, 94A575, 94R580, 94A589, 94R593), one from the White River Basin (92NL65), ten from the Colorado River Basin (93SS01, 93SS11, 93SS20, 93SS21, 93SS51, 93GK36, 93GK44, 93GK48, 93DR16, 93DR20), eighteen from the Gunnison River Basin (94GK08, 94GK22, 94GK32, 94GK40, 94GK41, 94GK49, 94GK50, 94JB10, 94JB17, 94JB35, 94JB47, 94MD32, 94MD33, 94MD34, 94RR14, 94RR18, 94RR42), ten from the San Juan National Forest (93C331, 94MS40, 94DR55, 94DR56, 95CR19, 95CR38, 95CR53, 95CR54), and nine from the Rio Grande River Basin (95RG46, 95RG47, 95RG48, 97BG04, 97BG19, 97EV18, 97EV23, 97EV33, 97GK38) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 8200-11,500 ft (2500-3500 m).

Site Geomorphology: This plant association occurs in narrow to wide valleys, 35-350 feet (10-100 m) wide, and is limited to the immediate stream channel edge and overflow areas. It usually establishes within 15 feet (5 m) of the channel and within 2 feet (0.5 m) of channel bankfull height. Stream channels were classified according to Rosgen Classification of Natural Rivers (Rosgen 1996). Typically this association occurs along steep (2-15% gradient), narrow streams (Rosgen's Channel Type: A2-A6,), but can also be found along moderate gradient stretches (Rosgen's Channel Type: B2-B6).

Soils: Soils range from a thin layer of skeletal sandy loams to somewhat deep, mottled loamy sands over colluvial boulders. Total soil depth is never more than 7 feet (2 m), and is typically less than 3 feet (1 m). Consistent to all profiles is a deep, dark brown color and high organic content. Some of the soils from the Colorado River Basin classify as fragmental to fine clayey Cryorthents, Cryaquepts, Cryofluvents, Cryoborolls.

Vegetation: *Picea engelmannii* (Engelmann spruce) and/or *Abies lasiocarpa* (subalpine fir) provide a dense overstory of 20-100% cover immediately bordering and usually overhanging the stream. There is generally very little shrub cover, but occasionally, at high elevations, *Vaccinium myrtillus* (Rocky Mountain whortleberry) intergrades from the upslopes into the riparian area with up to 50% cover. *Salix drummondiana* (Drummond willow), *Lonicera involucrata* (honeysuckle), and *Ribes* (currant) species can be present, but with less than 10% cover. The forb layer is dense and rich with 20-80% cover. Forb species nearly always present, but with widely varying abundance, include up to 50% cover of *Cardamine cordifolia* (bittercress), up to 40% cover of *Mertensia ciliata* (mountain bluebells), and up to 20% cover each of *Oxypolis fendleri* (cowbane), *Senecio triangularis* (arrowleaf groundsel) and *Micranthes odontoloma* (brook saxifrage).

Successional and Ecological Processes: Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number riparian of Abies lasiocarpa-Picea engelmannii plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is slow (200 + years) and many factors can alter its path. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community (Peet 1988). Others suggest that the two species coexist in non-equilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the overstory (Aplet *et al*. 1988). Current literature suggests that the spruce-fir forest will never become a single-species dominated "climax" forest, but rather it is a perpetually changing mosaic of patches that are of different ages and composition. In addition, the successional dynamics of the forest is a complex interaction of the life history traits of spruce and fir, local site physical characteristics, and disturbance from fire, wind-throw or insect outbreak at both large (entire stand) and small (individual trees) scales.

Picea engelmannii has the potential to outlive *Abies lasiocarpa* by as much as 200 years (Aplet *et al*. 1988), but it has a much lower rate of establishment on the forest floor (Peet 1981). As the shorter-lived *Abies lasiocarpa* begin to die, a new generation of mostly *Abies lasiocarpa* seedlings establish, perpetuating a mixed stand (Peet 1981). On mesic sites, *Picea engelmannii* is faster-growing and will overtop Abies lasiocarpa. However, Abies lasiocarpa is more successful at establishing in the shade and on organic substrates (Peet 1988).

The fire frequency of *Abies lasiocarpa* and *Picea engelmannii* in moist areas is lower than on the dry upland sites (Peet 1981), but the trees in riparian areas do burn. Following a crown fire, both *Abies lasiocarpa* and *Picea engelmannii* colonize the burned area. *Picea engelmannii* establishment is greater for the first several decades, but as the ground becomes shaded, *Abies lasiocarpa* seedlings increase in abundance (Veblen *et al*. 1991).

Wind-throw and insect attack also affect the composition and age structure of *Abies lasiocarpa* and *Picea engelmannii* stands. Fallen trees, downed by wind or left as logging debris, act as hosts to the endemic spruce beetle (*Dendroctonus rufipennis*). During population surges, the beetle infests larger areas of live trees, selectively attacking and killing individuals with diameters greater than 4 inches (10 cm) (Veblen *et al*. 1991). The dead trees remain standing for years. Instead of being replaced by new seedlings, young *Abies lasiocarpa* and *Picea engelmannii* saplings are "released" from competition and grow to fill in the canopy (Veblen *et al*. 1991).

Adjacent riparian vegetation: This plant association commonly dominates the entire stream reach and is rarely part of a mosaic. However, adjacent riparian vegetation can include other *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forest types and *Alnus incana* (thinleaf alder) shrublands. Along steep, narrow streams adjacent to broader valleys, *Salix geyeriana* (Geyer willow) *Salix planifolia* (planeleaf willow) shrublands occur in adjacent riparian areas.

Adjacent upland vegetation: The upland vegetation is *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) and *Populus tremuloides* (aspen) forests.

Management: Forage value of this plant association is minimal due to the limited understory. Soils may be easily compacted by livestock grazing along the wet, mossy stream banks (Hansen *et al.* 1995).

This type is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1992).

Table 8. Percent Cover of Plant Species in Stands of the *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG46	95RG47	95RG48	97BG04	97BG19	97EV18	97EV23	97EV33	97GK38
Species name and age class/ Site Rank	A/B	A	B	B	B	A	B	B	B
TREES									
Abies lasiocarpa (Hook.) Nutt.--older trees	1			1		10			
Abies lasiocarpa (Hook.) Nutt.--saplings	8		5			1	2		
Abies lasiocarpa (Hook.) Nutt.--seedlings	1					8	5	1	
Picea engelmannii Parry ex Engelm.--older trees	13	11		52	4.2	17	51	34	46
Picea engelmannii Parry ex Engelm.--saplings	1	3				5		2	14
Picea engelmannii Parry ex Engelm.--seedlings	20	9	6					1	12
Picea pungens Engelm.--older trees		9	6						
Picea pungens Engelm.--saplings		8							
Picea pungens Engelm.--seedlings		3							
Populus tremuloides Michx.--older trees				44					18
SHRUBS									
Lonicera involucrata Banks ex Spreng.	5		2						
Ribes montigenum McClatchie	9		6	1		27			
Salix eriocephala Michaux var. ligulifolia				7					
Salix planifolia Pursh		11		7					
Vaccinium myrtillus L. ssp. oreophilum (Rydb.) Love et al.	2					6			
Vaccinium scoparium Leiberg	1	2							
GRAMINOIDS									
Carex aquatilis Wahlenb.				3	4	9			
Carex disperma Dewey									11
Carex sp.	1	6	2				1		
FORBS									
Achillea millefolium var. apicola (Rydb.) Garrett		1	2	4	1				
Arnica cordifolia Hook.						15		1	2
Cardamine cordifolia Gray	1	1	12		4	9	3	1	11
Conioselinum scopulorum Coult. & Rose	1	1		1	2	1			
Dodecatheon pulchellum (Raf.) Merr.				3	6				4
Fragaria virginiana Miller	1		2	2	1		1		
Geranium richardsonii Fisch. & Trautv.				2		3	20		1
Mertensia ciliata (James ex Torr.) G. Don	14		34				1	2	1
Osmorhiza depauperata Phil.						1	4	1	1
Oxypolis fendleri (Gray) Heller	8	7	1	2	6	17	11	1	17
Saxifraga odontoloma Piper	3	4				1	1		7
Senecio triangularis Hook						5			22
Veronica americana Schwein. ex Benth.								11	
HORESTAILS									
Equisetum arvense L.					2			3	1

Subalpine fir-Engelmann spruce/one of several gooseberry species (*Abies lasiocarpa-Picea engelmannii/Ribes* spp. (*montigenum, lacustre, inerme, wolfii*)) Plant Association

CNHP Rarity Rank: G5 / S3 This is a common subalpine forest of the Rocky Mountains. It is known from northern Nevada, Idaho, southern Montana, Wyoming, Utah, east-central New Mexico, and Colorado. This is a common, if small community in Colorado.

General Description and Comments: The *Abies lasiocarpa-Picea engelmannii/Ribes* spp. (subalpine fir-Engelmann spruce/current) is a heavily shaded forest with a very open shrub layer of just a few individual shrubs. It has a wide elevational range, 8300-12,200 ft (2500-3700 m), and is a common and facultative riparian community. It occurs along very steep streams where the riparian area is narrow and dominated by species of the surrounding forest. *Abies lasiocarpa* (subalpine fir) and *Picea engelmannii* (Engelmann spruce) dominate the tree canopy, while any of the following four *Ribes* (currant) species dominate the shrub layer: *Ribes inerme* (whitestem gooseberry), *R. lacustre* (prickly currant), *R. montigenum* (gooseberry currant), or *R. wolfii* (Wolf currant).

Related Literature and Synonyms: The *Abies lasiocarpa-Picea engelmannii/Ribes* spp. (subalpine fir-Engelmann spruce/currant) plant association (Bourgeron and Engelking 1994, Johnston 1987) is synonymous with the Colorado plant association of the same name.

Similar Communities: Closely related communities include the conifer/*Actaea rubra* (baneberry) community type (Padgett *et al*. 1989) and the *Abies lasiocarpa-Picea engelmannii/Actaea rubra* (subalpine fir-Engelmann spruce/baneberry) plant association (Johnston 1987) which only occasionally include several *Ribes* species.

Regional Distribution: This plant association occurs in Nevada, Idaho, Montana, Wyoming, Utah, New Mexico (Bourgeron and Engelking 1994, Johnston 1987), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs throughout the state. It has been documented from the Flat Tops Plateau in the White and Colorado River Basins and in the San Juan, Rio Grande, Gunnison, White River, Routt, and Pike National Forests (Kittel *et al.* 1994, Kettler and McMullen 1996, and Johnston 1987).

The following information is based on: a total of fourteen quantitative plots: two from the Routt National Forest (94R527, 94R605), six from the White River Basin (92GK50, 92GK53, 92NL32, 92NL56, 92NL60, 92NL66), three from the Colorado River Basin (93SS03, 93GK28, 93GK46), two from the San Juan National Forest (94MS54, 95CR10), and one from the Rio Grande River Basin (95RG55) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 8300-12,200 ft (2500-3700 m).

Site Geomorphology: In Wyoming, this plant association occurs on plateaus and moderate to steeper slopes. In Colorado, this plant association occurs along narrow to moderately wide streams in steep ravines and valleys. Stream channels were classified according to Rosgen

Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow and steep (Rosgen's Channel Type: A2, A5) or moderately wide and sinuous with a moderate gradient (Rosgen's Channel Types: B4)

Soils: Soils are sands or loam over sand, gravel, and cobbles. In the White and Colorado River Basins, the soils classify as loamy-fragmental, and fragmental aeric Cryaquepts to clayey Cryaquepts.

Vegetation: *Abies lasiocarpa* (subalpine fir) and *Picea engelmannii* (Engelmann spruce) dominate the tree canopy with 1-80% cover. The shrub layer is dominated by 1-30% cover of any of the following *Ribes* (current) species- *Ribes inerme, R. lacustre, R. montigenum, R. wolfii*. Other shrubs include up to 20% cover of *Lonicera involucrata* (honeysuckle) and up to 10% cover of *Sorbus scopulina* (mountain ash). *Salix drummondiana* (Drummond willow) often occurs along the stream edge with up to 10% cover. Mesic forb cover includes up to 20% cover of *Senecio triangularis* (arrowleaf groundsel), up to 15% cover of *Actaea rubra* (baneberry), and up to 10% cover each of *Mertensia ciliata* (mountain bluebells), *Streptopus fassettii* (twistedstalk), and *Cardamine cordifolia* (bittercress). Graminoid cover is minor.

Successional and Ecological Processes: Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number riparian of Abies lasiocarpa-Picea engelmannii plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is slow (200 + years) and many factors can alter its path. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community (Peet 1988). Others suggest that the two species coexist in non-equilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the overstory (Aplet *et al*. 1988). Current literature suggests that the spruce-fir forest will never become a single-species dominated "climax" forest, but rather it is a perpetually changing mosaic of patches that are of different ages and composition. In addition, the successional dynamics of the forest is a complex interaction of the life history traits of spruce and fir, local site physical characteristics, and disturbance from fire, wind-throw or insect outbreak at both large (entire stand) and small (individual trees) scales.

Picea engelmannii has the potential to outlive *Abies lasiocarpa* by as much as 200 years (Aplet *et al*. 1988), but it has a much lower rate of establishment on the forest floor (Peet 1981). As the shorter-lived *Abies lasiocarpa* begin to die, a new generation of mostly *Abies lasiocarpa* seedlings establish, perpetuating a mixed stand (Peet 1981). On mesic sites, *Picea engelmannii* is faster-growing and will overtop Abies lasiocarpa. However, Abies lasiocarpa is more successful at establishing in the shade and on organic substrates (Peet 1988).

The fire frequency of *Abies lasiocarpa* and *Picea engelmannii* in moist areas is lower than on the dry upland sites (Peet 1981), but the trees in riparian areas do burn. Following a crown fire, both *Abies lasiocarpa* and *Picea engelmannii* colonize the burned area. *Picea engelmannii* establishment is greater for the first several decades, but as the ground becomes shaded, *Abies lasiocarpa* seedlings increase in abundance (Veblen *et al*. 1991).

Wind-throw and insect attack also affect the composition and age structure of *Abies lasiocarpa* and *Picea engelmannii* stands. Fallen trees, downed by wind or left as logging debris, act as hosts to the endemic spruce beetle (*Dendroctonus rufipennis*). During population surges, the beetle infests larger areas of live trees, selectively attacking and killing individuals with diameters greater than 4 inches (10 cm) (Veblen *et al*. 1991). The dead trees remain standing for years. Instead of being replaced by new seedlings, young *Abies lasiocarpa* and *Picea engelmannii* saplings are "released" from competition and grow to fill in the canopy (Veblen *et al*. 1991).

Adjacent riparian vegetation: Adjacent riparian areas include *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests, *Alnus incana* (thinleaf alder) shrublands, and *Carex utriculata* (beaked sedge) wetlands.

Adjacent upland vegetation: The upslopes are forested with *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) and *Populus tremuloides* (aspen).

Management: This plant association is sensitive to timber harvesting activities due to high soil moisture content (Hansen *et al*. 1995). Timber productivity is fairly low. Management usually considers *Picea engelmannii* the most productive species. However, consideration must be given to the uneven-aged structure and the inability of *Picea* to regenerate without providing protection for seedling survival. Small clear cuts, shelterwood, or group or individual tree selection methods should be designed to prevent seedling mortality from frost, desiccation from winter winds, sunscald, and soil movement (Youngblood and Mauk 1985).

This type is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1992).

Table 9. Percent Cover of Plant Species in Stands of the *Abies lasiocarpa-Picea engelmannii*/Mixed *Ribes* spp. Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG55
Species name and age class/ Site Rank	A
TREES	
Abies lasiocarpa (Hook.) Nutt.--older trees	9
Abies lasiocarpa (Hook.) Nutt.--saplings	7
Picea engelmannii Parry ex Engelm.--older trees	4
Picea engelmannii Parry ex Engelm.--saplings	4
Picea pungens Engelm.--seedlings	2
SHRUBS	
Lonicera involucrata Banks ex Spreng.	4
Ribes montigenum McClatchie	4
Ribes wolfii Rothrock	15
Vaccinium myrtillus L. ssp. oreophilum (Rydb.) Love et al.	6
FORBS	
Conioselinum scopulorum (Gray) Coult. & Rose	4
Epilobium angustifolium L.	8
Fragaria virginiana Miller	1
Geranium sp.	5
Geum macrophyllum Willdenow	1
Mertensia ciliata (James ex Torr.) G. Don	4
Mertensia franciscana Heller	2
Pseudocymopterus montanus (Gray) Coult. & Rose	1
Sorbus scopulina Greene	17
Veronica wormskjoldii Roemer & J.A. Schultes	1
Viola canadensis var. corymbosa Nutt. ex Torr & Gray	2
Viola sp.	2

Subalpine fir – Engelmann spruce/Drummond willow (*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*) Plant Association

CNHP Rarity Rank: G5 / S4 This is a common and well-documented plant association by Rocky Mountain researchers. In Colorado, this community occurs on rocky second- and third-order streams.

General Description and Comments: The *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* (subalpine fir-Engelmann spruce/Drummond willow) plant association is a heavily forested type found along steep, narrow second- and third-order streams above 9,000 feet (2700 m) where *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests also occur on adjacent hillslopes. Tall *Alnus incana* (thinleaf alder) and *Salix drummondiana* (Drummond willow) grow in a thick band along the edge of the stream. At lower elevations, *Alnus incana* is more abundant than *Salix drummondiana*. At mid-elevations, the two shrubs can be co-dominant. At higher elevations, *Salix drummondiana* becomes dominant and *Alnus incana* drops out, forming the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association. *Picea pungens* is occasionally present at the stream edge and represents a variation of this type.

Recognition and Classification Problems: The *Abies lasiocarpa-Picea engelmannii/Alnus incana* ssp. *tenuifolia-Salix drummondiana* has been split into two closely related plant associations: the *Abies lasiocarpa-Picea engelmannii/Alnus incana* plant association, which occurs at lower elevations and has *Alnus incana* in the understory; and the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association, which occurs at higher elevations and has very little to no *Alnus incana* in the understory (Kittel *et al.* 1996). Stands with both *Alnus incana* and *Salix drummondiana* appear to be transitional between these two plant associations.

Related Literature and Synonyms: The *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association (Kittel *et al*. 1996, Kittel *et al*. 1995, Richard *et al*. 1996), the *Abies lasiocarpa-Picea engelmannii/Alnus incana* ssp. *tenuifolia-Lonicera involucrata-Salix drummondiana* plant association (Baker 1989), and the *Abies lasiocarpa/Alnus incana* ssp. *tenuifolia-Salix* plant association (Bourgeron and Engelking 1994) are considered synonymous with the Nature Conservancy's *Abies lasiocarpa/Salix drummondiana* plant association. The lack of *Picea engelmannii* in the name does not imply *Picea engelmannii* is not a consistent nor important component of this community, it is merely a nomenclatural simplification of the name. In fact, all *Abies lasiocarpa* communities within The Nature Conservancy's Regional Western Vegetation Classification are based on the concept of a mixed *Picea engelmannii* and *Abies lasiocarpa* mixed forest.

Similar Communities: Closely related communities include the *Picea/Cornus stolonifera* (spruce/red-osier dogwood) community type (Youngblood *et al.* 1985) which has similar overstory species, but has a dense shrub layer of *Alnus incana* and with only occasional *Salix drummondiana,* the *Picea/Cornus stolonifera* and *Picea/Equisetum arvense* (spruce/field horsetail) habitat types (Hansen *et al.* 1995) which can have abundant *Salix drummondiana* and *Alnus incana*, but also a more diverse tree species component.

Regional Distribution: This association has been documented in Colorado, and is expected to occur in Wyoming, Idaho, Utah, and Montana (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the San Juan Mountains (Richard *et al.* 1996), and the Colorado, Gunnison, Arkansas, and South Platte River Basins (Kittel *et al.* 1994, Kittel *et al*. 1995, Kittel *et al*. 1996).

The following information is based on: a total of fifty-one quantitative plots: one from the Colorado River Basin (92NL31), fourteen from the Gunnison River Basin (94GK17, 94GK20, 94GK35, 94JB07, 94JB27, 94JB30, 94JB36, 94JB46, 94MD11, 94MD22, 94RR12, 94RR20, 94RR28, 94RR49), sixteen from the San Juan National Forest (93C352, 93C401, 93C471, 93C501, 93C512, 94MS20, 94MS24, 94MS26, 95CR09, 95CR18, 95CR21, 95CR26, 95CR27, 95CR28, 95CR29, 95CR30), seven from the Rio Grande River Basin (95RG22, 95RG54, 95RG56, 95RG75, 97EV24, 97EV31, 97MD13), one from the Arkansas River Basin (95AM43), and twelve from the South Platte River Basin (96LS10, 96LS13, 96LS24, 96LS32, 96GK30, 96GK32, 96AM8, 96AM60, 96AM67, 96AM54, 96GK01, 96GK13) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 8400-10,900 ft (2600-3300 m).

Site Geomorphology: Stream channels were classified according to Rosgen Classification of Natural Rivers (Rosgen 1996). This plant association is commonly found on steep (2-25% gradient), narrow (<10 m), first-order streams in moderate to deep V-shaped valleys (Rosgen's Channel Type: A2, A3, A4, A5). The thick shrub canopy is restricted to a narrow band along the rocky stream bank. It can also occur in wider valleys along moderate gradient reaches with channel bottoms that range from bedrock to gravel (Rosgen's Channel Type: B1, B2, B3, and B4). One site in the Gunnison River Basin occurs along a braided stream channel (Rosgen's Channel Type: D2).

Soil: Soils are typically shallow (<1 m) sandy loams to sandy clay loams packed between large angular boulders and cobbles with a thin layer of partially decomposed organic matter under the litter layer.

Vegetation: This plant association has a dense canopy of 20-90% cover of *Abies lasiocarpa* (subalpine fir) and *Picea engelmannii* (Engelmann spruce). *Picea pungens* (Colorado blue spruce) is occasionally present with up to 10% cover in lower elevation, wet stands, and *Pinus contorta* is present with up to 20% cover in drier, early-seral stands. A narrow but dense strip of shrubs consists of 1-90% cover of *Salix drummondiana* (Drummond willow), up to 40% cover of *Salix monticola* (mountain willow), up to 30% cover each of *Salix brachycarpa* (barrenground willow) and *Salix planifolia* (planeleaf willow), and up to 20% cover of *Lonicera involucrata* (honeysuckle). *Alnus incana* (thinleaf alder) and *Cornus sericea* (red-osier dogwood) may be present in small amounts with up to 10% cover. The dense herbaceous undergrowth is characterized by up to 30% cover each of *Heracleum lanatum* (cow parsnip) and *Mertensia ciliata* (mountain bluebells), up to 20% cover each of *Micranthes odontoloma* (brook saxifrage) and *Cardamine cordifolia* (bittercress), and up to 10% cover each of *Mertensia franciscana* (bluebells), *Senecio triangularis* (arrowleaf groundsel), and *Geranium richardsonii* (Richardson geranium). Graminoid cover is minor, but can include up to 30% cover of *Calamagrostis canadensis* (bluejoint reedgrass) and up to 5% cover of *Carex aquatilis* (water sedge).

Four stands sampled in the Gunnison River Basin (94JB07, 94MD11, 94MD22, 94MD23) had significant cover (10 to 30%) of *Alnus incana*. These stands appear to represent a transition between higher elevation occurrences where *Salix drummondiana* dominates the shrub canopy and lower elevation occurrences where *Alnus incana* becomes more abundant.

Successional and Ecological Processes: The dense *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) overstory, thick *Salix drummondiana* (Drummond willow) shrub canopy, and thick forb undergrowth of this plant association indicate that it is late-seral. High forb cover suggests that with time and further upper canopy closure, this association may shift to an *Abies lasiocarpa/Mertensia ciliata* (subalpine fir/bluebells) plant association. With a more open forest canopy, shrubs such as *Alnus incana* (thinleaf alder) or *Salix drummondiana* may be present. Stands with high cover of both *Salix drummondiana* and *Alnus incana* in the understory may be transitional as *Salix drummondiana* replaces *Alnus incana* at higher elevations.

Many first- and second-order streams run through subalpine spruce-fir forests providing habitats for obligate riparian shrubs, forbs, and grasses, forming a number riparian of Abies lasiocarpa-Picea engelmannii plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is slow (200 + years) and many factors can alter its path. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community (Peet 1988). Others suggest that the two species coexist in non-equilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the overstory (Aplet *et al*. 1988). Current literature suggests that the spruce-fir forest will never become a single-species dominated “climax” forest, but rather it is a perpetually changing mosaic of patches that are of different ages and composition. In addition, the successional dynamics of the forest is a complex interaction of the life history traits of spruce and fir, local site physical characteristics, and disturbance from fire, wind-throw or insect outbreak at both large (entire stand) and small (individual trees) scales.

Picea engelmannii has the potential to outlive *Abies lasiocarpa* by as much as 200 years (Aplet *et al*. 1988), but it has a much lower rate of establishment on the forest floor (Peet 1981). As the shorter-lived *Abies lasiocarpa* begin to die, a new generation of mostly *Abies lasiocarpa* seedlings establish, perpetuating a mixed stand (Peet 1981). On mesic sites, *Picea engelmannii* is faster-growing and will overtop Abies lasiocarpa. However, Abies lasiocarpa is more successful at establishing in the shade and on organic substrates (Peet 1988).

The fire frequency of *Abies lasiocarpa* and *Picea engelmannii* in moist areas is lower than on the dry upland sites (Peet 1981), but the trees in riparian areas do burn. Following a crown fire, both *Abies lasiocarpa* and *Picea engelmannii* colonize the burned area. *Picea engelmannii* establishment is greater for the first several decades, but as the ground becomes shaded, *Abies lasiocarpa* seedlings increase in abundance (Veblen *et al*. 1991).

Wind-throw and insect attack also affect the composition and age structure of *Abies lasiocarpa* and *Picea engelmannii* stands. Fallen trees, downed by wind or left as logging debris, act as hosts to the endemic spruce beetle (*Dendroctonus rufipennis*). During population surges, the beetle infests larger areas of live trees, selectively attacking and killing individuals with diameters greater than 4 inches (10 cm) (Veblen *et al*. 1991). The dead trees remain standing for years. Instead of being replaced by new seedlings, young *Abies lasiocarpa* and *Picea engelmannii* saplings are "released" from competition and grow to fill in the canopy (Veblen *et al*. 1991).

Adjacent Riparian Vegetation: This plant association does not generally form a mosaic and is often the only riparian association along a stream reach. Adjacent riparian associations can include small stands of *Alnus incana* (thinleaf alder) or *Salix drummondiana* (Drummond willow) shrublands or *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce) forests along wider, moderate-gradient reaches.

Adjacent Upland Vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests occur on adjacent hillsides, commonly intergrading with the riparian canopy. *Populus tremuloides* (aspen) forests are also common and often intermix with the *Abies lasiocarpa-Picea engelmannii* forests. Mesic shrubs such as *Acer glabrum* (mountain maple) and *Symphoricarpos rotundifolius* (snowberry) occur on adjacent toeslopes .

Management: Forage value is high in this plant association when forb growth is abundant. However, grazing during wet periods can churn wet soil and destroy plant cover (Hansen *et al.* 1995). This riparian association is sensitive to timber harvesting activities due to high soil moisture content. It is also is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1992).

Table 10. Percent Cover of Plant Species in Stands of the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG22	95RG54	95RG56	95RG75	97EV24	97EV31	97MD13
Species name and age class/ Site Rank	A	A	A	B	B	A	A
TREES							
Abies lasiocarpa (Hook.) Nutt.--older trees	3		3		13	22	1
Abies lasiocarpa (Hook.) Nutt.--saplings	6	7	3			1	
Abies lasiocarpa (Hook.) Nutt.--seedlings	3	6	2		1	10	
Picea engelmannii Parry ex Engelm.--older trees	12	6	5	7	24	33	32
Picea engelmannii Parry ex Engelm.—saplings	1	4			2		
Picea engelmannii Parry ex Engelm.—seedlings	65	13	16	7	2	4	
Picea pungens Engelm.--older trees		5					
SHRUBS							
Cornus sericea L.					1	3	
Lonicera involucrata Banks ex Spreng.	12	1					8
Ribes montigenum McClatchie		2				7	
Salix bebbiana Sarg.							12
Salix drummondiana Barratt ex Hook.	1	16	43	33	44	36	34
Salix eriocephala Michaux var. ligulifolia				7			
Salix monticola Bebb				1		7	9
FORBS							
Arnica cordifolia Hook.			5			3	1
Cardamine cordifolia Gray		11	15		5	4	1
Conioselinum scopulorum (Gray) Coult. & Rose		7		3		12	1
Fragaria virginiana Miller	3	1	1	8	1	1	3
Geranium richardsonii Fisch. & Trautv.	5	6	3	1	4	5	1
Heracleum sphondylium L. var. montanum	1	16	4				
Mertensia ciliata (James ex Torr.) G. Don		2	2	1	1	3	14
Mitella stauropetala Piper		11	15				
Oxypolis fendleri (Gray) Heller		15	9		8	4	8
Saxifraga odontoloma Piper		4	17		1		
Senecio triangularis Hook		1	6				
Taraxacum officinale G.H. Weber ex Wiggers	1		1	5	1	1	1
Thalictrum fendleri Engelm. ex Gray	2			10		1	
HORESTAILS							
Equisetum pratense Ehrhardt	1	1	14		1	1	

Colorado Blue spruce (*Picea pungens*) Alliance

No riparian *Picea pungens* (Colorado blue spruce) plant associations were identified in the Rio Grande and Closed Basins during this study. Three stands sampled were dominated by *Picea pungens* (Colorado blue spruce), but did not match any known associations. All three stands showed signs of heavy grazing with an abundance of increaser and introduced plant species, and may represent degraded examples of known *Picea pungens* (Colorado blue spruce) plant associations. However, they will remain classified to the Alliance level only at this time. Details about these stands are provided below.

Along the Alamosa River, just above USFS Alamosa Campground at 8650 feet elevation, there is a large riparian floodplain mosaic with *Populus angustifolia-Picea pungens/Alnus incana* (narrowleaf cottonwood-Colorado blue spruce/thinleaf alder) forests, *Alnus incana*-mixed *Salix* spp (thinleaf alder-mixed willow) shrublands, and stands of *Picea pungens* (Colorado blue spruce) mixed with *Populus tremuloides* (quaking aspen) on the outer edge of the floodplain. Plot 95RG14 was in this last patch-type along the floodplain. It may represent variability with the *Populus angustifolia-Picea pungens/Alnus incana* (narrowleaf cottonwood-Colorado blue spruce/thinleaf alder) community, however, this stand has no *Populus angustifolia* (narrowleaf cottonwood) nor *Alnus incana* (thinleaf alder), at least not on the transect. The plot indicated 60% cover of *Picea pungens* (Colorado blue spruce) and about 40% cover of *Populus tremuloides* (quaking aspen) with barely 10% total shrub cover, divided among several species (Table 11). The herbaceous layer was very sparse within the plot with less than a total of 20%.

Along Clear Creek, near Santa Maria Reservoir, at 9210 feet elevation, is a stand dominated by *Picea pungens* with abundant *Ribes inerme*, a thick carpet of *Juncus balticus* (baltic rush), *Poa pratensis* (Kentucky bluegrass), *Trifolium repens* (sweet clover), and *Taraxacum officinale* (dandelion) (Table 11). *Ribes* (gooseberry) and *Juncus* (rush) are known to increase with disturbance, indicating the stand has been heavily grazed in the past. The stand may be a degraded example of the *Picea pungens/Alnus incana* (Colorado blue spruce/thinleaf alder) plant association.

Plot 97BG23 was located along the Alamosa River at Government Park (elevation 9460 feet), in what appears to be an abandoned river channel. The stand consisted of 40% *Picea pungens* with no shrubs present, and almost no herbaceous cover (Table 11). The surrounding vegetation has abundant introduced species (e.g., *Poa pratensis, Taraxacum officinale* and *Trifolium repens*) indicative of heavy grazing. The area may have been recently scoured by floods, which would account for the low herbaceous and shrub cover. It does not fit any known *Picea pungens* (Colorado blue spruce) plant associations at this time.

Table 11. Percent Cover of Plant Species in Stands of the *Picea pungens* Alliance from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG07	97BG23	95RG14
Species name and age class/ Site Rank	C	C	C
TREES			
Picea engelmannii Parry ex Engelm.—seedlings			2
Picea pungens Engelm.--older trees	34	38	63
Picea pungens Engelm.—saplings	3		10
Populus tremuloides Michx.--older trees		1	36
Pseudotsuga menziesii (Mirbel) Franco--older trees			2
SHRUBS			
Alnus incana (L.) Moench	7		
Lonicera involucrata Banks ex Spreng.			3
Pentaphylloides floribunda (Pursh) A. Love	7		2
Ribes inerme Rydb.	32		1
Rosa woodsii Lindl.			4
Salix monticola Bebb	6		6
GRAMINOIDS			
Carex disperma Dewey			3
Carex occidentalis Bailey			2
Carex sp.		1	1
Poa pratensis L.			3
Poa sp.			1
FORBS			
Achillea millefolium var. apicola (Rydb.) Garrett			1
Androsace septentrionalis L.			1
Antennaria sp.		1	
Epilobium sp.			1
Fragaria virginiana Miller			2
Geranium sp.			1
Maianthemum stellatum (L.) Link			4
Mertensia ciliata (James ex Torr.) G. Don		16	
Osmorhiza depauperata Phil.			2
Pedicularis sp.			1
Thalictrum fendleri Engelm. ex Gray			1
Unknown forb			1
Vicia sp.			1
HORESTAILS			
Equisetum pratense Ehrhardt			1

Pseudotsuga menziesii (Douglas Fir) Alliance

Douglas fir /red-osier dogwood (*Pseudotsuga menziesii / Cornus sericea*) Plant Association

CNHP Rarity Rank: G4 / S2 This is an uncommon association that occurs naturally in small patches. Less than ten stands have been documented in Colorado, and it is threatened by heavy recreational use and improper livestock grazing. However it is fairly common in Montana.

General description and Comments: The *Pseudotsuga menziesii/Cornus sericea* (Douglas-fir/red-osier dogwood) plant association is a limited riparian type in Colorado. It forms small pockets in very narrow, rocky streams and canyons where *Pseudotsuga menziesii* may also grow on the adjacent hillslopes.

Related Literature and Synonyms: Three closely related communities include the 1) *Pseudotsuga menziesii/Acer glabrum* (Douglas-fir/mountain maple) plant association (Johnston 1987) which is as an upland community and does not contain any *Cornus sericea*, 2) the *Pseudotsuga menziesii/Cornus sericea* (Douglas-fir/red-osier dogwood) Habitat Type (Hansen *et al.* 1995), which has several cottonwood species included in the overstory and 3) the conifer/*Cornus sericea* community type (Padgett *et al.* 1989) which includes *Abies lasiocarpa* (subalpine fir) as the dominant overstory species in some stands.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the San Juan National Forest (Richard *et al.* 1996), the San Miguel/Dolores (Kittel and Lederer 1993), Gunnison (Kittel *et al*. 1995), and White River Basins (Kittel *et al*. 1994).

The following information is based on: a total of five quantitative plots: one from the San Juan National Forest (217), one from the San Miguel/Dolores River Basin (91NL66), one from the Gunnison River Basin (94RR09), one from the White River Basin (92NL24) and one from the Rio Grande (97EV20) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5600-8500 ft (1700-2400 m).

Site Geomorphology: This plant association occurs in narrow valleys with variable stream gradients (5-25%) on narrow floodplains and elevated benches. Stands occur well above the stream channel bankfull height, 1-10 feet (0.16-3 m). Stream channels were classified according to Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A3).

Soil: The soils are generally well-drained and well-developed colluvial clay loams to sandy loams. Coarse fragments range from 0 to 25%. The water table is at least one meter below the surface.

Vegetation: *Pseudotsuga menziesii* (Douglas-fir) dominates the overstory with 30-60% cover. Other tree species with less than 20% cover each include *Populus angustifolia* (narrowleaf cottonwood), *Populus tremuloides* (quaking aspen), *Abies concolor* (white fir), *Acer negundo* (boxelder), and *Picea pungens* (blue spruce). *Cornus sericea* (red-osier dogwood) forms a dense shrub layer with 20-70% cover. Other shrub species include *Acer glabrum* (mountain maple) with up to 40% cover, *Quercus gambelii* (Gambel oak), *Alnus incana* (thinleaf alder) with up to 30% cover, and *Ribes* (currant) species with up to 10% cover. The ground is covered with a thick layer of duff and few herbaceous plants.

Successional and Ecological Processes: *Pseudotsuga menziesii* (Douglas-fir) is a non-obligate riparian species. This plant association is limited to narrow canyon bottoms where adjacent *Pseudotsuga menziesii* forests on north-facing slopes grade into riparian corridors. Narrow canyons with steep slopes create pockets of moist, cool air by funneling cold-air drainage and providing a microsite for *Pseudotsuga menziesii*. *Cornus sericea* (red-osier dogwood) is more abundant on level sites where water tables are periodically high (Johnston 1987). At lower elevations, Douglas-fir can occur in cool valley bottoms where it cannot survive on the valley slopes. Well drained colluvial soils also favor *Pseudotsuga menziesii* establishment.

Adjacent riparian vegetation: This association is often the only type within a narrow valley profile. Adjacent riparian areas may have *Cornus sericea* (red-osier dogwood) and *Acer glabrum* (Rocky Mountain maple) communities.

Adjacent upland vegetation: *Pseudotsuga menziesii* (Douglas-fir) and *Pinus ponderosa* (ponderosa pine) forests and *Quercus gambelii* (Gambel oak) scrub can occur on adjacent hillslopes. *Populus tremuloides* (quaking aspen) and *Pinus edulis-Juniperus* (*osteosperma* or *monosperma*) (pinyon pine-juniper) woodlands can occur on south-facing slopes.

Management: This plant association requires minimal management because the steep and rocky terrain provides intrinsic protection. However, *Cornus sericea* (red-osier dogwood) is considered to be an "ice cream" plant (e.g. it is readily eaten and is a preferred browse species) for livestock and wildlife. Browsing of this species can be high if the stands are accessible. (Hansen *et al*. 1995).

Pseudotsuga menziesii (Douglas-fir) regeneration is favored by fire which creates suitable seedbeds and eliminates competition. Mature trees are relatively fire resistant, but seedlings and saplings are vulnerable to surface fires. *Cornus sericea* (red-osier dogwood) can survive all but the most severe fires. After fire, new shoots sprout from the surviving rhizomes (Hansen *et al.* 1995).

Cornus sericea is a very effective stream bank stabilizer and should be considered for revegetating degraded sites. The rapid growth following direct seeding or transplanting allows this shrub to quickly establish on streambanks (Hansen *et al*. 1995).

The stand table for the *Pseudotsuga menziesii/Cornus sericea* plant association follows the next community description.

Douglas-fir/river birch (*Pseudotsuga menziesii/Betula occidentalis*) Plant Association

CNHP Rarity Rank: G3? / S3 This plant association is documented from Colorado and is expected to occur in Nevada and Utah. It is limited to foothill tributaries along the Colorado Front Range and is highly threatened by development, road maintenance and improvements, and heavy recreational use. The question mark in the Global rank indicates that the community is suspected to be more abundant, but additional locations have not been documented.

General Descriptions and Comments: The *Pseudotsuga menziesii/Betula occidentalis* (Douglas-fir/river birch) plant association occurs in narrow valley bottoms and steep canyons with cold-air drainage. The riparian area is narrow and dominated almost entirely by this one plant association.

Related Literature and Synonyms: One closely related community, the Conifer/*Betula occidentalis* (Manning and Padgett 1995), includes stands (in the Snake Range, Nevada) that have *Pseudotsuga menziesii* (Douglas-fir) with *Betula occidentalis* (river birch) in the understory.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997) and possibly in Nevada (Manning and Padgett 1995)

Distribution in Colorado: This plant association occurs in narrow foothill canyons of the Colorado Front Range in the upper Arkansas and South Platte River Basins (Kittel *et al.* 1996, Kittel *et al.* 1997), and in the Sangre de Cristo Mountains within the Rio Grande and Closed Basins watersheds (Colorado Natural Heritage Program 1997).

The following information is based on: a total of seven quantitative plots: three from the Arkansas River Basin (95AM07, 95AM31, 95AM50), three from the South Platte River Basin (96AM74, 96AM77, 96AM89) and one (97BG08) from the Rio Grande and Closed Basins (Colorado Natural Heritage Program 1998).

Elevation Range in Colorado: 6,600-8080 ft (2000-2500 m).

Site Geomorphology: The *Pseudotsuga menziesii/Betula occidentalis* (Douglas-fir/river birch) plant association occurs in narrow canyons with small streams and is limited to a narrow band along stream banks. Stream channels were classified according to Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow with mostly rocky beds (Rosgen's Stream Classification: A2-A3, one B3).

Soil: The soils, derived from alluvial and colluvial deposits, are fairly shallow, 60-135 inches (25- 55 cm) thick, and become skeletal with depth. Surface layers are sandy loams, clay loams, and loams. Subsurface layers are sandy loams with 10-30% cobbles and gravels. Organic matter from accumulated litter appears to be concentrated in the upper layers.

Vegetation: The upper canopy of this plant association is dominated by 20-35% cover of *Pseudotsuga menziesii* (Douglas-fir). Other trees occasionally present include 20% cover of

Populus angustifolia (narrowleaf cottonwood) and 10% cover of *Pinus ponderosa* (ponderosa pine). *Abies concolor* (white fir) and *Populus tremuloides* (quaking aspen) are abundant (>35%) in the southern-most stands in the Rio Grande and Closed Basin watershed. The shrub canopy is fairly thick and diverse with 20-40% cover of *Betula occidentalis* (river birch), 55% cover of *Alnus incana* (thinleaf alder), and 15% cover of *Acer glabrum* (mountain maple). The herbaceous undergrowth is sparse and limited by heavy shade.

Successional and Ecological Processes: The *Pseudotsuga menziesii/Betula occidentalis* (Douglas-fir/river birch) plant association appears to be in a late-seral successional stage since *Pseudotsuga menziesii* is successfully reproducing. It also appears that this association is limited to sites with strong cold-air drainage and perennial stream flow, providing a cool and moist environment to support a diverse shrub canopy. *Betula occidentalis* occupies a narrower elevational band than *Alnus incana* ssp. *tenuifolia* in Colorado. Because of its proximity to cities and suburbs, *Betula occidentalis* communities are threatened by housing developments recreational use, and water storage facilities. Stands of this plant association in the San Luis Valley are some of the least impacted and best examples in the state.

Adjacent Riparian Vegetation: In general, this is the only riparian community occurring along a narrow stream reach. Occasionally, stands of *Betula occidentalis* (river birch) or *Alnus incana* (thinleaf alder) may occur on adjacent stream benches and overflow areas.

Adjacent Upslope Vegetation: Steep colluvial slopes and canyon walls have *Pseudotsuga menziesii* (Douglas-fir) and *Pinus ponderosa* (ponderosa pine) forests or *Juniperus monosperma* (oneseeded juniper) and *Pinus edulis* (pinyon pine) woodlands mixed with patches of *Quercus gambelii* (Gambel oak).

Management: *Pseudotsuga menziesii* (Douglas-fir) regeneration is favored by fire which creates seedbeds and eliminates competition. Mature trees are relatively fire resistant, but seedlings and saplings are vulnerable to surface fires due to their thin bark and resin blisters (Hansen *et al.* 1995). The thick shrub cover and multiple vertical canopy layers of this plant association provide excellent wildlife habitat for hiding and thermal cover. Severe disturbance to this plant association may reduce the shrub cover (Hansen *et al.* 1988) and result in a more open, herbaceous understory community of introduced species (Hansen *et al*. 1995).

Table 12. Percent Cover of Plant Species in Stands of the Two *Pseudotsuga menziesii* Plant Associations and One Unclassified plot from the Rio Grande and Closed Basin Watersheds.

Plant Association	Unclassified Pseudotsuga menziesii	Pseudotsuga menziesii/ Betula occidentalis	Pseudotsuga menziesii/ Cornus sericea
Plot Number	95RG19	97BG08	97EV20
Species name and age class/ Site and Riparian Health Rank	C	A	A
TREES			
Abies concolor--mature trees		36	11
Abies lasiocarpa (Hook.) Nutt.--older trees		13	
Acer negundo var. interius L.--older trees	16		
Juniperus scopulorum Sarg.		2	2
Picea pungens Engelm.--older trees			18
Populus angustifolia James--older trees		4	
Populus tremuloides Michx.--older trees		38	17
Populus tremuloides Michx.--seedlings			2
Pseudotsuga menziesii (Mirbel) Franco--older trees	48	38	45
Pseudotsuga menziesii (Mirbel) Franco--saplings			1
Pseudotsuga menziesii (Mirbel) Franco--seedlings			1
SHRUBS			
Alnus incana (L.) Moench	27		
Amelanchier utahensis Koehne			3
Betula occidentalis Hooker		86	
Cornus sericea L.			51
Holodiscus dumosus (Nutt. ex Hook.) Heller	6		4
Jamesia americana Torrey.		2	
Physocarpus monogynus (Torrey) Coulter			14
Prunus virginiana L. var. melanocarp (A. Nels.) Sarg.			16
Ribes inerme Rydb.	3		
Ribes montigenum McClatchie			3
Rosa woodsii Lindl.			9
GRAMINOIDS			
Poa pratensis L.	4		
Poa sp.	2		
FORBS			
Achillea millefolium var. apicola (Rydb.) Garrett	3		
Fragaria virginiana Miller	2		
Geranium richardsonii Fisch. & Trautv.	10		
Mertensia ciliata (James ex Torr.) G. Don	6		
Pseudocymopterus montanus (Gray) Coult. & Rose	5		
Rubus idaeus L.	3		
Urtica dioica ssp. gracilis (Ait.) Seland.	3		
Veronica sp.	6		
HORESTAILS			
Equisetum pratense Ehrhardt	1		

USNVC:	II. C. 3. B. Seasonally Flooded/Saturated Mixed Needle-leaved Evergreen-Cold Deciduous Open Tree Canopy
COWARDIN:	Palustrine
CDOW GAP MAP:	61001 Forest Dominated Wetland/Riparian Type d. Mountain Mixed Riparian

Abies concolor Seasonally Flooded Forest Alliance

White fir-Colorado blue spruce-narrowleaf cottonwood/Rocky Mountain Maple (*Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum*) Plant Association

CNHP Rarity Rank: G2 / S2 This community is known only from south-central Colorado. It may occur in northern New Mexico. Additional inventory is needed. It is known from less than 10 stands, and no more than 15 are expected to occur in the state. It is threatened by improper livestock grazing, heavy recreational use and stream flow alterations.

General Description and Comments: The *Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum* (white fir-Colorado blue spruce-narrowleaf cottonwood/Rocky Mountain maple) plant association is a multi-layered, mixed conifer-deciduous forest occurring on active floodplains and stream banks of montane valley floors. The presence of *Abies concolor* distinguishes this community from the more common *Populus angustifolia-Picea pungens/Alnus incana* (narrowleaf cottonwood-Colorado blue spruce/thinleaf alder) plant association, and is indicative of the southern-most mountains of Colorado

Recognition and Classification Problems: Stands sampled in the Sangre de Cristo Mountains did not have any *Picea pungens* (Colorado blue spruce) present (Table 13). However, they are very similar in all other respects to what Baker (1989) described from the same area. Further research from the Sangre de Cristo and San Juan Mountains may reveal two distinct plant associations. For now, with only two samples, the authors are more comfortable using Baker's published name than proposing a new type.

Related Literature and Synonyms: Baker (1989) first described this community from the San Juan Mountains and notes that northern New Mexico may have similar stands, citing DeVelice *et al.* (1986). Colorado stands that have an *Abies concolor* component were previously included in the *Populus angustifolia-Picea pungens/Alnus incana* plant association, and the two associations were thought to be synonymous (Kittel *et al.* 1994, 1995, and 1996). Current research (1995 and 1997) indicates a distinct regional variation, resulting in the "resurrection" of Baker's association (*Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum*) in the Colorado classification.

Similar Communities: A closely related type, the *Abies lasiocarpa-Picea engelmannii-Populus angustifolia/ Lonicera involucrata* plant association (Baker 1989, Richard 1996) lacks *Abies concolor* and *Picea pungens.*

Regional Distribution: This plant association is currently known only from southern Colorado (Baker 1989, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is known only from the San Juan and San de Cristo Mountains of south-central Colorado (Colorado Natural Heritage Program 1997).

The following information is based on: a total of nine quantitative plots from the Upper San Juan River (93C012, 93C322, 93C571, 94DR20, 94MS57, 95CR50, 95CR58) and Closed Basins (97BG17, 97GK27) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7400-8700 ft. (2300-2700 m).

Site Geomorphology: This community is located on narrow to moderately wide valleys, 50-300 ft. (17-100 m) on immediate stream banks, floodplains and upper terraces, 1-6.5 feet (0.3-2.0 m), above the channel high-water level with an average of 1.5 ft. (0.35m). Stream channels were classified according to Rosgen Classification of Natural Rivers (Rosgen 1996). Streams are steep (2-6%, average 4% gradient) (Rosgen Channel Types: A3, A5, B2, B3, B4, B5).

Soils: The soils are well drained and poorly developed Entisols with shallow sandy loams over coarse alluvial materials.

Vegetation: A thick canopy of *Populus angustifolia* (narrowleaf cottonwood) and *Abies concolor* (white fir) dominates this community with 60-80% cover. Other conifers present include *Pseudotsuga menziesii* (Douglas-fir) and *Juniperus scopulorum*, (Rocky Mountain juniper). Shrubs are densest near the stream channel with 20-50% *Alnus incana* (thinleaf alder), 10-20% *Betula occidentalis* (river birch), 10-50% *Acer glabrum* and 10% *Rosa woodsii* (rose). The herbaceous undergrowth is sparse with a total cover of less than 5%. Common species include scattered *Equisetum arvense* (horsetail) and *Pyrola rotundifolia* (swamp wintergreen).

Successional and Ecological Processes: The *Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum* plant association is a mid- to late-seral community. High elevations and cool, shaded canyon bottoms create an environment for *Abies concolor* (white fir) and *Picea engelmannii* (Engelmann spruce). The active channel flooding and sediment deposition along the reach allows *Populus angustifolia* (narrowleaf cottonwood) to perpetuate. On higher terraces that no longer experience flooding, *Abies* and *Picea* may become the climax tree species.

Some authors suggest mixed riparian stands will eventually become dominated by conifer species (see Padgett *et al.* 1989, Hansen *et al.* 1995). In Colorado, observations indicate that with continued fluvial processes, cottonwoods will continue to persist on the stream banks and floodplains. The presence of conifer species on an active floodplain is not necessarily an indication of future "climax" dominance.

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 a little bit more 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, including beaver, or livestock, 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.

Adjacent Riparian Vegetation: This community can dominate the reach, however smaller patches of *Alnus incana* (thinleaf alder) and *Salix* spp. (willow) shrublands or meadows of *Carex* spp. (sedges) or forbs were located within the immediate area.

Adjacent Upland Vegetation: Side canyon slopes are generally dominated by *Pinus ponderosa* (ponderosa pine) or *Pinus edulis* (pinyon pine) at lower elevations and *Populus tremuloides* (quaking aspen), *Abies concolor* (white fir) and *Pseudotsuga menziesii* (Douglas-fir) at higher elevations.

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 would allow 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 can be high and very palatable to livestock. Cottonwood seedlings and saplings and the associated shrub species 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. This plant association also provides excellent hiding and thermal cover for mammals and birds (Hansen *et al.* 1995).

Table 13. Percent Cover of Plant Species in Stands of the *Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97BG17	97GK27
Species name and age class/ Site Rank	B	A
TREES		
Abies concolor--mature trees	66	50
Populus angustifolia James--older trees	29	50
Pseudotsuga menziesii (Mirbel) Franco--older trees		20
SHRUBS		
Acer glabrum Torr.	62	50
Alnus incana (L.) Moench		50
Betula occidentalis Hooker		10
Ribes sp.	5	
Rosa woodsii Lindl.	1	10
Symphoricarpos sp.	7	
VINES		
Clematis ligusticifolia Nuttall.	1	
GRAMINOIDS		
Bromus hordeaceus L.	2	1
Carex sp.		1
FORBS		
Ambrosia sp.	1	
Epilobium ciliatum Rafinesque	6	
Maianthemum stellatum (L.) Link		1
Orthilia secunda (L.) House		1
Pyrola asarifolia ssp. asarifolia Michaux		1
HORSETAILS		
Equisetum arvense L.		1

Narrowleaf cottonwood (*Populus angustifolia*) Temporarily Flooded Woodland Alliance

Narrowleaf cottonwood-Colorado blue spruce/thinleaf alder (*Populus angustifolia-Picea pungens/Alnus incana*) Plant Association

CNHP Rarity Rank: G3 / S3-- This is an abundant community in Colorado and is likely to occur in other Rocky Mountain states. This is a common community of montane valleys. Few pristine examples are known, and it is highly threatened by improper livestock grazing, heavy recreational use, and stream flow alterations.

General Description and Comments: This is a common mixed deciduous-evergreen plant association with *Populus angustifolia* (narrowleaf cottonwood) and *Picea pungens* (Colorado blue spruce) co-dominant along a stream reach. Frequently, other conifer trees are present, but not as abundant as *Picea pungens* (Colorado blue spruce). The shrub understory is typically dense and diverse. *Alnus incana* is always present. (Note that plots 95RG02 and 95RG16 don't have *Alnus incana* in Table 14. This in an example of a case where the shrub was present, but not caught on the vegetation transect).

Recognition and Classification Problems: Both *Populus angustifolia* dominated and mixed *Populus angustifolia*-confer plant associations occur in this classification. The criteria for identifying the *Populus angustifolia-Picea pungens* plant association is that *Picea pungens* or *Picea engelmannii* or *Abies concolor* or some combination) have at least half as much cover as *Populus angustifolia* across the entire stand. More often than not, the *Populus angustifolia* can be twice as abundant as the *Picea pungens* (or *Picea engelmannii*). Most of the stands sampled in Colorado had abundant *Picea pungens*, however, in the southern part of the state, in the San Juan Mountains, *Picea engelmannii* and *Abies concolor* appear to be replacing *Picea pungens*, at least at higher elevations (Table 14). With more research, these stands may become they're own type.

Related Literature and Synonyms: In the Colorado literature, the following five names are synonymous with the Colorado *Populus angustifolia-Picea pungens/Alnus incana* (narrowleaf cottonwood-Colorado blue spruce/thinleaf alder) plant association: *Populus angustifolia-(Picea pungens)/Alnus incana* ssp. *tenuifolia-Cornus sericea* (narrowleaf cottonwood-Colorado blue spruce/thinleaf alder-red-osier dogwood) association (Baker 1989, Kittel and Lederer 1993, Richard *et al*. 1996), *Populus angustifolia-Picea pungens/Alnus incana* ssp. *tenuifolia-Lonicera involucrata* (narrowleaf cottonwood-Colorado blue spruce/thinleaf alder-honeysuckle) association (Baker 1989, Kittel and Lederer 1993), *Populus angustifolia-Picea pungens/Lonicera involucrata* (narrowleaf cottonwood-Colorado blue spruce/honeysuckle) association (Richard *et al*. 1996), *Populus angustifolia-Picea pungens/*bare ground association (Richard *et al*. 1996) and *Populus angustifolia-Picea pungens/Alnus incana* association (Baker 1986, Baker 1989, Kittel *et al*. 1994, Kittel *et al*. 1995).

Similar Communities: Closely related communities are described from Montana, Wyoming, New Mexico and Utah. The related communities are dominated by conifers such as *Pinus contorta*, *Abies lasiocarpa*, *Picea engelmannii*, and *Picea pungens*, and are not synonymous with the Colorado *Populus angustifolia-Picea pungens/Alnus incana* plant association. However, some of the stands within these communities contain a significant cover of *Populus angustifolia* and *Alnus incana* and could be included in the Colorado *Populus angustifolia-Picea pungens/Alnus incana* plant association. These closely related communities are: *Picea/Cornus stolonifera* Habitat Type (Hansen *et al.* 1995), *Picea pungens/Alnus incana* ssp. *tenuifolia* plant association (Johnston 1987), Conifer/*Cornus sericea*, Conifer/*Equisetum arvense* and Conifer/*Actaea rubra* (Padgett *et al.* 1989).

Regional Distribution: This plant association has not been reported outside Colorado. Closely related communities occur in Montana (Hansen *et al.* 1995), Wyoming, New Mexico (Johnston 1987) and Utah (Padgett *et al.* 1989).

Distribution in Colorado: This plant association occurs in the Yampa, White, Colorado, Gunnison, and San Miguel River Basins and the Uncompahgre and San Juan National Forests (Johnston 1987, Hess and Wasser 1982, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Komarkova 1986, and Richard *et al*. 1996). It is also likely to occur along the Colorado Front Range.

The following information is based on: a total of sixty-five quantitative plots: seven from the Yampa River Basin (31, 32, 69, 104, 113, GK06, GK07), three from the White River Basin (92NL14, 92NL15, 92NL38), one from the Colorado River Basin (93GK50), ten from the Gunnison River Basin (94GK43, 94GK44, 94GK45, 94GK46, 94JB08, 94JB11, 94JB50, 94MD04, 94MD09, 94RR54), nineteen from the San Miguel/Dolores River Basin (7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 36, 37, 46, 47, 82, EO#1, EO#3, EO#5, EO#10), seventeen from the San Juan National Forest (6, 25, 29, 49, 63, 68, 120, 155, 180, 211, 214, 219, 225, 226, 261, 270, 274), and eight from the Rio Grande Basin (95RG02, 95RG10, 95RG16, 95RG33, 97EV27, 97GK03, 97GK32, 97MD28) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7300-9000 ft. (2200-2700 m).

Site Geomorphology: This association occurs in valleys with narrow to moderately wide floodplains, 30-430 feet (10-130 m), and in deep canyons. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This association is commonly found on slightly meandering to meandering floodplains of broad reaches (Rosgen's Channel Type: B2-B5, C2-C4). Occasionally, stands occur along steep reaches (Rosgen's Channel Type: A2, A3).

Soil: Soils range from shallow sandy loams to silty clay loams and clays over cobbles and boulders. Profiles are generally highly stratified, with layers of fine soils over layers of coarser sediments. In the White and Colorado River Basins, the soils classify as loamy-skeletal, calcareous aquic typic Cryochrepts. It establishes on narrow terraces, benches, and cobble bars adjacent to the channel.

Vegetation: The overstory is dominated by 20-95% cover of *Populus angustifolia* (narrowleaf cottonwood) and up to 80% cover of *Picea pungens* (Colorado blue spruce). The flooding history and time since the last flood can influence the relative abundance of these two species. At lower elevations, *Pseudotsuga menziesii* (Douglas-fir) may also be present with up to 35% cover.

In the San Juan mountains, *Abies lasiocarpa* (subalpine fir), *Picea engelmannii* (Engelmann spruce), and *Abies concolor* (white fir) can replace *Picea pungens* (Colorado blue spruce) at higher elevations (see plots 95RG10, 97RG27, and 97EV27 in Table 14). Stands with the above conifers have been classified as the *Abies lasiocarpa-Picea engelmannii-Populus angustifolia/ Lonicera involucrata* plant association.

The dense shrub layer consists of up to 95% cover of *Cornus sericea* (red-osier dogwood), up to 70% cover of *Alnus incana* (thinleaf alder), up to 30% cover of *Amelanchier* spp. (serviceberry), and up to 20% cover each of *Acer glabrum* (mountain maple) and *Lonicera involucrata* (honeysuckle). A variety of *Salix* (willow) species may be present with <50% cover. A few stands (plot SJ-25 in the San Juan watershed and plots 95RG02 and 95RG16, Table 14) had no alder present, and up to 25% *Symphoricarpos* sp. (snowberry) in plot SJ-25 and may represent a drier variation of this community, or severely disturbed examples. While the shrub species present can be variable, the overstory mix of *Picea pungens* and *Populus angustifolia* is the best indicator of this community (some exceptions exist, see comments in the Recognition and Classification Problems section, above).

The undergrowth is diverse yet sparse, rarely with more than 30% total cover. Common forb species include *Actaea rubra* (baneberry), *Osmorhiza depauperata* (blunt-fruit sweet-cicely), *Maianthemum stellatum* (false Solomon seal), *Geranium richardsonii* (Richardson geranium), *Mertensia ciliata* (mountain bluebell), and *Fragaria virginiana* (mountain strawberry). Graminoid cover is minor (Table 14).

Successional and Ecological Processes: This mixed deciduous-evergreen plant association is a mid-seral community. With continued fluvial activity, such as flooding, channel migration, sediment deposition, and scouring, narrowleaf cottonwood and blue spruce will continue to co-occur along the reach. Gradual and slightly sinuous stream channels that have overbank flow and sediment deposition favor establishment of *Populus angustifolia*. *Picea pungens* is favored along reaches in deep valleys with steep canyon walls that provide conditions for strong cold-air drainage. If the floodplain is no longer active, *i.e.,* is no longer flooded because the stream channel has become lower (surface becomes a terrace) or upstream dams control floods, then cottonwoods will eventually die and the conifers may persist.

Some authors suggest mixed riparian stands will eventually become dominated by conifer species (see Padgett *et al.* 1989, Hansen *et al.* 1995). In Colorado, observations indicate that with continued fluvial processes, cottonwoods will continue to persist on the stream banks and floodplain. The presence of conifer species on an active floodplain is not necessarily an indication of future “climax” dominance.

Adjacent riparian vegetation: The adjacent riparian vegetation depends on the width and complexity of the riparian area. In narrow canyons, *Populus angustifolia* may drop out, leaving a *Picea pungens/Alnus incana* (Colorado blue spruce/thinleaf alder) stands. *Alnus incana* and mixed *Alnus incana-Cornus sericea* (thinleaf alder-red-osier dogwood) or *Alnus incana-Salix drummondiana* (thinleaf alder-Drummond willow) shrublands occur adjacent to the floodplain forest on steep-sided banks. *Salix* (willow) species shrublands occur in low, open areas, on point bars, overflow channels, and islands.

Adjacent upland vegetation: At lower elevations, mixed coniferous forests including *Pseudotsuga menziesii* (Douglas-fir), *Pinus ponderosa* (ponderosa pine), *Abies concolor* (white fir), or *Picea pungens* (Colorado blue spruce) occur on adjacent hill slopes. *Pinus edulis-Juniperus monosperma* (pinyon pine-Rocky Mountain juniper) and *Populus tremuloides* (quaking aspen) woodlands, *Quercus gambelii* (Gambel oak) scrub, and *Amelanchier alnifolia* (serviceberry) shrublands also occur. At higher elevations, *Picea engelmannii-Abies lasiocarpa* (Engelmann spruce-subalpine fir) forests occur on adjacent hill slopes.

Management: Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alterations 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 would allow 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 can be high and very palatable to livestock. Cottonwood seedlings and saplings and the associated shrub species 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. This plant association also provides excellent hiding and thermal cover for mammals and birds (Hansen *et al* 1995).

Table 14. Percent Cover of Plant Species in Stands of the *Populus angustifolia-Picea pungens/Alnus incana* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG10	95RG33	97EV27	97GK03	97GK32	97RG27	95RG02	95RG16
Species name/Site and Riparian Rank	A	B	B	B	B	C	C	C
TREES								
Abies concolor—older trees			4	6				
Picea engelmannii Parry ex Engelm.--older trees	7					3		
Picea engelmannii Parry ex Engelm.--saplings	3					9		
Picea engelmannii Parry ex Engelm.--seedlings	37					2		
Picea pungens Engelm.--older trees	*	29	5*	15	14	*	74	25
Picea pungens Engelm.—saplings					12		2	
Picea pungens Engelm.—seedlings				3	2	2		
Populus angustifolia James—older trees	48	45	69	60	60	30	35	72
Populus angustifolia James—saplings		3						
Populus angustifolia James—seedlings		2						
Pseudotsuga menziesii (Mirbel) Franco-- trees		18						
Pseudotsuga menziesii ---saplings		3						
SHRUBS								
Alnus incana (L.) Moench	10	27	52	8	6	1	**	**
Cornus sericea L.			2		7			
Holodiscus dumosus (Nutt. ex Hook.) Heller		6						
Lonicera involucrata Banks ex Spreng.				1				1
Ribes inerme Rydb.	1				1			1
Salix bebbiana Sarg.		1		3				
Salix drummondiana Barratt ex Hook.					1			3
Salix lucida ssp. caudata (Nutt.) E. Murr.					1			5
Salix monticola Bebb								5
GRAMINOIDS								
Calamagrostis canadensis (Michx.) Beauv.				1	5			
Poa pratensis L.					12	8		16
FORBS								
Achillea millefolium var. apicola(Rydb)Garrett	2		2	1	1	3		2
Actaea rubra (Ait.) Willd.				4	4			
Erigeron sp.	1	1				20		18
Fragaria virginiana Miller		2	1	1	1			2
Geranium richardsonii Fisch. & Trautv.			2	2	10	6		9
Maianthemum racemosum				3	1			
Maianthemum stellatum (L.) Link	3			3	1	1	3	2
Senecio sp.								6
Taraxacum officinale G.H. Weber ex Wiggers		2	2	1	2	16	1	4
HORESTAILS								
Equisetum pratense Ehrhardt	1				5	1	1	1

** See comments in Recognition and Classification Problems section, above.
* See comments in Vegetation section, above.

Narrow-leaf cottonwood-Rocky Mountain juniper (*Populus angustifolia-Juniperus scopulorum*) Plant Association

CNHP Rarity Rank: G2G3 / S2-- This is an uncommon association limited to desert riparian areas. It is known only from foothill streams of Wyoming, Colorado and New Mexico. This association is uncommon in Colorado. Stands along the Colorado river appear to be decadent. Only one large, viable occurrence has been documented and it is threatened by improper livestock grazing and ground water development. The double Global rank indicates that the known abundance is between a G2 and a G3.

General Description and Comments: *Populus angustifolia* (narrowleaf cottonwood) and *Juniperus scopulorum* (Rocky Mountain juniper) dominated riparian areas are uncommon. The community occurs along lower foothill streams with perennial to intermittent stream flows. Total biomass and canopy cover is usually low. The association is characterized by an open canopy of *Populus angustifolia* (narrowleaf cottonwood) and *Juniperus scopulorum* (Rocky Mountain juniper), often with little else growing in the understory. The species composition and percent cover is variable and depends on aspect, elevation, and stream flow, in addition to the degree of disturbance by recreational use and livestock grazing.

Related Literature and Synonyms: Two plant associations are synonymous with the Colorado *Populus angustifolia-Juniperus scopulorum* plant association: the *Populus angustifolia/Physocarpus monogynus-Padus virginiana* (narrowleaf cottonwood/mountain ninebark-chokecherry) plant association (Gerard *et al.* 1995) and the *Populus angustifolia-Juniperus scopulorum* community type (Durkin *et al*. 1995).

Similar Communities: Four communities are closely related to, but are not synonymous with, the Colorado *Populus angustifolia-Juniperus scopulorum* plant association. These communities have *Populus angustifolia* and *Juniperus scopulorum* in the name or descriptions, but have additional tree species not present in the Colorado association. These closely related communities include: *Populus angustifolia/Amelanchier alnifolia* (narrowleaf cottonwood/serviceberry) plant association (Johnston 1987), where *Juniperus scopulorum* is co-dominant, but *Pseudotsuga menziesii* (Douglas-fir), *Picea pungens* (Colorado blue spruce) and *Acer negundo* (boxelder) are present as well; *Populus angustifolia/Poa pratensis* (narrowleaf cottonwood/Kentucky blue grass) plant association (Cooper and Cottrell 1990) includes *Juniperus scopulorum*, but with only up to 10% canopy cover; and *Juniperus scopulorum* Dominance Type and *Juniperus scopulorum/Cornus sericea* (Rocky Mountain juniper/red-osier dogwood) Habitat Type (Hansen *et al.* 1988, Hansen *et al.* 1995), where *Populus angustifolia* is present but dying out and may indicate later successional stages of the *Populus angustifolia-Juniperus scopulorum* plant association.

Regional Distribution: The *Populus angustifolia-Juniperus scopulorum* plant association is known from Wyoming (Gerard *et al*. 1995) New Mexico (Durkin *et al*. 1995), and Colorado (Johnston 1987, Cooper and Cottrell 1990, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs at lower elevations in the White River National Forest, in the Colorado River and Closed Basins, and along narrow foothill streams of the Front Range (Cooper and Cottrell 1990, Johnston 1987, Kittel *et al.* 1994, Kittel *et al.* 1996, Colorado Natural Heritage Program 1997).

The following information is based on: a total of sixteen quantitative plots: ten from the upper Arkansas River Basin (95AM14, 95AM22, 95AM52, 95AM56, 95AM60, 95AM61, 95AM62, 95RR01, 95RR14, 95RR28), four from the Closed Basin (97BG02, 97BG07, 97GK04, 97GK07), and two from the Colorado River Basin (93RR39, 93RR48) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6000-8600 ft. (1800-2600 m).

Site Geomorphology: This plant association occurs along stream banks of narrow ephemeral washes and creeks in steep-sided canyons. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow with rocky to sandy bottoms (Rosgen Channel Type: A1-A5). This association can also occur on upper terraces and elevated islands of wide, meandering river reaches such as those found along the Arkansas and Colorado Rivers (Rosgen Channel Type: B4-B5 C3, C4). Valley widths are typically 700 feet (200 m) or less and stream gradients are generally low to moderate (0.5-2.5%). *Juniperus scopulorum* is situated at the high water line and above, while the *Populus angustifolia* grades into the active floodplain area.

Soil: Soils of this plant association are derived from alluvial deposits. The surface soils consist of loamy sand, clay loams, silty clays or organic matter. Subsurface layers range from sandy loams and loamy sands to clay loams and sandy clay loams with 20-50% gravel and cobbles. Soil depth ranges from 15-25 inches (40 to 65 cm). In the Colorado River Basin, the soils classify as sandy-coarse loam, calcareous Camborthids and loamy-clay, calcareous typic Cryothents.

Vegetation: This plant association is characterized by an open to closed canopy of 20-100% cover of *Populus angustifolia* (narrowleaf cottonwood) and scattered to abundant *Juniperus scopulorum* (Rocky Mountain juniper) with 5-85% cover. Typically there is no shrub canopy and little to no herbaceous undergrowth due to dry conditions. However, stream banks with cool, northern aspects can have up to 15% cover of *Pseudotsuga menziesii* (Douglas-fir) and a diversity of shrubs including up to 25% cover each of *Acer glabrum* (Rocky Mountain maple) and *Quercus gambelii* (Gambel oak), *Clematis ligusticifolia* (white virgin's bower) with up to 30%, and up to 5% cover of *Rhus trilobata* (skunkbrush). *Poa pratensis* (Kentucky blue grass) can be present in the undergrowth with up to 30% cover.

Successional and Ecological Processes: Cottonwood woodlands grow within an alluvial environment that is continually changing 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 well documented. Periodic flooding events can leave sandbars of bare, mineral substrate. Cottonwood seedlings germinate and become established on newly-deposited, moist sandbars. In the absence of large floods in subsequent years, seedlings begin to trap sediment. In time, the sediment accumulates and the sandbar rises. The young forest community is then above the annual flood zone of the river channel.

In this newly elevated position, with an absence of excessive browsing, fire, and agricultural conversion, this cottonwood community can grow into a mature riparian forest. At the same time, the river channel continually erodes stream banks and creates 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 or tree species that may comprise the climax plant association for that area.

In Colorado, *Juniperus scopulorum* (Rocky Mountain juniper) appears to be successfully reproducing in stands of the *Populus angustifolia-Juniperus scopulorum* plant association. In Montana, stands of mixed *Populus* spp. and *Juniperus scopulorum* are considered to be early successional communities that will eventually become *Juniperus scopulorum/Cornus sericea* (Rocky Mountain juniper/red-osier dogwood) habitat types (Hansen *et al.* 1995).

Adjacent Riparian Vegetation: This plant association is often the only riparian community along a stream reach. However, *Eleocharis palustris* (creeping spikerush) wetlands or *Carex* (sedge) species meadows can occur in mesic swales. Stands of *Salix exigua* (coyote willow) can occur along adjacent perennial stream channels.

Adjacent Upslope Vegetation: Woodlands of *Pinus edulis* (pinyon pine) and *Juniperus monosperma* (one-seed juniper) occur on dry, south-facing hill slopes. Stands of *Pseudotsuga menziesii* (Douglas-fir) and *Quercus gambelii* (Gambel oak) occur on north-facing slopes. *Artemisia tridentata* (big sagebrush) shrublands also occur on the upslopes.

Management: Because the regeneration and establishment of new stands of cottonwood is dependent upon flooding events, any alterations 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 would allow 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 low to moderate. Cottonwood seedlings and saplings are frequently browsed by cattle, but *Juniperus scopulorum* (Rocky Mountain juniper) is not palatable. Some stands of *Populus angustifolia-Juniperus scopulorum* in Colorado may be grazing induced according to David Cooper (*pers. comm.,* 1999) as cattle will browse the young cottonwoods, allowing *Juniperus scopulorum* to gain a better foot hold in the community. However this was not observed by the authors. 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. This plant association also provides excellent hiding and thermal cover for mammals and birds. *Juniperus scopulorum* berries are a good food source for small mammals and birds (Hansen *et al* 1995).

Fire potential is low to moderate for *Juniperus scopulorum.* Young trees are easily killed by fire, but older trees are more resistant due to their thicker bark. Extremely hot fires can damage older trees (Hansen *et al.* 1995).

Table 15. Percent Cover of Plant Species in Stands of the *Populus angustifolia-Juniperus scopulorum* Plant Association and One Unclassified plot from the Rio Grande and Closed Basin Watersheds.

Plot Number	97BG07	97GK04	97GK07	97BG02
Species name and age class/ Site and Riparian Health Rank	B		B	A
TREES				
Juniperus scopulorum Sarg.	10	8	6	46
Pinus edulis Engelm.		1		
Pinus ponderosa P. & C. Lawson--older trees	6			
Populus angustifolia James--older trees	38	81	96	28
Populus angustifolia James--saplings			1	
Populus tremuloides Michx.--older trees				
SHRUBS				
Acer glabrum Torr.				10
Chrysothamnus nauseosus (Pallas) Britton		2		
Juniperus communis L.		2		
Quercus gambelii Nutt.				22
Rhus trilobata Nuttall ex Torrey & Gray var. trilobata				1
Ribes cereum Dougl.		1		
Ribes montigenum McClatchie			26	
GRAMINOIDS				
Bouteloua gracilis (H.B.K.) Lag.		3		
Festuca idahoensis Elmer		6		
Oryzopsis hymenoides (Roemer & Schultes) Ricker	1			
Pascopyron smithii (Rydb.) A. Love	1	1		
Poa compressa L.	1			
Poa fendleriana (Steudel) Vasey		4		
Poa palustris L.		1		
Poa pratensis L.			14	
FORBS				
Achillea millefolium var. apicola (Rydb.) Garrett		1	1	
Artemesia frigida		1		
Brickellia grandiflora (Hooker) Nuttal	1			
Fragaria virginiana Miller			1	
Galium boreale L.			1	
Geranium richardsonii Fisch. & Trautv.			1	
Geum macrophyllum			1	
Hacklea floribunda			1	
Heterotheca villosa (Pursh.)	1	1		
Maianthemum stellatum (L.) Link			1	10
Opuntia polyacantha Haworth	1			
Puccinellia nuttalliana	3			
Streptopus amplexifolius var. chalazatus Fassett	1			
Thermopsis divaricarpa Nelson			7	

USNVC:	II. B. 2. b. Seasonally/Temporarily Flooded Cold-Deciduous Open Tree Canopy
COWARDIN:	**Palustrine**
CDOW GAP: 61001 Forest Dominated Wetland/Riparian Type	
	b. Mountain Deciduous Riparian

Populus angustifolia (narrowleaf cottonwood) Alliance

Narrowleaf cottonwood/thin-leaf alder (*Populus angustifolia/Alnus incana* ssp. *tenuifolia*) Plant Association

CNHP Rarity Rank: G3? / S3 --This association is known from New Mexico and Colorado. Although not well documented from other states, it is expected to occur throughout the range of *Populus angustifolia* in the Rocky Mountains. In Colorado, it is a common community along montane streams, but few high quality examples exist. This association is threatened by improper livestock grazing, development and stream flow alterations. The question mark in the Global Rank indicates the community is probably more abundant, but new locations have not been documented.

General Description and Comments: The *Populus angustifolia/Alnus incana* ssp. *tenuifolia* (narrowleaf cottonwood/thinleaf alder) plant association is characterized by a dense stand of *Alnus incana* lining the stream bank and an open to nearly closed canopy of *Populus angustifolia*. Other shrubs may occur but *Alnus* (thinleaf alder) has at least 10-20% cover and is the most abundant of all other shrubs within the stand. It occurs along narrow, fast-moving stream reaches in montane areas.

Recognition and Classification Problems: If conifers are present, the stand may belong to a mixed *Populus angustifolia* – Conifer plant association. Conifer canopy must comprise 10% or at least half that of the *Populus angustifolia* canopy cover. For example, a stand with 30% *Populus angustifolia* and 15% *Picea pungens* would fall into a *Populus angustifolia-Picea pungens* plant association. Conversely, in conifer dominated stands, the *Populus angustifolia* must have at least 10% cover or half that of the conifer cover to be considered a “mixed” plant association.

Similar Communities: The *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) plant association can have abundant *Alnus incana* (thinleaf alder) as well, but the presence and abundance of *Cornus sericea* (red-osier dogwood) distinguishes the two associations. If the two shrubs are in equal or near equal abundance, and *Cornus sericea* is greater than 10%, the stand would fall in to *the Populus angustifolia/Cornus sericea* plant association

Related Literature and Synonyms: The *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) community type described from New Mexico (Durkin *et al.* 1994) is synonymous with the Colorado *Populus angustifolia/Alnus incana* plant association. The *Populus angustifolia/Alnus incana* type described by Walford (1993) is not synonymous with the Colorado association of the same name. Walford’s association appears to be more closely aligned with the *Populus angustifolia/Salix exigua* (narrowleaf cottonwood/ coyote willow) plant association as it occurs on point bars and consists of mostly young trees.

Regional Distribution: This plant association occurs in New Mexico (Durkin *et al.* 1994) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs on the Western Slope in the Yampa, Gunnison, and San Miguel River Basins, on the San Juan and Rio Grande National Forests (Kittel *et al.* 1993, Kittel *et al.* 1994, Colorado Natural Heritage Program 1997, Richard *et al*. 1996), and along the Colorado Front Range in the Arkansas and South Platte River Basins (Kittel *et al.* 1996, Kittel *et al.* 1997).

The following information is based on: a total of thirty-six quantitative plots: four from the Yampa River Basin (66, 74, 77, 81), six from the Gunnison River Basin (94JB09, 94MD20, 94MD21, 94RR13, 94RR23, 94RR50), ten from the San Juan National Forest (5, 7, 26, 118, 160, 258, 268, 269, 271, 272), eight from the Rio Grande Basin (95RG28, 95RG40, 97BG11, 97EV21, 97EV25, 97GK09, 97MD06, 97MD17), four from the Arkansas River Basin (95AM11, 95AM46, 95AM51, 95RR03), four from the South Platte River Basin (96LS25, 96GK48, 96AM17, 96AM19)(Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6200-9300 ft. (1900-2800 m).

Site Geomorphology: 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 widths are highly variable. Stream channels are classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). 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 (Rosgen's Channel Type: B2-B5), low gradient, highly sinuous reaches (Rosgen's Channel Type: C3, C4), or very narrow and highly sinuous stream sections (E5, E6).

Soils: Soils are mostly coarse textured ranging from deep sands to shallow sandy loams. Some profiles show stratification with loams to clay loams alternating with sands. Most profiles become skeletal at an average depth of 12 inches (30 cm). In the San Luis valley, stands have primarily sandy clay loam to about 30 to 56 cm, becoming increasingly skeletal with depth.

Vegetation: This plant association has an open to dense canopy of up to 80% cover of *Populus angustifolia* (narrowleaf cottonwood). *Abies concolor* (white fir), *Pseudotsuga menziesii* (Douglas fir), or *Picea pungens* (Colorado blue spruce) may occasionally co-dominate the overstory with <10% cover. A few stands (e.g. 97RG40 and 97MD28) include a small amount of *Picea engelmannii* (Engelmann spruce) trees (mature and sapling-sized individuals).

The shrub understory is dominated by a dense band of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) lining the stream bank. A variety of other shrubs may be present, intermingling with the alder and ranging in cover from 1 to 40%, but always less than the total alder cover. Other shrub species include: *Salix bebbiana* (Bebb willow), *Salix monticola* (mountain willow), *Salix* *drummondiana* (Drummond willow), *Salix eriocephala* var. *ligulifolia* (strapleaf willow), *Salix lucida* var. *caudata* (whiplash willow), *Salix exigua* (coyote willow), *Cornus sericea* (red-osier dogwood), *Rosa woodsii* (woods rose), *Acer glabrum* (Rocky Mountain maple), and *Betula occidentalis* (river birch). The herbaceous undergrowth is generally sparse due to the dense overstory.

Successional and Ecological Processes: The *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) 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 (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 a little bit more 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). After 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* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Alnus incana (thinleaf alder) 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, Bowman and Steltzer *in press*). Nitrogen rich alder detritus speeds soil development and bank stability. It also provides an important source of nutrients for aquatic invertebrates.

Adjacent riparian vegetation: In narrow canyons, the *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) plant association is often the only community along stream banks. Along wider stream reaches, this association is adjacent to stands of *Pseudotsuga menziesii* (Douglas fir), other *Populus angustifolia* (narrowleaf cottonwood) communities, 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* (thinleaf alder), *Betula occidentalis* (water birch), or *Salix* (willow) shrublands occur on the floodplain.

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

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 loses the diversity vegetated seral stages, becoming 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. Some altered riparian areas become dominated by only early-seral communities, such as coyote willow and sapling cottonwoods. If the stream is straightened, then each year the same community is flooded or scoured, and succession never proceeds forward, again resulting in lower diversity of riparian vegetation successional stages.

Forage productivity for the *Populus angustifolia/Alnus incana* plant association is high and palatable to livestock. Cottonwood seedlings, saplings, and *Alnus incana* (thinleaf alder) 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 other aquatic critters.

Table 16. Percent Cover of Plant Species in Stands of the *Populus angustifolia/Alnus incana* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG28	95RG40	97BG11	97EV21	97EV25	97GK09	97MD28	97MD17
Species name and age class/ Site Rank	C	C	B	B	C	B	B	B
TREES								
Abies concolor (Grenier & Godon) Lindley—mature trees								7
Juniperus scopulorum Sarg.		1				2		5
Picea engelmannii Parry ex Engelm.—older trees		2						
Picea engelmannii Parry ex Engelm.—saplings		4					3	
Picea engelmannii Parry ex Engelm.—seedlings		6					2	
Populus angustifolia James—older trees	74	19	60	13	54	39	44	58
Populus tremuloides Michx.—older trees							2	34
SHRUBS								
Acer glabrum Torr.								4
Alnus incana (L.) Moench	15	35	41	30	5	49	50	42
Betula occidentalis Hooker						10		
Ribes inerme Rydb.		11					1	
Ribes montigenum McClatchie			39	2				
Salix drummondiana Barratt ex Hook.	5	35		4		3		6
Salix eriocephala Michaux var. ligulifolia			6		1			1
Salix lasiandra var. caudata (Nutt.) Sudworth			25			8		11
Salix monticola Bebb	14			10	9		1	
Vaccinium myrtillus L.			5					
GRAMINOIDS								
Calamagrostis canadensis (Michx.) Beauv.	2	2		17	5		1	
Carex sp.	3	1			2			
Carex utriculata Boott	1		6					
Poa pratensis L.	16	14	15	12	25		10	7
FORBS								
Achillea millefolium var. apicola (Rydb.) Garrett	4	4	1	12	2	1	1	
Cardamine cordifolia Gray	1	2	6					
Crunocallis chamissoii (Ledebour) Cockerell								5
Geranium richardsonii Fisch. & Trautv.	2	5		1			1	
Geum macrophyllum Willdenow		6		1				1
Maianthemum stellatum (L.) Link			10	1		1		
Mertensia ciliata (James ex Torr.) G. Don		5				1		
Oxypolis fendleri (Gray) Heller	3	4						1
Rubus idaeus L.		1		9				
Taraxacum officinale G.H. Weber ex Wiggers	8	18		1	7		7	
Trifolium repens L.	48			1	20			

Narrowleaf cottonwood/red-osier dogwood (*Populus angustifolia/Cornus sericea*) Plant Association

CNHP Rarity Rank: G4 / S3 -- A widespread community occurring in Nevada, Idaho, Wyoming, New Mexico, and Colorado. Many stands occur in Colorado, but are threatened by improper livestock grazing, development, highway corridors, and stream flow alterations. No large, pristine stands remain in Colorado.

General Description and Comments: The *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) plant association is found along moderate-size rivers in the montane zone. It is highly variable in the number of conifer and shrub species present along the reach. However, it is generally recognized by a clear dominance of *Populus angustifolia* with less than 10% cover of other tree species and a thick understory of *Cornus sericea*.

Regional Distribution: This plant association occurs in Nevada (Manning and Padgett 1995), Idaho (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989), Wyoming (Johnston 1987), and Colorado (Johnston 1987 and Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs throughout the Rocky Mountains of Colorado (Johnston 1987, Hess and Wasser 1982, Jankovsky-Jones 1994, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Richard *et al*. 1996).

Recognition and Classification Problems: If conifers are present, the stand may belong to a mixed *Populus angustifolia* – Conifer plant association. Conifer canopy must comprise 10% or at least half that of the *Populus angustifolia* canopy cover. For example, a stand with 30% *Populus angustifolia* and 15% *Picea pungens* would fall into a *Populus angustifolia-Picea pungens* plant association. Conversely, in conifer dominated stands, the *Populus angustifolia* must have at least 10% cover or half that of the conifer cover to be considered a "mixed" plant association.

Related Literature and Synonyms: The following seven communities are all considered synonymous with the Colorado *Populus angustifolia/Cornus sericea* plant association: 1) the *Populus angustifolia/Cornus sericea—Betula occidentalis* phase, the *Populus angustifolia/Amelanchier alnifolia,* 2) the *Populus angustifolia/Amelanchier utahensis/Smilacina stellata*, 3) the *Populus angustifolia/Amelanchier* species (Johnston 1987, Colorado Natural Heritage Program 1997), 4) the *Populus angustifolia/ Amelanchier alnifolia/Smilacina stellata* (*Crataegus rivularis-Cornus sericea* phase)) plant association (Hess and Wasser 1982), 5) the *Populus angustifolia/Cornus sericea* community type (Hansen *et al*. 1989, Padgett *et al.* 1989, Youngblood *et al.* 1985), 6) the *Populus/Cornus sericea* community type occurs in Nevada (Manning and Padgett 1995) and 7) *Populus angustifolia/Lonicera involucrata* (Reid and Bourgeron 1991).

Similar Communities: Closely related communities include the *Populus angustifolia/Betula occidentalis* (narrowleaf cottonwood/river birch) community type (Padgett *et al.* 1989), which has more abundant and consistent *Betula occidentalis*, the *Populus angustifolia/Prunus virginiana* (narrowleaf cottonwood/chokecherry) ecological type (Girard *et al.* 1995) which has a dense herbaceous understory and little, if any, *Cornus sericea* shrub cover, the *Populus angustifolia/Rosa woodsii* (narrowleaf cottonwood/woods rose) community type (Girard *et al.* 1995 and Padgett *et al.* 1989) which does not always have *Cornus sericea* (red-osier dogwood), and the *Populus angustifolia-Acer negundo/*mixed shrub/mixed graminoid mixed forb vegetation type in New Mexico (Dick-Peddie 1993).

The following information is based on: a total of fifty-one quantitative plots: eight from the Yampa River Basin (45, 57, 61, 75, GK09, GK20), one from the White River Basin (92GK19), seventeen from the Colorado River Basin (92GK29, 92GK33, 92NL22, 92NL33, 92NL35, 92NL36, 92NL37, 93SS09, 93SS14, 93SS15, 93SS34, 93RR26, 93RR54, 93RR55, 93GK18, 93GK21, 93GK23), one from the Roaring Fork River Basin (92MJ005), twelve from the Gunnison River Basin (94GK25, 94GK28, 94GK30, 94GK39, 94GK42, 94JB03, 94JB04, 94MD19, 94RR07, 94RR31, 94RR52, 94RR53), seven from the San Miguel/Dolores River Basin (40, 41, 43, 70, 80, EO#2), seven from the San Juan National Forest (3, 15, 107, 118, 133, 215, 221), and one from the Rio Grande Basin (97GK16) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6000-8700 ft. (1800-2700 m).

Site Geomorphology: The *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) plant association occurs in narrow to wide valleys, 30-500 ft (10-150 m), having variable gradients (1-16.5%) and moderately steep stream channels (2-5% gradient). This association occurs on narrow benches along narrow stream channels and on large floodplains along broad, meandering rivers. This association usually occurs between 2 to 10 feet (0.5-2 m) above the stream channel. Stream channels are classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels vary widely in slope and width including broad, moderately sinuous, and moderate-gradient reaches (Rosgen's Channel Type: B2-B6), and broad, highly sinuous, low-gradient, reaches (Rosgen's Channel Type: C2, C3, C5). Occasionally, stream channels are steep and narrow (Rosgen's Channel Type: A5).

Soil: Soils are highly variable and stratified. Soil textures include silty clays, silty clay loams, clay loams, sandy clays, sandy clay loam, and loamy sands. The soils are 1.5-3 feet (0.5-1 meter) deep and become skeletal at depth. Soils in the White and Colorado River Basins classify as argic pachic Cryoborolls on terraces, and typic or oxyaquic Cryorthents, typic Craquents, lithic ustic Torriorthents, udic Ustorthents and sandy oxyaquic Cryofluvents on lower floodplains.

Vegetation: This is one of the most diverse cottonwood-dominated riparian plant associations. The upper canopy consists of several species, but *Populus angustifolia* (narrowleaf cottonwood) is always dominant with 20-70% cover. Other trees include up to 30% cover of *Acer negundo* (boxelder), up to 20% cover each of *Juniperus scopulorum* (Rocky Mountain juniper), *Picea pungens* (Colorado blue spruce), and *Pinus ponderosa* (ponderosa pine), up to 10% cover of *Picea engelmannii* (Engelmann spruce), and, if present, less than 5% cover of *Pseudotsuga menziesii* (Douglas-fir).

The shrub layer is dense and diverse with 10-80% cover of *Cornus sericea* (red-osier dogwood), up to 40% cover of *Alnus incana* (thinleaf alder), up to 30% cover each of *Amelanchier utahensis* (Utah serviceberry), *Rosa woodsii* (woods rose), *Acer glabrum* (Rocky Mountain maple), *Quercus gambelii* (Gambel oak), and *Salix* (willow) species, up to 25% cover of *Crataegus rivularis* (river hawthorn), up to 20% cover of *Lonicera involucrata* (honeysuckle), and up to 10% cover of *Amelanchier alnifolia* (serviceberry). In stands where aspect and shade provide a moist environment, the herbaceous cover can be as much as 50%. Forb species include up to 50% cover of *Maianthemum stellatum* (false Solomon seal), up to 20% cover of *Heracleum sphondylium* (cow parsnip), and up to 10% cover each of *Achellia millefolium* var. *apicola* (milfoil yarrow), and *Osmorhiza depauperata* (blunt-fruit sweet cicely). Graminoid cover is insignificant. Other sites are relatively dry with a sparse herbaceous undergrowth (<10% cover) and a number of exotic, hay meadow grasses, probably introduced from cattle grazing.

Successional and Ecological Processes: In Colorado, some stands of the *Populus angustifolia/Cornus sericea* association appear to be mid- to late-seral mature cottonwood forests that are isolated from frequent flooding and sediment deposition. A seasonally high water table is required to maintain a vigorous *Cornus sericea* layer (Padgett *et al.* 1989). Stands of this association growing at lower elevations and on high, drier terraces have greater cover of *Amelanchier utahensis* (Utah serviceberry), *Amelanchier alnifolia* (serviceberry) and *Crataegus rivularis* (river hawthorn) and may have undergone over-grazing in the past.

In Utah, Padgett *et al.* (1989) suggest that the *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) plant association may be an early- to mid-seral association due to its proximity to the channel. If the channel and terraces remain stable, this association may be replaced by a conifer/*Cornus sericea* type.

In Montana, Hansen *et al*. (1989) describe three stages of disturbance of the *Populus angustifolia/Cornus sericea* plant association. Relatively undisturbed sites have a dense, rich shrub layer of *Cornus sericea* (red-osier dogwood), *Amelanchier alnifolia* (serviceberry), *Prunus virginiana* (chokecherry), and several *Salix* (willow) and *Ribes* (currant) species. Moderately disturbed sites have *Symphoricarpos* (snowberry) and *Rosa* (rose) species that increase in abundance as the previously mentioned shrub species decrease in cover. With continued disturbance, *Rosa* and *Symphoricarpos* species may become quite abundant until eventually, shrub cover begins to decline and the site dries out.

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 a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a 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.

Adjacent riparian vegetation: Adjacent riparian areas include woodlands of *Populus angustifolia* (narrowleaf cottonwood). Adjacent shrublands include stands of *Salix exigua* (coyote willow) on point bars and *Salix monticola* (mountain willow), *Salix boothii* (Booth willow), and *Alnus incana* (thinleaf alder) on the stream banks and floodplains. *Carex utriculata* (beaked sedge) wetlands occur in low-lying swales and at the channel edge.

Adjacent upland vegetation: Vegetation on adjacent hillslopes includes *Picea engelmannii* (Engelmann spruce), *Pseudotsuga menziesii* (Douglas-fir), and *Pinus ponderosa* (ponderosa pine) forests, *Pinus edulis-Juniperus osteosperma* (pinyon pine-Utah juniper) woodlands, *Quercus gambelii* (Gambel oak) and *Artemisia tridentata* (big sagebrush) shrublands.

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 can be high and very palatable to livestock. Cottonwood seedlings and saplings are frequently browsed by cattle and *Cornus sericea* (red-osier dogwood) is considered to be an “ice cream” plant (e.g. it is readily eaten and is a preferred browse species) to livestock and wildlife. Excessive grazing and browsing in this association 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). *Cornus sericea* (red-osier dogwood) provides good stream bank stability due its rhizomatous growth.

Table 17. Percent Cover of Plant Species in a Stand of the *Populus angustifolia/Cornus sericea* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK16
Species name and age class/ Site and Riparian Health Rank	C
TREES	
Populus angustifolia James—older trees	30
Populus angustifolia James—saplings	16
SHRUBS	
Cornus sericea L.	30
Lonicera involucrata Banks ex Spreng.	2
Ribes inerme Rydb.	1
Rosa woodsii Lindl.	34
GRAMINOIDS	
Bromus inermis Leyss.	1
Calamagrostis canadensis (Michx.) Beauv.	4
Carex sp.	3
Poa pratensis L.	8
FORBS	
Asparagus officinalis L.	1
Cirsium arvense L.	13
Glycyrrhiza leptidota Pursh	1
Maianthemum stellatum (L.) Link	3
Stachys palustris L. ssp. pilosa	1
Taraxacum officinale G.H. Weber ex Wiggers	1
Thermopsis rhombifolia var. montana (Nutt.) Isely	1
Vicia americana Muhlenberg.	1
HORESTAILS	
Equisetum arvense L.	5

Narrowleaf cottonwood/mixed willow species (*Populus angustifolia*/mixed *Salix* species) Plant Association

CNHP Rarity Rank: G3 / S3—This association is known from the Colorado Plateau, the San Juan Mountains and the Great Basin areas of Colorado, Utah and Nevada. It is known from 4 stands in the San Juan Mountains and at least 25-50 more are expected to occur. It is threatened by improper livestock grazing, heavy recreational use and stream flow alterations.

General Description and Comments: The *Populus angustifolia*/mixed *Salix* species (narrowleaf cottonwood/mixed willow species) plant association is early to mid-seral. The cottonwoods are fairly young, pole and small dbh (5-15 inches, 12-53 cm in diameter), with a diverse mix of willows and other shrubs in the understory canopy.

Related Literature and Synonyms: The Colorado *Populus angustifolia/*mixed *Salix* species plant association is closely related to the *Populus/Salix* community type described by Manning and Padgett (1995) from Nevada. However, it is not considered synonymous because the Manning and Padgett community includes stands dominated by *Populus trichocarpa* and *Salix eriocephala* var. *watsonii*, two taxa that do not occur in Colorado (Dorn 1995, Colorado Natural Heritage Program 1997).

Regional Distribution: This community is known only from the San Juan Mountains of southwestern Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This diverse community is known only from the San Juan Mountains in southwestern Colorado (Colorado Natural Heritage Program 1997).

The following information is based on: four quantitative plots: 2 from the San Juan National Forest (26,268) and 2 from the Rio Grande and Closed Basins (95RG21, 95RG26) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7900- 8880 ft. (2400-2700 m)

Site Geomorphology: This community occurs on active floodplains, stream benches and low terraces, generally within 1-4.5 ft. (0.3-1.4 m) of the active channel elevation. Stream channels are classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels range from steep and narrow (Rosgen Channel Types: A5 and A6) to broad, moderate gradient and more sinuous (Rosgen Channel Types: B4 and C4). All sites showed signs of active flooding. One stand occurs on an overflow or back channel.

Soils: Soils are somewhat deep (about 3 ft, 1 m), loamy to clay sands over very coarse alluvial layers with at least 25% gravel and other coarse fragments present in all layers. No mottling is present.

Vegetation: The upper canopy is dominated by young (sapling, pole and small bole-sized 5-15 inches, 12-53 cm in diameter) *Populus angustifolia* (narrowleaf cottonwood) trees with 25-80% cover. The understory has a consistent mixture of two or more willow species, which can include *Salix exigua* (coyote willow), *S. eriocephala* var. *ligulifolia* (strapleaf willow), *S. monticola* (mountain willow), *S. lucida* var. *caudata* (whiplash willow), *S. drummondiana* (Drummond willow*)*, and *S. geyeriana* (Geyer willow). Total cover of the shrub layer is between 15-85%. No single species has more than 5-10% canopy cover. Other, non-willow shrubs are usually present as well, and include *Rosa woodsii* (rose), *Ribes* spp. (gooseberry), *Alnus incana* (thinleaf alder), *Crataegus rivularis* (hawthorn), *Pentaphylloides floribunda* (shrubby cinquefoil) and/or *Symphoricarpos* spp. (snowberry). Each species generally has less than 5% cover.

The herbaceous undergrowth is generally low in total cover, with 10-30% forbs and 10-15% graminoids. Common species include *Maianthemum stellatum* (false Solomon seal), *Trifolium* spp. (clover), *Erigeron* spp. (fleabane), *Poa pratensis* (Kentucky bluegrass), and *Bromus inermis* (smooth brome).

Successional and Ecological Processes: 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 a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a 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.

Adjacent Riparian Vegetation: This plant association can be the only community along narrow, ephemeral streams. It can also be part of a mosaic with older *Populus angustifolia* (narrowleaf cottonwood) woodlands or pockets of pure willows, such as *Salix exigua* (coyote willow) or *Salix monticola* (mountain willow).

Adjacent Upland Vegetation: Hillsides adjacent to riparian areas can have *Populus tremuloides* (quaking aspen) and *Pinus edulis* (pinyon pine) woodlands or dry areas of *Bouteloua gracilis* (blue grama grass) grasslands.

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. Cattle frequently browse Cottonwood seedlings, saplings, and young shoots of Salix (willow). 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).

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). Most *Salix* species can be grown and transplanted from cuttings. 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).

Table 18. Percent Cover of Plant Species in Stands of the *Populus angustifolia*/Mixed *Salix* species Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG21	95RG26
Species name and age class/ Site and Riparian Health Rank	C	C
TREES		
Juniperus monosperma (Engelm.) Sarg.—older trees	10	
Juniperus monosperma (Engelm.) Sarg.—saplings	1	
Pinus ponderosa P. & C. Lawson—older trees	1	
Populus angustifolia James—older trees	82	27
Populus angustifolia James—saplings	3	21
Populus angustifolia James—seedlings	4	3
SHRUBS		
Ribes cereum Dougl.		7
Ribes inerme Rydb.		9
Rosa woodsii Lindl.	1	8
Salix eriocephala Michaux var. ligulifolia	2	
Salix exigua Nutt.	6	4
Salix lasiandra var. caudata (Nutt.) Sudworth		7
Salix monticola Bebb	6	
Symphoricarpos rotundifolius A. Gray		4
GRAMINOIDS		
Agrostis sp.	1	
Bromus inermis Leyss.		1
Bromus sp.		1
Eleocharis sp.	4	
Juncus balticus ssp. montanus Engelm.	1	1
Poa pratensis L.	8	13
FORBS		
Achillea millefolium var. apicola (Rydb.) Garrett	1	2
Erigeron sp.		5
Iris missouriensis Nutt.	1	
Lupinus sp.		4
Maianthemum stellatum (L.) Link		5
Senecio sp.		1
Taraxacum officinale G.H. Weber ex Wiggers	2	2
Trifolium sp.	7	4

Narrowleaf cottonwood/skunkbrush (*Populus angustifolia/Rhus trilobata*) Plant Association

CNHP Rarity Rank: G3 / S3--This community is known from Colorado, Nevada and Utah. In Colorado, this association is limited to the southwest and south central Colorado. It is highly threatened by improper livestock grazing, development, road building and maintenance and altered stream flow regimes.

General Description and Comments: The *Populus angustifolia/Rhus trilobata* (narrowleaf cottonwood/skunkbrush) plant association is characterized by a scattered overstory of *Populus angustifolia* with an occasional *Populus* x *acuminata* (lanceleaf cottonwood) or *Populus deltoides* ssp. *wislizenii* (Rio Grande cottonwood) individuals. The shrub understory is a dense layer of *Rhus trilobata* (skunkbrush). It occurs in sandstone canyons and on streams adjacent to sand dunes.

Related Literature and Synonyms: Two communities in the literature are synonymous with the Colorado *Populus angustifolia/Rhus trilobata* plant association: the *Populus angustifolia/Rhus aromatica* var. *trilobata* (narrowleaf cottonwood/skunkbrush) community type from Utah (Padgett *et al.* 1989) and the *Populus/Rhus aromatica* var. *trilobata* (cottonwood/skunkbrush) community type from Nevada (Manning and Padgett 1995). *Rhus aromatica* var. *trilobata* is a synonym for *Rhus trilobata* var. *trilobata* (Kartesz 1994).

Regional Distribution: This plant association occurs in Nevada (Padgett *et al.* 1989), Utah (Manning and Padgett 1995), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs on the Uncompahgre Plateau in the San Miguel and Dolores River Basins (Kittel and Lederer 1993), the Colorado River Basin (Kittel *et al*. 1994), the San Juan National Forest (Richard *et al*. 1996), and in the San Luis Valley (Colorado Natural Heritage Program 1997).

The following information is based on: a total of thirty quantitative plots; five from the Colorado River Basin (93RR05, 93RR06, 93RR17, 93GK05, 93GK17), eight from the Gunnison River Basin (94GK04, 94JB06, 94JB40, 94MD03, 94MD05, 94MD06, 94RR04, 94RR05), fourteen from the San Miguel River Basin (91NL20, 91NL21, 91NL23, 91NL24, 91NL25, 91NL26, 91NL28, 91NL29, 91NL30, 91NL31, 91NL38, 92NL28, 92GK30, 92GK32), one from the San Juan National Forest (113) and two from the Closed Basin (97GK08, 97MD10) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5000-7100 ft. (1500-2200 m).

Site Geomorphology: This plant association occurs on immediate river banks, floodplain meanders and narrow benches in narrow to wide, 65-500 feet (20-150 m), sandstone canyons. Stands generally occur within 3 feet (1 m) of the high water mark, but can also occur on higher terraces, up to 10 feet (3 m) above the channel. In the western portion of the Colorado River drainage, this association occurs on small streams in shale canyon areas. Stream channels are classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and highly sinuous (Rosgen's Channel Type: C3, C4, C6) or wide and moderately sinuous (Rosgen's Channel Type: B3). Occasionally, stream channels are narrow and steep (Rosgen's Channel Type: A3).

Soil: The soils associated with this plant association are often alkaline and of a calcareous parent material. The soil textures are fine sandy loams, clay loams, silty clay loams, and silty clay. In the Colorado River Basin, the soils classify as ustic Torriorthents, Ustifluvents, mesic ardic Ustorthents, and ustalfic Haplargids.

Vegetation: The overstory is dominated by up to 80% cover of *Populus angustifolia* (narrowleaf cottonwood). Other trees include up to 30% cover each of *Populus* x *acuminata* (lanceleaf cottonwood) and *Acer negundo* (boxelder) and up to 10% cover each of *Juniperus osteosperma* (Utah juniper) or *J. monosperma* (one-seeded juniper), and *Juniperus scopulorum* (Rocky Mountain juniper).

The shrub layer is dominated by 10-70% cover of *Rhus trilobata* (skunkbrush). Other shrubs include up to 30% cover each of *Prunus virginiana* (chokecherry) and *Berberis fendleri* (barberry), up to 20% cover of *Quercus gambelii* (Gambel oak), up to 10% cover each of *Rosa woodsii* (woods rose) and *Cornus sericea* (red-osier dogwood), and up to 5% cover of *Amelanchier utahensis* (Utah serviceberry).

The herbaceous undergrowth is usually sparse, but can include up to 20% cover of *Maianthemum stellatum* (false Solomon seal) and up to 10% cover each of *Thalictrum fendleri* (Fendler meadowrue) and *Melilotus officinale* (yellow sweet clover). Graminoid cover includes up to 20% *Poa pratensis* (Kentucky bluegrass).

Successional and Ecological Processes: In Utah, the *Populus angustifolia/Rhus trilobata* (narrowleaf cottonwood/skunkbrush) plant association is considered a late successional community within the riparian area (Padgett *et al.* 1989). In southwestern Colorado, *Rhus trilobata* is present in both young and old cottonwood stands. As the stand matures, *Rhus trilobata* becomes denser and excludes other shrubs. On higher terraces that are less frequently flooded, *Populus angustifolia* does not reproduce. This indicates succession to an upland community. The presence of *Quercus gambelii* (Gambel oak) in some stands may indicate a trend toward an oak upland shrub community (Padgett *et al.* 1989).

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 a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a 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.

Adjacent riparian vegetation: This plant association may intergrade with *Populus deltoides* ssp. *wislizenii/Rhus trilobata* (Rio Grande cottonwood/skunkbrush) forests at lower elevations where the distributions of the two *Populus* (cottonwood) species overlap. *Salix exigua* (coyote willow) shrublands can also occur on adjacent point bars and stream banks.

Adjacent upland vegetation: *Pinus edulis-Juniperus* (*osteosperma* or *monosperma)* (pinyon pine-Utah or one-seeded juniper) woodlands, *Pinus ponderosa-Quercus gambelii* (ponderosa pine-Gambel oak) forests, *Quercus gambelii* (Gambel oak) scrub, and *Artemisia tridentata* (big sagebrush) and *Chrysothamnus* spp. (rabbitbrush) shrublands often occur on adjacent hill slopes.

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 are frequently browsed by cattle. However, in California, *Rhus trilobata* is considered useless browse for livestock and only fair to poor browse for wildlife (Padgett *et al*. 1989). In areas with limited cover of palatable species, *Rhus trilobata* may be more heavily browsed. Excessive grazing and browsing of both *Populus angustifolia* and *Rhus trilobata* 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).

Table 19. Percent Cover of Plant Species in Stands of the *Populus angustifolia/Rhus trilobata* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK08	97MD10
Species name and age class/ Site and Riparian Health Rank	B	A
TREES		
Populus angustifolia James—older trees	78	47
Populus angustifolia James—saplings	1	
Populus angustifolia James—seedlings	1	
SHRUBS		
Chrysothamnus viscidiflorus (Hooker) Nuttall		1
Rhus trilobata Nuttall ex Torrey & Gray var. trilobata	69	28
Ribes aureum Pursh.	4	
Rosa woodsii Lindl.	5	
VINES		
Clematis ligusticifolia Nuttall.	1	
GRAMINOIDS		
Carex sp.		1
Oryzopsis hymenoides (Roemer & Schultes) Ricker		1
Pascopyron smithii (Rydb.) A. Love		21
Redfeldia flexulosa (Thurb.) Vasey	1	
FORBS		
Chenopodium alba L.		1
Hackelia floribunda (Lehman) Johnston		1
Psoralidium lanceolatum (Pursh) Rydberg	1	
Senecio sp.		3

Narrowleaf cottonwood/Drummond willow-Rocky Mountain maple (*Populus angustifolia/Salix drummondiana-Acer glabrum*)

CNHP Rarity Rank: G1? / S1?-- This is a newly described community from south-central Colorado, where it is known from one large and nearly pristine stand in the Sangre de Cristo Mountains. The question mark in the Global and State ranks indicates the community is suspected to be more abundant, but more occurrences have not been documented.

General Description and Comments: *The Populus angustifolia/Salix drummondiana-Acer glabrum* (narrowleaf cottonwood/Drummond willow-Rocky Mountain maple) community is a multi-layered deciduous forest. It is characterized by a dense overstory of *Populus angustifolia* (narrowleaf cottonwood) and *Salix drummondiana* (Drummond willow) along the immediate stream bank and scattered *Acer glabrum* (Rocky Mountain Maple) and other willows (e.g. *Salix lucida* var. *caudata,* whiplash willow) across the floodplain.

Related Literature and Synonyms: This community has not been previously described in the literature

.

Similar Communities: The *Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum* plant association differs in having no *Salix drummondiana* present and a much higher abundance of *Abies concolor* in the overhead canopy.

Regional Distribution: This plant association has not been reported from other states; it is known only from one location in south central Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is known from one large and nearly pristine stand along Sand Creek on the west side of the Sangre de Cristo Mountains (Colorado Natural Heritage Program 1997).

The following information is based on: three quantitative plots from the Closed Basin (97GK24, 97GK25, 97GK26) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7800-8600 ft. (1800-2000 m).

Site Geomorphology: This plant association occurs on a wide, 300 feet (100 m), and active floodplain in a deep, U-shaped valley. The floodplain shows signs of active flooding, mud and debris flows, as well as avalanches from the steep valley sides slopes. The ground surface is relatively flat with trenches, scour holes, debris deposits and downed logs. The community occurs across the entire floodplain, from the immediate stream edge to the toeslopes of the valley walls. Stream channels are classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The stream channel gradient is moderately steep (3.5%), and wide (12-30 ft, 6-10 m) with pool-drop sequences in some sections. It classifies as a Rosgen's A3 type stream channel, however it appears in width and sinuosity to be more like a steep B3 type.

Soils: Surface horizon textures are sandy loams and loam sands grading to pure sand. Coarse alluvial cobbles appear at a depth of 15 inches (40 cm).

Vegetation: Tall (20-30 feet, 2.5-10 m), mid-sized (>5 inches, 13 cm diameter) *Populus angustifolia* (narrowleaf cottonwood) dominate the upper canopy with 30-80% cover. *Abies concolor* (white fir) may be present with up to 10% cover and sapling-sized (10-15 feet, 2-2.5 m) growing beneath the cottonwood canopy. Other trees present with up to 20% cover include *Populus tremuloides* (quaking aspen*), Pseudotsuga menziesii* (Douglas fir) and *Juniperus scopulorum* (Rocky Mountain juniper).

Salix drummondiana (Drummond willow) occurs across the floodplain, but it is notably more concentrated at the stream edge with 20-80% cover. *Acer glabrum* (Rocky Mountain maple) also occurs along the stream edge and scattered across the floodplain with 5-20% cover. Other shrubs present with up to 5% cover include *Alnus incana* (thinleaf alder), *Rosa woodsii* (rose), *Jamesia americana* (wax flower), *Salix lucida* var. *caudata* (whiplash willow), and *Prunus virginiana* (common chokecherry). Herbaceous cover is generally low (10-20%). Mesic forbs occur along the stream bank edge and include *Orthilia secunda* (one-sided wintergreen), *Maianthemum stellatum* (false Solomon seal), *M. amplexicaule* (false Solomon seal), and *Oxypolis fendleri (*cowbane). Graminoid cover is insignificant.

Successional and Ecological Processes: 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 a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.
If not damaged by a 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.

Adjacent Riparian Vegetation: This community fills the entire floodplain/riparian area. An *Abies concolor-Picea pungens-Populus angustifolia/Acer glabrum* (white fir-Colorado blue spruce-narrowleaf cottonwood/Rocky Mountain maple) community occurs immediately downstream.

Adjacent Upland Vegetation: *Pinus edulis* (pinyon pine) woodlands intermixed with *Holodiscus dumosa* (ocean-spray) and *Cercocarpos montanus* (Mountain mahogany) shrublands occur on south-facing slopes. Pockets of *Pseudotsuga menziesii (*Douglas fir), *Abies concolor* (white fir) and *Populus tremuloides* (quaking aspen) forests occur on the north-facing slopes.

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 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).

Table 20. Percent Cover of Plant Species in Stands of the *Populus angustifolia/Salix drummondiana-Acer glabrum* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK24	97GK25	97GK26
Species name and age class/ Site and Riparian Health Rank	A	A	A
TREES			
Abies concolor (Grenier & Gordon) Lindley—mature trees		10	5
Abies concolor (Grenier & Gordon) Lindley —seedlings	1	1	
Juniperus scopulorum Sarg.	3		
Picea pungens Engelm.—saplings	5		
Populus angustifolia James—older trees	80	32	60
Populus angustifolia James—saplings	6		
Populus tremuloides Michx.—saplings	8	22	
Populus tremuloides Michx.—seedlings		1	
Pseudotsuga menziesii (Mirbel) Franco—older trees		13	2
SHRUBS			
Acer glabrum Torr.	17	6	20
Alnus incana (L.) Moench	4	1	
Jamesia americana Torrey.		2	
Juniperus communis L.	4		
Prunus virginiana L. var. melanocarp (A. Nels.) Sarg.	2		1
Rosa woodsii Lindl.	5	5	30
Salix drummondiana Barratt ex Hook.	19	62	60
Salix lasiandra var. caudata (Nutt.) Sudworth	7		1
Symphoricarpos sp.	1		1
GRAMINOIDS			
Bromus hordeaceus L.	2		1
Cinna latifolia (Trev. Ex Goepp.) Griseb.			1
Poa sp.	2	1	
FORBS			
Epilobium angustifolium L.			6
Fragaria virginiana Miller	1	1	1
Galium triflorum Michx.	4		1
Maianthemum racemosum Nuttal	1	1	20
Maianthemum stellatum (L.) Link	4	7	10
Orthilia secunda (L.) House	8	1	20
Oxypolis fendleri (Gray) Heller		3	
Pyrola asarifolia ssp. asarifolia Michaux		10	

Narrowleaf cottonwood/coyote willow (*Populus angustifolia/Salix exigua*) Plant Association

CNHP Rarity Rank: G4 / S4-- This is a very common, early-seral *Populus angustifolia* dominated community. It occurs in New Mexico and Colorado, and is expected to occur in Wyoming and Montana. In Colorado, this association is widespread with >100 estimated stands. Its presence is an important indicator of fluvial processes and riparian health.

General Description and Comments: This is a very common plant association of young seedling and sapling *Populus angustifolia* (narrowleaf cottonwood) intermixed with *Salix exigua* (coyote willow). The association occupies point bars, gravel bars, benches and low areas that are flooded annually or semi-annually.

Related Literature and Synonyms: The *Populus angustifolia/Salix exigua* plant association described by Durkin *et al.*(1994 and 1995) is synonymous with the Colorado *Populus angustifolia/Salix exigua* plant association. A closely related community, *Populus angustifolia/*recent alluvial bar (Jones 1990, Hansen *et al*. 1995), is not considered synonymous because many stands do not have *Salix exigua* (coyote willow) present, it is however, very similar in stand age.

Similar Communities: The *Populus angustifolia/Salix exigua* Habitat Type (Hess 1981, Baker 1984), which has significant *Betula occidentalis* present, and the *Populus angustifolia/Salix exigua-Betula fontinalis* (narrowleaf cottonwood/coyote willow-river birch) plant association described by Johnston (1987) are closely related to the Colorado *Populus angustifolia/Salix exigua* plant association.

Regional Distribution: The *Populus angustifolia/Salix exigua* plant association occurs in New Mexico and Colorado (Durkin *et al.* 1994, 1995, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa, White, Gunnison, Rio Grande and Arkansas River Basins, and the San Juan National Forest (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1996, Johnston 1987, Richard *et al.* 1996).

The following information is based on: a total of ten quantitative plots; two from the Yampa River Basin (63, 108), three from the White River Basin (92GK13, 92NL41, 92NL25), one from the Rio Grande Basin (97MD24), two from the Upper Arkansas River Basin (95AM16, 95GK70), and two from the San Juan National Forest (17, 126) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6300-7500 ft. (1900-2300 m).

Site Geomorphology: This plant association occurs on recently flooded point bars, low terraces, and stream benches. It is usually well within the active channel and immediate floodplain of the stream and does not occur more than 3-6 feet (1-2 m) above the high-water mark. Stream channels are classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and slightly sinuous (Rosgen's Channel Type: B3, B4) or wide and moderately sinuous (Rosgen's Channel Type: C3, C4).

Soil: Soils not very well developed Entisols and are mostly are skeletal (40% gravel and 10-20% cobbles) and shallow, 15 inches (35 cm) deep, sands, sandy loams, sandy clay loams, or silty clays over coarse alluvial material.

Vegetation: This plant association is characterized by an open to dense stand of 15-65% cover of *Populus angustifolia* (narrowleaf cottonwood) seedlings (< 1.5 m in height) and saplings (< 12 cm in diameter) and 5-60% cover of *Salix exigua* (coyote willow). The herbaceous undergrowth is generally weedy (non-native) and sparse due to frequent flooding disturbance. Weedy species include up to 40% cover of *Trifolium repens* (white clover), up to 20% cover of *Agrostis stolonifera* (redtop), and up to 15% cover each of *Poa pratensis* (Kentucky bluegrass) and *Linaria vulgaris* (butter-and-eggs).

Successional and Ecological Processes: *Populus angustifolia/Salix exigua* (narrowleaf cottonwood/coyote willow) is one of the earliest successional stages of a cottonwood-dominated plant association. *Populus angustifolia* and *Salix exigua* seeds often germinate together on freshly deposited sandbars. If the site becomes more stable and less frequently flooded (i.e., the stream channel migrates away from the site), the *Populus angustifolia* saplings mature, but the *Salix exigua* population eventually declines. The association can become one of several mid- or late-seral floodplain types including *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) and *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood).

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 a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a 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.

Adjacent Riparian Vegetation: Thick stands of *Salix exigua* (coyote willow) or *Alnus incana* (thinleaf alder) shrublands often occur within the same reach as *Populus angustifolia/Salix exigua*. *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) and *Populus angustifolia/Amelanchier* spp. (narrowleaf cottonwood/serviceberry) forests occur on higher terraces.

Adjacent Upland Vegetation: *Pinus ponderosa* (ponderosa pine) forests, *Pinus edulis-Juniperus monosperma* (pinyon pine-one-seed juniper) woodlands, *Quercus gambelii* (Gambel oak) scrub, and *Artemisia tridentata* (big sagebrush) shrublands occur on adjacent rocky valley slopes.

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 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 can be high and very palatable to livestock. Cottonwood and willow seedlings and saplings 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).

Salix exigua (coyote willow) is an excellent stream bank stabilizer that can be planted as stems or wattles for restoration purposes. However, cattle may browse the young shoots in the winter and kill newly planted poles.

The stand table for the *Populus angustifolia/Salix exigua* plant association follows the next community description.

Narrowleaf cottonwood/whiplash willow (*Populus angustifolia/Salix lasiandra* var. *caudata*) Plant Association

CNHP Rarity Rank: G1Q / S1Q--This is a newly described community known from one stand in south central Colorado. It may be more closely aligned with the *Populus angustifolia/*Mixed *Salix* species plant association. The Q in the Global and State ranks indicate the question as to whether the community is its own taxonomic entity.

General Description and Comments: The *Populus angustifolia/Salix lucida* var. *caudata* (narrowleaf cottonwood/whiplash willow) plant association is a new tentative association known from only one location in south central Colorado. It is a mature stand of narrowleaf cottonwood with a sub-canopy of *Salix lucida* var. *caudata* (whiplash willow).

Related Literature and Synonyms: This association has not been previously described in the literature. It is closely related to the *Populus angustifolia*/mixed *Salix* species (narrowleaf/whiplash willow) plant association in this classification, which can have *Salix lasiandra* var. *caudata* in the understory. *Salix lucida* ssp. *caudata* is a synonym for *S. lasiandra* var. *caudata* (Dorn 1997)

Regional Distribution: This association is known only from Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This community has only been reported from one stand in the San Luis Valley in south central Colorado (Colorado Natural Heritage Program 1997).

The following information is based on: one quantitative plot from the Closed Basin (97GK12) (Colorado Natural Heritage Program 1997).
.
Elevation Range in Colorado: 7600 ft. (2300 m).

Site Geomorphology: The *Populus angustifolia/Salix lasiandra* var. *caudata* community occurs on low terraces and floodplains. The low terrace is a flat, nutrient-rich surface approximately 3 feet (1 m) above the active channel. The terrace appears to be an old beaver pond that was drained by the stream. Stream channels are classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The channel was once braided (Rosgen Channel Type: D5), but is now sinuous (Rosgen Channel Type: C5), and is becoming incised.

Soils: The soil is a deep loamy sand with 10-25% organic matter that accumulated in the once-present beaver pond. Lower layers have no coarse fragments and little horizon development.

Vegetation: Tall (25-40 feet, 7-10 m), mature *Populus angustifolia* with 30-40% cover create the upper canopy. Tall (10-15 feet, 3-4 m) *Salix lasiandra* var. *caudata* comprise the second canopy. No other shrubs are present. The herbaceous undergrowth is sparse with a 25% cover *Poa pratensis* (Kentucky bluegrass) and a 10% cover of *Carex nebrascensis* (Nebraska sedge). No forbs are present.

Successional and Ecological Processes: *Salix lasiandra* var. *caudata* is often associated with abandoned beaver ponds or found along steep stream reaches below beaver ponds. It appears to colonize areas that have filled with silt or are in the process of doing so. Eventually, this association will be replaced by slightly drier-site willow species. However, with disturbance such as overuse by livestock, willow cover may decline. With severe disturbance, the willows will completely disappear. This association will then become dominated by *Rosa woodsii* (woods rose) and eventually, *Poa pratensis* (Kentucky bluegrass) (Hansen *et al*. 1995).

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 a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a 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.

Adjacent Riparian Vegetation: No other riparian communities are present at the site. A *Populus angustifolia-Juniperus scopulorum* (narrowleaf cottonwood-Rocky Mountain Juniper) forest occurs upstream.

Adjacent Upland Vegetation: *Chrysothamnus* spp. (rabbitbrush) shrublands and *Stipa comata-Oryzopsis hymenoides* (needle-and-thread grass-Indian ricegrass) grasslands occur at the edges of the riparian area.

Management: *Salix lucida* var. *caudata* (whiplash willow) is moderate to highly palatability to livestock, large mammals and beaver (Kovalchik *et al*. 1988). In Montana, the *Salix lucida* ssp. *caudata* community type is considered to have limited forage value for livestock due to frequent flooding at the sites (Hansen *et al*. 1995). This may be the case in Colorado as well, since the association is located along banks and floodplains of meandering streams. *Salix lasiandra* var. *caudata* is sensitive to fire, but as with most willows, can re-sprout. *Salix lasiandra* var. *caudata* is a good shrub species to plant for stream bank stabilization. It establishes easily and forms abundant roots from cuttings approximately 10 days after planting (Platts *et al*. 1987).

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. Cattle frequently browse Cottonwood seedlings and saplings. 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).

Table 21. Percent Cover of Plant Species in Stands of the *Populus angustifolia/Salix exigua* and the tentative *Populus angustifolia/Salix lasiandra* var. *caudata* Plant Associations from the Rio Grande and Closed Basin Watersheds.

Plant Association	Populus angustifolia/ Salix exigua	Populus angustifolia/ Salix lasiandra var. caudata
Plot Number	97MD24	97GK12
Species name and age class/ Site and Riparian Health Rank	C	C
TREES		
Abies lasiocarpa (Hook.) Nutt.—older trees	2	
Picea pungens Engelm.—older trees	12	
Populus angustifolia James—older trees	25	35
Populus tremuloides Michx.—older trees	1	
SHRUBS		
Alnus incana (L.) Moench	5	
Rosa woodsii Lindl.	2	
Salix exigua Nutt.	64	
Salix lasiandra var. caudata (Nutt.) Sudworth		80
GRAMINOIDS		
Carex nebrascensis Dewey		10
Carex sp.	1	
Elymus elymoides (Raf.) Swezey	1	
Juncus balticus ssp. montanus Engelm.	1	
Poa pratensis L.	1	25
FORBS		
Achillea millefolium var. apicola (Rydb.) Garrett	1	
Geum sp.	1	
Mentha arvensis L.	1	
Solidago sp.	1	
Taraxacum officinale G.H. Weber ex Wiggers	1	
Trifolium repens L.	1	

Narrowleaf cottonwood Sand Dune Forest (*Populus angustifolia* Sand Dune Forest) Plant Association

CNHP Rarity Rank: G1 / S1-- This is a newly described community, known from one large and nearly pristine stand in south central Colorado. The physical environment is unique in the Southern Rocky Mountain area.

General Description and Comments: The *Populus angustifolia* (narrowleaf cottonwood) Sand Dune Forest plant association consists of stands of mature cottonwoods with no shrub or herbaceous plants in the understory. It occurs in an unusual environmental setting: a sandy, braided, stream channel adjacent to actively moving sand dunes. It is known only from the east side of the San Luis Valley, at the base of the Sangre de Cristo Mountains, just northwest of Great Sand Dunes National Monument.

Related Literature and Synonyms: This community has not been previously described in the literature.

Regional Distribution: This community is known from the San Luis valley in south central Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This community is known from one location in the San Luis valley in south central Colorado (Colorado Natural Heritage Program 1997).

The following information is based on: one quantitative plot from the Closed Basin (97DM11) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7600 ft. (2300 m).

Site Geomorphology: The *Populus angustifolia* Sand Dune Forest community occurs on a series of sand dunes stabilized by vegetation. The cottonwoods occur on the ridges of the sand dunes and increase in age with distance from the active stream channel. The cottonwood stands may have created the sand dunes by trapping wind-borne sand. Stream channels are classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The stream channel is braided (Rosgen Channel type: D5) with additional dry channels on either side of the active channel, giving the impression of an alluvial fan.

Soils: The soil is deep (30 inches, 73 cm) loamy sand with little horizon development.

Vegetation: This community is a mature stand of up to 90% canopy cover *Populus angustifolia* (narrowleaf cottonwood) with no shrubs or herbaceous species under the canopy. The ground is covered with a thick layer of cottonwood leaf litter (65%), wood (cottonwood branches) (15%) and bare sand (20%).

Successional and Ecological Processes: The *Populus angustifolia* Sand Dune Forest appears to be a product of a unique environment in Colorado. As the cottonwoods increase in age and distance from the active stream channel, trees trap wind-borne sand and create ridges of sand, or sand dunes. As trees are buried, the cottonwoods send out aerial roots and grow taller, much in the same way that the species responds to burial by flooding and fluvial deposition. We found several large old trees, up to 8 feet (2 m) in diameter near the center of the sand dune forest. Younger trees (2 inch, 4.5 cm) occur in thick bands on slightly lower sand dune ridges. These sapling and pole-sized trees produced sucker shoots, creating another band of seedling-sized cottonwoods.

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 a little bit more flood born sediments, and the sandbar rises. The young forest community becomes increasingly stable as it grows older.

If not damaged by a 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.

Adjacent Riparian Vegetation: *Juncus balticus* (baltic rush) meadows and *Salix exigua* (coyote willow) shrublands.

Adjacent Upland Vegetation: *Chrysothamnus nauseosus* (rubber rabbitbrush) shrublands and *Oryzopsis hymenoides* (Indian ricegrass) grasslands.

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 low for livestock. Cottonwood seedlings and saplings 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).

Heavy elk browsing on willows and sapling cottonwoods in the area has been observed, but not all stands were browsed, and the overall impact to the riparian area is minor. *Salix* (willow) and *Populus* (cottonwood) reproduction appear to be abundant.

Table 22. Percent Cover of Plant Species in Stands of the *Populus angustifolia* Sand Dune Forest Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97MD11
Species name and age class/ Riparian Health Rank	A
TREES	
Populus angustifolia James—older trees	92

Miscellaneous Unclassified *Populus angustifolia* stands

Five stands (see table below) from the Rio Grande and Closed Basin fall into a "catch-all bin" category of cottonwood dominated stands, the "*Populus angustifolia*/Mesic graminoids" community. It is not a tracked or ranked community by the Heritage program. There is no (or very little) shrub understory layer, and the ground cover is primarily dominated by non-native grasses. These stands are assumed to be, for the most part, a product of human-induced change, chronic or historical disturbance. Growing season-long grazing combined with winter grazing can reduce diverse cottonwood stands to this community. After a rest of 2-3 growing seasons, short duration grazing may allow for the development of a shrub layer and cottonwood regeneration.

This community is quite common in the mountain valleys. It forms narrow strips along riverbanks, and is often surrounded by hay fields. It is easily recognized by its characteristic lack of or very sparse shrub layer and heavy abundance on non-native herbaceous species. It has not been well sampled as part of the Colorado Riparian Classification Project because it is considered a disturbed community type.

Another very common "community" is the *Populus angustifolia* Recent Alluvial Bar Plant Association. This community consists of young, newly established stands of pure cottonwood seedlings and saplings on point bars, sand bars, stream banks and islands (Jones and Walford 1995)

Table 23. Percent Cover of Plant Species in Miscellaneous Unclassified *Populus angustifolia* stands from the Rio Grande and Closed Basin Watersheds.

Plant Association Name	Populus angustifolia/Mesic graminoid					Populus angustifolia Recent Alluvial Bar
Plot Number	97BG06	97EV12	97EV16	97MD25	97MD31	95RG01
Species name and age class/ Site Rank	B	C	B	C	C	B
TREES						
Populus angustifolia James—older trees	11	47	89	68	83	
Populus angustifolia James—saplings		8				5
Populus angustifolia James—seedlings		5				14
SHRUBS						
Chrysothamnus nauseosus (Pallas) Britton	9					
Pentaphylloides floribunda (Pursh) A. Love		2				1
Salix drummondiana Barratt ex Hook.						2
Salix geyeriana Anderss.		5				
GRAMINOIDS						
Agropyron cristatum (L.) Gaertn.					18	
Agropyron sp.				8		
Bromus inermis Leyss.		1	1		1	
Carex sp.		1	1		1	2
Pascopyron smithii (Rydb.) A. Love	5					
Poa pratensis L.		5		6	12	6
FORBS						
Achillea millefolium var. apicola (Rydb.) Garrett		1				2
Asparagus officinalis L.					2	
Chenopodium glaucum L.	4					
Descurania sp.	9					
Lathyrus lanszwertii (Rydb.) Dorn					6	
Lupinus sp.			2			
Maianthemum stellatum (L.) Link			15		3	
Trifolium repens L.						7
Vicia americana Muhlenberg.			9			
Vicia sp.					2	

Quaking aspen (*Populus tremuloides*) Alliance

Quaking aspen/thinleaf alder (*Populus tremuloides/Alnus incana* ssp. *tenuifolia*) Plant Association

CNHP Rarity Rank: G3 / S3-- This plant association has been documented only in Colorado. It is expected to occur in other Rocky Mountain States. This plant association is known from throughout the western slope.

General Description and Comments: The *Populus tremuloides/Alnus incana* ssp. *tenuifolia* (quaking aspen/thinleaf alder) plant association is located in narrow ravines and along first and second-order streams where upland *Populus tremuloides* forests intermix with riparian shrub vegetation and at lower elevations where *Populus tremuloides* persists only in the riparian zone. The presence of obligate riparian species distinguish this association from upland *Populus tremuloides* communities.

Related Literature and Synonyms: This type has not been described in any previous literature.

Regional Distribution: This plant association has not been documented outside of Colorado.

Distribution in Colorado: This association occurs in the Routt National Forest, and the Colorado and Gunnison River Basins (Kettler and McMullen 1996, Kittel *et al*. 1994, Kittel *et al*. 1995).

The following information is based on: a total of thirteen quantitative plots; four from the Colorado River Basin (93SS06, 93SS36, 93DR21, 93DR22), four from the Gunnison River Basin (94GK09, 94GK10, 94MD37, 94RR46), one from the Routt National Forest (#535), and four from the Rio Grande and Closed Basins (97MD06, 97BG20, 97EV02, 97EV10) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 8400-9600 ft (2600-2900 m).

Site Geomorphology: This plant association occurs in narrow, 25-225 feet (10-70 m) wide, valleys along stream banks of first- and second-order streams. Stream channels were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A3, A4) and occasionally, of moderate gradient and width (Rosgen's Channel Type: B3). Stream gradients range from 1-30%.

Soils: Soils are generally skeletal, shallow, sandy and sandy clay loams or deeper sandy clay loams. In the Colorado River Basin, the soils classify as coarse loamy to sandy cumulic Cryaquolls or Cryoborolls to oxyaquic Cryorthents.

Vegetation: This plant association has a tall, 20-40 foot (6-12 m), overstory of 10-70% cover of *Populus tremuloides* (quaking aspen). Several conifer species can also occur including up to

20% cover of *Pinus contorta* (lodgepole pine) and up to 10% cover each of *Abies lasiocarpa* (subalpine fir), *Picea pungens* (Colorado blue spruce), and *Pseudotsuga menziesii* (Douglas-fir).

The shrub understory and forb species along the immediate stream bank distinguish this riparian plant association from the adjacent forests. The shrub layer is dominated by 10-90% cover of *Alnus incana* (thinleaf alder). In plots from the Colorado and Gunnison River basins other shrubs included up to 20% cover of *Salix drummondiana* (Drummond willow), and up to 10% cover each of *Lonicera involucrata* (honeysuckle) and *Rosa woodsii* (woods rose). The forb undergrowth can be dense and includes *Mertensia ciliata* (mountain bluebells), *Osmorhiza depauperata* (blunt-fruit sweet-cicely), and *Senecio triangularis* (arrowleaf groundsel). Graminoid cover is minor.

Successional and Ecological Processes: *Populus tremuloides* (quaking aspen) woodlands can be self perpetuating climax plant associations or an early-seral stage of coniferous types (DeByle and Winokur 1985). *Populus tremuloides* (quaking aspen) is a non-obligate riparian species and often occurs in upland communities. Where valley bottoms are moist and stable, *Populus tremuloides* can dominate the riparian area, while also occurring on adjacent mesic hillslopes.

Alnus incana ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After 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* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

Alnus incana (thinleaf alder) fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia* and increases the ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder species ranges from 16 to 150 kg/ha annually compared to 1 to 10 kg/ha/yr deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

Adjacent Riparian Vegetation: *Alnus incana* (thinleaf alder) and *Salix* spp. (willow) shrublands often occur on adjacent, rockier and steeper gradient stream reaches.

Adjacent Upslope Vegetation: *Pinus contorta* (lodgepole pine) and *Populus tremuloides* (quaking aspen) forests can occur on adjacent hill slopes.

Management: Dense stands of *Alnus incana* (thinleaf alder) hinder livestock access into this plant association. *Alnus incana* is not particularly palatable to livestock, but can be trampled as animals search for more palatable species. Open stands may provide moderate forage and shade in the summer (Hansen *et al*. 1995). With heavy livestock grazing, the shrub layer can become dominated by *Symphoricarpos* spp. (snowberry) (DeByle and Winokur 1985). This is likely to occur in valley bottoms where overgrazing has dried the soil and dropped the water table.

Fire as a management tool may be useful in regenerating old stands of *Populus tremuloides* (Hansen *et al*. 1995). Light fires will stimulate *Populus tremuloides* suckering, but may also kill the canopy trees. Most fires kill *Alnus incana* resulting a sparse herbaceous understory and bank destabilization. It may be necessary to protect these sites from beaver and grazing animals in order to ensure successful regeneration following a fire (Hansen *et al.* 1988, Hansen *et al*. 1995).

Alnus incana sprouts quickly when cut at 4-5 year intervals and can be used for restabilizing stream banks. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow-growing sprouts (Hansen *et al*. 1995).

Table 24. Percent Cover of Plant Species in Stands of the *Populus tremuloides/Alnus incana* Plant Association from the Rio Grande and Closed Basin Watershed.

Plant Association Name	Populus tremuloides/Alnus incana			
Plot Number	97MD06	97BG20	97EV02	97EV10
Species name and age class/ Site and Riparian Health Rank	C	A	B	C
TREES				
Abies lasiocarpa (Hook.) Nutt.--older trees		4		
Juniperus monosperma (Engelmann) Rydberg			38	
Picea pungens Engelm.--older trees		18		
Populus tremuloides Michx.--older trees	48	3	71	14
Populus tremuloides Michx.--seedlings			1	1
SHRUBS				
Alnus incana (L.) Moench	89	72	10	9
Ribes inerme Rydb.				2
Ribes montigenum McClatchie	11		1	6
Rosa woodsii Lindl.				1
Salix exigua Nutt.				5
Salix lasiandra var. caudata (Nutt.) Sudworth			20	
GRAMINOIDS				
Calamagrostis canadensis (Michx.) Beauv.	5	1		8
Carex disperma Dewey		9		
Poa compressa L.		1	3	9
Poa palustris L.	1	1		
FORBS				
Cardamine cordifolia Gray	19	2		1
Maianthemum stellatum (L.) Link		3		
Mertensia ciliata (James ex Torr.) G. Don		5		1
Oxypolis fendleri (Gray) Heller	8	6		
Saxifraga odontoloma Piper		4		
Taraxacum officinale G.H. Weber ex Wiggers	5	2	1	9
Urtica dioica ssp. gracilis (Ait.) Seland.			1	1
HORESTAILS				
Equisetum arvense L.	3			1

Quaking aspen/river birch (*Populus tremuloides/Betula occidentalis*) Plant Association

CNHP Rarity Rank: G3? / S2 --This plant association is known from Nevada and the Colorado Front Range. It is limited to steep perennial streams. This plant association is known only from foothill streams of the west side of the Sangre de Cristo Mountains and along the Colorado Front Range. This association is highly threatened by development, recreational use, and stream impoundments. The question mark in the Global rank indicates the community is suspected to be more abundant but additional stands have not been documented.

General Description and Comments: The *Populus tremuloides/Betula occidentalis* (quaking aspen/river birch) plant association is a lush, deciduous riparian woodland with a diverse canopy of aspen and conifer trees. The understory has a high structural diversity of shrubs and an herbaceous undergrowth ranging from a thick carpet of grasses and forbs to a very sparse ground cover in heavily shaded areas. The presence of obligate riparian shrub species distinguish this association from upland *Populus tremuloides* communities.

Related Literature and Synonyms: The *Populus tremuloides/Betula occidentalis* community type (Manning and Padgett 1995) is closely related and possibly synonymous with the Colorado *Populus tremuloides/Betula occidentals* plant association.

Regional Distribution: This plant association is documented from Nevada (Manning and Padgett 1995) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association is documented from the Front Range in the South Platte River Basin (Kittel *et al*. 1997) and along the foothills of the Sangre de Cristo mountains in the San Luis Valley (Colorado Natural Heritage Program 1997).

The following information is based on: a total of seven quantitative plots; five from the South Platte River Basin (96GK16, 96GK23, 96AM01, 96AM28, 96AM76) and two from the Closed Basin (97GK20, 97MD14) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7540-10,400 ft (2300-3100 m).

Site Geomorphology: This plant association occurs along stream banks, benches and narrow floodplains in narrow valleys, 40-200 feet (130-660 m) wide, and steep, first-order gulches. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: G2-G4, A3, A4) or moderately steep and slightly meandering (Rosgen's Channel Type: B3).

Soils: The soils are uniformly sandy loams becoming skeletal at a 3 foot (1 m) depth. A sandy clay layer consistently appears at an average depth of 5 inches (12 cm).

Vegetation: This plant association is characterized by an open to dense canopy of *Populus tremuloides* (quaking aspen) with 20-85% cover. *Betula occidentalis* (river birch) forms a thick band along the stream banks with 40-80% cover. Associated tree species vary with elevation. *Pinus ponderosa* (ponderosa pine) and *Populus* x *acuminata* (lanceleaf cottonwood) occur at lower elevations while *Abies lasiocarpa* (subalpine fir) occurs at higher elevations. Other shrub species include up to 50% cover of *Cornus sericea* (red-osier dogwood), up to 30% cover of *Salix monticola* (mountain willow), up to 20% cover of *Salix bebbiana* (Bebb willow), up to 10% cover of *Acer glabrum* (Rocky Mountain maple) and < 5% cover of *Alnus incana* ssp. *tenuifolia* (thinleaf alder). The herbaceous undergrowth is sparse to thick, depending on the amount of sunlight reaching the ground.

Successional and Ecological Processes: *Populus tremuloides* (quaking aspen) woodlands can be self perpetuating climax plant associations or an early-seral stage of coniferous types (DeByle and Winokur 1985). *Populus tremuloides* (quaking aspen) is a non-obligate riparian species and often occurs in upland communities. Where valley bottoms are moist and stable, *Populus tremuloides* can dominate the riparian area, while also occurring on adjacent mesic hillslopes.

Betula occidentalis (river birch) becomes abundant along stream banks with perennial stream flow and well-aerated soils. The presence of seedling and sapling conifers in some stands of this plant association indicates the potential to become a conifer/*Betula occidentalis* type (Manning and Padgett 1995). The suppression of fire in this plant association may allow conifer species to gain dominance since *Populus tremuloides* and *Betula occidentalis* sprout following fires (Manning and Padgett 1995).

Adjacent Riparian Vegetation: The *Populus tremuloides/Betula occidentalis* plant association is usually the only riparian community along a stream reach.

Adjacent Upland Vegetation: Adjacent uplands are heavily forested with stands of *Pinus ponderosa* (ponderosa pine), *Pseudotsuga menziesii* (Douglas fir), or *Populus tremuloides* (quaking aspen).

Management: Forage for livestock grazing is limited in this plant association due to the low herbaceous productivity along heavily shaded reaches. However, the multiple canopy structure is excellent for wildlife cover. Fire as a management tool may be useful in regenerating old stands of *Populus tremuloides* (Hansen *et al*. 1995). Light fires will stimulate *Populus tremuloides* suckering, but may also kill the canopy trees. Fire can easily kill *Betula occidentalis* shoots due to thin bark. However, new shoots of *Betula occidentalis* will resprout from uninjured basal buds. It may be necessary to protect these sites from beaver and grazing animals in order to ensure successful regeneration following a fire (Hansen *et al.* 1988, Hansen *et al*. 1995). *Betula occidentalis* and *Populus tremuloides* are effective streambank stabilizers due to their strong root systems. Nursery grown seedlings of *Betula occidentalis* can be successfully transplanted and will typically grow quickly (Hansen *et al.* 1988).

The stand table for *Populus tremuloides/Betula occidentalis* plant association will follow the next plant association description.

Quaking aspen/tall forb (*Populus tremuloides/*Tall Forbs) Plant Association

CNHP Rarity Rank: G5 / S5-- This is a large and small patch forest type known from throughout the U.S. and Canadian Rocky Mountains. This community is common on the upslopes and in riparian areas of the Colorado west slope.

General Description and Comments: *Populus tremuloides* (quaking aspen) forests are abundant in the Rocky Mountains. The *Populus tremuloides/*tall forb plant association is found on steep hill sides and often along narrow riparian areas. The undergrowth is characterized by a thick carpet of 1-3 foot (<1 m) tall forbs with no one species dominant. Forb species along stream bank stands can be different from hill side stands.

Related Literature and Synonyms: The *Populus tremuloides/*tall forb plant association (Bourgeron and Engelking 1994) and the *Populus tremuloides*/*Ligusticum* spp. (quaking aspen/ligusticum) plant association (Johnston 1987) are synonymous with the Colorado *Populus tremuloides/*tall forb plant association.

Similar Communities: Closely related communities include: the *Populus tremuloides/Heracleum sphondylium* (quaking aspen/cow parsnip) plant association (Johnston 1987) which has significant shrub cover and the *Populus tremuloides*/*Heracleum sphondylium* plant association (Hoffman and Alexander 1980) which has different forb species. *Heracleum lanatum* is a synonym for *Heracleum sphondylium* (Kartesz 1994).

Regional Distribution: This plant association occurs in Nevada, Idaho, Montana, Wyoming, Utah, and Colorado (Bourgeron and Engelking 1994, Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Routt National Forest (Kettler and McMullen 1996), the White River Basin (Johnston 1987, Kittel *et al.* 1994), the San Juan National Forest (Richard *et al.* 1996) and the Closed Basin (Colorado Natural Heritage Program 1997).

The following information is based on: a total of eight quantitative plots; one from the Routt National Forest (525), three from the Colorado River Basin (93GK13, 93GK14, 93GK30), one from the San Juan National Forest (147) and three from the Closed Basin (97BG15, 97EV15, 97GK28), and a community description from The Nature Conservancy (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7000-10,000 ft (2100-3000 m).

Site Geomorphology: This plant association occurs on broad, gently sloping hillsides and valley bottoms. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are high-gradient and very narrow (Rosgen's Channel Type: A3, A5), moderately wide and moderately sinuous (Rosgen's Channel Type: B2, B3), or wide and sinuous (Rosgen's Channel Type: C4, C5).

Soil: The soils are derived from alluvial deposition of a variety of parent materials (Mueggler 1988). The soils are deep, well-drained loams, sandy loams to clay loams (Boyce 1977, Hess and Wasser 1982). With increasing depth, coarse rock fragments increase in proportion. There is a thin litter layer on the surface (Hess and Wasser 1982) and little organic matter in the A horizon (Boyce 1977). Soils in the Colorado River Basin classify as fine-loamy pachic and cumulic Cryoborolls and fine-loamy or fine clayey mollic Cryofluvents.

Vegetation: *Populus tremuloides* is the dominant tree species in this plant association with 10-80% cover. Shrub cover is generally minor. The undergrowth is characterized by the presence of one or more species of tall forbs, accompanied by a mixture of low forbs and graminoids. Forb cover includes up to 50% *Hydrophyllum fendleri* (waterleaf), up to 40% *Heracleum sphondylium* (cow parsnip), up to 30% *Osmorhiza occidentalis* (western sweet-cicely), and up to 10% each of *Delphinium barbeyi* (western larkspur) and *Senecio triangularis* (arrowleaf groundsel). Additional tall forbs include *Aconitum columbianum* (monkshood), *Delphinium barbeyi* (larkspur), *Mertensia ciliata* (mountain bluebells), and *Rudbeckia laciniata* (cutleaf coneflower). Other low forbs include *Achillea lanulosa* (yarrow), *Galium boreale* (northern bedstraw), *Galium triflorum* (sweet-scented bedstraw), *Geranium richardsonii* (Richardson geranium), *Maianthemum stellatum* (false Solomon's seal), *Thalictrum fendleri* (Fendler meadowrue), and *Viola* spp. (violet). Graminoid cover includes up to 30% cover of *Equisetum arvense* (field horsetail) and 1-20% cover of *Poa pratensis* (Kentucky bluegrass). Other graminoid cover includes *Calamagrostis canadensis* (bluejoint reedgrass), *Carex* spp. (sedge), and *Elymus glaucus* (blue wildrye).

Successional and Ecological Processes: *Populus tremuloides* (quaking aspen) woodlands can be self-perpetuating climax plant associations or an early-seral stage of coniferous types (DeByle and Winokur 1985). *Populus tremuloides* is a non-obligate riparian species and often occurs in upland communities. Where valley bottoms are moist and stable, *Populus tremuloides* can dominate the riparian area, while also occurring on adjacent mesic hillslopes.

Adjacent Riparian Vegetation: Other *Populus tremuloides* (quaking aspen) riparian types and forb communities occur in adjacent riparian areas.

Adjacent Upslope Vegetation: *Populus tremuloides* woodlands and *Artemisia tridentata* (big sagebrush) or *Symphoricarpos* spp. (snowberry) shrublands occur on adjacent upslopes.

Management: The primary source of disturbance for this plant association is livestock grazing, which can have severe impacts. Species diversity will decrease and palatable forbs may be eliminated. There may also be a shift in species composition to dominance by unpalatable forbs such as *Lathyrus* and *Rudbeckia* species. Heavy grazing may result in a community dominated by annuals (Mueggler 1988). Livestock may also significantly impact the growth of aspen shoots, impeding regeneration (Johnston and Hendzel 1985). This plant association provides high quality summer range for large mammals as well as cover for other wildlife species. Forage production can be high with proper management (Hoffman and Alexander 1980).

This association is moderately to highly productive for timber harvesting. Clear cutting in patches or small blocks is the most effective method for harvesting. Erosion is generally not a problem on the high quality sites where soils are well developed. However, there is potential for mass movement of soils if the overstory is clear-cut in large blocks (Hoffman and Alexander 1980). Large clear-cuts will also result in a higher water table and reduced regeneration of aspen. If the goal of cutting is to stimulate aspen suckering, diseased trees should be removed first to avoid infection of young shoots (Powell 1988).

Fire as a management tool may be useful in regenerating old stands of *Populus tremuloides* (quaking aspen). The tall forb layer may help to carry fires, particularly during the dry fall season. Light fires will stimulate *Populus tremuloides* suckering, but may also kill the canopy trees. It may be necessary to protect these sites from beaver and grazing animals in order to ensure successful regeneration following a fire (Hansen *et al*. 1995).

Table 25. Percent Cover of Plant Species in Stands of the *Populus tremuloides/Betula occidentalis* and *Populus tremuloides/*Tall Forbs Plant Associations from the Rio Grande and Closed Basin Watershed.

Plant Association Name	Populus tremuloides/ Betula occidentalis		Populus tremuloides/Tall Forbs		
Plot Number	97GK20	97MD14	97BG15	97EV15	97GK28
Species name and age class/ Site and Riparian Health Rank	A	A	A	B	A
TREES					
Abies concolor--mature trees					6
Picea pungens Engelm.--older trees				15	
Picea pungens Engelm.--saplings				8	
Populus tremuloides Michx.--older trees	77	85	77	48	76
SHRUBS					
Betula occidentalis Hooker	75	77			
Cornus sericea L.	46				
Juniperus communis L.			9		3
Prunus virginiana L. var. melanocarp (A. Nels.) Sarg.			6		3
Ribes montigenum McClatchie			10		
Rosa woodsii Lindl.	10	14	27	3	25
Salix bebbiana Sarg.	3	15	20		
GRAMINOIDS					
Calamagrostis canadensis (Michx.) Beauv.		1		2	4
Carex disperma Dewey					9
Carex hoodii F. Boott in Hook.				8	
Carex utriculata Boott				10	
FORBS					
Aconitum columbianum Nutt.	1		1		1
Cardaria latifolia					5
Conioselinum scopulorum (Gray) Coult. & Rose			18		9
Fragaria virginiana Mill			14		
Maianthemum stellatum (L.) Link	13	6		1	
Oxypolis fendleri (Gray) Heller			1		14
HORESTAILS					
Equisetum arvense L.			13	6	32

Miscellaneous Unclassified *Populus tremuloides* stands

The upper reaches of Deadman Creek (elevation 8400) in Saguache county had a stand (Plot 97MD07) dominated by *Populus tremuloides* (aspen) and *Acer glabrum* (mountain maple) in the understory. This is a rare community type (G1 S1), and we were surprise to find it in a riparian area. We did see this community elsewhere in the study area in narrow valleys of the Sangre de Cristo Mountains, on National Monument land and US Forest Service Land. It is a mesic deciduous forest, dominated by aspens and an open to dense subcanopy of *Acer glabrum* (mountain maple) (Table 26). It typically grows on steep, north facing slopes.

Hudson Branch of Medano Creek has steep side slopes that come directly down to the narrow little stream banks. *Populus tremuloides* (quaking aspen) thickly covers most of these upslopes, and completely cover the stream banks and the *Salix drummondiana* (Drummond's willow) growing along the stream banks. This stand (97MD15) was first classified as a *Salix drummondiana* type, but, in retrospect, it is impossible to separate the willow from its overstory canopy. There are many stands like this in Colorado, where aspens grow right in the stream bank, as well as on adjacent hill sides. Currently there is no *Populus tremuloides/Salix drummondiana* (quaking aspen/Drummond's) plant association described for Colorado. This is likely to change as the *Populus tremuloides* (quaking aspen) dominated riparian plots are re-assessed.

Table 26. Percent Cover of Plant Species in Miscellaneous Unclassified *Populus tremuloides* Stands from the Rio Grande and Closed Basin Watershed.

Tentative plant association name	Populus tremuloides/Acer glabrum	Populus tremuloides/Salix drummondiana
Plot Number	97MD07	97MD15
Species name and age class/ Site and Riparian Health Rank	A	C
TREES		
Abies concolor--mature trees		3
Picea pungens Engelm.--older trees		4
Populus tremuloides Michx.--older trees	65	75
SHRUBS		
Acer glabrum Torr.	24	
Alnus incana (L.) Moench		5
Betula occidentalis Hooker		
Cornus sericea L.	8	
Rosa woodsii Lindl.	23	
Salix bebbiana Sarg.	1	
Salix drummondiana Barratt ex Hook.		52
GRAMINOIDS		
Calamagrostis canadensis (Michx.) Beauv.	8	7
Carex disperma Dewey		2
FORBS		
Conioselinum scopulorum (Gray) Coult. & Rose		8
Dodecatheon pulchellum (Raf.) Merr.		5
Epilobium angustifolium L.	26	9
Fragaria virginiana Miller		1
Geranium richardsonii Fisch. & Trautv.		7
Maianthemum stellatum (L.) Link	7	
Saxifraga odontoloma Piper		12
Oxypolis fendleri (Gray) Heller		5
HORESTAILS		
Equisetum arvense L.		17

CDOW GAP:	6001. Forest Dominated Wetland/Riparian Type. a. Plains deciduous Riparian

Salix amygdaloides (peach-leaf willow) Alliance

One stand sampled (97GK05) on the Rio Grande, at the Alamosa Wildlife Refuge, had widely scattered groups of *Salix amygdaloides* (peach-leaf willow) and *Salix exigua* (coyote willow). This stand does not fit any know plant associations, but is similar to several stands CNHP has sampled throughout the state on larger rivers (e.g. the South Platte). These stands appear to be degraded examples of the lower elevation, broad floodplain communities dominated by either plains or Rio Grande cottonwoods, and peach-leaf willows. Both *Populus angustifolia* (narrowleaf cottonwood) and *Populus deltoides* ssp. *wislizenii* are present on the floodplain at the Alamosa Wildlife Refuge. The reach and floodplain are highly altered, with human-created wetlands, water level-controlled ponds, and agricultural fields, and is managed specifically for waterfowl habitat. The river channel itself is becoming entrenched, and is less sinuous than it was historically. The stand occurs at 7500 feet elevation, on the immediate stream bank, in between a levee (an access maintenance road to the ponds) and the river channel, 0.5 m above annual high water level. The soil is a deep silty clay loam, over one meter deep, with no visible mottles in the profile.

Table 27. Percent Cover of Plant Species in the Stand of *Salix amygdaloides* Alliance from the Rio Grande and Closed Basin Watershed.

Plot Number	97GK05
Species name and age class/ Site and Riparian Health Rank	C
TREES	
Salix amygdaloides --older trees	26
SHRUBS	
Ribes aureum Pursh.	18
Salix exigua Nutt.	1
GRAMINOIDS	
Carex lanuginosa Michx.	1
Pascopyron smithii (Rydb.) A. Love	4
Phragmites australis (Cav.) Trin.	3
FORBS	
Cardaria latifolia	35
Chenopodium alba	1
Cirsium arvense	13
Epilobium angustifolium L.	3
Rumex sp.	2

USNVC:	III. B. 2. c. Seasonally/Temporarily Flooded Cold-Deciduous Shrubland
COWARDIN:	***Palustrine***
CDOW GAP MAP:	62001. Shrub Dominated Wetland/Riparian Type a. Foothills and Montane Shrubland

Alnus incana ssp. *tenuifolia* Seasonally Flooded Shrubland Alliance

Thinleaf alder/Mesic Forbs (*Alnus incana* ssp. *tenuifolia*/Mesic Forbs) Plant Association

CNHP Rarity Rank: G3G4Q / S3 -- This plant association is not rare, but is declining from its historic extent. It is rarely found in good condition and stands usually have an abundance of non-native species in the undergrowth. Because this community can change significantly with improper grazing, this plant association may not be recognized as the same type across state lines, and thus the taxonomy is in question (Q). In Colorado, there are many (>30) documented occurrences, however, few are large and in pristine condition. This plant association is threatened by improper livestock grazing, stream flow alterations, road and railroad improvements and maintenance and heavy recreational use.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia*/mesic forb (thinleaf alder/mesic forb) plant association is characterized by stands of medium-tall, deciduous shrubs and a thick herbaceous undergrowth of forbs and wetland-indicator grasses. A low canopy of shorter shrubs may also be present with *Ribes* (currant) and *Salix* (willow) species and *Cornus sericea* (red-osier dogwood). Undisturbed stands have abundant forbs and native grasses. Stands disturbed by season-long livestock grazing have reduced forb cover and an increase in non-native grasses including *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop). Large, 22,500 sq. ft (>100 m^2), stands with the native herbaceous undergrowth intact are uncommon.

Related Literature and Synonyms: The *Alnus incana* ssp. *tenuifolia*/mesic forb (thinleaf alder/mesic forb) plant association has been described by a variety of names in the literature. These types appear to be synonymous, or nearly so, with the Colorado *Alnus incana/*mesic forb plant association. Synonymous communities include: the *Alnus incana* association and an *Alnus incana* Springs association (Kovalchik 1987), the *Alnus incana* community type (Hansen *et al.* 1995), the *Alnus incana*/mesic forb community type (Manning and Padgett 1995, Padgett *et al.* 1989), and the *Alnus incana/Ribes hudsonianum* community type (Youngblood *et al.* 1985). Other closely related communities include: the *Alnus incana* ssp. *tenuifolia/Rudbeckia laciniata* association (Cooper & Cottrell 1990), the *Alnus incana-Betula fontinalis/Salix* spp. and *Alnus incana-Salix drummondiana/Equisetum arvense* plant associations (Johnston 1987).

Similar Communities: Closely related communities dominated by *Alnus tenuifolia* occur in Alaska, but grow in very wet, swampy areas with an understory of *Calamagrostis canadensis* (bluejoint reedgrass) and various *Equisetum* (horsetail) species (Viereck *et al.* 1992). *Alnus tenuifolia* is a synonym for *Alnus incana* ssp. *tenuifolia* (Kartesz 1994).

Regional Distribution: This plant association occurs in Oregon (Kovalchik 1987), Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), Montana (Hansen *et al*. 1995), Idaho, Wyoming (Youngblood *et al.* 1985, Jones 1992), and Colorado (Cooper and Cottrell 1990, Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs throughout the Rocky Mountains of Colorado (Cooper and Cottrell 1990, Johnston 1987, Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996, Kettler and McMullen 1996, Richard *et al.* 1996, Colorado Natural Heritage Program 1997).

The following information is based on: a total of thirty-six quantitative plots;: thirteen from the Routt National Forest (93K042, 93K061, 93K202, 93K362, 94A513, 94A514, 94A517, 94R532, 94A540, 94A547, 94R549, 94R570, 94A583), two from the Yampa River Basin (90MR28, 90MR90), three from the White River Basin (92NL43, 92NL44, 92NL49), four from the Colorado River Basin (93SS29, 93SS33, 93GK49, 93DR10), five from the Gunnison River Basin,(94GK13, 94MD38, 94RR44, 94RR47, 94RR51), one from the San Juan National Forest (93C382), two from the Rio Grande National Forest (97EV08, 97EV09), five from the Closed Basin (97MD05, 97MD08, 97EV01, 97BG12), and one from the lower South Platte River Basin (95GK22) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6400-9600 ft (2000-2900 m).

Site Geomorphology: This plant association occurs along narrow, 130-230 feet (40-70 m) wide, alluvial benches and terraces of canyons and valleys. It also occurs as narrow bands in wider valleys, >400 feet (>120 m), and occasionally forms a wide band on the floodplain. Streams channels were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are highly variable. They can be steep (3-12% gradient) and narrow (Rosgen's Channel Type: A3, A4, A6) or wider, rocky, and moderately sinuous (Rosgen's Channel Type: B2, B3, B4, B5). Occasionally, stream channels are low gradient and highly sinuous (Rosgen's Channel Type: C3, C4), narrow and highly sinuous (Rosgen's Channel Type: E3), or braided (Rosgen's Channel Type: D5).

Soil: Soils are well drained silt loams, loams, sandy clay loams, or sandy loams. Some profiles have a high percentage of organic matter and are either skeletal or stratified with skeletal layers. Some profiles have significant silt fractions in the upper layers. Soils in the Colorado River Basin, classify as sandy oxyaquic Cryumbrepts, loamy typic Cryorthents, fragmental (calcareous) Cryaquents and loamy over sandy Typic Cryoboralfs.

Vegetation: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) creates a dense, tall (15-25 feet) shrub canopy with 20-95% cover. Other shrubs include up to 30% cover of *Lonicera involucrata* (honeysuckle), up to 20% cover of *Salix geyeriana* (Geyer willow), up to 35% cover each of *Salix monticola* (mountain willow) and *Salix eriocephala* var. *ligulifolia* (strapleaf willow), and up to 15% cover each of *Salix drummondiana* (Drummond willow) and *Salix bebbiana* (Bebb willow). A few trees may be present along the edges of the stand including up to 20% cover each of *Picea engelmannii* (Engelmann spruce) and *Populus tremuloides* (quaking aspen) and up to 10% cover of *Populus angustifolia* (narrowleaf cottonwood).

The ground is generally very wet and covered with tall, 3-7 feet (1-2 m), forbs and graminoids. Forbs include up to 70% cover of *Heracleum sphondylium* (cow parsnip), up to 45% cover of *Angelica ampla* (giant angelica), up to 20% cover each of *Mertensia ciliata* (mountain bluebells) and *Rudbeckia laciniata* (cutleaf coneflower), and up to 15% cover of *Viola canadensis* (Canada violet). Graminoids include up to 25% cover of *Glyceria* spp. (mannagrass), up to 20% cover each of *Calamagrostis canadensis* (bluejoint reedgrass) and *Carex utriculata* (beaked sedge), and up to 5% cover of *Carex microptera* (small-wing sedge). A dense cover of up to 30% *Equisetum arvense* (field horsetail) and up to 10% cover each of *Equisetum pratense* (meadow horsetail) and *Hippochaete hyemalis* (scouring rush) may be present.

Successional and Ecological Processes: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After establishment, young stands of *Alnus incana* are usually continually flooded. As stands mature, the stems 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 on this higher surface 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* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

Alnus incana (thinleaf alder) is a nitrogen fixer and increases the 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 to 150 kg/ha annually, as much as 100 times that of atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

Adjacent Riparian Vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests occur along narrow reaches and on higher ground above stream banks and floodplains. Along wider reaches, *Populus angustifolia* (narrowleaf cottonwood) and mixed *Populus angustifolia*-conifer (narrowleaf cottonwood-evergreen) forests or *Salix drummondiana* (Drummond willow), *Salix exigua* (coyote willow), *Salix boothii* (Booth willow), and *Salix monticola* (Rocky Mountain willow) shrublands occur on stream banks and floodplains. *Calamagrostis canadensis* (bluejoint reedgrass) and *Carex utriculata* (beaked sedge) meadows may also occur in low-lying swales on adjacent floodplains.

Adjacent Upslope Vegetation: At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests and *Populus tremuloides* (quaking aspen) woodlands occur on adjacent hillslopes. At lower elevations, open woodlands of *Pinus ponderosa* (ponderosa pine) and *Juniperus osteosperma* or *monosperma* (Utah or one-seeded juniper) occur on south-facing slopes, while thick forests of *Pseudotsuga menziesii* (Douglas-fir) and *Pinus contorta* (lodgepole pine) occur on north-facing slopes.

Management: The *Alnus incana* ssp. *tenuifolia/*mesic forb (thinleaf alder/mesic forb) plant association is a relatively long-lived and stable community, but can change in response to the impacts of improper livestock grazing. Dense stands of *Alnus incana* (thinleaf alder) may hinder livestock access. *Alnus incana* (thinleaf alder) is not particularly palatable to livestock, but can be trampled as animals search for more palatable forb species (Hansen *et al*. 1995). Season-long grazing reduces the native forb cover and allows non-native grasses to increase. This may convert the site to an *Alnus incana*/mesic graminoid (thinleaf alder/mesic grasses) community. With rotation and rest, this type may be reverted back to the *Alnus incana* ssp. *tenuifolia*/mesic forb plant association (Padgett *et al.* 1989, Hansen *et al.* 1995).

In addition, if the herbaceous undergrowth of the *Alnus incana/*mesic forb plant association is dominated by non-native, weedy species, the stand may be a product of improper grazing. In the undergrowth is dominated by native forbs, the site is near potential.

Most fires kill *Alnus incana* (thinleaf alder) dominated stands, resulting in a sparse herbaceous understory and bank destabilization due to root death. *Alnus incana* ssp. *tenuifolia* sprouts quickly when cut at 4-5 year intervals and can be used as pole plantings for restabilizing stream banks. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow-growing sprouts (Hansen *et al*. 1995).

Table 28. Percent Cover of Plant Species in Stands of the *Alnus incana*/Mesic Forbs Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97BG12	97EV01	97EV08	97EV09	97MD05	97MD08
Species name and age class/ Site Rank	B	C	B	C	C	A
TREES						
Picea engelmannii Parry ex Engelm.--older trees						
Populus angustifolia James--older trees						21
Populus tremuloides Michx.--older trees					5	
SHRUBS						
Alnus incana (L.) Moench	93	86	33	38	76	35
Ribes montigenum McClatchie	2	31				2
Rosa woodsii Lindl.			1			7
Salix bebbiana Sarg.		9	1	11		
Salix drummondiana Barratt ex Hook.			7			
Salix eriocephala Michaux var. ligulifolia						18
Salix lasiandra var. caudata (Nutt.) Sudworth						32
Salix monticola Bebb			5			6
Symphoricarpos sp.						2
GRAMINOIDS						
Calamagrostis canadensis (Michx.) Beauv.	6		7	13	7	2
Carex sp.		1	5	3		3
Glyceria striata (Lam.) A.S. Hitchc.	11			4		
Poa compressa L.		13	2			
Poa pratensis L.	5		8	12		1
Unknown graminoid	1				2	
FORBS						
Achillea millefolium var. apicola (Rydb.)Garrett	8	3	2	4	3	
Angelica ampla Nelson	45					
Conioselinum scopulorum (Gray) Coult. & Rose				2	6	
Geranium richardsonii Fisch. & Trautv.			15	1		
Heracleum sphondylium L. var. montanum			1	2		
Hydrophyllum fendleri						
Maianthemum stellatum (L.) Link						27
Mentha arvensis L.	14	1			1	
Mertensia ciliata (James ex Torr.) G. Don		1			19	
Potentilla pulcherimma x hippiana	8				2	
Taraxacum officinale G.H. Weber ex Wiggers		1	12	10	1	
Trifolium pratense				14		
Urtica dioica ssp. gracilis (Ait.) Seland.	6	11	6		2	
HORSETAILS						
Equisetum sp.				1	1	13

Thinleaf alder/Mesic Graminoids (*Alnus incana* ssp. *tenuifolia*/Mesic Graminoids) Plant Association

CNHP Rarity Rank: G5Q / S3 This is a common plant association with over 100 occurrences throughout the Rocky Mountains. However it is rare to find stands in excellent condition, namely, dominated by native species in the undergrowth. In Colorado, many stands are in a degraded condition, with the bulk of the herbaceous undergrowth biomass replaced by non-native species. This association is threatened by improper livestock grazing and stream impoundments. The Q in the Global rank indicates there is some question as to the taxonomy (*i.e.*, what other states call by the same name may, in fact, be a different plant association).

General Description and Comments: The *Alnus incana* ssp. *tenuifolia*/Mesic Graminoids plant association is a stand of medium-tall deciduous shrubs with a thick herbaceous cover of mostly native forb and grass species and little to no overstory tree canopy. Heavily disturbed stands have abundant non-native grasses. In Nevada, Utah, southeastern Idaho, and Wyoming, this type is considered a grazing-induced community derived from the *Alnus incana*/mesic forb type (Padgett *et al.* 1989, Manning and Padgett 1995, and Jones 1992) and the species composition reflects this interpretation. In Colorado, however, several undisturbed stands have been observed with an undergrowth dominated by native graminoid species. This indicates a native version of this association may exist and it is not only created by improper grazing.

Related Literature and Synonyms: The *Alnus incana*/mesic graminoid plant association reported from Nevada, Utah, southeastern Idaho, and Wyoming (Jones 1992, Padgett *et al.* 1989, Manning and Padgett 1995) is synonymous with the Colorado *Alnus incana*/Mesic Graminoids plant association described here.

Similar Communities: Closely related communities include: the *Alnus incana* ssp. *tenuifolia-Betula fontinalis*/*Salix* spp. (thinleaf alder-river birch/willow) plant association (Johnston 1987) which has significant cover of *Betula fontinalis*; and the Closed Tall Shrub Swamp and Closed Tall Alder Scrub types (Viereck *et al.* 1992) both found in very wet, swampy areas, an environment unlike that of the Colorado stands. *Betula fontinalis* is a synonym for *Betula occidentalis* (Kartez 1994).

Regional Distribution: This plant association is reported to occur in Wyoming (Jones 1992), Idaho, Utah (Padgett *et al.* 1989), Nevada (Manning and Padgett 1995), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Routt and San Juan National Forests, the San Miguel River Basin, the Rio Grande Basin, and the upper Arkansas River Basin (Kettler and McMullen 1996, Richard *et al*. 1996, Colorado Natural Heritage Program 1997, Kittel *et al*. 1996).

The following information is based on: a total of fourteen quantitative plots; three from the Routt National Forest (93K011, 94A597, 94R598), one from the San Juan National Forest (94MS13), three from the Rio Grande Basin (97BG18, 97BG21, 97GK42), and seven from the upper Arkansas River Basin (95AM04, 95AM17, 95AM26, 95AM28, 95RR17, 95GK71, 95GK72) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6400-9800 ft. (2000-3000 m).

Site Geomorphology: This plant association occurs on narrow to moderately wide floodplains, stream benches, frequently flooded point bars, recently deposited islands, and dredged stream banks. It also occurs on isolated hillside seeps. Stream channels were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels can be steep and straight to highly sinuous (Rosgen's Channel Type: A3, A4, F3) or moderately steep and sinuous (Rosgen's Channel Type: B2, B3, B4, B6). Where this association occurs on point bars, stream channels are low gradient (<1% gradient) and highly sinuous (Rosgen's Channel Type: C5).

Soil: Soils are mostly coarse alluvium, but characteristically have silt loams or sandy clay loams at the surface with a high percentage of organic matter. Soils are shallow, 15-20 inches (35-53 cm), and become increasingly skeletal with depth. Most profiles have 10-50% mottles at 7-10 inches (18-25 cm) depth. One profile had gleyed, mineral soils indicating saturated conditions.

Vegetation: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) dominates the upper canopy with 10-90% cover. Other shrubs include up to 20% cover each of *Rubus deliciosus* (delicious raspberry) and *Betula occidentalis* (river birch), and 15% cover of *Salix exigua* (coyote willow). The undergrowth is a thick carpet of grasses. Native graminoids include up to 65% cover of *Calamagrostis canadensis* (bluejoint reedgrass), 30% cover of *Carex* spp. (sedge), and 25% cover each of *Glyceria striata* (fowl mannagrass) and *Festuca rubra* (red fescue). Some stands are dominated by introduced, non-native grasses including 41% cover of *Poa pratensis* (Kentucky bluegrass), and 25% cover each of *Agrostis stolonifera* (redtop) and *Bromus inermis* (smooth brome). Forb cover can be sparse.

Successional and Ecological Processes: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After 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* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer* *negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

Alnus incana (thinleaf alder) fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia* and increases the ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder species ranges from 16 to 150 kg/ha annually compared to 1 to 10 kg/ha/yr deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

In Nevada, Utah, southeastern Idaho, Montana, and Wyoming, the *Alnus incana*/Mesic Graminoids type is considered a grazing-induced community, derived from the *Alnus incana*/mesic forb plant association (Padgett *et al*. 1989, Manning and Padgett 1995, and Jones 1992). In Colorado, most stands of this plant association appear to be disturbed by improper grazing and have an abundance of non-native graminoid species. A few stands, however, appear undisturbed and have an undergrowth dominated by native grasses.

Adjacent Riparian Vegetation: *Populus angustifolia* (narrowleaf cottonwood) woodlands, *Betula occidentalis* (river birch) and *Salix exigua* (coyote willow) shrublands, and *Calamagrostis canadensis* (bluejoint reedgrass), *Carex aquatilis* (aquatic sedge), *Carex utriculata* (beaked sedge), and mesic forb meadows occur in adjacent riparian areas.

Adjacent Upland Vegetation: *Pinus ponderosa* (ponderosa pine), *Pseudotsuga menziesii* (Douglas-fir), and *Pinus edulis* (pinyon pine) woodlands occur on adjacent hill slopes.

Management: Dense stands of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) hinder livestock access. *Alnus incana* ssp. *tenuifolia* is not particularly palatable to livestock, but can be trampled as animals search for more palatable species (Hansen *et al*. 1995). *Salix* (willow) species are highly palatable to livestock, large mammals, and beaver (Kovalchik *et al.* 1988). Open stands may provide moderate forage and shade in the summer (Hansen *et al*. 1995).

Stands of the *Alnus incana*/Mesic Graminoids plant association that are dominated by non-native grasses and grass-like plants in the undergrowth are thought to be grazing-induced stages of the *Alnus incana*/mesic forb association (Hansen *et al.* 1995, Padgett *et al.* 1989, Kittel *et al.* 1996). However, several stands in Colorado have an undergrowth dominated by native grasses including *Calamagrostis canadensis* (bluejoint reedgrass), and several *Carex* (sedge) and *Equisetum* (horsetail) species (Kettler and McMullen 1996). These stands are clearly not disturbed and may represent the potential natural vegetation for stands in similar physical settings with non-native graminoids.

Most fires kill *Alnus incana* (thinleaf alder) dominated stands resulting in a sparse herbaceous understory and bank destabilization due to root death. *Alnus incana* ssp. *tenuifolia* sprouts quickly when cut at 4-5 year intervals and can be used as pole plantings for restabilizing stream banks. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow-growing sprouts (Hansen *et al*. 1995).

Table 29. Percent Cover of Plant Species in Stands of the *Alnus incana*/Mesic Graminoids Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97BG18	97BG21	97GK42
Species name and age class/ Site Rank	A	C	C
TREES			
Picea pungens Engelm.--older trees	5		
SHRUBS			
Alnus incana (L.) Moench	55	8	91
Ribes inerme Rydb.			3
Ribes montigenum McClatchie		3	
Salix bebbiana Sarg.			8
Salix drummondiana Barratt ex Hook.	8		
Salix eriocephala Michaux var. ligulifolia			3
Salix lasiandra var. caudata (Nutt.) Sudworth			6
Salix monticola Bebb		3	
Agrostis stolonifera L.			8
GRAMINOIDS			
Calamagrostis canadensis (Michx.) Beauv.	65		
Carex aquatilis Wahlenb.	1		
Carex utriculata Boott	8		
Cinna latifolia (Trev. Ex Goepp.) Griseb.			9
Deschampsia cespitosa (L.) Beauv.	1	12	
Elymus lanceolatus (Schribn. & Sm.) Gould.			14
Glyceria grandis S. Wats.			9
Glyceria striata (Lam.) A.S. Hitchc.	2	6	
Juncus saximontana Nelson		8	
Juncus sp.		1	
Poa pratensis L.		38	41
Scirpus microcarpa Presl.			1
Unknown graminoid		5	
FORBS			
Achillea millefolium var. apicola (Rydb.) Garrett	1	13	
Conioselinum scopulorum (Gray) Coult. & Rose	5		
Epilobium hornmannii Haussknecht			5
Mentha arvensis L.	7		14
Mertensia ciliata (James ex Torr.) G. Don	11		1
Taraxacum officinale G.H. Weber ex Wiggers	2	14	1
Unknown forb		6	
Urtica dioica ssp. gracilis (Ait.) Seland.	3	2	2
Vicia sp.	6		
Equisetum arvense L.	7	3	

Thinleaf alder-red-osier dogwood (*Alnus incana* ssp. *tenuifolia-Cornus sericea*) Plant Association

CNHP Rarity Rank: G4G3 / S3-- This plant association is widespread throughout the Rocky Mountains. However, all of the occurrences are small and threatened by improper grazing and stream impoundments. In Colorado, there are less than 100 stands. This association is threatened by improper livestock grazing, stream impoundments, and heavy recreational use.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia-Cornus sericea* (thinleaf alder-red-osier dogwood) plant association is a narrow thicket of medium to tall shrubs lining the stream bank. It is an uncommon association restricted to small tributaries and narrow, constricted reaches of larger rivers. Due to heavy shading, there is usually a limited herbaceous understory.

Related Literature and Synonyms: The following two communities are synonymous with the Colorado *Alnus incana-Cornus sericea* plant association: the *Alnus incana/Cornus sericea* community type (Padgett *et al.* 1989 and Manning and Padgett 1995) and the *Alnus incana* ssp. *tenuifolia/Swida sericea* plant association (Komarkova 1986). *Swida sericea* is synonym for *Cornus sericea* (Kartesz 1994, Weber and Wittmann 1996a, 1996b).

Similar Communities: Closely related communities include: the *Alnus incana* ssp. *tenuifolia/Ribes hudsonianum* (thinleaf alder/northern black current) community type (Youngblood *et al.* 1985) which has significant cover of *Ribes hudsonianum*, the *Cornus sericea/Galium triflorum* (red-osier dogwood/sweet-scented bedstraw) community type (Youngblood *et al.* 1985) which includes *Alnus* in the canopy, but not consistently, the *Alnus incana/Rudbeckia laciniata* (thinleaf alder/cutleaf coneflower) plant association (Cooper and Cottrell 1990) which has a more diverse forb undergrowth, and the *Alnus oblongifolia-Cornus sericea* (Arizona alder-red-osier dogwood) community type (Durkin *et al.* 1994) which has a different species of *Alnus* and more diverse and dense understory.

Regional Distribution: This plant association occurs in Nevada, Utah (Padgett *et al.* 1989, Manning and Padgett 1995), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa, Colorado, Gunnison, San Juan, upper Arkansas River and Rio Grande River Basins (Johnston 1987, Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996, Richard *et al.* 1996, Colorado Natural Heritage Program 1997).

The following information is based on: a total of nineteen quantitative plots; four from the Yampa River Basin (90MR31, 90MR34, 90MR70, 90MR80, 91GK10), one from the San Miguel/Dolores River Basin (91NL81), six from the Colorado River Basin (93RR23, 93RR28, 93RR36, 93RR41, 93RR42, 93SS50), three from the Gunnison River Basin (94GK01, 94GK23, 94GK38), three from the San Juan National Forest (93C141, 93C321, 94DR22), one from the Rio Grande Basin (95RG42), and one from the upper Arkansas River Basin (95GK74) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6400-8600 ft. (2000-2600 m).

Site Geomorphology: This plant association occurs on narrow, rocky banks and benches of small channels as well as narrow, constricted reaches of larger rivers. It can also occur along overflow channels and narrow tributaries. Stream channels were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A2, A3, A4), wider and moderately sinuous (Rosgen's Channel Type: B3, B4), or wider and highly sinuous (Rosgen's Channel Type: C2, C3).

Soils: Soils range from loamy sand to sandy clay loam. Mottling is evident at approximately 12 inches (30 cm) and gravel or cobble layers appear at 20-40 inches (50-100 cm) beneath the surface. In the Colorado River Basin, the soils classify as recently buried typic Cryaquolls, sandy typic Cryoborolls, Histisols, typic Cryaquents, loamy to clayey Cryofluvents and fragmental Cryaquents.

Vegetation: This plant association is characterized by a dense thicket of shrubs dominated by 10-80% cover each of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) and *Cornus sericea* (red-osier dogwood). A wide variety of other shrub species may be present including up to 30% cover each of *Salix eriocephala* var. *ligulifolia* (strapleaf willow) and *Salix lasiandra* var. *caudata* (whiplash willow), up to 20% cover each of *Salix monticola* (mountain willow), *Lonicera involucrata* (honeysuckle), *Rosa woodsii* (woods rose), and *Betula occidentalis* (river birch), and up to 10% cover each of *Salix bebbiana* (Bebb willow) and *Rubus idaeus* (raspberry). One stand in the Yampa River Basin had 70% cover of *Salix bebbiana*. The one stand sampled on the Rio Grande River had a much lower shrub diversity, but was not an a typical for this type. Tree species are scattered and not consistently present.

Forb cover is highly variable depending on the amount of light that penetrates through the canopy. Forb species may include up to 20% cover each of *Rudbeckia laciniata* (cutleaf coneflower) and *Heracleum sphondylium* (cow parsnip), up to 10% cover each of *Maianthemum stellatum* (false Solomon seal) and *Ozmorhiza depauperata* (blunt-fruit sweet cicely), and up to 5% cover of *Ligusticum porteri* (southern ligusticum). Graminoid cover is usually low, but can include up to 45% cover of *Poa pratensis* (Kentucky bluegrass) and up to 10% cover of *Equisetum arvense* (meadow horsetail) in more disturbed stands.

Successional and Ecological Processes: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After 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* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

Alnus incana (thinleaf alder) fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia* and increases the ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder species ranges from 16 to 150 kg/ha annually compared to 1 to 10 kg/ha/yr deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

In Colorado, the *Alnus incana* ssp. *tenuifolia-Cornus sericea* (thinleaf alder-red-osier dogwood) plant association is tolerant of flooding and requires a high water table each spring. It appears to be a stable, long-lived association where succession to other types can be very slow (Manning and Padgett 1995).

Adjacent Riparian Vegetation: The *Alnus incana* ssp. *tenuifolia-Cornus sericea* (thinleaf alder-red-osier dogwood) plant association is often the only riparian community along a reach. However, *Pseudotsuga menziesii* (Douglas-fir) forests can occur along narrow reaches. *Populus angustifolia* (narrowleaf cottonwood) forests occur on floodplains and stream banks along wider reaches. *Salix exigua* (coyote willow) shrublands also occur along wider reaches on point bars and stream banks.

Adjacent Upland Vegetation: At lower elevations, *Pseudotsuga menziesii* (Douglas-fir) forests occur on north-facing slopes. *Pinus ponderosa* (ponderosa pine) forests and *Quercus gambelii* (Gambel oak) and *Amelanchier* spp. (serviceberry) shrublands may occur on steep south-facing slopes. At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests and *Populus tremuloides* (quaking aspen) woodlands grow on north-facing slopes.

Management: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is not particularly palatable to livestock, but can be trampled as animals search for more palatable forb species (Hansen *et al*. 1995). *Cornus sericea* (red-osier dogwood) is considered to be an “ice cream” plant (e.g. it is readily eaten and is a preferred browse species) for livestock and wildlife. However, dense stands of *Alnus incana* ssp. *tenuifolia* and *Cornus sericea* hinder livestock access. Season-long grazing reduces the native forb cover and allows non-native grasses to increase (Padgett *et al.* 1989, Hansen *et al.* 1995).

According to Hansen *et al*. (1995), most fires kill *Alnus incana* (thinleaf alder) dominated stands, resulting in a sparse herbaceous understory and bank destabilization due to root death. *Cornus* *sericea* can survive all but the hottest fires. After fire, new shoots sprout from the surviving rhizomes (Hansen *et al.* 1995). Frequent fire may sift this community to *Cornus sericea* dominated types.

Both *Alnus incana* ssp. *tenuifolia* and *Cornus sericea* are capable of sprouting and have rhizomatous roots which provide good stream bank stabilization. *Alnus incana* ssp. *tenuifolia* sprouts quickly when cut at 4-5 year intervals. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow-growing sprouts. The rapid growth following direct seeding or transplanting allows this shrub to quickly establish on streambanks (Hansen *et al*. 1995). *Alnus incana* ssp. *tenuifolia* and *Cornus sericea* may be useful for revegetating higher gradient streams where seasonal, scouring floods occur (Hansen *et al*. 1995).

Table 30. Percent Cover of Plant Species in Stands of the *Alnus incana-Cornus sericea* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG42
Species name and age class/ Site Rank	A
SHRUBS	
Alnus incana (L.) Moench	29
Cornus sericea L.	32
Ribes inerme Rydb.	9
GRAMINOIDS	
Poa sp.	1
FORBS	
Actaea rubra (Ait.) Willd.	2
Cardamine cordifolia Gray	1
Galium boreale L.	1
Heracleum sphondylium L. var. montanum	17
Maianthemum stellatum (L.) Link	1
Mertensia franciscana Heller	7
Rubus idaeus L.	3
Rudbeckia laciniata var. ampla (A. Nels.) Cronq.	13
Streptopus amplexifolius var. chalazatus Fassett	2
Urtica dioica ssp. gracilis (Ait.) Seland.	1

Thinleaf alder-mixed willow species (*Alnus incana* ssp. *tenuifolia*-mixed *Salix* species) Plant Association

CNHP Rarity Rank: G3 / S3-- This association is widespread on the Western Slope of Colorado and is expected to occur in other Rocky Mountain states.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia*/mixed *Salix* species (thinleaf alder/mixed willow species) plant association is a more general type than other *Alnus incana* types. It has a high diversity of associated shrub species, unlike the nearly pure stands of alder found in other *Alnus incana* ssp. *tenuifolia* dominated plant associations. The abundance of other shrubs may represent a transition in the physical setting, for example, from a broad floodplain dominated by *Salix* to a narrow valley bottom and channel lined with only *Alnus incana* (alder).

Related Literature and Synonyms: Two closely related communities are described in the literature: the *Alnus incana*/bench community type (Manning and Padgett 1995) which has a wide variety of co-dominant shrubs (including *Salix*) and the *Alnus incana* ssp. *tenuifolia/ Equisetum arvense* (thinleaf alder/field horsetail) community type (Padgett *et al.* 1989, Komarkova 1986, and Hess 1981) which also has variety co-dominant shrub species.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Yampa (Kittel and Lederer 1993), White, Colorado (Kittel *et al*. 1994), and Gunnison River Basins (Kittel *et al*. 1995), and the San Juan National Forest (Richard *et al*. 1996).

The following information is based on: a total of twenty-one quantitative plots; two from the Yampa River Basin (90MR72, 91GK15), one from the White River Basin (92GK49), one from the Colorado River Basin (93RR37), four from the Gunnison River Basin (94GK02, 94JB43, 94RR11, 94MD12), eight from the San Juan National Forest (93C173, 93C181, 94MS11, 94MS18, 94DR24, 94MS29, 94MS41, 95CR51), four from the Rio Grande Basin (95RG09, 95RG15, 95RG25, 95RG37), and one from the Closed Basin (97GK22) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7200-8900 ft. (2200-2700 m).

Site Geomorphology: This association occurs along narrow, moderately steep streams (10-20 meters wide with an average gradient of 10%) and in moderately wide to wide river valleys on cobble point bars, islands, flat alluvial benches, and large alluvial floodplains. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A3), moderately steep and wide (Rosgen's Channel Type: B3, B4, B6), or less steep, wide and sinuous (Rosgen's Channel Type: C3, C4).

Soils: Soils are poorly developed with loamy sands, sandy loams, and silt loams over coarse alluvium.

Vegetation: This plant association is characterized by the dominance of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) with 14-100% cover. There is considerable variation of associated shrub species between and within the stands. Other shrubs include up to 55% cover of *Salix monticola* (mountain willow), up to 40 % cover each of *Salix lasiandra* var. *lasiandra* (longleaf willow), *Salix drummondiana* (Drummond willow), *Salix bebbiana* (Bebb willow), and *Salix exigua* (coyote willow), up to 30% cover each of *Salix lasiandra* var. *caudata* (whiplash willow) and *Acer glabrum* (Rocky Mountain maple), up to 20% cover each of *Salix geyeriana* (Geyer willow) and *Salix eriocephala* var. *ligulifolia* (strapleaf willow), and up to 5% cover of *Amelanchier alnifolia* (serviceberry). Tree cover is sparse, but can include up to 20% cover of *Picea pungens* (Colorado blue spruce), up to 15% cover of *Populus tremuloides* (quaking aspen), and up to 10% cover each of *Populus angustifolia* (narrowleaf cottonwood) and *Picea engelmannii* (Engelmann spruce). The herbaceous undergrowth is varied with 10-90% total cover.

Successional and Ecological Processes: *Alnus incana* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After 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* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Alnus incana (thinleaf alder) fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia* and increases the ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder species ranges from 16 to 150 kg/ha annually compared to 1 to 10 kg/ha/yr deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) or conifers (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

In Colorado, the *Alnus incana-mixed Salix species* plant association may represent response to recent changes in the environment. Several stands occur on abandoned beaver dams, for example. This shift in the physical environment may explain the diverse mix of shrub species in the canopy. If the water table lowers, this plant association may succeed to a more stable, drier communities such as *Salix geyeriana* (Geyer willow) or *Populus tremuloides* (quaking aspen) associations. Other stands appear to be disturbed by livestock grazing and may represent a grazing-induced stage of the *Alnus incana* ssp. *tenuifolia/*mesic forb plant association.

Adjacent Riparian Vegetation: This association tends to be the only riparian community along narrow stream reaches. *Populus tremuloides/Alnus incana* (quaking aspen/thinleaf alder) stands occur in some narrow portions where the hillside forest mixes with the riparian shrubs. *Salix exigua* (coyote willow) shrublands and *Eleocharis palustris* (creeping spikerush) marshes can also occur in adjacent riparian areas.

Adjacent Upslope Vegetation: Dense *Populus tremuloides* (quaking aspen) forests occur immediately adjacent to the stream corridor on toeslopes. At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) and *Populus tremuloides* (quaking aspen) forests occur on upper slopes. At lower elevations, *Quercus gambelii* (Gambel oak) shrublands and *Pinus ponderosa* (ponderosa pine) woodlands can occur on adjacent side slopes.

Management: Dense stands of *Alnus incana* (thinleaf alder) hinder livestock access. *Alnus incana* is not particularly palatable to livestock, but can be trampled as animals search for more palatable species (Hansen *et al*. 1995). Most *Salix* (willow) species are highly palatable to livestock, large mammals, and beaver. Open stands may provide moderate forage and shade in the summer (Hansen *et al*. 1995).

According to Hansen *et al*. (1995), most fires kill *Alnus incana* (thinleaf alder) dominated stands, resulting in a sparse herbaceous understory and bank destabilization due to root death. *Alnus incana* (alder) sprouts quickly when cut at 4-5 year intervals and can be used as pole plantings for restabilizing stream banks. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow-growing sprouts (Hansen *et al*. 1995).

Table 31. Percent Cover of Plant Species in Stands of the *Alnus incana*-mixed *Salix* species Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG09	95RG15	95RG25	95RG37	97GK22
Species name and age class/ Site Rank	A	A	B	C	A
TREES					
Populus angustifolia James--older trees		3	10		
Populus tremuloides Michx.--older trees					5
SHRUBS					
Alnus incana (L.) Moench	26	45	62	14	55
Ribes inerme Rydb.	1		3	12	7
Rosa woodsii Lindl.	3			2	1
Salix bebbiana Sarg.			23	39	
Salix drummondiana Barratt ex Hook.	18	5	5		40
Salix eriocephala Michaux var. ligulifolia		11			
Salix lasiandra var. caudata (Nutt.) Sudworth		3	23	31	29
Salix lasiandra var. lasiandra (Nutt.) Sudworth	24				
Salix monticola Bebb	2	17			
GRAMINOIDS					
Bromus sp.	5				
Calamagrostis canadensis (Michx.) Beauv.			5		6
Carex aquatilis Wahlenb.				3	
Carex lanuginosa Michx.			3		
Carex microptera Mackenzie		1			
Carex sp.	3			3	
Carex utriculata Boott			10		
Juncus balticus ssp. montanus Engelm.	1	8	1	1	
Poa pratensis L.		21	7	12	
FORBS					
Achillea millefolium var. apicola (Rydb.) Garrett	2	2	2	6	
Argentina anserina (L.) Rydb.	2	1	1		
Cirsium sp.	6			2	
Epilobium sp.		4		2	1
Erigeron sp.		4	2		
Geranium richardsonii Fisch. & Trautv.		1		17	5
Heracleum sphondylium L. var. montanum	2			9	10
Mentha arvensis L.			4	2	
Mertensia ciliata (James ex Torr.) G. Don	1	1	2	19	
Rubus idaeus L.			1	1	9
Rudbeckia laciniata var. ampla (A. Nels.) Cronq.	5			4	
Sidalcea neomexicana				4	
Trifolium repens L.				27	
HORSETAILS					
Equisetum arvense L.	1		2	1	30
Equisetum pratense Ehrhardt	1	26			

Thinleaf alder-Drummond willow (*Alnus incana* ssp. *tenuifolia-Salix drummondiana*) Plant Association

CNHP Rarity Rank: G3 / S3-- This plant association has only been documented from Colorado, where it is small but widespread. It is highly threatened by improper livestock grazing and stream impoundments.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia-Salix drummondiana* (thinleaf alder-Drummond willow) is a common plant association. The association is generally found along steep-gradient streams with stable, shaded stream banks.

Related Literature and Synonyms: Closely related communities include: the *Alnus incana* ssp. *tenuifolia-Salix drummondiana/Equisetum arvense* (thinleaf alder-Drummond willow/field horsetail) plant association (Komarkova 1986) which has a slightly different herbaceous understory, and the *Alnus incana* spp. *tenuifolia/Equisetum arvense* (thinleaf alder/field horsetail) plant association (Hess 1981 and Bourgeron and Engelking 1994) which does not necessarily have *Salix drummondiana* in the shrub canopy.

Regional Distribution: This plant association has not been found to occur outside of Colorado. It is expected to occur in other Rocky Mountain States.

Distribution in Colorado: This association occurs in the Gunnison River Basin and the San Juan National Forest (Kittel *et al*. 1995, Richard *et al*. 1996).

The following information is based on: a total of seventeen quantitative plots; seven from the Gunnison River Basin (94GK02, 94GK15, 94GK27, 94JB12, 94JB43, 94JB45, and 94RR11), four from the San Juan National(94DR15, 94DR19, 94DR54, 95CR49), and six from the Rio Grande Basin (95RG08, 95RG11, 95RG29, 95RG41, 97EV06, 97MD03) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7300-9400 ft. (2200-2900 m).

Site Geomorphology: This association occurs along very steep, fast-moving streams in sheer-walled, confined canyons. It also occurs along or within the active channel of moderately to slightly entrenched channels in wider valleys. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and rocky (Rosgen's Channel Type: A1, A2), less steep with limited floodplains and gravel and cobble bottoms (Rosgen's Channel Type: B3, B4), or wide and sinuous (Rosgen's Channel Type: C3, C4).

Soils: Soils of this association are highly variable, but most are stratified alluvium with buried A horizons. Stands with a rich, herbaceous undergrowth have a thick layer, 5-10 inches (10-30 cm), of fine sandy loam over a coarse alluvial deposit. Stands with little shrub cover and herbaceous growth have coarse, skeletal soils without an accumulated fine layer at the surface.

Vegetation: This plant association is characterized by a dense, closed canopy of 10-100% cover of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) and 8-60% cover of *Salix drummondiana*

(Drummond willow) bordering the stream. Other shrubs include up to 20% cover each of *Acer glabrum* (Rocky Mountain maple), *Rosa woodsii* (woods rose) and *Ribes inerme* (whitestem gooseberry) and up to 15% cover of *Lonicera involucrata* (honeysuckle).

Some stands have a rich herbaceous understory that includes up to 20% cover of *Heracleum sphondylium* (cow parsnip), 15% cover of *Equisetum pratense* (meadow horsetail), and up tp 15% cover each of *Rudbeckia laciniata* (cutleaf coneflower), *Angelica ampla* (angelica), and *Mertensia ciliata* (mountain bluebells). In other stands, the herbaceous undergrowth is sparse (<10% cover) where heavy shading and coarse substrates from recent flood scouring limit herbaceous growth.

Successional and Ecological Processes: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on fluvial or glacial deposits as well as the spoils of placer mining (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994, Hansen *et al.* 1989). After 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* has been observed on high-gradient streams and is thought to require well-aerated water (Hansen *et al*. 1988, Padgett *et al.* 1989).

Undisturbed *Alnus incana* (thinleaf alder) stands may become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). In Alaska, thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). In Utah, *Acer negundo* (boxelder) often becomes the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

Alnus incana (thinleaf alder) fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia* and increases the ecosystem nitrogen supply with the deposition of nitrogen-rich leaf litter (Binkley 1986). The annual input of nitrogen to soils from alder species ranges from 16 to 150 kg/ha annually compared to 1 to 10 kg/ha/yr deposited by atmospheric precipitation alone (Binkley 1986, Bowman and Steltzer *in press*). Nitrogen rich detritus is an important source of nutrients for the aquatic ecosystem as well.

The *Alnus incana* ssp. *tenuifolia-Salix drummondiana* (thinleaf alder-Drummond willow) plant association is an early-seral community restricted to stream margins, rarely forming large, extensive stands. *Alnus incana* can and does colonize bar cobble bars at montane elevations. Both species are prolific seed producers and are the first to colonize coarse-textured cobble bars and recently scoured alluvial surfaces. When young, these shrubs are flexible, can tolerate most flood events, and readily resprout. With time, *Salix drummondiana* may become more abundant by taking advantage of the nitrogen-rich soils associated with *Alnus incana* ssp. *tenuifolia* (Kittel *et al*. 1995).

Adjacent Riparian Vegetation: *Populus angustifolia* (narrowleaf cottonwood) or *Picea pungens* (Colorado blue spruce) woodlands occur on adjacent stream banks and floodplains. *Salix exigua* (coyote willow) shrublands occur along adjacent gravel bars and stream banks. *Carex utriculata* (beaked sedge) wetlands occur in low-lying swales on wider floodplains.

Adjacent Upslope Vegetation: 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) and *Pseudotsuga menziesii* (Douglas-fir) forests and *Quercus gambelii* shrublands can be present.

Management: Dense stands of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) hinder livestock access. *Alnus incana* ssp. *tenuifolia* is not particularly palatable to livestock, but can be trampled as animals search for more palatable species (Hansen *et al*. 1995). *Salix drummondiana* (Drummond willow) is highly palatable to livestock, large mammals, and beaver (Kovalchik 1988). Open stands may provide moderate forage and shade in the summer (Hansen *et al*. 1995).

Most fires kill *Alnus incana* (thinleaf alder) dominated stands, resulting in a sparse herbaceous understory and bank destabilization due to root death (Hansen *et al.* 1995). *Alnus incana* (alder) sprouts quickly when cut at 4-5 year intervals and can be used as pole plantings for restabilizing stream banks. Cutting in spring and winter results in rapid sprouts. Cutting in the summer results in fewer, slow-growing sprouts (Hansen *et al*. 1995).

Table 32. Percent Cover of Plant Species in Stands of the *Alnus incana-Salix drummondiana* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG08	95RG11	95RG29	95RG41	97EV06	97MD03
Species name and age class/ Site Rank	A	A	B	C	B	B
TREES						
Pseudotsuga menziesii (Mirbel) Franco--older trees	13					
SHRUBS						
Acer glabrum Torr.	6					
Alnus incana (L.) Moench	14	26	60	60	34	18
Cornus sericea L.	5					10
Lonicera involucrata Banks ex Spreng.		1			14	5
Ribes inerme Rydb.	6	2		1		
Ribes montigenum McClatchie					6	
Salix bebbiana Sarg.					3	
Salix boothii Dorn		10				
Salix drummondiana Barratt ex Hook.	8	56	44	32	8	13
Salix exigua Nutt.						6
Salix lasiandra var. lasiandra (Nutt.) Sudworth			5			
Salix monticola Bebb			4	4	2	3
GRAMINOIDS						
Calamagrostis canadensis (Michx.) Beauv.	4	7	1		10	5
Carex aquatilis Wahlenb.			13			
Carex microptera Mackenzie			9			
Carex sp.	7	9				
Poa pratensis L.		9	7	5		
FORBS						
Achillea millefolium var. apicola (Rydb.) Garrett	2	8	5	3	1	
Cardamine cordifolia Gray			11	6	3	4
Cirsium sp.	2	1	1			
Conioselinum scopulorum (Gray) Coult. & Rose				4		
Epilobium angustifolium L.	1	2		1		
Fragaria vesca		8				
Fragaria virginiana Miller			2	2		
Geranium sp.	5	2		4		
Geum macrophyllum		2	4	2	2	
Heracleum sphondylium L. var. montanum	4	4			8	3
Mertensia ciliata (James ex Torr.) G. Don		12	4		1	
Mimulus guttatus DC.			5			
Oxypolis fendleri (Gray) Heller		1	14	7	1	
Rubus idaeus L.	4				1	
Rudbeckia laciniata var. ampla (A. Nels.) Cronq.	6				8	
Taraxacum officinale G.H. Weber ex Wiggers	2	8	13	6	2	
Thalictrum fendleri Engelm. ex Gray	5					
Trifolium sp.		5	2			
Unknown forb		2	4	5	1	1
HORESTAILS						
Equisetum pratense Ehrhardt	2	1	16	5		

River birch (*Betula occidentalis*) Seasonally Flooded Shrubland Alliance

River birch/Mesic Forbs (*Betula occidentalis*/Mesic Forbs) Plant Association

CNHP Rarity Rank: G3 / S2-- This association is well documented in the western states. In Colorado, fewer than thirty stands are documented, and while more are estimated to occur, this association is highly threatened by development, road and railroad improvements and maintenance, heavy recreational use, and stream flow alterations.

General Description and Comments: The *Betula occidentalis/*mesic forb (river birch/mesic forb) plant association is a tall (5-8 ft., 1.5-2.5 m), narrow band of shrubs lining a stream channel. The undergrowth can be sparse or a thick carpet of grasses and forbs. In undisturbed stands, forb species richness can be high, with over thirty species in one stand. At higher elevations, conifer trees on the upslopes intermix with *Betula occidentalis* at the stream bank.

Related Literature and Synonyms: The *Betula occidentalis*/mesic forb community types (Manning and Padgett 1995, Padgett *et al.* 1989) is synonymous with the Colorado *Betula occidentalis*/Mesic Forbs plant association.

Similar Communities: Closely related communities include: the *Betula occidentalis-Cornus sericea* (river birch-red-osier dogwood) community type (Padgett *et al.* 1989), the *Betula occidentalis* community type (Hansen *et al.* 1995) which includes degraded stands with abundant non-native grasses in the undergrowth, the *Alnus incana-Betula occidentalis* (thinleaf alder-river birch) community type (Kittel 1994), the *Alnus incana-Betula fontinalis/Salix* spp. (thinleaf alder-river birch/willow) plant association (Johnston 1987). *Betula fontinalis* is a synonym for *Betula occidentalis* (Kartesz 1994).

Regional Distribution: The *Betula occidentalis/*mesic forb (river birch/mesic forb) plant association occurs in Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Gunnison River (Kittel *et al.* 1995), Colorado River (Kittel *et al.* 1994), and Rio Grande and Closed Basins (Colorado Natural Heritage Program 1997). It also occurs along the Colorado Front Range and in the upper Arkansas River Basin (Cooper and Cottrell 1990, Kittel *et al.* 1996).

The following information is based on: a total of eighteen quantitative plots; three from the Colorado River Basin (92NL34, 93RR44, 93GK09), four from the Gunnison River Basin (94MD01, 94RR01, 94RR03, 94RR08), one from the Rio Grande and Closed Basin (97GK21), and eleven from the Arkansas River Basin (95AM20, 95AM21, 95AM33, 95RR04, 95RR19, 95RR21, 95RR22, 95GK21, 95GK24, 95LS20, 95LS22) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6400-8800 ft (2000-2700 m).

Site Geomorphology: This plant association occupies moderately wide stream benches and floodplains in narrow to moderately wide valleys and on hillside seeps. At lower elevations along sunny valley bottoms, well-developed, large occurrences occupy relatively flat stream benches and often extend away from the channel edge. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide, rocky/cobble-bottomed, moderately steep, and sinuous (Rosgen's Channel Type: B2, B3, B4), wide, cobble-bottomed, less steep, and highly sinuous (Rosgen's Channel Type: C3), or braided from beaver activity (Rosgen's Channel Type: D6). This association also occurs along small floodplains of steep-gradient, narrow streams where the valley side slope meets the stream edge (Rosgen's Channel Type: A2). In these stands, *Betula occidentalis* (river birch) is squeezed between large boulders and herbaceous growth is limited to small pockets. This association also occurs around seeps adjacent to the stream channel and along isolated springs on hillslopes away from the valley bottom.

Soil: Soils are fairly shallow, ranging from 12 to greater than 25 inches (30 to >60 cm). Most soils have a surface layer of 50-90% organic matter. Subsurface layers are clay loams, sandy clays, and sandy loams. Most profiles have signs of saturation (mottles) at about 4-10 inches (10-25 cm) depth. Skeletal layers, derived from alluvium, occur at a greater depth. Stands along narrow, steep stream channels occur between large alluvial and colluvial boulders and have almost no soil development. In the Colorado River Basin, the soils classify as fragmental calcareous lithic Cryorthents, fine-loamy ustic Torrifluvents.

Vegetation: *Betula occidentalis* (river birch) forms a nearly continuous tall-shrub to small-tree canopy along the stream bank with 15-90% cover. Other shrubs include up to 40% cover each of *Alnus incana* spp. *tenuifolia* (thinleaf alder) and *Cornus sericea,* (red-osier dogwood), up to 25% cover of *Salix exigua* (coyote willow), up to 20% cover each of *Jamesia americana* (cliff jamesia), *Amelanchier utahensis* (Utah serviceberry), and *Prunus virginiana* (chokecherry), and up to 10% cover of *Salix monticola* (Rocky Mountain willow). Along narrow valleys at higher elevations, conifers may overhang the stream edge. Conifer cover can include up to 65% cover of *Pseudotsuga menziesii* (Douglas-fir), up to 30% cover of *Abies lasiocarpa* (subalpine fir), and up to 20% cover of *Picea pungens* (Colorado blue spruce).

Due to the dense shrub canopy, herbaceous undergrowth is usually limited (<10% cover). Forb cover includes 40% *Maianthemum stellatum* (false Solomon seal), 35% cover of *Heracleum sphondylium* (cow parsnip), 20% cover of *Thalictrum fendleri* (Fendler meadowrue), and 10% cover of *Rudbeckia laciniata* (cutleaf coneflower). Graminoid cover is usually low and includes 35% cover each of *Poa pratensis* (Kentucky bluegrass) and *Equisetum* spp. (horsetail), 25% cover of *Carex utriculata* (beaked sedge), and 20% cover of *Juncus balticus* (Baltic rush). An abundance of non-native grass species is considered an indication of heavy grazing.

Successional and Ecological Processes: The *Betula occidentalis*/mesic forb (river birch) plant association is considered a mid-seral type. With heavy grazing, this association may succeed to a *Salix* (willow) dominated association (Hansen *et al.* 1995). On wetter sites, the undergrowth potential may be for mesic grasses such as *Calamagrostis canadensis* (bluejoint reedgrass) and *Carex* spp. (sedge). This association may also be an early successional stage for conifer-dominated associations (Padgett *et al.* 1989).

Betula occidentalis can tolerate flooding (Hansen *et al.* 1988), but not a permanent inundation of water. *Betula occidentalis* occurs at slightly lower elevations and on lower- gradient stream reaches than *Alnus incana* spp. *tenuifolia* (thinleaf alder). Because *Betula occidentalis* communities occupy low elevation, foothill habitats in Colorado, they are more threatened by development and stream impoundments than *Alnus incana* spp. *tenuifolia* or *Cornus sericea* (red-osier dogwood) riparian communities. Consequently, few large, undisturbed, and unaltered stands of the *Betula occidentalis*/mesic forb plant association exist today.

Adjacent Riparian Vegetation: The *Betula occidentalis*/mesic forb plant association is often the only association along narrow reaches. However, *Populus angustifolia* (narrowleaf cottonwood) and *Populus tremuloides* (quaking aspen)woodlands occur on adjacent floodplains. *Cornus sericea* (red-osier dogwood) and *Salix monticola* (Rocky Mountain willow) shrublands occur on adjacent wider floodplains. *Salix exigua* (coyote willow) shrublands occur on nearby sand bars while open hay meadows occur on adjacent cultivated floodplains.

Adjacent Upland Vegetation: Adjacent upslope communities include *Pinus edulis-Juniperus osteosperma* or *J. monosperma* (pinyon pine-Utah or one-seeded juniper) and *Pinus ponderosa* (ponderosa pine) woodlands on south-facing slopes. *Pseudotsuga menziesii* (Douglas-fir), and mixed *Abies* (fir) and *Pinus* (pine) forests are present on north-facing slopes.

Management: Due to the dense shrub cover, stands of this plant association may hinder livestock access. In the Arkansas River Basin, this plant association has a lush undergrowth dominated by native grasses and forbs in areas where livestock grazing is minimal. With season-long grazing, however, non-native grasses, such as *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop), may begin to dominate the undergrowth. Livestock grazing can also reduce stream bank stability and cause sloughing. *Betula occidentalis* provides shade, organic matter, and overhanging banks for fish habitat (Hansen *et al.* 1988).

Betula occidentalis is an effective streambank stabilizer. Nursery grown seedlings can be successfully transplanted and will typically grow quickly (Hansen *et al.* 1988). Fire can easily kill *Betula occidentalis* shoots due to the shrub's thin bark. However, new shoots will resprout from uninjured basal buds (Hansen *et al.* 1988).

Table 33. Percent Cover of Plant Species in Stands of the *Betula occidentalis*/Mesic Forbs Plant Association from the Rio Grande and Closed Basin Watershed.

Plot Number	97GK21
Species name and age class/ Site Rank	B
SHRUBS	
Betula occidentalis Hooker	81
Cornus sericea L.	37
Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg.	17
Ribes inerme Rydb.	1
Rosa woodsii Lindl.	3
Salix drummondiana Barratt ex Hook.	1
Salix eriocephala Michaux var. ligulifolia	1
Sambucus racemosa L. var. microbotrys (Rydb.) Kearney & Peebles	5
GRAMINOIDS	
Bromus inermis Leyss.	1
Carex sp.	1
FORBS	
Aconitum columbianum Nutt.	3
Actaea rubra (Ait.) Willd.	2
Cirsium arvense	1
Geranium richardsonii Fisch. & Trautv.	1
Heracleum sphondylium L. var. montanum	7
Hydrophyllum fendleri	1
Maianthemum stellatum (L.) Link	8
Pyrola asarifolia ssp. asarifolia	1
Rubus idaeus L.	10
Thalictrum fendleri Engelm. ex Gray	21
HORSETAILS	
Equisetum arvense L.	7

Red-osier dogwood (*Cornus sericea*) Temporarily Flooded Shrubland Alliance

Red-osier dogwood (*Cornus sericea*) Plant Association

CNHP Rarity Rank: G4 / S3-- This association is a common riparian shrubland that occurs in several western states. In Colorado, this is a common association, with an estimated >50 stands. This association is, however, threatened by improper livestock grazing.

General Description and Comments: The *Cornus sericea* (red-osier dogwood) plant association is a medium-height (3-6 ft., 1-2 m), shrubland that often forms continuous, narrow bands along stream banks, benches, and bars. It can form very dense, small stands with limited disturbance, often at the base of a cliff.

Related Literature and Synonyms: The *Cornus sericea* (red-osier dogwood) community type (Hansen *et al.* 1988, Manning and Padgett 1995) is synonymous with the Colorado *Cornus sericea* plant association. *Cornus stolonifera* is a synonym for *Cornus sericea* (Kartesz 1994).

Similar Communities: Closely related communities include the *Cornus stolonifera/Galium triflorum* (red-osier dogwood/sweet-scented bedstraw) community type (Youngblood *et al.* 1985) and the *Cornus sericea/Heracleum lanatum* (red-osier dogwood/cow parsnip) community type (Padgett *et al.* 1989, Youngblood *et al.* 1985). Both of these similar types have significant herbaceous cover, while the Colorado stands generally have a sparse herbaceous understory.

Regional Distribution: This association occurs in Montana (Hansen *et al.* 1988), Nevada (Manning and Padgett 1995), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the White and Colorado River Basins (Kittel *et al*. 1994), the San Juan National Forest (Richard *et al.* 1996), and in the Rio Grande watershed (Colorado Natural Heritage Program 1997).

The following information is based on: a total of thirteen quantitative plots; two from the White River Basin (92GK47, 92NL42), ten from the Colorado River Basin (93SS07, 93SS08, 93SS35, 93GK03, 93GK20, 93GK29, 93GK33, 93GK47, 93RR31, 93RR43), one from the San Juan National Forest (94MS05) and two from the Rio Grande and Closed Basins (97EV19, 97GK29) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 6500-8300 ft (2000-2500 m).

Site Geomorphology: This plant association occurs adjacent to stream channels and near seeps on moist toeslopes of canyon walls. It also occurs on narrow benches in ravines and on narrow terraces of wider valleys. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996).Stream channels are narrow and moderately steep with gravel streambeds (Rosgen's Channel Type: A4, B4).

Soil: The soils are relatively deep mollic silty to sandy clay loams with stratified layers. In the Colorado River Basin, the soils classify as fine loamy to coarse-loamy (calcareous) cumulic or pachic Cryoborolls, oxyaquic and mollic Cryorthents, fine clayey Haplustolls, fragmental ustic Torriorthents, and loamy Ustorthents.

Vegetation: This plant association is characterized by a dense stand of 20-100% cover of *Cornus sericea* (red-osier dogwood). Other shrub species may include 40-50% cover of *Ribes inerme* (whitestem gooseberry), *R. aureum* (golden current), 10-30% cover *Betula occidentalis* (river birch), 10-25% cover of *Crataegus rivularis* (river hawthorn), 5-20% cover each of *Rosa woodsii* (woods rose) and *Acer glabrum* (Rocky Mountain maple), and up to 10% cover of *Alnus incana* (thinleaf alder).

While trees occur in a few stands, typically, this shrubland has no overstory canopy. Scattered tree species include 10% cover along the reach of mature *Populus angustifolia* (narrowleaf cottonwood), 15% cover of *Pinus ponderosa* (ponderosa pine), 10% cover of *Pseudotsuga menziesii* (Douglas-fir) or 20% *Abies concolor* (white fir). The herbaceous undergrowth varies in composition. A stand sampled in the San Juan National Forest had high forb cover with 20% cover of *Rudbeckia laciniata* (cutleaf coneflower), 10% cover of *Taraxacum officinale* (dandelion), and 5% cover of *Geranium richardsonii* (Richardson's geranium). Graminoid cover was sparse, with less than 10%. Stands sampled in the White and Colorado River Basins had sparse forb and graminoid cover. Stands in the Rio Grande watershed had moderate forb cover with 5-20% of *Maianthemum stellatum* (false Salomon's seal), among other species (Table 34).

Successional and Ecological Processes: *Cornus sericea* forms a relatively stable community because of its strong rhizomes and stolons (Hansen *et al.* 1988). Subsequent succession takes place over a long period of time (Padgett *et al.* 1989). In Montana, this plant association is considered to be early-seral since it colonizes stream bars and adjacent floodplains (Hansen *et al.* 1995). With time, the association may eventually become dominated by conifer or deciduous tree species.

Adjacent Riparian Vegetation: *Juniperus scopulorum* (Rocky Mountain juniper) and *Pseudotsuga menziesii* (Douglas-fir) woodlands and *Salix monticola* (mountain willow) shrublands occur in adjacent riparian areas.

Adjacent Upland Vegetation: *Pinus ponderosa* (ponderosa pine), mixed conifer-*Pseudotsuga menziesii* (Douglas-fir), and *Picea pungens-Populus tremuloides* (Colorado blue spruce) forests and *Quercus gambelii* (Gambel oak) and *Juniperus osteosperma* (Utah juniper) or *J. monosperma* (one-seeded juniper) woodlands occur on adjacent hillslopes.

Management: *Cornus sericea* (red-osier dogwood) is considered to be an "ice cream plant" (e.g., it is readily eaten as a preferred browse species) for livestock and has moderate to high forage production. In open areas, livestock use can be quite high. Dense stands of *Cornus sericea*, however, may restrict livestock access. (Hansen *et al*. 1995).

Cornus sericea is a very effective stream bank stabilizer due to its strong, rhizomatous root structure and should be considered for revegetating degraded sites. The rapid growth following direct seeding or transplanting allows this shrub to quickly establish on stream banks. It can also resprout after burial by fluvial deposition. *Cornus sericea* can survive all the but the most severe fires. After fire, new shoots sprout from the surviving rhizomes (Hansen *et al*. 1995).

Table 34. Percent Cover of Plant Species in Stands of the *Cornus sericea* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97EV19	97GK29
Species name and age class/ Site Rank	B	C
TREES		
Abies concolor--mature trees	16	
Populus tremuloides Michx.--older trees	1	
SHRUBS		
Alnus incana (L.) Moench	1	
Cornus sericea L.	99	52
Ribes aureum Pursh.		50
Ribes montigenum McClatchie	12	
Rosa woodsii Lindl.	5	4
Salix bebbiana Sarg.	4	
Salix drummondiana Barratt ex Hook.	1	
Salix exigua Nutt.		8
VINES		
GRAMINOIDS		
Bromus sp.	1	
Carex sp.	1	
Muhlenbergia sp.		1
Poa compressa L.	1	
Poa sp.	1	
Unknown graminoid	1	3
FORBS		
Actaea rubra (Ait.) Willd.	1	
Cirsium arvense		5
Geranium richardsonii Fisch. & Trautv.	2	
Hacklea floribunda		6
Maianthemum stellatum (L.) Link	6	19
Rubus idaeus L.	1	
Thalictrum fendleri Engelm. ex Gray	5	

Shrubby cinquefoil/tufted hairgrass (*Pentaphylloides floribunda/Deschampsia cespitosa*) Deciduous Alluvial Shrublands Alliance

Shrubby cinquefoil/tufted hairgrass (*Pentaphylloides floribunda/Deschampsia cespitosa*) Plant Association

CNHP Rarity Rank: G4 / S3S4--This association is well documented from many western states. In Colorado, many stands appear to be grazing induced, and therefore may be more abundant than it was historically. A few near-pristine stands were discovered in 1997. More research is required to understand their response to grazing management.

General Description and Comments: The *Pentaphylloides floribunda/Deschampsia cespitosa* (shrubby cinquefoil/tufted hairgrass) plant association is an open, low shrubland with thick cover of the bunch grasses. Most stands of this association in Colorado appear to be grazing-induced. *Pentaphylloides floribunda* (shrubby cinquefoil) increases in abundance with continuous, season long grazing within a riparian area (Stubbendieck *et al*. 1982), and *Deschampsia cespitosa* (tufted hairgrass) is highly palatable to livestock.

Related Literature and Synonyms: The *Potentilla fruticosa/Deschampsia cespitosa* (shrubby cinquefoil/tufted hairgrass) community (Padgett *et al*. 1989, Youngblood *et al*. 1985, Johnston 1987, and Hansen *et al*. 1995) is synonymous with the Colorado *Pentaphylloides floribunda/ Deschampsia cespitosa* plant association.

Similar Communities**: A closely related community, the *Pentaphylloides floribunda/Salix brachycarpa/ Kobresia myosuroides* (shrubby cinquefoil/barrenground willow/kobresia) plant association, appears to be a transition community between *Pentaphylloides floribunda/ Deschampsia cespitosa* and extremely rich fens and peatland plant associations (Sanderson and March 1996). It is not synonymous with the Colorado *Pentaphylloides floribunda/Deschampsia cespitosa* plant association because it is a strong indicator of the presence of the extremely rich fen communities, which are rare in Colorado (Sanderson and March 1996). *Potentilla fruticosa* is a synonym of *Pentaphylloides floribunda* (Kartesz 1994).**

Regional Distribution: This plant association occurs in Utah (Padgett *et al*. 1989), southeastern Idaho, western Wyoming (Youngblood *et al*. 1985), Montana (Hansen *et al.* 1995) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in South Park (Sanderson and March 1996), Routt National Forest (Kettler and McMullen 1996) and in the Rio Grande River Basin (Colorado Natural Heritage Program 1997).

The following information is based on: a total of six quantitative plots; one in Routt National Forest (241), three Element Occurrence Records from the South Park Fen Inventory, and two from the Rio Grande and Closed Basins (97BG25, 97BG26) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 8400-9900 ft (2500-3000 m).

Site Geomorphology: This association occurs on terraces above the stream channel and along the drier edges of isolated wetlands and rich fens. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow and highly sinuous (Rosgen's Channel Type: E4).

Soils: The soils are sandy loams over sand and gravel layers.

Vegetation: *Pentaphylloides floribunda* (shrubby cinquefoil) dominates the overstory of this plant association with 5-30% cover. The graminoids layer is very thick with *Deschampsia cespitosa* (tufted hairgrass) ranging from 8-70% cover. Other graminoids that may be present include up to 30% cover of *Poa secunda* (Sandberg bluegrass), 20% cover of *Festuca rubra* (red fescue), and *Juncus balticus* (Baltic rush). Stands in excellent condition (*i.e.,* not grazing induced) have high cover of *Carex aquatilis* (water sedge) and *Trifolium longipes* (clover). Disturbed stands have *Rumex aquaticus* (western dock) and *Fragaria virginiana* (Virginia strawberry) with 10% cover each, and abundant *Taraxacum officinale* (dandelion).

Succession and Ecological Processes: This association is a mid-seral stage of secondary succession when a product of heavy grazing. With improper grazing, *Pentaphylloides floribunda* will increase in abundance because it is unpalatable to livestock. Other species that increase with grazing in this association are *Poa pratensis* (Kentucky bluegrass), *Juncus balticus* (Baltic rush), and *Taraxacum officinale* (dandelion) (Padgett *et al*. 1989). Extended grazing may cause this plant association to convert to a *Pentaphylloides floribunda*/*Poa pratensis* (shrubby cinquefoil/Kentucky bluegrass) plant association.

Adjacent Riparian Vegetation: *Betula glandulosa* (bog birch shrubland) communities are found in adjacent riparian areas.

Adjacent Upland Vegetation: This information is not available.

Management: *Pentaphylloides floribunda* is not very palatable to livestock and large mammals. However, *Deschampsia cespitosa* is highly palatable and is heavily grazed. With livestock grazing, *Pentaphylloides floribunda* and less palatable *Juncus balticus* (Baltic rush) increase in cover while the highly palatable *Deschampsia cespitosa* (tufted hairgrass) decreases in cover (Hansen *et al.* 1995). Grazing should be delayed until soils are dry to maintain vigor of the plants in this association and to prevent damage to soils (Hansen *et al.* 1988). In Colorado, one grazing regime appears to be maintaining the health of an excellent condition stand of this association. It is in the Saguache Park allotment, in pasture IV along the North Fork Saguache Creek, one of five large pastures in a well managed rest and rotation system (as viewed by the author in early July 1997. For more information about this allotment, contact Rio Grande National Forest).

Pentaphylloides floribunda quickly resprouts after fires. The use of prescribed burning may not be particularly effective if the desired outcome is a reduced cover of this species. *Deschampsia* *cespitosa* is resistant to damage from fire. With repeated burning, however, rhizomatous species such as *Poa pratensis* (Kentucky bluegrass) will establish and may out compete *Deschampsia cespitosa* (Hansen *et al.* 1995).

Pentaphylloides floribunda is an effective streambank stabilizer. It grows fairly quickly and provides soil stability (Hansen *et al.* 1988). *Pentaphylloides floribunda* has been used for erosion control and beautification projects along highways (Stubbendieck *et al*. 1982). *Deschampsia cespitosa* has a weak fibrous root system and is not very valuable as a streambank stabilizer (Youngblood *et al.* 1985).

Table 35. Percent Cover of Plant Species in Stands of the *Pentaphylloides floribunda/Deschampsia cespitosa* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97BG25	97BG26
Species name and age class/ Site Rank	B	B
SHRUBS		
Pentaphylloides floribunda (Pursh) A. Love	5	24
GRAMINOIDS		
Carex aquatilis Wahlenb.	51	
Carex aurea Nutt.		9
Carex microptera Mackenzie	2	35
Deschampsia cespitosa (L.) Beauv.	8	13
FORBS		
Achillea millefolium var. apicola (Rydb.) Garrett	1	8
Caltha leptosepala var. leptosepala		2
Conioselinum scopulorum (Gray) Coult. & Rose		1
Epilobium ciliatum Rafinesque	1	
Geum macrophyllum	1	1
Potentilla pulcherimma x hippiana	2	4
Potentilla sp.	1	
Taraxacum officinale G.H. Weber ex Wiggers	6	6
Thalictrum fendleri Engelm. ex Gray	1	
Trifolium longipes ssp. pygmaeum (Gray) J. Gillett		8
Trifolium pratense	1	
Trifolium repens L.		2
Unknown forb	2	6

Gambel oak/snowberry (*Quercus gambelii/ Symphoricarpos oreophilus*) Deciduous Alluvial Shrubland Alliance

Gambel oak/snowberry (*Quercus gambelii/ Symphoricarpos oreophilus*)
Plant Association

CNHP Rarity Rank: G5 / S3S4-- This association is common and widespread within the western states. In Colorado, it is an abundant community on the Western Slope. It tends to occurs in riparian areas at the lower elevational limit of Gamble's oak in Colorado..

General Description and Comments: The *Quercus gambelii/Symphoricarpos oreophilus* plant association is a non-obligate riparian community. It appears to be transitional between riparian areas and drier upland communities such as *Artemisia* spp. (sagebrush). This association is adapted to deep, well-drained soils in cool, moist sites (Johnston 1987) and occurs in narrow draws adjacent to *Quercus gambelii* woodlands. Consequently, the upland *Quercus gambelii* shrubs often intermix with the mesic shrubs in the riparian area. *Quercus gambelii* is about 5-6 feet (1.5-2 m) tall, while *Symphoricarpos* is only about 2-3 feet (0.5-1 m) tall, thus the name of the association uses a "/" to indicate the different canopy heights occupied by the two species.

Related Literature and Synonyms: Two closely related communities (listed below) are considered to be upland communities, however these are probably the same community because the Colorado riparian *Quercus gambelii/ Symphoricarpos oreophilus* plant association as described here is a facultative riparian community, occurring in narrow draws and at the outer fringes of the riparian area.

Similar Communities: Closely related communities include the *Quercus gambelii/Symphoricarpos rotundifolius* (Gambel oak/snowberry) plant association (Johnston 1987) and the *Quercus gambelii-Amelanchier utahensis*-(*Artemisia tridentata-Cercocarpos montanus-Symphoricarpos oreophilus*)/*Carex geyeri* (Gambel oak-serviceberry-(big sagebrush-mountain mahogany-snowberry)/elk sedge) plant association (Baker 1982). *Symphoricarpos rotundifolius* is a synonym for *Symphoricarpos oreophilus* (Kartesz 1994, Weber and Wittmann 1996).

Regional Distribution: This plant association occurs in central and northwestern Utah and in Colorado (Johnston 1987).

Distribution in Colorado: This association occurs in the Colorado River Basin (Kittel *et al*. 1994), in the Closed Basin (Colorado Natural Heritage Program 1997), and on the San Juan National Forest (Richard *et al*. 1996).

The following information is based on: a total of four quantitative plots; two from the Colorado River Basin (93GK04, 93GK08), one from the Closed Basin (97MD22) and one from the San Juan National Forest (99) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 7400-7600 ft. (2200-2300 m).

Site Geomorphology: This plant association occurs in narrow to moderately wide, ephemeral gulches and draws. It usually establishes several feet (0.6-2 m) above the channel. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow and moderately steep (Rosgen's Channel Type: B3 and B5).

Soil: Soils are deep, well-drained, silty clay loams over coarse skeletal layers. In the Colorado River Basin, the soils classify as fine-loamy mesic ardic Ustifluvents or Ustorthents, and fine-loamy mesic xeric Torrifluvents.

Vegetation: *Quercus gambelii* (Gambel oak) forms an open to dense tall-stature shrub thicket (5-6 feet, 1.5-2 m tall) with 30-95% cover. The lower-stature shrub understory (1-3 feet, 0.5-1 m tall) consists of up to 50% cover of *Symphoricarpos oreophilus* (snowberry), up to 40% cover of *Berberis fendleri* (Fendler barberry), 1-10% cover each of *Prunus virginiana* (common chokecherry) and *Amelanchier alnifolia* (serviceberry), up to 25% cover of *Rosa woodsii* (woods rose) and up to 20% of *Salix bebbiana* (Bebb willow). Occasionally, tree species are present in the overstory including up to 15% cover of *Pinus ponderosa* (ponderosa pine) and up to 10% cover each of *Juniperus scopulorum* (Rocky Mountain juniper) and *Pseudotsuga menziesii* (Douglas-fir).

The herbaceous understory is typically sparse, but can include high graminoid cover with up to 30% cover each of *Glyceria* (mannagrass) and *Carex* (sedge) species. Forb cover can include up to 10% cover of *Maianthemum stellatum* (false Solomon's seal) and up to 5% cover each of *Rudbeckia laciniata* (cutleaf coneflower), *Thalictrum fendleri* (Fendler meadowrue), and *Erigeron* (daisy) species.

Successional and Ecological Processes: *Quercus gambelii* (Gambel oak) is limited in its geographic range to Utah, Colorado, New Mexico and Arizona (Neilson and Wullstein 1983). The northern boundaries in Utah and Colorado appear to be controlled by spring freeze stress and summer moisture stress (Neilson and Wullstein 1983). In Colorado, *Quercus gambelii* occupies large areas on the Western Slope plateaus and along the Colorado Front Range between the elevations of 6,000 and 9,000 (1800-2750 m) (Weber 1987). *Quercus gambelii* occupies riparian zones in warmer areas at its lower elevational in Colorado, *i.e.* the Grand Junction and San Luis Valleys where *Quercus gambelii* is limited by more pronounced summer drought stress. Growing in the riparian zone alleviates that stress.

Quercus gambelii-Symphoricarpos oreophilus plant association is a long-lived, late seral community. Once oak seedlings become established, the shelter and shading of these individuals create further favorable microhabitat for additional seedling establishment (Neilson and Wullstein 1983). Large clumps of *Quercus gambelii* can persist because of this positive feedback loop. It is suggested that stands became established during a past warmer climate when the "Arizona Monsoon" extended much farther north than it does today (during the Hypsithermal interval, some 4000-8000 years ago) (Neilson and Wullstein 1983). Large stands of this oak in Colorado may be clones that have persisted for thousands of years through its rhizomatous rooting structure (Neilson and Wullstein1983).

Adjacent Riparian Vegetation: This plant association is typically the only riparian community in narrow, ephemeral draws. However, *Artemisia tridentata* (big sagebrush) shrublands can occur in adjacent riparian areas**.**

Adjacent Upland Vegetation: *Pinus ponderosa* (ponderosa pine) and mixed conifer-*Pseudotsuga menziesii* (Douglas-fir) forests, *Quercus gambelii* (Gambel oak) woodlands, and *Stipa comata* (needle and thread grass) grasslands occur on adjacent hillslopes. At lower elevations, *Pinus edulis-Juniperus osteosperma* or *J. monosperma* (pinyon pine-Utah or one-seeded juniper) woodlands are often present.

Management: Both *Quercus gambelii* (Gambel oak) and *Symphoricarpos oreophilus* (snowberry) are low in forage value for livestock. However, *Quercus gambelii* is relatively tolerant of defoliation (Steele 1994). This association provides valuable winter range for large mammals and cover for birds.

Quercus gambelii rapidly sprouts following fire and *Symphoricarpos oreophilus* (snowberry) can withstand low-intensity burns (Steele 1994). If increased forage value is the goal of a prescribed fire, a mixture of grass species should be seeded following the burn (Harper *et al*. 1985).

Table 36. Percent Cover of Plant Species in Stands of the *Quercus gambelii/Symphoricarpos oreophilus* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97MD22
Species name and age class/ Site and Riparian Health Rank	B
SHRUBS	
Holodiscus dumosus (Nutt. ex Hook.) Heller	7
Quercus gambelii Nutt.	80
Ribes cereum Dougl.	2
Ribes montigenum McClatchie	6
Rosa woodsii Lindl.	21
Salix bebbiana Sarg.	13
VINES	
Clematis ligusticifolia Nuttall.	2
GRAMINOIDS	
Carex sp.	2
Poa pratensis L.	11
FORBS	
Achillea millefolium var. apicola (Rydb.) Garrett	1
Allium sp.	1
Fragaria virginiana Miller	2
Lupinus sp.	1
Penstemon sp.	1
Taraxacum officinale G.H. Weber ex Wiggers	1
Thalictrum fendleri Engelm. ex Gray	2

Bebb willow (*Salix bebbiana*) Deciduous Alluvial Shrubland Alliance

Bebb willow (*Salix bebbiana*) Plant Association

CNHP Rarity Rank: G3? / S2--This association is known to occur in several states. There is some uncertainty as to whether it is in decline or increasing in abundance. In Colorado, this association is uncommon, there are no known large, excellent condition stands, and no known protected stands. It is threatened mainly by poorly managed livestock grazing. The question mark in the Global rank indicates the community is probably more abundant, but additional stands have not been documented.

General Description and Comments: The *Salix bebbiana* (Bebb willow) plant association is a minor type in Colorado. It is a tall (5-15 ft, 1.5-3 m), deciduous shrubland with a open to closed canopy, generally forming small thickets within larger riparian mosaics or long and thin continuous thickets in narrow tributary canyon streams.

Related Literature and Synonyms: The *Salix bebbiana*/mesic graminoid community type (Padgett *et al.* 1989) and the *Salix bebbiana* community type (Hansen *et al.* 1995) are synonymous with the Colorado *Salix bebbiana* plant association.

Similar Communities: Two closely related communities are the *Salix bebbiana* community types (Girard *et al*. 1995), which differ in having significant undergrowth cover of *Carex rostrata* (beaked sedge) or *Poa pratensis* (Kentucky bluegrass).

Regional Distribution: The *Salix bebbiana* plant association occurs as a minor type in Utah (Padgett *et al.* 1989), Montana (Hansen *et al.* 1988) and Colorado (Colorado Natural Heritage Program).

Distribution in Colorado: This association occurs in canyon country at lower elevations in the San Juan National Forest (Richard *et al.* 1996), the Rio Grande River Basin (Colorado Natural Heritage Program 1997) and in foothill canyons of the South Platte River Basin (Kittel *et al.* 1997).

The following information is based on: a total of eight quantitative plots: two from the San Juan National Forest (115, 216), four from the Rio Grande River Basin (97BG01, 97EV03, 97EV11, 97EV14), and two from the South Platte River Basin (96AM30, 96AM83) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 7000-8000 ft (2200-2400 m).

Site Geomorphology: This plant association occurs on briefly flooded, low-gradient streams or along narrow alluvial terraces of canyons. It can also occur on broad, seep-fed meadows. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A4), wider, less steep, and moderately sinuous (Rosgen's Channel Type: B3, B5, B6), or moderately wide and sinuous (Rosgen's Channel Type: C3, C4).

Soil: Soils are highly stratified layers of sandy loams, clay loams, and silty clay with mottling near the surface. Soils can also be deep, dark-colored silty clay loams with high organic content and mottling or they can be shallow, becoming skeletal at about 10 inches (25 cm) depth. In the spring and early summer, soils are saturated for several days to weeks and then slowly dry out over the rest of the growing season.

Vegetation: *Salix bebbiana* (Bebb willow) commonly forms a dense overstory with 15-70% cover. Other shrubs can include up to 25% cover of *Alnus incana* (thinleaf alder) and up to 10% cover each of *Cornus sericea* (red-osier dogwood) and *Salix eriocephala* var. *ligulifolia* (yellow willow). The herbaceous undergrowth is characterized by a sparse to moderately dense forb layer on raised, better-drained hummocks and ridges beneath the willow canopy.

Forb species can include up to 10% cover each of *Achillea millefolium* (milfoil yarrow), *Fragaria virginiana* (mountain strawberry), *Galium septentrionale* (northern bedstraw), *Geranium richardsonii* (Richardson's geranium) and *Maianthemum stellatum* (false Solomon-seal). Graminoid species can dominate wetter swales and low-lying areas between the shrubs. Graminoid species can include up to 20% cover each of *Calamagrostis canadensis* (bluejoint reedgrass) and *Carex simulata* (analogue sedge), up to 10% cover of *Carex microptera* (small-wing sedge) and up to 5% cover each of *Carex lanuginosa* (woolly sedge), *Festuca thurberi* (Thurber fescue) and *Juncus tracyi* (swordleaf rush). Non-native forb and graminoid species may be present with 15% cover of *Poa pratensis* (Kentucky bluegrass), *Agrostis gigantea* (redtop) *Linaria* spp. (butter-and-eggs), and *Taraxacum officinale* (dandelion), or with greater cover, if the stand is heavily disturbed.

Successional and Ecological Processes: In Utah, the *Salix bebbiana* (Bebb willow) plant association is considered a stable, climax community. However, adjacent graminoid meadows are frequently subject to livestock grazing which inhibits the establishment of *Salix bebbiana* seedlings. Continued season-long livestock use may lead to dominance by non-native herbaceous species including *Poa pratensis* (Kentucky bluegrass) in the undergrowth (Padgett *et al.* 1989).

In Montana, this type is considered a grazing-induced stage of *Salix geyeriana* (Geyer willow), *Salix lutea* (yellow willow) or *Salix drummondiana* (Drummond willow) dominated communities (Hansen *et al.* 1995). *Salix bebbiana* is highly palatable to livestock and seems to tolerate grazing very well. *Salix bebbiana* actually increases in cover with grazing while the other willow species decrease. With prolonged grazing, *Salix bebbiana* is often the last willow remaining on a site (Hansen *et al*. 1995).

In Colorado, stands of *Salix bebbiana* do not frequently occur. *Salix bebbiana* appears to be very sensitive to grazing, and forms the classic "mushroom" shape with overgrazing. *Salix bebbiana* rarely forms large willow carrs and is limited to small patches within larger riparian mosaics or in protected, narrow canyon bottoms that preclude livestock grazing.

Adjacent riparian vegetation: *Populus angustifolia/Salix exigua* (narrowleaf cottonwood/coyote willow) woodlands and *Alnus incana* (thinleaf alder) shrublands occur on adjacent stream reaches. *Eleocharis palustris* (creeping spikerush) and *Carex utriculata* (beaked sedge) meadows occupy swales and pond edges in and around the floodplain.

Adjacent upland vegetation: *Pinus ponderosa-Quercus gambelii* (ponderosa pine-Gambel oak) forests and *Populus tremuloides* (quaking aspen) woodlands can occur on adjacent hillsides.

Management: *Salix bebbiana* (Bebb willow) is highly palatable to livestock and wildlife and can tolerate grazing to a certain extent. With continued browsing, however, this willow species will decline in vigor and may eventually be eliminated from the site. The soils and stream banks of this association are also subject to compaction and degradation from livestock use. In order to maintain the vigor and productivity of this plant association, periods of rest from livestock grazing are necessary, possibly by delaying livestock access until the sites are drier (Hansen *et al*. 1995). In addition, late-summer browsing reduces willow density and vigor since cattle prefer the more nutritious willows over sedges and grasses at that time of year (Kovalchik and Elmore 1992). Deferred or delayed grazing regimes can have the same negative affect on willow vigor as late-season use (Kovalchik and Elmore 1992).

Prescribed burning is an effective method for rejuvenating decadent stands of *Salix bebbiana*. This willow vigorously sprouts following fire. Quick, hot fires result in more sprouts, while slow fires damage plants (Hansen *et al*. 1995).

Salix bebbiana is an effective stream bank stabilizer and is valuable for revegetating degraded sites. The best results come from transplanting cuttings grown in a nursery. Cuttings should be taken in the spring from dormant 2-4 year old wood that are 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 following planting (Hansen *et al*. 1995).

Table 37. Percent Cover of Plant Species in Stands of the *Salix bebbiana* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97BG01	97EV03	97EV11	97EV14
Species name and age class/ Site and Riparian Health Rank	C	B	B	C
SHRUBS				
Pentaphylloides floribunda (Pursh) A. Love			2	9
Ribes inerme Rydb.	17	8		
Ribes montigenum McClatchie		24	36	6
Rosa woodsii Lindl.			3	
Salix bebbiana Sarg.	46	14	15	69
Salix lasiandra var. lasiandra (Nutt.) Sudworth	40			
Salix monticola Bebb				18
GRAMINOIDS				
Calamagrostis canadensis (Michx.) Beauv.	2	13	12	1
Carex simulata Mack.				16
Carex utriculata Boott		2		3
Deschampsia cespitosa (L.) Beauv.				4
Glyceria striata (Lam.) A.S. Hitchc.				2
Juncus balticus ssp. montanus Engelm.			3	1
Phleum pratense L.				1
Poa pratensis L.		1	4	7
FORBS				
Achillea millefolium var. apicola (Rydb.) Garrett		3	1	2
Angelica ampla Nelson				6
Antennaria parvifolia Nuttall				1
Cardamine cordifolia Gray				5
Dodecatheon pulchellum (Raf.) Merr.			1	2
Geranium richardsonii Fisch. & Trautv.	4	7	6	5
Heracleum sphondylium L. var. montanum	21			
Hydrophyllum fendleri	20			
Iris missouriensis Nutt.				4
Maianthemum stellatum (L.) Link		1	4	1
Potentilla pulcherimma x hippiana		2	3	3
Thermopsis divaricarpa Nelson		1	8	3

Shortfruit willow (*Salix brachycarpa*) Alliance

Shortfruit willow/Mesic Forbs (*Salix brachycarpa*/Mesic Forbs)

CNHP Rarity Rank: G4/ S4 --This association has not been documented outside Colorado, however it is expected to occur in other Rocky Mountain states. This association is common in the subalpine and alpine areas throughout Colorado.

General Description and Comments: Typically, the *Salix brachycarpa*/Mesic Forbs (shortfruit willow/mesic forb) plant association occurs on well-drained slopes in subalpine valleys. This association is often considered part of a *Salix planifolia-Salix brachycarpa* (planeleaf willow-shortfruit willow) mixed type. However, *Salix brachycarpa* occurs on slightly drier sites and is often adjacent to wetter, pure stands of *Salix planifolia*. The two species intermix at the ecotone between the wetter and drier sites.

Related Literature and Synonyms: The *Salix planifolia-Salix brachycarpa/Caltha leptosepala* (planeleaf willow-shortfruit willow/marsh marigold) plant association is synonymous with the Colorado *Salix brachycarpa*/Mesic Forbs plant association.

Similar Communities: *Salix phylicifolia* ssp. *planifolia* is a synonym for *Salix planifolia* (Kartesz 1994). The *Salix phylicifolia* ssp. *planifolia*/*Caltha leptosepala* (planeleaf willow/marsh marigold) and the *Salix wolfii/Deschampsia cespitosa* (Wolf willow/tufted hairgrass) plant associations (Johnston 1987) are closely related as they both have some *Salix brachycarpa,* but not in significant amounts.

Regional Distribution: This association occurs in Colorado (Colorado Natural Heritage Program 1997, Baker 1989, Johnston 1987).

Distribution in Colorado: This plant association occurs in subalpine areas of the San Juan Mountains, the Rio Grande and Closed Basin watersheds, the San Miguel/Dolores, Gunnison, Colorado and White River Basins, the Routt National Forest, and along the Colorado Front Range (Baker 1989, Hess and Wasser 1982, Komarkova 1986, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Kettler and McMullen 1996, Richard *et al*. 1996).

The following information is based on: a total of sixteen quantitative plots; five from the San Juan National Forest (81, 152, 190, 200, 201), two from the San Miguel/Dolores River Basin (55, 92), one from the Gunnison River Basin (94RR37), two from the Colorado River Basin (93RR27, 93DR03), one from the White River Basin (92GK40), three from the Routt National Forest (291, 303, 541), and two form the Rio Grande and Closed Basins (95RG68, 97BG16) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 8600-11,200 ft. (2600-3400 m).

Site Geomorphology: The *Salix brachycarpa*/Mesic Forbs (shortfruit willow/mesic forb) plant association occurs along the drier fringes of broad, glaciated basins and along broad, straight streams in the subalpine zone. This association occupies elevated hummocks and drier side slopes, often surrounding wetter, low areas vegetated with *Salix planifolia* (planeleaf willow) associations. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and shallow (Rosgen's Channel Type: B1-B3) or narrow, deep and sinuous (Rosgen's Channel Type: E4).

Soil: Soil textures range from silty clay loams to fine sandy loams with some mottling. There is often an upper or buried fibric or hemic layer. Soils in the Colorado River Basin classify as typic Cryaquolls and Cryorthents.

Vegetation: *Salix brachycarpa* (shortfruit willow) occurs in almost pure stands with 20-100% cover on hummocks and well-drained slopes adjacent to the valley floor. *Salix planifolia* (planeleaf willow) occurs as pure stands in low, poorly-drained areas and intermixes with *Salix brachycarpa* at the ecotone between the micro-sites. *Salix planifolia* can be occasionally present in this association with up to 30% cover. *Salix monticola* (mountain willow) is present along straight stream stretches with up to 50% cover and *Salix wolfii* (Wolf willow) occurs with up to 30% cover.

The herbaceous undergrowth can be quite dense in wetter stands. Forb cover can include up to 30% cover of *Caltha leptosepala* (marsh marigold), up to 20% cover of *Senecio triangularis* (arrowleaf groundsel), and up to 10% cover each of *Thalictrum* spp. (meadowrue), *Pseudocymopterus montanus* (mountain parsley), *Fragaria virginiana* (mountain strawberry), *Oxypolis fendleri* (cowbane), *Ligusticum* spp. (ligusticum) and *Mertensia ciliata* (mountain bluebells). Graminoids include up to 25% cover of *Deschampsia cespitosa* (tufted hairgrass), up to 20% cover of *Carex aquatilis* (aquatic sedge), and up to 10% cover of *Calamagrostis canadensis* (bluejoint reedgrass). Lichen and moss-covered boulders are also present. Drier stands often have a lower overall forb and graminoid cover, with less-mesic species present (Table 38).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow)*, Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

This plant association appears to be stable, but little is known about its successional trends. It is sometimes heavily grazed by sheep, which may alter the species composition.

Adjacent riparian vegetation: *Salix planifolia* (planeleaf willow) and *Salix wolfii* (Wolf willow) shrublands occur on adjacent wet swales and hummocks. *Carex aquatilis* (water sedge) and *Carex utriculata* (beaked sedge) meadows occur on adjacent flat, saturated areas. *Abies lasiocarpa-Picea engelmannii*/*Calamagrostis canadensis* (subalpine fir/bluejoint reedgrass) forests also occur in adjacent riparian areas.

Adjacent upland vegetation: Adjacent hillslopes are covered with *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests and dry subalpine meadows with *Danthonia* spp. (oatgrass) or *Festuca thurberi* (Thurber fescue).

Management: Management information for this plant association is not available.

Table 38. Percent Cover of Plant Species in Stands of the *Salix brachycarpa/*Mesic Forbs Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG68	97BG16
Species name and age class/ Site and Riparian Health Rank	C	A
SHRUBS		
Lonicera involucrata Banks ex Spreng.		2
Pentaphylloides floribunda (Pursh) A. Love	9	
Ribes inerme Rydb.		1
Salix brachycarpa Nutt.	67	98
Salix drummondiana Barratt ex Hook.	6	
Salix monticola Bebb	4	
Salix planifolia Pursh		9
Salix wolfii Bebb	16	
GRAMINOIDS		
Calamagrostis canadensis (Michx.) Beauv.		1
Carex norvegica Retz.	3	
Juncus balticus ssp. montanus Engelm.	4	
Phleum alpinum L.	1	
Poa compressa L.	1	
Poa pratensis L.	1	1
FORBS		
Achillea millefolium var. apicola (Rydb.) Garrett	8	1
Androsace septentrionalis L.	1	
Antennaria rosea Rydb.	3	
Aquilegia coerulea James		3
Astragalus sp.	29	
Cardamine cordifolia Gray		1
Castilleja sulphurea Rydb.	1	
Conioselinum scopulorum (Gray) Coult. & Rose	2	1
Epilobium angustifolia		3
Fragaria virginiana Miller	8	
Mertensia ciliata (James ex Torr.) G. Don		10
Oxypolis fendleri (Gray) Heller	1	1
Sedum rhodanthum Gray	1	
Senecio triangularis Hook		1
Swertia perennis L.	1	
Taraxacum officinale G.H. Weber ex Wiggers	16	
Thalictrum alpinum L.	1	

Drummond willow (*Salix drummondiana*) Alliance

Drummond willow/Mesic Forbs (*Salix drummondiana*/Mesic Forbs)

CNHP Rarity Rank: G4 / S4--This is a common and abundant association, although it commonly forms fairly small and often narrow riparian habitats. In Colorado, over 40 stands have been documented and many more expected to occur. However, it is currently threatened by poorly managed livestock grazing, stream flow alterations and heavy recreational use.

General Description and Comments: The *Salix drummondiana*/Mesic Forbs (Drummond willow/Mesic Forbs) plant association most commonly occurs on relatively steep streams and rarely forms more than a narrow, 5-25 feet (1.5-7.5 m) wide, band along stream banks. The closed to partially open canopy of *Salix drummondiana* and a thick carpet of many forb species characterize this plant association. Other willow species may be present with nearly equal cover to that of *Salix drummondiana* (e.g. *Salix monticola*) and in these cases one must remember that the concept of this community is that it is a narrow strip of willows along a relatively steep stream, as opposed to a broader stand of willows on wider, flatter floodplains.

Recognition and Classification Problems: Without catkins (the flowering stalk), *Salix drummondiana* (Drummond willow) can be difficult to distinguish from the similar looking *Salix geyeriana* (Geyer willow). Both species are tall, greater than 5 feet (2 meters), montane willows with strongly pruinose (a waxy covering that rubs off, similar to the coating on a plum) current-year twigs. Happily, the two species can be distinguished using only vegetative characters. *Salix geyeriana* (Geyer willow) leaves are never more than 0.5 inches (13 mm) wide and *Salix drummondiana* (Drummond willow) leaves are, on average, over 0.5 inches (13 mm) wide (on non-sucker shoots) (Welsh *et al*. 1987).

Related Literature and Synonyms: The *Salix drummondiana/Mertensia ciliata* (Drummond willow/mountain bluebell) association (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 Forbs plant association.

Similar Communities: Closely related communities include: the *Salix boothii*/mesic forb (Booth's willow/mesic forb) community type (Padgett *et al.* 1989) which includes stands dominated by *Salix drummondiana* (Drummond willow), the *Salix boothii*/*Smilacina stellata* (Booth's 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.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997). It is expected to occur in Wyoming (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989) and Nevada (Manning and Padgett 1995).

Distribution in Colorado: This plant association occurs throughout the West 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).

The following information is based on: a total of forty-eight quantitative plots; four from the White River Basin (92GK16, 92NL48, 92NL62, 92NL52,) sixteen from the Colorado River Basin (93SS04, 93SS10, 93SS37, 93SS39, 93SS40, 93DR02, 93DR06, 93DR19, 93RR24, 93RR25, 93GK26, 93GK27, 93GK35, 93GK39, 93GK40, 93GK41), three from the Gunnison River Basin (94MD18, 94MD27, 94MD28), one from the San Miguel/Dolores River Basin (54), eighteen from the San Juan National Forest (55, 57, 62, 124, 135, 149, 150, 156, 164, 178, 193, 194, 204, 208, 230, 238, 239, 273), one from the Arkansas River Basin (95AM42), one from the South Platte River Basin (95LS18), and four from the Rio Grande and Closed Basins (95RG62, 95RG71, 95RG73, 95RG78) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7500-11,300 ft (2400-3500 m).

Site Geomorphology: This plant association occurs in a variety of habitats. All streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). 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 down cutting channels (Rosgen's Channel Type: F6). This association also occur near seeps.

Soil: 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.

Vegetation: *Salix drummondiana* (Drummond willow) forms an open to closed, narrow canopy of tall shrubs lining the stream bank with 20-100% cover. Other shrubs present at the upper elevations of the community's range can include up to 40% cover of *Salix brachycarpa* (barrenground) and up to 20% cover of *Salix planifolia* (planeleaf willow). At lower elevations, other shrub species include up to 30% cover of *Lonicera involucrata* (honeysuckle), up to 20% cover of *Alnus incana* (thinleaf alder) and up to 40% cover of *Salix monticola* (Rocky Mountain willow), and <1% cover of *Salix bebbiana* (Bebb willow). Tree species occasionally present in the overstory, include up to 30% cover each of *Picea engelmannii* (Engelmann spruce) and *Abies lasiocarpa* (subalpine fir) and up to 20% cover of *Populus angustifolia* (narrowleaf cottonwood).

The herbaceous undergrowth in some stands is sparse due to heavy shade and shallow soils. Other stands have a rich diversity of forbs in the undergrowth. Dominant forbs include up to 40% cover each of *Mertensia ciliata* (mountain bluebell) and *Heracleum sphondylium* (cow parsnip), up to 30% cover of *Cardamine cordifolia* (heartleaf bittercress), up to 25% cover each of *Oxypolis fendleri* (cowbane) and *Hydrophyllum fendleri* (waterleaf), and up to 15% cover of *Saxifraga odontoloma* (brook saxifrage). Graminoid species include up to 30% cover each of

Carex utriculata (beaked sedge) and *Equisetum arvense* (field horsetail) and up to 20% cover of *Calamagrostis canadensis* (bluejoint reedgrass).

Successional and Ecological Processes: The *Salix drummondiana*/Mesic Forbs (Drummond willow/Mesic Forbs) 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 associations which also occurs along steep streams and alternates with the willow carrs. In wider valleys, the *Salix drummondiana*/Mesic Forbs (Drummond willow/mesic forbs) plant association occurs as a broad willow carr on well-developed soils near seeps or downstream from beaver dams. It appears to be a stable community in these environments.

Adjacent Riparian Vegetation: At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests or mesic forb seeps occur on adjacent stream banks along narrow reaches and *Salix planifolia* (planeleaf willow) shrublands occur in wider, sub-alpine valleys. At lower elevations, adjacent riparian vegetation includes *Alnus incana* (thinleaf alder), *Cornus sericea* (red-osier dogwood), or *Salix monticola* (mountain willow) dominated shrublands, and *Populus angustifolia-Picea pungens* (mixed narrowleaf cottonwood-Colorado blue spruce), *Picea pungens* (Colorado blue spruce) or *Populus angustifolia* (narrowleaf cottonwood) riparian woodlands.

Adjacent Upland Vegetation: At higher elevations, north-facing slopes are covered with *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests. South-facing slopes are more open stands of *Pinus ponderosa* (ponderosa pine), *Pinus contorta* (lodgepole pine) or *Pinus edulis* (pinyon pine) woodlands and *Populus tremuloides* (quaking aspen) forests. Dry, upland grasslands with *Danthonia* spp. (oatgrass) and *Festuca thurberi* (Thurber fescue) occur on steep hillsides. At lower elevations, *Pseudotsuga menziesii* (Douglas-fir) forests and *Quercus gambelii* (Gambel oak) shrublands occur on surrounding hillslopes.

Management: *Salix drummondiana* (Drummond willow) 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* (Drummond willow) (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 down cutting, 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 should consider maintaining beaver activity 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. The best results come from transplanting nursery grown cuttings. 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).

Table 39. Percent Cover of Plant Species in a Stand of the *Salix drummondiana/*Mesic Forbs Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG71	95RG62	95RG78	95RG73
Species name and age class/ Site and Riparian Health Rank	B	B	B	B
TREES				
Picea engelmannii		6	2	
SHRUBS				
Lonicera involucrata		23	2	
Salix drummondiana Barratt ex Hook.	61	42	47	58
Salix eriocephala var. ligulifolia			7	
Salix monticola Bebb	31	29	40	37
Salix planifolia Pursh	2			
GRAMINOIDS				
Bromus sp.				5
Calamagrostis canadensis (Michx.) Beauv.	10	2		7
Carex aquatilis Wahlenb.				8
Carex norvegica Retz.				4
Carex sp.	4	7		2
Deschampsia cespitosa			2	
FORBS				
Cardamine cordifolia Gray	2			4
Castilleja sp.				2
Conioselinum scopulorum (Gray) Coult. & Rose		1	1	3
Epilobium angustifolium L.	2	8	1	
Fragaria virginiana Miller		5	1	2
Geranium richardsonii Fisch. & Trautv.		1	1	14
Geum macrophyllum	1			1
Heracleum sphondylium L. var. montanum				4
Limnorchis sp.				2
Mertensia ciliata (James ex Torr.) G. Don	32			2
Mimulus guttatus DC.				3
Oxypolis fendleri (Gray) Heller				23
Potentilla sp.				4
Rumex sp.				2
Saxifraga odontoloma Piper			1	6
Senecio triangularis Hook	1			1
Stellaria sp.			1	2
Taraxacum officinale G.H. Weber ex Wiggers	1		1	8
Thalictrum fendleri Engelm. ex Gray	5			
Viola sp.			1	5
HORESTAILS				
Equisetum sp.				12

Strapleaf willow (*Salix eriocephala* var. *ligulifolia*) Alliance

Strapleaf willow (*Salix eriocephala* var. *ligulifolia*) Plant Association

CNHP Rarity Rank: G2G3 /S2S3 This community is recently described, and is probably more abundant than currently documented. There are over 20 occurrences in Colorado, and at least another 50-100 are expected to occur. It has not been reported by other western states.

General Description and Comments: The *Salix eriocephala* var. *ligulifolia* (strapleaf willow) plant association is a medium- to tall-willow shrubland occurring on saturated floodplains and stream banks of montane elevations. *Salix eriocephala* var. *ligulifolia* often mixes with *Salix exigua* (coyote willow) and *Salix lucida* (whiplash willow) in the foothills, forming the *Salix exigua-Salix eriocephala* var. *ligulifolia* (coyote willow-strapleaf willow) plant association. In the mountains, *Salix eriocephala* var. *ligulifolia* mixes with *Salix monticola* (mountain willow) and *Salix drummondiana* (Drummond willow) where it grows in relatively broad valley bottoms.

Recognition and Classification Problems: *Salix eriocephala* var. *ligulifolia* (strapleaf willow) is the new name for specimens formally attributed to *Salix ligulifolia* and *Salix lutea* in Colorado (Dorn 1995).

Related Literature and Synonyms: This community has not been previously described in the literature.

Regional Distribution: This association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs along the Colorado Front Range (Kittel *et al.* 1996) and in the San Juan and Rio Grande National Forests (Richard *et al.* 1996, Colorado Natural Heritage Program 1997).

The following information is based on: a total of eight quantitative plots; four from the San Juan National Forest (10, 20, 37, 110), one from the Arkansas River Basin (95AM34), one from the South Platte River Basin (95GK19), and 2 from the Rio Grande and Closed Basins (97EV26, 97EV28) (Colorado Natural Heritage Program 1997).

Elevation Range: 6700-10,200 ft (2000-3100 m).

Site Geomorphology: This association occurs in moderately wide valleys along low terraces and floodplains, and stream banks of narrower reaches. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The plant association occurs along reaches with vegetated islands between multiple channels below an active beaver pond (Rosgen's Channel Type: D3), along slightly sinuous broad channels (Rosgen's Channel Type: B2, B4), along more sinuous channels with well developed floodplains (Rosgen's Channel Type: C4), and along steep narrow gullies (Rosgen's Channel Type: G3).

Soil: Soils are saturated sandy loams and clay loams with a high organic matter content in the upper layers.

Vegetation: This association has a canopy dominated by 30-70% cover of *Salix eriocephala* var. *ligulifolia* (strapleaf willow) mixed with up to 45% cover each of *Salix monticola* (mountain willow) and *Salix drummondiana* (Drummond willow), and *Salix geyeriana* (Geyer willow). Several other willows may be present with 5-10% cover, including *Salix bebbiana* (Bebb willow), *Salix lucida* ssp. *lasiandra* (whiplash willow), *Salix wolfii* (Wolf willow), and *Salix planifolia* (planeleaf willow). Additional shrubs that may be present include *Alnus incana* (thinleaf alder) and *Pentaphylloides floribunda* (shrubby cinquefoil). Graminoid cover is sparse to dense. A variety of species have a cover of up to 40% including *Carex utriculata* (beaked sedge), *Carex nebrascensis* (Nebraska sedge), *Carex lanuginosa* (woolly sedge), *Juncus balticus* (Baltic rush), and *Calamagrostis canadensis* (bluejoint reedgrass). Forb cover is generally low, but can be high (see Plot 97EV26, Table 40).

Succession and Ecological Processes: This association appears to be long-lived mid to late-seral type since they are associated with beaver activity and saturated soils throughout the growing season.

Adjacent Riparian Vegetation: This association is often adjacent to and intermixes with *Carex aquatilis* (aquatic sedge) or *Carex utriculata* (beaked sedge) meadows. *Populus angustifolia* (narrowleaf cottonwood) woodlands can also occur nearby.

Adjacent Upland Vegetation: *Artemisia* spp. (sagebrush) shrublands, *Pinus ponderosa* stands, and mixed conifer-*Populus tremuloides* (quaking aspen) and *Abies lasiocarpa*-*Picea engelmannii* (subalpine fir-Engelmann spruce) forests can occur on surrounding hillsides.

Management: In Montana, *Salix lutea* (a synonym of *S. eriocephala* (Dorn 1995)) is highly palatable to livestock, therefore, season long grazing, especially late summer and early fall browsing, should be avoided in order to maintain the vigor of woody species (Hansen *et al.* 1995). Overuse by livestock may cause the site to dry and become dominated by introduced grass species such as *Poa pratensis* (Kentucky bluegrass) or *Bromus inermis* (smooth brome) (Manning and Padgett 1995). With continued overuse, the willow species will decline and eventually become eliminated from the site (Hansen *et al*. 1995).

Beaver are important in maintaining this plant association. Beaver dams raise the water table, which is beneficial to willow and sedge species as well as other hydrophilic plants. Beaver dams also help control bank erosion, channel down cutting, and the loss of sediment downstream. (Hansen *et al*. 1995).

Prescribed fires may be useful for rejuvenating *Salix lutea* (a synonym of *S. eriocephala* (Dorn 1995)), since this willow vigorously sprouts after burning, especially in wetter areas (Hansen *et al*. 1995). Willow roots provide stream bank stability and should be considered by managers for stream bank restabilization projects and revegetation purposes (Hansen *et al.* 1995, Padgett *et al.* 1989).

Table 40. Percent Cover of Plant Species in Stands of the *Salix eriocephala* var. *ligulifolia* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97EV26	97EV28	97GK35
Species name and age class/ Site and Riparian Health Rank	C	B	C
SHRUBS			
Alnus incana (L.) Moench		6	
Pentaphylloides floribunda (Pursh) A. Love	8	2	
Salix eriocephala Michaux var. ligulifolia	18	66	35
Salix exigua			25
Salix geyeriana Anderss.	1	12	
Salix lasiandra var. lasiandra (Nutt.) Sudworth		1	29
Salix monticola Bebb	15	11	43
GRAMINOIDS			
Bromus inermis Leyss.	2		
Calamagrostis canadensis (Michx.) Beauv.	7	5	10
Carex lanuginosa			8
Carex sp.	4	8	
Deschampsia cespitosa (L.) Beauv.	1		
Juncus balticus ssp. montanus Engelm.	3	1	
Poa pratensis L.	28		
FORBS			
Achillea millefolium var. apicola (Rydb.) Garrett	7	1	
Fragaria virginiana Miller	1	1	
Geum macrophyllum	1		
Mentha arvensis L.	1		
Oxypolis fendleri (Gray) Heller		1	
Pedicularis groenlandica Retz.		1	
Potentilla sp.	2	1	
Saxifraga odontoloma Piper		1	
Stellaria sp.	1	1	
Taraxacum officinale G.H. Weber ex Wiggers	8		
Thermopsis divaricarpa Nelson	5		
Trifolium repens L.	34	1	
Viola sp.	1	3	
HORESTAILS			
Equisetum sp.	1	1	

Coyote willow-strapleaf willow (*Salix exigua-Salix eriocephala* var. *ligulifolia*) Plant Association

CNHP Rarity Rank: G2G3 / S2S3 This community is described for the first time. Only about 10 occurrences have been documented, however, another 10-100 are expected to occur. No other state has reported occurrences, although it probably occurs in New Mexico.

General Description and Comments: The *Salix exigua-Salix eriocephala* var. *ligulifolia* (coyote willow-strapleaf willow) plant association is a medium- to tall-willow shrubland occurring on saturated point bars and active stream channels of foothill tributary streams. In the mountains, *Salix eriocephala* var. *ligulifolia* mixes with *Salix monticola* (mountain willow) and *Salix drummondiana* (Drummond willow), forming the *Salix eriocephala* var. *ligulifolia* (strapleaf willow) plant association. In the foothills, *Salix eriocephala* var. *ligulifolia* mixes with *Salix exigua* (coyote willow) and *Salix lucida* (whiplash willow), forming the *Salix exigua-Salix eriocephala* var. *ligulifolia* (coyote willow-strapleaf willow) plant association.

Recognition and Classification Problems: *Salix eriocephala* var. *ligulifolia* (strapleaf willow) is the new name for specimens formerly attributed to *Salix ligulifolia* and *Salix lutea* in Colorado (Dorn 1995).

Related Literature and Synonyms: This community has not been previously described in the literature.

Regional Distribution: This association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs along the Colorado Front Range (Kittel *et al.* 1996), along foothill streams of the lower San Luis Valley (upper Rio Grande Basin) (Colorado Natural Heritage Program 1997) and in the San Juan National Forests (Richard *et al.* 1996).

The following information is based on: a total of nine quantitative plots; four from the San Juan National Forest (104, 105, 106, 122), three from the Rio Grande watershed (97GK30, 97GK39, 97GK40), and two from the South Platte River Basin (95LS07, 95GK15) (Colorado Natural Heritage Program 1997).

Elevation Range: 5700-8000 ft (1700-2400 m).

Site Geomorphology: This plant association occurs in the wettest part of the riparian area, usually adjacent to the channel on low point bars, islands, low stream banks and overflow channels. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The streams are broad and meandering with sandy beds (Rosgen's Channel Type: C5) or braided channels (Rosgen's Channel Type: D5).

Soil: Soils of foothill sites are shallow sandy clay loams and sands over unconsolidated alluvial material with thin buried layers of organic material.

Vegetation: This plant association is predominantly tall stands of 20-70% cover of *Salix eriocephala* var. *ligulifolia* (strapleaf willow) mixed with 10-85% cover of *Salix exigua* (coyote willow). *Salix lucida* ssp. *caudata* (Pacific willow) may be present with up to 10%. Other shrubs that may be present include: *Rosa woodsii* (Woods rose), *Quercus gambelii* (Gambel oak), *Symphoricarpos rotundifolia* (mountain snowberry), *Prunus virginiana* (chokecherry), *Crataegus rivularis* (river hawthorn), *Alnus incana* (thinleaf alder), and *Betula occidentalis* (river birch) with about 10% cover, each. The graminoid undergrowth is lush, dominated by 5-45% cover of *Carex lanuginosa* (woolly sedge), up to 35% cover each of *Carex nebrascensis* (Nebraska sedge) and *Eleocharis palustris* (spike rush). Forb cover can be insignificant, or abundant, as in plot 97GK39 (Table 41).

Succession and Ecological Processes: This plant association appears to be an early- to mid-seral community. It occupies point bars and low stream banks that are flooded annually in the spring. It may be a transition zone between the common low elevation *Salix exigua* (coyote willow) plant association and the less common montane elevation *Salix eriocephala* var. *ligulifolia* (strapleaf willow) dominated associations.

Adjacent Riparian Vegetation: This plant association occurs as part of a diverse mosaic of young *Populus angustifolia* (narrowleaf cottonwood), *Populus deltoides* (plains cottonwood), and *Salix amygdaloides* (peach-leaved willow) stands. On higher terraces, there are stands of older *Populus deltoides* and *Salix* species and open meadows of *Bromus inermis* (smooth brome).

Adjacent Upland Vegetation: Stands of this association are surrounded by irrigated hay meadows of *Bromus inermis* (smooth brome) and scattered *Quercus gambelii* (Gambel oak) and *Pinus ponderosa* (ponderosa pine) trees on rocky hillsides.

Management: This plant association is highly productive and provides ample forage for livestock. Both *Carex lanuginosa* (woolly sedge) and *Carex nebrascensis* (Nebraska sedge) are highly palatable to livestock. *Carex nebrascensis* can withstand trampling and defoliation without apparent reduction in abundance (Kovalchik *et al.* 1988). *Salix lutea* (a synonym for *S. eriocephala* (Dorn 1995)) is highly palatable to livestock (Hansen *et al.* 1995). Therefore season-long grazing, especially late summer and early fall browsing, should be avoided in order to maintain the vigor of woody species. Overuse by livestock may cause the site to dry and become dominated by introduced grass species such as *Poa pratensis* (Kentucky bluegrass) and *Bromus inermis* (smooth brome) (Manning and Padgett 1995). With continued overuse, the willow species will decline and eventually become eliminated from the site (Hansen *et al*. 1995).

Beaver are important in maintaining this plant association. Beaver dams raise the water table, which is beneficial to willow and sedge species as well as other hydrophilic plants. Beaver dams also help control bank erosion, channel down cutting, and the loss of sediment downstream (Hansen *et al*. 1995).

Prescribed fires may be useful for rejuvenating *Salix lutea* (a synonym for *Salix eriocephala* (Dorn 1995)) since this willow species vigorously sprouts after burning, especially in wetter areas (Hansen *et al*. 1995). Willow roots provide stream bank stability and should be considered by managers for stream bank restabilization projects and revegetation purposes (Hansen *et al.* 1995, Padgett *et al.* 1989).

Table 41. Percent Cover of Plant Species in Stands of the *Salix exigua*-*Salix eriocephala* var. *ligulifolia* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK30	97GK39	97GK40
Species name and age class/ Site and Riparian Health Rank	C	C	B
SHRUBS			
Betula occidentalis Hooker	1		12
Chrysothamnus nauseosus (Pallas) Britton		2	
Cornus sericea L.			10
Rhus trilobata Nuttall ex Torrey & Gray var. trilobata		1	
Ribes aureum Pursh.		1	
Ribes wolfii Rothrock			5
Rosa woodsii Lindl.		6	
Salix eriocephala Michaux var. ligulifolia	30	17	25
Salix exigua Nutt.	85	57	42
Salix lasiandra var. caudata (Nutt.) Sudworth	1		
Sarcobatus vermiculatus (Hook.) Torr. In Emory		9	
VINES			
Clematis ligusticifolia Nuttall.		4	1
GRAMINOIDS			
Agrostis stolonifera L.		1	9
Bromus tectorum L.	10		
Calamagrostis stricta (Timm) Koeler			11
Carex lanuginosa Michx.		32	4
Juncus balticus ssp. montanus Engelm.		10	
Muhlenbergia asperifolia (Nees & Meyen) L.R. Parodi		13	7
FORBS			
Aster hesperius		4	5
Centurea diffusa	10		
Cirsium arvense			4
Epilobium angustifolium L.	3		
Geranium richardsonii Fisch. & Trautv.			5
Glycyrrhiza leptidota		1	3
Lactuca serriola L.		20	3
Maianthemum stellatum (L.) Link			37
Medicago lupulina		1	
Mentha arvensis L.		2	1
Potentilla hippiana Lehm.		3	
Solidago sp.		2	4
Sphaerophysa salsula		10	
Thalictrum fendleri Engelm. ex Gray			4
HORESTAILS			
Equisetum arvense L.		10	4

Coyote willow (*Salix exigua*) Alliance

Coyote willow/bare ground (*Salix exigua*/bare ground) Plant Association

CNHP Rarity Rank: G5 / S5-- This is a common and widespread early-seral association in all states where reported to occur. It is expected to be equally abundant in other states. This is a common early-seral association of nearly all Colorado streams below 8,000 ft (2400 m) elevation.

General Description and Comments: *Salix exigua* (coyote willow) is one of the most common willow species in Colorado. It comprises two associations, the *Salix exigua*/Mesic Graminoids and the *Salix exigua*/Bare Ground. These are easy to recognize as they are nearly pure stands of the willow, with few other species present. An undergrowth of dense grasses and forbs covering at least 30% of the ground falls into the mesic graminoid type, while an undergrowth of a few, widely scattered forbs and grasses, where exposed cobbles or sand characterizes the ground cover, constitutes the *Salix exigua*/bare ground association. *Salix exigua*/bare ground association occurs within the annual flood zone of a river on point bars, islands, sand or cobble bars and stream banks, while the *Salix exigua*/mesic graminoid association generally occurs along backwater channels and other perennial wet, but less scoured sites, such as floodplain swales and irrigation ditches.

Related Literature and Synonyms: The *Salix exigua*/barren ground plant association (Culver *et al.* 1996, Kittel *et al.* 1994, 1995), the *Salix exigua* plant association (Richard *et al.* 1996), the *Salix exigua/*bench (Manning and Padgett 1995), the *Salix exigua*/barren (Padgett *et al.* 1989), and the *Salix exigua*/sparse and *Salix exigua*/scour (Durkin *et al.* 1995, Durkin *et al.* 1997) are synonymous with the Colorado *Salix exigua*/bare ground plant association.

Similar Communities: Closely related communities include: unclassified stands of *Salix exigua* (Jones and Walford 1995), the *Salix exigua* community type (Hansen *et al*. 1995), and the *Salix exigua-Salix* spp./*Poa* spp. (Johnston 1987).

Regional Distribution: This plant association occurs in Nevada (Manning and Padgett *et al.* 1995), Utah (Padgett *et al.* 1989), New Mexico (Durkin *et al.* 1995, 1997), and Colorado (Colorado Natural Heritage Program 1997, Johnston 1987).

Distribution in Colorado: This association occurs throughout Colorado, on the western slope (Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995), on the eastern plains (Christy 1973, Culver *et al.* 1996, Kittel *et al*. 1996), along the foothills and mountains of the eastern Front Range (Kittel *et al*. 1996, Kittel *et al*. 1997), and in the Rio Grande and Closed Basin watersheds (Colorado Natural Heritage Program 1997).

The following information is based on: a total of forty-one quantitative plots; three from the Comanche National Grasslands (40, 44, 52), seven from the South Platte River Basin (95LS04, 95LS34, 95LS37, 95GK37, 95GK46, 95GK56, 96AM85), six from the Arkansas River Basin (95AM05, 95AM18, 95AM47, 95RR07, 95RR08, 95RR10), seven from the Yampa River Basin

(15, 16, 19, 22, 29, 30, 46), three from the White River Basin (92GK02, 92GK03, 92NL08), five from the Colorado River Basin (93RR29, 93RR30, 93RR33, 93RR47, 93RR50), two from the Gunnison River Basin (94GK29, 94GK37), six from the San Miguel/Dolores River Basin (27, 32, 69, 74, 76, 78), two from the San Juan National Forest (16, 102), and two form the Rio Grande and Closed Basins (97BG10, 97MD09) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 4500-8500 ft (1400-2600 m).

Site Geomorphology: This plant association occurs primarily on sand and cobble bars of larger (second order and up) rivers. It is associated with annual flooding and inundation and will grow well into the channel, where it water flows, even in dry years. It can form large, wide stands on mid-channel islands on larger rivers such as the Gunnison, Colorado and South Platte Rivers, or narrow stringer bands on small, rocky tributaries. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This plant association occurs along a wide variety of stream reaches: from moderately sinuous and moderate gradient reaches (Rosgen's Channel Type: B2-B6), to broad, meandering rivers with wide floodplains (Rosgen's Channel Type: C3-C5) or broad, braided channels (Rosgen's Channel Type: D5). Many stands also occur within highly entrenched or eroding gullies (Rosgen's Channel Type: F3, F6).

Soil: Soils of this association are typically coarse alluvial deposits of sand, silt and cobbles that are highly stratified with depth from flooding scour and deposition. Highly stratified profiles consist of alternating layers of clay loam and organic material with coarser sand or thin layers of sandy loam over very coarse alluvium. Occasionally, this association occurs on deep pockets of sand. In the Colorado River Basin, the soils are stratified sand/loam/clay and classify as Cryorthents, oxyaquic Cryorthents, typic Cryaquents, typic Cryopsamments, and oxyaquic Cryofluvents.

Vegetation: This association is characterized by an almost exclusive canopy of 10-90% cover of *Salix exigua* (coyote willow) with very little herbaceous cover. Occasionally, there is up to 10% cover of either *Populus angustifolia* (narrowleaf cottonwood) or *Populus deltoides* (plains cottonwood) seedlings in the understory. Combined bare soil, gravel, cobble and rock ground cover estimates are typically high.

Successional and Ecological Processes: The *Salix exigua*/bare ground (coyote willow/bare ground) plant association is considered an early seral community, capable of colonizing freshly deposited sand and gravel bars. *Salix exigua* (coyote willow) is an excellent soil stabilizer with a deep root system and flexible stems that can withstand flooding. *Salix exigua* reduces erosion potential by increasing the friction of stream flow, trapping sediments and building a protected seed bed for a number of tree and shrub species. Succession without disturbance may lead to a greater understory cover, which, in turn, facilitates the establishment of shrub and tree seedlings. The presence of cottonwood seedlings within this association indicates succession to a cottonwood stand, if seedlings survive subsequent flooding events.

Adjacent Riparian Vegetation: Because this is one of the most abundant riparian plant associations in Colorado, nearly any type of riparian vegetation may be adjacent. *Populus angustifolia* (narrowleaf cottonwood), *Populus deltoides* (plains cottonwood) or *Juniperus* *scopulorum* (Rocky Mountain juniper) woodlands are often present. Along the South Platte River, the *Populus deltoides-(Salix amygdaloides)/Salix exigua* (plains cottonwood-peach leaf willow/coyote willow) early seral (seedlings and sapling size trees only) community occurs on adjacent sand bars and low terraces, and older stands of *Populus deltoides-Salix amygdaloides/ Spartina pectinata* (plains cottonwood-peach leaf willow/prairie cordgrass) occur on higher terraces. Other adjacent riparian vegetation includes *Tamarix ramosissima* (salt cedar) on the Colorado River in the vicinity of Grand Junction and on the Arkansas River in eastern Colorado. In the foothills and higher mountains, *Alnus incana* (thinleaf alder), *Cornus sericea* (red-osier dogwood) or *Betula occidentalis* (water birch) shrublands, and *Eleocharis palustris* (spikerush), *Typha angustifolia* (narrow-leaved cattail) or *Carex* (sedge) wetlands can be neighboring riparian types to the *Salix exigua*/Bare Ground plant association.

Adjacent Upland Vegetation: Agricultural fields (sugar beets, winter wheat, and others) and rolling hills of *Artemisia filifolia* (silversage), xeric tall-grass prairies and *Bouteloua gracilis* (blue grama) short-grass prairies occur on surrounding rolling hills and plains of the South Platte River on the eastern plains. In the steep canyons of the foothills, upslope vegetation includes *Pseudotsuga menziesii* (Douglas-fir) and *Pinus ponderosa* (ponderosa pine) forests, *Pinus edulis* (pinyon pine), *Juniperus monosperma* (one-seed juniper) and *Juniperus osteosperma* or *J. monosperma* (Utah or one-seeded juniper) woodlands, *Quercus gambelii* (Gambel oak) shrublands, and *Artemisia tridentata* (big sagebrush) and *Sarcobatus vermiculatus* (greasewood) scrub. In the lower montane, upslope vegetation includes *Pinus contorta* (lodgepole pine) and *Populus tremuloides* (aspen) forests. Again, because this is probably the most common riparian community in Colorado, just about any vegetation can occur upslope of the riparian area. So this list is not exhaustive, nor probably very helpful.

Management: Forage production is typically low to moderate in *Salix exigua* stands due to the high densities of stems. The dense overstory may limit livestock movement within the association (Manning and Padgett 1995). Overgrazing by livestock will reduce the vigor of the willows present and may eventually eliminate them from the site. The opening up of *Salix exigua* stands may result in the invasion of introduced and non-palatable native species. However, release from heavy grazing pressure will allow *Salix exigua* to reestablish itself, provided it has not been completely eliminated from the site. Soil compaction is generally not a problem in this association because of the high coarse fragment content of the soils. However, fine textured soils are subject to compaction when moist (Hansen *et al.* 1995).

The limited information on fire as a management tool in this association indicates that *Salix exigua* vigorously sprouts following fire. Quick, hot fires result in more sprouts than slow fires which are actually more damaging to willows and tend to result in fewer sprouts (Hansen *et al.* 1995).

Salix exigua is an excellent streambank stabilizer due to its ability to send up individual stems from an underground root system. It also has an excellent capability of re-colonizing and spreading on disturbed areas. Once *Salix exigua* becomes established on disturbed areas, other shrubs and herbaceous species can become established as well. Removal of this association and subsequent stream bank exposure can lead to severe degradation and devastating results (Hansen *et al*. 1995).

Salix exigua can be useful for revegetating degraded sites and exposed sand/gravel bars since it will produce many roots along the entire stem. For best results, cuttings should be taken in the spring from dormant two to four year old wood. The cuttings should be 30-50 cm (12-20 in) long and >1 cm (0.5 in) in diameter. To insure survival, the cuttings should be rooted and grown in a nursery. Roots and shoots can be expected within 10 days of planting (Hansen *et al*. 1995).

Table 42. Percent Cover of Plant Species in Stands of the *Salix exigua*/Bare ground Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97BG10	97MD09
Species name and age class/ Site and Riparian Health Rank	C	A
SHRUBS		
Pentaphylloides floribunda (Pursh) A. Love	18	
Rhus trilobata Nuttall ex Torrey & Gray var. trilobata		1
Rosa woodsii Lindl.	5	
Salix exigua Nutt.	67	70
Salix lasiandra var. caudata (Nutt.) Sudworth		13
GRAMINOIDS		
Calamagrostis canadensis (Michx.) Beauv.		7
Glyceria sp.		1
Juncus balticus ssp. montanus Engelm.		1
Juncus sp.	1	1
Oryzopsis hymenoides (Roemer & Schultes) Ricker		1
Pascopyron smithii (Rydb.) A. Love		1
Poa palustris L.		1
Poa sp.	2	
Redfeldia flexulosa ((Thurb.) Vasey		1
FORBS		
Achillea millefolium var. apicola (Rydb.) Garrett	2	
Epilobium sp.	1	
Mentha arvensis L.		1
Thalictrum alpinum L.	1	

Coyote willow/Mesic Graminoids (*Salix exigua*/Mesic Graminoids) Plant Association

CNHP Rarity Rank: G5 / S5 -- This is a common association known from Utah to Kansas. This is one of the most common associations in Colorado, with well over 200 stands estimated to occur.

General Description and Comments: *Salix exigua* (coyote willow) is one of the most common willow species in Colorado. It comprises two associations, the *Salix exigua*/Mesic Graminoids and the *Salix exigua*/bare ground. These are easy to recognize as they are nearly pure stands of the willow, with few other species present. An undergrowth of dense grasses and forbs covering at least 30% of the ground falls into the Mesic Graminoids type, while an undergrowth of a few, widely scattered forbs and grasses, where exposed cobbles or sand characterizes the ground cover, constitutes the *Salix exigua*/bare ground association. *Salix exigua*/bare ground association occurs within the annual flood zone of a river on point bars, islands, sand or cobble bars and stream banks, while the *Salix exigua*/Mesic Graminoids association generally occurs along backwater channels and other perennial wet, but less scoured sites, such as floodplain swales and irrigation ditches.

Related Literature and Synonyms: The *Salix exigua*/Mesic Graminoids community types (Padgett *et al.* 1989, Jones and Walford 1995) are synonymous with the Colorado Salix exigua/Mesic Graminoids plant association.

Regional Distribution: This plant association occurs in Wyoming (Jones and Walford 1995), Utah, Nebraska, Kansas, Oklahoma (The Nature Conservancy 1997) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs throughout the western slope: San Miguel/Dolores River Basin (Kittel and Lederer 1993) and on the San Juan National Forest (Richard *et al*. 1996), along the Colorado Front Range (Friedman 1993, Koch 1994, Kittel 1994, Cooper and Cottrell 1990), the mainstem and tributaries of the South Platte River (Christy 1973, Kittel *et al.* 1996, Kittel *et al.* 1997), and in southeastern Colorado on the Comanche National Grasslands (Culver *et al.* 1996).

The following information is based on: a total of thirty-one quantitative plots; three from the San Juan National Forest (18, 121, 141), four from the San Miguel/Dolores River Basin (3, 33, 60, 68), three from the Yampa River Basin (96, 6, 4), five from the Arkansas River Basin (95AM48, 95RR11, 95GK65, 95GK66, 95GK75), twelve from the South Platte River Basin (95LS15, 95LS17, 95LS26, 95GK06, 95GK13, 95GK18, 95GK23, 95GK28, 95GK29, 96AM31, 96AM35, 96AM71), and four from the Rio Grande and Closed Basins (97EV04, 97EV36, 97GK06, 97MD21) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 5700- 9100 ft. (1750-2700 m).

Site Geomorphology: This plant association usually occurs within 1 meter vertical distance of the stream channel on point bars, low floodplains, terraces and along overflow channels. It can also occur away from the stream channel in mesic swales or along the margins of beaver ponds.

Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are broad to narrow meandering with sand or cobble beds (Rosgen's Channel Type: C5).

Soil: Soils are typically somewhat more developed than the *Salix exigua*/bare ground plant association due to a slightly more stable environment and greater input of organic matter. However, the soils are generally thin (<1 m) and skeletal with depth (10-50% cobbles). Textures are typically loamy sands interspersed with layers of silty clays and alternating with coarse sands. Upper layers (10-30 cm) often have 25-30% organic matter.

Vegetation: *Salix exigua* dominates the canopy of this association with 15-98% cover, giving the association its characteristic grayish-green color. Other willow species can occur in the canopy including up to 25% cover of *Salix eriocephala* var. *ligulifolia* (yellow willow) and up to 15% cover of *Salix monticola* (Rocky Mountain willow). The undergrowth has at least 20-35% cover of various graminoid species including *Carex lanuginosa* (woolly sedge), *Eleocharis palustris* (spikerush) and *Juncus balticus* (Baltic rush). Non-native *Poa pratensis* (Kentucky bluegrass) can be significant with up to 41% cover.

Several stands along the Arikaree River had significant amounts of *Panicum virgatum* (switchgrass), *Sorghastrum nutans* (indiangrass), and *Spartina pectinata* (prairie cordgrass) in the undergrowth due their proximity to tall-grass wet meadows. These stands are included as a variation within this plant association.

Forb cover is generally low, but can include a high percentage of non-native species such as up to 30% cover of *Medicago lupulina* (black medic), and up to 10% cover of *Melilotus officinalis* (sweetclover).

Successional and Ecological Processes: This plant association is typical of recent floodplains and highly disturbed, low, wet areas and is considered early-seral. The amount of herbaceous growth in the understory is an indication of the amount of time since the last scouring (or depositional) flood event. *Salix exigua* (coyote willow) is an excellent soil stabilizer with a deep root system and flexible stems that can withstand flooding. *Salix exigua* reduces erosion potential by increasing the friction of stream flow, trapping sediments and building a protected seed bed for a number of tree and shrub species. The presence of cottonwood seedlings within this association indicates succession to a cottonwood stand (and may represent the *Populus angustifolia* or *Populus deltoides/Salix exigua* plant associations), if seedlings survive subsequent flooding events.

Adjacent Riparian Vegetation: Stands of *Populus angustifolia* (narrowleaf cottonwood) or *Populus deltoides-Salix amygdaloides* (plains cottonwood-peach-leaf willow) woodlands, *Prunus virginiana* (chokecherry) and *Ribes* spp. (currant) thickets, or irrigated hay meadows generally occur on higher terraces and adjacent elevated floodplains. Stands of *Carex aquatilis* (water sedge) can occur in adjacent wet areas and *Symphoricarpos* spp. (snowberry) shrublands occur in drier areas of the floodplain.

Adjacent Upland Vegetation: Streams cutting through steep rock gullies and canyons often have *Pinus ponderosa* (ponderosa pine) or *Pinus edulis* (pinyon pine) and *Juniperus monosperma* (one-seed juniper) woodlands on the uplands with *Quercus gambelii* (Gambel oak) thickets on lower slopes. *Pseudotsuga menziesii* (Douglas fir) forests can occur on north facing canyon walls. Irrigated hay meadows and other agricultural crops commonly occur on the immediate uplands of more gentle streams.

Management: Forage production is typically low to moderate in *Salix exigua* stands due to the high densities of stems. The dense overstory may limit livestock movement within the association (Manning and Padgett 1995). Overgrazing by livestock will reduce the vigor of the willows present and may eventually eliminate them from the site. The opening up of *Salix exigua* stands may result in the invasion of introduced and non-palatable native species. However, release from heavy grazing pressure will allow *Salix exigua* to reestablish itself, provided it has not been completely eliminated from the site. Soil compaction is generally not a problem in this association because of the high coarse fragment content of the soils. However, fine textured soils are subject to compaction when moist (Hansen *et al.* 1995).

The limited information on fire as a management tool in this association indicates that *Salix exigua* vigorously sprouts following fire. Quick, hot fires result in more sprouts than slow fires, which are actually more damaging to willows and tend to result in fewer sprouts (Hansen *et al.* 1995).

Salix exigua is an excellent streambank stabilizer due to its ability to send up individual stems from an underground root system. It also has an excellent capability of re-colonizing and spreading on disturbed areas. Once *Salix exigua* becomes established on disturbed areas, other shrubs and herbaceous species can become established as well. Removal of this association and subsequent stream bank exposure can lead to severe degradation and devastating results (Hansen *et al*. 1995).

Salix exigua can be useful for revegetating degraded sites and exposed sand/gravel bars since it will produce many roots along the entire stem. For best results, cuttings should be taken in the spring from dormant two to four year old wood. The cuttings should be 30-50 cm (12-20 in) long and >1 cm (0.5 in) in diameter. To insure survival, the cuttings should be rooted and grown in a nursery. Roots and shoots can be expected within 10 days of planting (Hansen *et al*. 1995).

Table 43. Percent Cover of Plant Species in Stands of the *Salix exigua*/Mesic Graminoids Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97EV04	97EV36	97GK06	97MD21
Species name and age class/ Site and Riparian Health Rank	B	C	C	C
SHRUBS				
Pentaphylloides floribunda (Pursh) A. Love	8			
Ribes aureum Pursh.			1	2
Rosa woodsii Lindl.			27	
Salix exigua Nutt.	27	97	37	97
Salix lasiandra var. caudata (Nutt.) Sudworth	13		6	
GRAMINOIDS				
Calamagrostis canadensis (Michx.) Beauv.		39		
Carex lanuginosa Michx.			6	
Carex sp.		8		
Carex utriculata Boott	2			
Hordeum jubatum L.				1
Juncus balticus ssp. montanus Engelm.	38		1	
Pascopyron smithii (Rydb.) A. Love			3	
Poa sp.	2	10		
FORBS				
Achillea millefolium var. apicola (Rydb.) Garrett	15			
Antennaria sp.	1			
Cardaria latifolia			1	10
Chenopodium alba			1	
Cirsium arvense			2	1
Cirsium sp.		15		
Comandra umbellata (L.) Nuttall			6	
Iris missouriensis Nutt.	1			
Maianthemum stellatum (L.) Link			3	
Mentha arvensis L.				1
Mentha sp.	1	2		
Plantago major				7
Potentilla pulcherimma x hippiana	3			9
Streptopus amplexifolius var. chalazatus Fassett		1		
Taraxacum officinale G.H. Weber ex Wiggers	1			
Trifolium repens L.	6			
Unknown forb	3	4	1	1
HORESTAILS				
Equisetum arvense L.	1			2

Salix geyeriana Seasonally Flooded Shrubland Alliance

Geyer willow/bluejoint reedgrass (*Salix geyeriana/Calamagrostis canadensis*) Plant Association

CNHP Rarity Rank: G5 / S3--This association is reported from several states, however it is relatively uncommon in Colorado. Few stands are in pristine condition. It may be less common than it was historically due to heavy grazing at the turn of the century. Today it continues to be threatened by poor management of livestock grazing, stream flow alterations and heavy recreational use.

General Description and Comments: The *Salix geyeriana/Calamagrostis canadensis* (Geyer willow/bluejoint reedgrass) plant association is a tall (2-3 m), deciduous shrubland, often forming large expanses of willows on broad montane valley floors. The ground is usually hummocky with a thick carpet of grasses and grass-like plants. These shrublands are often associated with beaver-created wetlands.

Recognition and Classification Problems: Without catkins (the flowering stalk), *Salix geyeriana* (Geyer willow) can be difficult to distinguish from the similar looking *Salix drummondiana* (Drummond willow). Both species are tall, greater than 5 feet (2 meters), montane willows with strongly pruinose (a waxy covering that rubs off, similar to the coating on a plum) current-year twigs. Luckily, the two species can be distinguished using only vegetative characters. *Salix geyeriana* (Geyer willow) leaves are never more than 0.5 inches (13 mm) wide and *Salix drummondiana* (Drummond willow) leaves are, on average, over 0.5 inches (13 mm) wide (on non-sucker shoots) (Welsh *et al*. 1987).

Related Literature and Synonyms: The *Salix geyeriana-Salix monticola/Calamagrostis canadensis* (Reid and Bourgeron 1991), the *Salix geyeriana-Salix* spp./*Calamagrostis canadensis* (Johnston 1987), and the *Salix geyeriana/Calamagrostis canadensis* (Hess 1981, Padgett *et al.* 1989, Youngblood *et al.* 1985, Hansen *et al.* 1995, Cooper and Cottrell 1990) are all synonymous with the Colorado *Salix geyeriana/Calamagrostis canadensis* plant association.

Regional Distribution: This plant association occurs in Montana (Hansen *et al*. 1995), Idaho, Utah (Padgett *et al*. 1989), Wyoming (Youngblood *et al*. 1985), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Colorado River Basin (Kittel *et al*. 1994), the upper South Platte River Basin (Cooper and Cottrell 1990), and on the Routt, Arapaho, Roosevelt, and Gunnison National Forests (Kettler and McMullen 1996, Johnston 1987).

The following information is based on: a total of eight quantitative plots; seven from the Colorado River Basin (93SS18, 93SS22, 93SS23, 93SS25, 93DR04, 93DR07, 94JS38A), one from the Routt National Forest (591), and one from the Gunnison River Basin (94JS05E) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 8000-10,300 ft (2400-3100 m).

Site Geomorphology: This plant association occurs along sinuous, moderate to low gradient (0.1-8%) rivers and adjacent to beaver ponds on hummocky land surfaces. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and strongly meandering (Rosgen's Channel Type: C3, C4, C5/6).

Soils: Soil textures are fine silty clay loams with high organic content. In the Colorado River Basin, the soils classify as Typic and Cumulic Cryaquolls and Oxyaquic Cryorthents.

Vegetation: *Salix geyeriana* (Geyer willow) dominates the tall-shrub overstory with 20-70% cover. Other shrubs include up to 20% cover each of *Salix monticola* (Rocky Mountain willow), *Salix planifolia* (planeleaf willow), *Salix drummondiana* (Drummond willow) with up to 30%, and up to 10% cover of *Alnus incana* (thinleaf alder). The undergrowth is always dominated by 1-40% cover of *Calamagrostis canadensis* (bluejoint reedgrass). Other graminoids include up to 30% cover of *Carex aquatilis* (aquatic sedge) and up to 20% cover of *Carex utriculata* (beaked sedge). Forb cover is relatively low.

Successional and Ecological Processes: *Salix geyeriana* dominated associations appear to be long-lived and late-seral, remaining in areas where a shallow water table saturates soils, not dropping below 3 ft. (1 m) for much of the growing season. Stands are limited to cold, wet environments of broad valley bottoms at high elevations. Due to the colder environments, organic matter builds up in the soils and succession to other associations is likely to be slow (Padgett *et al.* 1989). Beaver activity is also important in maintaining this association since it may be the last successional community to establish on naturally silted-in beaver ponds (Cooper and Cottrell 1990).

Carex utriculata (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) 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 (beaked sedge) occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channel with the shallowest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (water sedge) (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* (water sedge) dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* (bluejoint reedgrass) dominated stands.

Padgett *et al*. (1989) suggest that in Utah and southeast Idaho, the presence of *Pinus contorta* in or near the *Salix geyeriana/Calamagrostis canadensis* (Geyer willow/bluejoint reedgrass) plant association indicates a conversion to a conifer/*Calamagrostis canadensis* type. Stands on the Routt National Forest in Colorado have young *Pinus contorta* (lodgepole pine) invading the area and may be changing to this conifer/*Calamagrostis canadensis* type.

Adjacent Riparian Vegetation: Mesic *Pinus contorta/Calamagrostis canadensis* (lodgepole pine/bluejoint reedgrass) forests, *Salix geyeriana* (Geyer willow) shrublands, and *Carex* (sedge) meadows occur in adjacent riparian areas.

Adjacent upslope vegetation: *Pinus contorta-Picea engelmannii* (lodgepole pine-Engelmann spruce) forests and *Artemisia tridentata* (big sagebrush) shrublands occur on adjacent hillsides.

Management: *Salix geyeriana* (Geyer willow) appears to be less tolerant of browsing pressure than other tall montane willow species (Hansen *et al*. 1995*)*. *Salix geyeriana* (Geyer willow) will form the classic "mushroom" shape with over browsing by deer and cattle. Overuse by livestock can also result in decreased vigor of the willows present and their eventual elimination from the site.

Palatability is high to moderately high for *Calamagrostis canadensis* (bluejoint reedgrass), depending on the season and availability of other species. Young foliage is most palatable, but wet conditions early in the grazing season limit access to livestock. Season-long grazing may result in decreased vigor of *Calamagrostis canadensis* and an increase in non-native *Poa pratensis* (Kentucky bluegrass). In order to maintain productivity and vigor of the plants and prevent damage to the soils, grazing should be deferred until soils dry. Periods of rest from grazing are also necessary in order to maintain this community (Hansen *et al*. 1995). However, 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 down cutting, bank erosion, and movement of sediment by slowing stream flow and reducing stream gradients. Beaver dams raise the water table across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raise the channel bed and create a wetland environment. Land managers should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

Prescribed burning is 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. *Calamagrostis canadensis*, if present prior to burning, is an aggressive invader of moist, burned sites due to its propagation from seeds and rhizomes. Burning also temporarily increases the productivity of *Carex aquatilis* (aquatic sedge) and *Carex utriculata* (beaked sedge). Grazing should be eliminated from burned sites for 2-3 years following a fire in order to prevent livestock from browsing the young, palatable regrowth (Hansen *et al*. 1995).

Both *Salix geyeriana* (Geyer willow) and *Calamagrostis canadensis* (bluejoint reedgrass) are valuable for revegetating and stabilizing stream banks. *Calamagrostis canadensis* is valuable due to its propagation from rhizomes. *Salix geyeriana* can be grown from nursery cuttings and then transplanted. 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).

Table 44. Percent Cover of Plant Species in a Stand of the *Salix geyeriana/Calamagrostis canadensis* Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	97MD04
Species name and age class/ Site and Riparian Health Rank	D
SHRUBS	
Alnus incana (L.) Moench	1
Pentaphylloides floribunda (Pursh) A. Love	1
Ribes inerme Rydb.	3
Salix geyeriana Anderss.	25
Salix monticola Bebb	17
GRAMINOIDS	
Calamagrostis canadensis (Michx.) Beauv.	10
Carex aquatilis Wahlenb.	1
Carex microptera Mackenzie	1
Carex sp.	1
Carex utriculata Boott	3
Eleocharis palustris (L.)	1
Glyceria striata (Lam.) A.S. Hitchc.	2
Juncus drummondii E. Mey.	1
Poa pratensis L.	6
FORBS	
Achillea millefolium var. apicola (Rydb.) Garrett	2
Conioselinum scopulorum (Gray) Coult. & Rose	3
Fragaria virginiana Miller	1
Mertensia ciliata (James ex Torr.) G. Don	1
Mertensia franciscana Heller	1
Oxypolis fendleri (Gray) Heller	1
Potentilla pulcherimma x hippiana	1
Rumex crispus	1
Taraxacum officinale G.H. Weber ex Wiggers	4
Thermopsis rhombifolia var. montana (Nutt.) Isely	1
Trifolium longipes ssp. pygmaeum (Gray) J. Gillett	2
Trifolium pratense	3
Vicia americana Muhlenberg.	1
HORESTAILS	
Equisetum arvense L.	4

Geyer willow/beaked sedge (*Salix geyeriana/Carex utriculata*) Plant Association

CNHP Rarity Rank: G5 / S3 --This association is well documented from many western states. This association is relatively uncommon in Colorado. Few stands are in pristine condition. It may be less common than it was historically due to heavy grazing at the turn of the century. Today it continues to be threatened by improper livestock grazing, stream flow alterations and heavy recreational use.

General Description and Comments: The *Salix geyeriana/Carex utriculata* (Geyer willow/beaked sedge) plant association is a tall (5-15 ft, 1.5-2.5 m), deciduous shrubland with a nearly closed canopy of willows and thick carpet of sedges in the undergrowth. It is often wet, with saturated soils throughout much of the growing season.

Recognition and Classification Problems: Without catkins (the flowering stalk), *Salix geyeriana* (Geyer willow) can be difficult to distinguish from the similar looking *Salix drummondiana* (Drummond willow). Both species are tall, greater than 5 feet (2 meters), montane willows with strongly pruinose (a waxy covering that rubs off, similar to the coating on a plum) current-year twigs. Luckily, the two species can be distinguished using only vegetative characters. *Salix geyeriana* (Geyer willow) leaves are never more than 0.5 inches (13 mm) wide and *Salix drummondiana* (Drummond willow) leaves are, on average, over 0.5 inches (13 mm) wide (on non-sucker shoots) (Welsh *et al*. 1987).

Related Literature and Synonyms: The *Salix geyeriana/ Carex rostrata* (Geyer willow/beaked sedge) community type (Hansen *et al*. 1995, Youngblood *et al*. 1985, Padgett *et al*. 1989, Girard *et al*. 1995, Jones 1992) and the *Salix geyeriana-Salix* spp./*Carex utriculata* (Geyer willow-several willow species./beaked sedge) plant association (Phillips 1977, Johnson 1987) are synonymous with the Colorado *Salix geyeriana/Carex utriculata* plant association. *Carex rostrata* var. *utriculata* is a synonym for *Carex utriculata* (Kartesz 1994). This association is listed as the *Salix geyeriana/Carex rostrata* in the Terrestrial Vegetation of the United States (Anderson *et al*. 1998).

Regional Distribution: This plant association occurs in Montana (Hansen *et al*. 1995), Utah (Padgett *et al*. 1989), Idaho and Wyoming (Youngblood *et al*. 1985, Girard *et al*. 1995, Jones 1992) and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in north-central Colorado, the Arapaho-Roosevelt (Johnston 1987) and Routt National Forests (Kettler and McMullen 1996), in the Yampa (Kittel and Lederer 1993), South Platte (Kittel *et al*. 1997), and Rio Grande and Closed Basin watersheds (Colorado Natural Heritage Program 1997).

The following information is based on: a total of nine quantitative plots; four from the Yampa River Basin (67, 71, 93, GK16), three from the Routt National Forest (71, 271, 536), two from the South Platte River Basin (96LS01, 96LS03), and two from the Rio Grande and Closed Basins (97GK02, 97MD02) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6800-9000 ft (2100-2800 m).

Site Geomorphology: This association occurs in moderately wide to wide valley bottoms in swales and overflow channels of active floodplains adjacent to wide stream channels. This association often occurs near beaver activity. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are slightly meandering (Rosgen's Channel Type: B4) or braided from beaver activity (Rosgen's Channel Type: D6).

Soil: Soil textures are silty clay loam, clay, and sandy clay, usually forming thick, cohesive layers interspersed with layers of gravel or sand. Mottling or gleying is often present. In Utah, this association occurs on organic and mineral soils. Mottling often occurs in the mineral soil horizons (Padgett *et al*. 1989)

Vegetation: *Salix geyeriana* (Geyer willow) dominates the shrub overstory with 20-60% cover. Other willow species include up to 20% cover of *Salix monticola* (mountain willow) and up to 10% cover each of *Salix drummondiana* (Drummond willow), *Salix wolfii* (Wolf willow) and *Salix planifolia* (planeleaf willow). Other shrubs with less than 10% cover include *Alnus incana* ssp. *tenuifolia* (thinleaf alder) and *Lonicera involucrata* (honeysuckle). The graminoid layer is dominated by 20-60% cover of *Carex utriculata* (beaked sedge). Other graminoids include up to 30% cover of *Carex aquatilis* (water sedge), up to 10% cover of *Calamagrostis canadensis* (bluejoint reedgrass) and up to 5% cover each of *Carex nebrascensis* (Nebraska sedge) and *Carex praegracilis* (clustered field sedge). Forb cover is generally minor.

Successional and Ecological Processes: *Salix geyeriana* dominated associations appear to be long-lived and late-seral, remaining in areas where a shallow water table saturates soils, not dropping below 3 ft. (1 m) for much of the growing season. Stands are limited to cold, wet environments of broad valley bottoms at high elevations. Due to the colder environments, organic matter builds up in the soils and succession to other associations is likely to be slow (Padgett *et al.* 1989). Beaver activity is also important in maintaining this association since it may be the last successional community to establish on naturally silted-in beaver ponds (Cooper and Cottrell 1990).

Carex utriculata (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) 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 (beaked sedge) occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channel with the shallowest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (water sedge) (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* (water sedge) dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* (bluejoint reedgrass) dominated stands.

Adjacent Riparian Vegetation: Adjacent riparian areas have *Populus tremuloides* (quaking aspen) and *Picea pungens* (Colorado blue spruce) forests, *Salix monticola* (mountain willow) and *Alnus incana* (thinleaf alder) shrublands and *Carex utriculata* (beaked sedge) or *Ranunculus aquatilis* (water crowfoot) wet meadows.

Adjacent Upland Vegetation: *Pinus contorta* (lodgepole pine) forests and *Artemisia tridentata* (big sagebrush) scrub occur on surrounding hillslopes.

Management: *Salix geyeriana* (Geyer willow) appears to be less tolerant of browsing pressure than other tall montane willow species (Hansen *et al*. 1995). *Salix geyeriana* (Geyer willow) will form the classic "mushroom" shape with over browsing by deer and cattle. *Carex* (sedge) species are often heavily grazed by livestock in narrow riparian areas in mid-elevation rangelands. Overgrazing by livestock can dry the site, increase non-native grass 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).

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 movement of sediment by slowing stream flow and reducing stream gradients. Beaver dams raise the water table across the floodplain and provide year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raise the channel bed and create a wetland environment. Land managers should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

According to Hansen *et al*. (1995), burning this plant association temporarily increases the productivity of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge) . However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 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.

Salix geyeriana (Geyer willow), *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge) are all effective stream bank stabilizers. *Carex utriculata* and *Carex aquatilis* are useful due to their dense network of rhizomatous roots. *Salix geyeriana* can be grown from nursery cuttings and then transplanted. 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).

Table 45. Percent Cover of Plant Species in Stands of the *Salix geyeriana/Carex utriculata* Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK02	97MD02
Species name and age class/ Site and Riparian Health Rank	C	C
SHRUBS		
Alnus incana (L.) Moench		1
Pentaphylloides floribunda (Pursh) A. Love	1	
Ribes cereum Dougl.	1	
Ribes inerme Rydb.	20	
Ribes montigenum McClatchie	6	
Rosa woodsii Lindl.	1	
Salix geyeriana Anderss.	37	60
Salix monticola Bebb	12	
VINES		
GRAMINOIDS		
Calamagrostis canadensis (Michx.) Beauv.	1	2
Carex aquatilis Wahlenb.	2	
Carex utriculata Boott	18	14
Deschampsia cespitosa (L.) Beauv.	1	3
Juncus balticus ssp. montanus Engelm.	4	1
Poa pratensis L.	6	
FORBS		
Achillea millefolium var. apicola (Rydb.) Garrett	1	1
Crunocallis chamissoii		1
Epilobium sp.	1	
Erigeron sp.	3	
Iris missouriensis Nutt.	1	
Mentha arvensis L.	1	4
Potentilla pulcherimma x hippiana	7	3
Potentilla sp.	1	
Rumex crispus		2
Trifolium longipes ssp. pygmaeum (Gray) J. Gillett	1	
Unknown forb	1	
Urtica dioica ssp. gracilis (Ait.) Seland.	1	
Veronica americana Schwein. ex Benth.		1
Veronica sp.	1	
Viola sp.	1	

Salix geyeriana Temporarily Flooded Shrubland Alliance

Geyer willow/Mesic Forbs (*Salix geyeriana*/Mesic Forbs) Plant Association

CNHP Rarity Rank: G3 / S3 --This association is well documented in several western states. However, large, pristine stands with no non-native species in the undergrowth are extremely rare. This association is known from less than ten locations, but an additional ten to twenty are expected to occur. Few stands are in pristine condition and no locations are formally protected. This association is threatened by improper livestock grazing, stream flow alterations, and heavy recreational use.

General Description and Comments: The *Salix geyeriana/*mesic forb (Geyer willow/mesic forb) plant association is a tall (5-15 ft., 1.5-2.5 m), deciduous shrubland confined to a narrow band along stream banks. The herbaceous undergrowth is dominated by mosses and forbs.

Recognition and Classification Problems: Without catkins (the flowering stalk), *Salix geyeriana* (Geyer willow) can be difficult to distinguish from the similar looking *Salix drummondiana* (Drummond willow). Both species are tall, greater than 5 feet (2 meters), montane willows with strongly pruinose (a waxy covering that rubs off, similar to the coating on a plum) current-year twigs. Luckily, the two species can be distinguished using only vegetative characters. *Salix geyeriana* (Geyer willow) leaves are never more than 0.5 inches (13 mm) wide and *Salix drummondiana* (Drummond willow) leaves are, on average, over 0.5 inches (13 mm) wide (on non-sucker shoots) (Welsh *et al*. 1987).

Related Literature and Synonyms: The *Salix geyeriana/*mesic forb community type (Padgett *et al.* 1989, Youngblood *et al.* 1985), the *Salix geyeriana/Achillea millefolium* ssp. *lanulosa* (Geyer willow/yarrow) plant association (Bourgeron and Engelking 1994) are synonymous with the Colorado Salix geyeriana/mesic forb plant association.

Similar Communities: Closely related communities include the *Salix geyeriana-Salix* spp./*Calamagrostis canadensis* (Geyer willow-willow/bluejoint reedgrass) association (Johnston 1987) and the *Salix geyeriana-Deschampsia cespitosa* community type (Padgett *et al.* 1987), which have significant graminoid cover rather than forb cover in the undergrowth.

Regional Distribution: This plant association occurs in Idaho, Wyoming (Youngblood *et al.* 1985, Girard *et al.* 1995, Johnston 1987) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the Arapaho, Gunnison (Johnston 1987), Routt (Kettler and McMullen 1996) and in the San Juan and Rio Grande National Forests (Richard *et al*. 1996, Colorado Natural Heritage Program 1997).

The following information is based on: a total of seven quantitative plots; five from the Routt National Forest (92, 531, 551, 558, 559), two from the San Juan National Forest (47, 86), and two form the Rio Grande and Closed Basins (97GK43, 97MD27) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 8200-9900 ft (2500-3000 m).

Site Geomorphology: Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This plant association generally occurs along moderately wide, low-gradient valley bottoms with sinuous stream channels (Rosgen Channel Type: C4). It can also occur in narrow valley bottoms (65-165 ft., 20-50 m), and on flood benches of moderately sinuous stream channels (Rosgen's Channel Type: B2).

Soil: Soils are coarse skeletal sandy loams and sandy clay loams overlaying gravel and cobble horizons. Soils of this plant association tend to have more coarse fragments than other more moist *Salix geyeriana* associations (Padgett *et al.* 1989).

Vegetation: *Salix geyeriana* (Geyer willow) dominates the tall-shrub canopy with 30-75% cover. Other willow species include up to 30% cover each of *Salix monticola* (Rocky Mountain willow) and *Salix drummondiana* (Drummond willow), up to 10% cover of *Salix planifolia* (planeleaf willow), and up to 5% cover each of *Salix wolfii* (Wolf willow) and *Salix brachycarpa* (barrenground willow). *Alnus incana* (thinleaf alder) may be present with up to 50% cover. Forb cover is low to fairly dense with up to 35% cover of *Mertensia ciliata* (mountain bluebells), up to 30% cover of *Heracleum sphondylium* (cow parsnip), up to 10% cover each of *Senecio triangularis* (arrowleaf groundsel) and *Oxypolis fendleri*, and *up to* 5% cover of *Fragaria virginiana* (mountain strawberry). Graminoid cover is usually sparse (<10%), but two stands sampled in the Rio Grande and Closed Basins had over 40% cover by Graminoids in addition to the over 50% cover by forbs. *Carex utriculata* (beaked sedge) was present in one plot with 11% and *Carex aquatilis* (water sedge) in another plot with 18% cover.

Successional and Ecological Processes: The *Salix geyeriana*/Mesic forb (Geyer willow/mesic forb) plant association appears to be a long-lived, late-seral community that will remain dominant where a high water table saturates soils for much of the growing season. However, if the stand has predominantly non native species in the undergrowth, such as *Trifolium repens* (white dutch clover), and *Taraxacum officinale* (common dandelion), it is likely a grazing induced community. With appropriate grazing management, the stand can revert back to the *Salix geyeriana*/mesic forb or the *Salix geyeriana*/mesic graminoid plant association.

Season-long livestock grazing can increase the cover of non-native grasses such as *Poa pratensis* (Kentucky bluegrass). Padgett *et al*. (1989) note that this type of conversion will increase the risk of bank sloughing due to the relatively shallow rooting nature of *Poa pratensis* (Kentucky bluegrass). In addition, the saturated soils are susceptible to compaction by heavy equipment or heavy livestock use. With continued, season-long grazing, this association is likely to convert to a drier community with a more open willow canopy, and less desirable forage in the undergrowth.

Adjacent riparian vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests and *Salix boothii* (Booth willow), *Salix drummondiana* (Drummond willow), *Salix lasiandra var. caudata* (whiplash willow) and *Alnus incana* (thinleaf alder) shrublands occur within the riparian mosaic as well as *Carex utriculata* (beaked sedge) meadows on adjacent low-lying, flat floodplains.

Adjacent upland vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests and *Populus tremuloides* (quaking aspen) woodlands occur on adjacent hillslopes.

Management: *Salix geyeriana* (Geyer willow) appears to be less tolerant of browsing pressure than other tall montane willow species (Hansen *et al*. 1995*). Salix geyeriana* (Geyer willow) will form the classic "mushroom" shape with over browsing by deer and cattle. The wet and often saturated soils of this plant association are also vulnerable to compaction by livestock and heavy equipment. The herbaceous undergrowth of native forbs does not provided as good a root structure as certain rhizomatous grasses, making this plant association very vulnerable to soil compaction and stream bank damage (Padgett *et al*. 1989). In addition, heavy grazing by livestock can dry sites, increase non-native grass cover, and reduce the vigor of willow root structure. 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 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 should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

Prescribed burning is 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 geyeriana (Geyer willow) is an effective stream bank stabilizer that can be grown from nursery cuttings and then transplanted. 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).

Table 46. Percent Cover of Plant Species in Stands of the *Salix geyeriana/*Mesic Forbs Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK43	97MD27
Species name and age class/ Site and Riparian Health Rank	C	B
TREES		
Picea engelmannii Parry ex Engelm.--older trees		16
SHRUBS		
Pentaphylloides floribunda (Pursh) A. Love	7	
Ribes inerme Rydb.	19	
Salix geyeriana Anderss.	55	46
Salix monticola Bebb	6	32
Salix planifolia Pursh	1	
GRAMINOIDS		
Agrostis sp.	9	
Calamagrostis canadensis (Michx.) Beauv.		6
Calamagrostis stricta (Timm) Koeler	1	
Carex aquatilis Wahlenb.	18	
Carex microptera Mackenzie	4	3
Carex sp.	6	
Carex utriculata Boott		11
Deschampsia cespitosa (L.) Beauv.	1	
Festuca idahoensis Elmer	5	
Juncus balticus ssp. montanus Engelm.	1	
Poa pratensis L.	20	
FORBS		
Achillea millefolium var. apicola (Rydb.) Garrett	23	1
Aconitum columbianum Nutt.		9
Castilleja sp.		6
Cirsium sp.	12	
Conioselinum scopulorum (Gray) Coult. & Rose	5	3
Dodecatheon pulchellum (Raf.) Merr.		3
Mertensia ciliata (James ex Torr.) G. Don	5	
Potentilla pulcherimma x hippiana	3	
Prunella vulgaris L.		5
Senecio sp.	8	
Senecio triangularis Hook		2
Solidago sp.		8
Taraxacum officinale G.H. Weber ex Wiggers	13	8
Trifolium longipes ssp. pygmaeum (Gray) J. Gillett	1	11
Trifolium repens L.	6	
Viola sp.		5
HORESTAILS		
Equisetum pratense Ehrhardt		18

Geyer willow-mountain willow/Mesic Forbs (*Salix geyeriana*-*Salix monticola*/Mesic Forbs) Plant Association

CNHP Rarity Rank: G3 / S3-- This association is known only from Colorado. In Colorado, this association is documented from over twenty-one locations, and at least that many more are expected to occur. Stands with their native herbaceous undergrowth intact are extremely rare.

General Description and Comments: The *Salix geyeriana*-*Salix monticola*/Mesic Forbs plant association is a tall, mixed-willow shrubland with an undergrowth species composition that is grazing-induced. The two willows have nearly equal abundance, are co-dominant, and the observer cannot determine which is the more dominant willow species. The undergrowth is a carpet of grasses and forbs on a hummocky ground surface. Season-long grazing has increased the non-native grass cover and reduced the native forbs.

Recognition and Classification Problems: Without catkins (the flowering stalk), *Salix geyeriana* (Geyer willow) can be difficult to distinguish from the similar looking *Salix drummondiana* (Drummond willow). Both species are tall, greater than 5 feet (2 meters), montane willows with strongly pruinose (a waxy covering that rubs off, similar to the coating on a plum) current-year twigs. Luckily, the two species can be distinguished using only vegetative characters. *Salix geyeriana* (Geyer willow) leaves are never more than 0.5 inches (13 mm) wide and *Salix drummondiana* (Drummond willow) leaves are, on average, over 0.5 inches (13 mm) wide (on non-sucker shoots) (Welsh *et al*. 1987).

Related Literature and Synonyms: The *Salix monticola-Salix geyeriana/*mesic forb plant association (Kittel and Lederer 1993, Kittel *et al*. 1996) is synonymous with the *Colorado Salix geyeriana-Salix monticola*/Mesic Forbs. This association is listed as *Salix monticola-Salix geyeriana* Shrubland in the Terrestrial Vegetation of the United States (Anderson *et al.* 1998)

Similar Communities: Closely related communities include: the *Salix geyeriana*/Mesic Forb plant association, which can have *Salix monticola* in it, the key difference being that the *Salix monticola* is always sub-dominant to *Salix geyeriana* (*i.e., Salix monticola* cover is not more than half that of *Salix geyeriana*); the *Salix geyeriana-Salix monticola/Calamagrostis canadensis-Carex aquatilis-Carex rostrata* (Geyer willow-mountain willow/bluejoint reedgrass-aquatic sedge-beaked sedge) plant association (Baker 1989) which has only native graminoids in the undergrowth, the *Salix geyeriana-Salix* spp./*Calamagrostis canadensis* (Geyer willow-willow/bluejoint reedgrass) plant association (Johnston 1987) which has only native graminoids in the undergrowth, and the *Salix boothii* (Booth willow) community types (Padgett *et al.* 1989) which have both *Salix geyeriana* and *Salix monticola* co-dominated stands include in them.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997). Since it is a grazing induced association, it is expected to occur in other western states.

Distribution in Colorado: This association occurs in the Routt National Forest (Kettler and McMullen 1996) and the San Miguel (Kittel and Lederer 1993), Arkansas (Kittel *et al*. 1996), and Rio Grande and Closed Basin watershed (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7700-9400 ft (2300-2900 m).

Site Geomorphology: This plant association occurs on broad alluvial floodplains with steep side slopes. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are broad and moderately sinuous to highly sinuous (Rosgen's Channel Type: B3, C4) or narrow, entrenched, ephemeral gullies (Rosgen's Channel Type: G4).

Soil: Soils are silt, silty loams, silty clay loams, sandy clay loams and deep sands. Several stands in the San Miguel River Basin occur on deep clay loams of old beaver ponds. Some soil profiles have considerable coarse materials while others are relatively fine textured. Mottling is evident near the surface indicating elevated water tables during part of the year.

The following information is based on: a total of twenty-two quantitative plots; twelve from the San Miguel River Basin (16, 19, 35, 48, 49, 53, 84, 86, 88, 92NL27, EO#8, EO#9), five from the Routt National Forest (41, 43, 151, 530, 546), four from the Arkansas River Basin (95AM19, 95AM44, 95AM45, 95AM58), and one from the Rio Grande and Closed Basin (97EV30) (Colorado Natural Heritage Program 1997).

Vegetation: This plant association is characterized by a tall, nearly closed canopy of *Salix monticola* (mountain willow) and *Salix geyeriana* (Geyer willow), with a combined cover between 10-90% and usually so near in abundance, one cannot determine which is the dominant willow in the stand. Other shrubs include up to 35% cover of *Ribes inerme* (whitestem gooseberry), up to 20% cover of *Alnus incana* (thinleaf alder) and up to 25% cover each of *Salix drummondiana* (Drummond willow) and *Pentaphylloides floribunda* (shrubby cinquefoil).

The undergrowth in undisturbed stands is a thick carpet of forbs including up to 15% cover each of *Mertensia ciliata* (mountain bluebells), *Achillea millefolium* (yarrow) and *Heracleum sphondylium* (cow parsnip), up to 10% cover each of *Conioselinum scopulorum* (hemlock parsley) and *Senecio triangularis* (arrowleaf groundsel) and up to 5% cover of *Cardamine cordifolia* (heartleaf bittercress).

The graminoid layer is usually sparse, but includes up to 10% cover each of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge). Disturbed stands have a high cover of non-native grasses including up to 50% cover of *Agrostis stolonifera* (redtop) and up to 20% cover of *Poa pratensis* (Kentucky bluegrass).

Successional and Ecological Processes: *Salix geyeriana* (Geyer willow) willow carrs seem to require a high water table that is not less than 3 feet (1 m) from the soil surface (Padgett *et al.* 1989). These willow carrs are commonly, but not always, associated with beaver ponds. Where this association occurs on first- and second-order streams, it may be a fairly stable, late-seral community. Along lower order streams subject to flooding and channel adjustments or where associated with beaver ponds, this plant association may be subject to a shorter successional cycle.

The *Salix geyeriana-Salix monticola*/Mesic Forbs plant association differs from the *Salix geyeriana*/Mesic Forbs plant association because *Salix monticola* is always present with a significant cover and sometimes in a greater abundance than *Salix geyeriana*. The presence of *Salix monticola* may be due to differences in environmental factors or may represent a different successional stage of the *Salix geyeriana*/Mesic Forbs association. This plant association is a grazing-induced type due to the abundance of non-native grasses in some stands (Kittel *et al*. 1996). With removal of season-long grazing, this association may return to a native forb dominated undergrowth or a dominance of *Calamagrostis canadensis* (bluejoint reedgrass), becoming a *Salix geyeriana-Salix monticola/Calamagrostis canadensis* plant association.

Adjacent Riparian Vegetation: A narrow band of *Alnus incana* (thinleaf alder) or *Betula occidentalis* (river birch) shrublands may occur at the stream edge. Upstream and downstream plant associations include mixed *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce) forests, *Alnus incana* (thinleaf alder) and *Salix planifolia* (planeleaf willow) shrublands, and *Carex aquatilis* (aquatic sedge), *Carex utriculata* (beaked sedge) and *Eleocharis quinqueflora* (spikerush) meadows.

Adjacent Upland Vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce), *Pseudotsuga menziesii* (Douglas-fir), *Picea pungens* (Colorado blue spruce) and *Populus tremuloides* (quaking aspen) forests and *Quercus gambelii* (Gambel oak) woodlands occur on adjacent hillslopes.

Management: The management responses of this plant association are likely to be similar to other tall-willow shrublands dominated by *Salix geyeriana* (Geyer willow) or *Salix monticola* (mountain willow). The wet and often saturated soils of this plant association are vulnerable to compaction by livestock and heavy equipment. Overgrazing by livestock can dry the site, increase non-native grass cover, and reduce the vigor of willow root structure. 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) and continue for only short duration.

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 regrowth. 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 down cutting, 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 should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

Prescribed burning is 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 geyeriana (Geyer willow) is an effective stream bank stabilizer that can be grown from nursery cuttings and then transplanted. 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).

Table 47. Percent Cover of Plant Species in a Stand of the *Salix geyeriana-Salix monticola*/Mesic Forbs Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	97EV30
Species name and age class/ Site and Riparian Health Rank	B
SHRUBS	
Pentaphylloides floribunda (Pursh) A. Love	22
Salix geyeriana Anderss.	26
Salix monticola Bebb	24
Salix planifolia Pursh	11
GRAMINOIDS	
Bromus sp.	1
Carex aquatilis Wahlenb.	3
Carex sp.	11
Deschampsia cespitosa (L.) Beauv.	2
Juncus balticus ssp. montanus Engelm.	1
Juncus sp.	1
Poa palustris L.	7
Poa pratensis L.	6
FORBS	
Achillea millefolium var. apicola (Rydb.) Garrett	2
Actaea rubra (Ait.) Willd.	1
Caltha leptosepala var. leptosepala	1
Castilleja sp.	1
Fragaria virginiana Miller	1
Geum macrophyllum	1
Hydrophyllum fendleri	1
Oxypolis fendleri (Gray) Heller	1
Pedicularis groenlandica Retz.	1
Potentilla sp.	1
Prunella vulgaris L.	7
Sidalcea sp.	1
Taraxacum officinale G.H. Weber ex Wiggers	15
Trifolium longipes ssp. pygmaeum (Gray) J. Gillett	8
Trifolium pratense	10
Viola sp.	5

Salix lasiandra Temporarily Flooded Shrubland Alliance

Shinning willow (*Salix lasiandra* (var. *lasiandra* or var. *caudata*)) Plant Association

CNHP Rarity Rank: G3Q / S2S3-- This association is documented from Montana to Colorado. In Colorado, less than ten stands have been documented. An additional five or ten are estimated to occur. It is highly threatened by stream channelization. The Q in the rank indicates there is some question about the total global abundance, since it has not been well documented.

General Description and Comments: The *Salix lasiandra* (whiplash willow) plant association is a tall willow community often found within a mosaic of several other riparian communities. It is generally a small patch type on large floodplain ecosystems and is more or less confined to the low montane belt (5,000-8,000 ft) in Colorado. Both varieties *caudata* and *lasiandra* are included in this association.

Related Literature and Synonyms: The *Salix lasiandra* community type (Hansen *et al*. 1995), the *Salix lasiandra* var. *caudata*/mesic graminoid plant association (Kittel and Lederer 1993), and the *Salix lasiandra* slough (The Nature Conservancy 1996) are considered synonymous with the Colorado *Salix lasiandra* plant association. Stands dominated by either of the two varieties, *caudata* or *lasiandra,* recognized by Dorn (1977), are included in this association.

Similar Communities: One closely related community, the *Salix lasiandra var. caudata-Salix monticola/ Calamagrostis canadensis-Equisetum arvense* (whiplash willow-mountain willow/bluejoint reedgrass-field horsetail) plant association (Jankovsky-Jones 1994) differs slightly by having significant cover of *Salix monticola* and sparse forb and graminoid cover. Note that *Salix lucida* is a synonym for *Salix lasiandra* (Kartesz 1994, Weber and Whitmann 1996b). The authors follow Dorn (1977, 1995 and 1997) for *Salix* nomenclature.

Regional Distribution: This association occurs in Montana (Hansen *et al.* 1995) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This is a minor plant association that occurs in the Yampa River Basin (Kittel and Lederer 1993), the South Platte River Basin (Kittel *et al*. 1996), and in the Rio Grande and Closed Basin watersheds (Colorado Natural Heritage Program 1997).

The following information is based on: a total of nine quantitative plots; six from the Yampa River Basin (39, 41, 100, 101, 105, 112), one from the Routt National Forest (553), one from the South Platte River Basin (95LS08), and four from the upper Rio Grande and Closed Basins (95RG23, 97BG13, 97GK01, 97GK33) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5400-8200 ft (1600-2500 m).

Site Geomorphology: This plant association occurs in saturated areas, usually adjacent to the channel flow. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). It is found on low point bars and islands, as well as on low stream banks and overflow channels of larger rivers (Rosgen's Channel Type: C6). It also occurs in steep foothill tributary streams (Rosgen's Channel Type: A2).

Soils: Soils have high organic matter content with reduced conditions.

Vegetation: *Salix lasiandra* var. *lasiandra* (whiplash willow) or *Salix lasiandra* var. *caudata* (caudate willow) dominates the canopy with 10-85% cover, and typically is the only willow in the stand. Other willows that may be present is widely varied, and depends on the stand elevation and region of the state. Other willow species that may be present with 10-20% cover include *Salix eriocephala* var. *ligulifolia* (strapleaf willow), *Salix boothii* (Booth willow), *Salix geyeriana* (Geyer willow), and *Salix amygdaloides* (peach leaf willow). Other shrub species present may include up to 20% *Ribes montigenum* (currant), up to 10% *Alnus incana* ssp. *tenuifolia* (thinleaf alder) and up to 20% *Betula occidentalis* (river birch). One higher elevation stand had 15% cover of *Pinus contorta* (lodgepole pine).

The undergrowth is dominated by mesic grasses and sedges including *Calamagrostis canadensis* (bluejoint reedgrass) and several *Carex* (sedge) species. Forb cover is insignificant. Along the Yampa River, the undergrowth also included non-native grasses such as *Agrostis gigantea* (redtop), *Phleum pratense* (timothy), and *Poa pratensis* (Kentucky bluegrass).

Succession and Ecological Processes: The *Salix lasiandra var. caudata* plant association establishes on deep alluvial materials and is considered to be early seral (Hansen *et al*. 1995). It is often associated with abandoned beaver ponds or along steeper reaches below beaver ponds. It appears to colonize areas that have been or are currently filling in with silt. This association will eventually be replaced by slightly drier-site willow species. However, with disturbance such as overuse by livestock, willow cover may decline. With severe disturbance, the willows will completely disappear. This association will then become dominated by *Rosa woodsii* (woods rose) and eventually *Poa pratensis* (Kentucky bluegrass) (Hansen *et al*. 1995).

Adjacent riparian vegetation: Populus angustifolia (narrowleaf cottonwood) woodlands, *Salix exigua* (coyote willow), and *Salix boothii* (Booth willow) shrublands, and *Carex aquatilis-Carex utriculata* (aquatic sedge-beaked sedge) wet meadows occur within the surrounding floodplain.

Adjacent upland vegetation: *Pinus edulis-Juniperus* species (Piñon pine-juniper) woodlands and *Artemesia tridentata* (big sagebrush) and *Quercus gambelii* (Gamble oak) scrub occur on the surrounding hillslopes.

Management: *Salix lasiandra* var. *caudata* (whiplash willow) has a moderately high palatability to livestock, large mammals and beaver (Kovalchik *et al*. 1988). In Montana, the *Salix lasiandra* var. *caudata* community type is considered to have limited forage value for livestock since there is frequent flooding in those areas (Hansen *et al*. 1995). This may be the case in Colorado as well, since the association is found right along meandering streambanks and in the floodplain. However, the high amount of introduced grass species in one stand indicates that those areas may have been heavily grazed at one time. *Salix lasiandra* var. *caudata* is sensitive to fire, but as with most willows, can resprout. *Salix lasiandra* var. *caudata* is a good shrub species to plant for streambank stabilization. It establishes easily and forms abundant roots from cuttings approximately 10 days after planting (Platts *et al*. 1987).

Table 48. Percent Cover of Plant Species in Stands of the *Salix lasiandra* Plant Association From the Rio Grande and Closed Basin watersheds.

Plot Number	95RG23	97BG13	97GK01	97GK33
Species name and age class/ Site and Riparian Health Rank	B	C	C	C
TREES				
Picea pungens Engelm.--older trees				17
Populus tremuloides Michx.--older trees	3			
Populus tremuloides Michx.--seedlings	4			
SHRUBS				
Alnus incana (L.) Moench		10		4
Artemesia tridentata var. vaseyana (Rydb.) J. Boivin			4	
Betula occidentalis Hooker			7	
Lonicera involucrata Banks ex Spreng.	11			
Pentaphylloides floribunda (Pursh) A. Love			4	1
Salix exigua Nutt.	6			1
Salix geyeriana Anderss.		10		
Salix lasiandra var. caudata (Nutt.) Sudworth	8		43	20
Salix lasiandra var. lasiandra (Nutt.) Sudworth		82		
GRAMINOIDS				
Agrostis stolonifera L.				18
Bromus inermis Leyss.		7	3	
Calamagrostis canadensis (Michx.) Beauv.				23
Carex lanuginosa Michx.				14
Elymus trachycaulus (Link) Gould ex Shinners				7
Juncus balticus ssp. montanus Engelm.			3	21
Poa pratensis L.		9	30	30
FORBS				
Achillea millefolium var. apicola (Rydb.) Garrett	1	1	5	1
Epilobium angustifolium L.	11			
Erigeron sp.	4		8	
Geranium richardsonii Fisch. & Trautv.	15			
Mertensia ciliata (James ex Torr.) G. Don	12			
Rudbeckia laciniata var. ampla (A. Nels.) Cronq.				3
Taraxacum officinale G.H. Weber ex Wiggers	9		9	1
Thermopsis rhombifolia var. montana (Nutt.) Isely		9		
Trifolium repens L.		10	15	
Trifolium sp.		13		
Vicia sp.		10		
HORESTAILS				
Equisetum arvense L.	13	4		1

Salix monticola Temporarily Flooded Shrubland Alliance

Mountain willow/bluejoint reedgrass (*Salix monticola/Calamagrostis canadensis*) Plant Association

CNHP Rarity Rank: G3 / S3 -- This association is known only from Colorado. In Colorado, this association occurs throughout the Rocky Mountains. There are thirteen documented locations and an additional twenty to thirty more stands are expected to occur. This association is threatened by improper livestock grazing, stream flow alterations, and heavy recreation use.

General Description and Comments: The *Salix monticola/Calamagrostis canadensis* (mountain willow/bluejoint reedgrass) plant association is a tall (4-5 ft, 1.5-2 m) 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. It is recognized by a near monotypic stand of *Salix monticola* (mountain willow). Other willow species may be mixed in, but the bulk of the canopy is made up of *Salix monticola*. Forbs and mesic graminoids comprise the undergrowth and *Calamagrostis canadensis* is always present but may not have a high cover.

Recognition and Classification Problems: *Salix monticola* appears to be in 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* 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 (Brunsfeld and Johnson 1985).

Related Literature and Synonyms: There are no synonyms in the literature for any of the Colorado *Salix monticola* plant associations.

Similar Communities: Four closely related communities have a mixture of other willow species with varying amounts of *Salix monticola*. These closely related communities are: 1) the *Salix drummondiana-Salix monticola/Calamagrostis canadensis-Carex utriculata* (Drummond willow-Rocky Mountain willow/bluejoint reedgrass-beaked sedge), and 2) the *Salix geyeriana-Salix monticola/Calamagrostis canadensis-Carex aquatilis-Carex utriculata* (Geyer willow-Rocky Mountain willow/bluejoint reedgrass-aquatic sedge-beaked sedge) plant associations (Baker 1989), 3) the *Salix drummondiana/Calamagrostis canadensis* (Drummond willow/bluejoint reedgrass) plant association (Komarkova 1986, Johnston 1987) has some Salix monticola, but it is never dominant or co-dominant, and 4) the *Salix geyeriana-Salix* spp./*Calamagrostis canadensis* (Geyer willow-willow/bluejoint reedgrass) plant association (Johnston 1987) which includes some *Salix monticola*.

Regional Distribution: This association occurs only in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs along the Colorado Front Range (Cooper and Cottrell 1990), in north-central Colorado and the Crested Butte region (Cooper 1993). It also occurs in the Colorado and South Platte River Basins (Kittel *et al*. 1994, Sanderson and Kettler 1996, Kittel *et al*. 1997).

The following information is based on: a total of thirteen quantitative plots: four from the Colorado River Basin (93SS42, 93DR09, 26C, 42E), three from the West Slope Wetland Vegetation Classification (JS94-26C, JS94-42E, DC93-60), six from the South Platte River Basin (96GK15, 96LS29, 96LS14, 96GK39, 96GK22, 96AM73), and five from the Rio Grande and Closed Basins (95RG04, 97BG09, 97EV34, 97GK34, 97MD23) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 8300-9400 ft (2500-2900 m)

Site Geomorphology: 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. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are steep and narrow (Rosgen's Channel Type: A4), moderately steep and wide (Rosgen's Channel Type: B4), wide and sinuous (Rosgen's Channel Type: C3, C4), or braided from beaver activity (Rosgen's Channel Type: D6).

Soils: 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: This plant association has a closed, mixed canopy of willows with *Salix monticola* (mountain willow) the clear dominant with 20-90% cover. Other willows include up to 40% cover of *Salix drummondiana* (Drummond willow), up to 20% cover each of *Salix wolfii* (Wolf willow) and *Salix geyeriana* (Geyer willow), and up to 10% cover of *Salix boothii* (Booth willow).

Calamagrostis canadensis (bluejoint reedgrass) forms an open to dense graminoid layer with 1-50% cover. Other graminoids include up to 10% cover each of *Carex aquatilis* (aquatic sedge) and *Carex utriculata* (beaked sedge) and up to 5% cover of *Carex microptera* (small-wing sedge), *Deschampsia cespitosa* (tufted hairgrass), and *Glyceria striata* (fowl mannagrass).

Total forb cover ranges from 1-50%. Forb cover can be diverse, with many species, each contributing only approximately 1% cover. Forb species that may be present include *Cardamine cordifolia* (heartleaf bittercress), *Geranium richardsonii* (Richardson geranium), *Mertensia ciliata* (mountain bluebells), *Oxypolis fendleri* (cowbane), *Geum macrophyllum* (large-leaved avens), *Solidago canadensis* (goldenrod), *Senecio biglovii* (Bigelow groundsel), and *Galium boreale* (northern bedstraw).

Successional and Ecological Processes: *Salix monticola* (mountain willow) 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 an increase 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 (beaked sedge)*, Carex aquatilis* (aquatic sedge)*,* and *Calamagrostis canadensis* (bluejoint reedgrass) 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 (beaked sedge) occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channel with the shallowest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (water sedge) (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* (water sedge) dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* (bluejoint reedgrass) dominated stands.

Adjacent Riparian Vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests and mesic forb plant associations occur along steep, narrow reaches. *Salix drummondiana* (Drummond willow) shrublands occur on broad floodplains. *Carex aquatilis* (aquatic sedge), *Carex utriculata* (beaked sedge) and *Deschampsia cespitosa* (tufted hairgrass) meadows also occur on adjacent floodplains.

Adjacent Upland Vegetation: 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 hill slopes

Management: The forage value of *Calamagrostis canadensis* (bluejoint reedgrass) is most palatable to livestock 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 down cutting, 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 should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

Fire can stimulate production of willows, increasing available browse species for wildlife and livestock (Hansen *et al.* 1995). *Calamagrostis canadensis* (bluejoint reedgrass) 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* (mountain willow) and *Calamagrostis canadensis* (bluejoint reedgrass) 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).

Table 49. Percent Cover of Plant Species in Stands of the *Salix monticola/Calamagrostis canadensis* Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG04	97BG09	97EV34	97GK34	97MD23
Species name and age class/ Site and Riparian Health Rank	A	A	B	C	C
SHRUBS					
Alnus incana (L.) Moench	18				17
Pentaphylloides floribunda (Pursh) A. Love	1	4	1	1	
Ribes montigenum McClatchie		3	1	1	
Salix bebbiana Sarg.	5	9		14	
Salix drummondiana Barratt ex Hook.	4				
Salix eriocephala Michaux var. ligulifolia	10	8		4	3
Salix exigua Nutt.	2			2	
Salix geyeriana Anderss.	2				
Salix lasiandra var. caudata (Nutt.) E. Murr.	11				11
Salix monticola Bebb	47	17	81	42	29
Salix planifolia Pursh			7	3	
GRAMINOIDS					
Calamagrostis canadensis (Michx.) Beauv.	12	45	28	41	11
Carex aquatilis Wahlenb.		1		3	1
Carex festivella Mackenzie			19		
Carex lanuginosa Michx.				28	
Carex microptera Mackenzie				11	
Carex sp.	11		1		2
Carex utriculata Boott		3		2	
Cinna latifolia (Trev. Ex Goepp.) Griseb.				13	
Deschampsia cespitosa (L.) Beauv.			4		
FORBS					
Achillea millefolium var. apicola (Rydb.) Garrett	1	2	4		1
Cardaria latifolia					8
Fragaria virginiana Miller			1	1	1
Geranium richardsonii Fisch. & Trautv.				5	
Geum macrophyllum				5	5
Maianthemum stellatum (L.) Link		5		3	
Mentha arvensis L.				1	2
Potentilla pulcherimma x hippiana		3	1		
Taraxacum officinale G.H. Weber ex Wiggers	1		3	5	16
Trifolium longipes ssp. pygmaeum (Gray) J. Gillett			3		1
Trifolium repens L.		25			17

Mountain willow/water sedge (*Salix monticola/Carex aquatilis*) Plant Association

CNHP Rarity Rank: G3 / S3 -- This association is known only from Colorado. In Colorado, this association is documented at only five locations, however in an additional twenty to thirty stands are expected to occur. This association is threatened by improper livestock grazing, stream flow alterations, and heavy recreation use.

General Description and Comments: The *Salix monticola/Carex aquatilis* (mountain willow/water sedge) plant association is a tall (5-8 ft., 1.5-2.5 m), deciduous shrubland with an 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* (water sedge). *Carex utriculata* (beaked sedge) and *Calamagrostis canadensis* (bluejoint reedgrass) are often also present, but *Carex aquatilis* is either the clear dominant or is most consistently present throughout the stand. This distinguishes this association from the *Salix monticola/Carex utriculata* (mountain willow/beaked sedge) and *Salix monticola/Calamagrostis canadensis* (mountain willow/bluejoint reedgrass) associations.

Recognition and Classification Problems: *Salix monticola* appears to be in 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* 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 (Brunsfeld and Johnson 1985).

Related Literature and Synonyms: There are no synonyms in the literature for any of the Colorado *Salix monticola* plant associations.

Similar Communities: Closely related communities include the *Salix boothii/Carex aquatilis* (Booth willow/aquatic sedge) community type (Padgett *et al*. 1989) which has *Salix monticola* occasionally in the canopy.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is a minor type known to occur in the Yampa (Kittel and Lederer 1993) and South Platte River Basins (Kittel *et al*. 1997), and in the San Juan National Forest (Richard *et al*. 1996).

The following information is based on: a total of eight quantitative plots; two from the Yampa River Basin (62, 103), two from South Platte River Basin (96GK04, 96AM88), one from the San Juan National Forest (95), and three from the Rio Grande and Closed Basins (95RG58, 97GK41, 97MD30) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7000-9400 ft (2100-2900 m).

Site Geomorphology: This plant association occurs in narrow valleys on coarse-textured stream banks. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow and highly sinuous (Rosgen's Channel Type: D6E4) or braided by beaver activity (Rosgen's Channel Type: D6).

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

Vegetation: This plant association forms a tall, narrow band of shrubs dominated by 30-90% cover of *Salix monticola* (mountain willow). Other shrubs present may include up to 20% cover of *Salix bebbiana* (Bebb willow), and up to 10% cover each of *Salix planifolia* (planeleaf willow), *Salix drummondiana* (Drummond willow), *Cornus sericea* (red-osier dogwood) and *Lonicera involucrata* (honeysuckle).

Carex aquatilis (aquatic sedge) dominates the herbaceous undergrowth 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.

Successional and Ecological Processes: *Salix monticola* (mountain willow) 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 an increase 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 (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) 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 (beaked sedge) occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channel with the shallowest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (water sedge) (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* (water sedge) dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* (bluejoint reedgrass) dominated stands.

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

Adjacent Upland Vegetation: 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.

Management: *Salix monticola* (mountain willow) 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 and 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 down cutting, 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 raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity 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* (aquatic sedge). 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 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).

Table 50. Percent Cover of Plant Species in Stands of the *Salix monticola/Carex aquatilis* Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG58	97GK41	97MD30
Species name and age class/ Site and Riparian Health Rank	A	C	A
SHRUBS			
Pentaphylloides floribunda (Pursh) A. Love	2	6	
Ribes inerme Rydb.	1		
Ribes montigenum McClatchie		4	
Salix boothii Dorn	2		
Salix brachycarpa Nutt.	1		
Salix eriocephala Michaux var. ligulifolia	1		
Salix monticola Bebb	34	43	88
Salix planifolia Pursh	10	6	
GRAMINOIDS			
Alopecurus sp.		5	
Calamagrostis canadensis (Michx.) Beauv.	2	26	1
Carex aquatilis Wahlenb.	25	32	10
Carex microptera Mackenzie		2	6
Carex sp.		6	1
Deschampsia cespitosa (L.) Beauv.	4	12	3
Festuca thurberi Vasey		6	
Luzula parviflora (Ehrh.) Desv.	2		
Phleum alpinum L.		1	1
FORBS			
Achillea millefolium var. apicola (Rydb.) Garrett	8	7	2
Aconitum columbianum Nutt.	2		1
Cardamine cordifolia Gray	1	9	11
Castilleja sp.	20		
Conioselinum scopulorum (Gray) Coult. & Rose	6		4
Epilobium hornmannii Haussknecht		9	
Epilobium sp.	2		
Erigeron sp.	3		
Mentha arvensis L.			6
Mertensia ciliata (James ex Torr.) G. Don	10		1
Taraxacum officinale G.H. Weber ex Wiggers		4	

Rocky Mountain willow/Mesic Forbs (*Salix monticola/*Mesic Forbs) Plant Association

CNHP Rarity Rank: G3 / S3 -- This association is known only from Colorado. In Colorado, over thirty stands have been documented. Many stands of this association may represent grazing induced shifts from other *Salix monticola* dominated plant associations. Stands with a complete native herbaceous understory intact are threatened by improper livestock grazing, stream flow alterations, and heavy recreational use.

General Description and Comments: The *Salix monticola/*mesic forb (Rocky Mountain willow/mesic forb) plant association is a tall (5-8 ft., 1.5-2.5 m), deciduous shrubland with a fairly open canopy and an herbaceous layer dominated by a variety of forbs and grasses. While no single herbaceous species is a clear dominant, total forb cover is generally greater than 30% and exceeds total graminoid cover.

Recognition and Classification Problems: *Salix monticola* appears to be in 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* 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 (Brunsfeld and Johnson 1985).

Related Literature and Synonyms: *Salix monticola* occurs as nearly pure stands in Colorado, but is replaced by other *Salix* (willow) species such as *Salix boothii* and *Salix drummondiana* further north and west of the state line. A similar *Salix boothii*/mesic forb (Booth willow/mesic forb) type described from Utah and southeastern Idaho includes stands that occasionally have some *Salix monticola* (Padgett *et al.* 1989). Similar types with *Salix monticola* as an associated canopy species and *Calamagrostis canadensis* as the dominant undergrowth have been described by Johnston (1987) and Cooper and Cottrell (1990). However, the *Salix monticola*/mesic forb plant association tends to have a higher forb cover compared to the *Calamagrostis canadensis* types. The similar types include a *Salix drummondiana/Calamagrostis canadensis* (Drummond willow/bluejoint reedgrass) plant association from the Gunnison National Forest in Colorado, a *Salix geyeriana-Salix* spp./*Calamagrostis canadensis* plant association from Idaho, Wyoming and Colorado (Johnston 1987) and a *Salix monticola/Calamagrostis canadensis* from the Colorado Front Range (Cooper and Cottrell 1990). There are no synonyms in the literature for any of the Colorado *Salix monticola* plant associations.

Similar Communities: One closely related community is the *Salix drummondiana/Mertensia ciliata* plant association (Cooper and Cottrell 1990) which has some *Salix monticola*.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is a major type in the upper montane areas of the San Miguel/Dolores (Kittel and Lederer 1993), Colorado, White (Kittel *et al.* 1994), Gunnison (Kittel *et al.* 1995) and South Platte River Basins (Copper and Cottrell 1990, Kittel *et al*. 1997), the San Juan National Forest (Richard *et al.* 1996), and in the Rio Grande and Closed Basin watersheds (Colorado Natural Heritage Program 1997).

The following information is based on: a total of forty-two quantitative plots; two from the San Miguel/Dolores River Basin (84, 86), four from the White River Basin (92NL11, 92NL50, 92NL46, 92NL10), six from the Colorado River Basin (93SS16, 93RR52, 93GK38, 93DR18, 93GK12, 93DR11), eight from the Gunnison River Basin (94GK03, 94GK11, 94JB01, 94JB02, 94JB13, 94JB22, 94MD02, 94RR24), twelve from the San Juan National Forest (11, 13, 40, 45, 51, 56, 60, 68, 79, 92, 166, 187), two from the South Platte River Basin (96AM27, 96AM10), and eight from the Rio Grande and Closed Basins (95RG03, 95RG57, 95RG70, 95RG76, 97BG22, 97GK36, 97GK37, 95RG52) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6600-10,700 ft. (2000-3260 m).

Site Geomorphology: The *Salix monticola*/mesic forb (mountain willow/mesic forb) plant association occurs along broad, swift-moving streams and active floodplains in narrow to moderately wide valleys (20-250 m). The ground surface is usually undulating, from past flooding or beaver activity. Stands form narrow bands at the stream edge, ranging from 1-6 ft.(0.1-2 m) above the channel elevation. In wider valley bottoms, stands occur further from the bank, but never more than 2.5 ft. (0.75 m) above the annual high water mark. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Most stands occur adjacent to fairly straight, wide, and shallow channels ranging from bedrock to silty-bottomed reaches (Rosgen's Channel Type: B1-B6). A few stands occur on meandering, cobble-bottomed reaches (Rosgen's Channel Type: C3) or streams braided by beaver activity (Rosgen's Channel Type: D6).

Soil: Soils are fine textured sandy clays to silty and sandy clay loams. Mottling and gleyed layers are common within 5 inches (12 cm) of the ground surface indicating elevated water tables for part of the year. Coarse material varies from 0 to 80% in the upper horizons. In the Colorado River Basin, the soils classify as Cryofluvents and Cryorthents.

Vegetation: *Salix monticola* (mountain willow) forms a dense to open canopy with 20-100% cover and a very diverse, rich forb layer in the undergrowth. Other shrub species present at higher elevations include a variety of *Salix* (willow) species with up to 60% cover and *Lonicera involucrata* (bush honeysuckle) with up to 10% cover. At lower elevations, other shrubs include up to 30% cover of *Crataegus rivularis* (hawthorn), up to 20% cover each of *Ribes inerme* (gooseberry) and *Salix eriocephala* (yellow willow), and up to 10% cover of *Alnus incana* (thinleaf alder).

Total forb cover ranges from 10-70% and includes up to 70% cover of *Heracleum sphondylium* (cow parsnip), up to 20% cover each of *Rudbeckia laciniata* (cone flower), *Mertensia ciliata* (chiming bells) and *Fragaria virginiana* (wild strawberry). Graminoid cover ranges from up to 50% and includes up to 20% cover each of *Calamagrostis canadensis* (bluejoint reedgrass) and

Carex utriculata (beaked sedge). Generally, forbs are dominant under shrubs on hummocks and ridges while graminoids dominate the undergrowth in low-lying, wetter swales. In the San Juan National Forest, stands of this association show a significant shift in forb species at lower elevations with *Rudbeckia laciniata* (cone flower) more dominant and the average cover of exotic species higher. This may indicate heavy grazing pressure in the past. Exotic graminoid and forb species include up to 40% cover of *Poa pratensis* (Kentucky bluegrass), up to 20% cover of *Trifolium repens* (sweet clover), and up to 10% cover of *Taraxacum officinale* (dandelion).

Successional and Ecological Processes: *Salix monticola* (mountain willow) 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 an increase in the water table.

The *Salix monticola/*mesic forb (mountain willow/mesic forb) plant association occurs on mesic sites and supports a rich diversity of forbs. On broad, hummocky floodplains stands can form extensive willow carrs. Sites with a higher abundance of exotic forbs and graminoids may be grazing-induced. At higher elevations, this association grades into the *Salix planifolia*/mesic forb (planeleaf willow) association. Stands with abundant *Salix planifolia* present may indicate a transition between higher sites dominated by *Salix planifolia* and the wider, lower montane areas where *Salix monticola* becomes more abundant.

Adjacent Riparian Vegetation: *Populus angustifolia* (narrowleaf cottonwood), *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-blue spruce) forests and *Salix planifolia* (planeleaf willow), *Salix wolfii* (Wolf willow), *Salix boothii* (Booth willow), *Salix geyeriana* (Geyer willow) or *Alnus incana* (thinleaf alder) shrublands occur on well-drained, adjacent floodplains. Mesic meadows of *Carex aquatilis* (aquatic sedge), *Eleocharis quinqueflora* (spikerush) or *Juncus balticus* (Baltic rush) also occur on flat areas of the floodplain. In narrow valleys at higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests occur.

Adjacent Upslope Vegetation: At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine-fir-Engelmann spruce) forests and *Populus tremuloides* (aspen) woodlands occur on adjacent hill slopes. At lower elevations, *Pinus ponderosa* (ponderosa pine), *Pinus ponderosa-Quercus gambelii* (ponderosa pine-Gambel oak) and mixed *Pinus contorta* (lodgepole pine) forests occur on adjacent hill slopes.

Management: Stands with an abundance on non-native and increaser herbaceous species in the undergrowth are likely grazing induced shifts from either the native forb component of the Salix monticola/Mesic forb plant association, or a shift from another Salix monticola dominated plant association. Improper livestock grazing can dry sites, increase non-native cover, and reduce the vigor of willow root structure. Rest periods from grazing are recommended in order to provide time for plant regrowth. 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).

Disturbed stands or stands with a history of improper grazing may respond to rest and rotation periods. These stands may have potential for higher graminoid biomass including species such as *Carex aquatilis* (water sedge) and *Calamagrostis canadensis* (bluejoint reedgrass).

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 should consider maintaining beaver activity in an area versus their removal (Hansen *et al*. 1995).

Prescribed burning in this plant association 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 monticola (mountain willow) is an effective stream bank stabilizer. It 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).

Table 51. Percent Cover of Plant Species in Stands of the *Salix monticola*/Mesic Forbs Plant Association From the Rio Grande and Closed Basin Watersheds. (Some species' authors were deleted to better fit on the table. Full scientific names are listed in Appendix 1).

Plot Number	95RG03	95RG57	95RG70	95RG76	97BG22	97GK36	97GK37	95RG52
Species name / Site Rank	C	B	B	C	B	C	C	B
TREES								
Populus angustifolia--trees	12							
Populus tremuloides--trees					16			
SHRUBS								
Alnus incana (L.) Moench	9				13			
Pentaphylloides floribunda	1	6	1	5		6	10	13
Salix bebbiana Sarg.					16	1		
Salix drummondiana	6	12		7				
Salix eriocephala var. l.	4			19				7
Salix exigua Nutt.	1			13				
Salix monticola Bebb	48	80	97	63	38	78	66	68
Salix planifolia Pursh		6	1	1			6	1
Salix wolfii Bebb			1	3				7
GRAMINOIDS								
Calamagrostis canadensis			2		10	2	2	
Carex aquatilis Wahlenb.							33	3
Carex norvegica Retz.			12					
Carex sp.	1	9	2	4		1		8
Poa pratensis L.	3			7		5	4	3
FORBS								
Achillea millefolium	1	5	9	2		3	2	3
Aconitum columbianum Nutt.					12	16	3	
Aster foliaceous							12	
Aster hesperius						14		
Caltha leptosepala				1			1	
Cardamine cordifolia Gray			1			3	3	
Conioselinum scopulorum		3	2	1	2			
Epilobium angustifolium L.	3		11			1	1	
Erigeron sp.		17						
Fragaria virginiana Miller		7	10	1		10	5	6
Geranium richardsonii		3	2	1			2	
Heracleum sphondylium L.	4				16			
Maianthemum stellatum	3		1			12	2	
Mertensia ciliata			5			12		
Pedicularis groenlandica Retz.							2	6
Rudbeckia laciniata	4				28			
Swertia perennis L.		5						
Taraxacum officinale	1	3	1	10		2	5	7
Trifolium repens L.				4			1	22

Mountain willow/Mesic Graminoids (*Salix monticola*/Mesic Graminoids) Plant Association

CBHP Rarity Rank: G3 / S3 -- While this community is not documented outside of Colorado, stands with abundant *Salix monticola* are. In Colorado, this association is documented at six locations, and twenty to fifty additional stands are estimated to occur. Stands with a native herbaceous undergrowth intact are threatened by improper livestock grazing, inappropriate stream flow alterations, and heavy recreational use.

General Description and Comments: The *Salix monticola*/mesic graminoid (mountain willow/mesic graminoid) plant association is a tall (5-8 ft., 1.5-2.5 m), deciduous shrubland, with an open to closed canopy of willows on broad, gentle floodplains, or in narrow canyon bottoms. The herbaceous undergrowth is diverse, with a variety of graminoid (grass and grass-like) and forb species. This association is distinguished from the *Salix monticola*/mesic forb association by having a higher cover of graminoid species. Stands with predominantly non-native graminoid species in the undergrowth are considered grazing induced. Stands with predominantly native graminoid species in the undergrowth are considered at potential.

Recognition and Classification Problems: *Salix monticola* appears to be in 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* 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). In Idaho, *Salix monticola* also has a limited distribution and largely associates with other *Salix* (willow) species (Brunsfeld and Johnson 1985).

Related Literature and Synonyms: One stand from a *Salix monticola*-*Salix planifolia*/mesic forb (mountain willow-planeleaf willow/mesic forb) plant association (Kittel *et al*. 1995) is synonymous with the Colorado *Salix monticola*/mesic graminoid plant association..

Similar Communities: One closely related community is the *Salix boothii*/mesic graminoid (Booth willow/mesic graminoid) community type (Padgett *et al.* 1989) which includes some stands that have *Salix monticola*. For other closely related communities with the graminoid species *Calamagrostis canadensis* (bluejoint reedgrass) in the undergrowth, see the *Salix monticola/Calamagrostis canadensis* plant association described earlier in this report.

Regional Distribution: This association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Gunnison and South Platte River Basins (Kittel *et al.* 1995, Kittel *et al.* 1997), on the San Juan National Forest (Richard *et al* 1996), and in the Rio Grande and Closed Basin watersheds (Colorado Natural Heritage Program 1997).

The following information is based on: a total of ten quantitative plots; one from the San Juan National Forest (159), one from the Gunnison River Basin (94MD16), four from the South Platte River Basin (96AM06, 96AM44, 96AM62, 96AM84), and four from the Rio Grande and Closed Basin watersheds (97EV29, 97BG03, 97EV07, 97EV22) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7800-10,200 ft. (2400-3100 m).

Site Geomorphology: The *Salix monticola*/mesic graminoid (mountain willow/mesic graminoid) plant association dominates stream reaches in narrow to wide valleys, 65-400 feet (20-120 m) wide, with active floodplains and broad, swift-moving streams. Stands usually occur > 2 feet (0.5 m) above the bankfull channel along the stream edge or away from the channel up to 50 feet (15 m). The ground surface is usually undulating due to past flooding or beaver activity. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels can be fairly steep and narrow with cobble beds (Rosgen's Channel Type: A4, F4), moderately wide and sinuous with cobble beds (Rosgen's Channel Type: B3) or broad, meandering rivers with a developed floodplain (Rosgen's Channel Type: C4). Some stands also occur along channels that are braided due to beaver activity (Rosgen's Channel Type: D6).

Soil: Soils are fine textured clay loams and sandy clay loams of varying depths, 4-18 inches (10-45 cm). Mottling and gleyed layers often occur within 5 inches (12 cm) of the ground surface.

Vegetation: *Salix monticola* (mountain willow*)* forms a dense to open canopy with 15-80% cover. Other shrubs present at higher elevations include up to 40% cover of *Salix planifolia* (planeleaf willow), up to 20% cover of *Salix geyeriana* (Geyer willow) and up to 5% cover of *Salix brachycarpa* (barrenground willow). At lower elevations, other shrubs include *up to* 45% cover of *Salix irrorata* (bluestem willow), up to 25% cover of *Salix lucida* var. *caudata* (whiplash willow), up to 15% cover of *Alnus incana* (thinleaf alder), and up to 10% cover of *Pentaphylloides floribunda* (shrubby cinquefoil).

Total graminoid cover ranges from 10-55% and includes up to 40% cover of *Poa pratensis* (Kentucky bluegrass) and up to 10% cover each of *Juncus balticus* (Baltic sedge), *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge). Forb cover ranges from 5-20% and includes up to 30% cover of *Heracleum sphondylium*(cow parsnip), up to 20% cover of *Fragaria virginiana* (strawberry), and up to 10% cover of *Achillea lanulosa* (yarrow). Within the canopy of this association, graminoids typically dominate the undergrowth in low-lying, wetter swales, while forbs dominate under shrubs on hummocks and ridges.

Successional and Ecological Processes: The *Salix monticola/*mesic graminoid (mountain willow/moist grasses and grass-like plants) plant association appears to be a stable, long-lived community. Stands with an abundance of *Poa pratensis* (Kentucky bluegrass) or *Agrostis stolonifera* (redtop) may be a grazing-induced disclimax. Stands with abundant *Salix planifolia* (planeleaf willow) may indicate a transition between higher elevational sites dominated by *Salix planifolia* and lower elevational sites where *Salix monticola* is more abundant.

Adjacent Riparian Vegetation: This plant association is often the only riparian community along a stream reach. However, *Populus angustifolia* (narrowleaf cottonwood) woodlands and *Pentaphylloides floribunda* (shrubby cinquefoil) shrublands can occur on adjacent floodplains of wider valleys and *Picea pungens* (Colorado blue spruce) forests can occur along adjacent, steeper canyon reaches.

Adjacent Upslope Vegetation: At lower elevations, *Pinus ponderosa* (ponderosa pine), *Pinus contorta* (lodgepole pine) and *Populus tremuloides* (aspen) forests or arid grasslands occur on adjacent hill slopes. At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) and *Populus tremuloides* (aspen) forests occur on adjacent hill slopes.

Management: Stands with an abundance on non-native and increaser herbaceous species in the undergrowth are likely grazing induced shifts from either the native graminoid component of the *Salix monticola*/mesic graminoid plant association, or a shift from another *Salix monticola* dominated plant association. Improper livestock grazing can dry sites, increase non-native cover, and reduce the vigor of willow root structure. Rest periods from grazing are recommended in order to provide time for plant regrowth. 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).

Disturbed stands or stands with a history of improper grazing may respond to rest and rotation periods. These stands may have potential for higher graminoid biomass including species such as *Carex aquatilis* (water sedge) and *Calamagrostis canadensis* (bluejoint reedgrass).

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 should consider maintaining beaver activity in an area versus their removal (Hansen *et al*. 1995).

Prescribed burning in this plant association 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 monticola (mountain willow) is an effective stream bank stabilizer. It 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).

Table 52. Percent Cover of Plant Species in Stands of the *Salix monticola*/Mesic Graminoids Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	97EV29	97BG03	97EV07	97EV22
Species name and age class/ Site and Riparian Health Rank	B	C	B	C
SHRUBS				
Alnus incana (L.) Moench			19	4
Pentaphylloides floribunda (Pursh) A. Love	8	10		7
Ribes montigenum McClatchie			10	
Salix bebbiana Sarg.			16	
Salix eriocephala Michaux var. ligulifolia	13	4		
Salix geyeriana Anderss.	2		6	
Salix monticola Bebb	41	47	26	49
Salix wolfii Bebb	16			
GRAMINOIDS				
Calamagrostis canadensis (Michx.) Beauv.	15	5	10	1
Carex aquatilis Wahlenb.	1	14		3
Carex hoodii F. Boott in Hook.	25			
Carex sp.	1		10	2
Carex utriculata Boott	6	1		13
Poa pratensis L.	1			27
FORBS				
Achillea millefolium var. apicola (Rydb.) Garrett	2	6	2	4
Conioselinum scopulorum (Gray) Coult. & Rose	1	2		5
Dodecatheon pulchellum (Raf.) Merr.		10		
Geranium richardsonii Fisch. & Trautv.		1		4
Mertensia ciliata (James ex Torr.) G. Don			6	1
Potentilla pulcherimma x hippiana		4		
Stellaria sp.	1	3		2
Taraxacum officinale G.H. Weber ex Wiggers	12		3	22
Trifolium pratense		2		
Trifolium repens L.	6		1	6
Unknown forb	10		5	10
Veronica sp.	1		1	
Viola sp.	6		4	1

Salix planifolia Seasonally Flooded Shrubland Alliance

Planeleaf willow/marsh marigold (*Salix planifolia/Caltha leptosepala*) Plant Association

CNHP Rarity Rank: G4 / S4-- This is a common and widespread plant association known from throughout the Rocky Mountains. This is a common and widespread plant association of subalpine habitats in Colorado.

General Description and Comments: The *Salix planifolia/Caltha leptosepala* (planeleaf willow/marsh marigold) plant association is a common and abundant upper montane and subalpine community occurring on very wet to saturated soils. This association is characterized by low-stature shrubs, less than 3 feet (1.0 m) tall, and a thick carpet of forbs in the undergrowth. There may be scattered patches of other willows present.

Related Literature and Synonyms: The following five community names are synonymous with the Colorado *Salix planifolia/Caltha leptosepala* plant association: 1) the *Salix planifolia-Salix wolfii/Caltha leptosepala* (planeleaf willow-Wolf willow/marsh marigold) type and 2) the *Salix planifolia-Salix brachycarpa/Caltha leptosepala* (planeleaf willow-shortfruit willow/marsh marigold) type listed by Bourgeron and Engelking (1994), 3) the *Salix brachycarpa-Salix planifolia/Caltha leptosepala-Carex aquatilis* (shortfruit willow-planeleaf willow/marsh marigold-water sedge) type described by Baker (1986), 4) the *Salix planifolia/Caltha leptosepala* type described by Cooper and Cottrell (1990) and Hess and Wasser (1982), and 5) the *Salix phylicifolia* ssp. *planifolia/Caltha leptosepala* association described by Johnston (1987). *Salix phylicifolia* ssp. *planifolia* is a synonym for *Salix planifolia* (Kartesz 1994).

Similar Communities: The closely related *Salix planifolia/*forb community type described by Girard *et al.* (1995) does not include *Caltha leptosepala* in the undergrowth.

Regional Distribution: This plant association occurs in Wyoming (Johnston 1987) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This is a major subalpine wetland plant association that occurs throughout the Rocky Mountains of Colorado. It has been documented from the San Juan, Gunnison, Routt, Roosevelt, Arapaho and Pike National Forests (Richard *et al.* 1996, Johnston 1987, Kettler and McMullen 1996). It has also been documented from the San Miguel/Dolores, Gunnison, Colorado, Arkansas, South Platte and Rio Grande River Basins, as well as the Closed Basin watershed (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996, Colorado Natural Heritage Program 1997).

The following information is based on: a total of sixty-six quantitative plots; ten from the Colorado West Slope (08A, 09B, 10D, 19B, 20A, 24C, 28B, 28C, 30B, 34B), seventeen from the San Juan National Forest (41, 46, 69, 71, 87, 153, 170, 192, 195, 196, 227, 229, 244, 245, 250, 255, 259), three from the San Miguel/Dolores River Basin (56, 57, 89), eleven from the Gunnison River Basin (94GK07, 94GK33, 94JB14, 94JB24, 94JB29, 94JB32, 94JB34, 94JB42, 94MD13, 94RR39, 94RR41), six from the Colorado River Basin (93SS02, 93SS26, 93SS49, 93GK45, 93DR17, 93RR57), thirteen from the Routt National Forest (181, 421, 533, 534, 538, 562, 563, 565, 579, 588, 610, 615, 619), one from the Arkansas River Basin (95RR26), one from the South Platte River Basin (95LS19), and four from the Rio Grande and Closed Basin Watersheds (95RG36, 95RG45, 95RG51, 95RG60) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 9200-12,100 ft. (2800-3700 m).

Site Geomorphology: This plant association typically occurs in wide, glaciated valleys adjacent to streams. It occurs in swales, depressions and on slopes where snow melt runoff saturates soils for much of the growing season. The ground may be flat or uneven with raised hummocks. Stream gradients range from <1% in broad floodplains to 14% in steep snowmelt basins. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels vary. Channels may be steep and narrow, first-order streams in snow melt basins (Rosgen’s Channel Type: A3), relatively wide and straight (Rosgen’s Channel Type: B3, B4), narrow, relatively deep, and meandering in broad, glaciated valleys (Rosgen's Channel Type: E3, E4) or braided, multiple channels below beaver dams (Rosgen's Channel Type: D6).

Soil: Soil textures are highly variable. Mineral soils vary along a moisture gradient. Wet sites have soil textures of silty clays and silt loams, while slightly drier sites have loamy sands and sandy loams overlying gravely alluvium. Some stands occur on well-drained, mineral soils with well-oxygenated water and no mottled or gleyed layers. Other sites have a shallow organic layer overlying a gravel or cobble layer within 10-20 inches (20-50 cm) of the surface. The water table at these sites is usually near the surface throughout the growing season and may be perched by a clay horizon. Still other stands occur on deep, dark clay loams with high organic content or a fibric or hemic layer on top. Soils in the Colorado River Basin classify as oxyaquic Cryumbrepts, typic Cryoborolls, Cryochrepts, typic Cryorthents, and typic Cryaquents.

Vegetation: *Salix planifolia* (planeleaf willow) forms nearly pure stands with 14-100% cover. Other willows present at lower elevations include up to 20% cover of *Salix geyeriana* (Geyer willow) and up to 10% cover of *Salix monticola* (mountain willow). At higher elevations, other shrubs include up to 30% cover of *Salix brachycarpa* (shortfruit willow) on drier sites, and up to 15% cover of *Betula glandulosa* (glandular birch) and up to 10% cover of *Salix wolfii* (Wolf willow) on wetter sites. *Picea engelmannii* (Engelmann spruce) is occasionally scattered throughout the stand with up to 30% cover.

Typically, the willow canopy is nearly closed and an herbaceous undergrowth occurs only in openings between willow patches. The undergrowth is characterized by an abundance of forbs with few graminoids. Forb species include 1-40% cover of *Caltha leptosepala* (marsh marigold), up to 60% cover of *Cardamine cordifolia* (heartleaf bittercress), up to 30% cover of *Senecio triangularis* (arrowleaf groundsel), up to 20% cover of *Mertensia ciliata* (mountain bluebells), and up to 10% cover each of *Pedicularis groenlandica* (elephant-head), *Polygonum bistortoides* (American bistort), and *Sedum rhodanthum* (pink stonecrop). Graminoids include up to 40% cover of *Calamagrostis canadensis* (bluejoint reedgrass) and up to 30% cover of *Carex aquatilis* (water sedge).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow), *Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

Salix planifolia also grows at elevations below the subalpine, and becomes a much taller willow due to a longer growing season. The two ecotypes were once thought to be two varieties of the species (Weber 1990). In montane elevations, *Salix planifolia* is often a co-dominant in *Salix monticola* plant associations. While *Salix planifolia* is not rhizomatous, it can be stimulated by browsing and has been shown to produce ten times more shoot biomass and twice as much root biomass as *Salix monticola* (Cottrell 1995). This may explain why *Salix planifolia* is so abundant in the upper reaches of most mountain watersheds in Colorado.

The *Salix planifolia/Caltha leptosepala* (planeleaf willow/marsh marigold) plant association occurs in wet swales that are saturated throughout most or all of the growing season. It is a long-lived, stable association that changes with fluctuations in the water table and degree of soil saturation. Cooper and Cottrell (1990) state that this type may be successional to another, presumably drier, *Salix planifolia* type.

Adjacent Riparian Vegetation: *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge) *Caltha leptosepala* (marsh marigold) and *Eleocharis palustris* (creeping spikerush) meadows or other *Salix planifolia* (planeleaf willow) shrublands occur in adjacent areas with saturated soils. *Salix brachycarpa* (shortfruit willow) shrublands or *Deschampsia cespitosa* (tufted hairgrass) grasslands occur in adjacent drier sites. *Picea engelmannii/Salix* spp. (Engelmann spruce/willow) and *Abies lasiocarpa/Mertensia ciliata* (subalpine fir/mountain bluebells) types are adjacent in narrow valley reaches or may occur on islands of higher ground within in the wetland mosaic.

Adjacent Upland vegetation: Adjacent hill slopes are covered with *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests, *Salix brachycarpa* (shortfruit willow) shrublands, or *Danthonia* spp. (oatgrass) meadows. At higher elevations, the surrounding slopes have alpine tundra vegetation, dominated by *Acomastylis rossii* (Ross avens).

Management: *Salix planifolia* (planeleaf willow) is highly palatable to wildlife and livestock. Low-stature *Salix planifolia* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season. However, livestock may avoid the wettest sites until August or September. If season-long grazing does occur, the plants and soils will be damaged. Heavy grazing opens the canopy and lowers the water table due to streambed down cutting and increased evapotranspiration. This will dry the site and allow *Salix brachycarpa* (shortfruit willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (Kittel *et al.* 1994).

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 high water table necessary for the health of the riparian ecosystem. Beaver dams aid in controlling channel down cutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophilic plants such as willows and sedges. Sediment trapped behind beaver dams, raises the channel bed creates a broader wetland area. Land managers should consider maintaining beaver activity in an area rather than removing them (Hansen *et al*. 1995).

Salix planifolia is valuable for revegetating and stabilizing disturbed stream banks. *Salix planifolia* can be grown from nursery cuttings and then transplanted. Best results are obtained from cuttings 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. Once transplanted, roots and shoots should appear within 10-15 days if conditions are right (Hansen *et al*. 1995).

Table 53. Percent Cover of Plant Species in Stands of the *Salix planifolia/Caltha leptosepala* Plant Association From the Rio Grande and Closed Basin Watersheds.

Plant Association	Salix planifolia/Caltha leptosepala			
Plot Number	95RG36	95RG45	95RG51	95RG60
Species name / Site Health Rank	B	A	A	B
SHRUBS				
Pentaphylloides floribunda	1			
Salix boothii Dorn	17			
Salix brachycarpa Nutt.			3	
Salix monticola Bebb	5			
Salix planifolia Pursh	14	67	37	51
Salix wolfii Bebb	1			
GRAMINOIDS				
Agrostis sp.			1	5
Carex aquatilis Wahlenb.	6		1	19
Carex norvegica Retz.				
Carex sp.		9	8	6
Deschampsia cespitosa (L.) Beauv.		1	6	1
FORBS				
Achillea millefolium		1	1	2
Aconitum columbianum Nutt.	1	3		
Caltha leptosepala var. leptosepala	30	23	64	20
Cardamine cordifolia Gray		4	4	
Cardamine sp.	23			
Conioselinum scopulorum		8	4	
Epilobium sp.	9	1	4	
Mertensia ciliata		7		
Oxypolis fendleri (Gray) Heller		14	9	
Pedicularis groenlandica Retz.		4	4	
Polygonum viviparum L.		1		6
Potentilla sp.		1	5	3
Pseudocymopterus sp.				22
Saxifraga odontoloma Piper		16	1	
Sedum rhodanthum Gray		6	4	1
Senecio triangularis Hook	4	4		
Swertia perennis L.				6
Taraxacum officinale	2	1	1	1
Veronica wormskjoldii		2	2	1
Viola sp.	1	4		2

Planeleaf willow/water sedge (*Salix planifolia/Carex aquatilis*) Plant Association

CNHP Rarity Rank: G5 / S4 -- This is a common association of subalpine habitats throughout the Rocky Mountains. This is a common subalpine plant association. It is threatened by improper livestock grazing and heavy recreational use.

General Description and Comments: The *Salix planifolia/Carex aquatilis* (planeleaf willow/water sedge) plant association is a low-stature willow shrubland that grows in wet to saturated soils above 9000 feet (2800 m). It is a common plant association of subalpine glacial valleys. *Salix planifolia* occasionally mixes with *Salix brachycarpa* (shortfruit willow) or *Salix wolfii* (Wolf willow) at higher elevations and grades into taller willow carrs with *Salix monticola* (mountain willow) at lower elevations.

Related Literature and Synonyms: The following three names are synonymous with the Colorado *Salix planifolia/Carex aquatilis* plant association: *Salix planifolia/Carex aquatilis* habitat/community type (Padgett *et al.* 1989, Johnston 1987, Komarkova 1986, Hess 1981, Cooper and Cottrell 1990), *Salix planifolia/Carex* spp. ecological type in the Bighorn National Forest (Girard *et al.* 1995), and the *Salix planifolia/Caltha leptosepala*-(*Carex aquatilis-Carex rostrata* phase) habitat type (Hess and Wasser 1982). *Carex rostrata* var. *utriculata* is a synonym for *Carex utriculata* (Kartesz 1994).

Similar Communities: Closely related communities include: the *Salix planifolia* community type reported by Youngblood *et al.* (1985), which does not always have a significant cover of *Carex aquatilis,* the *Salix planifolia-Salix wolfii/Caltha leptosepala-Carex aquatilis* (planeleaf willow-Wolf willow/marsh marigold-water sedge) plant association reported by Baker (1989), which is a broader plant association that includes stands of more narrowly defined *Salix wolfii/Carex aquatilis, Salix planifolia/Carex aquatilis,* and *Salix planifolia/Caltha leptosepala* associations within it, the *Salix planifolia/Deschampsia cespitosa* (planeleaf willow/tufted hairgrass) type is reported from western Colorado, which is a drier type representing the outer fringe of *Salix planifolia* areas (Colorado Natural Heritage Program 1997).

Regional Distribution: This plant association occurs in Wyoming (Girard *et al.* 1995, Youngblood *et al.* 1985), Idaho (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989), and Colorado (Baker 1989, Cooper and Cottrell 1990, Hess 1981, Hess and Wasser 1982, Johnston 1987, Komarkova 1986, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is a common type and occurs throughout the Rocky Mountains of Colorado (Baker 1989, Cooper and Cottrell 1990, Hess 1981, Hess and Wasser 1982, Johnston 1987, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al*. 1995, Kittel *et al*. 1996, Komarkova 1986).

The following information is based on: a total of fifteen quantitative plots; two from the Yampa River Basin (GK11, GK13), seven from the Colorado River Basin (92NL30, 92GL28, 93SS17, 93SS19, 93SS48, 93SS44, 93DR05), three from the Gunnison River Basin (94MD30, 94RR30, 94RR43), one from the Arkansas River Basin (95RR24), one from the South Platte River Basin (95GK20), one from the San Juan National Forest (252), and six from the Rio

Grande and Closed Basin Watersheds (95RG67, 95RG24, 95RG43, 95RG49, 97MD29, 97EV35) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 9000-11,200 ft. (2800-3400 m).

Site Geomorphology: This plant association occurs in wide, wet valleys on snow-melt fed swales. It also occurs in narrow valleys with sinuous streams and wet floodplains associated with beaver ponds. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and moderately sinuous (Rosgen's Channel Type: B3), narrow and sinuous (Rosgen's Channel Type: E4), or highly braided by beaver activity (Rosgen's Channel Type: D4).

Soil: Soils have an organic peat top layer over mineral silty clays, heavy silty clay loams, silty loams, sandy loams, or loamy sands. Mottling is often evident. Soils in the Colorado River Basin classify as Histisols, Cryaquolls, Hemists, and Borohemists.

Vegetation: This plant association is characterized by 10-90% cover of low-stature (.5-1.5 m) *Salix planifolia* (planeleaf willow). Other willows include up to 40% cover each of *Salix monticola* (mountain willow) and *Salix wolfii* (Wolf willow), up to 20% cover of *Salix boothii* (Booth willow), and up to 10% cover each of *Salix geyeriana* (Geyer willow) and *Salix drummondiana* (Drummond willow). One stand in the Colorado River Basin had 80% cover of *Salix brachycarpa* (shortfruit willow) with 90% *Salix planifolia*. But the Salix brachycarpa was confined to the more well drained and drier slopes along the outer edges of the wet, *Salix planifolia* dominated swale.

The undergrowth is dominated by graminoids including up to 30% cover of *Carex aquatilis* (water sedge), up to 50% cover of *Carex utriculata* (beaked sedge), up to 40% cover of *Calamagrostis canadensis* (bluejoint reedgrass), and up to 20% cover of *Deschampsia cespitosa* (tufted hairgrass). Forb cover is typically less than 20% of the total undergrowth cover, but can be higher. Species may include *Caltha leptosepala* (marsh marigold), *Cardamine cordifolia* (heartleaf bittercress), *Pedicularis groenlandica* (elephant-head) and *Conioselinum scopulorum* (hemlock parsley).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow), *Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

Salix planifolia also grows at elevations below the subalpine, and becomes a much taller willow due to a longer growing season. The two ecotypes were once thought to be two varieties of the species (Weber 1990). In montane elevations, *Salix planifolia* is often a co-dominant in *Salix monticola* plant associations. While *Salix planifolia* is not rhizomatous, it can be stimulated by browsing and has been shown to produce ten times more shoot biomass and twice as much root biomass as *Salix monticola* (Cottrell 1995). This may explain why *Salix planifolia* is so abundant in the upper reaches of most mountain watersheds in Colorado.

Carex utriculata (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) 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 (beaked sedge) occurs on the wettest sites, such as shallow pond margins, low-lying swales, and overflow channel with the shallowest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites that have saturated but not inundated soils. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the drier sites with lower water tables. As wetter sites become drier, it can colonize stands of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (water sedge) (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* (water sedge) dominated stands (regardless of any overstory canopy) may shift toward *Calamagrostis canadensis* (bluejoint reedgrass) dominated stands.

The *Salix planifolia/Carex aquatilis* (planeleaf willow/water sedge) plant association occurs in wet swales that are saturated throughout the growing season. The dense canopy layers and thick undergrowth indicate stable conditions. Both *Carex aquatilis* (water sedge) and *Caltha leptosepala* (marsh marigold) can tolerate saturated soils, and occasionally they co-dominate the undergrowth (Padgett *et al.* 1989).

Adjacent riparian vegetation: Adjacent riparian and wetland vegetation include *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge), or *Calamagrostis canadensis* (bluejoint reedgrass) wet meadows intergrading with the *Salix planifolia* stands. *Salix brachycarpa* (shortfruit willow) shrublands occur on higher ground.

Adjacent upslope vegetation: At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) or *Pinus contorta* (lodgepole pine) forests occur on adjacent hillsides. At lower elevations, *Artemisia tridentata* (big sagebrush) scrub is present.

Management: *Salix planifolia* (planeleaf willow) is highly palatable to wildlife and livestock. In general, graminoid and forb production is moderate in this plant association. Forage value for *Carex aquatilis* (water sedge) and *Carex utriculata* (beaked sedge) is variable depending on the season, previous grazing use, and the size of the rangelands. In narrow riparian areas within extensive rangelands, the undergrowth of this association may be heavily grazed (Hansen *et al*. 1995).

Low-stature *Salix planifolia* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season (Girard *et al.* 1995). However, livestock may avoid the wettest sites until August or September. If season-long grazing does occur, the plants and soils will be damaged. Heavy grazing opens the canopy and lowers the water table due to streambed down cutting and increased evapotranspiration. This allows *Salix brachycarpa* (shortfruit willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (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 can be important for maintaining the high water table necessary for the health of the riparian ecosystem. Beaver dams aid in controlling channel down cutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophilic plants such as willows and sedges. Sediment trapped behind beaver dams, raises the channel bed creates a broader wetland area. Land managers should consider maintaining beaver activity in an area rather than removing them (Hansen *et al*. 1995).

Burning of this plant association temporarily increases the productivity of *Carex aquatilis* and *Carex utriculata*. Grazing should be eliminated from the burned sites for 2-3 years following a fire in order to prevent livestock from browsing young, palatable regrowth (Hansen *et al*. 1995).

Salix planifolia and *Carex* (sedge) species are valuable for revegetating and stabilizing stream banks. *Salix planifolia* can be grown from nursery cuttings and then transplanted. Best results are obtained from cuttings 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 within 10-15 days after planting if conditions are right. *Carex aquatilis* and *Carex utriculata* are effective due to their dense network of rhizomatous roots (Hansen *et al*. 1995).

Table 54. Percent Cover of Plant Species in Stands of the *Salix planifolia/Carex aquatilis* Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG24	95RG43	95RG49	97MD29	97EV35
Species name and age class/ Site and Riparian Health Rank	B	B	A	B	A
SHRUBS					
Pentaphylloides floribunda (Pursh) A. Love	7	6		1	
Salix boothii Dorn		1			
Salix brachycarpa Nutt.		1		33	
Salix planifolia Pursh	37	45	66	54	89
Salix wolfii Bebb	1			7	
GRAMINOIDS					
Calamagrostis canadensis (Michx.) Beauv.				1	4
Carex aquatilis Wahlenb.	2	16	22	23	1
Carex sp.		4	3		
Carex utriculata Boott					42
Deschampsia cespitosa (L.) Beauv.	1	3	6		
FORBS					
Achillea millefolium var. apicola (Rydb.) Garrett	1	4	6	2	
Caltha leptosepala var. leptosepala		8	10		1
Cardamine cordifolia Gray		2		1	1
Conioselinum scopulorum (Gray) Coult. & Rose		7		1	6
Epilobium sp.	2	2			
Erigeron sp.	2	4	12		
Fragaria virginiana Miller		4	1		
Geum macrophyllum		2	1		
Pedicularis groenlandica Retz.	11	4			
Polygonum viviparum L.	2	6	1		
Potentilla sp.	6	4	19	2	
Primula parryi Gray		8			
Pseudocymopterus montanus (Gray) Coult. & Rose	10				
Sedum rhodanthum Gray		1			
Senecio triangularis Hook		8			
Taraxacum officinale G.H. Weber ex Wiggers	3	2	2		
Thalictrum alpinum L.	2	1			
Veronica wormskjoldii Roemer & J.A. Schultes		2	8		
Viola sp.		2	12		

Planeleaf willow/Mesic Forbs (*Salix planifolia*/Mesic Forbs) Plant Association

CNHP Rarity Rank: G4 / S4-- This is a common and widespread plant association known from throughout the Rocky Mountains. This is a common and widespread plant association in subalpine habitats in Colorado.

General Description and Comments: The *Salix planifolia*/Mesic Forbs (planeleaf willow/Mesic Forbs) plant association is low stature (<3 feet, 1.0 m) shrubland with abundant and diverse forbs under the willow canopy. It is a common community of the subalpine and lower alpine areas. It occurs on mesic soils, and may represent degraded occurrences of *Salix planifolia/Caltha leptosepala* (planeleaf willow/marsh marigold) or other *Salix planifolia* (planeleaf willow) community types.

Related Literature and Synonyms: This association has not been previous described in the literature. Similar communities include the Low *Salix*/Mesic Forbs (Manning and Padgett 1995) and the *Salix wolfii*/Mesic Forbs (Padgett et al. 1989) community types. These have similar undergrowth species composition, but differ in their overstory willow species from the Colorado stands.

Regional Distribution: This plant association occurs in Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in the San Juan National Forest (Richard *et al.* 1996) and in the Rio Grande and Closed Basin Watersheds (Colorado Natural Heritage Program 1997).

The following information is based on: a total of twelve quantitative plots; eight from the San Juan National Forest (70, 94,175, 192, 227, 229, 244, 255) and three from the Rio Grande and Closed Basins (95RG30, 95RG53, 95RG59) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 9200-12,100 ft. (2800-3700 m).

Site Geomorphology: This plant association typically occurs in wide, glaciated valleys adjacent to streams. It occurs in swales, depressions and on slopes where snow melt runoff saturates soils for much of the growing season. The ground may be flat or uneven with raised hummocks. Stream gradients range from <1% in broad floodplains to 14% in steep snowmelt basins. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Channels may be steep and narrow, first-order streams in snow melt basins (Rosgen's Channel Type: A3), relatively wide and straight (Rosgen's Channel Type: B3, B4), narrow, relatively deep, and meandering in broad, glaciated valleys (Rosgen's Channel Type: E3, E4) or braided, multiple channels below beaver dams (Rosgen's Channel Type: D6).

Soil: Soil textures are highly variable. Mineral soils vary along a moisture gradient. Wet sites have soil textures of silty clays and silt loams, while slightly drier sites have loamy sands and sandy loams overlying gravely alluvium. Some stands occur on well-drained, mineral soils with well-oxygenated water and no mottled or gleyed layers. Other sites have a shallow organic layer overlying a gravel or cobble layer within 10-20 inches (20-50 cm) of the surface. The water table at these sites is usually near the surface throughout the growing season and may be perched by a clay horizon. Still other stands occur on deep, dark clay loams with high organic content or a fibric or hemic layer on top. Soils in the Colorado River Basin classify as oxyaquic Cryumbrepts, typic Cryoborolls, Cryochrepts, typic Cryorthents, and typic Cryaquents.

Vegetation: *Salix planifolia* (planeleaf willow) forms nearly pure stands with 30-100% cover. Other willows present at lower elevations include up to 20% cover of *Salix geyeriana* (Geyer willow) and up to 10% cover of *Salix monticola* (mountain willow). At higher elevations, other shrubs include up to 30% cover of *Salix brachycarpa* (shortfruit willow) on drier sites, and up to 15% cover of *Betula glandulosa* (glandular birch) and up to 10% cover of *Salix wolfii* (Wolf willow) on wetter sites. *Picea engelmannii* (Engelmann spruce) is occasionally scattered throughout the stand with up to 30% cover.

Typically, the willow canopy is nearly closed and an herbaceous undergrowth occurs only in openings between willow patches. The undergrowth is characterized by an abundance of forbs with few graminoids. Forb species include *Mertensia ciliata* (chiming bells) , *Senecio triangularis* (arrowleaf goldenrod), *Conioselinum scopulorum* (hemlock parsley), *Aconitum columbianum* (monkshood) , *Potentilla* spp. (cinquefoil), and *Viola* spp. (violet).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow), *Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

Salix planifolia also grows at elevations below the subalpine, and becomes a much taller willow due to a longer growing season. The two ecotypes were once thought to be two varieties of the species (Weber 1990). In montane elevations, *Salix planifolia* is often a co-dominant in *Salix monticola* plant associations. While *Salix planifolia* is not rhizomatous, it can be stimulated by browsing and has been shown to produce ten times more shoot biomass and twice as much root biomass as *Salix monticola* (Cottrell 1995). This may explain why *Salix planifolia* is so abundant in the upper reaches of most mountain watersheds in Colorado.

The *Salix planifolia/*Mesic Forbs association may be a grazing-induced phase of the *Salix planifolia/Caltha leptosepala* (planeleaf willow/marsh marigold) association. Many stands in the Routt National Forest are heavily grazed and contain a high number of exotic and increaser species such as *Taraxacum officinale* (dandelion) and *Fragaria virginiana* (mountain strawberry). Other stands in Colorado, however, do not indicate an increase in non-native species. Padgett *et al.* (1989) consider this association to be a stable community based on its well-developed soil morphology and lush undergrowth, and that succession from a *Carex aquatilis* (water sedge) understory to mesic forbs would be slow to occur.

The *Salix planifolia/Caltha leptosepala* (planeleaf willow/marsh marigold) plant association occurs in wet swales that are saturated throughout most or all of the growing season. It is a long-lived, stable association that changes with fluctuations in the water table and degree of soil saturation. Cooper and Cottrell (1990) state that this type may be successional to another, presumably drier, *Salix planifolia* type.

Adjacent Riparian Vegetation: *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge) *Caltha leptosepala* (marsh marigold) and *Eleocharis palustris* (creeping spikerush) meadows or other *Salix planifolia* (planeleaf willow) shrublands occur in adjacent areas with saturated soils. *Salix brachycarpa* (shortfruit willow) shrublands or *Deschampsia cespitosa* (tufted hairgrass) grasslands occur in adjacent drier sites. *Picea engelmannii/Salix* spp. (Engelmann spruce/willow) and *Abies lasiocarpa/Mertensia ciliata* (subalpine fir/mountain bluebells) types are adjacent in narrow valley reaches or may occur on islands of higher ground within in the wetland mosaic.

Adjacent Upland vegetation: Adjacent hill slopes are covered with *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests, *Salix brachycarpa* (shortfruit willow) shrublands, or *Danthonia* spp. (oatgrass) meadows. At higher elevations, the surrounding slopes have alpine tundra vegetation, dominated by *Acomastylis rossii* (Ross avens).

Management: *Salix planifolia* (planeleaf willow) is highly palatable to wildlife and livestock. Low-stature *Salix planifolia* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season. However, livestock may avoid the wettest sites until August or September. If season-long grazing does occur, the plants and soils will be damaged. Heavy grazing opens the canopy and lowers the water table due to streambed down cutting and increased evapotranspiration. This will dry the site and allow *Salix brachycarpa* (shortfruit willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (Kittel *et al.* 1994).

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 high water table necessary for the health of the riparian ecosystem. Beaver dams aid in controlling channel down cutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophilic plants such as willows and sedges. Sediment trapped behind beaver dams, raises the channel bed creates a broader wetland area. Land managers should consider maintaining beaver activity in an area rather than removing them (Hansen *et al*. 1995).

Salix planifolia is valuable for revegetating and stabilizing disturbed stream banks. *Salix planifolia* can be grown from nursery cuttings and then transplanted. Best results are obtained from cuttings 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. Once transplanted, roots and shoots should appear within 10-15 days if conditions are right (Hansen *et al*. 1995).

Table 55. Percent Cover of Plant Species in Stands of the *Salix planifolia*/Mesic Forbs Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG30	95RG53	95RG59
Species name / Site Health Rank	B	A	B
SHRUBS			
Pentaphylloides floribunda	1	5	3
Salix boothii Dorn		20	8
Salix brachycarpa Nutt.		9	
Salix eriocephala var. ligulifolia		9	
Salix monticola Bebb		1	3
Salix planifolia Pursh	74	46	59
GRAMINOIDS			
Agrostis sp.		4	
Carex aquatilis Wahlenb.	9		
Carex norvegica Retz.			8
Carex sp.	3	8	16
Carex utriculata Boott	5		
Deschampsia cespitosa (L.) Beauv.		5	16
FORBS			
Achillea millefolium	1	13	10
Aconitum columbianum Nutt.	2		1
Antennaria corymbosa E. Nelson		10	
Cardamine cordifolia Gray			1
Conioselinum scopulorum		6	13
Epilobium sp.	4		8
Erigeron sp.	3		
Fragaria virginiana Miller		5	1
Geranium richardsonii			7
Geum macrophyllum	3		1
Geum rossii ssp. rossii		4	
Mertensia ciliata	5		16
Polygonum viviparum L.		3	1
Potentilla sp.	1	28	2
Sedum rhodanthum Gray		1	
Senecio triangularis Hook			6
Swertia perennis L.		2	
Taraxacum officinale	1	2	
Veronica wormskjoldii		2	
Viola sp.	10	6	

Salix wolfii Temporarily Flooded Shrubland Alliance

Wolf willow/mesic forb (*Salix wolfii*/Mesic Forbs) Plant Association

CNHP Rarity Rank: G3 / S3 --This is a wide spread association, although never very abundant where it occurs. This association is known form less than 20 locations. More stands are expected to occur. It is threatened by improper livestock grazing and heavy recreational use.

General Description and Comments: The *Salix wolfii*/mesic forb (Wolf willow/mesic forb) plant association occurs at mid- to upper montane and lower subalpine elevations. It frequently covers wide, open, gently sloping areas near first- and second-order streams. It can be recognized by the generally dense layer of low-growing, silvery *Salix wolfii* dominating the overstory with a variety of mesic forbs and some graminoids in the undergrowth.

Related Literature and Synonyms: The *Salix wolfii*/mesic forb (Wolf willow/mesic forb) and the *Salix wolfii/Fragaria virginiana* (Wolf willow/mountain strawberry) community types (Padgett *et al.* 1989, Youngblood *et al.* 1985, Johnston 1987) are synonymous with the Colorado *Salix wolfii*/mesic forb plant association. The *Salix wolfii/Swertia perennis-Pedicularis groenlandica* (Wolf willow/felwort-elephant-head) plant association (Tuhy and Jensen 1982, as cited in Bourgeron and Engelking 1994) may also be synonymous with the Colorado type. The *Salix wolfii* Shrubland [Provisional] listed in Anderson *et al.* (1998), includes the Salix wolfii/Mesic Forbs plant association.

Regional Distribution: This plant association occurs in Utah, Idaho, western Wyoming (Padgett *et al.* 1989, Youngblood *et al.* 1985, Johnston 1987) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs on the West Slope in the Yampa, White and Colorado River Basins and in the San Juan, Routt, and Rio Grande National Forests (Sanderson and Kettler 1996, Kittel and Lederer 1993, Kittel *et al*. 1994, Richard *et al*. 1996, Kettler and McMullen 1996, Colorado Natural Heritage Program 1997).

The following information is based on: a total of twenty quantitative plots; five from the Yampa River Basin (50, 72, 80, 85, 89), three from the White River Basin (92GK42, 92GK43, 92NL54), one plot from the Colorado River Basin (93RR56), two from the San Juan National Forest (90, 236), and five from the Routt National Forest (133, 245, 383, 543, 585), and four from the Rio Grande and Closed Basin Watersheds (95RG63, 95RG34, 95RG63, 95RG69) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 7900-11,000 ft. (2400-3400 m).

Site Geomorphology: This plant association occurs in wide mountain valleys. It occurs along first- or second-order streams on well-drained slopes and hummocks on the valley floor. The water table is usually within the top meter of soil and groundwater slowly seeps to the surface.

Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow, relatively deep and sinuous (Rosgen's Channel Type: E4).

Soil: The soils may be saturated in the spring and early summer, but dry somewhat during the summer as the water table drops. Soil textures often have a high organic content and are silty clays, silty clay loams, silty loams, or deep sandy clays, clay loams, and sandy clay loams over gravels and rocks. Some stands have a loamy horizon underlain by a clay horizon. One profile in the Colorado River Basin classifies as a dystric Cryochrept.

Vegetation: *Salix wolfii* (Wolf willow) dominates the shrub layer with 20-100% cover. Other willow species present include up to 80% cover of *Salix planifolia* (planeleaf willow), up to 40% cover of *Salix boothii* (Booth willow), and up to 20% cover each of *Salix geyeriana* (Geyer willow) and *Salix brachycarpa* (shortfruit willow). Graminoid species are diverse, yet generally have a low cover. Graminoid species include up to 40% cover of *Deschampsia cespitosa* (tufted hairgrass) and up to 10% cover each of *Calamagrostis canadensis* (bluejoint reedgrass) and various *Carex* (sedge) species.

Forb cover is variable with no single dominant species. Forb species include up to 60% cover of *Caltha leptosepala* (marsh marigold), up to 20% cover of *Mertensia ciliata* (mountain bluebell), up to 10% cover each of *Senecio triangularis* (arrowleaf groundsel), *Ligusticum porteri* (Southern ligusticum), *Fragaria virginiana* (mountain strawberry), and *Cardamine cordifolia* (heartleaf bittercress), and up to 5% cover each of *Geum macrophyllum* (large-leaved avens) and *Heracleum sphondylium*(cow parsnip).

Successional and Ecological Processes: *Salix planifolia* (planeleaf willow), *Salix brachycarpa* (shortfruit willow) and *Salix wolfii* (Wolf willow) are abundant low-stature (1-3 ft, 0.3-1 m) willows of first- and second-order streams of subalpine elevations of Colorado. *Salix planifolia* and *Salix brachycarpa* can form extensive stands, often creating intricate mosaics in broad, subalpine valleys. In general, *Salix planifolia* occupies the wettest micro-habitats on peat soils, although it can grow well on mineral soils. *Salix brachycarpa* is more often found on slightly drier and more well-drained micro-habitats than *Salix planifolia*. *Salix brachycarpa* grows on lateral moraines, coarse-textured stream banks, ridge tops and on small hummocks (Kittel 1994).

Stands of *Salix wolfii* are less frequently encountered, and are usually limited in size. *Salix wolfii* dominated stands are more common on the western slope (David Cooper, *personal communication*). Of the twenty-eight *Salix wolfii* stands documented by the Colorado Natural Heritage Program, twenty-six are located on the west slope (Colorado Natural Heritage Program 1997). According to Phillips (1977), *Salix wolfii* grows on deep, undecomposed peat, while *Salix planifolia* tends to grow on more decomposed (humified) organic soils.

Further north in Montana, *Salix planifolia* stands are observed on wetter and finer-textured soils than sites containing *Salix wolfii* dominated communities (Hansen *et al.* 1988).

Kettler and McMullen (1996) suggest that the *Salix wolfii*/mesic forb association may be a grazing-induced phase of the *Salix wolfii/Carex aquatilis* (Wolf willow/water sedge) association. Many stands in the Routt National Forest are heavily grazed and contain a high number of exotic and increaser species such as *Taraxacum officinale* (dandelion) and *Fragaria virginiana* (mountain strawberry). Other stands in Colorado, however, do not indicate an increase in non-native species. Padgett *et al.* (1989) consider this association to be a stable community based on its well-developed soil morphology and lush undergrowth, and that succession from a *Carex aquatilis* (water sedge) understory to mesic forbs would be slow to occur.

Adjacent riparian vegetation: Adjacent riparian areas include *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests along narrow reaches and wet meadows of *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge), *Deschampsia cespitosa* (tufted hairgrass) or *Eleocharis palustris* (creeping spikerush) along wider sections of streams. *Salix boothii* (Booth willow), *Salix planifolia* (planeleaf willow), *Alnus incana* (thinleaf alder), or *Betula glandulosa* (glandular birch) shrublands are also present.

Adjacent upland vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce), *Pinus contorta* (lodgepole pine) and *Populus tremuloides* (quaking aspen) forests occur on steep-sided slopes. *Artemisia tridentata* (big sagebrush) scrub and subalpine meadows with *Festuca thurberi* (Thurber fescue) occur outside the riparian areas in broad valleys.

Management: *Salix wolfii* (Wolf willow) is moderately palatable to livestock. Low-stature *Salix wolfii* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season (Girard *et al.* 1995). However, livestock may avoid the wettest sites until August or September. If season-long grazing does occur, the plants and soils will be damaged. Heavy grazing opens the canopy and lowers the water table due to streambed down cutting and increased evapotranspiration. This allows *Salix brachycarpa* (shortfruit willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (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 high water table necessary for the health of the riparian ecosystem. Beaver dams aid in controlling channel down cutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophilic plants such as willows and sedges. Sediment trapped behind beaver dams, raises the channel bed creates a broader wetland area. Land managers should consider maintaining beaver activity in an area rather than removing them (Hansen *et al*. 1995).

Prescribed burning can aid in rejuvenating decadent stands of *Salix wolfii*. Quick, hot fires result in more sprouts, while slow fires damage the willows and result in fewer sprouts (Hansen *et al*. 1995).

Salix wolfii is valuable for revegetating and stabilizing disturbed stream banks, but success in transplanting cuttings is inconsistent. Best results are obtained from cuttings 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.

Table 56. Percent Cover of Plant Species in Stands of the *Salix wolfii*/Mesic Forbs Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG34	95RG63	95RG67	95RG69
Species name and age class/ Site and Riparian Health Rank		B		B
SHRUBS				
Pentaphylloides floribunda (Pursh) A. Love	2	7		1
Salix brachycarpa Nutt.		1		
Salix monticola Bebb	24	24		
Salix planifolia Pursh	20	26	28	
Salix wolfii Bebb	30	32	53	81
GRAMINOIDS				
Carex aquatilis Wahlenb.	18	8	19	11
Juncus balticus ssp. montanus Engelm.				8
Phleum alpinum L.				1
FORBS				
Achillea millefolium var. apicola (Rydb.) Garrett	2	3	5	3
Antennaria corymbosa E. Nelson		3	2	2
Castilleja rhexiifolia		5		
Castilleja sulphurea Rydb.		2		1
Conioselinum scopulorum (Gray) Coult. & Rose		10	8	1
Erigeron sp.	11	5	6	1
Fragaria virginiana Miller	1	4	1	20
Gentianopsis thermalis (Kuntze) Iltis				1
Mertensia ciliata (James ex Torr.) G. Don		6		
Pedicularis groenlandica Retz.	1	1	1	1
Potentilla sp.		3	3	6
Solidago spathulata DC.				6
Taraxacum officinale G.H. Weber ex Wiggers	4	4	2	7
Trifolium sp.		19		
Unknown forb		1		3
Veronica wormskjoldii Roemer & J.A. Schultes		1	2	1
Vicia sp.		5		
Viola sp.		1		6
HORESTAILS				
Equisetum pratense Ehrhardt		5		

Greasewood (*Sarcobatus vermiculatus*) Intermittently Flooded Shrubland Alliance

Greasewood/salt grass (*Sarcobatus vermiculatus/Distichlis spicata*) Plant Association

CNHP Rarity Rank: G4 / S1 – This is a widespread community within its habitat in the Western U.S. In Colorado, only one of five documented stands is a large, viable occurrence.

General Description: Greasewood forms expansive shrublands on alkaline soils with a perennial high water table in southern and western Colorado. In the San Luis valley, it grows between playa lakes on sandy hummocks. The shrubs are 2-4 feet tall and usually have non-overlapping canopies. The understory is sparse, open herbaceous cover of salt grass and other salt tolerant species.

Related Literature and Synonyms: The *Sarcobatus vermiculatus/Distichlis spicata* (greasewood/saltgrass) community is described from Oregon and Washington by Daubenmire (1970) and Franklin (1973), and from Montana by Mueggler and Stewart (1980).

Similar Communities: Several *Sarcobatus vermiculatus* (greasewood)communities, with different dominant undergrowth species, can be differentiated across the landscape with changes in soil texture, salinity, and available moisture (Renée Rondeau, CNHP Ecologist, *personnel communication*). These undergrowth species include *Sporobolus airoides* (alkali sacaton), *Juncus balticus* (arctic rush), and *Bouteloua gracilis* (blue grama grass) (Knight 1994, Anderson *et al.* 1998).

Regional Distribution: *Sarcobatus vermiculatus/Distichlis spicata* (greasewood/saltgrass) plant association occurs in Colorado, Idaho, Montana, Oregon and Washington, and possibly Nevada (Anderson *et al.* 1998).

Colorado Distribution:. Stands of *Sarcobatus vermiculatus* (greasewood) have been observed on the western slope as far east as Eagle, on the eastern plains in the Arkansas drainage (Mutel and Emerick 1992), and in the Rio Grande and Closed Basin watersheds, where the largest and most pristine stand in the state occurs (Colorado Natural Heritage Program 1997).

The following information is based on: a total of two quantitative plots from the Closed Basin Watershed (97GK11 and 97GK15) (Colorado Natural Heritage Program 1997).

Elevational Range: 5500 –7550 ft. (1700–2300 m).

Site Geomorphology: This community occurs on the highest ground between salt flat depressions called playa lakes in the northern part of the San Luis Valley. The shrubs occur on hummocks, approximately 1.2 m above the lake bed. The drainage pattern of the lakes did not fit any of Rosgen's stream channel categories (Rosgen 1996).

Soil: Soils are deep, fine textured sandy loams to clay loams. Surface soil is very hard when dry, but the subsurface soils, below 31 cm, are friable loamy texture.

Vegetation: The shrub canopy is fairly open with 18-25% cover of *Sarcobatus vermiculatus* (greasewood). *Chrysothamnus nauseosus* (rubber rabbit brush) occurred in one stand with 10% cover. The herbaceous understory is a dry carpet of *Distichlis spicata* (saltgrass) with up to 29% cover. Other species present are *Juncus balticus* (arctic rush) and *Ipomopsis* spp. (Gilia).

Successional and Ecological Processes: Greasewood often occurs as a band of abrupt concentric rings of vegetation around a salt flat or depression. This visible zonation is cause by the change in dominant species and their relative tolerances to soil salinity and depth to groundwater. 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 *Artemesia* spp. (sagebrush), but not as clayey as that occupied by *Pascopyron smithii* (western wheatgrass) (Knight 1994).

In the San Luis Valley, a large playa lake ecosystem supports the largest and most pristine example of *Sarcobatus vermiculatus* shrublands in the state. The Playas are ephemeral to perennial shallow lakes, depending on the variation in the annual precipitation (driven by snowmelt runoff). The mosaic of communities as observed by Renee Rondeau (CNHP ecologist) in 1997 is depicted below:

Moisture Gradient

Wet
Drier

Salinity Gradient

Saline
Not Saline

Salicornia spp. etlands	Scirpus pungens; Eleocharis palustris Wetlands	Distichlis spicata; Scirpus nevadensis Grasslands and Wetlands	Sporobolus airoides; Juncus balticus Grasslands and Wetlands	Sarcobatus vermiculatus /Distichlis spicata; Chrysothamnus nauseosus /Distichlis spicata; Sarcobatus vermiculatus /Juncus balticus; Chrysothamnus nauseosus /Juncus balticus; Sarcobatus vermiculatus /Sporobolus airoides; Chrysothamnus nauseosus /Sporobolus airoides Shrublands On clay soils	Sarcobatus vermiculatus /Bouteloua gracilis Shrublands	Chrysothamnus nauseosus /Bouteloua gracilis Shrublands

Sarcobatus vermiculatus (greasewood) shrublands are long lived and self perpetuating. Seedlings can survive under parent shrubs, where salinity is the highest (Knight 1994). Seeds germinate in spring when surface soils are wet with spring runoff, and the salinity is most diluted (Knight 1994).

Although characteristic of desert climates, greasewood cannot tolerate droughts, and grow only at the edges of lakes or arroyos. Greasewood has salt glands adapted for excreting excess slats, often increasing the soil salinity over time (Knight 1994).

Adjacent Riparian Vegetation: In the San Luis Valley, adjacent vegetation types are successive rings of *Distichlis spicata* (salt grass), *Juncus balticus* (arctic rush), and *Eleocharis palustris* (spikerush), in that order, between the greasewood and the open water of the playa lakes (see also diagram above).

Adjacent Upland Vegetation: None.

Management: Groundwater pumping is one of the greatest threats to the biodiversity of the Closed Basin. 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.

Table 57. Percent Cover of Plant Species in Stands of the *Sarcobatus vermiculatus/Distichlis spicata* Plant Association From the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK11	97GK15
Species name and age class/ Site and Riparian Health Rank	C	B
SHRUBS		
Chrysothamnus nauseosus (Pallas) Britton	10	
Sarcobatus vermiculatus (Hook.) Torr. In Emory	18	25
GRAMINOIDS		
Distichlis spicata (L.) Greene	29	19
Juncus balticus ssp. montanus Engelm.	8	
FORBS		
Cardaria latifolia	1	
Ipomopsis sp.	1	

USNVC:	V. B. 2. c. Seasonally/Temporally Flooded Temperate Forb Vegetation
COWARDIN:	Palustrine
CDOW GAP :	62002 Graminoid and Forb Dominated Wetland/Riparian Type b. Mountain Wetland/Riparian grassland

Marsh marigold (*Caltha leptosepala*) Saturated Herbaceous Alliance

Marsh marigold (*Caltha leptosepala*) Plant Association

CNHP Rarity Rank: G4 / S4-- This is a common association of subalpine and alpine wetlands. It is well documented throughout the Rocky Mountain states. This is a common subalpine and alpine wetland association. It is well documented throughout its range in Colorado, and many stands are within National Park and wilderness area boundaries.

General Description and Comments: The frequently seen *Caltha leptosepala* (marsh marigold) plant association occurs in the subalpine and lower alpine on perennially saturated ground. This association is often associated with shallow seeps on hillslopes. It can be recognized by the prominence of *Caltha leptosepala*, a near absence of shrubs and low cover of *Sedum rhodanthum* (pink stonecrop).

Related Literature and Synonyms: The following names are considered synonymous with the Colorado *Caltha leptosepala* plant association: the *Caltha leptosepala* plant association (Sanderson and Kettler 1996), *Caltha leptosepala* dominated stands (Padgett *et al.* 1989, Ellison 1954), the *Caltha leptosepala* dominance type (Hansen *et al.* 1988, 1995), the *Caltha leptosepala-Sedum rhodanthum* plant association (Komarkova 1986) and the *Caltha leptosepala-Deschampsia cespitosa* plant association (Sanderson and Kettler 1996, Bourgeron and Engelking 1994). Johnston (1987) describes a *Deschampsia cespitosa-Caltha leptosepala* community that maybe a either synonymous or a closely related phase of the Colorado *Caltha leptosepala* plant association.

Regional Distribution: This association occurs in Utah (Padgett *et al.* 1989, Ellison 1954), Idaho, Montana (Hansen *et al.* 1988, 1995), Wyoming (Bourgeron and Engelking 1994), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association occurs in mountainous regions throughout Colorado (Sanderson and Kettler 1996, Johnston 1987, Komarkova 1986).

The following information is based on: eleven quantitative plots; ten from the western slope (94JS09A, 94JS19C, 94JS20B, 94JS20D, 94JS40A, 94JS41B, 94JS17A, 94JS25B, 94JS28A, 94JS20C) and one from the Rio Grande and Closed Basin Watersheds (95RG50) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 9800-11500 ft. (3000-3500 m)

Site Geomorphology: This association typically occupies seeps, stream sides, springs, and wet, sub-irrigated meadows and on slopes up to 30%.

Soils: Komarkova (1986) reported this association on Cryaquepts or aquic Cryorthents, but it can also occur on peat soils.

Vegetation: A dense, conspicuous layer of *Caltha leptosepala* (marsh marigold) dominates the plant association (Table 58). Many graminoid and forbs that tolerate long-term soil saturation may also be present. *Carex aquatilis* (water sedge) is very common and is sometimes a co-dominant with *Caltha leptosepala*. *Deschampsia cespitosa* (tufted hairgrass) may be present, but in small amounts. Forbs may include *Pedicularis groenlandica* (elephant head), *Stellaria umbellata* (umbell starwort), *Swertia perennis* (star gentian), *Sedum rhodanthum* (pink stonecrop), and several others.

Successional and Ecological Processes: *Caltha leptosepala* is considered a stable community type (Padgett *et al.* 1989).

Adjacent Riparian Vegetation: In forest openings this association is found with *Salix planifolia* (planeleaf willow) shrublands and *Carex aquatilis* (water sedge) and *Senecio triangularis* (arrowleaf groundsel) meadows. On high elevation peatlands it occurs with stands of *Eleocharis quinqueflora* (spikerush) and *Salix planifolia* (planeleaf willow) shrublands.

Adjacent Upland Vegetation: This information is not available.

Management: This association receives little use by livestock due to the wet conditions and the bitter, acrid taste of the foliage (Craighead *et al.* 1965, as cited in Sanderson and Kettler 1996). Elk and deer may use this association heavily when it occurs in forest openings.

In alpine wetland areas, livestock should not be allowed to remain in any area for very long. Intensive range-riding or herding is recommended for nondestructive use by livestock in alpine areas (Thilenius 1975, 1979, as cited by Cooper *et al.* 1997). In addition, 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 regrowth and soil damage recovery (Hansen *et al*. 1995).

Table 58. Percent Cover of Plant Species in a Stand of the *Caltha leptosepala* Plant Association from the Rio Grande and Closed Basin Watershed.

Plot Number	95RG50
Species name and age class/ Site Rank	A
GRAMINOIDS	
Carex aquatilis Wahlenb.	13
Carex sp.	2
Deschampsia cespitosa (L.) Beauv.	2
Juncus drummondii E. Mey.	5
Phleum alpinum L.	1
Unknown graminoid	4
FORBS	
Caltha leptosepala var. leptosepala	35
Cardamine cordifolia Gray	11
Cirsium sp.	3
Epilobium sp.	2
Pedicularis groenlandica Retz.	3
Polygonum bistortoides	4
Potentilla sp.	2
Pseudocymopterus montanus (Gray) Coult. & Rose	9
Rumex sp.	7
Sedum rhodanthum Gray	1
Trifolium longipes ssp. pygmaeum (Gray) J. Gillett	4
Veronica wormskjoldii Roemer & J.A. Schultes	1

Cardamine cordifolia Saturated Herbaceous Alliance

Heartleaf bittercress-mountain bluebells-arrowleaf groundsel (*Cardamine cordifolia-Mertensia ciliata-Senecio triangularis*) Plant Association

CNHP Rarity Rank: G4 / S4--- This association is common in the upper subalpine and lower alpine of the Colorado Rocky Mountains. It has not been reported outside of Colorado, but is expected to occur in similar habitats in other western states. This association is found throughout its habitat in Colorado.

General Description and Comments: The generally small stands of the *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* (heartleaf bittercress-mountain bluebells-arrowleaf groundsel) plant association are found in and near running water of small streams, seeps, and springs. Associated taxa may vary greatly with this plant association, but the dominance of *Cardamine cordifolia*, *Mertensia ciliata* or *Senecio triangularis* is clear. All of these species may be present or only one of the three.

Related Literature and Synonyms: This plant association has been called by several names in the literature and all are considered synonymous with the Colorado *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* (heartleaf bittercress-mountain bells-arrowleaf groundsel**)** plant association. These communities include: the *Cardamine cordifolia/Caltha leptosepala* (heartleaf bittercress/marsh marigold) (Johnston 1987), *Epilobium angustifolium-Cardamine cordifolia* (fireweed -heartleaf bittercress) (Komarkova 1976), *Senecio triangularis-Trisetum wolfii* (arrowleaf groundsel-Wolf trisetum) (Komarkova 1986), and the *Oxypolis fenderli-Senecio triangularis* (fendler cowbane-arrowleaf groundsel) (Cooper 1993).

Similar Communities: Closely related communities include the *Senecio triangularis* (arrowleaf groundsel) community type (Hansen *et al.* 1995) and the *Mertensia ciliata* (streamside bluebells) community type (Padgett *et al.* 1989). These communities have fewer species associated with the dominants but have a similar physical setting to the Colorado *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* plant association.

Regional Distribution: This association occurs in Colorado (Johnston 1987, Komarkova 1976, Cooper 1993, Colorado Natural Heritage Program 1997) and is expected to occur throughout the western states.

Distribution in Colorado: This association occurs throughout upper subalpine areas and lower alpine areas in central and south-central Colorado (Sanderson and Kettler 1996, Johnston 1987, Komarkova 1976, Cooper 1993, Colorado Natural Heritage Program 1997).

The following information is based on: a total of twenty quantitative plots: five from the western slope (94JS03C, 94JS25A, 94JS30C, 94JS30D, 94JS25C), two from the Routt National Forest (94A526, 94A594), ten from the San Juan National Forest (93C261, 93C271, 93C442, 93C541, 94DR39, 94MS39, 94DR44, 94MS46, 95CR34, 95CR41), and three from the Rio

Grande and Closed Basins (95RG44, 95RG72, 97GK23) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 10,500-12,300 ft. (3200-3800 m).

Site Geomorphology: Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This association typically occurs on moderately steep to very steep first order streams (Rosgen's Channel Type: A2, A3), but can occur on nearly flat stream reaches as well (Rosgen's Channel Type: B2, B4). In many cases this habitat probably experiences a long period of snow cover (Sanderson and Kettler 1996).

Soils: This association is found on a variety of mineral soils that are thin and skeletal.

Vegetation: Associated taxa may vary greatly with this plant association, but the dominance of *Cardamine cordifolia*, *Mertensia ciliata* or *Senecio triangularis* is clear. All of these species may be present or only one of the three (Table 59). *Caltha leptosepala* (marsh marigold) can have up to 30% cover. Other commonly present forbs include: *Saxifraga odontoloma* (brook saxifrage), *Mitella pentandra* (fivestar miterwort), *Oxypolis fendleri* (fendler cowbane), *Delphinium barbeyi* (tall larkspur), and *Epilobium hornmannii* (willowherb).

Successional and Ecological Processes: The *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* plant association appears to be a stable community. However, with excessive grazing by sheep, it may be converted to communities dominated by various increaser species (Padgett *et al.* 1989). Hansen *et al.* (1995) suggest this type of habitat is early-seral and experiences frequent fluvial depositions, keeping any invading conifers from advancing beyond the sapling stage.

Adjacent Riparian Vegetation: This community is often the only association along the creek. *Salix planifolia* (planeleaf willow) and *Salix brachycarpa* (shortfruit willow) shrublands occur above and below, along broader, less steep reaches. Occasionally stands or this plant association are located in small openings of forested creeks, with *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests on adjacent stream banks.

Adjacent Upland Vegetation: Alpine talus, *Picea engelmannii* Krumholtz, and *Abies lasiocarpa-Picea engelmannii* forests occur on surrounding hillslopes.

Management: Perennial wet soils, steep gradients and a short growing season make this association vulnerable to heavy disturbance (Hansen *et al.* 1995). Forage value and productivity is low for this community. Excessive grazing by sheep may convert this association to one dominated by various increaser species (Padgett *et al.* 1989).

Table 59. Percent Cover of Plant Species in Stands of the *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* Plant Association from the Rio Grande and Closed Basin watersheds.

Plot Number	95RG44	95RG72	97GK23
Species name and age class/ Site Rank	B	A	A
GRAMINOIDS			
Carex aquatilis Wahlenb.			25
Carex sp.	6		
Juncus drummondii E. Mey.	3		
Poa sp.	14	2	1
Unknown graminoid	2		
FORBS			
Cardamine cordifolia Gray	16	18	7
Conioselinum scopulorum (Gray) Coult. & Rose		2	1
Epilobium sp.	6	1	
Erigeron sp.	2		
Mertensia ciliata (James ex Torr.) G. Don	1	62	48
Mimulus guttatus DC.		2	
Oxypolis fendleri (Gray) Heller	8		
Polygonum sp.			1
Potentilla sp.	1		
Ranunculus alismifolius Geyer ex Benth.	1		
Rumex sp.	2		
Saxifraga odontoloma Piper	3	1	
Sedum integrifolium ssp. integrifolium			5
Sibbaldia procumbens L.	1		
Taraxacum officinale G.H. Weber ex Wiggers	1		
Unknown forb	4		

USNVC:	V. A. 5. j. Seasonally/Temporally Flooded Temperate Grassland
COWARDIN:	Palustrine
CDOW GAP:	62002 Graminoid and Forb Dominated Wetland/Riparian Type b. Mountain Wetland/Riparian Grassland.

Carex aquatilis Herbaceous Vegetation Alliance

Water sedge (*Carex aquatilis*) Plant Association

CNHP Rarity Rank: G5 / S4 -- This is a common association that is well documented throughout the western states. This is a common association in Colorado. It is well documented throughout its range. Many stands are protected within National Park and Wilderness Area boundaries. However, many acres are improperly grazed by livestock and remain in severely degraded condition.

General Description and Comments: The *Carex aquatilis* is a common, wide spread plant association that can occur as large meadows in high montane valleys or as narrow strips bordering ponds and streams at lower elevations. It occurs in a variety of environmental settings in the montane and subalpine zones. A clear dominance by *Carex aquatilis* and low cover of *Carex utriculata* or *Pedicularis groenlandica* sets this plant association apart from closely related types.

Related Literature and Synonyms: The *Carex aquatilis* community type, plant association and habitat type described by Sanderson and Kettler (1996), Girard *et al.* (1995), Manning and Padgett (1995), Cooper and Cottrell (1990), Hansen *et al.* (1988), Padgett *et al.* (1989) and Youngblood *et al.* (1985) are synonymous with the Colorado *Carex aquatilis* plant association.

Similar Communities: Closely related associations include *Carex aquatilis-Carex utriculata* (Johnston 1987, Hess and Wasser 1982) and *Carex aquatilis-Carex utriculata-Deschampsia cespitosa* (Baker 1989). These associations are more broadly defined and may include stands of *Carex aquatilis* that would fit into the Colorado *Carex aquatilis* plant association.

Regional Distribution: This common type is widespread throughout the Rocky Mountain region. It occurs in Montana (Hansen *et al.* 1988), eastern Idaho, western Wyoming (Youngblood *et al.* 1985), Utah (Johnston 1987, Padgett *et al.* 1989), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: The *Carex aquatilis* plant association has been reported from Arapaho-Roosevelt, White River, Routt, Gunnison, and Rio Grande National Forests (Kettler and McMullen 1996, Sanderson and Kettler 1996, Kittel *et al.* 1995, Kittel *et al.* 1996, Colorado Natural Heritage Program 1997), and from Rocky Mountain National Park (Johnston 1987).

The following information is based on: a total of thirty-eight quantitative plots; nine from the San Juan National Forest (94MS30, 94MS31, 94MS32, 94DR36, 94DR46, 95CR15, 95CR33, 95CR35, 95CR47), seven from the Routt National Forest (93K021, 93K251, 93K411, 94A599, 94A609, 94R613, 94R620), ten from the Gunnison River Basin (94JS11D, 94GK14, 94JB19, 94JB21, 94JB25, 94MD35, 94RR10, 94RR33, 94RR40, 94RR45), two from the Colorado River Basin (94JS24B, 94JS34C), two from the San Miguel/Dolores River Basin (91NL58, 91NL91) and eight from the Rio Grande and Closed Basins (95RG31, 95RG35, 95RG39, 95RG65, 95RG66, 97BG05, 97BG14, 97MD19) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado 8100-11,400 ft. (2460-3500 m).

Site Geomorphology: This plant association occurs in a variety of valley types, but the largest expanses occur in broad, low-gradient valleys where large snow-melt fed swales and slopes dominate the landscape. It can also grow in fine sediments at the margins on lakes and beaver ponds. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). The largest occurrences are found adjacent to narrow, deep, sinuous streams (Rosgen's Channel Type: E4, E5, E6). Some stands occur along steep streams (Rosgen's Channel Type: A3), others along wide, shallow streams (Rosgen's Channel Type: B3), as well as where beaver dams and ponds have altered the channel morphology.

Soils: Soils are mostly deep, dark colored heavy clays, silts or organic layers over more skeletal layers. Soils are often saturated to the surface, and if not, mottling is commonly present within 10 cm of the surface.

Vegetation: This plant association is characterized by a dense rhizomatous meadow of *Carex aquatilis* (water sedge) (10-80%), usually accompanied a few other graminoids species such as *Calamagrostis canadensis* (Canadian reedgrass) (up to 40%) or *Deschampsia cespitosa* (tufted hairgrass) (up to 5%) (Table 60). *Carex utriculata* (beaked sedge) can often be present but is usually not more than 10-30% cover. A few forbs are commonly present, such as *Pedicularis groenlandica* (elephant head) (up to 1%), *Caltha leptosepala* (marsh marigold) (up to 10%), or *Epilobium* spp. (willowherb) (up to 5%).

Successional and Ecological Processes: Presence of *Carex utriculata* may indicate the site has progressed from the more wet *Carex utriculata* community to the current less mesic conditions, and may become dominated by *Salix planifolia* or *Salix wolfii* (Youngblood *et al*. 1985). Wilson (1969) reports that *Carex aquatilis* associations trap sediment from overbank flows which forms a clay pan, eventually raising the water table. This process drives retrogressive succession and a plant association dominated by *Carex utriculata* takes over on these sites (Wilson 1969).

Adjacent Riparian Vegetation: This meadow association almost always occurs in a mosaic of many riparian plant associations, including *Salix planifolia*, *Salix wolfii*, and *Salix monticola-Salix geyeriana* shrublands, and *Carex utriculata* wetlands in adjacent standing water.

Adjacent Upland Vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests, alpine fell-fields occur on adjacent hillslopes.

Management: The *Carex aquatilis* plant association occurs on soils that are typically wet throughout the growing season, and livestock grazing can often cause compaction, pitting and hummocking of the soil (Padgett *et al.* 1989). *Carex aquatilis* is highly palatable to cattle and horses and provide valuable source of forage (Youngblood *et al.* 1985). Kovalchik and Elmore (1992) suggest early-spring grazing of sedge dominated systems, with later-season rest to allow for root reserve buildup.

Overgrazing by livestock can dry the site, increase non-native grass cover, and reduce the vigor of 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 if there are adjacent willows, they are vulnerable to pruning damage due to limited regrowth before 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 aid in controlling channel down cutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophilic plants including willows and sedges. The trapping of sediment behind beaver dams, along with plant reproduction, raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity in an area versus their removal (Hansen *et al*. 1995).

Burning of this plant association temporarily increases the productivity of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge) . However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 years after burning. This is necessary in order to keep livestock from damaging young, palatable regrowth and to allow for root reserve build up. Prescribed burning is also an effective method of rejuvenating decadent clumps 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).

Table 60. Percent Cover of Plant Species in Stands of the *Carex aquatilis* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG31	95RG65	95RG66	97BG05	97BG14	97MD19	95RG35	95RG39
Species name and age class/ Site Rank	B	B	B	B	A	B	B	A
TREES								
Picea engelmannii Parry ex Engelm.--older trees						15		
GRAMINOIDS								
Calamagrostis canadensis (Michx.) Beauv.		7	3		3			
Carex aquatilis Wahlenb.	56	64	32	33	52	17	21	9
Carex canescens L.		1	6					
Carex sp.	13		15		4			11
Carex utriculata Boott	8		5			2		1
Deschampsia cespitosa (L.) Beauv.		12	11		1			
Eleocharis palustris (L.)				8		1		
Eleocharis sp.								7
Koeleria macrantha (Lebedour) Schult.				5				
Phleum alpinum L.			2			3		2
Poa pratensis L.	6		5	2		5		
Unknown graminoid	6			1				7
FORBS								
Achillea millefolium var. apicola (Rydb.) Garrett			5		1	4		
Caltha leptosepala var. leptosepala						3		2
Conioselinum scopulorum (Gray) Coult. & Rose					2	1		
Dodecatheon pulchellum (Raf.) Merr.						6		
Geum macrophyllum		2	3					
Mentha arvensis L.						1		
Mertensia ciliata (James ex Torr.) G. Don					39			
Oxypolis fendleri (Gray) Heller						3		
Polygonum bistortoides	1							3
Potentilla pulcherimma x hippiana						3		
Pseudocymopterus montanus (Gray) Coult. & Rose								6
Sedum integrifolium ssp. integrifolium				2				
Senecio sp.								3
Swertia perennis L.		2						
Taraxacum officinale G.H. Weber ex Wiggers	2		2			7		
Veronica americana Schwein. ex Benth.			1					2
Veronica wormskjoldii Roemer & J.A. Schultes			2				6	1

Water sedge-beaked sedge (*Carex aquatilis–Carex utriculata*) Plant Association

CNHP Rarity Rank: G4 / S4 -- This is a common community, well documented throughout the western states. In Colorado, over one-hundred stands have been documented and many enjoy formal protection within National Parks or Wilderness Areas.

General Description and Comments: This plant association is recognized by the presence of both *Carex aquatilis* and *Carex utriculata* in roughly equal proportions. This is a common association that generally occurs in small to moderate size patches in very shallow, slow-moving to still water or on saturated soils near low-order streams, lakes, and backwater areas of larger rivers.

Recognition and Classification Problems: There remains some question as to whether the *Carex aquatilis-Carex utriculata* plant association is a distinct type or simply an intermixing of the two *Carex aquatilis* and *Carex utriculata* plant associations (Padgett *et al.* 1989). In Colorado, while we recognize the latter two associations as clear, distinct types, there are stands where the two species are so intermingled and the environment uniform across the stand, that separating them, or calling the stand an ecotone just isn't possible. So, a third plant association, *Carex aquatilis-Carex utriculata* was developed. Further research may reveal that these mixed stands represent a transition in time between the *Carex aquatilis* and the *Carex utriculata* plant associations.

Related Literature and Synonyms: The *Carex rostrata-Carex aquatilis* community type (Girard *et al.* 1995, Komarkova 1986, as cited in Reid and Bourgeron 1994, Hess and Wasser 1982), the *Carex rostrata*-(*Carex aquatilis* phase) (Hansen *et al.* 1989) community type, the *Carex aquatilis/Carex utriculata* Johnson 1987) plant association and the *Carex utriculata-Carex aquatilis* (Cooper 1986) plant association are considered synonymous with the Colorado *Carex aquatilis-Carex utriculata* plant association. *Carex utriculata* has often been incorrectly identified as *Carex rostrata*, in Colorado (Weber 1987, Weber and Whitmann 1995). This community is listed as *Carex aquatilis-Carex rostrata* in the Terrestrial Vegetation of the U. S. Vol. II. (Anderson *et al.* 1998).

Similar Communities: The *Carex aquatilis* plant association can have some *Carex utriculata* present, but usually in amounts less than one third that of the *Carex aquatilis* cover. The *Carex utriculata* plant association can have some *Carex aquatilis* present, but usually in amounts less than one third that of the *Carex utriculata* cover (See Key to Plant Associations, page 44).

Regional Distribution: This plant association occurs in subalpine meadows throughout the Rocky Mountains including Montana (Hansen *et al*. 1989), Idaho, Utah, Wyoming (Girard *et al*. 1995) and Colorado (Johnston 1987, Komarkova 1986, as cited in Reid and Bourgeron 1994, Hess and Wasser 1982, Colorado Natural Heritage Program 1997). It also may occur in Arizona and Nevada (Bourgeron and Engelking 1994).

Distribution in Colorado: This association occurs throughout the Rocky Mountains of Colorado (Hess and Wasser 1982, Johnston 1987, Kettler and McMullen 1996, Kittel *et al*. 1994, Kittel *et al*. 1995, Komarkova 1986, as cited in Reid and Bourgeron 1994, Richard *et al*. 1996, Colorado Natural Heritage Program 1997).

The following information is based on: a total of fourteen quantitative plots; two from the White River Basin (92GK41, 92NL58), three from the Colorado River Basin (93SS24, 93RR14, 93SS32), three from the Gunnison River Basin (94GK21, 94JB41, 94MD26), three from the San Juan National Forest (93C292, 93C452, 94MS17), two from the Rio Grande River Basin (95RG20) and two from the Routt National Forest (93K243, 94A537) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado 8200-11,100 ft. (2500-3400 m).

Site Geomorphology: This plant association occurs in broad, glaciated, subalpine meadows that remain saturated with snowmelt runoff for most of the growing season. It is also often associated with beaver activity. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are narrow, deep, and sinuous (Rosgen's Channel Type: E4, E6), or wide and shallow (Rosgen's Channel Type: B2 and B4).

Soil: Soils are often thick peat or sandy clays and sandy clay loams originating from glacial till. In the Colorado River Basin, soils classify as loamy, clayey or sandy typic and cumulic Cryaquolls.

Vegetation: This plant association has relatively low species diversity due to saturated soil conditions. *Carex aquatilis* (water sedge) and *Carex utriculata* (beaked sedge) co-dominate the association with 14-70% cover (Table 61). Both species are present in equal or near equal amounts. For example, a stand with 10% cover of each *Carex* species would classify as this type, however a stand with 10% *Carex aquatilis* and 80% *Carex utriculata* would classify as a *Carex utriculata* plant association. Other forb and graminoid cover is sparse.

Successional and Ecological Processes: The difficulty in classifying mixed stands of *Carex aquatilis* and *Carex utriculata* has been discussed in the literature and attempts have been made to differentiate the types based on soil characteristics. Sanderson and Kettler (1996) note a dominance of *Carex utriculata* on organic soils and *Carex aquatilis* on mineral soils. Kittel *et al.* (1995) note the opposite trend where *Carex aquatilis* appears to occur more often on rich Histisols, while *Carex utriculata* occurs on less nutrient rich soils. Richard *et al.* (1996) note that pure stands of *Carex utriculata* tend to occur on mineral soils with some organic epipedons, a trend also noted by Padgett *et al.* (1989).

Water availability appears to be a stronger factor in determining relative dominance of these two sedge species. *Carex utriculata* appears to tolerate standing water and may be a pioneering species since it readily establishes on exposed, saturated mineral soil (Padgett *et al.* 1989, Hansen *et al.* 1988). In Colorado, *Carex utriculata* occurs more often in standing water and often grades into a mesic terrestrial habitat where *Carex aquatilis* is commonly dominant. The *Carex aquatilis*-*Carex utriculata* plant association may, therefore, represent a spatial transition between a wet *Carex utriculata* association and a mesic *Carex aquatilis* association.

Adjacent riparian vegetation: This plant association commonly part of a riparian or wetland mosaic, intermixing with pure stands of *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge), and *Juncus balticus* (Baltic rush) or *Salix planifolia* (planeleaf willow), *Salix* *brachycarpa* (barrenground willow), *Salix wolfii* (Wolf willow), *Salix boothii* (Booth willow), or *Salix geyeriana* (Geyer willow) shrublands. *Deschampsia cespitosa* (tufted hairgrass) grasslands often occur on drier margins and *Veratrum tenuipetalum* (Colorado false hellebore) patches often occur on moist toe-slope seeps.

Adjacent upslope vegetation: *Abies lasiocarpa*-*Picea engelmannii* (subalpine fir-Engelmann spruce) and *Pinus contorta* (lodgepole pine) forests and *Artemisia tridentata* (big sagebrush) shrublands occur on adjacent hillslopes.

Management: Palatable *Carex* (sedge) species can be heavily utilized by livestock in 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 native species root structure that can 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 regrowth. Late summer and fall grazing is not recommended if there are adjacent willow shrublands, as 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 create a high water table, abate channel down cutting, bank erosion, and movement of sediment by slowing the stream flow and reducing stream gradients. Beaver dams raise the water table across the floodplain and provided year-round saturated soils. Plant establishment and sediment build-up behind beaver dams raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity rather than removing them (Hansen *et al*. 1995).

Burning of this plant association temporarily increases the productivity of *Carex aquatilis* (aquatic sedge) and *Carex utriculata* (beaked sedge). However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 years after to prevent livestock from damaging young, palatable regrowth and to allow for root reserve build up (Hansen *et al*. 1995).

Carex aquatilis and *Carex utriculata* (beaked sedge) are effective stream bank stabilizers due to their rhizomatous root growth. They tend to form a dense, thick sod that is highly resistant to erosion (Hansen *et al*. 1995).

Table 61. Percent Cover of Plant Species in a Stand of the *Carex aquatilis-Carex utriculata* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG20
Species name and age class/ Site Rank	C
GRAMINOIDS	
Carex aquatilis Wahlenb.	14
Carex microptera Mackenzie	1
Carex nebrascensis Dewey	
Carex simulata Mack.	
Carex utriculata Boott	15
Eleocharis sp.	6
Juncus balticus ssp. montanus Engelm.	7
Poa pratensis L.	11
FORBS	
Achillea millefolium var. apicola (Rydb.) Garrett	2
Argentina anserina (L.) Rydb.	8
Taraxacum officinale G.H. Weber ex Wiggers	3
Thermopsis rhombifolia var. montana (Nutt.) Isely	2
HORESTAILS	
Equisetum arvense L.	

Carex lanuginosa Seasonally Flooded Herbaceous Alliance

Woolly sedge (*Carex lanuginosa*) Plant Association

CNHP Rarity Rank: G3? / S3-- This community is documented from Oregon east to South Dakota and Montana south to Colorado and Kansas. 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, and no stands are formally protected. The question mark in the global rank indicates there are probably more occurrences of this community then are currently documented.

General Description and Comments: *Carex lanuginosa* (woolly sedge) is a distinctive wetland-indicator sedge that forms small- to medium sized meadows. It occurs in depressions and swales at the saturated edge of stream channels or in standing water. On the eastern plains of Colorado, it can occur under the canopy of cottonwood trees, forming the *Populus deltoides* subsp. *monilifera/Carex lanuginosa* (plains cottonwood/wooly sedge) plant association.

Related Literature and Synonyms: The *Carex lanuginosa* community types documented from Montana (Hansen *et al*. 1988, Hansen *et al*. 1991), Idaho, Oregon, and Utah (Bourgeron and Engelking 1994) are synonymous with the Colorado *Carex lanuginosa* plant association.

Similar Communities: Closely related communities include two *Carex lanuginosa-Scirpus* spp. (wooly sedge-bulrush) plant associations and the *Carex lanuginosa-Spartina pectinata* (wooly sedge-prairie cordgrass) plant association reported from North and South Dakota, Nebraska, and Kansas (Midwest Heritage Task Force 1994).

Regional Distribution: This plant association occurs in North and South Dakota, Nebraska, Kansas (Midwest Heritage Task Force 1994), Montana (Hansen *et al*. 1988, Hansen *et al*. 1991), Oregon, Utah, Idaho, and Colorado (Kovalchik 1987, Bourgeron and Engelking 1994, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is documented from the Gunnison (Kittel *et al*. 1995), South Platte (Kittel *et al*. 1996, Kittel *et al*. 1997), and Rio Grande River Basins (Colorado Natural Heritage Program 1997).

The following information is based on: a total of three quantitative plots: one from the Gunnison River Basin (94JB38), one from the South Platte River Basin (95LS13) and one from the Rio Grande River Basin (97MD20) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5000-7400 ft (1500-2300 m).

Site Geomorphology: This plant association occurs in very wet conditions, generally at the saturated edge of the stream channel or in standing water. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are sinuous with a moderate gradient (Rosgen's Channel Type: C4, C6).

Soils: Soils are deep silt loams to clays. Mottling often occurs throughout the profile.

Vegetation: This plant association is characterized by a nearly monotypic stand of 40-90% cover of *Carex lanuginosa* (woolly sedge) (Table 63). Other graminoid cover is minor, but includes up to 10% cover of *Phalaroides arundinacea* (reed canarygrass) and up to 5% cover each of *Carex nebrascensis* (Nebraska sedge) and *Scirpus pungens* (threesquare bulrush). Scattered forbs include up to 10% cover of *Mentha arvense* (wild mint) and up to 5% cover of *Cirsium arvense* (Canadian thistle).

Successional and Ecological Processes: The Carex lanuginosa (wooly sedge) plant association appears to be a fairly stable community because of its 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 lanuginosa* 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.

Adjacent Riparian Vegetation: Stands of *Salix amygdaloides* (peach leaf willow) and *Populus angustifolia* (narrowleaf cottonwood) woodlands occur along foothill streams. *Populus deltoides* (plains cottonwood) woodlands occur along streams on the eastern plains.

Adjacent Upland Vegetation: Along foothill tributaries, adjacent hill slopes have *Pinus ponderosa* (ponderosa pine) forests. Along eastern plains streams, adjacent hill slopes have *Bouteloua gracilis* (blue grama) shortgrass prairies.

Management: *Carex lanuginosa* (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 lanuginosa* is an effective stream bank stabilizer and is resistant to fire damage (Hansen *et al.* 1988).

The Stand Table for *Carex lanuginosa* (wooly sedge) follows the *Carex simulata* (slender sedge) Plant Association discussion.

Carex nebrascensis Seasonal Flooded Herbaceous Alliance

Nebraska sedge (*Carex nebrascensis*) Plant Association

CNHP Rarity Rank: G4 / S3 --This is a common community documented from many western states. In Colorado, this is a common but declining association. It is threatened by improper livestock grazing, stream flow alterations and heavy recreational use.

General Description and Comments: *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 on the plains. The soils are generally saturated for much of the growing season and are subject to compaction by livestock.

Related Literature and Synonyms: The *Carex nebrascensis* (Nebraska sedge) community types from 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), Colorado (Cooper and Cottrell 1990, Colorado Natural Heritage Program 1997), and New Mexico (Durkin *et al.* 1994, Durkin *et al.* 1995, Bourgeron and Engelking 1994) are synonymous with the Colorado *Carex nebrascensis* plant association.

The *Carex nebrascensis/Deschampsia cespitosa* (Nebraska sedge/tufted hairgrass) plant association documented from Wyoming and Idaho (Johnston 1987) and the *Carex nebrascensis/Catabrosa aquatica-Juncus arcticus* (Nebraska sedge/water whorlgrass-arctic sedge) plant association documented from Colorado are also considered synonymous with the Colorado *Carex nebrascensis* plant association.

Regional 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, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa River Basin (Kittel and Lederer 1993), the White and Colorado River Basins (Kittel *et al.* 1994), the South Platte River Basin (Baker 1982, as cited in Johnston 1987, Cooper and Cottrell 1990, Kittel *et al*. 1996, Kittel *et al*. 1997), and the San Luis Valley (Colorado Natural Heritage Program 1997).

The following information is based on: a total of ten quantitative plots; three from the Yampa River Basin (90MR05, 90MR40, 90MR84), one from the White River Basin (92GK26), one from the Colorado River Basin (93RR11), one from the Rio Grande River Basin (97BG24), and four from the South Platte River Basin (95LS01, 95LS05, 95GK02, 95GK03) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 4100-7900 ft (1200-2400 m).

Site Geomorphology: This plant association appears to be restricted to saturated soils of flat floodplains bordering ponds or pools adjacent to stream channels. It can also occur along flat, marshy areas surrounding springs. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are low-gradient (0.5-0.75%), moderately narrow, and sinuous (Rosgen's Channel Type: C6, F6) or very narrow and sinuous (Rosgen's Channel Type: E6).

Soils: Soils are heavy clays and silty clay loams with high organic matter content. Anoxic conditions often occur within 8 inches (20 cm) of the surface either in the form of a gleyed layer or abundant mottling.

Vegetation: This plant association is dominated by 30-80% cover of *Carex nebrascensis* (Nebraska sedge) (Table 62). Other graminoids include up to 40% cover of *Eleocharis palustris* (common spikerush), up to 30% cover of *Carex praegracilis* (clustered field sedge), and up to 10% cover of *Scirpus pungens* (threesquare bulrush). Forb cover is generally low and includes up to 10% cover of *Ranunculus cymbalaria* (buttercup) and up to 15% cover of *Melilotus officinalis* (sweetclover). *Potamogeton* sp. (pondweed) is abundant in one occurrence with 35% cover.

Successional and Ecological Processes: In Montana, the *Carex nebrascensis* (Nebraska sedge) 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.

Adjacent Riparian Vegetation: *Populus angustifolia* (narrowleaf cottonwood) forests, *Salix exigua* (coyote willow), *Salix lasiandra* var. *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: *Pinus edulis-Juniperus* spp. (pinyon pine-juniper) and *Quercus gambelii* (Gambel oak) woodlands, *Sarcobatus vermiculatus* (greasewood) and *Artemisia tridentata* (big sagebrush) shrublands, and *Bouteloua gracilis* (blue grama) short-grass prairies occur on adjacent hill slopes.

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 withstand 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, such that less damage occurs with spring and summer grazing on this association (Dean Erhard, Forest Ecologist, *pers. comm.*).

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 should consider maintaining beaver activity 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* (Hansen *et al*. 1995).

Table 62. Percent Cover of Plant Species in a Stand of the *Carex nebrascensis* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97MD18	97BG24
Species name and age class/ Site and Riparian Health Rank	B	B
GRAMINOIDS		
Calamagrostis stricta (Timm) Koeler		1
Carex nebrascensis Dewey	35	66
Carex simulata Mack.	4	
Carex sp.		9
Carex utriculata Boott	25	
Juncus balticus ssp. montanus Engelm.	8	1
Poa pratensis L.	6	
Unknown graminoid		9
FORBS		
Epilobium hornmannii Haussknecht		1
Epilobium leptophyllum Rafinesque		1
Galium trifidum L.		1
Lactuca serriola L.		1
HORESTAILS		
Equisetum arvense L.	1	

Carex simulata Saturated Herbaceous Alliance

Analogue sedge (*Carex simulata*) Plant Association

CNHP Rarity rank: G4 / S2—This association is widespread in the Pacific Northwest, but is known from only 5-10 stands in Colorado.

General Description and Comments: *Carex simulata* (analogue sedge) is found only on quaking fens in Colorado. It is commonly found with many other sedge species, but its presence is associated with deep organic soils and a perennially high water table.

Related Literature and Synonyms: The *Carex simulata* community has been well described and documented outside of Colorado. It is described from Idaho (Tuhy and Jensen 1982), Utah (Youngblood *et al*. 1985 and Padgett *et al.* 1989), Montana (Hansen *et al*. 1989), Oregon (Kovalchik 1987) and California (Nachlinger 1985).

Similar Communities: Stands dominated by *Carex aquatilis*, *Carex nebrascensis*, or *Carex utriculata* with no *Carex simulata* present would not belong to the *Carex simulata* Plant Association.

Regional Distribution: This association is known from Idaho, Montana, Nevada, Oregon, Utah, Wyoming and Colorado, and may possibly occur in California (Anderson *et al*. 1998).

Colorado Distribution: *Carex simulata* fens are known from Larimer County south to the San Luis Valley, more or less restricted to the high mountain valleys in the central part of the state.

Elevation Range in Colorado: 7900-9560 ft. (2400-2900 m).

Site Geomorphology: This community is located on saturated organic soils in moderate to wide valleys (250 ft to >1 mile). The surface of the ground is hummocky, and "quakes" when walked or jumped on. Stream channels were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Streams are low gradient and highly sinuous (Rosgen Channel Type: E4) to broader, slightly more steep streams (Rosgen channel Type: B3).

Soils: Soils are deep, dark brown to black, 100% organic peat, saturated to the surface. Water tables in two sampled pits rose to 45 and 9 cm of the surface, respectively

The following information is based on: total of three quantitative plots from the Rio Grande and Closed Basin Watersheds (97EV32, 97GK18, 97GK19) (Colorado Natural Heritage Program 1997).

Vegetation: Grasses and grass-like plants cover the ground entirely (90-100%), with *Carex simulata* (analogue sedge) (10-30%), *Carex aquatilis* (water sedge) (up to 50%), *Carex utriculata* (beaked sedge) (up to 45%), *Carex nebrascensis* (Nebraska sedge) (up to 1%), *Juncus balticus* (arctic rush) up to 28% and others (Table 64). A variety of forbs may be inconspicuously present (total cover >10%). Shrub cover is usually absent , but if present then stunted in height. Shrub species that can be present include *Salix geyeriana* (Geyer willow), *Salix monticola* (Rocky mountain willow), and *Pentaphylloides floribunda*(shrubby cinqfoil).

Successional and Ecological Processes: Groundwater pumping is one of the greatest threats to the biodiversity of the Closed Basin. 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 waterbirds, amphibians, or invertebrates may be affected by even brief fluctuations in wetland hydrology.

Adjacent Riparian Vegetation: Concentric rings or a mosaic of patches of other herbaceous wetland types can be adjacent and intermixed with *Carex simulata* (analogue sedge) fens, for example *Carex utriculata* (beaked sedge) , *Juncus balticus* (arctic rush), and *Carex nebrascensis* (Nebraska sedge), as well as shrublands of *Salix geyeriana* (Geyer willow) and forests of *Populus tremuloides* (quaking aspen).

Adjacent Upland Vegetation: Surrounding slopes can have *Picea pungens* (Colorado blue spruce) forests, Pinyon-pine and Juniper woodlands, or drier grasslands.

Management: 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. Management of the valley bottom sites presented in this report will require, therefore, not only local protection of on-site wetland elements, but secure water resources and greater understanding of how current and anticipated water uses within the watershed will affect the wetlands. For an accurate assessment of the risks to Closed Basin biodiversity posed by water development, further quantitative research linking hydrology, vegetation, and wetland fauna is imperative.

Table 63. Percent Cover of Plant Species in Stands of the *Carex lanuginosa* and *Carex simulata* Plant Associations from the Rio Grande and Closed Basin Watersheds.

Plant Association	Carex lanuginosa	Carex simulata		
Plot Number	97MD20	97EV32	97GK18	97GK19
Species name and age class/ Site Rank	C	A	A	C
SHRUBS				
Salix geyeriana Anderss.		18		
GRAMINOIDS				
Carex aquatilis Wahlenb.			47	46
Carex lanuginosa Michx.	91		1	
Carex nebrascensis Dewey			1	1
Carex simulata Mack.		30	21	10
Carex sp.	1	4		
Carex utriculata Boott		38		45
Deschampsia cespitosa (L.) Beauv.		5	1	2
Eleocharis palustris (L.)	2	7		1
Juncus balticus ssp. montanus Engelm.		3	28	
FORBS				
Mentha arvensis L.	13			2
Thalictrum alpinum L.		5		
Unknown forb	1	2		

Carex utriculata Seasonally Flooded Herbaceous Alliance

Beaked sedge (*Carex utriculata*) Plant Association

CNHP Rarity Rank: G5 / S4-- This association is well documented throughout the western states. This association is well documented throughout its habitat in Colorado.

General Description and Comments: The *Carex utriculata* (beaked sedge) plant association is a common wet meadow community that occurs around the edges of montane lakes and beaver ponds, along the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains. The water table is usually near the surface for most of the growing season.

Recognition and Classification Problems: *Carex utriculata* has been incorrectly identified as *Carex rostrata* in previous Colorado literature (Weber and Whitman 1992).

Related Literature and Synonyms: The *Carex rostrata* community types from Oregon (Kovalchik 1987), Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), Montana (Hansen *et al.* 1995), Idaho, Wyoming (Youngblood *et al.* 1985, Girard *et al.* 1995) and Colorado (Cooper and Cottrell 1990) are synonymous with the Colorado *Carex utriculata* plant association. This association is listed as *Carex rostrata* in the Terrestrial Vegetation of the U.S. Vol. II. (Anderson et al. 1998).

Similar Communities: Closely related communities are more broadly defined, and probably contain stands that would match the Colorado *Carex utriculata* plant association. These closely related communities include: the *Carex rostrata-Carex aquatilis* (Hess and Wasser 1982), the *Carex aquatilis-Carex utriculata-Carex utriculata* Phase (Johnston 1987), and the *Carex aquatilis-Carex rostrata-Deschampsia cespitosa* (Baker 1989) plant association.

Regional Distribution: This plant association occurs in Oregon (Kovalchik 1987), Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), Idaho, Wyoming (Youngblood *et al.* 1985, Jones and Walford 1995), Montana (Hansen et al. 1995), and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in Rocky Mountain National Park, the Roosevelt, Arapaho, White River, Routt, Gunnison and San Juan National Forests, (Johnston 1987, Kettler and McMullen 1996, Richard *et al.* 1996), and the Yampa, San Miguel/Dolores (Kittel and Lederer 1993), White, Colorado (Kittel *et al.* 1994), Gunnison (Kittel *et al.* 1995), Arkansas (Kittel *et al.* 1996), South Platte River Basins (Kittel *et al.* 1997) and the Rio Grande and Closed Basins (Colorado Natural Heritage Program 1997).

The following information is based on: twenty-one quantitative plots: six from the Routt National Forest (93K051, 93K111, 93K131, 93K203, 93K302, 94R596), four from the Gunnison River Basin (94GK19, 94JB28, 94JB49, 94RR36), three from the San Miguel/Dolores River Basin (91NL17, 91NL34, 91NL87), six from the San Juan National Forest (93C163, 93C222, 93C562, 94DR07, 94MS15, 94MS07), and three from the Rio Grande and Closed Basins (95RG74, 95RG77, 97EV13) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 7500-9600 ft (2300-2900 m).

Site Geomorphology: *Carex utriculata* (beaked sedge) grows in standing water or saturated soils of wet swales and overflow channels along low-gradient streams. It also occurs along the margins of lakes and beaver ponds. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and slightly sinuous (Rosgen's Channel Type: B5 and B6).

Soils: Soils are saturated organics or fine silty clays to clays over cobbles and alluvium. Mottling often occurs within a few centimeters of the surface. In the Colorado River Basin, the soils classify as very-fine clayey to loamy skeletal calcareous Cumulic or Typic Cryaquolls, Aquepts, fine-loamy and sandy-skeletal Typic Cryaquents, and Histic Cryaquepts.

Vegetation: This plant association is characterized by nearly pure stands of *Carex utriculata* (beaked sedge) (20-98%) (Table 64). Graminoids dominate the herbaceous layer and can be quite diverse. Other *Carex* (sedge) species present include *C. lenticularis* and *C. microptera* (small-wing sedge), but usually with low cover (<30%). Other graminoid species present are *Glyceria striata* (fowl mannagrass), *Calamagrostis canadensis* (Canadian reedgrass), and *Juncus balticus* (mountain rush). Forb cover is low (<10%). Willow carrs (shrublands) are often adjacent and a few scattered willows will occur within the *Carex utriculata* (beaked sedge) stand, such as *Salix monticola* (mountain willow), *Salix drummondiana* (Drummond willow), *S. geyeriana* (Geyer willow) or *S. planifolia* (planeleaf willow). See Table 64 for Rio Grande and Closed Basin specific data.

Successional and Ecological Processes: The *Carex utriculata* plant association occurs on the wettest sites of the riparian or wetland area, such as low-lying swales, and shallow margins of lakes and ponds, often in standing water. It is an early-seral community and is known to invade margins of newly formed beaver ponds, as well as the freshly exposed silt beds of drained beaver ponds (Padgett *et al.* 1989). With time, the *Carex utriculata* plant association will grade into a *Carex aquatilis* and *Calamagrostis canadensis* associations. *Calamagrostis canadensis* dominates the driest sites with the lowest water tables and colonizes drying stands of *Carex utriculata* and *C. aquatilis* (Cooper 1986).

Successional shifts in species composition can be initiated by a change in the physical environment of the riparian area. Flooding events can result in sediments deposited on the floodplain, raising the surface higher above the water table (Cooper 1986). As aggradation, or build up, of the floodplain proceeds, the site can become drier and the dominant graminoid cover changes.

Abandoned beaver ponds also go through a similar succession. With time, ponds become silted-in and *Carex utriculata* establishes on the new, saturated substrate. As the site becomes firm and raised above the old pond level, *Carex aquatilis* and willows may become established. With further aggradation and time *Calamagrostis canadensis* may become established in the

undergrowth. Depending on site characteristics, various willow species may become established in the overstory as well, creating the *Salix monticola/Carex utriculata* plant association and the *Salix geyeriana/Calamagrostis canadensis* plant association, for example.
Distance from the stream channel can also differentiate the graminoid dominance spatially within the riparian mosaic. *Carex utriculata* commonly occurs at the stream channel edge where the water table is close to or at the ground surface. As the floodplain surface becomes higher with increased distance from the channel edge, the ground becomes slightly less saturated and shifts to mesic meadows of *Carex aquatilis*, or on higher surfaces, to slightly drier meadows of *Calamagrostis canadensis* (Kittel 1994).

Adjacent Riparian Vegetation: This association is often part of a wetland mosaic, with *Salix monticola, Salix drummondiana,* and *Salix geyeriana* shrublands. It also occurs adjacent to and intergrades with *Carex aquatilis* or *Eleocharis palustris* meadows. *Populus angustifolia-Picea pungens, Populus angustifolia* and *Picea pungens* riparian forests occur on adjacent stream terraces in narrower valleys.

Adjacent Upland Vegetation: *Abies lasiocarpa-Picea engelmannii* forests, *Populus tremuloides* woodlands at higher elevations; *Pinus ponderosa* and *Populus tremuloides* forests and *Quercus gambelii* shrublands occur on adjacent hillslopes at lower elevations.

Management: *Carex utriculata* generally occupies the wettest habitats in the riparian area. The soils are highly susceptible to compaction and churning. Heavy use by livestock can dry the site, increase non-native grass cover, and reduce the vigor of willow root structure. However, *Carex utriculata* has a low palatable, especially late in the season (Herman 1970). 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 adjacent willow individuals are vulnerable to pruning damage due to limited regrowth before 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 aid in controlling channel down cutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophilic plants including willows and sedges. The trapping of sediment behind beaver dams, along with plant reproduction, raises the channel bed and creates a wetland environment. Land managers should consider maintaining beaver activity in an area versus their removal (Hansen *et al*. 1995).

Burning of this plant association temporarily increases the productivity of *Carex utriculata* (beaked sedge) and *Carex aquatilis* (aquatic sedge) . However, livestock grazing needs to be eliminated for the year prior to burning and for at least 2-3 years after burning. This is necessary in order to keep livestock from consuming young, palatable regrowth. Prescribed burning is also an effective method of rejuvenating decadent clumps 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).

Table 64. Percent Cover of Plant Species in Stands of the *Carex utriculata* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG74	95RG77	97EV13
Species name and age class/ Site Rank	A	A	A
GRAMINOIDS			
Calamagrostis canadensis (Michx.) Beauv.	15	1	1
Carex aquatilis Wahlenb.	20		
Carex sp.			6
Carex utriculata Boott	44	72	32
Deschampsia cespitosa (L.) Beauv.	1		6
Juncus balticus ssp. montanus Engelm.			6
FORBS			
Mentha arvensis L.			11
Potentilla pulcherimma x hippiana			6
Pseudostellaria jamesiana	1		
Rumex sp.			4

Tufted hairgrass (*Deschampsia cespitosa*) Alliance

Tufted hairgrass (*Deschampsia cespitosa*) Plant Association

CNHP Rarity Rank: G4?/ S4--This is a common association that is well documented throughout its range. This is a common association in Colorado, however few pristine stands have been documented. It is highly threatened by improper livestock grazing, invasion by non-native species, and reduced fire frequency. The question mark in the global rank indicates there are probably more occurrences than currently documented.

General Description and Comments: This dense, bunch-grass meadow occurs in broad, nearly flat, valley bottoms in openings of willow carrs and coniferous forests in subalpine regions across Colorado. It is characterized by a dense sward of *Deschampsia cespitosa* (tufted hairgrass) and minor cover of other graminoids and forbs. Drier phases of this association grows on gentle slopes above the valley floor.

Related Literature and Synonyms: 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 SCS 1978, as cited in Johnston 1987); 5) *Deschampsia cespitosa-Caltha leptosepala* (tufted hairgrass-marsh marigold) from Colorado (Johnston 1987, Sanderson and Kettler 1996) and Montana (Cooper *et al.* 1997); 6) *Deschampsia cespitosa-Mertensia ciliata* (tufted hairgrass-mountain bluebells) from Colorado (Colorado Natural Heritage Program 1997); 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.

Regional Distribution: This plant association occurs in Oregon, Washington (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, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant 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, Colorado Natural Heritage Program 1997).

The following information is based on: a total of fifteen quantitative plots; eight from the Routt National Forest (102, 132, 382, 571, 573, 574, 576, 577), one from the White River Basin (92GK52), two from the Colorado River Basin (JS94-27B, JS94-39B), two from the San Juan National Forest (74, 183) and one from the Rio Grande Basin (95RG61) (Colorado Natural Heritage Program 1996).

Elevation Range in Colorado: 9000-11,000 ft (2800-3300 m).

Site Geomorphology: This meadow plant association generally occurs in broad, glaciated valleys on well-drained ridges and hummocks adjacent to low to moderate gradient streams. It occurs on sites with a moderately high water table (indicated by the presence of mottles or gleying in the soil at a depth of 8 in, 20 cm) and other environmental conditions similar to the *Carex aquatilis* (water sedge) and *Carex utriculata* (beaked sedge) plant associations. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are wide and moderately sinuous (Rosgen's Channel Type: C4) or narrow and highly sinuous (Rosgen's Channel Type: E6).

Soils: Soils are 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) depth.

Vegetation: This plant association is characterized by a dense stand of 20-70% cover of *Deschampsia cespitosa* (tufted hairgrass) (Table 65). Other graminoids include up to 50% cover of *Carex aquatilis* (water sedge) and up to 20% cover each of *Carex utriculata* (beaked sedge) and *Calamagrostis canadensis* (bluejoint reedgrass). Forb cover is generally low with *Caltha leptosepala* almost always present with up to 45% cover. Other forb cover is minor. Occasionally, a few shrub stems from adjacent stands occur within this association, including *Pentaphylloides floribunda* (shrubby cinquefoil), *Salix planifolia* (planeleaf willow), and *Salix brachycarpa* (barrenground willow).

Successional and Ecological Processes: The *Deschampsia cespitosa* (tufted hairgrass) 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 *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* (mountain rush), or non-native invader species such as *Poa pratensis* (Kentucky bluegrass), and *Taraxacum officinale* (dandelion) in this plant association 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).

Sheep grazing in the alpine areas of Montana appear to increase the abundance of *Poa pratensis* (Kentucky bluegrass) and *Juncus balticus* (mountain rush) in moist and wet sites, indicating these areas are most susceptible to alteration of species composition from grazing (Cooper *et al.* 1997).

Adjacent Riparian Vegetation: Adjacent riparian vegetation includes *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge), *Eleocharis palustris* (common spikerush), and *Calamagrostis canadensis* (bluejoint reedgrass) wet meadows, and *Salix planifolia* (planeleaf willow), *Salix wolfii* (Wolf willow), *Salix brachycarpa* (barrenground willow), and *Betula glandulosa* (bog birch) shrublands.

Adjacent Upland Vegetation: *Abies lasiocarpa*-*Picea engelmannii* (subalpine fir-Engelmann spruce) forests occur on adjacent hillslopes.

Management: *Deschampsia cespitosa* (tufted hairgrass) 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, *personnel communication*). On the Rio Grande National Forest, *Deschampsia cespitosa* (tufted hairgrass) has been observed to increase for a time under moderate to heavy grazing, but then become reduced and eventually replaced by *Poa pratensis* (Kentucky bluegrass) (Dean Erhard, Forest Ecologist, *personnel communication*).

Deschampsia cespitosa is relatively resistant to fire. However, with repeated burning, rhizomatous species such as *Poa pratensis* (Kentucky bluegrass) may be favored. Livestock grazing should be deferred immediately after burning in order to protect the young, palatable regrowth (Hansen *et al*. 1995).

The typically wet soils of this plant association are easily compacted by vehicles and livestock use (Padgett *et al*. 1989). *Deschampsia cespitosa* is not very useful as a stream bank stabilizer due to its fibrous root structure. However, this is a useful species for revegetation and mine reclamation efforts (Hansen *et al*. 1995).

Table 65. Percent Cover of Plant Species in a Stand of the *Deschampsia cespitosa* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG61
Species name and age class/ Site Rank	B
GRAMINOIDS	
Agrostis sp.	2
Calamagrostis canadensis (Michx.) Beauv.	9
Carex aquatilis Wahlenb.	22
Carex brunnescens (Pers.) Poir.	1
Carex sp.	9
Deschampsia cespitosa (L.) Beauv.	27
Phleum alpinum L.	11
Poa pratensis L.	1
FORBS	
Caltha leptosepala var. leptosepala	13
Cardamine cordifolia Gray	3
Conioselinum scopulorum (Gray) Coult. & Rose	3
Epilobium sp.	1
Pedicularis groenlandica Retz.	1
Polygonum bistortoides	2
Polygonum viviparum L.	1
Potentilla sp.	1
Pseudocymopterus montanus (Gray) Coult. & Rose	3
Stellaria sp.	1
Taraxacum officinale G.H. Weber ex Wiggers	1
Veronica wormskjoldii Roemer & J.A. Schultes	1
Viola sp.	1

Eleocharis palustris Seasonally Flooded Herbaceous Alliance

Creeping spikerush (*Eleocharis palustris*) Plant Association

CNHP Rarity Rank: G5 / S4 -- This association is known throughout the western states. This association is a common, if small, component of many streams in Colorado.

General Description and Comments: The *Eleocharis palustris* (creeping spikerush) plant association is a conspicuous, common emergent association that occurs in shallow, mostly still water. Most of the sites where it occurs experience water levels that fluctuate to some degree throughout the growing season. It is recognized by the clear dominance, although sometimes sparse cover, of *Eleocharis palustris*.

Related Literature and Synonyms: The *Eleocharis palustris* (creeping spikerush) plant association is described by several authors and all are considered synonymous with the Colorado *Eleocharis palustris* plant association. These communities include: the *Eleocharis palustris* plant association described from Colorado, New Mexico, Utah, Wyoming and Idaho (Kittel and Lederer 1993, Cooper 1993, Cooper and Severn 1992, Durkin *et al.* 1995, Johnston 1987, Padgett *et al.* 1989, Youngblood *et al.* 1985), and the *Eleocharis palustris* association from central Oregon (Kovalchik 1987).

Regional Distribution: The *Eleocharis palustris* (creeping spikerush) plant association occurs in Oregon (Kovalchik 1987), Idaho, Wyoming (Youngblood *et al.* 1985), Montana (Hansen *et al.* 1995), Utah (Padgett *et al.* 1989), New Mexico (Durkin *et al.* 1995) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: The *Eleocharis palustris* plant association is common throughout the state and is documented to occur in the Yampa and San Miguel River Basins (Kittel and Lederer 1993), Routt and San Juan National Forests (Kettler and McMullen 1992, Richard *et al.* 1996), near Crested Butte (Cooper 1993) and in the Rio Grande and Closed Basins (Cooper and Severn 1992, Colorado Natural Heritage Program 1997).

The following information is based on: a total of fifteen quantitative plots; four from the western slope (94JS11C, 94JS15A, 94JS15B, 94JS38E), two from Routt National Forest (564, 569), one from the Yampa River Basin (24), one from the San Miguel/Dolores River Basins (65), four from San Juan National Forest (65, 66, 89, 169), one from the Rio Grande and Closed Basins (97GK13), and two from the Republic River Basin (95LS23, 95LS24) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5500-10,000 ft (1700-3050 m).

Site Geomorphology: This association occurs on wet sand bars and on finer substrates in backwater areas within the stream channel at low elevations. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This association usually occurs along narrow, sinuous (Rosgen's Channel Type: E3, E4) headwater rivulets where ground water flow is lateral, primarily fed from toe slope seeps.

Soils: High elevation stands consistently occur on organic (highly sapric) soils, or on a thick organic horizon that overlays fine to coarse alluvial material. Lower elevation stands occur on fresh alluvial deposits of fine-textured loamy sands, clays, and sandy clays. Two samples from the Arikaree River had considerable organic content in the upper 4-8 in. (10-20 cm).

Vegetation: *Eleocharis palustris* (creeping spikerush) can be very open with a sparse cover to quite dense, but is always the dominant species (10-80%). Because the *Eleocharis palustris* plant association occurs within a wide elevational range, the species composition can be quite variable. On the western slope in low elevation stands, co-occurring species include: *Phalaroides arundinacea* (common reed), *Juncus balticus* (mountain rush) and *Scirpus americanus* (threesquare bulrush) as well as the introduced *Melilotus officinale* (sweet clover) and *Bromus inermis* (smooth brome). Forb cover can also include: *Sparganium angustifolium* (narrowleaf bur-reed), *Lemna* spp. (duckweed) and *Potamogeton* spp. (pondweed). On the eastern plains, co-occurring species include: *Leersia oryzoides* (rice cutgrass) (15-40%), *Scirpus pungens* (bulrush) (20-30%), *Panicum virgatum* (switchgrass) (10-15%), *Carex lanuginosa* (wooly sedge) (10%), and *Spartina pectinata* (prairie cordgrass) (up to 10%). See Table 66 for additional Rio Grande and Closed Basin data.

At higher, montane elevations other graminoids present include: *Carex aquatilis* (water sedge), *Carex utriculata* (beaked sedge), and *Deschampsia cespitosa* (tufted hairgrass), with 0 to 10% cover each. Forb cover is typically low, but can be high up to 30% in some stands. Common forb species include: *Pedicularis groenlandica* (elephant head), *Rhodiola integrifolia* (king's crown), and *Caltha leptosepala* (marsh marigold).

Successional and Ecological Processes: At lower elevations the *Eleocharis palustris* plant association occurs well within the active channel and is inundated annually. This early seral community colonizes backwater eddies and shallow edges of slow moving reaches of small and larger rivers. It is probably an ephemeral community, scoured out each year during high spring flows. This association has been described as an early seral stage by Padgett *et al.* (1989). They describe light colored soils for the sites, indicating an early phase of soil development. At montane elevations, this association occurs in ponded sites on faster moving streams. If siltation occurs, sites may become dominated by *Carex utriculata* (beaked sedge). At higher elevations, this association appears to be stable. It occurs near seeps on soils with deep organic layers, often sapric, and saturated throughout the growing season.

Adjacent Riparian Vegetation: At higher elevations *Carex aquatilis* (water sedge) or *Carex utriculata* (beaked sedge) meadows and *Salix wolfii* (Wolf willow) or *Salix planifolia* (planeleaf willow) shrublands occur within the riparian mosaic. At lower elevations *Scirpus pungens* and *Scirpus lacustris* (bulrush) can occur within the stream channel and wet meadow prairies of *Panicum virgatum* (switchgrass) and *Sorghastrum nutans* (indiangrass) occupy the immediate stream banks and low floodplains. Sands of *Populus deltoides* (plains cottonwood) and *Salix amygdaloides* (peach leaf willow) can also occur scattered across the floodplain.

Adjacent Upland Vegetation: Low elevation streams on the Western Slope have *Pinus edulis-Juniperus* spp.(Piñon-juniper) woodlands and *Artemesia tridentata* (sagebrush) or *Sarcobatus* *vermiculatus* (greasewood) shrublands on adjacent hillslopes. At higher montane and subalpine elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann) forests occupy adjacent slopes. On the eastern plains, rolling upland hills are occupied by *Bouteloua gracilis* (blue grama) short grass prairie, or *Artemesia filifolius* (sandsage) shrublands.

Management: The low palatability of *Eleocharis palustris* and seasonally wet soils limit the grazing value of this type for livestock (Hansen *et al.* 1995).

Table 66. Percent Cover of Plant Species in a Stand of the *Eleocharis palustris* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK13
Species name and age class/ Site and Riparian Health Rank	B
GRAMINOIDS	
Eleocharis palustris (L.)	38

Glyceria spp. Semi-Permanently Flooded Herbaceous Alliance

No plant associations were found in the Rio Grande and Closed Basins, however two stands dominated by two different *Glyceria* species were sampled. They are described below.

Lower Deep Creek (95RG12) at 9220 ft (2800 m) elevation, has a beaver dam, pond and associated mosaic of riparian and wetlands plant communities. One of these communities was a slightly large wet meadow just downstream of a beaver pond, dominated by *Glyceria striata* (small manna grass) (Table 68). The surface is located 0.75 m above the active stream channel high water mark. Water apparently runs through the area very quickly. Soils are saturated deep silty clay over sand with no mottling or signs of an anoxic layer. The stream itself is undercut and has a high gradient of 6.1 %. Previous beaver dams have occupied the area, making a complex mosaic of old and new channels, buried and exposed silt deposits, and a variety of vegetation.

The South Fork of Cat Creek at 8920 ft (2700 m), had a very similar situation with a series of beaver dams and ponds in the stream. The riparian vegetation is a complex mosaic of *Picea pungens* (Colorado blue spruce) forests, *Alnus incana* (thin leaf alder), and *Pentaphylloides floribunda* (shrubby cinqfoil) shrublands, and saturated meadows of *Glyceria* (manna grass) and *Eleocharis* (spikerush) spp. The wet meadow (95RG18) has both *Glyceria grandis* (American mannagrass) (24%) and *Glyceria elata* (mannagrass) (6%) and does not fit any known plant associations yet described in Colorado (Table 68). The soil was saturated deep silt loam over layers of alternating sand and silt loam with high organic matter content, down to a gravel layer at 57 cm. *Glyceria stricta* (small mannagrass) was co-dominate in the neighboring meadow with *Juncus balticus* (arctic rush) (see plot 95RG17 under the *Juncus balticus* Plant Association).

Table 67. Percent Cover of Plant Species in Stands of the *Glyceria* Alliance from the Rio Grande and Closed Basin Watersheds.

Dominant Species	Glyceria grandis	Glyceria striata
Plot Number	95RG18	95RG12
Species name and age class/ Site and Riparian Health Rank	A	B
SHRUBS		
Alnus incana (L.) Moench		1
Salix boothii Dorn		1
Salix drummondiana Barratt ex Hook.		7
Salix geyeriana Anderss.		1
Salix lasiandra var. caudata (Nutt.) Sudworth	1	
GRAMINOIDS		
Calamagrostis canadensis (Michx.) Beauv.		6
Carex sp.		9
Carex utriculata Boott	4	4
Eleocharis palustris	11	
Glyceria elata (Nash ex Rydb.) M.E. Jones	6	
Glyceria grandis S. Wats.	24	
Glyceria striata (Lam.) A.S. Hitchc.		11
Juncus sp.	10	1
FORBS		
Cardamine cordifolia Gray		1
Cirsium sp.		1
Epilobium sp.		4
Galium bifolium S. Wats.		2
Galium trifidum L.		1
Geum sp.	1	1
Mentha arvensis L.		1
Mertensia ciliata (James ex Torr.) G. Don		1
Plantago sp.		2
Potentilla sp.		2
Urtica dioica ssp. gracilis (Ait.) Seland.		7
Veronica americana Schwein. ex Benth.		3
Veronica sp.	6	
HORESTAILS		
Equisetum arvense L.	1	2

Juncus balticus Seasonally Flooded Herbaceous Alliance

Mountain rush (*Juncus balticus* var. *montanus*) Plant Association

CNHP Rarity Rank: G5 / S5-- This is an abundant community throughout the western states. This is a common association, increasing in abundance due to improper grazing throughout Colorado.

General Description and Comments: This plant association occurs as small, dense patches on flat stream benches, along overflow channels, and near springs. It is characterized by a dense sward of *Juncus balticus* (mountain sedge) and often minor cover of *Carex* (sedge) species. Forb cover is generally low. This association is often considered to be a grazing-induced community since it increases with disturbance.

Related Literature and Synonyms: The *Juncus balticus* (mountain rush) community types documented from Nevada (Manning and Padgett 1995), Montana (Hansen *et al*. 1995), Idaho, Wyoming (Youngblood *et al*. 1985, Jones and Walford 1995), and Utah (Padgett *et al*. 1989) are synonymous with the Colorado Juncus balticus var. montanus plant association.

Similar Communities: Johnston (1987) describes two closely related communities: the *Juncus arcticus/Distichlis spicata* (mountain rush/inland salt grass) from Utah, which occurs in lowland alkaline environments, and the *Juncus arcticus/Carex* spp. (mountain rush/sedge) from Oregon, Idaho, Utah, Wyoming, and Colorado, which occurs in more montane habitats with species such as *Carex aquatilis* (water sedge). *Juncus arcticus* ssp. *ater* is a synonym for *Juncus balticus* var. *montanus* (Kartesz 1994).

Regional Distribution: This plant association occurs in Oregon, Nevada (Manning and Padgett 1995), Montana (Hansen *et al*. 1995), Idaho, Wyoming (Youngblood 1985, Jones and Walford 1995), Utah (Padgett *et al*. 1989), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association occurs in the Yampa (Kittel and Lederer 1993), White and Colorado River Basins (Kittel *et al*. 1994), the Rio Grande and Closed Basins (Colorado Natural Heritage Program 1997) and San Juan National Forest (Richard *et al.* 1996).

The following information is based on: a total of sixteen quantitative plots; two from the Yampa River Basin (7, 94), one from the White River Basin (92GK04), four from the Colorado River Basin (93RR09, 93RR13, 93GK06, 93GK11), two from the San Juan National Forest (14, 253), and seven from the Rio Grande River and Closed Basins (95RG05, 95RG17, 97GK10, 97GK17, 97MD01, 97MD12, 97MD26) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 6400-11,600 ft (2000-3500 m).

Site Geomorphology: This plant association occurs as small, dense patches on flat stream benches, along overflow channels, and near springs. Streams were classified according to the

Rosgen Classification of Natural Rivers (Rosgen 1996). Stream channels are highly variable and can be narrow and deeply entrenched (Rosgen's Channel Type: G5, G6), moderately wide and moderately sinuous (Rosgen's Channel Type: B4), moderately wide and very sinuous (Rosgen's Channel Type: C2), narrow and very sinuous (Rosgen's Channel Type: E6), or braided (Rosgen's Channel Type: D5).

Soils: The soils are sandy to silty clay loams or coarse-textured sandy loams with a high percentage of cobbles and gravel. Mottles or gleyed horizons are often present. Soils in the Colorado River Basin classify as sandy to clayey typic Cryoborolls, fine-loamy typic Hydraquents, and fine-clayey Aquepts.

Vegetation: This plant association is dominated by a thick stand of 10-80% cover of *Juncus balticus* (mountain rush). Other graminoid cover is minor, but can include less than 10% cover each of *Carex lanuginosa* (wooly sedge), *Carex aquatilis* (water sedge), *Carex canescens* (silvery sedge), *Leymus cinereus* (basin wildrye), and *Sporobolus airoides* (alkali sacaton). Forb cover is minor. Occasionally, a few tree or shrub seedlings are present including *Populus angustifolia* (narrowleaf cottonwood), *Pentaphylloides floribunda* (shrubby cinquefoil), and *Salix exigua* (coyote willow).(Table 68).

Successional and Ecological Processes: In low-disturbance areas, this plant association appears to be a stable, climax community. It occupies frequently inundated swales and wet, low- to mid-elevation sites (Kittel and Lederer 1993). However, in some areas, this association is considered to be grazing-induced (Padgett *et al.* 1989). *Juncus balticus* is considered an increaser due to its low forage value and high tolerance to grazing (USDA 1937, Hansen *et al*. 1995). It usually increases in abundance on sites formerly dominated by *Deschampsia cespitosa* (tufted hairgrass) or *Calamagrostis canadensis* (bluejoint reedgrass). Nearly pure stands of *Juncus balticus* (mountain rush) indicate that the site may have been heavily grazed in the past (Hansen *et al*. 1995).

Adjacent Riparian Vegetation: *Salix exigua* (coyote willow) shrublands, *Distichlis spicata* (desert salt grass) marshes, or *Carex* spp. (sedge) meadows occur in adjacent riparian areas.

Adjacent Upland Vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce), *Pseudotsuga menziesii* (Douglas fir), and *Populus tremuloides* (quaking aspen) forests, *Pinus edulis-Juniperus* spp. (pinyon pine-juniper) woodlands, and *Chrysothamnus nauseosus* (rubber rabbitbrush), *Sarcobatus vermiculatus* (greasewood), and *Artemisia tridentata* (big sagebrush) shrublands occur on adjacent hill slopes.

Management: Stands of the *Juncus balticus* (mountain rush) plant association are productive, but forage value is relatively low. Livestock grazing occurs when plants are young and tender, but as *Juncus balticus* matures, its palatability declines. Heavy grazing results in an increase of unpalatable forbs. The rhizomatous roots of *Juncus balticus* (mountain rush) is fairly resistant to grazing pressure (Hansen *et al*. 1995).

Table 68. Percent Cover of Plant Species in Stands of the *Juncus balticus ssp. montanus* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	95RG05	95RG17	97GK10	97GK17	97MD01	97MD12	97MD26
Species name and age class/ Site Rank	B	A	C	C	D	A	C
SHRUBS							
Pentaphylloides floribunda (Pursh) A. Love		15					
Ribes cereum Dougl.					9		
Ribes inerme Rydb.		4					
GRAMINOIDS							
Bromus inermis Leyss.					10		
Calamagrostis canadensis (Michx.) Beauv.	6						
Carex aquatilis Wahlenb.				18			
Carex lanuginosa Michx.				27			
Carex sp.	9	14			1	2	1
Distichlis spicata (L.) Greene			19				
Glyceria striata (Lam.) A.S. Hitchc.		16		8			
Juncus balticus ssp. montanus Engelm.	10	49	29	70	12	31	59
Phleum pratense L.		2		11			
Poa pratensis L.	2	8		13	10		
Poa sp.		7					
FORBS							
Achillea millefolium var. apicola (Rydb.) Garrett		10			2		
Argentina anserina (L.) Rydb.		8					
Cirsium arvense							6
Erigeron sp.		7					
Geum macrophyllum		5					
Mentha arvensis L.	15			3			
Potentilla hippiana Lehm.				6			
Taraxacum officinale G.H. Weber ex Wiggers	1	2	1	1			
Trifolium pratense				8	2		
Trifolium sp.		8					
Unknown forb	2	1			2		2
Viola adunca Sm.		5					

Typha (angustifolia, latifolia) Semi Permanently Flooded Herbaceous Alliance

Narrow-and broad leaf cattails (*Typha angustifolia-Typha latifolia*) Plant Association

CNHP Rarity Rank: G5 / S3-- This association is a common wetland community occurring throughout the western and mid-western states. This association is common in Colorado, where it is threatened by development, wetland draining, stream flow alterations, however it is also a natural invader to newly created wetlands, and will appear in newly ponded areas on its own.

General Description and Comments: The *Typha angustifolia-Typha latifolia* (narrowleaf cattail-common cattail) plant association is a commonly seen tall, dark green community growing in 2-4 feet of standing water. It is found in the shallow edges of ponds and lakes, and can occur in backwaters of larger river floodplains.

Recognition and Classification Problems: In Colorado, *Typha angustifolia* and *Typha latifolia* are almost impossible to distinguish in the field. They occupy the same habitats and have been observed to co-occur. We propose one community that can be dominated by either of the two species or by a co-mingling of the two.

Related Literature and Synonyms: The *Typha* spp. dominated wetlands described by Hansen *et al.* (1991), Jones and Walford (1995), Padgett *et al.* (1989) and the Midwest Heritage Task Force (1994) are considered synonymous with the Colorado *Typha angustifolia-Typha latifolia* plant association. A closely related community, the *Typha latifolia/Sagittaria latifolia* plant association, occurs in Nebraska, north eastern Colorado, western Wyoming, eastern Idaho, and North Dakota by Johnston (1987).

Regional Distribution: This association occurs throughout the northern and central Great Plain states, the Dakotas, Montana, Wyoming (Johnston 1987), Nebraska, Kansas, northern Texas, northwestern Oklahoma (Midwest Heritage Task Force 1994) and Colorado (Colorado Natural Heritage Program 1997).

Distribution in Colorado: This plant association is well documented in the literature, and many stands have been documented throughout the plains of eastern Colorado, on the Western Slope, and in the San Luis Valley (Colorado Natural Heritage Program 1997).

The following information is based on: a total of three quantitative plots; two from the South Platte River Basin (95GK47, 95GK59) and one from the Rio Grande and Closed Basin Watersheds (97GK31) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 4,000-7569 ft (1,200-2,300 m).

Site Geomorphology: This plant association occurs in standing water at least 1 foot in depth. It is found along the margins of beaver ponds, overflow channels, back water sloughs, floodplain swales, drainage ditches, behind railroad embankments, and anyplace where water collects to at least 2-3 feet in depth and remains for two-thirds of the growing season. Streams were classified

according to the Rosgen Classification of Natural Rivers (Rosgen 1996). This association can be found on nearly every type of channel, but typically along meandering, low gradient streams (Rosgen's Channel Type: C5, F5, and D5).
Soils: Soils are deep, heavy silty clay loam and organic mucks. Some profiles have 10-30% coarse material and are fairly well drained, others remain anoxic throughout most of the year.

Vegetation: *Typha angustifolia* forms near-monotypic (70-95%) stands between 3 and 6 feet tall (1-2 m). Other species include *Potamogeton* spp. (up to 25%), *Spartina pectinata* (up to 1%), *Veronica* spp. (up to 3%), and *Mentha arvense* (1%) (Table 69).

Successional and Ecological Processes: *Typha angustifolia* occupies inundated and disturbed grounds and can tolerate deeper water and higher alkalinity levels than *T. latifolia* (Great Plains Flora Association 1986). *Typha* species are prolific seed producer, spreading rapidly to become the early colonizers of wet mineral soil and will persist under wet conditions (Hansen *et al.* 1995). Its roots and lower stems are well adapted to prolonged submergence, but it requires periods of draw-down for seed germination to occur (Hansen *et al.* 1995).

Adjacent Riparian Vegetation: *Scirpus* (bulrush) marshes and *Carex* (sedge) meadows can be found adjacent to the *Typha* (cattail) plant association. Stands of *Populus deltoides* (plains cottonwood) and *Salix amygdaloides* (peach leaf willow) occur on higher terraces.

Adjacent Upland Vegetation: On the plains, *Bouteloua gracilis* (blue grama) short grass prairies or agricultural fields occur on the uplands.

Management: This association does not provide much forage for livestock. It is an important wetland type for many species of birds and waterfowl. It is reported, however, that with heavy livestock use stands can be converted to the *Carex nebrascensis* community type in Montana (Hansen *et al.* 1995).

Table 69. Percent Cover of Plant Species in a Stand of the *Typha latifolia* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK31
Species name and age class/ Site and Riparian Health Rank	C
GRAMINOIDS	
Agrostis stolonifera L.	1
Beckmannia syzigache (Steud.) Fern.	1
Eleocharis palustris (L.)	1
Juncus balticus ssp. montanus Engelm.	1
Typha latifolia L.	96
FORBS	
Cicuta douglasii	1
Epilobium ciliatum Rafinesque	1
Mentha arvensis L.	1
Rorippa sphaerocarpa	1

USNVC: V. A. 5. j. Seasonally/Temporally Flooded Temperate Grassland
COWARDIN: Palustrine
CDOW GAP: 62002 Graminoid and Forb Dominated Wetland/Riparian Type
c. Salt Meadow/Salt Flat Grassland

Inland saltgrass (*Distichlis spicata* var. *spicata*) Alliance

Inland saltgrass (*Distichlis spicata* var. *spicata*) Plant Association

CNHP Rarity Rank: G5 / S3 -- This is a common association in the Intermountain west and in Colorado. However, it had declined in abundance since European settlement. Large, pristine stands are virtually unknown. This association is threatened by agricultural conversion and groundwater development.

General Description and Comments: This plant association is characterized by open to thick stands of pure *Distichlis spicata* var. *spicata* (inland saltgrass) growing on alkaline or saline soils in basins, swales or on pond margins.

Related Literature and Synonyms: Synonymous *Distichlis spicata* var. *spicata* community types are documented from the Colorado Front Range (Baker 1984) and Montana (Hansen *et al*. 1995).

Similar Communities: Closely related communities having various associated species include *Distichlis spicata* var. *spicata-Elytrigia smithii* (inland saltgrass-western wheatgrass) documented from Saskatchewan, Nebraska and northeastern Wyoming and *Distichlis spicata* var. *spicata-Sporobolus airoides-Elytrigia smithii* (inland saltgrass-alkali sacaton-western wheatgrass) documented from Colorado, Wyoming, Nebraska, Kansas, Oklahoma and Utah (Johnston 1987).

Regional Distribution: This plant association and similar types occur in Montana (Hansen *et al*. 1995), Saskatchewan, Wyoming, Nebraska, Kansas, Oklahoma, Utah, and Colorado (Johnston 1987, Baker 1984, Colorado Natural Heritage Program 1997).

Distribution in Colorado: This association has been documented along the Colorado Front Range (Baker 1984), on the eastern plains (Steve Kettler, *personnel communication*), in the San Luis Valley in south-central Colorado (Colorado Natural Heritage Program 1997), and in the Yampa, White and Colorado River Basins (Kittel and Lederer 1993, Kittel *et al*. 1994).

The following information is based on: a total of seven quantitative plots; four from the Yampa River Basin (95, 13, 21, 36), one from the White River Basin (92NL04), one from the Colorado River Basin (93DR14) and one from the Closed Basin (97GK14) (Colorado Natural Heritage Program 1997).

Elevation Range in Colorado: 5000-7550 ft. (1530-2300 m).

Site Geomorphology: This plant association occurs on alkaline or saline soils; soils that have been formed from the accumulation of bases and soluble salts in poorly drained areas. This association occurs along narrow streams or the margins of playa lakes. Streams were classified according to the Rosgen Classification of Natural Rivers (Rosgen 1996). In the San Luis valley, stands of Distichlis spicata occur as concentric rings around playa lakes. These drainage patterns do not fit any of Rosgen's channel types.

Soil: Soils are alkaline and have textures of sandy clay, sandy loams, and sandy clay loams with gravel and cobbles. The soils may be heavily gleyed and can have fine, distinct mottles at a depth of about 20 inches (50 cm). Soils in the Colorado River Basin classify as loamy (calcareous) typic Cryaquents.

Vegetation: This plant association is characterized by almost pure stands of *Distichlis spicata* var. *spicata* (inland saltgrass) with 3-90% cover (Table 70). Occasionally several stems of *Chrysothamnus nauseosus* (rubber rabbitbrush) or *Sarcobatus vermiculatus* (greasewood) can be present with less than 3% cover. In degraded stands, *Iva axillaris* (poverty weed) can be present with up to 20% cover.

Successional and Ecological Processes: *Distichlis spicata* var. *spicata* (inland saltgrass) is a warm season grass and grows from early summer until fall primarily from rhizomes. *Distichlis spicata* var. *spicata* can tolerate low to moderately alkaline soils and is resistant to trampling by livestock. This community type may be considered climax if the salt content of the soil remains steady. Increasing the salt content may change the association to a *Puccinellia airoides* (Nuttall's alkaligrass) dominated community type (Johnston 1987).

Adjacent riparian vegetation: Adjacent vegetation includes meadows of *Triglochin* spp. (arrowgrass), *Eleocharis palustris* (common spikerush), *Juncus balticus* (Baltic rush), *Scirpus nevadensis* (Nevada bulrush), and *Carex* spp. (sedge).

Adjacent upslope vegetation: Adjacent uplands vegetation include *Sarcobatus vermiculatus* (greasewood) and *Artemisia tridentata* (big sagebrush) shrublands and *Juniperus osteosperma* or *J. monosperma* (Utah or one-seeded juniper) woodlands.

Management: *Distichlis spicata* var. *spicata* (inland saltgrass) is not particularly palatable to livestock and forage production is low in this plant association. With prolonged heavy grazing, *Hordeum jubatum* (foxtail barley) may replace *Distichlis spicata* var. *spicata*. In heavily grazed stands of *Sporobolus airoides* (alkali sacaton), *Distichlis spicata* var. *spicata* will increase significantly. *Distichlis spicata* var. *spicata* can be effective in revegetating degraded saline and alkaline sites due to its rhizomatous growth (Hansen *et al*. 1995).

Table 70. Percent Cover of Plant Species in a Stand of the *Distichlis spicata* Plant Association from the Rio Grande and Closed Basin Watersheds.

Plot Number	97GK14
Species name and age class/ Site and Riparian Health Rank	B
GRAMINOIDS	
Carex sp.	2
Distichlis spicata (L.) Greene	41
Eleocharis palustris (L.)	1
Hordeum jubatum L.	1
Juncus balticus ssp. montanus Engelm.	2
Pascopyron smithii (Rydb.) A. Love	1
FORBS	
Taraxacum officinale G.H. Weber ex Wiggers	1

Literature Cited

Anderson, M., P. Bourgeron, M. T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Goodin., D. H. Grossman, S. Landaal, 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. The National Vegetation Classification System: list of types. The Nature Conservancy, Arlington, Virginia, USA.

Alexander, B.G. 1981. A preliminary forest habitat classification for the Lincoln National Forest, New Mexico. USDA Forest Service, Rocky Mountain Range and Experiment Station, Flagstaff, Arizona. Final Report of contract 53-82-FT-9-104.

Aldous, A.E. and H.L. Shantz. 1924. Types of vegetation in the semiarid portion of the United States and their economic significance. *Journal of Agricultural Research* 28(2):99-128.

Akashi, Y. 1988. Riparian vegetation dynamics along the Bighorn River, Wyoming. Thesis. University of Wyoming, Laramie, WY.

Alexander, B.G. 1981. A preliminary forest habitat classification for the Lincoln National Forest, New Mexico. USDA Forest Service Final Report of Contract 53-82-FT-9-104. Rocky Mountain Forest and Range Experiment Station, Flagstaff, AZ.

Alexander, R.R. 1988. Forest Vegetation on National Forests in the Rocky Mountain and Intermountain Regions: Habitat Types and Community Types. USDA Forest Service General Technical Report RM-162. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Aplet, G.H., R.D. Laven, and F.W. Smith. 1988. Patterns of community dynamics in Colorado Engelmann spruce-subalpine fir forests. *Ecology* 69:312-319.

Austin, M.P. and P.C. Heyligers. 1989. Vegetation survey design for conservation: gradsect sampling of forests in north-eastern New South Wales. *Biological Conservation* 50: 13-32.

Baker, W.L. 1982. Natural vegetation of the Piceance Basin, Colorado, App. D. *In* J.S. Peterson and W.L. Baker, eds. Inventory of the Piceance Basin, Colorado. Report submitted to the Bureau of Land Management, Craig, CO. Colorado Natural Heritage Inventory, Denver, CO.

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

Baker, W.L. 1986. Riparian vegetation of the montane and subalpine zones in west-central and southwestern Colorado. Report submitted to the Colorado Field Office, The Nature Conservancy, Boulder, CO and the Colorado Natural Areas Program, Denver, CO.

Baker, W.L. 1989. Classification of the riparian vegetation of the montane and subalpine zones in western Colorado. *Great Basin Naturalist* 49(2):214-228.

Batson, Fred T., Paul E. Cuplin, and Wallace A. Crisco. 1987. Riparian area management: the use of aerial photography to inventory and monitor riparian areas. U.S. Department of the Interior Bureau of Land Management Technical Reference 1737-2.

Benedict, A.D. 1991. The Southern Rockies. Sierra Club Books, San Francisco. 578 pp.

Bierly, K.F. 1972. Meadow and fen vegetation in Big Meadows, Rocky Mountain National Park. Thesis. Colorado State University, Ft. Collins, CO.

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

Boring, L.R., W.T. Swank, J.B. Waide, and G.S. Henderson. 1988. Sources, fates, and impacts of nitrogen inputs to terrestrial ecosystems: review and synthesis. *Biogeochemistry* 6:119-159.

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.

Bourgeron, P. and J.S. Tuhy. 1989. Vegetation classification for the Colorado Plateau. Rocky Mountain Heritage Task Force, The Nature Conservancy, Lakewood, CO.

Bowman, W.D. and H. Steltzer. In press. Positive feedbacks to anthropogenic nitrogen deposition in Rocky Mountain alpine tundra. *Ambio*.

Boyce, D.A. 1977. Vegetation of the South Fork of the White River Valley, Colorado. Dissertation. University of Colorado, Boulder, CO.

Branson, F.A. 1985. Vegetation changes on western rangelands. Range Monograph No. 2. Society for Range Management, Denver, CO.

Brinson, 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.

Bunin, J.E. 1975. The vegetation of the west slope of the Park Range, Colorado. Dissertation. University of Colorado, Boulder, CO.

Caldwell, M.M. 1979. Physiology of sagebrush. *In* The Sagebrush Ecosystem: A Symposium, April, 1978. College of Natural Resources, Utah State University, Logan, UT.

Cambell, C.J. and W.A. Dick-Peddie. 1964. Comparisons of phreatophyte communities on the Rio Grande in New Mexico. *Ecology* 45:492-502.

Chadde, S.W., P.L. Hansen, and R.D. Pfister. 1988. Wetland plant communities of the northern range, Yellowstone National Park. Final contract report. School of Forestry, University of Montana, Missoula, MT.

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.

Christy, S. 1973. An analysis of the woody vegetation on the South Platte River flood plain in northeastern Colorado. Thesis. University of Northern Colorado, Greeley, CO.

Chronic, H. 1980. Roadside Geology of Colorado. Mountain Press, Missoula, MT. 322 pages.

Colorado Climate Center. 1984. Colorado Average Annual Precipitation 1951-1980 Map. Scale :500,000. Colorado State University, Ft. Collins, CO.

Colorado Division of Wildlife (CDOW) 1998. Gap Analysis Project: The Colorado Gap Analysis project. Maps are digitized interpretations of Thematic Mapper images. Resolution is about 100 hectares. Digital Map. Available on the Web at http://ndis.nrel.colostate.edu. Denver, CO.

Colorado Natural Heritage Program (CNHP). 1997. Biological and Conservation Data (BCD) System. Data from field surveys. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

Colorado Riparian Association. 1995. The Green Line. Spring/Summer Issue. Volume 7 Number1,2.

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. No place.

Cooper, D.J. 1990. Ecology of Wetlands in Big Meadows, Rocky Mountain National Park, Colorado. US Fish and Wildlife Service Biological Report 90(15). US Fish and Wildlife Service, Washington, DC.

Cooper, D.J. 1993. Wetlands of the Crested Butte region: mapping, functional evaluation, and hydrological regime. Report submitted to the town of Crested Butte and the Environmental Protection Agency, Region VIII, Denver, CO.

Cooper, D.J. and T.R. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Report submitted to the Colorado Field Office, The Nature Conservancy, Boulder, CO.

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. Report submitted to the State of Colorado Division of Wildlife, the US Fish and Wildlife Service and the Rio Grande Water Conservation District.

Cooper, S.V. 1975. Forest habitat types of northwestern Wyoming and contiguous portions of Montana and Idaho. Dissertation. Washington State University, Pullman, WA.

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

Cooper, S.V., K.E. Neiman, R. Steele, and D.W. Roberts. 1987. Forest Habitat Types of Northern Idaho: A Second Approximation. USDA Forest Service General Technical Report INT-236. Intermountain Research Station, Ogden, UT.

Corn, J. C. Pague, A. Ellingson, M. Sherman, T. Zwiejacz, G. Kittel, and C. Fleming. 1995. Final Report on the Geographic Extent of the Preble's Meadow Jumping Mouse Population on the United States Air Force Academy. Unpublished report Submitted to the U.S. Air Force Academy, Colorado Springs, CO. Prepared by The Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Cottrell, T.R. 1995. Willow colonization of Rocky Mountain mires. *Canadian Journal of Forest Research* 25:215-222.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. US Fish and Wildlife Service. FWS/OBS-79/31. 131 pp.

Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren. 1977. Intermountain Flora: Vascular Plants of the Intermountain West, U.S.A. Vol. 6: The Monocotyledons. The New York Botanical Garden, New York, NY.

Culver, D.R., M.A. March, S.M. Kettler, C.A. Pague. 1996. Natural heritage inventory of significant animals and plants and classification of riparian associations, Timpas Grazing District and Kim Grazing Association, Pike-San Isabel National Forest, Cimarron and Comanche National Grasslands. Natural Heritage Technical Report #96-1. Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Daley, R.H. 1972. The native sand sage vegetation of eastern Colorado. Thesis. Colorado State University, Ft. Collins, CO.

Daubenmire, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. *Ecological Monographs* 22(4):301-330.

Daubenmire, R.F. 1970. Steppe vegetation of Washington. Washington State University Agricultural Experiment Station Technical Bulletin No. 62. 131 pp.

Dawson, T.E. and J.R. Ehleringer. 1991. Streamside trees that do not use stream water. *Nature* 350:335-337.

Dawson, T.E. and J.R. Ehleringer. 1993. Gender-specific physiology, carbon isotope discrimination, and habitat distribution in boxelder, *Acer negundo*. *Ecology* 74:798-815.

DeByle, N.V. and R. Winokur, eds. 1985. Aspen: Ecology and Management in the Western United States. USDA Forest Service General Technical Report RM-119. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

DeVelice, R.L., J.A. Ludwig, W.H. Moir, F. Ronco, Jr. 1986. A Classification of Forest Habitat Types of Northern New Mexico and Southern Colorado. USDA Forest Service General Technical Report RM-131. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Dick-Peddie, W.A. 1993. New Mexico Vegetation: Past, Present, and Future. University of New Mexico Press, Albuquerque, NM.

Dix, R.J. and J.D. Richards. 1976. Possible changes in species structure of the subalpine forest induced by increased snowpack. *In* H.W. Steinhoff and J.D. Ives, eds. Ecological impacts of snowpack augmentation in the San Juan Mountains, Colorado. Report submitted to the Division of Atmospheric Water Resources, United States Bureau of Reclamation. Colorado State University, Ft. Collins, CO.

Donovan L.A. and J.R. Ehleringer. 1991. Ecophysiological differences among juvenile and reproductive plants of several woody species. *Oecologia* 86:594-597.

Dorn, R.D. 1977. Willows of the Rocky Mountain States. Rhodora 79:390-429.

Dorn, R.D. and J.L Dorn. 1977. Flora of the Black Hills. Published by the authors.

Dorn, R.D. 1992. Vascular Plants of Wyoming. 2nd ed. Mountain West Publishing, Cheyenne, WY.

Dorn, R.D. 1995. A taxonomic study of *Salix* section *Cordatae* subsection *Luteae* (Salicaceae). *Brittonia* 47(2):160-174.

Dorn. R.D. 1997. Rocky Mountain region willow identification field guide. Renewable Resources R2-RR-97-01. Denver, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region. 107 p.

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.

Elmore, W. and R. L. Beschta. 1987. Riparian Areas: Perceptions in Management. Rangelands. Vol. 9, No. 6.

Ellis, S. R., G. W. Levings, L.F. Carter, S.F. Richey and M. J. Radell. 1993. Rio Grande Valley, Coloardo, New Mexico, and Texas. Water Resources Bulletin, Paper No. 93132. American Water Resources Association. Vol. 29. No 4:617-646.

Ellison, L. 1954. Subalpine vegetation of the Wasatch Plateau, Utah. *Ecological Monographs* 24(2):89-184.

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

FGDC. 1996. FGDC Vegetation Classification and Information Standards, June 6, 1996. Federal Geographic Data Committee Vegetation Subcommittee, USGS National Center, Reston VA.

Fisher, N.T., M.S. Toll, A.C. Cully, and L.D. Potter. 1983. Vegetation along Green and Yampa Rivers and Response to Fluctuating Water Levels. Dinosaur National Monument. Final report to USDI National Park Service, by University of New Mexico, Albuquerque, NM.

Franklin, J.F. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service General Technical Report PNW-8. Pacific Northwest Forest and Range Experiment Station. Portland, OR. 417 pp.

Friedman, F.M. 1993. Vegetation Establishment and Channel Narrowing along a Great-Plains Stream Following a Catastrophic Flood. Unpublished Ph.D. thesis submitted to the University of Colorado, Department of Environmental, Population, and Organismic Biology.

Friedman, J.M., M.L. Scott, G.T. Auble. 1997. Water management and cottonwood forest dynamics along prairie streams. *In* F.L. Knopf and F.B. Samson, eds. Ecology and Conservation of Great Plains Vertebrates. Springer-Verlag, Inc., New York, NY.

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.

Gleason, H.A. and A. Cronquist. 1963. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. D. Van Nostrand Co., Inc., Princeton, NJ.

Graham, E.H. 1937. Botanical studies in the Uinta Basin of Utah and Colorado. *Annals of the Carnegie Museum* 26:1-432.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence, KS.

Great Plains Flora Association. 1977. Atlas of the Flora of the Great Plains. The Iowa State University Press, Ames, IA.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. *Bioscience* 41(8):540-551.

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

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., K. Boggs, R. Pfister, and J. Jay. 1991. Classification and management of riparian and wetland sites in 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.

Harper, K.T., F.J. Wagstaff, and L.M. Kunzler. 1985. Biology and Management of the Gambel Oak Vegetative Type: A Literature Review. USDA Forest Service General Technical Report INT-179. Intermountain Forest and Range Experimental Station, Ogden, UT.

Harrington, H.D. 1954. Manual of the Plants of Colorado. Sage Books, Denver, CO.

Hermann, F.J. 1970. Manual of the Carices of the Rocky Mountains and Colorado Basin. Agriculture Handbook No. 374. USDA Forest Service, Washington, DC.

Hess, K. 1981. Phyto-edaphic study of habitat types of the Arapaho-Roosevelt National Forest, Colorado. Dissertation. Colorado State University, Fort Collins, CO.

Hess, K and R.R. Alexander. 1986. Forest Vegetation of the Arapaho and Roosevelt National Forests in Central Colorado: A Habitat Type Classification. USDA Forest Service Research Paper RM-266. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Hess, K. And C.H. Wasser. 1982. Grassland, shrubland, and forestland habitat types of the White River-Arapaho National Forest (with pages 20-22 rewritten by Barry C. Johnston, July 1987). Report submitted to the USDA Forest Service, Rocky Mountain Region, Lakewood, CO.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, WA.

Hoffman, G.R. and R.R. Alexander. 1980. Forest Vegetation of the Routt National Forest in Northwestern Colorado: A Habitat Type Classification. USDA Forest Service Research Paper RM-221. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Jankovsky-Jones, M. 1994. Environmental factors affecting the distribution of riparian plant associations in the Roaring Fork River Basin, Colorado. Thesis. University of Wyoming, Laramie, WY.

Johnsgard, P. 1991. Crane Music: A natural History of American Cranes. Smithsonian Institution Press, Washington D.C. 136 pages.

Johnson, W. C. 1994. Woodland Expansion in the Platte River, Nebraska: Patterns and Causes. *Ecological Monographs* 64(1):45-84.

Johnston, B.C. and L. Hendzel. 1985. Examples of Aspen Treatment, Succession and Management in Western Colorado. USDA Forest Service report. Rocky Mountain Region, Lakewood, CO.

Johnson, J.R., and J.T. Nichols. 1982. Plants of South Dakota Grasslands. Agricultural Experiment Station Bulletin 566. South Dakota State University, Brookings, SD.

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. 1990. Workplan for a uniform statewide riparian vegetation classification. Wyoming Natural Diversity Database (The Nature Conservancy), Laramie, WY.

Jones G. 1992. A preliminary classification of riparian vegetation types of the Medicine Bow Range and the Sierra Madre. Report submitted to the Medicine Bow National Forest. Wyoming Natural Diversity Database (The Nature Conservancy), Laramie, WY.

Jones, G.P. 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.

Kartesz, J.T. 1994. A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland, Vol. II. 2nd ed. Timber Press, Portland, OR.

Keammerer, W.R. 1974. Vegetation of the Grand Valley area. *In* Ecological inventory of the Grand Valley area. Report submitted to the Colony Development Operation, Atlantic Richfield Company, Denver, CO.

Kettler, S., C. Carsey, and M. Aitken. 1994. San Juan National Forests Riparian Vegetation Classification Preliminary Report. Prepared for San Juan National Forest, Durango, CO. By the Colorado Natural Heritage Program, CSU, Ft. Collins, CO.

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. 1994. Montane riparian vegetation in relation to elevation and geomorphology along the Cache la Poudre River, Colorado. Thesis. University of Wyoming, Laramie, WY.

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, 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. 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, University of Colorado, Boulder, 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. 1998. A classification of the riparian vegetation of the South Platte River Basin (and part of the Republican River Basin), Colorado. Final 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.

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

Knighton D. 1984. Fluvial Forms and Processes. London, Edward Arnold. 218 pp.

Knopf, F.L. 1985. Significance of riparian vegetation to breeding birds along an attitudinal cline. *In* R.R. Johnson, C.D. Ziebell, D.R. Patten, P.F. Ffolliot, and R.H. Hamre, tech. coords. Riparian Ecosystems and Their Management. USDA Forest Service General Technical Report RM-120. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Knopf, F.L., R.R. Johnson, T. Rich, F.B. Samson, and R. Szaro. 1988. Conservation of riparian ecosystems in the United States. *Wilson Bulletin*. 100(2):272-284.

Komarkova, V. 1976. Alpine vegetation of the Indian Peaks area, Front Range, Colorado Rocky Mountains. Dissertation. University of Colorado, Boulder, CO.

Komarkova, V. 1986. Habitat types on selected parts of the Gunnison and Uncompahgre National Forests. Report submitted to the USDA Forest Service. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

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.

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., W.E. Hopkins and S.J Brunsfeld. 1988. Major Indicator Shrubs and Herbs in Riparian Zones on National Forests of Central Oregon. USDA Forest Service R6-ECOL-TP-005-88. Pacific Northwest Region, Bend, OR.

Ludwig, John and James F. Reynolds. 1988. Statistical Ecology: A Primer on Methods and Computing. New York, Wiley and Sons.

Manning, M.E. and W.G. Padgett. 1989. Preliminary Riparian Community Type Classification for Nevada. Draft manuscript. USDA Forest Service Intermountain Region, Ogden, UT.

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

Mauk, R.L. and J.A. Henderson. 1984. Coniferous Forest Habitat Types of Northern Utah. USDA Forest Service General Technical Report INT-170. Intermountain Forest and Range Experiment Station, Ogden, UT.

Mattson, D.J. 1984. Classification and environmental relationships of wetland vegetation in central Yellowstone National Park, Wyoming. Thesis. University of Idaho, Moscow, ID.

Mueggler, W. F. and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. USDA Forest Service General Tech. Report INT-66. Intermountain Forest & Range Experiment Station, Ogden, Utah. 155 pp.

Mueggler, W.F. 1988. Aspen Community Types of the Intermountain Region. USDA Forest Service General Technical Report INT-250. Intermountain Research Station, Ogden, UT.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. Wiley, New York.

Muldavin, E. 1992. Riparian ecological site inventory and demonstration project, northern Rio Grande River and tributaries, New Mexico. Report submitted to the Bureau of Land Management, Albuquerque, NM.

Mutel, C. and J. Emerick. 1984. From Grassland to Glacier: The Natural History of Colorado. Johnson Books, Boulder, CO.

Mutel, C. F. and J.C. Emerick. 1992 (2nd ed.). From Grasslands to Glacier: The Natural History of Colorado and the Surrounding Region. Johnson Books: Boulder.

Neilson, R.P. and L.H. Wullstein. 1983. Biogeography of two southwest American oaks in relation to atmospheric dynamics. *Journal of Biogeography* 10:275-297.

Neilson, R.P. and L.H. Wullstein. 1986. Microhabitat affinities of Gambel oak seedlings. *Great Basin Naturalist* 46(2):294-298.

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.

Peet, R.K. 1981. Forest vegetation of Colorado Front Range: composition and dynamics. *Vegetatio* 45:3-75.

Peet, R. K. 1988. Forests of the Rocky Mountains. Chapter 3. *In:* M. G. Barbour and W.D. Billings, eds. North American Terrestrial Vegetation. Cambridge University Press: Cambridge.

Peterson, J.S., S. Bowland, W.L. Baker, and D. Barton. 1984. Upper Colorado River Basin, Yampa River megasite draft conservation plan. Report submitted to The Nature Conservancy, Denver, CO.

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

Pfister, R.D., B.L. Kovalchik, S.F. Arno, and R.C. Presby. 1977. Forest Habitat Types of Montana. USDA Forest Service General Technical Report INT-34. Intermountain Forest and Range Experiment Station, Ogden, UT.

Platts, W.S., C. Armour, G.D. Booth, M. Bryant, J.L Buford, P. Cuplin, S. Jensen, G.W. Lienkaemper, G.W. Minshall, S.B. Monsen, R.L. Nelson, J.R. Sedell, and J.S. Tuhy. 1987. Methods for Evaluating Riparian Habitats with Applications to Management. USDA Forest Service General Technical Report INT-221. Intermountain Research Station, Ogden, UT.

Powell, D.C. 1988. Aspen community types of the Pike and San Isabel National Forests in south-central Colorado. USDA Forest Service R2-ECOL-88-01. Rocky Mountain Region, Lakewood, CO.

Reichmann, O.J. 1987. Konza Prairie: A Tallgrass Natural History. University Press of Kansas, Lawrence, KS.

Reid, M. and P. Bourgeron. 1991. Vegetation Classification for Colorado. Unpublished Working Draft. Western Regional Heritage Task Force, The Nature Conservancy, Boulder, 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.

Risser, P. 1990. The ecological importance of land-water ecotones. In: The Ecology and Management of Aquatic-Terrestrial Ecotones. R.J. Naimann and H. Decamps, eds. UNESCO, Paris.

Rondeau, R. 1995. Wetland and Riparian Inventory of Lakewood Raw Water Supply Pipeline Alternatives. Unpublished report prepared for the Boulder Ranger District of the Roosevelt National Forest, Ft. Collins, CO. Prepared by the Colorado Natural Heritage Program, Colorado State University, Ft. Collins, CO.

Rondeau, R. and G. Kittel. 1996. Gunnison Basin Riparian Ecosystems: The good, the bad, and the ugly. *In* Is the Greenline Green Status, Trend and Treatment of Colorado's Riparian Areas. Proceedings of the Eighth Annual Conference. Colorado Riparian Association, Boulder, CO.

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. 1994. A classification system for natural rivers. *Catena* 22:169-199.

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

Sanderson, J. and S. Kettler. 1996. A preliminary wetland vegetation classification for a portion of Colorado's West Slope. Report submitted to 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 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.

Schumm, S.A. 1977. <u>The Fluvial System</u>. New York, Wiley-Interscience.

Scott, M.L., J.M. Friedman, and G.T. Auble. 1996. Fluvial process and the establishment of bottomland trees. *Geomorphology* 14:327-339.

Sheeter, G.R. and E.W. Claire. 1989. Juniper for Streambank Stabilization in Eastern Oregon. USDA Forest Service General Technical Report PNW-110. Pacific Northwest Research Station, Portland, OR.

Spiro, V. 1998. An Assessment of the Range of Natural Variability of the Rio Grande National Forest.(Appendix A) *In:* Rio Grande National Forest Plan Revised Final Environmental Imapct Statement.

Steele, R., R.D. Pfister, R.A. Ryker, and J.A. Kittams. 1981. Forest Habitat Types of Central Idaho. USDA Forest Service General Technical Report INT-114. Intermountain Forest and Range Experiment Station, Ogden, UT.

Steele, R., and K. Geier-Hayes. 1994. The Douglas-Fir/White Spirea Habitat Type in Central Idaho: Succession and Management. USDA Forest Service General Technical Report INT-305. Intermountain Research Station, Ogden, UT.

Steen, O.A. and R.L Dix. 1974. A preliminary classification of Colorado subalpine forests. Dept. of Botany and Plant Pathology, Colorado State University, Ft. Collins, CO.

Strahler, A.N. 1952. Hypsometric (area-altitude) analysis of erosional topography. *Bulletin of the Geological Society of America* 63:1117-1142.

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

Szaro, R.C. 1989. Riparian forest and scrubland community types of Arizona and New Mexico. *Desert Plants* 9:69-138.

The Nature Conservancy. 1992. Upper Colorado River Basin Bioreserve Strategic Plan. Unpublished report. Colorado Field Office, The Nature Conservancy, Boulder, Colorado.

The Nature Conservancy. 1996. Yampa River site conservation plan. The Nature Conservancy, Boulder, CO.

Tweto, O. 1979. Geologic Map of Colorado. Scale: 1:500,000. US Geological Survey.
Unger, I.A. 1974. Halophyte communities of Park County, Colorado. *Bulletin of the Torrey Botanical Club* 101(3)145-152.

Unknown. 1976. Flora and terrestrial vertebrate studies of the Grand Valley, Colorado. Report submitted to the US Bureau of Reclamation. Ecology Consultants, Inc., Ft. Collins, CO.

USDA Soil Conservation Service. 1978. Range site descriptions for Colorado. Technical Guide, Section II-E. USDA Soil Conservation Service, Colorado State Office, Denver, CO.

USDA Forest Service, Rio Grande National Forest. 1996. Final Environmental Impact Statement: Revised Land and Resources Management Plan. USDA Forest Service, Rocky Mountain Region, Ft. Collins, CO.

USDA Natural Resources Conservation Service. 1997. PLANTS. http://plants.usda.gov/plants. National Plant Data Center, Baton Rouge, LA.

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

USFWS 1994. Instream flow and pulse flow recommendations for the Central Platte River, Nebraska. Results of March and May 1994 workshops. *In* D. Bowman and D. Carlson, eds. US Fish and Wildlife Service Comment Enclosures 2-8 and FERC Nos. 1417 and 1835.

USGS. 1993. National Water Summary 1990-91: Hydrological Events and Stream Water Quality. Compilers R. Paulson, E. Chase, J. Williams, and D. Moody. United States Geological Survey Water-Supply Paper 2400.

Valentine, John. E. 1990. Grazing Mangement. San Diego, Academic Press, Inc.

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.

Veblen, T.T., K.S. Hadley, M.S. Reid, and A.J. Rebertus. 1991. The response of subalpine forests to spruce beetle outbreak in Colorado. *Ecology* 72:213-231.

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.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska Vegetation Classification. General Technical Report PNW-GTR-286. Pacific Northwest Research Station, Portland, OR.

Wasser, C.H. 1982. Ecology and Culture of Selected Species Useful in Revegetating Disturbed Lands in the West. US Fish and Wildlife Service FWS/OBS-82/56. US Fish and Wildlife Service, Washington, DC.

Walford, G.M. 1993. Spatial variation in riparian vegetation along the Animas River, Colorado. Thesis. University of Wyoming, Laramie, WY.

Waring, R. H. and W. H. Schlesinger. 1985. Forest Ecosystems: Concepts and Management. Academic Press, Inc., Orlando, FL.

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

Weaver, J.E. 1968. Prairie Plants and their Environment: A Fifty-Year Study in the Midwest. University of Nebraska Press, Lincoln, NE.

Weber, W.A. 1987. Colorado Flora: Western Slope. Colorado Associated University Press, Boulder, CO.

Weber, W.A. 1990. Colorado Flora: Eastern Slope. University Press of Colorado, Niwot, CO.

Weber, W.A. and R.C. Wittmann. 1992. Catalog of the Colorado Flora: A Biodiversity Baseline. University Press of Colorado, Niwot, CO.

Weber, W.A. and R.C. Wittmann. 1996a. Colorado Flora: Eastern Slope. Rev. ed. University Press of Colorado, Niwot, CO.

Weber, W.A. and R.C. Wittmann. 1996b. Colorado Flora: Western Slope. Rev. ed. University Press of Colorado, Niwot, CO.

Welsh, S.L., N.D. Atwood, L.C. Higgins, and S. Goodrich, eds. 1987. A Utah Flora. Great Basin Naturalist Memoirs No. 9. Brigham Young University, Provo, UT.

Williams, G. P. 1978. Historical perspective of the Platte Rivers in Nebraska and Colorado. Pages 11-141 in: Lowland River and Stream Habitat in Colorado: A Symposium. Colorado Chapter Wildlife Society and the Colorado Audubon Council.

Willis, E.L. 1939. Plant associations of the Rillito floodplain in Pima County. Thesis. University of Arizona, Tuscon, AZ.

Woodward-Clyde. 1981. Interim Report South Platte River Basin Assessment. Prepared for the Colorado Water Conservation Board. Prepared by Woodward-Clyde Consultants, Denver, CO.

Wolman, M.G. and L.B. Leopold. 1957. River flood plains: some observations on their formation. United States Geological Survey Professional Paper 282C:87-109

Youngblood, A.P. and R.L. Mauk. 1985. Coniferous Forest Habitat Types of Central and Southern Utah. USDA Forest Service General Technical Report INT-187. Intermountain Research Station, Ogden, UT.

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.

Appendix 1. Riparian Plant Species of the Rio Grande and Closed Basin Watersheds. For common names and wetland indicator status, see the USDA Plants database on the Web at: http://plants.usda.gov/plantproj/plants/plntmenu.html

Plant Species Scientific Name, sorted by Life Form
TREES
Abies concolor--mature trees
Abies concolor--saplings
Abies concolor--seedlings
Abies lasiocarpa (Hook.) Nutt.--older trees
Abies lasiocarpa (Hook.) Nutt.--saplings
Abies lasiocarpa (Hook.) Nutt.--seedlings
Acer negundo var. interius L.--older trees
Juniperus osteosperma (Torrey) Little
Juniperus monosperma (Engelm.) Sarg.--older trees
Juniperus monosperma (Engelm.) Sarg.--saplings
Juniperus scopulorum Sarg.
Picea engelmannii Parry ex Engelm.--older trees
Picea engelmannii Parry ex Engelm.--saplings
Picea engelmannii Parry ex Engelm.--seedlings
Picea pungens Engelm.--older trees
Picea pungens Engelm.--saplings
Picea pungens Engelm.--seedlings
Pinus edulis Engelm.
Pinus flexilis James
Pinus ponderosa P. & C. Lawson--older trees
Populus angustifolia James--older trees
Populus angustifolia James--saplings
Populus angustifolia James--seedlings
Populus deltoides Marshall ssp. monilifera (Aiton) Eckenwalder
Populus tremuloides Michx.--older trees
Populus tremuloides Michx.—saplings
Populus tremuloides Michx.--seedlings
Pseudotsuga menziesii (Mirbel) Franco--older trees
Pseudotsuga menziesii (Mirbel) Franco--saplings
Pseudotsuga menziesii (Mirbel) Franco--seedlings
Salix amygdaloides --older trees
SHRUBS
Acer glabrum Torr.
Alnus incana (L.) Moench
Amelanchier utahensis Koehne
Artemesia tridentata ssp. vaseyana (Rydb.) Beetle
Betula occidentalis Hooker
Chrysothamnus nauseosus (Pallas) Britton

Appendix 1., Continued.

Chrysothamnus viscidiflorus (Hooker) Nuttall
Cornus sericea L.
Holodiscus dumosus (Nutt. ex Hook.) Heller
Jamesia americana Torrey.
Juniperus communis L.
Lonicera involucrata Banks ex Spreng.
Pentaphylloides floribunda (Pursh) A. Love
Physocarpus monogynus (Torrey) Coulter
Prunus virginiana L. var. melanocarp (A. Nels.) Sarg.
Quercus gambelii Nutt.
Rhus trilobata Nuttall ex Torrey & Gray var. trilobata
Ribes aureum Pursh.
Ribes cereum Dougl.
Ribes inerme Rydb.
Ribes montigenum McClatchie
Ribes sp.
Ribes wolfii Rothrock
Rosa woodsii Lindl.
Salix bebbiana Sarg.
Salix boothii Dorn
Salix brachycarpa Nutt.
Salix drummondiana Barratt ex Hook.
Salix eriocephala Michaux var. ligulifolia
Salix exigua Nutt.
Salix geyeriana Anderss.
Salix lasiandra Bentham var. caudata (Nutt.) Sudworth
Salix lasiandra Bentham var. lasiandra
Salix monticola Bebb
Salix planifolia Pursh
Salix wolfii Bebb
Sambucus racemosa L. var. microbotrys (Rydb.) Kearney & Peebles
Sarcobatus vermiculatus (Hook.) Torr. In Emory
Symphoricarpos albus (L.) Blake
Symphoricarpos sp.
Unknown shrub
Vaccinium cespitosum Michx.
Vaccinium myrtillus L. ssp. oreophilum (Rydb.) Love et al.
Vaccinium scoparium Leiberg
Vaccinium sp.
VINES
Clematis ligusticifolia Nuttall.
Parthenocissus quinquefolia (L.) Planchon

Appendix 1., Continued.

Vitis riparia Michaux.
GRAMINOIDS
Agropyron cristatum (L.) Gaertn.
Agropyron sp.
Agrostis sp.
Agrostis stolonifera L.
Agrostis thurberiana Hitchc.
Alopecurus sp.
Beckmannia syzigache (Steud.) Fern.
Blepharoneuron tricholepis (Torr.) Nash
Bouteloua gracilis (H.B.K.) Lag.
Bromus anomalus Rupr. ex Fourn.
Bromus ciliatus L.
Bromus hordeaceus L.
Bromus inermis Leyss.
Bromus sp.
Bromus tectorum L.
Calamagrostis canadensis (Michx.) Beauv.
Calamagrostis stricta (Timm) Koeler
Carex aquatilis Wahlenb.
Carex aurea Nutt.
Carex brunnescens (Pers.) Poir.
Carex canescens L.
Carex deweyana Schwein.
Carex disperma Dewey
Carex festiivella Mackenzie
Carex geyeri F. Boott
Carex hoodi F. Boott in Hook.
Carex interior Bailey
Carex lanuginosa Michx.
Carex microptera Mackenzie
Carex nebrascensis Dewey
Carex norvegica Retz.
Carex occidentalis Bailey
Carex parryi Dewey
Carex pelocarpa F.J. Herm.
Carex praegracilis W. Boott
Carex praticola Rydb.
Carex simulata Mack.
Carex sp.
Carex utriculata Boott
Cinna latifolia (Trev. Ex Goepp.) Griseb.
Cyperus aristatus Roettboell.
Danthonia sp.

Appendix 1., Continued.

Deschampsia cespitosa (L.) Beauv.
Distichilis spicata (L.) Greene
Eleocharis palustris (L.)
Eleocharis sp.
Elymus elymoides (Raf.) Swezey
Elymus lanceolatus (Schribn. & Sm.) Gould.
Elymus trachycaulus (Link) Gould ex Shinners
Elytrigia repens (L.) Nevski.
Festuca idahoensis Elmer
Festuca sp.
Festuca thurberi Vasey
Glyceria elata (Nash ex Rydb.) M.E. Jones
Glyceria grandis S. Wats.
Glyceria sp.
Glyceria striata (Lam.) A.S. Hitchc.
Hordeum jubatum L.
Hordeum sp.
Juncus balticus ssp. montanus Engelm.
Juncus drummondii E. Mey.
Juncus saximontana Nelson
Juncus sp.
Juncus tracyii Rydbg.
Koeleria macrantha (Lebedour) Schult.
Leymus cinerus (Scribn. & Merr.) A. Love
Luzula parviflora (Ehrh.) Desv.
Luzula sp.
Muhlenbergia asperifolia (Nees & Meyen) L.R. Parodi
Muhlenbergia sp
Oryzopsis hymenoides (Roemer & Schultes) Ricker
Pascopyron smithii (Rydb.) A. Love
Phleum alpinum L.
Phleum pratense L.
Phleum sp.
Phragmites austrailis (Cav.) Trin.
Poa arctica R.Br.
Poa compressa L.
Poa fendleriana (Steudel) Vasey
Poa leptocoma Trin.
Poa palustris L.
Poa pratensis L.
Poa reflexa Vasey & Scribn. ex Vasey
Poa sp.
Redfeldia flexulosa ((Thurb.) Vasey
Scirpus microcarpa Presl.

Appendix 1., Continued.

Scirpus pungens Vahl
Scirpus spp.
Scripus lacustre
Spartina gracilis Trin.
Trisetum wolfii Vasey
Typha latifolia L.
Unknown graminoid
FORBS
Achillea millefolium var. apicola (Rydb.) Garrett
Aconitum columbianum Nutt.
Actaea rubra (Ait.) Willd.
Agastache sp.
Agoseris aurantiaca (Hook.) Greene
Allium geyeri var. tenerum M.E. Jones
Allium sp.
Ambrosia sp.
Anaphalis margaritacea (L.) Benth. & Hook. f.
Androsace septentrionalis L.
Angelica ampla Nelson
Angelica sp.
Antennaria corymbosa E. Nelson
Antennaria parivifolia Nuttall
Antennaria rosea Rydb.
Antennaria sp.
Anthemis arvensis L.
Aquilegia coerulea James
Aquilegia elegantula Greene
Aquilegia sp.
Argentina anserina (L.) Rydb.
Arnica cordifolia Hook.
Artimesia frigida
Artimesia ludiviciana
Asperigus officinalis
Aster foliaceous
Aster hesperius
Aster sp
Astragalus sp.
Besseya alpina or plantaginea
Botrychium simplex E. Hitchc.
Botrychium sp.
Brickellia grandiflora (Hooker) Nuttal
Caltha leptosepala var. leptosepala
Calypso bulbosa (L.) Oakes
Cardamine cordifolia Gray

Appendix 1., Continued.

Cardamine sp.
Cardaria latifolia
Castilleja rhexiifolia
Castilleja sp.
Castilleja sulphurea Rydb.
Centurea diffusa
Cerastium nutans
Cercocarpus montanus
Chenopodium alba
Chenopodium glaucum L.
Cicuta douglasii
Cirsium arvense
Cirsium coloradense
Cirsium sp.
Comandra umbellata (L.) Nuttall
Conioselinum scopulorum (Gray) Coult. & Rose
Corydalis caseana ssp. brandegei (S. Wats.) G.B. Ownbey
Crunocallis chamissoii
Delphinium sp.
Descurania sp.
Dodecatheon pulchellum (Raf.) Merr.
Epilobium angustifolium L.
Epilobium ciliatum Rafinesque
Epilobium hornmannii Haussknecht
Epilobium leptophyllum Rafinesque
Epilobium sp.
Erigeron diversions
Erigeron sp.
Frageria vesca
Fragraria virginiana Miller
Galium aparine
Galium bifolium S. Wats.
Galium boreale L.
Galium sp.
Galium trifidum L.
Galium triflorum Michx.
Gaultheria humifusa
Gentiana fremontii Torr.
Gentiana sp.
Gentianopsis sp.
Gentianopsis thermalis (Kuntze) Iltis
Geranium richardsonii Fisch. & Trautv.
Geranium sp.
Geum macrophyllum

Appendix 1., Continued.

Geum rossii ssp. rossii
Geum sp.
Glycyrrhiza leptidota
Hacklea floribunda
Halerpestes cymbalaria
Harboria ap.
Hedysarum sp.
Helianthus annuus
Heracleum sphondylium L. var. montanum
Heterotheca villosa (Pursh.)
Heuchera parviflora
Heuchera sp.
Hydrophyllum fendleri
Hydrophyllum sp.
Hypericum formosum
Hypericum sp.
Ipomopsis sp.
Iris missouriensis Nutt.
Lactuca serriola L.
Lathyrus lanszwertii var. leucanthus (Rydb.) Dorn
Lepidium sp.
Lewisia pygmaea
Ligusticum filicinum S. Wats
Ligusticum porteri
Limnorchis dilata
Limnorchis hyperborea (L.) Rydeberg
Limnorchis sp.
Limnorchis stricta
Listera cordata (L.) R. Br. ex Ait. f.
Lupinus sp.
Lycopis asper
Lysiella obtusata
Maianthemum racemosum
Maianthemum stellatum (L.) Link
Medicago lupulina
Medicago sativa
Melilotus officinale
Mentha arvensis L.
Mentha sp.
Mertensia ciliata (James ex Torr.) G. Don
Mertensia franciscana Heller
Mimulus glabratus
Mimulus guttatus DC.
Mimulus sp.

Appendix 1., Continued.

Mitella pentandra Hook.
Mitella stauropetala Piper
Moneses uniflora
Oenothera sp
Opuntia polyacantha Haworth
Orthilia secunda (L.) House
Osmorhiza depauperata Phil.
Osmorhiza sp.
Oxypolis fendleri (Gray) Heller
Oxypolis sp.
Pedicularis crenulata
Pedicularis groenlandica Retz.
Pedicularis parryii
Pedicularis sp.
Penstemon rydbergii A. Nels.
Penstemon sp.
Plantago major
Plantago sp.
Plantago tweedyi Gray
Platanthera hyperborea
Polemonium sp.
Polygonum bistortoides
Polygonum sp.
Polygonum viviparum L.
Portulaca sp.
Potamogeton sp.
Potentilla argentea L.
Potentilla hippiana Lehm.
Potentilla pulcherimma x hippiana
Potentilla sp.
Primula parryi Gray
Prunella vulgaris L.
Pseudocymopteris sp.
Pseudocymopterus montanus (Gray) Coult. & Rose
Pseudostellaria jamesiana
Psoralidium lanceolatum
Puccinellia nuttalliana
Pyrola asarifolia ssp. asarifolia
Pyrola minor
Pyrola picta
Pyrola sp.
Ranunculus abortivus L.
Ranunculus alismifolius Geyer ex Benth.
Ranunculus sp.

Appendix 1., Continued.

Rorippa sphaerocarpa
Rubus idaeus L.
Rubus parviflorus var. parviflorus
Rudbeckia laciniata var. ampla (A. Nels.) Cronq.
Rumex crispis
Rumex sp.
Salsola collina
Saxifraga odontoloma Piper
Scutillaria galericulata var. epilobiifolia
Sedum integrifolium ssp. integrifolium
Sedum rhodanthum Gray
Senecio integerrimus Nutt.
Senecio sp.
Senecio triangularis Hook
Sibbaldia procumbens L.
Sidalcea neomexicana
Sidalcea sp.
Sisyrinchium palidum
Solidago sp.
Solidago spathulata DC.
Sorbus scopulina Greene
Sphaerophysa salsula
Sphralcea coccinea
Stachys palustris subsp. Pilosa
Stellaria longipes (Rydberg)
Stellaria sp.
Stellaria umbellata
Streptopus amplexifolius var. chalazatus Fassett
Swertia perennis L.
Taraxacum officinale G.H. Weber ex Wiggers
Thalictrum alpinum L.
Thalictrum fendleri Engelm. ex Gray
Thalictrum sp.
Thalictrum sparsiflorum Turcz. ex Fisch. & C.A. Mey.
Thermopsis divaricarpa Nelson
Thermopsis rhombifolia var. montana (Nutt.) Isely
Thlaspi arvense L.
Thlaspi montanum L.
Thlaspi sp.
Tragopogon sp.
Trautvetteria caroliniensis (Walt.) Vail
Trifolium brandegei
Trifolium longipes ssp. pygmaeum (Gray) J. Gillett
Trifolium pratense

Appendix 1., Continued.

Trifolium repens L.
Trifolium sp.
Trollius laxus ssp. albiflorus
Unknown forb
Urtica dioica ssp. gracilis (Ait.) Seland.
Valeriana capitata Pallas ex Link
Valeriana sp.
Veratrum tenuipetalium Heller.
Veronica americana Schwein. ex Benth.
Veronica nutans (=wormskjoldii Roemer & J.A. Schultes
Veronica peregrina L.
Veronica sp.
Veronica wormskjoldii Roemer & J.A. Schultes
Veronicastrum serpyllifolia ssp. serpyllifolia
Vicia americana Muhlenberg.
Vicia sp.
Viola adunca Sm.
Viola canadensis var. corymbosa Nutt. ex Torr & Gray
Viola labradorica Schrank
Viola sp.
HORESTAILS
Equisetum arvense L.
Equisetum hymenalis L.
Equisetum laevigatum A. Braun
Equisetum pratense Ehrhardt
Equisetum sp.
Equisetum variegatum Schleich. ex F. Weber & D.M. H. Mohr

.

Appendix 2. Memorandum of Understanding for a Colorado Statewide Riparian Classification.

NOTE: Appendix 2 is not available. Please contact the Colorado Natural Heritage Program for information, if necessary

Appendix 3. 1995 and 1997 Example Riparian Field Forms.

ABLA-Pien/ACIN   CA

FORM I.   RIPARIAN SITE SURVEY FORM   Plot No. 95RG13
CNHP 5/94

Y171

IDENTIFICATION AND LOCATION   Stratification Cell Type B3N

MANUAL 92A
STATE CO

Site Photo(s) 1.20

SITENAME Rock Creek   Mark Aiken + Erika VanWie

MO DAY YEAR   EXAMINERS

6 - 28 - 95

COUNTY: Rio Grande   QUADNAME: Granite Mountain   QUADCODE: 3710643

37N T/ 6E R/ 18 S/ SW 4S/ SE 4/4 95RG13   SECTION(s)

T/ R/ S/ 4S/ 4/4   SECTION(s)

Lat North 37 Deg 26 Min 45 Sec   Long West 106 Deg 21 Min 33 Sec

PURP E PREC S

ELEVATION 9640   VALWID 100'   VALSLP (GRADIENT) 80'/2200'

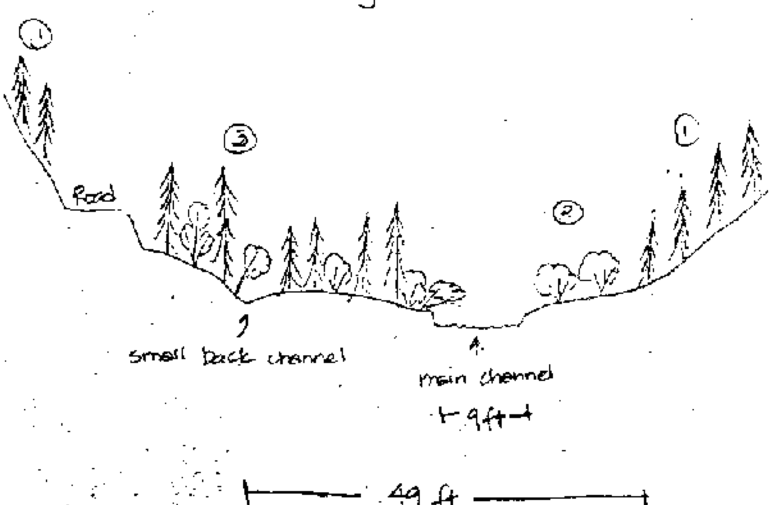
DIRECTIONS --> From Monte Vista head south on Gunbarrel Road (Hgwy 15) for 3 miles to USFS Rd 28 (county Rd 28). Head west. Site is 16.5 miles from Hgwy 15, just downstream of Comstock CG.

ELEMENT OCCURRENCES

Obs.#	Description (dominant spp. etc.)	% of site	Plot No.
(1)	Picea engelmannii - Abies lasiocarpa		
(2)	Salix bebbii - Salix drummondiana	30%	
(3)	Picea engelmannii/Alnus incana - Salix	30%	95RG13

SKETCH MAP (draw a cross-sectional profile of channel and valley floor; note (1) riparian communities (2) upslope communties or dominate plant species (3) plot locations, (4) natural landmarks (road, cliffs, etc.) (5) indicate scale (channel width, etc.). If room, draw a birds-eye sketch, indicate direction of river flow and North. Include any disturbance features, such as structures, trails, logging areas, etc.)

looking E (80°)



95RG13

FORM I. SITE SURVEY FORM Page 2

SITE DESCRIPTION/DESIGN

SITE DESCRIPTION (landscape condition and adjacent ct's)--> Site is in steep sided narrow valley with a road along the north side. Picea engelmannii-Abies lasiocarpa forests with occassional Populus tremuloides dominate the uplands. The riparian area consists of patches of Picea engelmannii / Alnus incana - Salix spp and patches dominated by Salix communities. Although the site is close to a road there are few signs of use.

TOPOGRAPHIC BASE MAP:

y yes ___ no 1. element locations and/or boundaries?

___ yes ___ no 2. both primary and secondary boundaries?

BOUNDARY JUSTIFICATION--> 1° boundary is element occurence.

PROTECTION URGENCY	MANAGEMENT URGENCY
U1 immediate threat	M1 needed this year
U2 threat w/i 5 yrs	M2 needed w/i 5 yrs (or loss)
U3 threat but not w/i 5 yrs	M3 needed w/i 5 yrs (or degrade)
U4 no threats	M4 may be needed in future
U5 land protected	M5 none needed
PU COMMENTS:	MU COMMENTS: Campgrounds located along stream have lots of trash. Campsites developing in flat sites along stream.

STEWARDSHIP

LAND USE COMMENTS --> Site does not appear to be grazed, but timber sales and recreational use are affecting quality of site and drainage. Road does not connect to anything but is used frequently.

POTENTIAL HAZARDS --> Holes in the ground.

EXOTIC FLORA/FAUNA COMMENTS--> Taraxacum officinale

OFF-SITE CONSIDERATIONS--> Selective tree harvesting near headwaters of stream. Numerous closed roads in the area. Campgrounds in area do not seem heavily used but are heavily impacted by the visitors.

SITE AND ELEMENT MANAGEMENT NEEDS --> Monitor visitor use

Plot #95-RG-13

FORM II. RIPARIAN COMMUNITY SURVEY FORM CNHP 5/94

GENERAL TRANSECT DATA

MANUAL 92A

TRANSECT IDENTIFICATION

Units: meters (unless otherwise noted)

PLOT NO. 95-RG-13 EOCODE ________*____

DL Tree Dominant Species Picea engelmannii

Community Occurence Size (acres) 50m × 15m (patch) - 5-7 patches over a 1 mile stretch.

(**Remember to map/label occurence on topo!***)

Transect Length 50 m + ______ + ______ = 30m TOTAL (min)

ENVIRONMENTAL FEATURES

(Soil Taxon ______________________)

PM MIAL (4-letter code) PLOT POS NVFP (4-letter code)

ASP flat degrees Stream Bearing 80° degrees Slope flat %

Horizon Angle (%): N 41 E 41 S 46 W 39

RIPARIAN FEATURES

Riparian Width (stream and both sides) 49 ft/m (circle one)

Bnkfl Channel Width 6' Channel Depth (pl/rfl) 1.2 1.4 1.3 ___ AVE 1.3'

Channel Entrenchment (2x bnkf dpth=fldprn wid/bkchnl wid)

___very ___med x slight Rosgen Channel Type C4 (looks more like a B)

Water Source x Direct ______ Indirect

Stream Gradient 4.1 - 7.4 Ft/37.5 ft + 33 ft. Dist * 100 = 4.7 %

Channel Bed Material: silt ______% sand 20 % gravel 35

cobble 25 % boulder 20 %=100%

Dist from BnkflChnl (frm center of stand) 8 m ft/m (circle one)

Height above BnkflChnl 0.1 ft ft/m (frm center of stand)

Height Surface

1. ______ ______

2. ______ ______

3. ______ ______

4. ______ ______

Stand Description (physical) Stand has an irregular surface both parallel and perpendicular to stream. At points stream flows under community, and sod bridges connect the vegetation. A small dry channel follows along the back of the community creating a narrow band of Alnus incana and Salix species.

COMMUNITY OCCURRENCE CONSERVATION RANKING

QUAL B Com: Small patch that repeats several times along the channel

(in comparison with others; size, productivity, vigor, regen)

COND B Com: Taraxacum officinale

(exotics, habitat pristine, recoverable, degraded, etc.)

VIAB C Com: Selective tree harvests and road crossings upstream

(intrinsic biological factors, physical processes intact for long term survival; resiliency)

DEFN C Com: close to road, campgrounds/campsites upstream + downstream

(likelihood of long term survival based on social/biophysical factors; vulnerability)

RANK C Com: close to road

THREATS

MGMT: Rio Grande NF Del Norte District

OWNERPROT y PROT:

DATA SENS no BESTSOURCE 1995 Rio Grande NF Riparian Survey Mark Aitken + Erika VanWie

Metric Conversion: 1 ft. = 0.3048 meters 3.281 ft. = 1 meter

LINE INTERCEPT FOR TREES AND SHRUBS PLOT NO. 95RG13

TRANSECT 1 50 m

													TOT	COV
TREES--TOTAL" COVER	1.0 42.2-42		1.1 41.9-40.8	5 35.9-30.9	1.1 27.8-26.7	2.9 26.6-23.7	4.2 19.2-15	2.8 9.5-6.7	2.7 6.3-3.6				29.2	59
Abies lasiocarpa 3	50-48.1												1.9	4
Picea engelmannii 3	1.5 50-48.5	5.9 48.1-42.2		4.9 40.8-35.9	33.9-27.8 0.1	4.5 23.7-19.2	5.6 6-?5	2.4 8.7-6.3	36				31.5	63
Abies lasiocarpa 1	0.4	0.4	0.1	0.3									1.2	3
SHRUBS--TOTAL COVER	1.7 50-48.3		2.4 48.4-46	3.1 45.4-42.3	0.3 42.2-41.9	1.8 41.7-39.9	6.1 39-32.9	0.8 32.5-31.7	1.5 30.9-29.4	1.9 29.3-14.3	3.3 10.2-6.9	3.1 5.8-2.7	6.9	14
Lonicera involucrata	0.1	0.3	0.8 31.7-30.9										1.2	3
Rosa woodsii	0.3												0.8	1
Salix boothii	0.1	0.9 39.9-39	1.1 6.9-5.8	0.3									2.9	6
Alnus incana	0.1	0.2	2.2 27-6.5										2.5	5
Ribes inerme	0.1	0.4	0.1	0.1									0.7	2

TRANSECT 2 ___ m

TREES--TOTAL COVER

SHRUBS--TOTAL COVER

COMMENTS (other species observed, etc.) Salix drummondiana

1=SEEDLING(<4.5'/1.25M) 2=SAPLING(>4.5',<5"dbh) 3=MATURE(>5"/12.6cm dbh)

CANOPY COVER OF MICROPLOTS

PLOT NO. [illegible]

TRANSECT 1 50 m — TRANSECT 2 ____ m

	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	TOT	COV
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48						
GRAMS--TOTAL COVER	10	3	10	–	16	10	–	26	10	–	10	3	3	–	16	–					99	7
Glyceria grandis	10	3			3	1			1												18	2
GR18 – Carex sp.		3			10	10		20	3												46	3
little dumps GR20 Poaceae sp.			10												10						20	2
Juncus arcticus								3													3	1
Deschampsia cespitosa									3												3	1
Calamagrostis canadensis											3	3	3								9	1
c Carex sp.											10										10	1
FORBS--TOTAL COVER	50	40	3	–	40	30	–	60	10	10	30	30	3	10	20	10					346	22
Erigeron sp. - wide smooth leaves	40	10	3		3	3						10				10					79	5
Potentilla sp.	3	20				3															26	2
GR-19 – Fragaria sp. vesca?	10	3			10									3							26	2
Achillea ~~lanulosa~~ mill.		10			10			10	3												33	2
Oxypolis fendleri		3									20										23	2 *
Galium bifolium		1									1		3								5	1
4 lvs Galium trifidum		1									1										2	1
Equisetum pratense			1		1						1	3	3								9	1
Conioselinum scopulorum					10																10	1
Geranium sp.					10	10															20	2
Epilobium angustifolium						3															3	1
Erigeron sp. fuzzy lvs						10		30													40	3
Taraxacum officianale						10		10													20	2
Geum macrophyllum								10			3										13	1
Maianthemum stellatum								3		10											13	1
Pseudocymopteris montanus									3						10						13	1
Pentaphylloides floribunda									3												3	1
Cardamine cordifolia											10	3			10						23	2 x
tiny flws, trailing											3										3	1
Mertensia ciliata												10			3						13	1
Aconitum columbiana												10									10	1 x
Thalictrum sp.														10							10	1
SHRUBS																						
Fern																						
Lichens																				0		
Bare soil						10				10	74									6	94	5.9
Gravel < 76mm																				0		
Rock > 76 mm																				0		
Litter	98	89	94	100	98	58	100	92	99	80		79	99	94	89	99				86	1373	85.8
Wood > 2cm diam											10	10			10					2	30	1.9
Moss		10	5			30		5		10		10								4 8	70	4.4
Basal Vegetation	2	1	1		2	2		3	1		1	1	1	1	1	1				1 3	18	1.1
Other water											15									1 2	15	0.9

Additional species in the stand: Bistorta sp., Luzula parviflora; Valeriana capitata

Noccea montana

Ground Cover Disturbance

CNHP COMMUNITY SURVEY FORM SOIL DESCRIPTION 5/94

PLOT # 95RG13 DATE 6.28.95

INVESTIGATOR Airren (SOIL SERIES)

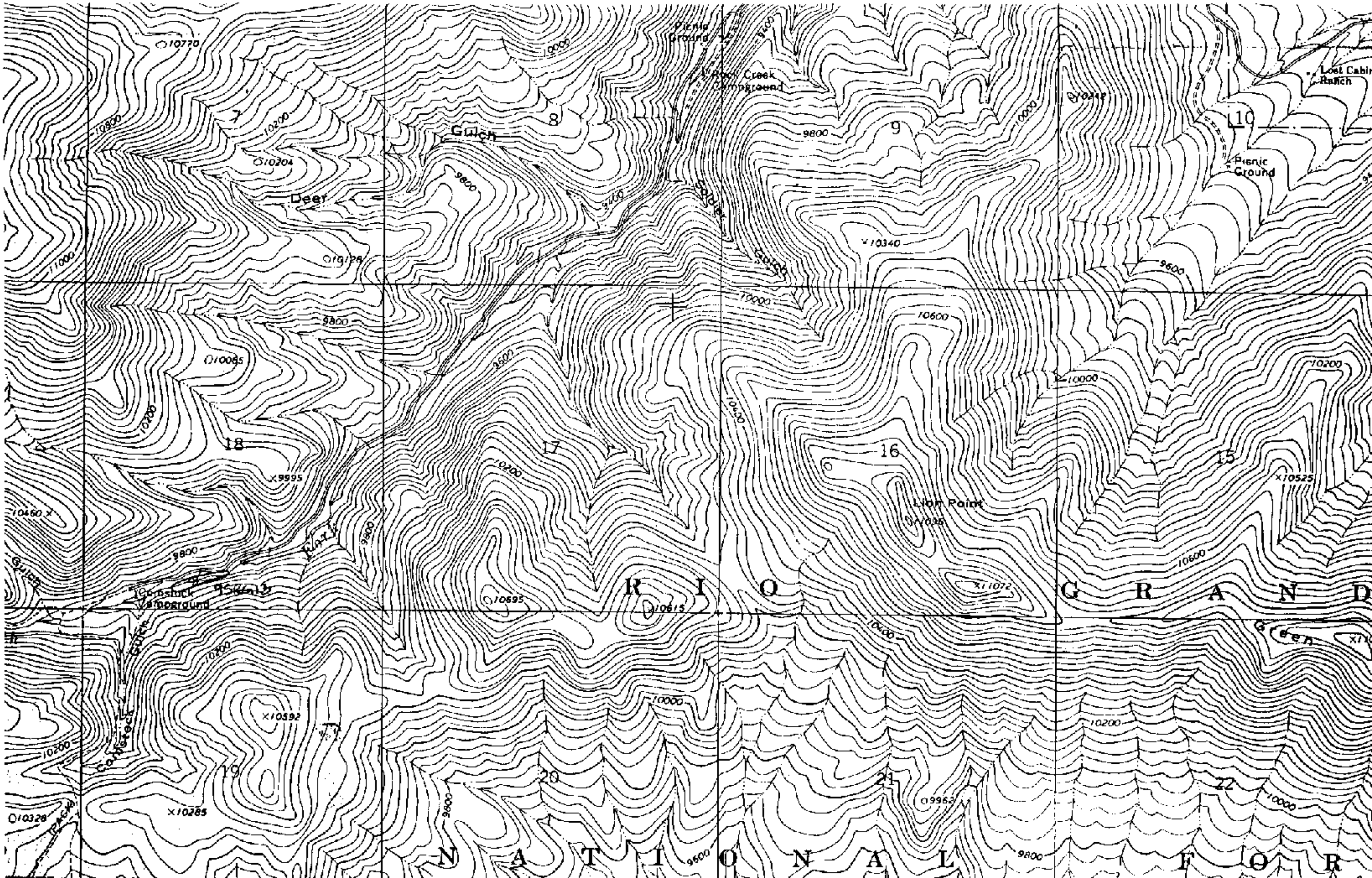
(SOIL CLASSIFICATION)

ESTIMATED DEPTH: TO ROCK LAYER 1 2 3 TO WATER TABLE 1 2 3

1=<.5M 2=.5-1M 3=>1.2M

HORIZON	DEPTH cm	TEXTURE	COLOR(moist)	STRUCTURE	COARSE	COMMENTS (90% root depth, charcoal, etc.)
litter	2-0				—	1.5" - 4" diam. roots crossing through pit prevent digging beyond 56 cm.
A	0-4	silty clay (borders silty clay loam)	5Y 2.5/1	subangular blocky fine weak	—	
abrupt						
B	4-16	silty clay	5Y 2.5/2	angular blocky fine, weak	—	
not clear boundary						
Bl c	16-56+	silty clay loam (on border w/ silty clay)	5Y 2.5/1	subangular blocky fine, weak	cobble 30%	fine roots present

Comments should include information on the following (evidence of mottles or gleying, rooting depth, water table depth, etc.)


RIO GRANDE
NATIONAL FOR
Lost Cabin Ranch
Picnic Ground
Picnic Ground
Rock Creek Campground
Gulch
Deer
Soldier
Gulch
Lion Point
Green
Comstock Campground
Comstock
Gulch
7
8
9
10
15
16
17
18
19
20
21
22
10770
10304
10128
10065
9995
10595
10615
11072
10525
10340
10592
10285
10328
9963

[BOLD ITEMS]=BCD EOR/SBR FIELDS PLOT No. 97EV20

FORM I. **RIPARIAN SITE SURVEY FORM AND NATURAL COMMUNITY EOR FORM** CNHP 5/97

IDENTIFICATION AND LOCATION Stratification Cell Type 5

PHOTOS B/G roll 3/16-17

SURVEYSITE Piedrosa Creek & Hot Creek confluence **STATE** CO

SURVEYDATE 97 - 08 - 07 **OBSERVERS** Grantham & Van Wie

COUNTY: Cone **QUADNAME:** Terrace Reservoir **QUADCODE:** 3710633

35N **T/** 6E **R/** 11 **S/** NE **1/4/** SW **4/4** [TRSNOTE]

___ **T/** ___ **R/** ___ **S/** ___ **1/4/** ___ **4/4** [TRSNOTE]

LAT North ___ Deg ___ Min ___ Sec **LONG** West ___ Deg ___ Min ___ Sec

PURP E **PRECISION** S

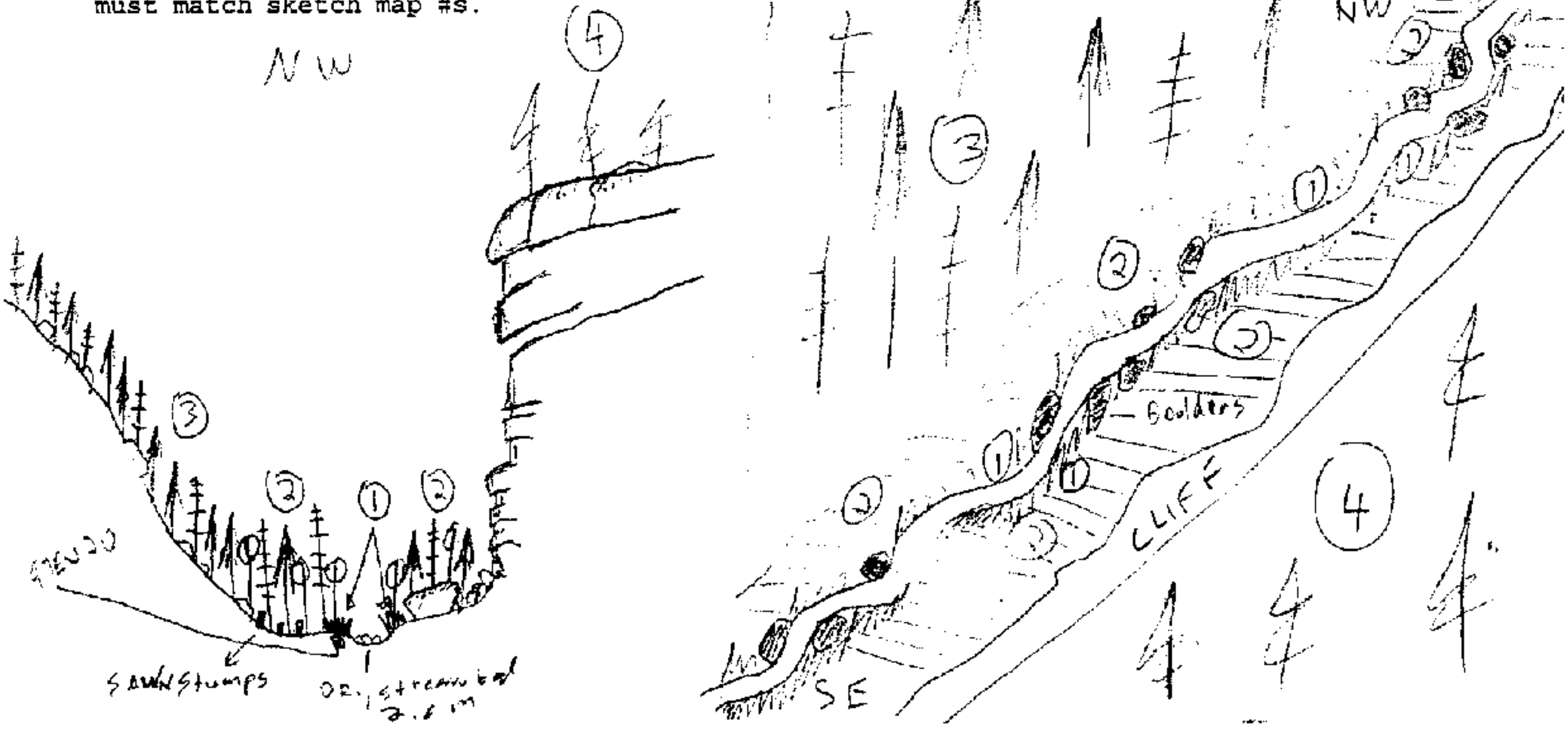
ELEVATION 8480 **VALWID** 150' **VALSLP** (GRADIENT) 40'/600': 6° along Piedrosa Creek

DIRECTIONS --> Plot is 2.8 AIR MILES south of JACOBS HILL. From Monte Vista take Hwy 15/Sunshine Rd. south 20 miles to Cortez. Take X Rd/FR255 west 2.8 miles to FR254. Follow through Hot Creek State Wildlife Area for 4 miles, just outside SWA. Hike down into canyon and walk ~0.5 mi to just above confluence of Hot Creek and Piedrosa Creek. Site is along Piedrosa Creek

ELEMENT OCCURRENCES

Obs.#Description (dominant spp. etc.)	% of site	Plot No.
(1) Abies concolor - Pseudotsuga menziesii - Populus tremuloides / Cornus sericea		97EV20
(2) Abies concolor - Pseudotsuga menziesii - Populus tremuloides		
(3) Pseudotsuga menziesii - Abies concolor / Ribes cereum - Fragaria virginiana		
(4) Pinus ponderosa		

SKETCH MAP (draw a cross-sectional profile of channel and valley floor; note (1) riparian communities (2) upslope communities or dominate plant species (3) plot locations, (4) natural landmarks (road, cliffs, etc.) (5) indicate scale (channel width, etc.). If room, draw a birds-eye sketch, indicate direction of river flow and North. Include any disturbance features, such as structures, trails, logging areas, etc.). Observation #s must match sketch map #s.



[BOLD ITEMS]=BCD EOR/SBR FIELDS PLOT No. [illegible]

SITE SURVEY FORM

GENERAL SITE DESCRIPTION

SITE DESCRIPTION [**GENDESC**] (landscape condition and adjacent ct's)

Occurrence is within a narrow slot canyon with steep 60-70' [illegible] on North east side of creek & steep hill [illegible] on the southwest. There are many boulders present. Stream is currently dry but shown as perennial on the map. The vegetation on the slopes is mixed conifer w/ little understory. Along the stream, [illegible] is present along with Cornus sericea & Rosa & Ribes under mixed conifer species. This entire canyon is a very interesting place in nearly pristine condition. There are no trails or roads going through. Below the confluence of [illegible] Creek and [illegible] Creek, the community instantly changes to Alnus incana - Cornus sericea/mesic forb. It is very dense and confined to a very narrow canyon

TOPOGRAPHIC BASE MAP [**BOUNDARIES**] : in some places there are large patches of Cicuta douglasii. Below that, there is a very long series of beaver ponds that continue for a 0.5 - 1 miles. NEAT PLACE!

X yes __ no 1. element locations and/or boundaries?

__ yes X no 2. both primary and secondary boundaries?

SITE-BOUND JUSTIFICATION--> element occurrence

MANAGEMENT URGENCY M1 M2 M3 M4 M5 (circle one)

MGMTCOM

LAND USE COMMENTS --> area is used by the occasional camper. There were fresh [illegible]

POTENTIAL HAZARDS --> [illegible]. Slippery [illegible]. Narrow drainage could be hazardous during potential flash floods.

EXOTIC FLORA/FAUNA COMMENTS--> Few to no exotics

OFF-SITE CONSIDERATIONS--> Stream bed is currently dry [illegible] rains occurred in the area the day before.

SITE AND ELEMENT MANAGEMENT NEEDS --> None [illegible]. [illegible] please.

PROTECTION URGENCY P1 P2 P3 P4 P5 (circle one)

PROTCOM/THREAT ASSESSMENT

Stress	Source	Element Impact	Severity	Immediacy	Info

Urgency ranks

P1=immediate threat 2=w/in 5 yrs 3=not w/in 5 yrs 4=no threats 5=protected

M1=immediate mgt need 2=need w/in 5 yrs or loss 3=need w/in 5yrs or degrade

4=future mgt need 5=none needed

[BOLD ITEMS]=BCD EOR/SBR FIELDS PLOT No. 97EV20

COMMUNITY OCCURRENCE CONSERVATION RANKING [EORANKCOM]

QUAL A Com: Good size & good productivity.

(in comparison with others; size, productivity, vigor, regen)

COND A Com: Few to no exotics. Habitat nearly pristine. Some evidence of old limited logging - old tree stumps present.

(exotics, habitat pristine, recoverable, degraded, etc.)

VIAB B Com: No water in stream! The community seems fine though it consists predominantly tree & shrubby.

(intrinsic biological factors, physical processes intact for long term survival; resiliency)

DEFN A Com: Accessibility to the area by humans or cattle is difficult & unlikely. Many boulders & dense veg. make travel here difficult.

(likelihood of long term survival based on social/biophysical factors; vulnerability)

RANK A **EORANKCOM:** excellent, pristine community in canyon w/ limited access
[EORANK]

RIPARIAN AREAS FUNCTION AND CONDITION RANK **[EORANKCOM]**

Stream bottoms: NA Com: Currently no water present. Stream bottoms are clear of silt or mud.

Stream Banks: A Com: Stream banks are vegetated & stable.

Hydrologic Regime: N/A Com: Currently no water in stream. It is unknown as to why.

Livestock Grazing: A Com: No grazing by livestock apparent.

Vegetation Cover: A Com: Vegetation is 99.9% native & in good health [illegible].

Mosaic: A Com: Appears to be a long & contiguous occurrence with little to no gaps

COMMENTS

THREATS **[PROTCOM]**

MANAME: Rio Grande Nat. For. **OWNER:** **CONTAINED**

PROTCOM:

DATASENS N

[BOLD ITEMS]=BCD EOR/SBR FIELDS PLOT No. 97EU20

FORM II. RIPARIAN COMMUNITY SURVEY FORM -- CNHP 5/97

GENERAL TRANSECT DATA MANUAL 97A

TRANSECT IDENTIFICATION Units:meters (unless otherwise noted)

PLOT NO[**EODATA**] .97- EU - 20 **EOCODE**______*___

DL 5 Dominant Species Cornus sericea Prunus virginiana

Mappable Community Occurrence width x length [illegible] x [illegible] *

(**Remember to map/label occurrence on topo!***) [illegible] / 43560 = 4.6 Ac

Conversions: 1 ft.=0.3048 meters 3.281 ft.=1 meter 5280 ft.=1 mile
1 ac=43560 $ft.^2$ 640 ac=1 mi^2 1 ac=0.4047 ha

ENVIRONMENTAL FEATURES

PM MIAL (4-letter code) PLOT POS MVSB (4-letter code)

ASP / degrees Stream Bearing 125° degrees Slope / %

Horizon Angle (%): N 22 E 40 S 39 W 37

RIPARIAN FEATURES

Riparian Width (stream and both sides) 20 ft/m (circle one)

Bnkfl Channel Width 3.1m Channel depth (pl/rfl)max 35 min 33 [illegible]

Channel Entrenchment (2x bnkf dpth=fldprn wid/bkchnl wid)
___very X med ___slight

Water Source X Direct ______Ind Rosgen Channel Type A [illegible]

Stream Gradient 2.62 - 1.54 Ht/13.6 +_____Dist * 100 = 8 %

Channel Bed Material: silt / % sand 10 % gravel 20 % cobble 60 %
boulder 10 %=100%

Dist from BnkflChnl (frm center of stand) 1.9 ft/m (circle one)

Height above BnkflChnl 0.1 ft/m (from center of stand)

Height Surface

1. 1.7 ______
2. 1.54 ______

Stand Description[**GENDESC**] (physical) Stand occurs on stream bank & a little into flood plain. Large [illegible] c [illegible] [illegible] [illegible] consists of deciduous shrubs.

[BOLD ITEMS]=BCD EOR/SBR FIELDS PLOT No. 97 EV20

FORM IIIA. LINE INTERCEPT FOR TREES AND SHRUBS Transect Length 50 m

TREES [EODATA IF >10% COVER]

		TOT	COV
TOT TREE COV	48.9-38.3/34.8-22.4/21.3-12.8/10.5-9.5/7.5-6.7/5	37.7	75
Abies concolor 3	48.8-47.3/33.1-30.3/23.7-22.4/	5.6	11
Juniperus scopulorum	44.6-44/27.5-27	1.1	2
Pseudotsuga menziesii 2	48.3-47.7/	0.6	1.2
Pseudotsuga menziesii 3	44.7-39.8/34.5-33.1/30.3-24.7/21.2-13.8	22.3	45
Picea pungens 3	41.1-38.3/0.3/24.6-23.1/21.3-20.7/5-1	9.2	18
Populus tremuloides 1	34.8-34	0.8	2
Populus tremuloides 3	30-27.9/25.8-23.5/14.1-12.8/10.5-9.5/7.5-6.7/1	8.5	17
Pseudotsuga menziesii 1	27.1-26.4/	0.7	1

SHRUBS [EODATA IF >10% COVER]

		TOT	COV
TOT SHR COVER	50-44.6/44.3-43.2/0.4/0.7/0.5/0.3/38.4-37/0.4/0.7/0.1/0.3 0.3/0.4/0.4/28.2-27.5/0.3/25-5.1/4.8-	37.1	74
Cornus sericea	50-44.6/0.5/38.4-37/0.2/25-13.3/12.6-11.7/0.2/9.1-8.4/ 0.1/6.4-5.2/0.1/3-	25.4	51
Ribes montigenum	0.2/0.1/0.3/9-8.4/0.2/	1.4	3
Holodiscus dumosus	49.5-49/0.3/10.5-9.5/	1.8	4
Rosa woodsii	47.7-47.4/0.1/43.7-43.3/0.2/38.4-37.9/0.2/0.1/0.3/0.4/0.1/ 0.1/11.9-11.4/0.1/0.2/0.3/0.1/0.2/0.2/	4.3	9
EV04 Physocarpus monogynus	0.1/0.1/0.2/44.6-44.4/44-43.4/0.4/0.3/0.4/28.2-27.5/0.3/ 22.9-22/16.7-16.3/0.3/13.3-12.8/0.3/0.3/0.2/0.3/0.2	6.8	14
Prunus virginiana	45.6-45.1/44.3-43.9/43.5-43.2/0.4/0.3/0.2/17-16.6/ 15.1-14.8/0.2/13-12.6/11.5-10.7/9.5-9.2/0.2/7.9-6.9/ 6.1-5.8/5.2-5.1/4.2-3.1/2.6-2.3/	8	16
EV05 Amelanchier utahensis	0.2/11.6-10.1/	1.7	3

OTHER COMMON SPECIES OBSERVED BUT NOT MEASURED IN TRANSECT [EODATA]

COMMENTS

1=SEEDLING(<4.5'/1.25M) 2=SAPLING(>4.5',5"dbh) 3=MATURE(>5"/12.6cm dbh)

[**BOLD ITEMS**]=BCD EOR/SBR FIELDS PLOT No. 97EV20

FORM IIIB. CANOPY COVER OF MICROPLOTS TRANSECT LENGTH 50 m

GRAMINOIDS [EODATA IF >10% COVER]									10							17	T	C
TOT GRAM COVER	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	Ø
POAPRA																			

FORBS [EODATA IF >10% COVER]									10							17	T	C
TOT FORB COVER	–	–	–	–	–	–	–	–	–	–	3	20	3	10	–	–	–	36	2
TAROFF																			
Fragaria vesca											3	10	3	3				19	1
Vaccinium myrtillus											1	10		10				21	1

									10							17	T	C
BARE SOIL																			
GRAVEL <76mm																			
ROCK >75mm							35							10				45	3
LITTER	100	100	100	80	100	100	65	75	100	100	75	100	95	80	85	100	100	1555	91
WOOD >2cm diam				20														20	1
MOSS								25			25		5					55	3
FERN																			
LICHEN														10	15			25	1
OTHER																			

GROUND COVER DISTURBANCE-COMMENTS

[BOLD ITEMS] =BCD EOR/SBR FIELDS PLOT No.

FORM IV. CNHP COMMUNITY SURVEY FORM SOIL DESCRIPTION 5/97

PLOT # 97EV20 DATE 8-7-97

INVESTIGATOR Grantham (SOIL SERIES)

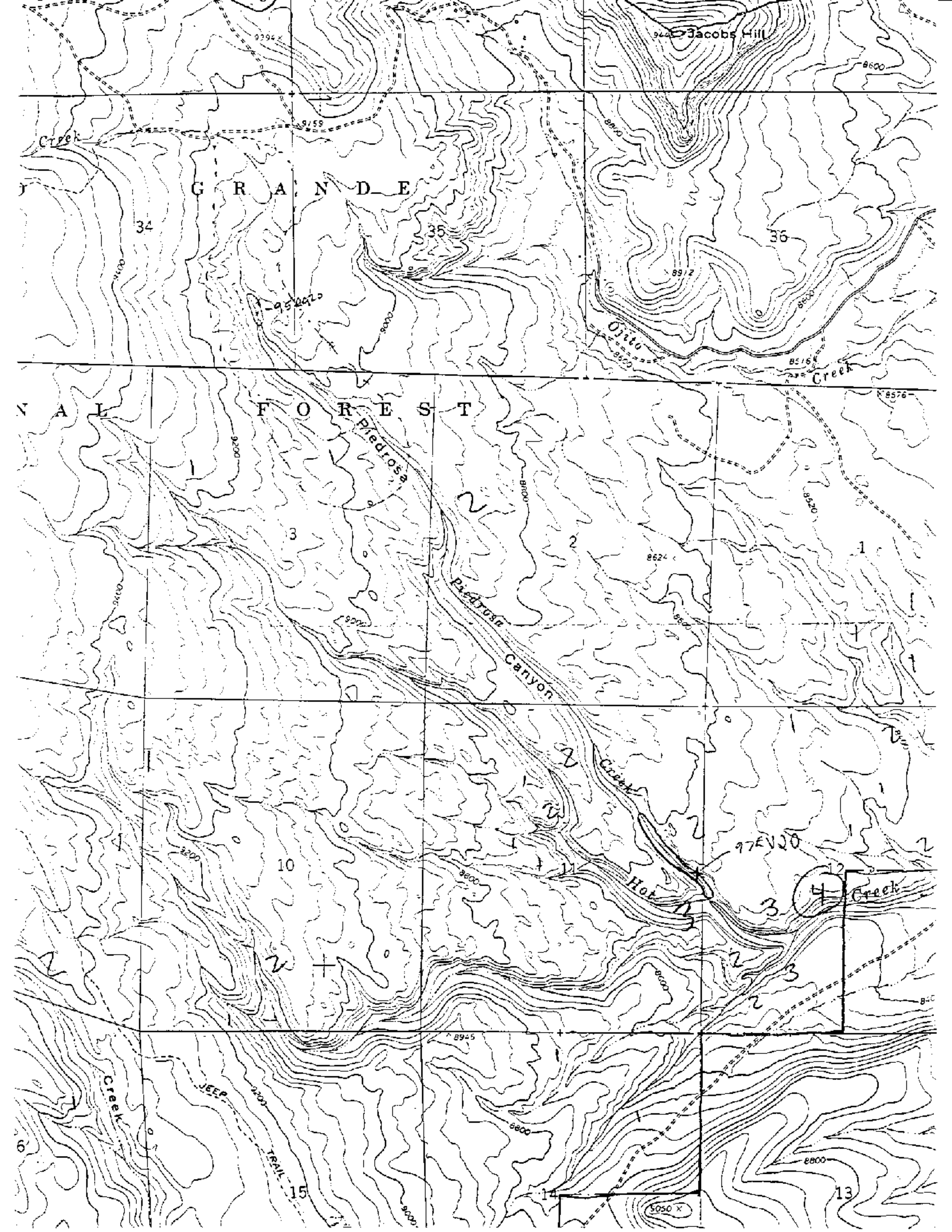
(SOIL CLASSIFICATION)

ESTIMATED DEPTH: TO ROCK LAYER 1 2 3 TO WATER TABLE 1 2 3
1=<.5M 2=.5-1M 3=>1.2M

HORIZON	DEPTH cm	TEXTURE	COLOR(moist)	STRUCTURE	COARSE	COMMENTS (90% root depth, charcoal, etc.)
Duff	2cm					Conifer & Bod decay litter
A/B	0-9cm	clay loam	10YR 2/1	sb, 3, m-c	5% cobble	Big cobble occupying side of horizon
Bt	9cm - 33cm+	clay loam	10YR 2/2	granular to sub. blocky	0%	This layer is very hard.

Comments should include information on the following: evidence of mottles or gleying, rooting depth, water table depth, etc.

97EV20



Jacobs Hill
8600
9159
Creek
G R A N D E
34
35
36
8912
Ojito
8516
Creek
8576
N A L
F O R E S T
Piedrosa
Piedrosa
Canyon
3
2
1
8624
Creek
10
11
12
Hot
Creek
8945
JEEP
TRAIL
Creek
15
14
13