A Classification of the Riparian Vegetation of the South Platte and Republican River Basins, Colorado 1998 Final Report

by

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Several individuals contributed to the success of this project. Lea Spears assisted in field data collection on in the South Platte study area, and entered data into the computer. Amy McMullen assisted in field data collection and edited early versions of this manuscript. Many people assisted with the logistics of the field season. We also would like to thank Will Tully of the BOR for assistance with access to BOR lands on the South Platte River, and the DOW managers, Larry Budde for providing camping, access, maps, advice and local history about DOW lands along the South Platte River. We thank Jeff Losche and Maggie Marston of the Pawnee National Grassland for lending us maps, providing free camping, and providing access to Research Natural Areas on the Grassland. Jonathan Friedman and Mike Scott of the NBS provided land owner information, and stimulating discussions on riparian ecology. In addition, Betsy Neely and Patrick Bourgeron of The Nature Conservancy conceived the idea of a state-wide basin by basin riparian classification project, and developed the methodology. Many private landowners provided access to their lands, without their cooperation this project would not be a success.

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SUMMARY

In this report we present results from field surveys conducted in 1995 and 1996 in the South Platte River Basin. We collected vegetation and environmental data from just under 300 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, similar species composition, and environmental setting. Three new plant associations are described from the main stem of the South Platte River, and several high quality foothill riparian areas were located in the upper parts of the watershed.

The classification presented is part of the Preliminary Vegetation Classification of the Western United States (Bourgeron and Engelking 1994) maintained by The Nature Conservancy's Western Heritage Task Force. This classification is hierarchical, and is based on the UNESCO Physiognomic-Ecological Classification of Plant Formations of the Earth (Mueller-Dombois and Ellenberg 1974, as revised by Driscoll *et al.* 1984 and The Nature Conservancy 1994). It is also cross-walked with the Classification of Wetland and Deepwater Habitats of the United States (Cowardin *et al.* 1979).

For each riparian plant association we describe the regional, state, and basin-wide distributions, and provide a general description including elevation, 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 classification is subject to peer review, field testing, and revision. This report is part of an ongoing project to develop a state wide classification of riparian vegetation. 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 Preliminary Vegetation Classification of the Western United States (Bourgeron and Engelking 1994) maintained by The Nature Conservancy's Western Heritage Task Force.

This project is a cooperative effort of 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) among all parties, consists of steering and technical committees that meet once a year to review methods, results, and 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 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. 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), and on the San Juan National Forest (Richard *et al.* 1996) (Figure 1). East of the contenintal divide, major watersheds include the Arkansas, South Platte, and the Rio Grande River basins. The Arkansas and South Platte 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), upper Arkansas (Pueblo west to the Continental Divide), and lower Arkansas (Pueblo east to the state line) (Figure 2). In this report, we present a classification of riparian vegetation from the upper and lower South Platte River Basins.

We classified representative homogeneous stands of riparian vegetation based on similar floristic composition and environmental setting. This classification is part of the Preliminary Vegetation Classification of the Western United States (Bourgeron and Engelking 1994) maintained by The Nature Conservancy's Western Heritage Task Force. It is based on the hierarchical UNESCO Physiognomic-Ecological Classification of Plant Formations of the Earth (Mueller-Dombois and Ellenberg 1974, as revised by Driscoll *et al.* 1984 and The Nature Conservancy 1994). It is also cross-walked with the Classification of Wetland and Deepwater Habitats of the United States (Cowardin *et al.* 1979).

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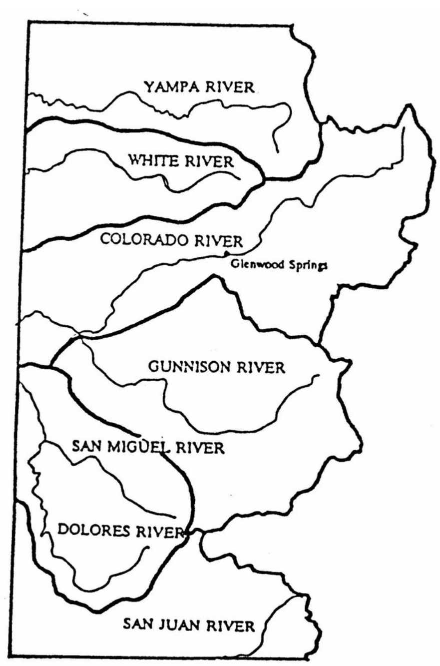


Figure 1. Map of the Major River Basins of the Colorado Western Slope.

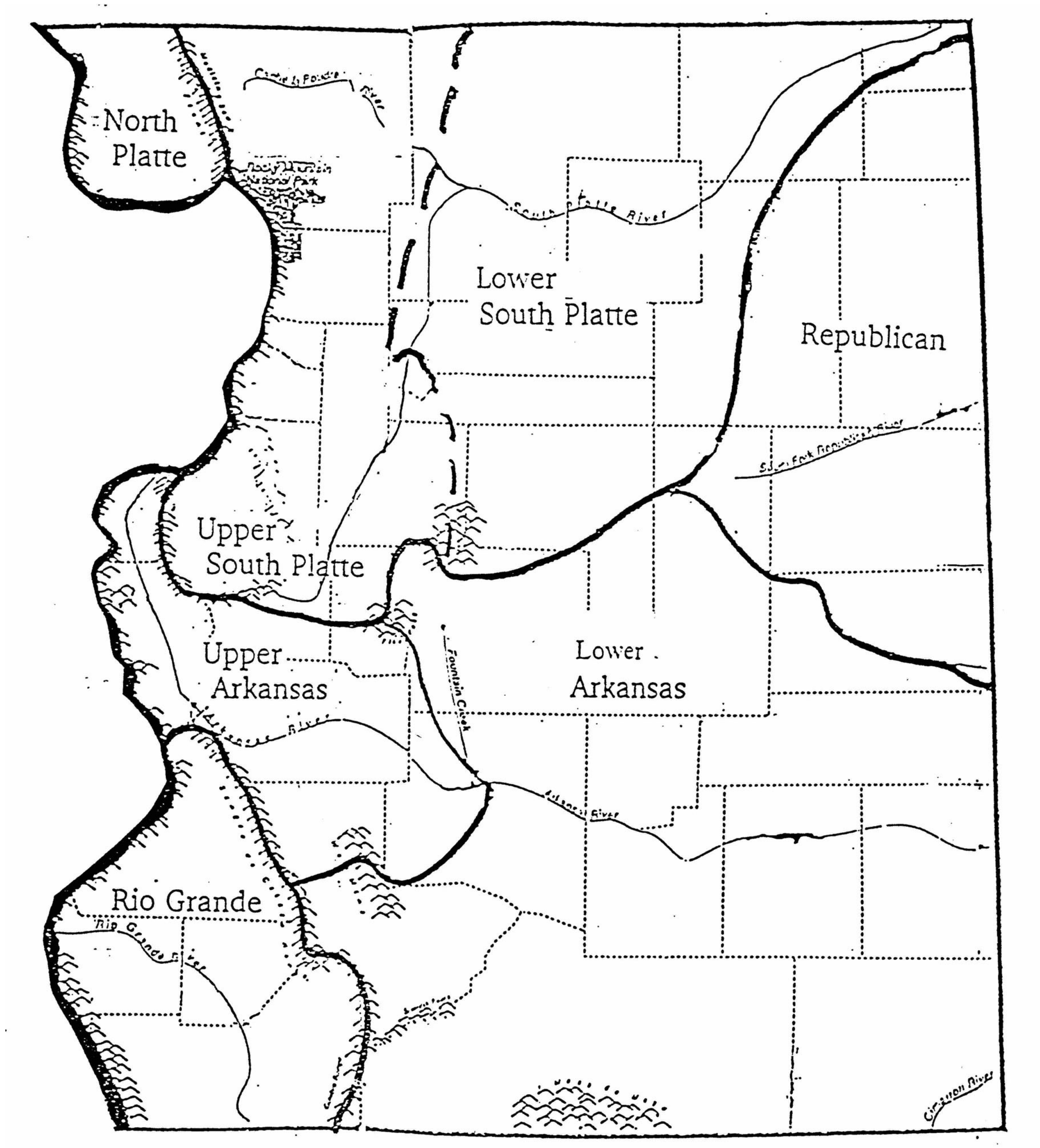


Figure 2. Map of the Major River Basins of the Colorado Eastern Slope.

STUDY AREA

This study focused on the South Platte River Basin in Colorado (Figure 3). The study area includes the watershed from the mountain divides between the North Platte River drainage at Cameron Pass on the west and the Arkansas River drainage in South Park to the south to the Nebraska, Kansas, and Wyoming state lines at eastern and northern boundaries, respectively. The South Platte River and its tributaries drain nearly one-fifth of Colorado, an area of approximately 12,138 square miles (USGS 1993). The South Platte basin was divided into two areas: the lower basin, encompassing the high plains of Colorado and the upper basin encompasses the mountainous and foothill regions.

The lower basin is relatively flat with gently rolling topography and is underlain by layers of the Cretaceous Pierre Shale Formation with thin layers of Tertiary sands and gravels that make up the Colorado Piedmont (Chronic 1980). Close to Denver and the Palmer Divide, tributaries are underlain by more consolidated sandstone and shale. Here, near-surface bedrock constrains lateral stream flow and keeps water from seeping into deeper aquifers, causing stream flow to be intermittent as it passes through areas of different geologic formations. Bedrock types used to stratify perennial stream reaches are given in Figure 4. Low annual precipitation and strong seasonal temperature changes characterize the high plains climate (Woodward-Clyde 1981). Precipitation increases with distance away from the mountains, ranging from 12 inches at Denver to roughly 20 inches in the far eastern counties (Colorado Climate Center).

Natural vegetation of the plains prior to European settlement was nearly entirely short grass prairie interrupted by low sandsage hills and patches of cottonwood and willows along the South Platte River (Mutel and Emerick 1984). Today much of the area has been converted to cropland or is used as range land. Forty percent of all Colorado agricultural production occurs along the Front Range. Irrigated acreage is increasing in eastern Colorado, adding demands on the shrinking Ogallala aquifer and in-stream water of the South Platte River (Woodward-Clyde 1981). Natural gas, petroleum, and coal represent important energy resources in the basin. Oil and gas production occurs primarily between Denver and Julesburg, with some coal production in northern Larimer and Weld counties (Woodward-Clyde 1981).

The upper basin of the South Platte watershed includes the foothills and mountainous terrain west of the I-25 corridor. This region encompasses the headwaters of the South Platte River, and is underlain with basement rocks that are mostly Precambrian gneiss and schist with granitic inclusions (Tweto 1979). In subalpine basins, streams flow over glacial till from the Pinedale and Bull lake glaciations. Elsewhere, streams and tributaries to the South Platte flow over Quaternary alluvial deposits of varying depth (except where bedrock is exposed in narrow canyon reaches). The upper glaciated reaches are in wide U-shaped valleys. Below elevations of the last terminal moraines, river canyons become narrow, and the rivers steeper, forming narrow, cool canyons with limited floodplain development. The elevational change is approximately 9,000 ft (2700 m) from over 14,000 to 5,000 ft at the base of the Colorado Front Range. The mountain front climate is characterized by cold, dry winters and hot, dry summers.

Nearly all precipitation comes in the winter as snow, with an average precipitation ranging from 40 inches in the higher mountain valleys to 10 inches at the base of the Front Range.

Hydrology of the South Platte River is primarily driven by spring and early summer snow-melt runoff from the mountains. The hydrology has been altered by several off-channel reservoirs, main stem flood control reservoirs, irrigation ditches, and channelized reaches. Large annual flooding can still occur (a 25 year return interval flood occurred in the spring of 1995) but peak floods in March, during ice-break up, have, for the most part, been eliminated (USFWS 1994). In addition transcontinental basin imports have added 300,000 acre-feet into the basin augmenting late-summer flows. Flows from plains tributaries result primarily from summer thunderstorms and can cause severe flooding, although these systems do not provide consistent significant flows to be considered part of the areas' water supply (Woodward-Clyde 1981).

Water quality of the South Platte River is severely degraded as if flows through Colorado's most populated corridor, Denver and the urban-industrial corridor to the north (USGS 1993). Concentrations of dissolved oxygen, fecal coliform bacteria, ammonia, and trace elements frequently do not meet water-quality standards (USGS 1993). These pollutants are diluted by several mountain tributaries that enter the river north of Denver. However, nitrates, nitrites, dissolved solids, selenium and suspended sediments soon become concentrated in the stream flow below Greeley due to runoff from agricultural areas (USGS 1993).

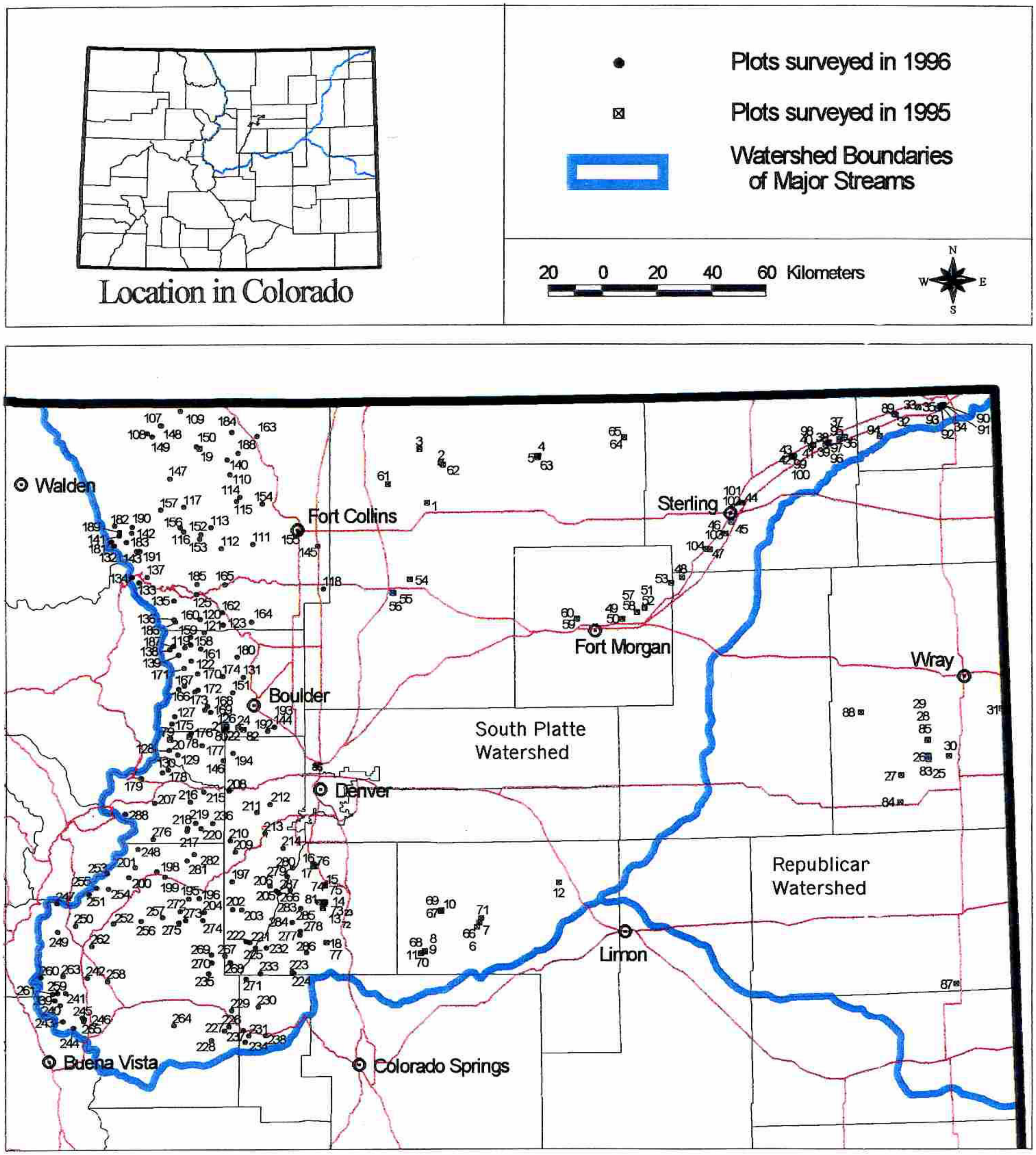


Figure 3. Map of the South Platte River Basin in Colorado, with sampling plot locations. See Table 1A. for plot location information.

Table 1A. South Platte River Basin Plot Locations and Land Ownership. Private land locations are withheld to protect landowner privacy. Abbreviations used: BLM= Bureau of Land Management, DOW= Colorado Division of Wildlife, NF= National Forest Service, NG= National Grassland, RMNP= Rocky Mountain National Park, WA= Wilderness Area. Map Numbers appear in Figure 3.

Map#	Plot #	Creek Name	County	Township/Range/Section	Owner
1	95GK01	Coal Creek	Weld	T08N R64W SEC 11	Pawnee NG
2	95GK02	Willow Creek	Weld	T10N R63W SEC 29	Pawnee NG
3	95GK03	Willow Creek	Weld	T10N R64W SEC 09	Pawnee NG
4	95GK04	Dave's Draw	Weld	T10N R60W SEC 24	Pawnee NG
5	95GK05	Dave's Draw	Weld	T10N R60W SEC 24	Pawnee NG
6	95GK06	West Bijou Creek	Elbert	Location Withheld	Private
7	95GK07	West Bijou Creek	Elbert	Location Withheld	Private
8	95GK08	West Kiowa Creek	Elbert	Location Withheld	Private
9	95GK09	West Kiowa Creek	Elbert	Location Withheld	Private
10	95GK10	Kiowa Creek	Elbert	Location Withheld	Private
11	95GK11	Kiowa Creek	Elbert	Location Withheld	Private
12	95GK12	East Bijou Creek	Elbert	Location Withheld	Private
13	95GK13	West Plum Creek	Douglas	T08S R68W SEC 14	Colorado Open Lands
14	95GK14	West Plum Creek	Douglas	T08S R68W SEC 11	Colorado Open Lands
15	95GK15	Plum Creek	Douglas	Location Withheld	Private
16	95GK16	Plum Creek	Douglas	Location Withheld	Private
17	95GK17	Plum Creek	Douglas	Location Withheld	Private
18	95GK18	West Plum Creek	Douglas	Location Withheld	Private
19	95GK19	Elkhorn Creek	Larimer	T09N R73W SEC 08	Larimer County
20	95GK20	South Boulder Creek	Gilpin	T02S R74W SEC 02	USFS
21	95GK21	South Boulder Creek	Boulder	T01S R72W SEC 25	USFS
22	95GK22	Winiger Gulch	Boulder	T01S R71W SEC 19	USFS
23	95GK23	Garber Creek	Douglas	T08S R68W SEC 11	Colorado Open Lands
24	95GK24	South Boulder Creek	Boulder	T01S R71W SEC 27	Boulder County
25	95GK25	Arikaree River	Yuma	Location Withheld	Private
26	95GK26	Arikaree River	Yuma	Location Withheld	Private
27	95GK27	Arikaree River	Yuma	Location Withheld	Private
28	95GK28	Arikaree River	Yuma	Location Withheld	Private
29	95GK29	Arikaree River	Yuma	Location Withheld	Private
30	95GK30	Arikaree River	Yuma	Location Withheld	Private
31	95GK31	Arikaree River	Yuma	Location Withheld	Private
32	95GK32	South Platte River	Sedgwick	T11N R46W SEC 16	DOW
33	95GK33	South Platte River	Sedgwick	T11N R45W SEC 04	DOW
34	95GK34	South Platte River	Sedgwick	T11N R44W SEC 05	DOW
35	95GK35	South Platte River	Sedgwick	T11N R44W SEC 07	DOW
36	95GK36	South Platte River	Logan	T10N R48W SEC 10	DOW
37	95GK37	South Platte River	Logan	T10N R48W SEC 08	DOW
38	95GK38	South Platte River	Logan	T10N R49W SEC 13	DOW
39	95GK39	South Platte River	Logan	T10N R49W SEC 14	DOW

Table 1A. Continued.

Map#	Plot #	Creek Name	County	Township/ Range/Section	Owner
40	95GK40	South Platte River	Logan	T10N R49W SEC 16	DOW
41	95GK41	South Platte River	Logan	T10N R49W SEC 17	DOW
42	95GK42	South Platte River	Logan	T10N R50W SEC 34	DOW
43	95GK43	South Platte River	Logan	T10N R50W SEC 34	DOW
44	95GK44	South Platte River	Logan	T08N R52W SEC 14	DOW
45	95GK45	South Platte River	Logan	T07N R52W SEC 05	DOW
46	95GK46	South Platte River	Logan	T07N R52W SEC 19	DOW
47	95GK47	South Platte River	Logan	T06N R53W SEC 04	DOW
48	95GK48	South Platte River	Washington	T05N R54W SEC 09	DOW
49	95GK49	South Platte River	Morgan	T04N R56W SEC 30	DOW
50	95GK50	South Platte River	Morgan	T04N R56W SEC 30	DOW
51	95GK51	South Platte River	Morgan	T04N R56W SEC 12	DOW
52	95GK52	South Platte River	Morgan	T04N R56W SEC 12	DOW
53	95GK53	South Platte River	Morgan	T05N R55W SEC 13	DOW
54	95GK54	Cache la Poudre R.	Weld	T05N R64W SEC 06	DOW
55	95GK55	South Platte River	Weld	T05N R65W SEC 21	DOW
56	95GK56	South Platte River	Weld	T05N R65W SEC 21	DOW
57	95GK57	South Platte River	Morgan	T04N R56W SEC 14	DOW
58	95GK58	South Platte River	Morgan	T04N R56W SEC 14	DOW
59	95GK59	South Platte River	Morgan	T04N R58W SEC 28	DOW
60	95GK60	South Platte River	Morgan	T04N R58W SEC 28	DOW
62	95LS01	Little Owl Creek	Weld	T09N R65W SEC 20	Pawnee NG
63	95LS02	Willow Creek	Weld	T10N R63W SEC 32	Pawnee NG
64	95LS03	David's Draw	Weld	T10N R60W SEC 24	Pawnee NG
65	95LS04	Two Mile Creek	Weld	T11N R56W SEC 32	Pawnee NG
66	95LS05	Two Mile Creek	Weld	T11N R56W SEC 32	Pawnee NG
67	95LS06	West Bijou Ranch	Elbert	Location Withheld	Private
68	95LS07	Kiowa Creek	Elbert	Location Withheld	Private
69	95LS08	West Kiowa Creek	Elbert	Location Withheld	Private
70	95LS09	Kiowa Creek	Elbert	Location Withheld	Private
71	95LS10	Kiowa Creek	Elbert	Location Withheld	Private
72	95LS11	West Bijou Creek	Elbert	Location Withheld	Private
73	95LS12	West Plum Creek	Douglas	T08S R68W SEC 14	Colorado Open Land
74	95LS13	West Plum Creek	Douglas	T08S R68W SEC 14	Colorado Open Land
75	95LS14	West Plum Creek	Douglas	Location Withheld	Private
76	95LS15	West Plum Creek	Douglas	Location Withheld	Private
77	95LS16	Plum Creek	Douglas	Location Withheld	Private
78	95LS17	West Plum Creek	Douglas	Location Withheld	Private
79	95LS18	South Boulder Creek	Gilpin	T01S R73W SEC 34	USFS
80	95LS19	South Boulder Creek	Gilpin	T02S R74W SEC 02	USFS
81	95LS20	South Boulder Creek	Boulder	T01S R72W SEC 25	USFS
82	95LS21	Garber Creek	Douglas	T08S R68W SEC 10	Colorado Open Space

Table 1A. Continued.

Map#	Plot #	Creek Name	County	Township/ Range/Section	Owner
83	95LS22	South Boulder Creek	Boulder	T01S R71W SEC 26	Denver Water Board
84	95LS23	Arikaree River	Yuma	Location Withheld	Private
85	95LS24	Arikaree River	Yuma	Location Withheld	Private
86	95LS25	Arikaree River	Yuma	Location Withheld	Private
87	95LS26	Arikaree River	Yuma	Location Withheld	Private
88	95LS27	Arikaree River	Yuma	Location Withheld	Private
89	95LS28	Arikaree River	Yuma	Location Withheld	Private
90	95LS29	South Platte River	Sedgwick	T11N R46W SEC 16	DOW
91	95LS30	South Platte River	Sedgwick	T11N R44W SEC 05	DOW
92	95LS31	South Platte River	Sedgwick	T11N R44W SEC 05	DOW
93	95LS32	South Platte River	Sedgwick	T11N R44W SEC 06	DOW
94	95LS33	South Platte River	Sedgwick	T11N R44W SEC 07	DOW
95	95LS34	South Platte River	Logan	T10N R48W SEC 10	DOW
96	95LS35	South Platte River	Logan	T10N R48W SEC 08	DOW
97	95LS36	South Platte River	Logan	T10N R49W SEC 13	DOW
98	95LS37	South Platte River	Logan	T10N R49W SEC 14	DOW
99	95LS38	South Platte River	Logan	T10N R49W SEC 16	DOW
100	95LS39	South Platte River	Logan	T10N R50W SEC 27	DOW
101	95LS40	South Platte River	Logan	T10N R50W SEC 27	DOW
102	95LS41	South Platte River	Logan	T08N R52W SEC 14	DOW
103	95LS42	South Platte River	Logan	T08N R52W SEC 14	DOW
104	95LS43	South Platte River	Logan	T07N R52W SEC 19	DOW
105	95LS44	South Platte River	Logan	T06N R53W SEC 04	DOW
106	95LS45	South Platte River	Washington	T05N R54W SEC 09	DOW
107	96LS01	West Fork Creek	Larimer	T11N R74W SEC 15	Roosevelt NF
108	96LS02	Cow Creek	Larimer	T11N R74W SEC 30	Roosevelt NF
109	96LS03	Tributary to Trail Creek	Larimer	T12N R73W SEC 20	Roosevelt NF
110	96LS04	Lone Pine Creek	Larimer	T09N R71W SEC 08	DOW
111	96LS05	Buckhorn Creek	Larimer	T07N R70W SEC 30	Private
112	96LS06	Sheep Creek	Larimer	T07N R72W SEC 36	Roosevelt NF
113	96LS07	Tributary Buckhorn Crk	Larimer	T07N R72W SEC 09	Roosevelt NF
114	96LS08	Cache la Poudre River	Larimer	T08N R71W SEC 03	Roosevelt NF
115	96LS09	Young Gulch	Larimer	T08N R71W SEC 09	Roosevelt NF
116	96LS10	Beaver Creek	Larimer	T07N R73W SEC 09	Roosevelt NF
117	96LS11	Bennett Creek	Larimer	T08N R73W SEC 16	Roosevelt NF
118	96LS12	Big Thompson River	Larimer	T05N R68W SEC 14	Private
119	96LS13	North Saint Vrain River	Boulder	T03N R73W SEC 28	RMNP
120	96LS14	Roaring Fork	Boulder	T03N R73W SEC 03	RMNP
121	96LS15	Unnamed tributary	Boulder	T03N R72W SEC 06	Roosevelt NF
122	96LS16	Rock Creek	Boulder	T02N R73W SEC 02	Roosevelt NF
123	96LS17	W. F. Little Thompson R.	Larimer	T04N R72W SEC 30	Roosevelt NF
124	96LS18	N.F.Cache la Poudre R.	Larimer	T11N R72W SEC 27	Roosevelt NF

Table 1A. Continued.

Map#	Plot #	Creek Name	County	Township/ Range/Section	Owner
125	96LS19	Cow Creek	Larimer	T05N R72W SEC 06	RMNP
126	96LS20	North Boulder Creek	Boulder	T01S R72W SEC 04	Roosevelt NF
127	96LS21	N.F.Middle Boulder Crk	Boulder	T01S R74W SEC 12	Roosevelt NF
128	96LS22	Mammoth Gulch	Boulder	T02S R74W SEC 14	Roosevelt NF
129	96LS23	North Clear Creek	Gilpin	T02S R73W SEC 30	Roosevelt NF
130	96LS24	Fall River	Clear Creek	T03S R74W SEC 11	Arapaho NF
131	96LS25	Lefthand Creek	Boulder	T02N R71W SEC 26	City of Boulder
132	96LS26	Unnamed Tributary	Larimer	T07N R76W SEC 36	Roosevelt NF
133	96LS27	Big Thompson River	Larimer	T05N R75W SEC 02	RMNP
134	96LS28	Cache la Poudre River	Larimer	T05N R75W SEC 04	RMNP
135	96LS29	Big Thompson River	Larimer	T05N R73W SEC 31	RMNP
136	96LS30	Boulder Brook	Larimer	T04N R73W SEC 19	RMNP
137	96LS31	Fall River	Larimer	T05N R74W SEC 06	RMNP
138	96LS32	North Saint Vrain River	Boulder	T03N R74W SEC 01	RMNP
139	96LS33	Cony Creek	Boulder	T03N R73W SEC 32	RMNP
140	96LS34	South Fork Rabbit Creek	Larimer	T10N R71W SEC 19	DOW
141	96LS35	Joe Wright Creek	Larimer	T07N R75W SEC 18	Roosevelt NF
142	96LS36	Cache la Poudre River	Larimer	T07N R75W SEC 15	Roosevelt NF
143	96LS37	Corral Creek	Larimer	T06N R75W SEC 02	Roosevelt NF
144	96LS38	Coal Creek	Boulder	T01S R70W SEC 24	Boulder County
145	96LS39	Cache la Poudre River	Larimer	T07N R68W SEC 34	City of Ft. Collins
146	96LS40	Ralston Creek	Gilpin	T02S R72W SEC 36	Roosevelt NF
147	96GK01	Elkhorn Creek	Larimer	T09N R74W SEC 11	Roosevelt NF
148	96GK02	West Fork Creek	Larimer	T11N R74W SEC 15	Roosevelt NF
149	96GK03	West Fork Creek	Larimer	T11N R74W SEC 20	Roosevelt NF
150	96GK04	Bull Creek	Larimer	T10N R73W SEC 01	Roosevelt NF
151	96GK05	Sheep Creek	Larimer	T07N R71W SEC 20	Roosevelt NF
152	96GK06	Buckhorn Creek	Larimer	T07N R72W SEC 16	Roosevelt NF
153	96GK07	Elk Creek	Larimer	T07N R72W SEC 19	Roosevelt NF
154	96GK08	Cache la Poudre River	Larimer	T08N R70W SEC 09	State Land
155	96GK09	S.F. Cache la Poudre R.	Larimer	T07N R73W SEC 15	Roosevelt NF
156	96GK10	Fish Creek	Larimer	T07N R73W SEC 08	Comanche Peak
157	96GK11	Black Hollow	Larimer	T08N R74W SEC 22	Roosevelt NF
158	96GK12	North Saint Vrain Creek	Boulder	T03N R73W SEC 22	RMNP
159	96GK13	Horse Creek	Boulder	T03N R73W SEC 10	RMNP
160	96GK14	Roaring Fork	Boulder	T03N R73W SEC 03	RMNP
161	96GK15	Rock Creek	Boulder	T03N R72W SEC 30	Roosevelt NF
162	96GK16	Little Thompson River	Larimer	T04N R72W SEC 13	Roosevelt NF
163	96GK17	Stonewall Creek	Larimer	T11N R70W SEC 29	Private
164	96GK18	N. F. Little Thompson R.	Larimer	T04N R71W SEC 25	Private
165	96GK19	Big Thompson River	Larimer	T05N R72W SEC 07	Roosevelt NF
166	96GK20	South Saint Vrain Creek	Boulder	T01N R73W SEC 07	Roosevelt NF

Table 1A. Continued.

Map#	Plot #	Creek Name	County	Township/ Range/Section	Owner
167	96GK21	South Saint Vrain Creek	Boulder	T01N R73W SEC 04	Roosevelt NF
168	96GK22	Gordon Creek	Boulder	T01N R72W SEC 32	Roosevelt NF
169	96GK23	Gordon Gulch	Boulder	T01N R72W SEC 32	Roosevelt NF
170	96GK24	Beaver Reservoir	Boulder	T02N R73W SEC 24	Roosevelt NF
171	96GK25	Middle Saint Vrain Crk	Boulder	T02N R73W SEC 16	Roosevelt NF
172	96GK26	Lefthand Creek	Boulder	T01N R73W SEC 12	BLM
173	96GK27	Unnamed Tributary	Boulder	T01N R73W SEC 11	Roosevelt NF
174	96GK28	James Creek	Boulder	T02N R72W SEC 25	Roosevelt NF
175	96GK29	Jasper Creek	Boulder	T01S R74W SEC 24	Indian Peaks WA
176	96GK30	Beaver Creek	Boulder	T01S R74W SEC 34	Roosevelt NF
177	96GK31	Ellsworth Creek	Gilpin	T02S R72W SEC 07	Roosevelt NF
178	96GK32	Mill Creek	Clear Creek	T03S R74W SEC 01	Arapaho NF
179	96GK33	Blue Creek	Clear Creek	T03S R75W SEC 23	Arapaho NF
180	96GK34	Central Gulch	Boulder	T02N R71W SEC 04	Roosevelt NF
181	96GK35	Unnamed Creek	Larimer	T07N R76W SEC 26	Roosevelt NF
182	96GK36	Fall Creek	Larimer	T07N R76W SEC 01	Roosevelt NF
183	96GK37	Trap Creek	Larimer	T07N R75W SEC 26	Roosevelt NF
184	96GK38	Dale Creek	Larimer	T11N R71W SEC 20	Private
185	96GK39	Fall River	Larimer	T05N R74W SEC 11	RMNP
186	96GK40	Boulder Brook	Larimer	T04N R73W SEC 30	RMNP
187	96GK41	Ouzel Creek	Boulder	T03N R74W SEC 25	RMNP
188	96GK42	N. Fk. Rabbit Crk	Larimer	T10N R71W SEC 15	DOW
189	96GK43	Unnamed Tributary	Larimer	T07N R75W SEC 18	Roosevelt NF
190	96GK44	Cache la Poudre River	Larimer	T07N R75W SEC 10	Roosevelt NF
191	96GK45	Corral Creek	Larimer	T06N R75W SEC 02	Roosevelt NF
192	96GK46	Coal Creek	Boulder	T01S R70W SEC 27	Boulder Open Space
193	96GK47	Coal Creek	Boulder	T01S R70W SEC 24	Boulder Open Space
194	96GK48	Deer Creek	Jefferson	T02S R71W SEC 20	Golden Gate State Park
195	96AM01	McArthur Gulch	Park	T08S R73W SEC 03	Pike NF
196	96AM02	Payne Gulch	Park	T08S R73W SEC 01	Pike NF
197	96AM03	Pine Gulch	Jefferson	T06S T71W SEC 17	State Land/Jefferson
198	96AM04	Geneva Creek	Park	T06S R74W SEC 32	Pike NF
199	96AM05	South Platte River	Park	T07S R74W SEC 10	Pike NF
200	96AM06	Beaver Creek	Park	T07S R75W SEC 07	Pike NF
201	96AM07	Lamping Creek	Park	T06S R75W SEC 33	Pike NF
202	96AM08	Redskin Creek	Jefferson	T08S R71W SEC 18	Pike NF
203	96AM09	Buffalo Creek	Jefferson	T08S R71W SEC 15	Pike NF
204	96AM10	Craig Creek	Park	T08S R72W SEC 19	Lost Creek WA
205	96AM11	N. Frk South Platte	Jefferson	T07S R70W SEC 25	Pike NF
206	96AM12	N. Frk Platte River	Jefferson	T07S R70W SEC 22	Pike NF
207	96AM13	South Clear Creek	Clear Creek	T04S R74W SEC 17	BLM
208	96AM14	Clear Creek	Clear Creek	T04S R71W SEC 06	Private

Table 1A. Continued.

Map	Plot #	Creek Name	County	Township/ Range/Section	Owner
209	96AM15	North Turkey Creek	Jefferson	T06S R71W SEC 08	State Land
210	96AM16	Maxwell Creek	Jefferson	T05S R71W SEC 31	Arapaho NF
211	96AM17	Bear Creek	Jefferson	T04S R70W SEC 30	Jefferson Open Space
212	96AM18	Mt. Vernon Creek	Jefferson	T04S R70W SEC 22	Jefferson Open Space
213	96AM19	Turkey Creek	Jefferson	T05S R70W SEC 22	Private
214	96AM20	Deer Creek	Jefferson	T06S R69W SEC 08	Jefferson Open Space
215	96AM21	Slaughterhouse Gulch	Clear Creek	T03S R72W SEC 31	Arapaho NF
216	96AM22	Soda Creek	Clear Creek	T04S R73W SEC 15	Arapaho NF
217	96AM23	Beartrack Creek	Clear Creek	T05S R73W SEC 21	Mt. Evans WA
218	96AM24	Unnamed Tributary	Clear Creek	T05S R73W SEC 15	Pike NF
219	96AM25	Pedee Creek	Clear Creek	T05S R73W SEC 11	Mount Evans SWA
220	96AM26	Bear Creek	Clear Creek	T05S R72W SEC 18	Mount Evens SWA
221	96AM27	Wigwam Creek	Jefferson	T09S R71W SEC 25	Pike NF
222	96AM28	Cabin Creek	Jefferson	T09S R71W SEC 26	Pike NF
223	96AM29	Missouri Gulch	Douglas	T10S R69W SEC 34	Pike NF
224	96AM30	Trout Creek	Douglas	T10S R69W SEC 34	Private
225	96AM31	South Platte River	Douglas	T09S R70W SEC 30	Pike NF
226	96AM32	South Platte River	Park	T12S R71W SEC 31	Pike NF
227	96AM33	South Platte River	Park	T13S R72W SEC 01	Pike NF
228	96AM34	South Platte River	Park	T13S R72W SEC 15	Pike NF
229	96AM35	South Platte River	Park	T12S R71W SEC 08	Pike NF
230	96AM36	Crystal Creek	Teller	T12S R71W SEC 11	Pike NF
231	96AM37	Grape Creek	Teller	T13S R71W SEC 11	Florissant NM
232	96AM38	Spring Gulch	Douglas	T09S R70W SEC 34	Pike NF
233	96AM39	Turkey Creek	Douglas	T10S R70W SEC 32	Pike NF
234	96AM40	Upper Grape Creek	Teller	T13S R71W SEC 23	Florissant NM
235	96AM41	Tarryall Creek	Park	T10S R72W SEC 32	Pike NF
236	96AM42	Corral Creek	Clear Creek	T05S R72W SEC 09	Private
237	96AM43	Twin Creek	Teller	T13S R71W SEC 02	Private
238	96AM44	Twin Creek	Teller	T13S R70W SEC 09	Private
239	96AM45	Rough & Tumbling Ck	Park	T11S R78W SEC 33	Pike NF
240	96AM46	Willow Creek	Park	T12S R78W SEC 03	San Isabel NF
241	96AM47	Rough &Tumbling Crk	Park	T11S R78W SEC 24	Pike NF
242	96AM48	Four Mile Creek	Park	T11S R77W SEC 02	DOW
243	96AM49	Unnamed Tributary	Park	T12S R78W SEC 26	Buffalo Creek WA
244	96AM50	Salt Creek	Park	T12S R77W SEC 33	Pike NF
245	96AM51	Pony Creek	Park	T12S R77W SEC 22	Pike NF
246	96AM52	Buffalo Creek	Park	T12S R77W SEC 22	Pike NF
247	96AM53	Middle Frk S. Platte R.	Park	T08S R78W SEC 09	Pike NF
248	96AM54	Kirby Gulch	Park	T06S R75W SEC 10	Arapaho NF
249	96AM55	Mosquito Creek	Park	TO9S R78W SEC 15	Pike NF
250	96AM56	Beaver Creek	Park	T09S R77W SEC 05	Pike NF

Table 1A. Continued.

Map#	Plot #	Creek Name	County	Township/ Range/Section	Owner
251	96AM57	Unnamed Tributary	Park	T08S R77W SEC 02	Pike NF
252	96AM58	Park Gulch	Park	T09S R76W SEC 03	BLM
253	96AM59	Unnamed Tributary	Park	T07S R76W SEC 09	Pike NF
254	96AM60	Michigan Creek	Park	T07S R76W SEC 28	Pike NF
255	96AM61	Unnamed Tributary	Park	T07S R77W SEC 25	Pike NF
256	96AM62	Michigan Creek	Park	T08S R75W SEC 35	Pike NF
257	96AM63	Radcliff Gulch	Park	T08S R74W SEC 33	Pike NF
258	96AM64	Middle Frk S. Platte R.	Park	T11S R76W SEC 09	City of Aurora
259	96AM65	South Frk South Platte	Park	T11S R78W SEC 22	Private
260	96AM66	South Frk South Platte	Park	T11S R79W SEC 01	Pike NF
261	96AM67	Rich Creek	Park	T11S R78W SEC 28	Pike NF
262	96AM68	Crooked Creek	Park	T09S R77W SEC 26	Private
263	96AM69	Sheep Creek	Park	T11S R78W SEC 11	Private
264	96AM70	Threemile Creek	Park	T12S R73W SEC 31	DOW
265	96AM71	Spring Creek	Park	T12S R77W SEC 27	Pike NF
266	96AM72	Unnamed Tributary	Douglas	T07S R70W SEC 36	Pike NF
267	96AM73	Goose Creek	Jefferson	T10S R72W SEC 12	Pike NF
268	96AM74	Goose Creek	Jefferson	T10S R71W SEC 19	Lost Creek WA
269	96AM75	Hay creek	Park	T10S R72W SEC 09	Lost Creek WA
270	96AM76	Unnamed tributary	Park	T10S R72W SEC 21	Lost Creek WA
271	96AM77	Metberry Gulch	Teller	T11S R71W SEC 02	Pike NF
272	96AM78	N. Frk South Platte R.	Park	T08S R73W SEC 18	Pike NF
273	96AM79	Lost Park Fen	Park	T08S R73W SEC 32	Pike NF
274	96AM80	Bluestem Draw	Park	T08S R72W SEC 31	Lost Creek WA
275	96AM81	Monkey Creek	Park	T08S R73W SEC 31	Pike NF
276	96AM82	Scott Gomer Creek	Clear Creek	T05S R74W SEC 29	Mt. Evans WA
277	96AM83	Watson Park Creek	Douglas	T09S R69W SEC 14	Pike NF
278	96AM84	Jackson Creek	Douglas	T09S R69W SEC 11	Pike NF
279	96AM85	South Platte River	Douglas	T07S R69W SEC 05	DWB
280	96AM86	South Platte River	Douglas	T06S R69W SEC 34	DWB
281	96AM87	Camp Creek	Park	T06S R73W SEC 21	Pike NF
282	96AM88	Unnamed tributary	Park	T06S R73W SEC 14	Pike NF
283	96AM89	North Garber Creek	Douglas	T08S R69W SEC 13	Pike NF
284	96AM90	Pine Creek	Douglas	T08S R69W SEC 33	Pike NF
285	96AM91	Stark Creek	Douglas	T08S R69W SEC 13	Pike NF
286	96AM92	Upper Bear Creek	Douglas	T10S R68W SEC 06	Pike NF
287	96AM93	Bear Creek	Douglas	T07S R69W SEC 28	Pike NF
288	96AM94	Grizzly Gulch	Clear Creek	T04S R75W SEC 31	Arapaho NF

Table 1B. Plant Association by Plot Number

Plot #	Plant Association
95GK01	*Carex praegracilis*
95GK02	*Carex nebrascensis*
95GK03	*Carex nebrascensis*
95GK04	*Prunus virginiana*
95GK05	*Symphoricarpos occidentalis*
95GK06	*Salix exigua/Mesic Graminoids*
95GK07	*Populus deltoides-(Salix amygdaloides)/Salix exigua*
95GK08	*Salix amygdaloides* Alliance
95GK09	*Populus x acuminata* Alliance
95GK10	*Salix eriocephala/Carex nebrascensis*
95GK11	*Salix eriocephala/Carex nebrascensis*
95GK12	*Populus deltoides/Bromus inermis*
95GK13	Salix exigua/ Mesic Graminoids
95GK14	*Alnus incana* Alliance
95GK15	*Salix eriocephala*
95GK16	*Populus deltoides/Prunus virginiana*
95GK17	*Populus deltoides/Prunus virginiana*
95GK18	*Salix exigua*/ Mesic Graminoids
95GK19	*Salix eriocephala*
95GK20	*Salix planifolia/Carex aquatilis*
95GK21	*Betula occidentalis*
95GK22	*Alnus incana*/Mesic Forbs
95GK23	*Salix exigua*/ Mesic Graminoids
95GK24	*Betula occidentalis*/ Mesic Forbs
95GK25	*Populus deltoides/Panicum virgatum*
95GK26	*Populus deltoides/Panicum virgatum*
95GK27	*Andropogon gerardii-Sorghastrum nutans*
95GK28	*Salix exigua*/ Mesic Granimoids
95GK29	*Salix exigua*/ Mesic Graminoids
95GK30	*Populus deltoides/Panicum virgatum*
95GK31	*Populus deltoides/Panicum virgatum*
95GK32	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK33	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK34	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK35	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK37	*Salix exigua*/ bare ground
95GK38	*Populus deltoides/Symphoricarpos occidentalis*
95GK39	*Populus deltoides/Symphoricarpos occidentalis*
95GK40	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK41	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK42	*Populus deltoides/Carex lanuginosa*
95GK43	*Populus deltoides-(Salix amygdaloides)/Salix exigua*

Table 1B. Plant Association by Plot Number

Plot #	Plant Association
95GK44	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK45	*Symphoricarpos occidentalis*
95GK46	*Salix exigua*/ bare ground
95GK47	*Typha angustifolia*
95GK48	*Symphoricarpos occidentalis*
95GK49	*Populus deltoides/Symphoricarpos occidentalis*
95GK50	*Populus deltoides-(Salix amygdaloides)/Salix exigua*
95GK51	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK52	*Populus deltoides-(Salix amygdaloides)/Salix exigua*
95GK53	*Populus deltoides/Symphoricarpos occidentalis*
95GK54	*Populus deltoides Alliance*
95GK55	*Populus deltoides/Carex lanuginosa*
95GK56	*Salix exigua*/ bare ground
95GK57	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95GK58	*Populus deltoides/Symphoricarpos occidentalis*
95GK59	*Typha angustifolia*
95GK60	*Scirpus acutus-Scirpus tabernaemontani*
95LS01	*Carex nebrascensis*
95LS02	*Carex praegracilis*
95LS03	*Prunus virginiana*
95LS04	*Salix exigua/* bare ground
95LS05	*Carex nebrascensis*
95LS06	*Populus deltoides-(Salix amygdaloides)/Salix exigua*
95LS07	*Salix eriocephala*
95LS08	*Salix lucida* var. *caudata* Alliance
95LS09	*Populus deltoides/Bromus inermis*
95LS10	*Populus deltoides/Bromus inermis*
95LS11	*Populus deltoides-(Salix amygdaloides)/Salix exigua*
95LS12	*Salix amygdaloides* Alliance
95LS13	*Carex lanuginosa*
95LS14	*Alnus incana* Alliance
95LS15	*Salix exigua*/ Mesic Graminoids
95LS16	*Populus deltoides/Prunus virginiana*
95LS17	*Salix exigua*/ Mesic Graminoids
95LS18	*Salix drummondiana/* Mesic Forbs
95LS19	*Salix planifolia/Caltha leptosepala*
95LS20	*Betula occidentalis*/ Mesic Forbs
95LS21	*Salix monticola* Alliance
95LS22	*Betula occidentalis/* Mesic Forbs
95LS23	*Andropogon gerardii/Sorghastrum nutans*
95LS24	*Andropogon gerardii/Sorghastrum nutans*
95LS25	*Populus deltoides/Panicum virgatum*
95LS26	*Salix exigua/* Mesic Graminoids

Table 1B. Plant Association by Plot Number

Plot #	Plant Association
95LS27	*Andropogon gerardii/Sorghastrum nutans*
95LS28	*Andropogon gerardii/Sorghastrum nutans*
95LS29	*Populus deltoides/Symphoricarpos occidentalis*
95LS30	*Populus deltoides/Symphoricarpos occidentalis*
95LS31	*Populus deltoides-(Salix amygdaloides)/Salix exigua*
95LS32	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95LS33	*Salix exigua/* bare ground
95LS34	*Salix exigua*/ bare ground
95LS35	*Populus deltoides/Symphoricarpos occidentalis*
95LS36	*Populus deltoides/Symphoricarpos occidentalis*
95LS37	*Salix exigua*/ bare ground
95LS38	*Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
95LS39	*Populus deltoides/Symphoricarpos occidentalis*
95LS40	*Populus deltoides/Carex lanuginosa*
95LS41	*Populus deltoides-(Salix amygdaloides)/Salix exigua*
95LS42	*Populus deltoides-(Salix amygdaloides)/Salix exigua*
95LS43	*Populus deltoides/Symphoricarpos occidentalis*
95LS44	*Populus deltoides/Symphoricarpos occidentalis*
95LS45	*Populus deltoides/Carex lanuginosa*
96LS01	*Salix geyeriana/Carex utriculata*
96LS02	*Salix geyeriana/Calamagrostis canadensis*
96LS03	*Salix geyeriana/Carex utriculata*
96LS04	*Populus angustifolia* Alliance
96LS05	*Populus angustifolia* Alliance
96LS06	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96LS07	*Alnus incana* /Mesic Graminoids
96LS08	*Pinus ponderosa/Alnus incana*
96LS09	*Populus angustifolia/Betula occidentalis*
96LS10	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96LS11	*Picea pungens/Betula occidentalis*
96LS12	*Populus deltoides* Alliance
96LS13	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96LS14	*Carex utriculata*
96LS15	*Betula occidentalis*
96LS16	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96LS17	*Corylus cornuta*
96LS18	*Populus angustifolia/Alnus incana*
96LS19	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96LS20	*Picea pungens/Betula occidentalis*
96LS21	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96LS22	*Salix planifolia/Carex aquatilis*
96LS23	*Salix planifolia/Carex aquatilis*
96LS24	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96LS25	*Populus angustifolia/Alnus incana*
96LS26	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*

Table 1B. Plant Association by Plot Number

Plot #	Plant Association
96LS27	*Salix planifolia/Carex aquatilis*
96LS28	*Salix planifolia/Carex aquatilis*
96LS29	*Salix monticola/Calamagrostis canadensis*
96LS30	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96LS31	*Salix planifolia/Carex aquatilis*
96LS32	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96LS33	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96LS34	*Betula occidentalis*
96LS35	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96LS36	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96LS37	*Salix planifolia/Caltha leptosepala*
96LS38	*Crataegus macracantha*
96LS39	*Populus deltoides* Alliance
96LS40	*Salix drummondiana* /Mesic Forbs
96GK01	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96GK02	*Populus balsamifera*
96GK03	*Mertensia ciliata-Cardamine cordifolia-Senecio triangularis*
96GK04	*Salix monticola/Carex aquatilis*
96GK05	*Corylus cornuta*
96GK06	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96GK07	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96GK08	*Populus angustifolia* Alliance
96GK09	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96GK10	*Salix drummondiana*/ Mesic Forbs
96GK11	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96GK12	*Salix geyeriana/Calamagrostis canadensis*
96GK13	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96GK14	*Salix monticola/Calamagrostis canadensis*
96GK15	*Salix monticola/Calamagrostis canadensis*
96GK16	*Populus tremuloides/Betula occidentalis*
96GK17	*Populus angustifolia/Salix irrorata*
96GK18	*Populus angustifolia/Prunus virginiana*
96GK19	*Alnus incana*/ Mesic Graminoids
96GK20	*Salix planifolia/Caltha leptosepala*
96GK21	*Salix planifolia/Carex aquatilis*
96GK22	*Salix monticola/Calamagrostis canadensis*
96GK23	*Populus tremuloides/Betula occidentalis*
96GK24	*Alnus incana-Salix drummondiana*
96GK25	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96GK26	*Alnus incana-Salix drummondiana*
96GK27	*Populus tremuloides*/ Tall Mesic Forbs
96GK28	*Corylus cornuta*
96GK29	*Salix planifolia/Carex aquatilis*
96GK30	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96GK31	*Alnus incana-Salix drummondiana*
96GK32	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*

Table 1B. Plant Association by Plot Number

Plot #	Plant Association
96GK33	*Populus tremuloides* Alliance
96GK34	*Populus angustifolia/Salix irrorata*
96GK35	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96GK36	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96GK37	*Salix planifolia/Caltha leptosepala*
96GK38	*Alnus incana/* Mesic Graminoids
96GK39	*Salix monticola/Calamagrostis canadensis*
96GK40	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96GK41	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96GK42	*Populus deltoides* Alliance
96GK43	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96GK44	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96GK45	*Salix planifolia/Carex aquatilis*
96GK46	*Populus angustifolia/Salix irrorata*
96GK47	*Populus angustifolia/Salix irrorata*
96GK48	*Populus angustifolia/Alnus incana*
96AM01	*Populus tremuloides/Betula occidentalis*
96AM02	*Picea pungens/Betula occidentalis*
96AM03	*Carex aquatilis*
96AM04	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96AM05	*Picea pungens/Betula occidentalis*
96AM06	*Salix monticola/* Mesic Graminoids
96AM07	*Populus tremuloides/* Tall Mesic Forbs
96AM08	*Picea pungens/Betula occidentalis*
96AM09	*Picea pungens/Betula occidentalis*
96AM10	*Salix monticola/* Mesic Forbs
96AM11	*Alnus incana* /Mesic Graminoids
96AM12	*Pinus ponderosa/Alnus incana*
96AM13	*Populus tremuloides/* Tall Mesic Forbs
96AM14	*Populus angustifolia/Salix exigua*
96AM15	*Salix drummondiana/* Mesic Forbs
96AM16	*Picea pungens/Betula occidentalis*
96AM17	*Populus angustifolia/Alnus incana*
96AM18	*Populus monilifera-Salix amygdaloides/Salix exigua*
96AM19	*Populus angustifolia/Alnus incana*
96AM20	*Populus angustifolia/Salix exigua*
96AM21	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96AM22	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96AM23	*Abies lasiocarpa-Picea engelmannii/Carex aquatilis*
96AM24	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96AM25	*Abies lasiocarpa-Picea engelmannii/Alnus incana*
96AM26	*Alnus incana* /Mesic Graminoids
96AM27	*Salix monticola* /Mesic Graminoids
96AM28	*Populus tremuloides/Betula occidentalis*
96AM29	*Picea pungens/Cornus sericea*
96AM30	*Salix bebbiana*

Table 1B. Plant Association by Plot Number

Plot #	Plant Association
96AM31	*Salix exigua* Alliance
96AM32	*Carex utriculata*
96AM33	*Betula occidentalis*
96AM34	*Betula occidentalis*
96AM35	*Salix exigua* Alliance
96AM36	*Betula occidentalis*
96AM37	*Carex utriculata*
96AM38	*Pinus ponderosa/Alnus incana*
96AM39	*Picea pungens/Betula occidentalis*
96AM40	*Carex aquatilis*
96AM41	*Picea pungens/Betula occidentalis*
96AM42	*Alnus incana* /Mesic Forbs
96AM43	*Carex aquatilis*
96AM44	*Salix monticola*/ Mesic Graminoids
96AM45	*Salix monticola/Carex utriculata*
96AM46	*Salix brachycarpa/Carex aquatilis*
96AM47	*Salix monticola/Carex utriculata*
96AM48	*Pentaphylloides floribunda/Juncus balticus*
96AM49	*Salix drummondiana/Carex aquatilis*
96AM50	*Salix eriocephala*
96AM51	*Carex utriculata*
96AM52	*Juncus balticus*
96AM53	*Salix planifolia/Caltha leptosepala*
96AM54	*Populus tremuloides*/ Tall Mesic Forbs
96AM55	*Salix planifolia/Carex aquatilis*
96AM56	*Salix wolfii/Carex aquatilis*
96AM57	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96AM58	*Carex utriculata*
96AM59	*Salix planifolia/Caltha leptosepala*
96AM60	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96AM61	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96AM62	*Salix monticola*/ Mesic Graminoids
96AM63	*Salix eriocephala*
96AM64	*Salix brachycarpa/Carex aquatilis*
96AM65	*Salix monticola/Carex utriculata*
96AM66	*Salix planifolia/Caltha leptosepala*
96AM67	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96AM68	*Carex utriculata*
96AM69	*Salix monticola/Carex utriculata*
96AM70	*Juncus balticus*
96AM71	*Salix exigua* Alliance
96AM72	*Pinus ponderosa/Alnus incana*
96AM73	*Salix monticola/Calamagrostis canadensis*
96AM74	*Corylus cornuta*
96AM75	*Salix planifolia/Carex aquatilis*
96AM76	*Populus tremuloides/Betula occidentalis*

Table 1B. Plant Association by Plot Number

Plot #	Plant Association
96AM77	*Corylus cornuta*
96AM78	*Salix planifolia/Carex aquatilis*
96AM79	*Salix planifolia/Carex aquatilis*
96AM80	*Abies lasiocarpa-Picea engelmannii/Carex aquatilis*
96AM81	*Salix wolfii/Carex aquatilis*
96AM82	*Salix planifolia/Caltha leptosepala*
96AM83	*Salix bebbiana*
96AM84	*Salix monticola/* Mesic Forbs
96AM85	*Salix exigua* Alliance
96AM86	*Populus deltoides* Alliance
96AM87	*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
96AM88	*Salix monticola/Carex aquatilis*
96AM89	*Corylus cornuta*
96AM90	*Alnus incana* /Mesic Graminoids
96AM91	*Salix eriocephala*
96AM92	*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*
96AM93	*Alnus incana-Cornus sericea*
96AM94	*Salix planifolia/Caltha leptosepala*

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 streams as defined on U.S. Geological Survey 1:24,000 and 1:100,000 topographic maps, although some ephemeral streams were included.

Representative 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 upper South Platte watershed riparian habitats, the two environmental variables were stream order, used as a surrogate for basin size, channel size and stream volume (Schumm 1977, Knighton 1984), and 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 (Figure 4).

In the lower South Platte watershed we used annual precipitation and bedrock geology to stratify the study area. Annual precipitation increases significantly west to east across the eastern plains, influencing upland species composition as well as stream flow. We used three categories: 10-12, 12-16, and 16-20 inches annually. The underlying bedrock influences stream channel type, direction of flow and the amount of in-stream flow. In addition, near-surface bedrock constrains lateral stream flow and keeps water from seeping into deeper aquifers, causing stream flow to be intermittent as it passes through areas of different geologic formations. Some of the geologic categories used include Quaternary Alluvium, the Ogallala , Laramie, and White River Formations, Dawson Arkose, Shales and Eolian Deposits (Figure 5).

In each study area we tallied the total perennial stream miles in the basin and the total miles within each cell type and calculated their percentage. Aerial photographs were used to eliminate areas of heavy disturbance. More than 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.

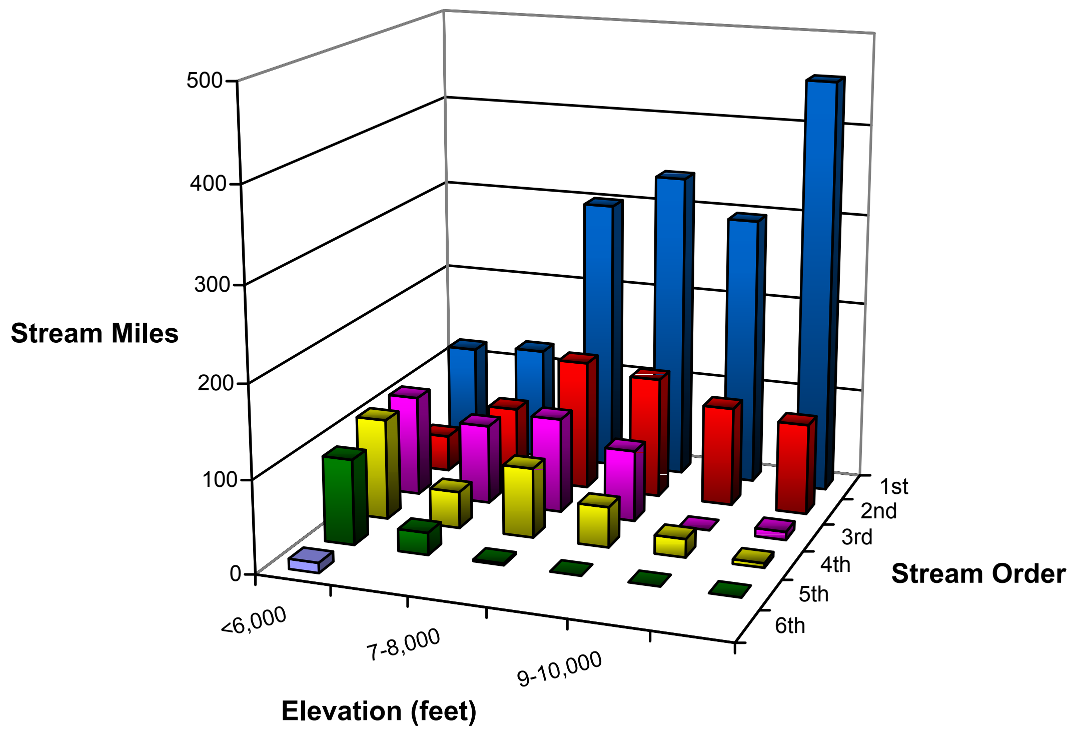
Thus the number of sampled stream miles per cell type was representative of the basin (Figures 4 and 5).

We sampled riparian areas which have not been drastically altered by human activity in the sampling regime, limiting the classification to plant associations native to Colorado, whose descriptions can serve as a reference point for management and restoration needs.

Color Infra-red aerial photographs were used (1989, 1990 NAPP 1:40,000, 1983 1:24,000) to delineate riparian corridors and determine their condition. Riparian corridors were delineated as tree, shrub, or herbaceous dominated riparian areas (Batson *et al.* 1987). Riparian vegetation appears bright red relative to dry hillside vegetation and has a texture unlike irrigated crop areas. Conifer dominated riparian reaches were also delineated. Riparian condition was ranked by the degree of disturbance (i.e., deviation from pristine) within and surrounding the riparian corridor. 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).

Disturbance ranking criteria were: 1) drastic disturbance such as agricultural conversion, adjacent irrigated fields, square-edge fields, road and railroad embankments, power line maintenance roads, gravel mining, logging, mining, dams, reservoir developments, etc., 2) heavy recreational use, such as off-road vehicle use, etc., 3) heavy livestock use such as over grazing (hillside trailing), or livestock holding sites, etc., and 4) road maintenance activities, gravel/sand piles ,or other dumping grounds.

A) Total Perennial Stream Miles



B) Sampled Stream Miles

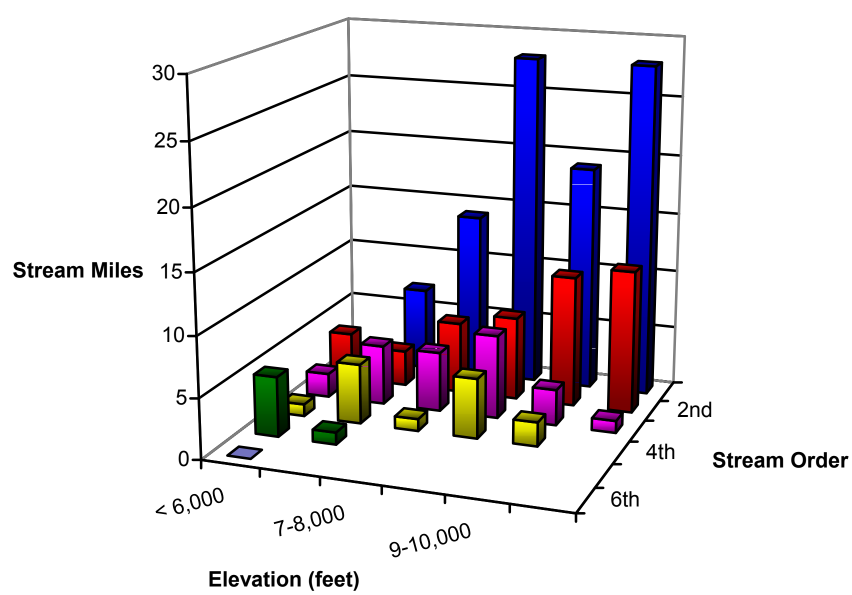
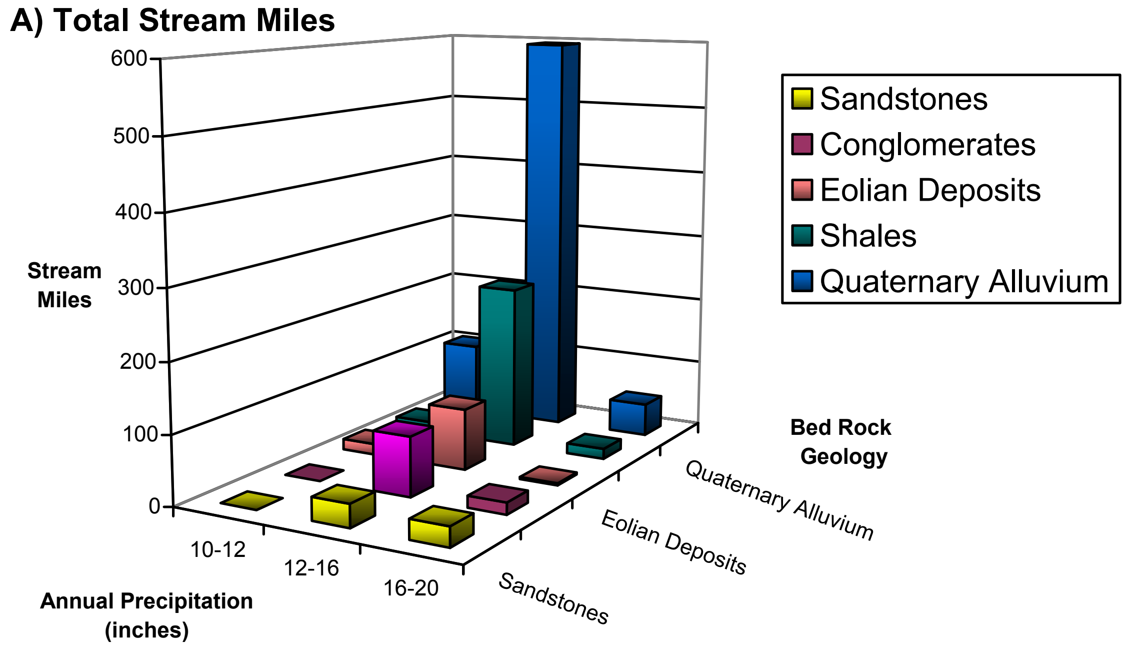


Figure 4. Riparian habitats of the upper South Platte River basin stratified by elevation and stream order. A) Total perennial stream miles by stratification type. B) Sampled stream miles by stratification type. The relative distribution of habitats of sampled streams is comparable to that of the entire basin.



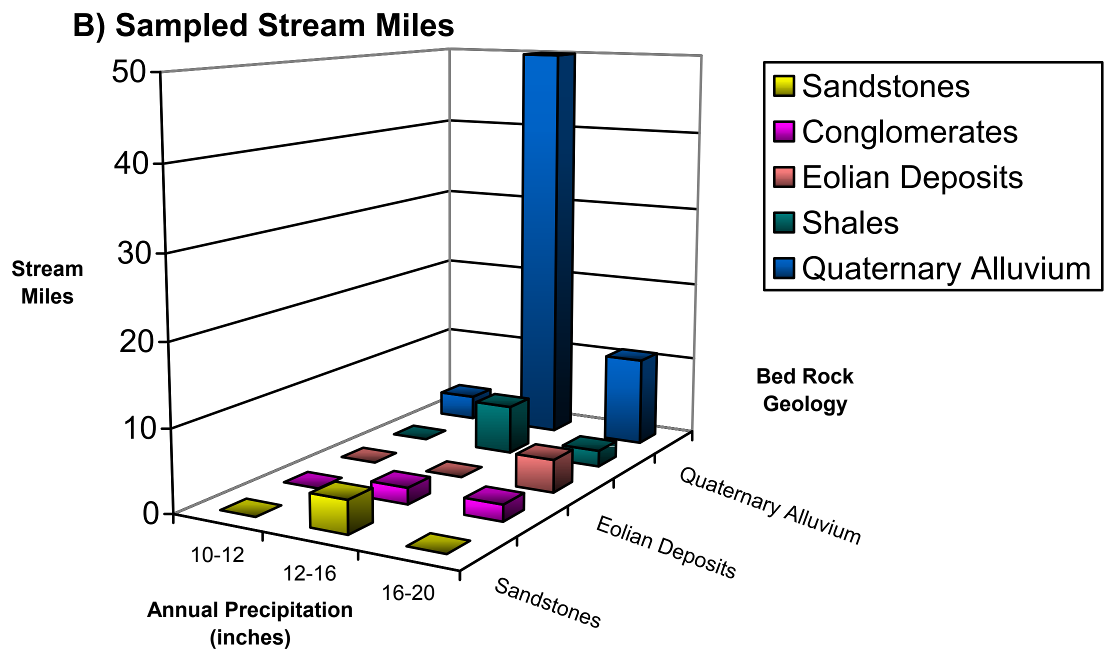


Figure 5. Riparian habitats of the lower South Platte River Basin stratified by bedrock geology and annual precipitation. A) Total perennial stream miles in the lower basin by stratification type. B) 1995 sampled stream miles by stratification type. The relative distribution of habitats is represented in the number of streams samples.

Representative Site Selection, continued.

Aerial photography assesment categorized riparian corridor condition into four types:
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. During field site visits, we further evaluated random reaches for the amount of weeds and eliminated sites that 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.

Classification Basis

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). Our definition differs slightly from the Daubenmire (1952) plant association concept in that we describe existing communities, rather than perceived climax vegetation types. Plant associations are 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. Most of the plant associations described in this report may be considered "community types" by the Daubenmire Habitat Typing system, in that they are frequently disturbed, and rarely reach a climatic climax.

<u>Field Vegetation and Environmental Data Collection</u>

Field site visits were conducted June 1st through September 15th. Private land was accessed only with landowner permission. Data collected at each plot location:

* 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. The system is based on the channel width to depth ratio, available floodplain width, and channel gradient. For a full description and explanation, see Rosgen (1994).
* hydrologic and geomorphic features (beaver dams, point bars, etc.)
* history of use (from landowner or manager) when obtainable
* Each site was ranked A (highest) through D (poorest) for quality, condition, defensibility, and viability, using the following criteria:

  <u>quality</u>--overall size, connectedness to surrounding natural ecosystems, degree of alteration.
  <u>condition</u>--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.
  <u>viability</u>--extrinsic factors: are natural hydrological processes in place, will the site improve, or remain in current condition with current management?
  <u>defensibility</u>--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.

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. Data collected at each site included:

* 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.

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. Nomenclature in this report follows Kartesz (1994). A list of scientific plant names for the lower and upper South Platte watersheds, can be found in Appendix C and D, respectively.

<u>Data Analysis and Classification Criteria</u>

Computer programs offering agglomerative cluster analysis were employed using Euclidean distance and average clustering method to determine groups of plots with similar species abundance. 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 were 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.

Riparian plant associations presented in this report are a part of the Preliminary Vegetation Classification of the Western United States (Bourgeron and Engelking 1994). The Western classification is currently being incorporated into a National Vegetation Classification by The Nature Conservancy, and is being used as the Federal Standard for Vegetation mapping and description (FGDC 1996). A cross-walk of The Nature Conservancy Vegetation Classification system with the Classification of Wetland and Deepwater Habitats of the United States (Cowardin *et al.* 1979) is presented in Table 2.

The classification currently used by The Nature Conservancy is based on the UNESCO system. This is a hierarchical system that uses physiognomy and environment to distinguish vegetation and other mapping units (FGDC 1996):

<u>Physiognomic Life form and relative cover:</u>

- 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.
- 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.
- 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.

<u>Floristic</u>

- 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.

- 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.

Table 2. Cross-reference of The Nature Conservancy's National Vegetation Classification (FGDC 1996) as used in the Colorado Natural Heritage Program's Riparian Plant Association Classification and the Wetland and Deep Water Habitat Types of the U.S. (Cowardin *et al.* 1979).

UNESCO-TNC (FGDC 1996)		COWARDIN *et al.* (1979)
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	
		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	

Table 2. Continued

UNESCO-TNC (FGDC 1996)		COWARDIN *et al.* (1979)
Formation:	c. Seasonally flooded/saturated	(Dominance type)
Floristic level	(1) Alliance	
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	(Dominance type)
Floristic level	(1) Alliance	
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 Persistent-Emergent Wetlands
Subclass:	Hydromorphic rooted vegetation.	
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	

Determination of Ecologically-Significant Sites

The Colorado Natural Heritage Program is responsible for gathering and updating information on features of natural diversity in Colorado. Each of these significant natural features (rare plant and animal species, significant plant associations) is a unit, or element, of natural diversity. Each element is assigned a global and a state rank that indicates its relative rarity on a five-point scale (1 = extremely rare; 5 = abundant; Table 3). By using the element ranks and the quality of each occurrence, priorities can be established for the management and/or protection of the most imperiled elements of biodiversity.

Each geographical location of any element is called an Element Occurrence. Element occurrences are ranked on four areas of overall quality. These are 1) **quality--** overall size, vigor, health of population, degree of connectedness to surrounding natural ecosystems, etc.; 2) **condition** or naturalness of the habitat, abundance of non-native species present, degree of human-induced disturbance, degree of soil compaction, degree species composition alteration by grazing, 3) **viability** are natural pollinators in place, is the hydrologic regime altered, will site improve or be maintained by current management practices; 4) **defensibility**-- ease or difficulty of protecting the occurrence from external threats, site specific problems, adjacent land use compatibility. Each criteria is given a rank (A, B, C, or D) and are they are summed for a final, overall Occurrence Rank: A= Pristine or undisturbed, B= Undisturbed to slightly altered, C= Disturbed to highly altered, D= barely functioning.

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.

Colorado Natural Heritage Program uses the Global/State Rarity and Occurrence Ranks to assess the overall significance of a Site, which may include one or many element occurrences. Based on these ranks, each site, or suite of elements, is assigned a Biodiversity (or "B") Rank:

B1 <u>Outstanding Significance</u>: only site known for an element or an excellent occurrence of a G1 species or plant association.
B2 <u>Very High Significance</u>: one of the best examples of a plant association, good occurrence of a G1 species, or excellent occurrence of a G2 or G3 species or plant association.
B3 <u>High Significance</u>: excellent example of any plant association, good occurrence of a G3 species, or a large concentration of good occurrences of state rare species/associations.
B4 <u>Moderate Significance</u>: good example of an association, excellent or good occurrence of state-rare species/association.

B5 General Biodiversity Significance: good or marginal occurrence of an association type, S1, or S2 species/association.

Ecologically significant sites are recognized as the highest-ranked community or species occurrences, including both common and globally rare riparian ecosystems. Sites that contain high-quality (excellent condition) examples of globally rare plant associations, or sites that contain a mosaic of rare and/or more common elements in good to excellent condition quickly rise to the top of the list of sites important to the conservation of riparian biodiversity. These sites can be uses as reference reaches for restoration and future research.

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 South Platte River 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.

Table 3. Colorado Natural Heritage Raity Ranks. Global ranks (G) refer to the worldwide range a the plant, animal, or natural community. State ranks (S) refer to the abundance with state boundaries. Note that GA and GN are not used. These ranks should not be interpreted as legal designations.

G/S1	Extremely rare: usually 5 or fewer occurrences in the state; or may be few remaining individuals; especially vulnerable to extirpation.
G/S2	Very rare; usually between 5 and 20 occurrences; or with many individuals in fewer occurrences; often susceptible to becoming endangered.
G/S3	Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale or chronic disturbances.
G/S4	Common; usually > 100 occurrences, but may be fewer with many large populations; may be restricted to only a portion of the state; usually not susceptible to immediate threats.
G/S5	Very common; demonstrably secure under present conditions.
SA	Accidental in the state.
G/SH	Historically known from the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently.
G/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, a rank of SZN is used.
G/SU	Status uncertain, often because of low search effort or cryptic nature of the element.
G/SX	Apparently extirpated from the state, or extinct.

RESULTS and DISCUSSION

Sixty-three plant associations within thirty-nine alliances were identified from the study area (Table 4, Figures 6 and 7). Complete descriptions of each plant association are the bulk of this report. Three associations found along the main stem of the South Platte River have not been previously described in the literature and are condsidered rare. These are the plains cottonwood-(peached-leaved willow)/sloughgrass riparian woodland (*Populus deltoides* spp. *monilifera-(Salix amygdaloides)/Spartina pectinata*), the plains cottonwood/wooly sedge riparian woodland (*Populus deltoides* spp. *monilifera/Carex lanuginosa*), and the sloughgrass riparian meadow (*Spartina pectinata*) plant association (Table 4). One association, the narrow-leaf cottonwood/ blue-stem willow (*Populus angustifolia/Salix irrorata*) was determined for the first time during the 1995 field season, and was further clarified in 1996. This type has only been previously described from New Mexico (Durkin *et al.* 1995). Along the lower montane and foothill reaches four new types were discovered: Colorado blue spruce/river birch (*Picea pungens/Betula occidentalis*), quaking aspen/river birch (*Populus tremuloides/Betula occidentalis*), ponderosa pine/thin-leaf alder (*Pinus ponderosa/Alnus incana*) and hawthorn (*Crataegus macracantha* var. *occidentalis*) plant associations.

Lower (Plains) South Platte Watershed

The key finding from the lower South Platte watershed (1995) was the predominance of native woody species within the continuous broad canopy of cottonwoods along the South Platte River from Greeley to the Nebraska state line. Within this canopy, we observed several native plant associations that represent various successional stages and micro-habitats of the floodplain. While this large riparian woodland is likely a product of human-induced change to the South Platte River ecosystem, the associations are dominated entirely by native species and exhibit signs of a diverse floodplain ecosystem.

In the late 1800's and early 1900's the North, South and main Platte Rivers had broad, braided river channels with little riparian vegetation along their banks (Williams 1978, Johnson 1994, Christy 1973, Knopf 1988, Snyder and Miller 1991, USFWS 1994). The amount of vegetation on stream banks and islands of the historical river is debated (Johnson 1994). However, it is fairly clear that what was there was not the continuous band of deciduous trees from Colorado to the Missouri River that occurs today.

This change in the amount of floodplain vegetation is thought to be a product of alterations in hydrology through several large dams on the North Platte River, off-channel storage and flood control reservoirs along the South Platte River, transcontinental inflows, countless irrigation dams, and miles of channelized reaches and floodplain development near large towns and cities (Williams 1978, USFWS 1994). These hydrologic alterations have resulted in three important factors that affect vegetative growth. 1) Late winter (i.e., March) ice break up and ice flows no longer occur. Ice flows damage and rip out plants rooted on low islands or in the active stream channel. 2) A reduction in the magnitude and duration of late-spring and early-summer peak flows. The main impact of flooding was inundation of surfaces, scouring and sediment deposition which disrupted existing vegetation while creating new surfaces for establishment, close in and away from the main channel. 3) The enhancement of very low flows in September and October resulting from the transfer of western slope water into the Platte River watershed. Vegetation establishment and growth used to be limited during the late-summer. (Johnson 1994, Williams 1978, USFWS 1994). These changes in combination have allowed native cottonwood and willows to encroach into the shallow braided channels of the Platte Rivers.

While it is fairly certain the current riparian vegetation along the South Platte River is a result of hydrologic alterations, river ecosystems in general are very dynamic. A one-shot-in-time assessment (such as those made at the turn of the century) does not tell the whole story. The San Pedro River in Arizona and the Arikaree River in eastern Colorado, for example, have exhibited dramatic shifts in the vegetation due to natural, broad scale geomorphic changes (Mike Scott, NBS, and Brian Richter, TNC, personal communication).

The apparent lack of abundant riparian vegetation on the South Platte River at the turn of this century does not necessarily mean that large patches of riparian forest never existed on its banks (Johnson 1994). Broad scale climate cycles of drought and flood coupled with geomorphic processes affecting the sediment loads would have dramatically affected the river ecosystem. The floodplain forest found today on the South Platte River is composed of species native to Colorado, and it seems likely that the same plant associations existed in the past (i.e., 200-500 years ago). The riparian forest did not provide a continuous overhead canopy, but rather occurred in patches, some large (a few miles) and some small (single oxbow lakes).

Some native willows and cottonwoods were present one hundred years ago (Johnson 1994). In 1843, Fremont observed "...timber appears to have been much more extensive formerly than now. There were but few trees... In many similar places I had occasion to remark an apparent progressive decay in the timber..." (Williams 1978, Johnson 1994). Thus it seems that the riparian forests found today indeed existed in the past, but on a reduced scale.

Several bird and fish species native to the Platte River ecosystem are in serious decline due to dramatic changes in the habitat structure. Once distinct species from their eastern counterparts, western birds are showing signs of hybidyzation (Knopf 1988). This is due to the now continuous forest canopy along the river connecting western and eastern habitats. In addition, the diversity of habitats has been reduced. The Platte River corridor used to be a huge mosaic of shallow oxbow lakes, flooded meadows, open gravel bars and mid-channel islands, as well as patches of floodplain forest. Most of this diversity is lost due to a reduction in geomorphic processes (flooding and channel migration). The combination of these habitats is critical to several migratory bird species, including the endangered Whooping Crane, one of the oldest bird species in North America (Johnsgard 1991).

The current riparian forest may be a one-time cohort of cottonwood trees produced from changes in the hydrology. This forest appears to be be narrowing, that is, trees at the outer edge of the floodplain are dying and are not being replaced (Johnson 1994, M. Scott, NBS, personal communication). With time the corridor may become more and more narrow along an increasingly channelized river. This is a new, stable system results from the now controlled and managed hydrologic regime.

We need to focus our conservation and restoration efforts on restoring the dynamic nature of the Platte River ecosystem, restoring a active, broad, braided channel, and open wet meadow habitats critical to maintaining fish and bird species. The current native riparian forests and shrublands will also benefit from such efforts, as they too evolved within a more dynamic environment. Preserves that protect the diversity of riparian habitats (open meadows, cottonwood forests and the broad shallow braided channel) in conjunction with hydrologic restoration (flooding flows, ice damage, and late summer drawn downs) are necessary to preserve bird, fish, and plant association biodiversity of the Platte River ecosystem.

Examples of the current floodplain forest and shrubland mosaic can be seen along the South Platte River floodplain at Tamarack Ranch State Wildlife Area and between the town of Sedgwick and the Nebraska state line on Division of Wildlife owned lands. These sites are in good condition (see Appendix B). Discussions with Kansas and Nebraska State Heritage ecologists indicate that these communities probably occur along river floodplains in those states. Detailed inventories of the South and North Platte Rivers in Nebraska and other riparian habitats in Kansas have yet to be conducted. Colorado Natural Heritage Rairty Ranks presented herein are subject to change and will be updated as more information becomes available.

<u>Upper (montane) South Platte Watershed</u>

Significant finds in the upper South Platte watershed were several near-pristine foothill riparian areas. Riparian areas below 7,000 feet elevation are rarely in good to excellent condition, because of the proximity to cities, towns, recreation centers and agricultural lands. The Rampart Range, in the southern part of the upper watershed, has very rugged terrain that precludes heavy recreation or livestock use. Several stands of unusual plant associations (G3 or rarer) where located in these rugged, steep-sided foothill canyons: the Bebb willow (*Salix bebbiana*) plant association and the thin-leaf alder/Mesic Forbs (*Alnus incana*/Mesic Forbs) plant association. See Appendix B for detail site descriptions and further discussion of these significant sites.

Figure 6. Cluster analysis Dendrogram for 105 stands from the Lower South Platte River Basin. Individual plots (e.g., SPGK01) are listed on the left. The axis across the top is Euclidean Distance, indicating the degree of dissimilarity (from left to right) in species composition. Vertical dashed lines indicate the levels of similarity at which plots were grouped. Groups of plots are shaded and labeled by their plant association names. Starred stands were placed in different groups due to environmental differences, or for other reasons. In addition, some groups that were split in the dendrogram due to differences in the relative amount of canopy cover have been combined because they have similar species composition. "u" indicates the stand was classified to the Alliance level only.

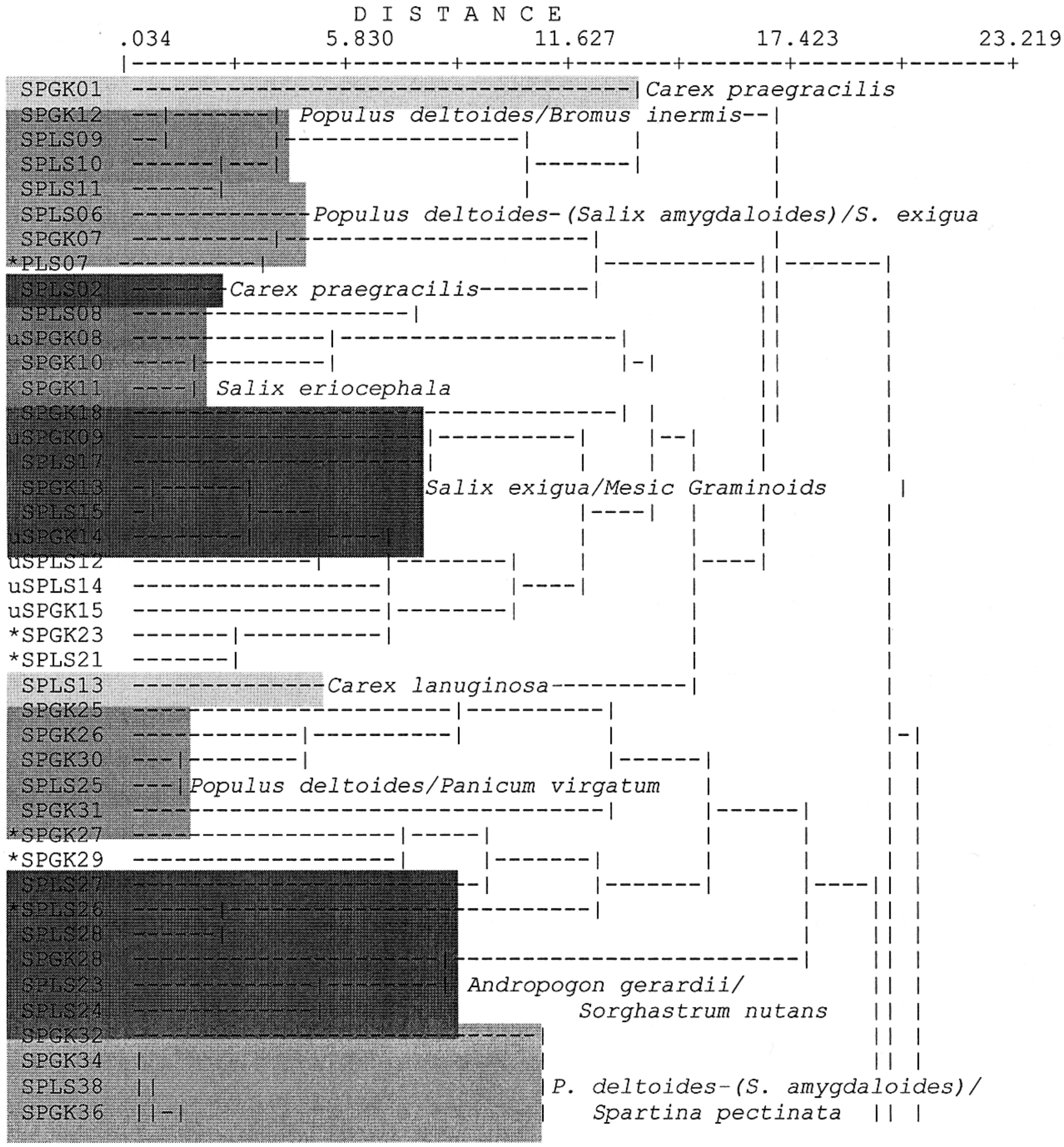


Figure 6. Continued.

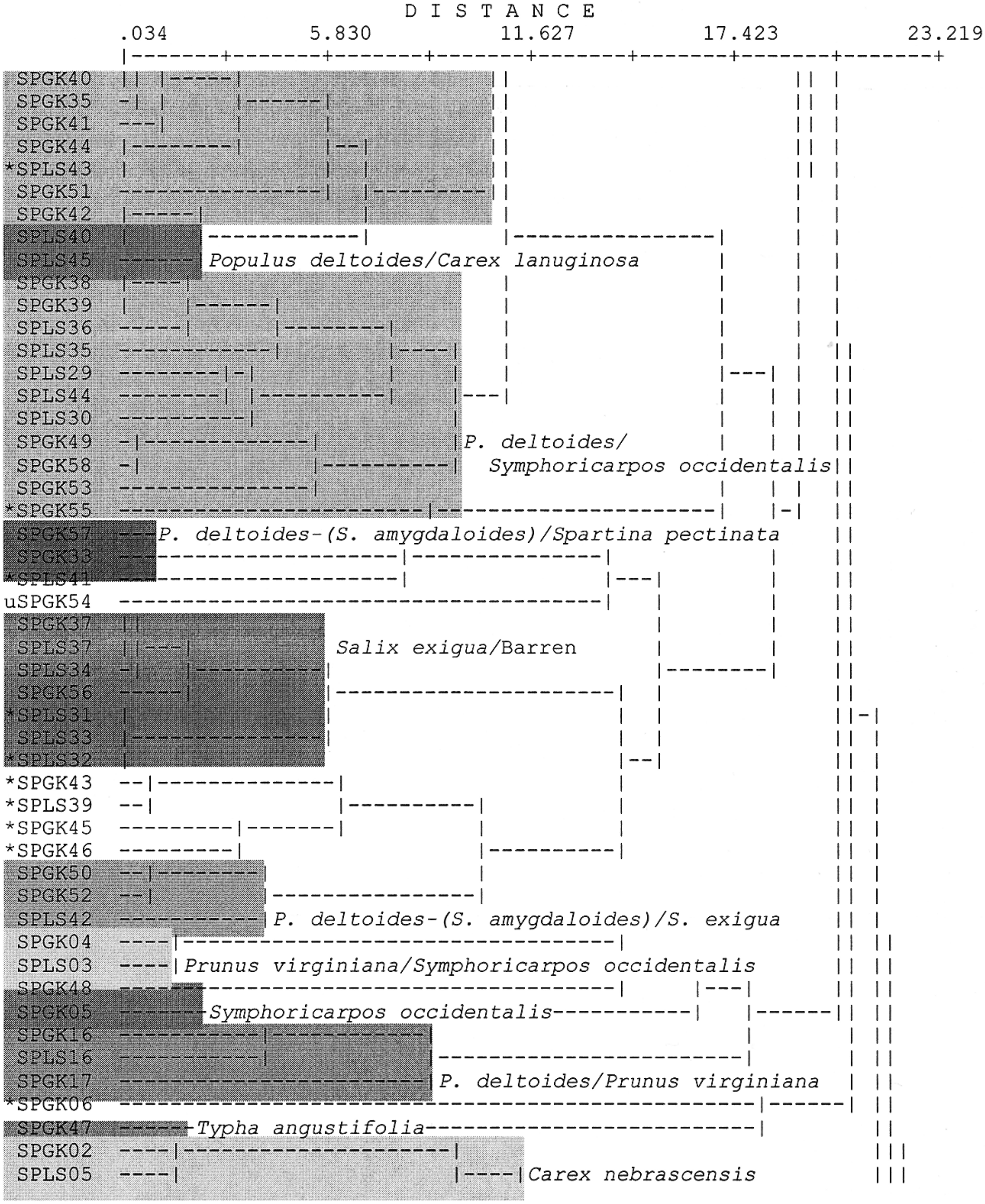


Figure 6. Continued.

```
                                D I S T A N C E
          .034            5.830           11.627          17.423          23.219
          |-------+-------+-------+-------+-------+-------+-------+-------+
SPLS01    -------------------------|    |-C. nebrascensis (cont'd)---|||
SPGK03    --------------|---------------|                            ||
*SPLS04   --------------|                                            ||
uSPGK19   -------|----------------------|                            ||
SPGK20    -------|Salix planifolia/Carex aquatilis---|               ||
SPLS19    --Salix planifolia/Caltha leptosepala      |--------|      |||
SPLS18    ----------Salix drummondiana/Mesic Forbs--|         |--|   |||
SPGK22    -------Alnus incana/Mesic Forbs---------------------|  |----|||
SPGK21    -----------------|-------------------------|           |    ||
SPLS20    -----------------| Betula occidentalis/Mesic Forbs----|    ||
SPGK24    --------------------------------------|-------|             ||
SPLS22    --------------------------------------|                     ||
*SPGK59   ------------------------------------------------------------||
SPGK60    -----Scirpus acutus-Scirpus tabernaemontani-----------------||
```

Figure 7. Cluster Analysis Dendrogram for 182 stands from the Upper South Platte River Basin. Individual plots are listed on the left (e.g. 96LS01). Top axis is Euclidean Distance, indicating the degree of dissimilarity in stand species composition. Vertical dashed lines indicate the level at which stands and groups were joined. Stands that comprise Plant Associations are shaded and labeled. Individual stands are also labeled as classified.

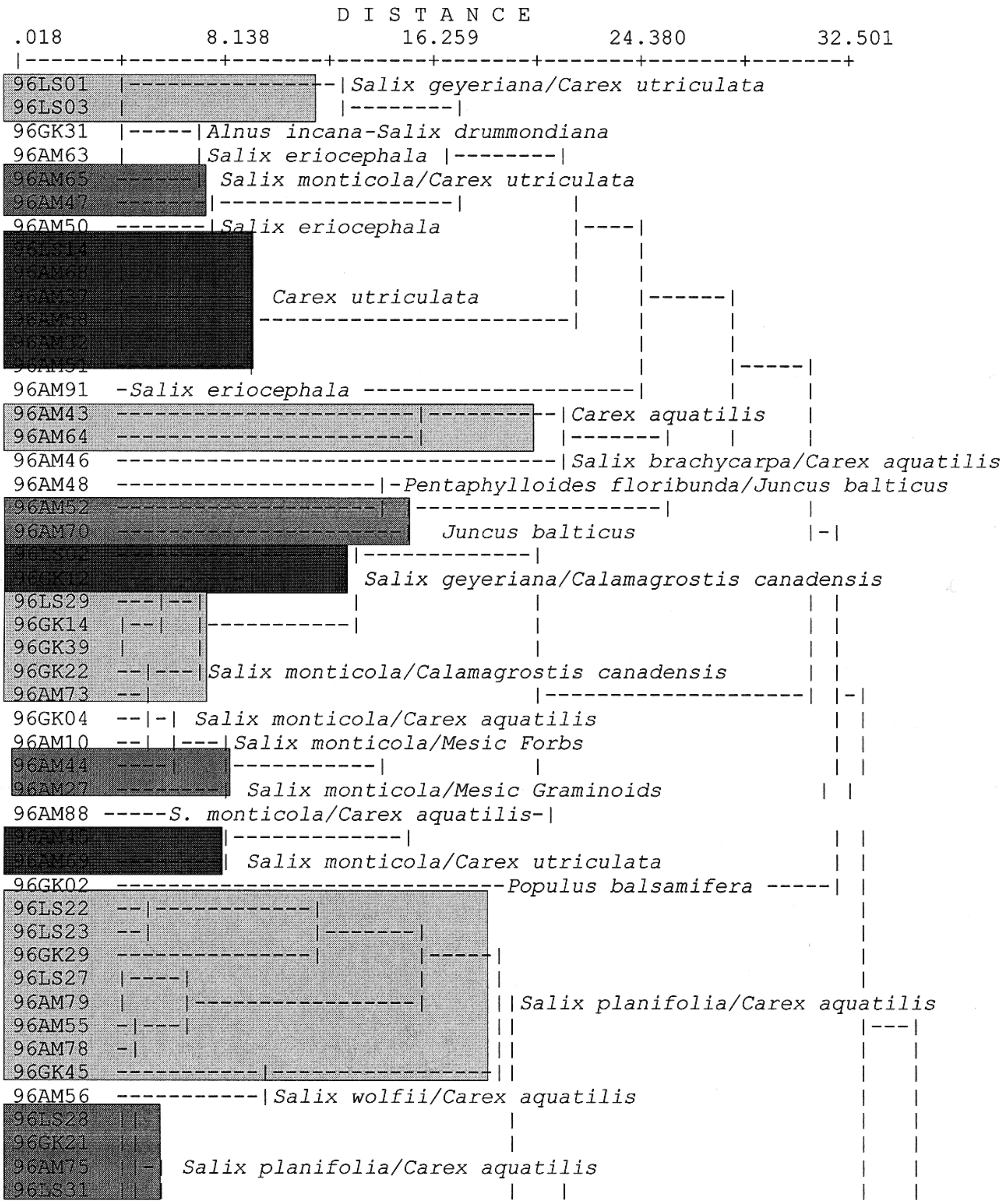


Figure 7. Continued.

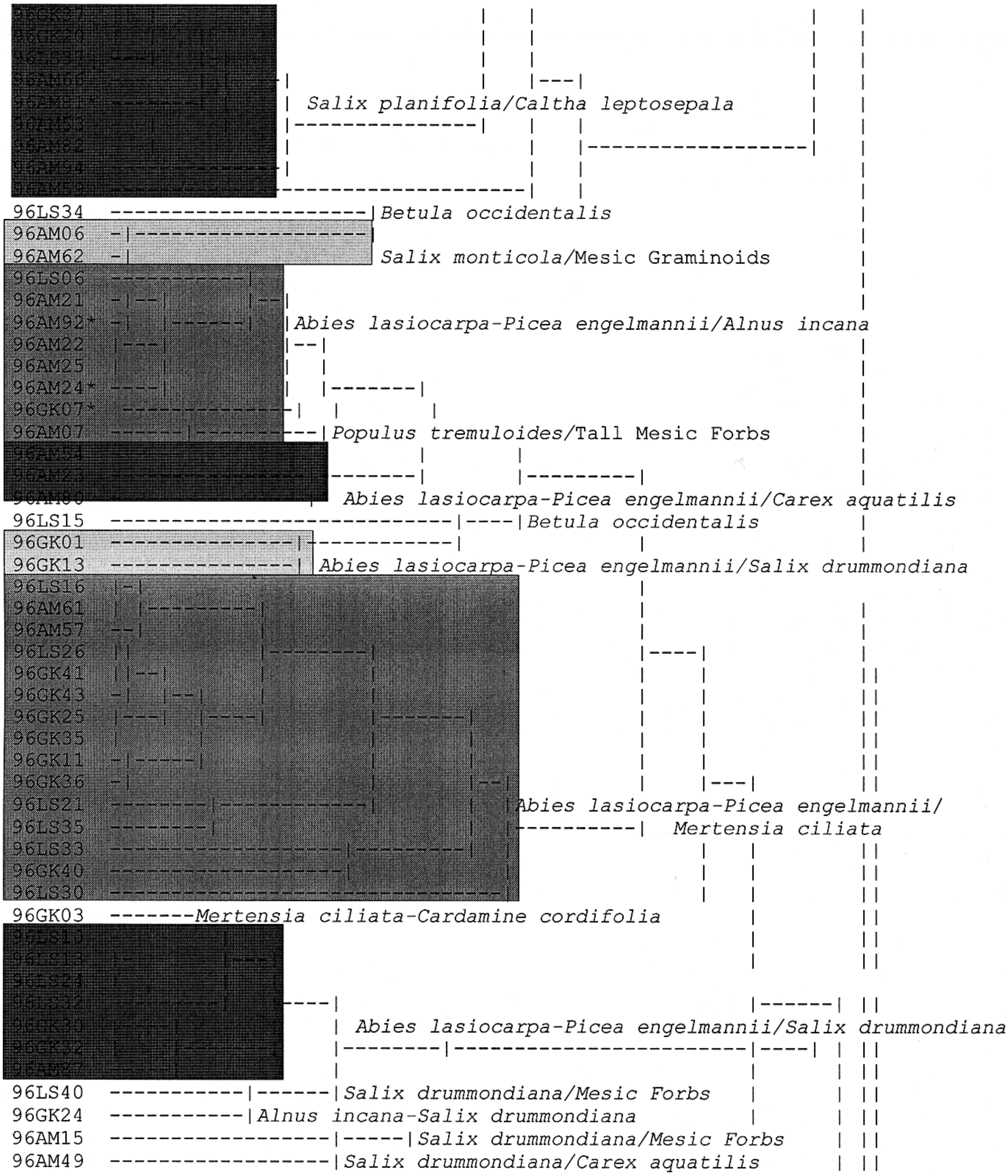


Figure 7. Continued.

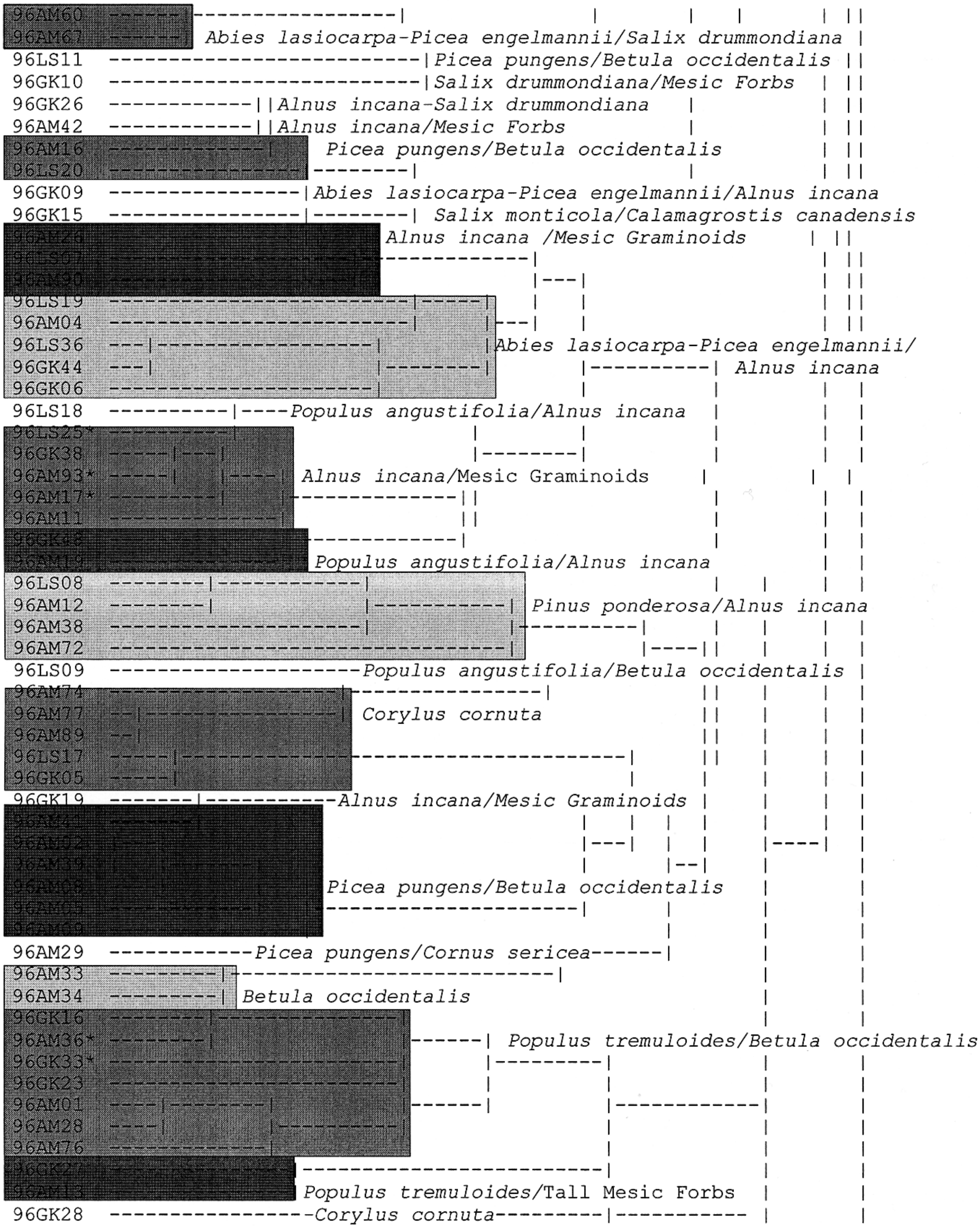


Figure 7. Continued.

```
96AM83  -----------------Salix bebbiana-----------|                      |
96LS04  --------------------------------Populus angustifolia Alliance    |
96LS05  ----------------------------|----|                   |----|      |
96GK08  ----------------------------|    |-------------|     |    |      |
96AM20  ---------------Populus angustifolia/Salix exigua --|      |---|  |
96GK18  ---------------P. angustifolia/Prunus virginiana          |   |  |
96GK17  --------------------|-------------------|                 |   |  |
96GK47  --------------------|                   |-----------------|   |  |
96GK34  ------------|---------------|           |Populus angustifolia/Salix irrorata
96GK46  ------------|               |-----------|                     |  |
96AM84  ----------------------------|Salix monticola/Mesic Forbs      |  |
[redacted]                                                            |  |
[redacted] -----------|                                           |   |  |
[redacted] Populus deltoides
[redacted] Alliance |                                                    |
96LS38  -------------Cratagegus macrancantha----------------------|      |
96AM03  -------------------Carex aquatilis------------------------|      |
96AM14  ----------Populus angustifolia/Salix exigua--------|      |      |
96AM18  ----------P. monilifera-Salix amygdaloides/Salix exigua---|
96AM31  -------------------------------------|         | |    |
96AM35  ---|-------------|                   |-------------| |----|
96AM85  ---|             |-------------------|  Salix exigua Alliance
96AM71  -----------------|                               |
96AM30  -------------------Salix bebbiana -----------|------|
96AM40  -------------------Carex aquatilis-----------|
```

Table 4. Riparian Plant Associations of the South Platte River Basin and part of the Republican River Basin. Plant Association names are preceeded by the Heritage Program Rarity Rank (G=Global, S=State, 1=rare, 5=common, two G or two S ranks=rank is inbetween these, ?=uncertaintiy about the rank, Q=taxonomy of the association is in question, U=not enough information to rank; see Table 3 for complete rank definitions).

SEASONALLY FLOODED/SATURATED EVERGREEN OPEN FORESTS

Abies lasiocarpa Alliance

- G5 S5 *Abies lasiocarpa-Picea engelmannii/Alnus incana*
- G3 S3 *Abies lasiocarpa-Picea engelmannii/Carex aquatilis*
- G5 S4 *Abies lasiocarpa-Picea engelmannii/Salix drummondiana*
- G5 S5 *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*

Picea pungens Alliance

- G3 S3 *Picea pungens/Alnus incana*
- G4 S2 *Picea pungens/Cornus sericea*
- G2 S2 *Picea pungens/Betula occidentalis*

Pinus ponderosa Alliance

- G2 S2 *Pinus ponderosa/Alnus incana*

Pseudotsuga menziesii Alliance

- G3? S3 *Pseudotsuga menziesii/Betula occidentalis*

SEASONALLY FLOODED/SATURATED DECIDUOUS OPEN FORESTS

Populus x acuminata Alliance

- Unclassified *Populus x acuminata* stands

Populus angustifolia Alliance

- G3? S3 *Populus angustifolia/Alnus incana*
- G3? S2 *Populus angustifolia/Betula occidentalis*
- G2G3 S1 *Populus angustifolia/Prunus virginiana*
- G4 S4 *Populus angustifolia/Salix exigua*
- G2? S2 *Populus angustifolia/Salix irrorata*
- Unclassified *Populus angustifolia* stands

Populus balsamifera Alliance

- GU SU *Populus balsamifera*

Populus deltoides Alliance

- N/A *Populus deltoides/Bromus inermis*
- G1? S1? *Populus deltoides/Carex lanuginosa*
- G1G2 S1 *Populus deltoides/Panicum virgatum*
- G1Q S1Q *Populus deltoides/Prunus virginiana*
- G2G3 S2 *Populus deltoides/Symphoricarpos occidentalis*
- G4? S3 *Populus deltoides-(Salix amygdaloides)/Salix exigua*
- G1G2 S1 *Populus deltoides-(Salix amygdaloides)/Spartina pectinata*
- Unclassified *Populus deltoides* stands

Table 4. Continued.

Salix amygdaloides Alliance

Unclassified *Salix amygdaloides* stands

Populus tremuloides Alliance

G5 S5 *Populus tremuloides*/Tall Mesic Forbs

G2G3 S2 *Populus tremuloides/Betula occidentalis*

SEASONALLY FLOODED/SATURATED DECIDUOUS SHRUBLANDS

Alnus incana Alliance

G5Q S3 *Alnus incana*/Mesic Graminoids

G3G4 S3 *Alnus incana-Cornus sericea*

G3 S3 *Alnus incana-Salix drummondiana*

Betula occidentalis Alliance

G3 S2 *Betula occidentalis*

Corylus cornuta Alliance

G3 S1 *Corylus cornuta*

Crataegus macracantha Alliance

GUQ SUQ *Crataegus macracantha* var. *occidentalis*

Pentaphylloides floribunda Alliance

G4 S3S4 *Pentaphylloides floribunda/Deschampsia cespitosa*

Prunus virginiana Alliance

G4Q S3 *Prunus virginiana*

Salix bebbiana Alliance

G3? S2 *Salix bebbiana*

Salix eriocephala var. *ligulifolia* Alliance

G2G3 S2S3 *Salix eriocephala* var. *ligulifolia*

Salix drummondiana Alliance

G2G3 S3 *Salix drummondiana /Carex aquatilis*

G4 S4 *Salix drummondiana*/Mesic Forbs

Salix exigua Alliance

G5 S5 *Salix exigua*/Barren

G5 S5 *Salix exigua/*Mesic Graminoids

Salix geyeriana Alliance

G5 S3 *Salix geyeriana/Carex utriculata*

G3 S3 *Salix geyeriana-Salix monticola*/*Calamagrostis canadensis*

Salix monticola Alliance

G3 S3 *Salix monticola/Calamagrostis canadensis*

G3 S3 *Salix monticola/Carex aquatilis*

G3 S3 *Salix monticola/Carex utriculata*

G3 S3 *Salix monticola/*Mesic Forbs

G3 S3 *Salix monticola/*Mesic Graminoids

Salix lucida var. *caudata* Alliance

G3Q S2S3 *Salix lucida* var. *caudata*

Symphoricarpos occidentalis Alliance

Table 4. Continued.

G4G5 S3 *Symphoricarpos occidentalis*

SUBALPINE DECIDUOUS SHRUBLANDS

Salix brachycarpa Alliance

G2G3 S2S3 *Salix brachycarpa/Carex aquatilis*

Salix planifolia Alliance

G4 S4 *Salix planifolia/Caltha leptosepala*

G5 S4 *Salix planifolia/Carex aquatilis*

Salix wolfii Alliance

G4 S3 *Salix wolfii/Carex aquatilis*

HERBACEOUS ASSOCIATIONS

Andropogon gerardii Alliance

G2 S1S2 *Andropogon gerardii-Sorghastrum nutans*

Carex aquatilis Alliance

G5 S4 *Carex aquatilis*

Carex praegracilis Alliance

G4 S4 *Carex praegracilis*

Carex nebrascensis Alliance

G4 S3 *Carex nebrascensis*

Carex lanuginosa Alliance

G3? S3 *Carex lanuginosa*

Carex utriculata Alliance

G5 S4 *Carex utriculata*

Juncus balticus spp. *montanus* Alliance

G5 S5 *Juncus balticus* ssp. *montanus*

Eleocharis palustris Alliance

G5 S4 *Eleocharis palustris*

Cardamine cordifolia Alliance

G4 S4 *Cardamine cordifolia-Mertensia ciliata*

Scirpus spp. Alliance

G3 S2S3 *Scirpus acutus-Scirpus tabernaemontani*

Spartina pectinata Alliance

GU SU *Spartina pectinata*

Typha angustifoli-(Typha latifolia) Alliance

G5 S3 *Typha angustifolia-Typha latifolia*

Dichotomous Key to the Riparian Plant Associations of the South Platte River Basin (and Parts of the Republican River basin), Colorado.

This key starts with a key to the overall physiognomic structure of the vegetation (forest or woodland, shrubland, or herbaceous dominated vegetation). The second part keys to individual plant associations. Most riparian associations occur within a mosaic of other associations along a river reach. Keep in mind that the following key is to each patch-type, or part, of the riparian mosaic.

Percent cover values used in the key are typical averages for the whole stand and do not represent rules but rather guidelines (I have tried to remove most of these and replace them with a ratio). Percent cover values found in the stand tables 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. I caution readers from using the stand table values as "make or break" rules for defining the plant association. Rather, the values in stand tables should be viewed as an indication of the proportion of the different species present within a stand.

Key to Physiognomic Groups:

1. Stand has an overstory canopy of trees with at least 20% cover, or if less, trees have a higher canopy coverage than any other shrub or herbaceous component combined. If a narrow strip of shrubs is present along the stream bank, and trees present are rooted in the same geomorphic surface as the shrubs, and at least half of tree canopy overhangs the shrubs (i.e. are not just barely overhanging from a neighboring stand), the trees are considered the dominant structure in the community (*i.e.,* it is equal to or greater than the total cover of the shrub or herbaceous canopy along the reach). (Stream banks with widely scattered *Ponderosa pine* will key here) ...2.

1. Stand does not have any trees, or if trees are present, their overstory canopy is less than 20%, or if higher, the shrub canopy is so thick that the trees appear as isolated individuals. If the tree canopy overhangs from an adjacent stand with less than half its canopy, and trees are not rooted in the same geomorphic surface as the shrubs, trees are not considered the dominant structure of the community (*i.e.*, trees are scattered and the shrub or herbaceous canopy layer is clearly much greater) ....3.

2. Coniferous trees dominate the overstory (if deciduous trees are present, they are less than one-half of the conifer canopy). .... **Group A.**

2. Deciduous trees dominate (if conifers are present, deciduous tree canopy is at least equal to the conifer canopy) ....**Group B.**

3. Stand has a shrub cover of at least 20%, if less, the distance between shrubs is less than one half their canopy diameter, and shrubs are clearly taller than the tallest herbaceous component. If the shrubs are clumped, the stand may be a mosaic shrubland and herbaceous communities. One exception is the shrubby cinquefoil/tufted hairgrass (*Pentaphlloides floribunda/Deschampsia ceaspitosa*) plant association, where the shrubs are scattered and the distance between them is greater than one-half their canopy diameter....................................4.

3. Herbaceous vegetation is the dominant canopy component, if shrubs are present, either the distance between shrubs is greater than half the canopy diameter, or they are very short and difficult to see in the herbaceous canopy. Clumped shrubs may indicate the stand is a mixture of a shrubland with an herbaceous community. One exception is the shrubby cinquefoil/tufted hairgrass (*Pentaphylloides floribunda/Deschampsia ceaspitosa*) plant association, where the shrubs are scattered and the distance between them is greater than one-half their canopy diameter (if so then go to Group E).. **Group C.**

   4. Willows (*Salix* spp.) dominate the overstory, other shrubs may be present, but are less than half as abundant .... **Group D.**

   4. Other, non-willow shrubs dominate the overstory. If willows are present, they are usually less abundant than the non-willow shrub species, or may be up to equal in abundance.............
   ....**Group E.**

Group A. Evergreen Forests and Woodlands

1. *Abies lasiocarpa* and/or *Picea engelmannii* are present and dominate the overstory, or nearly so from the adjacent forest that overhangs the riparian area...7.

1. *Abies lasiocarpa* and/or *Picea engelmannii* are not present, or if so are not the dominate conifer. *Picea pungens, Pinus ponderosa* and/or *Pseudotsuga menziesii* dominate the overstory (*Pinus contorta* may also be present) ....2.

   2. *Pseudotsuga menziesii* or *Pinus ponderosa* dominates the tree canopy.............................3.

      3. *Pinus ponderosa* dominates the tree cover (may have less than 20% cover) along the stream bank and terraces (it can be very open with large trees), *Alnus incana* lines the stream channel in non-continuous patches............. ***Pinus ponderosa/Alnus incana* p.a.**

      3. *Pseudotsuga menziesii* is the dominant tree along the riparian corridor ....4.

         4. *Betula occidentalis* is the dominant shrub along the stream bank, if *Alnus incana* is present than it is not more than half as abundant as the *Betula* ....
         .... ***Pseudotsuga menziesii/Betula occidentalis* p.a.**

         4. *Corylus cornuta* is the dominant understory shrub (An overstory of aspen also keys to this community).. ***Corylus cornuta* p.a.**

   2. *Picea pungens* dominates the overstory. *Populus angustifolia* may be present with less than 10% cover. If *Populus angustifolia* is more than half as abundant or equal to *Picea pungens*, the stand may be an example of the *Populus angustifolia-Picea pungens/Alnus incana* plant association, not sampled in the South Platte watershed during the study) ....5.

5. *Betula occidentalis* is the dominant shrub lining stream banks, *Alnus incana* may be present but not more than half as abundant as *Betula*, ...*Picea pungens/Betula occidentalis* **p.a.**

5. *Alnus incana* or *Cornus sericea* is the dominant understory ....6.

6. *Alnus incana* is the dominant shrub lining stream banks, *Cornus sericea* may be present in trace amounts ....***Picea pungens/Alnus incana*** **p.a.**

6. *Cornus sericea* is the dominant shrub in the understory canopy, *Alnus incana* may be present with not more than half the abundance of *Cornus*... ***Picea pungens/Cornus sericea*** **p.a.**

7. *Salix drummondiana* and/or *Alnus incana* are the dominant shrubs lining the stream bank ....8.

8. *Alnus incana* is more abundant than *Salix drummondiana* or *S. drummondiana* is not present ....***Abies lasiocarpa-Picea engelmannii/Alnus incana*** **p.a.**

8. *Salix drummondiana* is more abundant than *Alnus incana*, or *Alnus incana* is not present..................***Abies lasiocarpa-Picea engelmannii/Salix drummondiana*** **p.a.**

7. Shrub cover is 10% or less, and herbaceous species dominate the stream bank.................9.

9. Thick growth of forbs and mosses line the stream bank, and is dominated by any combination or singly by: *Mertensia ciliata*, *Cardamine cordifolia*, and *Senecio triangularis* ....***Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*** **p.a.**

9. *Carex aquatilis* grows in a thick to open-ish carpet under the trees, other graminoid species, such as *Calamagrostis canadensis*, may be present and nearly as abundant. Forb species, such as those listed above, are often present along the stream bank, but collectively in less cover than the *Carex aquatilis*-graminoid mix .... ***Abies lasiocarpa-Picea engelmannii/Carex aquatilis*** **p.a.**

Group B. Deciduous Dominated Forests

1. *Populus x acuminata, Populus balsamifera or Populus tremuloides* 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 angustifolia* and *P. deltoides* may be present in trace amounts ....2.

2. *Populus x acuminata* or *Populus balsamifera* is the dominant tree species ....3.

3. *Populus x acuminata* is the dominant tree, *Populus angustifolia* and *P. deltoides* may be present in trace amounts.. ***Populus x acuminata* Alliance**

3. *Populus balsamifera* is the dominant tree............................... ***Populus balsamifera* p.a.**

2. *Populus tremuloides* is the dominant tree along the reach..4.

4. Shrubs dominant the subcanopy ....5.

5. *Betula occidentalis* dominates the shrub canopy, if *Alnus incana* is present, it is not more than half as abundant as *Betula*.
....***Populus tremuloides/Betula occidentalis* p.a.**

5. *Corylus cornuta* dominates the shrub canopy. If other shrubs are present, they are half as abundant as *Corylus* or less .... ***Corylus cornuta* p.a.**

4. Few, if any shrubs occur, the undergrowth is a thick carpet of mixed, tall forb species
.... ***Populus tremuloides*/Tall Forbs p.a.**

1. *Populus angustifolia* or *Populus deltoides* dominate the overstory .... 5.

5. *Populus angustifolia* is the dominant deciduous tree, *P. deltoides* may be present in trace amounts ....6.

6. Mature trees dominate the tree canopy (taller than 1.5 meters and dbh greater than 5”, 12.6 cm) 7.

7. Shrubs create a subcanopy underneath the cottonwoods, sometimes the shrubs are confined to a single strip along the stream bank ....8.

8. *Alnus incana, Betula occidentalis* or *Prunus virginiana* dominates the shrub layer ....9.

9. *Prunus virginiana* is the dominate shrub present, generally more common on upper terraces, often occurring in patches in and amongst the cottonwood canopy .... ***Populus angustifolia/Prunus virginiana* p.a.**

9. *Prunus virginiana* not present, or if so, then more or less restricted to the outer and higher edges of the riparian area, and not below the canopy of cottonwoods. *Alnus incana* and/or *Betula occidentalis* growing in an thick bank along the stream edge...10.

10. *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.**

10. *Betula occidentalis* dominates the understory, *Alnus incana* and *Salix* spp. may be present, but with less than half the abundance of *Betula*, or if more, then are overtopped or shaded by the taller *Betula* shrubs***Populus angustifolia/Betula occidentalis* p.a.**

8. *Salix irrorata* is the dominant shrub, *Salix exigua* may be present in near equal to lesser amounts, other shrubs, if present, are less than the total *Salix irrorata* cover .... ***Populus angustifolia/Salix irrorata* p.a.**

7. No shrubs creating a subcanopy, if present than widely scattered, the undergrowth is dominated by mostly introduced hay-meadow grasses (e.g. *Poa pratensis, Agrostis stolonifera*)....................................... ***Populus angustifolia* (unclassified stands) Alliance**

6. Immature trees, mostly seedlings and saplings (less than 1.5 meters tall, and if taller, no more than 5", 12.6 cm dbh) ....11.

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

11. *Salix irrorata* is the understory dominant, *Salix exigua* may be present in lesser to equal amounts, sampled stands generally had older trees than above .... ***Populus angustifolia/Salix irrorata* p.a.**

5. *Populus deltoides* sap. *monilifera* is the dominant cottonwood, *Salix amygdaloides* is often present (1-25% cover), but not always ....12.

12. Mature, widely spaced, large *Populus deltoides* trees, *Salix amygdaloides* is usually present (1-25%), with or without a shrub understory (Taller than 1.5 meters, >5 inches, >12.6 cm dbh) ....13.

13. Stands have little to no shrub understory, the ground covered in herbaceous growth ... .14.

14. Native grasses and grass-like plants dominate the herbaceous layer ....15.

15. *Carex lanuginosa* or *Spartina pectinata* dominate the undergrowth and form a near monotypic carpet ....16.

16. *Carex lanuginosa* dominates the undergrowth (if mixed with *Spartina* and nearly equal in abundance, go to the next choice) ....***Populus deltoides/Carex lanuginosa* p.a.**

16. *Spartina pectinata* dominated the undergrowth in near mono-typic stands ....***Populus deltoides-(Salix amygdaloides)/Spartina pectinata*** **p.a.**

15. Tall-grass species such as *Panicum virgatum*, *Andropogon gerardii*, and *Sorghastrum nutans* occur underneath and between the cottonwood canopy .... ***Populus deltoides/Panicum virgatum*** **p.a.**

14. Non-native introduced hay meadow grasses and other weeds dominate the undergrowth ....17.

17. *Bromus inermis* is very abundant, forming near mono-typic lawn under the cottonwood canopy ....***Populus deltoides/Bromus inermis*** **p.a.**

17. Not as above in all respects .... ***Populus deltoides*** **(unclassified) Alliance**

13. Shrubs create a subcanopy underneath the trees..17.

17. A low (0.5-1 m tall) shrub layer consisting of *Symphoricarpos occidentalis* occurs in large patches under the canopy of the cottonwoods............................ ....***Populus deltoides/Symphoricarpos occidentalis*** **p.a.**

17. Medium tall stands of *Prunus virginiana* occur in small to large patches under the cottonwood canopy ....***Populus deltoides/Prunus virginiana*** **p.a.**

12. Younger stands, either saplings and seedlings or medium aged trees several meters apart, but not large and widely spaced..18.

18. Stands consist of seedling and sapling sized *Populus deltoides* mixed with similar sized *Salix amygdaloides* and *Salix exigua* stems, occurring on recently flooded point bars and overflow channels ....***Populus deltoides-(Salix amygdaloides)/Salix exigua*** **p.a.**

18. Not as above in all respects. ...... ***Populus deltoides*** **(unclassified) Alliance,** or ....***Salix amygdaloides*** **Alliance**

Group D. Willow Dominated shrubland

Tall montane willows often occur in stands with several species of willows. In this key, the dominant willow means the willow species with the highest individual cover. This is the willow that makes up the bulk or "matrix" of the shrubland, even though the other species may be present and have a greater combined cover. For example, a stand with 30% *Salix monticola,* 10% *Salix drummondiana*, 20% *Salix eriocephala*, and 20% *Salix geyeriana*, will key to a *Salix monticola* type. One exception is the *Salix geyeriana-Salix monticola* plant association, where, for the most part, only those two species occur together in varying amounts.

1. Willows of low stature, 0.5-1.5 m (1-5 ft.) tall, subalpine environments (10,000-11,500 ft) ...2.

1. Willows of tall stature, 1.5-3 m (5-18 ft) or more, lower subalpine, montane, or foothill environments ....5.

2. *Salix brachycarpa* dominates the willow cover, occupying drier habitats than the next. (Clumps of *Salix brachycarpa* can intermix with *Salix planifolia* creating a complex mosaic of the two associations) ....***Salix brachycarpa/Carex aquatilis* p.a.**

2. *Salix planifolia* or *Salix wolfii* dominate the stand ....3.

3. *Salix planifolia* dominates the shrub canopy and the herbaceous undergrowth is dominated by many forbs, *Caltha leptosepala* usually the most abundant species..... ....***Salix planifolia/Caltha leptosepala* p.a.**

3. *Salix planifolia* or *Salix wolfii* dominate the canopy, herbaceous undergrowth is dominated by graminoides, *Carex aquatilis* usually the most abundant species .....4.

4. *Salix planifolia* is the dominant shrub with at least 20% cover, other willow may be present, in lesser amounts....... ***Salix planifolia/Carex aquatilis* p.a.**

4. *Salix wolfii* is the dominant shrub ....***Salix wolfii/Carex aquatilis* p.a.**

5. *Salix exigua* present and dominant, usually occurs as a narrow band along stream margins and cobble bars. Montane and foothill environments...6.

6. Ground cover under the *Salix exigua* canopy is mostly coarse alluvium with a sparse herbaceous cover, where bare cobbles and sand are more abundant (at lease two-thirds that of developed soil and herbaceous plants)........................ ***Salix exigua/*Barren p.a.**

6. Ground cover under *Salix exigua* is mostly herbaceous vegetation, developed soil, and litter. Bare sand and cobbles may be present but make up less than one-third of ground cover. ....***Salix exigua*/Mesic Graminoids p.a.**

5. Tall *Salix* species other than *Salix exigua* are dominant in the stand.................................7.

7. *Salix geyeriana* is the dominant shrub, *Salix monticola* may be present, up to equal in abundance ....8.

8. *Salix geyeriana* mixed with *Salix monticola*. The ratio varies, one can be as low as 10%, but both present on the floodplain. Undergrowth is a thick carpet of mostly graminoid species, *Calamagrostis canadensis* is the most dominant or prevalent species ....***Salix geyeriana-Salix monticola*/*Calamagrostis canadensis* p.a.**

8. *Salix geyeriana* the sole dominant shrub, with a thick undergrowth of *Carex utriculata* ....***Salix geyeriana/Carex utriculata* p.a.**

7. *Salix drummondiana*, *Salix monticola*, *Salix eriocephala* or *Salix bebbiana* dominant ....9.

9. *Salix drummondiana* or *Salix monticola* dominate ....10.

10. *Salix drummondiana* forms a thick narrow bands along the stream banks of high gradient streams ....11.

11. Undergrowth is a mixture of forb species, difficult to choose a dominant, as all species are under 10%, although the combined cover is near (30) 40-50 (70) % ....***Salix drummondiana*/Mesic forbs p.a.**

11. Undergrowth is dominated by *Carex aquatilis*, with or without several other graminoid species, *Carex aquatilis* is most abundant of all species present, even if with only 5-9% cover ....***Salix drummondiana/Carex aquatilis* p.a.**

10. *Salix monticola* is often dominant on wide floodplains on low gradient, meandering streams, generally forming wide willow carrs (shrublands). *Salix monticola* is the dominant or matrix shrub species, several other willow species may be present with less cover individually, but combined they may be more than the total *Salix monticola* canopy cover ....12.

12. The herbaceous undergrowth may have several species, or only a few species, in either case one or two species can be identified as having the highest cover, so that one species can be thought of as the dominate ....13.

13. The herbaceous understory is dominated by *Calamagrostis canadensis*........................***Salix monticola/Calamagrostis canadensis* p.a.**

13. The herbaceous undergrowth is dominated by *Carex* spp. ....14.

14. Stand has very wet to saturated soils for the entire growing season. *Carex utriculata* is the dominant *Carex* throughout the stand ....***Salix monticola/Carex utriculata* p.a.**

14. Stand is mesic to wet, but not saturated for the entire growing-season, *Carex aquatilis* is the dominant sedge in the undergrowth ....***Salix monticola/Carex aquatilis* p.a.**

12. The herbaceous undergrowth is dominated by many forb or graminoid species (20-45+). No one species is dominant, all are nearly equal in cover. Stands may be heavily grazed...15.

15. Total graminoid cover (all species combined) is greater than cover of all the forb species taken together. No one graminoid species stands out as the dominant (many species with similar cover values)........................... ....***Salix monticola/M*esic Graminoids p.a.**

14. Total forb cover (all species combined) is greater than cover of all the graminoid cover taken together. No one forb species stand out as the dominant (many species with similar cover values)..................................... ....***Salix monticola*/Mesic Forbs p.a.**

9. *Salix eriocephala* var. *ligulifolia* (also known as *Salix lutea* and *Salix ligulifolia*) or *Salix bebbiana* dominates the shrub canopy..15.

15. *Salix eriocephala* var. *ligulifolia* is the dominant shrub, although several other willow species may also be present (such as *Salix monticola*, *Salix geyeriana*, and *Salix planifolia*), regardless of the undergrowth.. .... ***Salix eriocephala* var. *ligulifolia* p.a.**

15. *Salix bebbiana* is the dominant, and often the only, willow present, with a variable herbaceous undergrowth..***Salix bebbiana* p.a.**

Group E. Non-Willow Dominated Shrublands

1. *Alnus incana* or *Betula occidentalis* dominate the stream banks..2.

2. *Betula occidentalis* dominates the shrub canopy, if *Alnus incana* is present than it is not more than half as abundant as the *Betula* ....***Betula occidentalis* p.a.**

2. *Alnus incana* dominates the shrub canopy, solely or with other shrub species..................3.

3. *Salix drummondiana* or *Cornus sericea* are present with at least equal amounts ....4.

4. *Cornus sericea* is present in equal amounts to the *Alnus incana* ....***Alnus incana-Cornus sericea* p.a.**

4. *Salix drummondiana* is present in near-equal amounts, if *Cornus* is also present, it is not more than 10% of the total shrub canopy ....***Alnus incana-Salix drummondiana* p.a.**

3. *Alnus incana* is the sole dominant shrub, if other shrubs are present, they have 10% or less cover, the understory is a mixture of many graminoid and forb species, and the total graminoid cover is greater than the forb species ......***Alnus incana*/Mesic Graminoids p.a.**

1. *Prunus virginiana*, *Symphoricarpos occidentalis*, *Crataegus macracantha* var. *occidentalis, Pentaphylloides floribunda* or *Corylus cornuta* contribute at least 20% cover, are clearly the dominant and, more often, the sole shrub in the stand ....5.

5. *Prunus virginiana* and/or *Symphoricarpos occidentalis* dominate the shrub canopy..........6.

6. *Prunus virginiana* creates a thicket in draws and narrow stream benches, *Symphoricarpos* may be present, even co-dominant ....***Prunus virginiana* p.a.**

6. No *Prunus virginiana* occurs along the reach, *Symphoricarpos* forms large, low stature (0.5-1.0 m tall) thickets ....***Symphoricarpos occidentalis* p.a.**

5. *Crataegus macracantha*, *Corylus cornuta* or *Pentaphylloides floribunda* are dominant....7.

7. *Crataegus macracantha* forms a narrow thicket along steeply sloping stream banks at the foothill/plains transition elevation... ***Crataegus macracantha* var. *occidentalis* p.a.**

7. Stands not as above8.

8. *Corylus cornuta* is the dominant shrub in narrow, shaded canyons, often co-dominant with *Alnus incana*, and may have *Pseudotsuga menziesii*, *Picea pungens*, or *Populus tremuloides* in the overstory.................................. ***Corylus cornuta* p.a.**

8. *Pentaphylloides floribunda* is present in scattered to abundant amounts................... .... ***Pentaphylloides floribunda/Deschampsia cespitosa* p.a.**

Group C. Herbaceous Plant Associations

1. *Carex* species dominate the herbaceous growth, in small patches or large meadows, generally one species occurring with >25% cover ....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.

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 ....4.

4. 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.** (not sampled during the study but likely to occur in the upper South Platte drainage)

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 is, it contributes not more than one third of the total cover.... ***Carex utriculata* p.a.**

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

6. Low elevation creeks on the plains, *Carex praegracilis* is the dominant graminoid with few other graminoid species present..***Carex praegracilis* p.a.**

6. *Carex nebrascensis* dominant along creeks of the foothills and mountains, few other graminoids present .... ***Carex nebrascensis* p.a.**

7. Wetlands with standing water for much of the year with *Typha*, *Scirpus*, or *Eleocharis* dominant in or near standing water...8.

8. Small stands along the margins of ponds and slow moving reaches of streams, *Eleocharis palustris* dominant, some scattered *Scirpus* may occur, but with not more than 10% cover .... ***Eleocharis palustris* p.a.**

8. Large wetlands or small swales on the floodplain of larger rivers, *Typha angustifolia* or *Scirpus* spp. is the dominant tall graminoid ....9.

9. Tall mono-typic stands of *Typha angustifolia* .... ***Typha angustifolia*** **p.a.**

9. Little to no *Typha* present, *Scirpus acutus* or *S. tabernaemontani* dominant or co-dominant in any combination .... ***Scirpus acutus-S. tabernaemontani*** **p.a.**

7. Terrestrial or palustrine stands, little to no standing water, or if so than is occurs only for a short duration seasonally, and otherwise not as above ....10.

10. Tall-grass species such as *Andropogon gerardii*, *Sorghastrum nutans*, *Panicum virgatum* and/or *Spartina pectinata* dominate the herbaceous layer............................11.

11. A mixture of *Andropogon gerardii, Sorghastrum nutans*, *Panicum virgatum* and/or *Spartina pectinata* dominant the stand .... ***Andropogon gerardii-Sorghastrum nutans*** **p.a.**

11. *Spartina pectinata*, occurs in nearly mono-typic stands, often large areas on mud flats of larger rivers, or in small swales where there are pockets of clay ....***Spartina pectinata*** **p.a.**

10. Stands are dominated narrow bands of rushes (*Juncus* spp.) or forb species.........12.

12. Graminoids dominate the stands, *Juncus balticus* is a clear dominant .... ***Juncus balticus*** **p.a.**

12. Stands dominated by a narrow band of mixed forbs .... ***Cardamine cordifolia-Mertensia ciliata*** **p.a.**

UNESCO: **II.A.4.e OPEN TREE CANOPY, EVERGREEN, TEMPERATE SEASONALLY FLOODED/SATURATED**
COWARDIN: **PALUSTRINE-FORESTED, NEEDLE-LEAVED EVERGREEN**

Abies lasiocarpa Alliance

Subalpine fir-Engelmann spruce/thinleaf alder (*Abies lasiocarpa-Picea engelmannii /Alnus incana* ssp. *tenuifolia*) Plant Association
CNHP Rank: G5/S5
52 Quantitative Plots:
Dolores River Basin--2 plots (EO#6, EO#7),
Gunnison River Basin--11 plots (94GK24, 94GK26, 94GK47, 94JB18, 94JB48, 94MD07, 94MD08, 94MD39, 94RR15, 94RR25, 94RR29)
Colorado River Basin--1 plot (92NL31)
Yampa River Basin--6 plots (59, 60, 65, 73, 87, 110)
San Juan National Forest --8 plots (91, 165, 199, 202, 210, 218, 224, 235)
Routt National Forest--14 plots (617, 191, 211, 361, 412, 518, 528, 545, 556, 582, 587, 601, 602, 611)
South Platte River Basin--10 plots (96LS06, 96AM21, 96AM22, 96AM25, 96GK09, 96LS19,96AM04, 96LS36, 96GK44,96GK06).

South Platte River Basin Reference Reaches: One excellent occurrence can be seen along the Cache la Poudre River, along the Big South Trail, between Peterson lake and HWY 14, Arapaho-Roosevelt National Forest, Larimer County, T7N R75W, Sec 15. Another excellent occurrence can be seen on Soda Creek, Arapaho-Roosevelt National Forest, Clear Creek County, T4S, R73W, Sec 15.

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 subalpine fir-Engelmann spruce forests occur on the adjacent hillslopes as well. Tall *Alnus incana* (thinleaf alder) and *Salix drummondiana* (Drummond willow) grow in a thick band along the edge of the stream. *Alnus incana* is more abundant at lower elevations than *Salix drummondiana*. At mid-elevations, the two shrubs can be codominant. At higher elevations, *Salix drummondiana* becomes dominant and *Alnus incana* drops out, forming the *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association.

Regional Distribution: This plant association and closely related communities types occur in Nevada (Manning and Padgett 1995), Utah (Padgett *et. al*. 1989), eastern Idaho and western Wyoming (Youngblood *et al*. 1985), and Colorado (Colorado Natural Heritage Program 1996).

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

Vegetation: *Picea engelmannii* (Engelmann spruce) dominates the upper canopy with 10-60% cover. *Abies lasiocarpa* (subalpine fir) is usually present with up to 50% cover. Other tree species occasionally present with 1-15% cover are: *Populus angustifolia* (narrowleaf cottonwood), *Picea pungens* (Colorado blue spruce), *Pinus contorta* (lodgepole pine), and *Populus tremuloides* (aspen) (Table 5.). *Abies concolor* (white fir) can be present with up to 15% cover the southwestern part of the state.

An open to dense mid-canopy of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) is always present with 10-90% 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 20-60%. Characteristic forb species include *Mertensia ciliata* (mountain bluebell), *Mertensia fransiscana* (flagstaff bluebell), *Cardamine cordifolia* (heartleaf bittercress), *Heracleum lanatum* (cow parsnip), *Geum macrophyllum* (large-leaved avens), *Saxafraga odontoloma* (brook saxifrage), and *Geranium richardsonii* (Richardson's geranium). Graminoid cover is minimal in western slope stands. In the South Platte watershed, graminoid cover includes *Calamagrostis canadensis* (0-30%), *Carex disperma* (5-10%), and *Glyceria* spp. (0-16%). Overall graminoid cover can be as high as 50%. One plot had 43% *Equisetum arvensis*.

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

Site Geomorphology: This plant association generally occurs in narrow (40-250 m), V-shaped valleys on stream benches and stream banks, and usually occurs within 15-20 feet (5-6 m) of the channel edge and is rarely more than 2 feet (0.5 m) above the stream bank.

Rosgen's Stream Classification: This association is common along small, steep streams (A2 and A4), but can also occur along moderate gradient sections (B1, B2, and B3).

Soils: Soils are shallow (<1 m deep), dark-colored, loamy sands and sandy clay loams with high organic matter in the top 20 cm (average) and mottles at 40 cm (average), becoming skeletal by 60 cm. .

Adjacent riparian vegetation: This plant association is generally the only riparian association along a narrow stream reach. Adjacent riparian associations can include other *Abies lasiocarpa* (subalpine fir) 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 forest canopy.

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 the numerous riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, when present the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is complex. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community. Others suggest that the two species coexist in nonequilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the forest overstory (Aplet *et al*. 1988). The literature reviewed here suggests that the spruce-fir forest will never become a single-species dominated "climax" forest, but rather is a perpetually changing mosaic of patches that are of different ages and composition. The successional dynamics are a complex interaction of local site physical characteristics, the life history traits of spruce and fir, and the confounding effects of fire, windthrow and insect outbreak acting at both large (entire stand) and small (individual trees) scales. These interacting affects are outlined below.

Abies lasiocarpa has greater reproductive success in the shaded forest than *Picea engelmannii* (Peet 1981) and lives for approximately three hundred years. *Picea engelmannii* has a lower rate of establishment, but commonly lives longer than five hundred years (Aplet *et al*. 1988). In Colorado, all age classes of both species are generally found within the riparian zone.

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). As the stand matures, the faster-growing *Picea engelmannii* continues to shade *Abies lasiocarpa* in mesic sites. Over the next 100-300 years, barring other disturbances, shade tolerant *Abies lasiocarpa* seedlings replace small canopy gaps (Peet 1981).

Windthrow 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*), the most damaging insect to *Picea* *engelmannii*. During periodic rises in its population, however, the beetle infests large 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).

Composition of the riparian forest understory varies with the amount of shading and elevation. Under a closed canopy, tall mesic forbs may be the only obligate riparian species lining the stream, forming the *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* plant association. With a more open forest canopy, *Alnus incana* (thinleaf alder) or *Salix drummondiana* (Drummond willow) may be present forming the *Abies lasiocarpa-Picea engelmannii/Alnus incana* and *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant associations. Stands with a high cover of both *Alnus incana* and *Salix drummondiana* in the understory may be transitional as *Alnus incana* replaces *Salix drummondiana* at lower elevations.

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 (Padgett *et al.* 1989) at lower elevations. This successional shift may be attributed to a lack of fire in the association (Manning and Padgett 1995).

Management: The dense shrub layer within 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 short durations of standing water.

This plant association is should not be logged as the soils and slopes have high soil moisture content, and the timber productivity is fairly low (Youngblood and Mauk 1985). In addition, this association is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1990).

Related Types/Synonyms: This association has been called by several names: *Abies lasiocarpa/Alnus incana-Salix drummondiana* (Kittel *et al*. 1994, 1995, Kettler and McMullen 1996, Richard *et al.* 1996), *Picea engelmannii-Abies lasiocarpa/Alnus incana* (Kittel and Lederer 1993), and *Abies lasiocarpa-Picea engelmannii/Alnus incana* spp. *tenuifolia-Lonicera involucrata-Salix drummondiana* (Baker 1989).

The *Abies lasiocarpa/Alnus incana-Salix drummondiana* plant association was split into two distinct types (Kittel *et al.* 1995). One with mostly *Alnus incana* in the understory, *Abies lasiocarpa-Picea engelmannii/Alnus incana*, which occurs at slightly lower elevations, and one with *Salix drummondiana* dominant in the understory, *Abies alsiocarpa-Picea engelmannii/Salix drummondiana*, which occurs at slightly higher elevations. Stands where both *Alnus incana* and *Salix drummondiana* co-dominant appear to be transitional between these two plant associations.

Other, similar associations with significant *Cornus sericea* and very little *Alnus incana* have also been described, and may be a phase of the *Abies lasiocarpa-Picea engelmannii/Alnus incana* association. These include the *Abies lasiocarpa/Alnus incana-Cornus sericea* (subalpine fir/thinleaf alder-red-osier dogwood) plant association from Routt National Forest in north central Colorado (Kettler and McMullen 1996), the conifer/*Cornus sericea* (red-osier dogwood) community type found in Utah (Padgett *et al*. 1989) and Nevada (Manning and Padgett 1985), and the *Picea/Cornus stolonifera* (spruce/red-osier dogwood) community type found in eastern Idaho and western Wyoming (Youngblood *et al*. 1985).

Table 5. *Abies lasiocarpa-Picea engelmannii/Alnus incana* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number (96--)	LS06	AM21	AM22	AM25	GK09	LS19	AM04	LS36	GK44	GK06
Site Condition Rank	C	A	A	A	B	B	B	B	B	B
TREES										
Abies lasiocarpa - tree						5		8	6	6
Abies lasiocarpa - sapling					3			1	22	1
Picea englemannii - tree	53	57	44	48		20	20	11	17	7
Picea englemannii - sapling	1									9
Picea englemannii - seedling		1	24	1					3	3
Picea pungens - tree		5			9	1				
Picea pungens - sapling					1					
Pinus contorta – tree			2					12	17	
Populus tremuloides – tree	7	4	2			3	9		3	
Populus tremuloides – sapling							10			
SHRUBS										
Acer glabrum					13					
Alnus incana	21	16	25	9	11	28	30	77	62	38
Betula occidentalis		17					13			
Lonicera involucrata			4	1	1			3	2	2
Rosa woodsii			1	1	1	1	7		2	
Salix drummondiana					2			1	1	
FORBS										
Arnica cordifolia			1		2	1	6	1	1	1
Epilobium angustifolium			6	3	3		3		1	1
Erigeron eximius								39		
Fragaria virginiana	1	2	1	1	2		2			1
Heracleum sphondylium	1	1			1	2	4			1
Maianthemum racemosum	4				1					18
Mertensia ciliata	3	5	9	4	5				1	10
Saxifraga odontoloma	1	1	1	7						1
Streptopus amplexifolius		1	6	8	7	1		3	1	
GRAMINOIDES										
Calamagrostis canadensis	26	2	1	2	26	15		13	3	1
Carex disperma	4	5	1		2			1		2
Glyceria elata						14				
Glyceria striata						13				
HORSETAILS										
Equisetum arvense	15	1				43	2			

Subalpine fir-Engelmann spruce/aquatic sedge (*Abies lasiocarpa-Picea engelmannii/Carex aquatilis*) Plant Association
CNHP Rank: G3/S3
5 quantitative plots:
Routt National Forest-- 2 plots (93, 122)
South Platte--3 plots (96AM23, 96AM20, 96LS15)

South Platte River Basin Reference Reaches: An excellent example of this type can be seen along Bear Track Creek, Arapaho-Roosevelt National Forest, Mt. Evans Wilderness Area, Clear Creek County, T5S, R73W, Sec 21.

General Description and Comments: This plant association occurs below 10,000 ft (3000 m) on saturated soils along narrow streams and adjacent to willow carrs and sedge fens. This association has an herbaceous undergrowth that is dominated by *Carex aquatilis* (aquatic sedge) with *Calamagrostis canadensis* (bluejoint reedgrass) as an occasional a co-dominant.

Regional Distribution: This plant association and similar types occur in northeastern Utah (Mauk and Henderson 1984), western Wyoming, Idaho, Montana (Johnston 1987), and northern Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This plant association occurs along the Front Range and in Routt National Forest in north central Colorado (Colorado Natural Heritage Program 1996, Cooper and Cottrell 1990, Kettler and McMullen 1996).

Vegetation: *Picea engelmannii* (Engelmann spruce) is the dominant overstory species in this plant association with 15-30% cover. *Abies lasiocarpa* (subalpine fir) is also present with 1-10% cover. Shrub cover is low, but diverse, with *Lonicera involucrata* (0-10%), *Juniperius communis* (0-10%), *Salix bebbiana* (0-3%), *S. monticola* (0-4%), and *S. planifolia* (0-6%). One stand had *Betula occidentalis* with 4% cover. The herbaceous understory is dominated by 10-80% cover of *Carex aquatilis* (aquatic sedge), and occasionally *Calamagrostis canadensis* (0-16%) (Table 6). Forbs can be abundant or very sparse.

Elevation Range: 8200-9500 ft (2500-2900 m).

Site Geomorphology: In Wyoming and Utah, this plant association occurs on year-long saturated soils in cold, low lying swales and valley bottoms along stream banks and terraces. In Colorado, this association occurs on the margins of subalpine willow carrs and sedge fens and adjacent to moderate gradient, narrow streams (Cooper and Cottrell 1990, Kettler and McMullen 1996).

Soils: Soils are organic material or sandy clay loams.

Adjacent Riparian vegetation: Adjacent riparian areas can include shrublands of *Salix* *drummondiana* (Drummond willow), *S. geyeriana* (Geyer willow), *S. planifolia* (planeleaf willow), and *Picea engelmannii* (Engelmann spruce) forests.

Adjacent Upland Vegetation: Surrounding uplands have *Abies lasiocarpa* and *Picea engelmannii* forests at higher elevations and *Populus tremuloides* or *Pinus contorta* forests at lower elevations.

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 the numerous riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, when present the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is complex. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community. Others suggest that the two species coexist in nonequilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the forest overstory (Aplet *et al*. 1988). The literature reviewed here suggests that the spruce-fir forest will never become a single-species dominated "climax" forest, but rather is a perpetually changing mosaic of patches that are of different ages and composition. The successional dynamics are a complex interaction of local site physical characteristics, the life history traits of spruce and fir, and the confounding effects of fire, windthrow and insect outbreak acting at both large (entire stand) and small (individual trees) scales. These interacting affects are outlined below.

Abies lasiocarpa has greater reproductive success in the shaded forest than *Picea engelmannii* (Peet 1981) and lives for approximately three hundred years. *Picea engelmannii* has a lower rate of establishment, but commonly lives longer than five hundred years (Aplet *et al*. 1988). In Colorado, all age classes of both species are generally found within the riparian zone.

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). As the stand matures, the faster-growing *Picea engelmannii* continues to shade *Abies lasiocarpa* in mesic sites. Over the next 100-300 years, barring other disturbances, shade tolerant *Abies lasiocarpa* seedlings replace small canopy gaps (Peet 1981).

Windthrow 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*), the most damaging insect to *Picea engelmannii*. During periodic rises in its population, however, the beetle infests large 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).

The *Abies lasiocarpa-Picea engelmannii/Carex aquatilis* plant association is considered to be a climax community when it occurs along the edges of wet willow carrs and sedge fens. It can be the late development stage of pond succession. As ponds begin to dry, a fibrous mat forms allowing terrestrial species, such as sedges to become established. As ponds continue to fill in and the water level lowers, *Carex aquatilis* becomes the dominant sedge. As the area dries more and the water table lowers, conifers such as *Abies lasiocarpa* and *Picea engelmannii* become established (Cooper and Cottrell 1990).

The presence of *Pinus contorta* or *Populus tremuloides* indicates an early seral stage from disturbance.

Management: Livestock forage value for *Carex aquatilis* (aquatic sedge) is variable. With heavy grazing, the cover of *Carex aquatilis* will decrease and disturbance induced species may become established. Residual cover should be left to prevent sediment from entering the stream during rainstorms and spring runoff (Hansen *et al*. 1995). Livestock access should be restricted until late summer, when the animals will not churn the wet soil and destroy plant cover as well as conifer seedlings.

Carex aquatilis is an excellent stream bank stabilizer due to its rhizomatous growth. It tends to form a dense, thick sod that is highly resistant to erosion. *Carex aquatilis* responds well to prescribed burning, but the conifer species in the canopy do not. Fire will reduce the amount of litter accumulated and temporarily increase the productivity of *Carex aquatilis* (Hansen *et al*. 1995).

This plant association is sensitive to timber harvesting activities due to high soil moisture content and timber productivity is fairly low (Youngblood and Mauk 1985). In addition, this association is poorly suited for roads, trails, or other developments. Protection of water resources is a major consideration for any management activity (The Nature Conservancy 1990).

Related Types/Synonyms: The *Abies lasiocarpa/Calamagrostis canadensis* (subalpine fir/bluejoint reedgrass) plant association described by Cooper and Cottrell (1990), Hess (1981), Hess and Alexander (1986) has a high cover of *Carex aquatilis* (at least 10%) and, to a lesser extent, *Calamagrostis canadensis* and is therefore considered synonymous with the Colorado *Abies lasiocarpa-Picea engelmannii/Carex aquatilis* plant association..

Closely related communities include: the *Abies lasiocarpa*/*Carex aquatilis* (subalpine fir/aquatic sedge) plant association occurs along the northern Colorado Front Range (Cooper and Cottrell 1990), which differs by the presence and sometimes dominance of *Pinus contorta* (lodgepole pine); the *Picea engelmannii*/*Caltha leptosepala* (Engelmann spruce/marsh marigold) plant association occurs in western Wyoming and northeastern Utah (Johnston 1987), which differs by having a more diverse herbaceous understory. The *Abies lasiocarpa/Calamagrostis canadensis* plant association described by Cooper (1975), Cooper *et al*. (1987), Komarkova (1986), Mauk and Henderson (1984) , Pfister *et al*. (1977), and Steele *et al*. (1981 and 1983, as cited in Johnston 1987) which appears to not have any *Carex aquatilis* and is based primarily on upland forest stands.

Table 6. *Abies lasiocarpa-Picea engelmannii/Carex aquatilis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM23	96AM80	96LS15
Condition Rank	A	A	C
TREES			
Abies lasiocarpa - tree			7
Picea engelmannii - tree	32	22	26
Picea engelmannii - sapling		2	
Picea engelmannii - seedling	3	4	
Pinus contorta - tree			25
Populus tremuloides - tree			15
SHRUBS			
Alnus incana			8
Betula occidentalis			20
Lonicera involucrata	1		5
FORBS			
Caltha leptosepala		9	
Epilobium angustifolium	4	5	
Saxifraga odontoloma		13	
Senecio triangularis	6		
Streptopus amplexifolius var. *chalazatus*	1	6	
GRAMINOIDES			
Calamagrostis canadensis	5	9	16
Carex aquatilis	13	3	28
Carex canescens			10
Carex disperma	1	4	
Carex norvegica		10	3
Equisetum arvense	2		10

Subalpine fir-Engelmann spruce/Drummond willow (*Abies lasiocarpa-Picea engelmannii/Salix drummondiana*) Plant Association
CNHP Rank: G5/S4
34 quantitative plots:
Gunnison River Basin--14 plots (94GK17, 94GK20, 94GK35, 94JB07, 94JB27, 94JB30, 94JB36, 94JB46, 94MD11, 94MD22, 94RR12, 94RR20, 94RR28, 94RR49)
San Juan National Forest--6 plots (138, 222, 231, 239, 242, 243)
Arkansas River Basin--1 plot (95AM43)
Colorado River Basin-- 1 plot (92NL31)
South Platte River Basin--12 plots (96LS10, 96LS13, 96LS24, 96LS32, 96GK30, 96GK32, 96AM8, 96AM60, 96AM67, 96AM54, 96GK01, 96GK13)

South Platte River Basin Reference Reaches: One excellent example of this type can be seen on Kirby Creek, Arapaho-Roosevelt National Forest, Park County, T6S, R75W, Sec 10. Another high quality stand occurs along Beaver Creek, also in Arapaho-Roosevelt National Forest, Larimer County, T7N, R73W, Sec 9 and 16.

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 first-order streams above 9,000 feet (2700 m). *Picea pungens* is occasionally present at the stream edge and represents a variation of this type on the Colorado western slope. At the lower end of its elevation range, this association grades into the *Abies lasiocarpa-Picea engelmannii/Alnus incana* (subalpine fir-Engelmann spruce/thinleaf alder) plant association.

Regional Distribution: The *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* (subalpine fir-Engelmann spruce/Drummond willow) plant association has many closely related plant associations and community types common throughout the Rocky Mountains in Montana (Hansen *et al*. 1995), Wyoming, eastern Idaho (Youngblood *et al*. 1985), northern Utah, and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This plant association is common along first- and second-order streams, and occurs throughout the high mountain areas of Colorado. It has been documented in the San Juan Mountains, and in the Colorado, Gunnison, Arkansas and South Platte River Basins (Richard *et al.* 1996, Kittel *et al*. 1995, Kittel *et al*. 1996, Colorado Natural Heritage Program 1996).

Vegetation: This plant association has a dense canopy of 30-90% cover of *Abies lasiocarpa* (subalpine fir) and *Picea engelmannii* (Engelmann spruce). *Picea pungens* (Colorado blue spruce) is occasionally present with 0-10% cover in lower elevation, wet stands, and *Pinus contorta* is present up to 21% in early-seral stands. A narrow but dense strip of shrubs consists of 5-90% cover of *Salix drummondiana* (Drummond willow), 0-40% cover of *Salix monticola* (Rocky Mountain willow), 0-30% cover each of *Salix brachycarpa* (barrenground willow) and

Salix planifolia (planeleaf willow), and 0-20% cover of *Lonicera involucrata* (honeysuckle). *Alnus incana* (thinleaf alder) and *Cornus sericea* (red-osier dogwood) may be present in small amounts with 0-5% cover. The dense herbaceous undergrowth is characterized by 0-30% cover of *Heracleum lanatum* (cow parsnip) and 0-10% cover each of *Cardamine cordifolia* (bittercress), *Mertensia franciscana* (bluebells), *Mertensia ciliata* (mountain bluebells), *Senecio triangularis* (arrowleaf groundsel), *Micranthes odontoloma* (brook saxifrage) and *Geranium richardsonii* (Richardson's geranium). Graminoid can include *Calamagrostis canadensis* (0-14%) and *Carex aquatilis* (0-13%) (Table 7).

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

Site Geomorphology: This plant association is commonly found in moderate to deep V-shaped valleys. The thick shrub canopy is restricted to a narrow band along rocky stream banks.

Rosgen's Stream Channel Classification: This association occurs on steep (2-25% gradient), narrow (<10 m), first-order streams (A2), along moderate gradient reaches with channel bottoms that range from bedrock to gravel (B1, B2, B3, and B4) and occasionally along braided stream channels (D2), usually associated with beaver dams.

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.

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 vegetation can include *Alnus incana* (thinleaf alder) or *Salix drummondiana* (Drummond willow) shrublands, or *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-blue spruce) forests along wider, moderate- gradient reaches.

Adjacent Upland Vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests occur on adjacent hillsides, often 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.

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 the numerous riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, when present the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is complex. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community. Others suggest that the two species coexist in nonequilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the forest overstory (Aplet *et al*. 1988). The literature reviewed here suggests that the spruce-fir forest will never become a single-species dominated "climax" forest, but rather is a perpetually changing mosaic of patches that are of different ages and composition. The successional dynamics are a complex interaction of local site physical characteristics, the life history traits of spruce and fir, and the confounding effects of fire, windthrow and insect outbreak acting at both large (entire stand) and small (individual trees) scales. These interacting affects are outlined below.

Abies lasiocarpa has greater reproductive success in the shaded forest than *Picea engelmannii* (Peet 1981) and lives for approximately three hundred years. *Picea engelmannii* has a lower rate of establishment, but commonly lives longer than five hundred years (Aplet *et al*. 1988). In Colorado, all age classes of both species are generally found within the riparian zone.

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). As the stand matures, the faster-growing *Picea engelmannii* continues to shade *Abies lasiocarpa* in mesic sites. Over the next 100-300 years, barring other disturbances, shade tolerant *Abies lasiocarpa* seedlings replace small canopy gaps (Peet 1981).

Windthrow 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*), the most damaging insect to *Picea engelmannii*. During periodic rises in its population, however, the beetle infests large 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).

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.

Management: Forage value is high when forb growth is abundant. However, grazing during wet periods can churn wet soil and destroy plant cover (Hansen *et al.* 1995). This plant association is sensitive to timber harvesting activities due to high soil moisture content. Timber activity should be restricted to the driest sites. Timber productivity is fairly low. Consideration must be given to the uneven-aged structure and the inability of *Picea* to regenerate without providing protection for seedling survival. Small clearcuts, 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 1990).

Related Types/Synonyms: The *Abies lasiocarpa/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 Colorado *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* plant association.

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.

Table 7. *Abies lasiocarpa-Picea engelmannii/Salix drummondiana* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number (96--)	LS10	LS13	LS24	LS32	GK30	GK32	AM87	AM60	AM67	AM54	GK01	GK13
Condition Rank	B	B/A	C	A	C	B	B	B	A	A/B	C	B
TREES												
Abies lasiocarpa - tree		2	1	29				4		12		
Abies lasiocarpa - sapling				1							2	8
Picea engelmannii - tree	19	29	24	17	2	5	17	25	13	57	23	24
Picea pungens - sapling			4									
Pinus contorta - tree	21	3	7				10	4	11	21		14
Populus tremuloides - tree	1				21	28	11	1			12	6
SHRUBS												
Alnus incana	15	12			13						3	1
Lonicera involucrata		5	1	2	1				10	3	1	1
Rosa woodsii							8		1	3		
Salix bebbiana							9		7	7		
Salix drummondiana	59	77	82	48	63	56	54	32	35	6	21	13
Salix eriocephala								12	34			
Salix monticola			2			10	7	5	7	8	24	2
FORBS												
Arnica cordifolia			12					7	6		1	5
Cardamine cordifolia		4		5	4	5	8	3	1	1		
Epilobium angustifolium			2			9	9	3	5	3		5
Fragaria virginiana	2		3	1			2	1		3		1
Heracleum sphondylium	4		2	1	16	11	14				3	5
Mertensia ciliata		5	1	7	6	3	1	1	1		6	14
Orthilia secunda		12	9	6								1
Oxypolis fendleri		1	1	5	12	1	2		1	1		3
Saxifraga odontoloma		2			4						3	1
Senecio triangularis		1		11	5					5	1	2
Streptopus amplexifolius			1	1	1		26			1		44
Viola canadensis	17		1		3							1
GRAMINOIDES												
Calamagrostis canadensis	2	8	6	14	7	7	3		6	1	9	7
Carex aquatilis	11		6	13						2	3	2
Carex disperma	1			1			13	2		2		
Equisetum arvense	5							5	19	3	1	1

Subalpine fir-Engelmann spruce/mountain bluebells (*Abies lasiocarpa-Picea engelmannii/Mertensia ciliata*) Plant Association
CNHP Rank: G5/S5
77 Quantitative Plots:
Routt National Forest--20 plots (141, 161, 183, 312, 341, 401, 422, 431, 471, 491, 501, 529, 542, 544, 557, 572, 575, 580, 589, 593)
White River Basin--1 plot (92NL65)
Colorado River Basin--10 plots (93SS01, 93SS11, 93SS20, 93SS21, 93SS51, 93GK36, 93GK44, 93GK48, 93DR16, 93DR20)
Gunnison River Basin--18 plots (94GK08, 94GK22, 94GK32, 94GK40, 94GK41, 94GK49, 94GK50, 94JB10, 94JB17, 94JB35, 94JB47, 94MD32, 94MD33, 94MD34, 94RR14, 94RR18, 94RR42)
San Juan National Forest--10 plots (145, 179, 206, 207, 209, 223, 232, 240, 251, 267)
South Platte River Basin--18 plots (96AM92, 96AM24, 96GK07, 96LS16, 96AM61, 96AM57, 96LS26, 96GK41, 96GK43, 96GK25, 96GK35, 96GK11, 96GK36, 96LS21, 96LS35, 96LS33, 96GK40, 96LS30).

South Platte River Basin Reference Reaches: An excellent example of this type can be seen on Bear Creek, Pike-San Isabel National Forest, Douglas County, T10S, R68W, Sec 6.

General Description and Comments: The *Abies lasiocarpa-Picea engelmanni/Mertensia ciliata* plant association is a very common plant association in Colorado. The name is a bit tricky in that *Mertensia ciliata* (mountain bluebells) may not always be present. Actually, any combination of *Mertensia ciliata* (mountain bluebells), *Cardamine cordifolia* (bitter water cress), or *Senecio triangularis* (arrowleaf groundsel), along with several other forbs and mosses characterizes the undergrowth of this community. This association occurs along along first- and second-order streams in the upper montane and subalpine zones. It is a moist, heavily shaded association with little to no shrub cover and a thick carpet of wildflowers lining the mossy stream bank. In northern Colorado, *Vaccinium myrtillus* (Rocky Mountain whortleberry), typically an upslope species, can grade into this riparian plant association along the stream banks.

Regional Distribution: The *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* (subalpine fir-Engelmann spruce/mountain bluebells) plant association and similar types occur in western Montana, eastern Idaho, western Wyoming (Youngblood *et al*. 1985), Utah (Padgett *et al*. 1989), northwestern New Mexico (Johnston 1987), and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This is a common plant association throughout the southern Rocky Mountains of Colorado (Alexander 1981, Baker 1984, Boyce 1977, DeVelice *et al.* 1985, Dix 1974, Dix and Richards 1976, Johnston 1987, Kettler and McMullen 1996, Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et* al. 1995, Peet 1981, as cited in Baker 1989, Richard *et* al. 1996, Steen and Powell 1985, as cited in Johnston 1987).

Vegetation: *Picea engelmannii* (Engelmann spruce) and *Abies lasiocarpa* (subalpine fir) provide a dense overstory cover of 20-80%, immediately bordering and often 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 0-50% cover. Other shrubs occasionally present include *Lonicera involucrata*, *Salix drummondiana*, and *Ribes lacustre* (each with 0-10%). The forb layer is dense and rich with 20-80% cover. Forb species typically high in abundance include 0-50% cover of *Cardamine cordifolia* (bittercress), 0-40% cover of *Mertensia ciliata* (mountain bluebells), and 0-20% cover each of *Oxypolis fendleri* (cowbane), *Senecio triangularis* (arrowleaf groundsel) and *Micranthes odontoloma* (brook saxifrage) (Table 8).

Elevation Range: 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) above the bankfull channel height.

Rosgen's Stream Classification: Typically this association occurs along steep (2-15% gradient), narrow streams (A2, A3, and A4), but can also be found along moderate gradient stretches (B2, B3, B4, and 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 4 feet (1.5 m), and is typically less than 3 feet (1 m). Consistent to all profiles is a deep, dark brown color and high organic content in the top 10-20 cm. Some of the soils from the Colorado River Basin classify as fragmental to fine clayey Cryorthents, Cryaquepts, Cryofluvents, and Cryoborolls.

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 *Alnus incana* (thinleaf alder), *Salix geyeriana* (Geyer willow), or *Salix planifolia* (planeleaf willow) shrublands.

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

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 the numerous riparian *Abies lasiocarpa-Picea engelmannii* plant associations. Although *Abies lasiocarpa* and *Picea engelmannii* are not obligate riparian species, when present the two species strongly influence subalpine riparian ecosystems.

The successional process of the spruce-fir forest is complex. Some ecologists suggest that *Abies lasiocarpa* and *Picea engelmannii* are in equilibrium and form a stable climax community. Others suggest that the two species coexist in nonequilibrium and that given enough time, either *Abies lasiocarpa* or *Picea engelmannii* will dominate the forest overstory (Aplet *et al*. 1988). The literature reviewed here suggests that the spruce-fir forest will never become a single-species dominated "climax" forest, but rather is a perpetually changing mosaic of patches that are of different ages and composition. The successional dynamics are a complex interaction of local site physical characteristics, the life history traits of spruce and fir, and the confounding effects of fire, windthrow and insect outbreak acting at both large (entire stand) and small (individual trees) scales. These interacting affects are outlined below.

Abies lasiocarpa has greater reproductive success in the shaded forest than *Picea engelmannii* (Peet 1981) and lives for approximately three hundred years. *Picea engelmannii* has a lower rate of establishment, but commonly lives longer than five hundred years (Aplet *et al*. 1988). In Colorado, all age classes of both species are generally found within the riparian zone.

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). As the stand matures, the faster-growing *Picea engelmannii* continues to shade *Abies lasiocarpa* in mesic sites. Over the next 100-300 years, barring other disturbances, shade tolerant *Abies lasiocarpa* seedlings replace small canopy gaps (Peet 1981).

Windthrow 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*), the most damaging insect to *Picea engelmannii*. During periodic rises in its population, however, the beetle infests large 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).

Management: Forage value of this plant association is minimal due to the limited forage productivity. Soils may be easily compacted by livestock grazing along the wet, mossy stream banks (Hansen *et al.* 1995). This plant association is sensitive to timber harvesting activities due to high soil moisture content. Timber activity should be restricted to the driest sites. Timber productivity is fairly low. Consideration must be given to the uneven-aged structure and the inability of *Picea* to regenerate without providing protection for seedling survival. Small clearcuts, 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 1990).

Related Types/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).

Two closely related communities are 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 the *Picea*/*Galium triflorum* (spruce/fragrant bedstraw) community type (Youngblood *et al.* 1985), which has *Picea pungens* (Colorado blue spruce) as the dominate tree, rather than *Abies lasiocarpa* and *Picea engelmannii*.

Table 8. *Abies lasiocarpa-Picea engelmannii/Mertensia ciliata* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number (96--)	AM 92	AM 24	GK 07	LS 16	AM 61	AM 57	LS 26	GK 41	GK 43	GK 25	GK 35	GK 11	GK 36	LS 21	LS 35	LS 33	GK 40	LS 30
Condition Rank	A	A	C	C	A	A	C	A	B	C	B	B	B	C	B	A	A	A
TREE																		
Abies lasiocarpa - tree				10	15	16	13	14	5	31	15	9	7	33	27	9	21	
Abies lasiocarpa - sapling			1					5	12	11	11	9	5	19			3	
Picea engelmannii - tree	57	54	38	18	23	28	20	47	31	22	22	21	20	52	24	2		
Picea engelmannii - sapling	4		9					1		7	2	18	11	1				3
Picea engelmannii - seedling	7	2	4					2				6	1				1	
Pinus contorta - tree									7						9			
SHRUBS																		
Lonicera involucrata		1	2					1		1					8			
Ribes lucustre												9	10					
Salix drummondiana														4	13			
Salix geyeriana		27																
Vaccinium sp.							1	3			2		13	16	9			6
FORBS																		
Arnica cordifolia				1	3	2				10	4	2	2	4	1			
Caltha leptosepala			4				1	1	2					1	1	3		
Cardamine cordifolia				21	34	19	6	6	21	10	22	6	5	7	15	7	6	10
Conioselinum scopulorum	3							6	1	3			2	2		6		16
Epilobium angustifolium	1	1				1	1			1			10	4	3	1		2
Epilobium ciliatum							11				4		1	1	2	7	6	3
Erigeron peregrinus						10	1						10					
Heracleum sphondylium								1		2			16	1		1		
Mertensia ciliata	12	1	4	53	14	24	7	14	8	5	2	17	10	11	6	2	4	40
Mitella pentandra			4	3			7	7	15	9	1	1	6	8	5	4	8	
Oxypolis fendleri						2	16	2	11	14	17	2	8	10	11	7	4	8
Saxifraga odontoloma		1	5	14	38		29	37	13	9	10	12	6	1		6	56	14
Senecio triangularis				11	6		22	25	36	12	10	18	20	3	7	29	43	19
Streptopus amplexifolius		6	14				2	18	2	8		5	4	4		2		
GRAMINOIDES																		
Calamagrostis canadensis		6		7		1		3	3				5	2		5		18
Carex scopulorum																	2	11
Equisetum arvense	1									3			5		66	1		

Colorado blue spruce/thinleaf alder (*Picea pungens/Alnus incana* ssp. *tenuifolia*) Plant Association
CNHP Rank: G3/S3
30 Quantitative Plots:
San Juan National Forest--6 plots (32, 39, 50, 63, 68, 203)
San Miguel/Dolores River Basin--2 plots (5, 83)
Gunnison River Basin--2 plots (94MD07, 94RR26)
White River Basin--4 plots (92NL12, 92NL16, 92GK17, 92GK54)
Colorado River Basin--5 plots (93SS41, 93SS43, 93RR59, 93RR62, 93DR08)
Yampa River Basin-- 3 plots (47, 51, GK01)
Routt National Forest--6 plots (81, 221, 231, 372, 391, 392)
South Platte River Basin--2 plots (96AM16, 96LS11).

South Platte Basin Reference Reaches: A very good example of this association can be seen on Maxwell Creek, Arapaho National Forest, Jefferson County, T5S, R 71W, Sec 31 and 32.

Regional Distribution: This plant association and similar types occur in western Wyoming, northern New Mexico (Johnston 1987), and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This plant association occurs in the White, Colorado, Gunnison, and San Miguel/Dolores River Basins, and in the Routt, San Juan and Rio Grande National Forests (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kettler and McMullen 1996, Richard *et al.* 1996, Johnston 1987, Baker 1989).

Vegetation: *Picea pungens* (Colorado blue spruce) dominates the overstory with 15-70% cover. There are typically many understory seedling and saplings. *Abies lasiocarpa* (subalpine fir) may also be present with 0-25% cover. South Platte stands also have *Pinus contorta* (0-18%) and *Populus tremuloides* (10%) present. The thick shrub understory is confined to a narrow band lining the stream channel. Shrub species include 10-70% cover of *Alnus incana* (thinleaf alder), 1-40% cover of *Salix drummondiana* (Drummond willow), 0-30% cover of *Salix monticola* (mountain willow), 0-10% cover of *Cornus sericea* (red-osier dogwood), and 0-10% cover of *Lonicera involucrata* (honeysuckle). One stand has 32% *Salix bebbiana* (Table 9).

The herbaceous layer is quite thick. The forb layer is rich with up to 40 species, ranging from a total of 10-50% cover. Forb species include *Actea rubra* (baneberry), *Conioselinum scopulorum* (hemlock parsley), *Oxypolis fendleri* (cowbane), *Geranium richardsonii* (Richardson geranium), *Heracleum lanatum* (cow parsnip), *Maianthemum stellatum* (false Solomon's seal), *Mertensia ciliata* (mountain bluebells), and *Rudbeckia laciniata* (cutleaf cornflower). The graminoid layer can include *Calamagrostis canadensis* (0-8%), *Carex aquatilis* (0-14%), and *Luzula parviflora* (0-8%) (Table 9).

Elevation Range: 6100-9400 feet (1900-2900 m).

Site Geomorphology: This plant association occurs along narrow to moderately wide floodplains and stream benches in canyons subject to cold air drainage and limited sunlight.

Rosgen's Stream Classification: This association typically occurs along slightly meandering, broad stream reaches (B3, B4). However, some stands occur along narrow, steeper reaches (A3, A4) and others occur along broad, strongly meandering reaches (C3, C4).

Soils: Soils are generally shallow and range from loamy sand to silty clay loams with high organic matter content in the upper most layers, becoming skeletal with gravel, cobbles, and boulders in the lower most layers. Soils of the White and Colorado River Basins stands classify as sandy typic and oxyaquic Cryorthents, loamy typic and oxyaquic Cryoborolls, and fragmental typic Cryochrepts.

Adjacent riparian vegetation: This plant association is often the only type along narrow streams. Adjacent reaches may have forests of *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce),or *Picea engelmannii-Abies lasiocarpa* (Engelmann spruce-subalpine fir). Adjacent shrublands can include *Alnus incana* (thinleaf alder), *Salix geyeriana* (Geyer willow), or *Salix boothii* (Booth's willow) dominated types.

Adjacent upland vegetation: At higher altitudes, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) and *Populus tremuloides* (aspen) forests occur on adjacent hill slopes. At slightly lower altitudes, *Populus tremuloides* (quaking aspen), *Pseudotsuga menziesii* (Douglas-fir), *Pinus contorta* (lodgepole pine) or *Pinus ponderosa* (ponderosa pine) forests, *Pinus edulis-Juniperus osteosperma* (pinyon pine-one-seed juniper) woodlands, or *Quercus gambeli*i (Gambel's oak) shrublands can dominate adjacent hill slopes.

Successional and Ecological Processes: In deep, narrow canyons with swift-moving streams and narrow floodplains and stream benches, *Picea pungens* (Colorado blue spruce) appears to be a climax riparian species. *Picea pungens* will remain until removed or damaged by a catastrophic flood. More information is needed about the establishment requirements and successional role of *Picea pungens*.

Alnus incana ssp. *tenuifolia* (thinleaf alder) is a long-lived, early-seral species. It is one of the first species to establish on coarse 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.

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).

Hot crown fires will kill *Alnus incana* leaving the riparian area highly susceptible to erosion, but light ground fires do not (Hansen *et al.* 1995). *Alnus incana* sprouts quickly when cut at 4-5 year intervals and can be used for re-stabilizing 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).

Related Types/Synonyms: The *Picea pungens/Alnus incana* ssp. *tenuifolia* plant association (Baker 1989) is synonymous with the Colorado *Picea pungens/Alnus incana* plant association. Several stands within the *Populus angustifolia-Picea pungens/Alnus incana* ssp. *tenuifolia-Lonicera involucrata* (narrowleaf cottonwood-Colorado blue spruce/thinleaf alder-honeysuckle) plant association (Baker 1989) matched the *Picea pungens/Alnus incana* Plant association and were moved to that name.

A closely related community is the *Picea pungens/Alnus incana* ssp. *tenuifolia* plant association (Johnston 1987), but includes New Mexico stands which contain significant amounts of *Abies concolor* (white fir).

Table 9. *Picea pungens/Alnus incana* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96LS11	96AM16
Condition Rank	C	A
TREES		
Picea pungens - tree	32	15
Pinus contorta - tree		18
Populus tremuloides - tree	10	9
Populus tremuloides - sapling	1	
Pseudotsuga menziesii - tree		6
SHRUBS		
Acer glabrum		11
Alnus incana	8	26
Lonicera involucrata		11
Rosa woodsii	3	1
Salix bebbiana	32	
Salix drummondiana	4	21
Salix monticola	28	10
FORBS		
Aconitum columbianum	4	
Conioselinum scopulorum		3
Dodecatheon pulchellum	13	1
Fragaria virginiana	4	1
Heracleum sphondylium	2	1
Ligusticum porteri	12	
Maianthemum stellatum	1	1
Mertensia ciliata	3	5
Oxypolis fendleri	3	1
Taraxacum officinale	15	1
GRAMINOIDES		
Calamagrostis canadensis	8	8
Carex aquatilis	1	
Carex canescens	14	
Equisetum arvense	13	

Colorado blue spruce/red-osier dogwood (*Picea pungens/Cornus sericea*) Plant Association
CNHP Rank: G4/S2
12 quantitative plots:
San Juan National Forest--1 plot (265)
San Miguel/Dolores River Basin--3 plots (6, 42, 45)
Gunnison River Basin--4 plots (94GK12, 94JB05, 94RR06, 94RR32)
Colorado River Basin--3 plots (92GK25, 92GK36, 92NL20)
South Platte River Basin--1 plot (96AM29)

South Platte River Basin Reference Reaches: No reference reaches were found within the study area, however one fairly good stand can be seen on Missouri Gulch, Pike-San Isabel National Forest, Douglas County, T10S, R69W, Sec 34.

General Description and Comments: The *Picea pungens/Cornus sericea* (Colorado blue spruce/red-osier dogwood) plant association is a heavily shaded association with a thick, nearly impenetrable shrub layer. Few other trees or shrub species are found within this type. It often grows along narrow stream benches and in deep, narrow canyons. It represents more mesic and slightly more stable habitats than the *Picea pungens/Alnus incana* (Colorado blue spruce/thin leaf alder) plant association. Stands of the *Picea pungens/Cornus sericea* have less than 10% to no *Populus angustifolia* present along the reach, and should therefore not be confused with the *Populus angustifolia-Picea pungens/Alnus incana* (narrowleaf cottonwood-Colorado blue spruce/thin leaf alder) plant association.

Regional Distribution: This plant association occurs in western Wyoming (Youngblood *et al.* 1985), northern New Mexico, and Arizona (DeVelice *et al.* 1985, Bourgeron and Tuhy 1989).

Distribution in Colorado: This plant association occurs in the San Miguel/Dolores (Kittel and Lederer 1993), Gunnison (Kittel *et al.* 1995, Komarkova 1986), Colorado and White River Basins (Kittel *et al.* 1994), and the Routt (Hess and Wasser 1982, Johnston 1987, Colorado Natural Heritage Program 1996) and San Juan National Forests (Richard *et al.* 1996, DeVelice 1985).

Vegetation: The overstory of this plant association is an open to dense canopy of *Picea pungens* (Colorado blue spruce) with 15-60% cover. *Populus tremuloides* (quaking aspen) is occasionally present with 0-50% cover. *Cornus sericea* (red-osier dogwood) forms an open to dense shrub layer with 5-80% cover. Other shrubs include *Betula occidentalis* (river birch) with 0-30% cover, *Alnus incana* (thin leaf alder) and *Salix drummondiana* (Drummond willow) with 0-20% cover, and *Acer glabrum* (Rocky Mountain maple), *Lonicera involucrata* (honeysuckle), and *Amelanchier utahensis* (Utah serviceberry) with 0-10% cover. Understory vegetation is sparse with less than 20% cover (Table 10).

Elevation Range: 7000-8500 ft (2100-2600 m).

Site Geomorphology: This plant association occurs on floodplains and benches in narrow valleys, 20-100 feet (7-30 m) wide, with variable stream gradients (1-10%).

Rosgen's Stream Classification: It occurs along broad, slightly meandering channel reaches (B2, B3, B4) and occasionally along steeper reaches (A3, A6).

Soil: The soils of this plant association are deep, dark-colored clay loams to sandy loams, often with signs of mottling. Coarse fragments range from 0-50% with the percentage increasing with depth. There may be high amounts of organic matter in the top layers.

Adjacent riparian vegetation: Adjacent shrublands include *Alnus incana* (thin leaf alder), *Cornus sericea* (red-osier dogwood), *Salix monticola* (serviceberry willow), and *Salix drummondiana* (Drummond willow). *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce) forests also occur in adjacent riparian areas.

Adjacent upland vegetation: At higher elevations, *Pseudotsuga menziesii* (Douglas-fir) and *Pinus ponderosa* (ponderosa pine) forests occur on adjacent hill slopes. At lower elevations, *Populus tremuloides* (quaking aspen), *Pinus edulis-Juniperus osteosperma* (pinyon pine-one-seed juniper) woodlands, and *Quercus gambelii* (Gambel's oak) and *Artemisia tridentata* (big sagebrush) shrublands occur on adjacent hillslopes.

Successional and Ecological Processes: In deep, narrow canyons with swift-moving streams and narrow floodplains and benches, *Picea pungens* (Colorado blue spruce) appears to be a climax riparian species. *Picea pungens* will remain until removed or damaged by a catastrophic flood (Padgett *et al.* 1989). *Cornus sericea* (red-osier dogwood) is more abundant on level sites where water tables are periodically high (Johnston 1987).

Management: *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 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* can survive all the 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 stream banks (Hansen *et al.* 1995).

Related Types/Synonyms: The following two communities are synonymous with the Colorado *Picea pungens/Betula occidentals* plant association: the *Picea pungens/Amelanchier alnifolia-Cornus sericea* (Colorado blue spruce/serviceberry-red-osier dogwood) plant association (Hess and Wasser 1982, Kittel *et al*. 1994, Kittel *et al*. 1995, Komarkova 1986) and the *Picea pungens/Amelanchier alnifolia-Swida sericea* (Colorado blue spruce/serviceberry-red-osier dogwood) plant association (Johnston 1987). *Swida sericea* is a synonym for *Cornus sericea* (Kartesz 1994).

Closely related communities include: the *Picea* spp./*Cornus sericea* community type (Youngblood *et al.* 1985) and the conifer/*Cornus sericea* type (Padgett *et al.* 1989), which have conifers other than *Picea pungens* as the dominant overstory species.

Table 10. *Picea pungens/Cornus sericea* Plant Association Stand within the South Platte Watershed with Percent cover of Dominant Species.

Plot Number	96AM29
Condition Rank	B
TREES	
Picea pungens - tree	19
Populus tremuloides - sapling	1
SHRUBS	
Alnus incana	7
Cornus sericea	35
Juniperus communis	1
Rosa woodsii	25
FORBS	
Epilobium sp.	1
Fragaria virginiana	1
Geranium sp.	1
Heracleum sphondylium	1
Maianthemum stellatum	1
Potentilla sp.	1
Taraxacum officinale	1
GRAMINOIDES	
Bromopsis inermis	1
Calamagrostis canadensis	1
Carex sp.	1
Poa compressa	1

Colorado blue spruce/river birch (*Picea pungens/Betula occidentalis*) Plant Association
CNHP Rank: G2/S2
7 Quantitative Plots:
South Platte River Basin--7 plots (96AM05, 96AM08, 96AM09, 96AM39, 96LS20, 96AM02, 96AM41).

South Platte River Basin Reference Reaches: An excellent example of this type can be seen on Turkey Creek, Pike-San Isabel National Forest, Douglas County, T10S, R70W, Sec 32. There is no road or trail impacting this part of Turkey Creek.

General Description and Comments: The *Picea pungens/Betula occidentalis* association is a cool moist riparian woodland found in narrow, deep canyons in the foothills and at lower montane elevations. *Betula occidentalis* forms a thick line along the river bank overhanging the water and is overtopped by large, mature spruce trees along the narrow floodplain.

Regional Distribution: The *Picea pungens/Betula occidentalis* association occurs in Nevada (Manning and Padgett 1995) and Colorado (Colorado Natural Heritage Program Database 1996). Similar types are also reported from Utah (Padgett *et al.* 1989).

Distribution in Colorado: The *Picea pungens/Betula occidentalis* association is only known from narrow canyons of the Colorado Front Range (Colorado Natural Heritage Program Database 1996).

Vegetation: *Picea pungens* is the dominant tree with 10-60% cover. Occasionally *Populus tremuloides* or *Populus angustifolia* may be present as well with 0-30% cover. *Betula occidentalis* is always present (20-40%) and *Alnus incana* can be a co-dominant (0-34%). Other shrubs present may include *Salix bebbiana* (0-10%), *Salix exigua* (0-30%) and *Cornus sericea* (0-7%). The herbaceous undergrowth can be sparse, or abundant with forbs such as *Rudbeckia laciniata* (0-15%) and grasses such as *Calamagrostis canadensis* (0-41%). *Equisetum arvense* is always present (1-7%), indicating wet and/or frequently flooding sites (Table 11).

Elevation: 7180-8650 ft. (2185-2650 m).

Site Geomorphology: This association is limited to deep, narrow canyons (100-600 ft, 30-180 m), where it occurs on terraces, stream banks and narrow floodplains.

Rosgen's Stream Channel Type: This association occurs along steep (6-10%) narrow channels (A3, A4) and on broader, moderate gradient streams (1-2%) in wider valleys (B2-B5).

Soils: Soils are generally sandy loams to clay loams with mottling at 13-44 cm depth.

Adjacent Riparian Vegetation: The *Picea pungens/Betula occidentalis* association is often the only riparian vegetation along a reach, however stands of *Populus tremuloides* and mixed stands of *Picea pungens* and *Populus angustifolia* may also occur on slightly wider reaches.

Adjacent Upland Vegetation: Adjacent slopes are usually densely forested with *Pseudotsuga menziesii* and *Picea pungens* on north-facing slopes, and *Pinus ponderosa* on dry, south-facing slopes.

Succession and Ecological processes: The *Picea pungens/Betula occidentalis* plant association appears to be stable and late-seral. *Betula occidentalis* can sprout after fire, and fire may replace this type with early-seral types such as the *Populus tremuloides/Betula occidentalis* plant association.

Management: This association provides low forage amounts due to heavy shading. The strong root structure of *Betula occidentalis* provides stream bank stability. Fire may replace this type with earlier successional stages mentioned above.

Related Types/Synonyms: Manning and Padgett (1995) describe a Conifer/*Betula occidentalis* community type from eastern Nevada, but reported no *Picea pungens* in the overstory. Padgett *et al.* (1989) describe a somewhat similar Conifer/*Equisetum arvense* community type that includes stands dominated by *Picea pungens* that may have *Betula occidentalis* occasionally present in the understory and *Glyceria* spp. as well as *Equisetum* in the undergrowth, similar to Colorado stands.

Table 11. *Picea pungens/Betula occidentalis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM41	96AM02	96AM39	96AM08	96AM05	96AM09	96LS20
Condition Rank	B	B	A	B	B	B	B
TREES							
Juniperus scopulorum		6				2	
Picea engelmannii - tree							20
Picea pungens - tree	26	53	46	61	30	20	13
Picea pungens - sapling		7	2		4	10	
Populus angustifolia - tree					14		
Populus angustifolia - seedling					1		
Populus tremuloides - tree		1		7	30		
SHRUBS							
Alnus incana	34	23	12			14	8
Betula occidentalis	25	28	37	15	40	11	26
Cornus sericea			7				
Prunus virginiana					4		
Rosa woodsii		1	7	2	1	8	3
Salix bebbiana			3	10	6	4	
Salix exigua	33						
Salix lucida ssp. *caudata*		7					
FORBS							
Aster lanceolatus ssp. *hesperius*							10
Dodecatheon pulchellum			1	2		1	
Fragaria virginiana		3	1	1	4	2	
Geranium sp.		3		1	5		
Heracleum sphondylium		7	2		11		6
Mertensia ciliata		1	1			1	4
Rudbeckis laciniata var. *ampla*			15				1
Taraxacum officinale		1	2	4	1	2	3
GRAMINOIDES							
Agrostis stolonifera				2	3	8	
Calamagrostis canadensis			2				41
Glyceria striata			5				
Poa pratensis	1	1		2	14	9	
Scirpus pallidus	12						
HORSETAILS							
Equisetum arvense	4	1	1	1	7	1	2

Pinus ponderosa Alliance

Ponderosa pine/thin-leaf alder (*Pinus ponderosa/Alnus incana*) Plant Association
CNHP Rank: G2/S2
4 Quantitative Plots:
South Platte River Basin--4 Plots (96LS08, 96AM12, 96AM38, 96AM72).

South Platte River Basin Reference Reaches: Two small but good examples of this association can be seen on Pike-San Isabel National Forest: on Spring Gulch near Horse Creek in Douglas County, T9S, R70W, Sec 34, and on an unnamed ephemeral tributary to the Platte River canyon, near South Platte, Douglas County, T7S, R70W, Sec 36.

General Description and Comments: The *Pinus ponderosa/Alnus incana* riparian woodland is found only in the foothills and lower montane reaches of the Colorado Front Range. A narrow band of alders line the stream channel and large, mature ponderosa pine trees provide an open overstory canopy. These older trees are usually rooted at the top of the stream bank or at some distance from the edge of the channel in well-drained locations.

Regional Distribution: This association has only been reported to occur in Colorado, although similar, conifer dominated types are reported from Arizona and New Mexico (Muldavin *et al.* 1996 and Durkin *et al.* 1995). Other *Pinus ponderosa* dominated Habitat Types are reported from eastern and central Montana by Hansen *et al.* (1995).

Distribution in Colorado: The *Pinus ponderosa/Alnus incana* plant association is only known from the foothills of the Colorado Front Range (Colorado Natural Heritage Program 1996).

Vegetation: A thick line of 10-15 ft (3-4.5 m) tall *Alnus incana* line the stream channel with up to 30% cover. *Betula occidentalis* is usually present and can even replaced *Alnus* with 0-35% cover. Other shrubs present may include *Salix bebbiana* (0-3%), *Salix eriocephala* (0-4%), *Prunus virginiana* (0-15%) and *Toxicodendron rydbergii* (0-15%). The herbaceous undergrowth is generally sparse due to dry soils (Table 12).

Elevation: 5700-6900 ft (1700-2100 m)

Site Geomorphology: This association occurs in narrow valleys (30-150 ft, 10-50 m). It occurs on stream banks and islands, but usually at least 1.0 ft (0.3 m) above the channel water level.

Rosgen's Stream Channel Type: The *Pinus ponderosa/Alnus incana* association is found along steep gradient stream channels (A4, A6, F3), or more moderate gradient and wider streams (B4)

Soils: Soils are generally shallow (up to 20 cm) sandy loam and sandy clay over coarse alluvium. Occasionally deep sand loam deposits (up to 71 cm) occur. All soils sampled were relatively moist sands with some organic matter throughout the upper profile.

Adjacent Riparian Vegetation: Adjacent riparian vegetation included shrublands of *Salix exigua* or *Alnus incana*, and woodlands of *Populus angustifolia*.

Adjacent Upland Vegetation: South-facing slopes have sparse woodlands of *Pinus ponderosa* or *Juniperus* spp. North-facing slopes can have denser stands of *Pinus ponderosa* or mixed stands of *Pseudotsuga menziesii* and other conifers.

Succession and Ecological Processes: The *Pinus ponderosa/Alnus incana* association appears to be a late-seral riparian community. In Arizona, *Pinus* spp. germinate and grow on fresh, moist alluvium in the absence of competing grasses within the flood zone of desert stream reaches (Muldavin *et al.* 1996). This appears to be the case in Colorado where southern exposure in foothill canyons limit conifer growth except along the edge of the river. On the north-facing slopes, *Pinus* spp. must compete with several other conifer species. Non-obligate riparian species such as *Pinus* spp. grow along the riparian corridor where there is enough moisture relative to the surrounding uplands, and less competition from surrounding grasses for their germination and establishment (Muldavin *et al.* 1996, Kittel 1994).

Management: *Alnus incana* will resprout after a fire, and moderate fires will maintain open Ponderosa pine stands. *Alnus incana* roots are important for maintaining stream bank stability. Herbaceous forage production is low due to doughty soils (Manning and Padgett 1995).

Related Types/Synonyms: A similar *Pinus ponderosa-Populus angustifolia/Alnus incana* type described by Kittel (1994) occurs within the South Platte drainage on the foothill reaches of the Cache la Poudre River. Our stands lack the *Populus angustifolia* component, but are similar in all other respects. Hansen *et al*. (1995) describe two *Pinus ponderosa* dominated Habitat types; a *Pinus ponderosa/Prunus virginiana* and a *Pinus ponderosa/Cornus sericea* type. Both types have diverse shrub components, but *Alnus incana* is not present. Similar desert riparian communities dominated by *Pinus ponderosa* have been described by Muldavin *et al.* (1996). These include the *Pinus ponderosa/ Juglans major* and the *Pinus ponderosa/Acer gradidentatum* Habitat Types. Both associations have similar canopy structure and physical settings to the Colorado type, however the understory canopy species composition is completely different.

Table 12. *Pinus ponderosa/Alnus incana* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96LS08	96AM12	96AM38	96AM72
Condition Rank	B	B	A	A
TREES				
Juniperus scopulorum				6
Pinus ponderosa - tree	55	71	25	30
Populus tremuloides - sapling	1			
Pseudotsuga menziesii - tree		9	10	
SHRUBS				
Acer glabrum		3	1	1
Alnus incana	30	14	16	
Betula occidentalis		35	8	9
Cornus sericea				17
Juniperus communis			2	
Prunus virginiana	3	5	12	
Ribes montegeum			5	
Rosa woodsii		3	2	6
Rubus deliciosus			1	
Salix bebbiana		3		1
Salix eriocephala ssp. *ligulifolia*			4	1
Salix exigua	1	1		
Salix monticola			5	
Toxicodendron rydbergii	1	15		12
FORBS				
Circaea alpina			10	
Maianthemum stellatum		6		
Mentha sp.			3	2
Mertensia ciliata			3	
Streptopus amplexifolius var. *chalazatus*				7
Taraxacum officinale		1	2	
GRAMINOIDES				
Agrostis stolonifera		5		
Bromopsis inermis		1	1	
Calamagrostis canadensis	2		2	
Carex aquatilis				2
Carex disperma			8	
Carex utriculata	1			6
HORSETAILS				
Equisetum arvense	1	7	1	

Douglas-fir/river birch (*Pseudotsuga menziesii/Betula occidentalis*) Plant Association
CNHP Rank: G3?/S3
6 Quantitative Plots:
Arkansas River Basin--3 plots (95AM07, 95AM31, 95AM50)
South Platte River Basin-- 3 plots (96AM74, 96AM77, 96AM89)

South Platte River Basin Reference Reaches: An excellent stand can be seen on Goose Creek below Hawkins Gulch, Lost Creek Wilderness Area, Pike-San Isabel National Forest, Jefferson County, T10S, R71W, Sec 18 and 19.

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.

Regional Distribution: Similar plant associations have been documented in Utah (Padgett *et al*. 1989), Nevada (Manning and Padgett 1995), Montana (Hansen *et al*. 1988) and Idaho (Bourgeron and Engelking 1994).

Distribution in Colorado: This plant association occurs in narrow canyons along the Colorado Front Range (Colorado Natural Heritage Program 1996).

Vegetation: The upper canopy of this plant association is dominated by 20-35% cover of *Pseudotsuga menziesii* (Douglas-fir), 0-19% cover of *Populus angustifolia* (narrowleaf cottonwood), and 0-6% cover of *Pinus ponderosa* (ponderosa pine). The shrub canopy is fairly thick and diverse with 20-40% cover of *Betula occidentalis* (river birch), 0-55% cover of *Alnus incana* (thinleaf alder), 0-13% cover of *Acer glabrum* (mountain maple), and 3-20% cover of *Rosa woodsii* (woods rose). Herbaceous undergrowth is sparse and limited by heavy shade (Table 13).

Elevation Range: 6600-8080 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.

Rosgen's Stream Classification: This association occurs along stream channels that are narrow and steep with mostly rocky beds. (A2-A4, B3).

Soil: The soils, derived from alluvial and colluvial deposits, are fairly shallow, 25- 53 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 is concentrated in the upper layers.

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

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

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 perennial streams where the cold-air drainage and perennial stream flow provide a cool and moist environment to support a diverse shrub canopy.

Management: *Pseudotsuga menziesii* (Douglas-fir) regeneration is favored by fire which creates favorable seed beds and eliminates competition. Mature trees are relatively fire resistant, but seedlings and saplings are vulnerable to surface fires due to their thin, photosynthetically active bark, resin blisters, flammable needles, thin twigs, and bud scales (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).

Related Types/Synonyms: A similar community type with *Pseudotsuga menziesii* and *Abies concolor* in the upper canopy and *Betula occidentalis* in the understory has been documented in Nevada (Manning and Padgett 1995). Other similar plant associations dominated by *Pseudotsuga menziesii* in the overstory, but lacking *Betula occidentalis* in the understory, have been documented in Colorado in the San Juan Mountains, and the White and Gunnison River Basins as well as in Montana (Richard *et al*. 1996, Kittel *et al.* 1994, Hansen *et al.* 1988). There is also a *Pseudotsuga menziesii/Acer glabrum* plant association documented in Idaho (Bourgeron and Engelking 1994) and several *Betula occidentalis* dominated shrublands, having little if any *Pseudotsuga menziesii* in the upper canopy, documented in Nevada and Utah (Manning and Padgett 1995, Padgett *et al.* 1989).

Table 13. *Pseudotsuga menziesii/Betula occidentalis* Plant Association stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number						
Riparian Condition Rank	B	A	B	A	A	A
TREES						
Juniperus scopulorum		3	20		1	
Pinus ponderosa				10	4	6
Populus angustifolia		19	10	4		
Pseudotsuga menziesii--tree	27	35	20	42	28	50
Pseudotsuga menziesii--seedling	1		3	2		
Quercus gambelii		25	10			
SHRUBS						
Acer glabrum	13		10	4	1	5
Alnus incana ssp. tenuifolia	19	37		5	52	44
Betula occidentalis	30	20	40	25	20	16
Cornus sericea					26	5
Jamesia americana	3			13	1	
Prunus americana	9			3		
Rosa woodsii	20	3	3	5	6	
Rubus deliciosus		6				
Rubus idaeus	3					1
Salix bebbiana	19					2
GRAMINOIDES						
Agrostis stolonifera		1	1		1	
Carex filifolia			3			
Poa pratensis		7	3			
FORBS						
Clematis ligusticifolia			10			
Galium trifidum		1	3			
Maianthemum stellatum	3			1	1	
Melilotus officinalis			10			
Taraxacum officinale	1	1	3			
HORSETAILS						
Equisetum arvense		1	1			

UNESCO: **II.B.2.c. OPEN CANOPY, COLD-DECIDUOUS, SEASONALLY FLOODED/SATURATED, TREE DOMINATED ASSOCIATIONS**
COWARDIN: **PALUSTRINE-FORESTED, BROAD-LEAVED DECIDUOUS**

Populus x acuminata Alliance

Unclassified *Populus x acuminata* Stands

Along lower reaches of Cache la Poudre River in Poudre Canyon are stands of *Populus deltoides* intermix with stands of *Populus angustifolia*. The cross between these species is *Populus* x *acuminata*, which grows in similar habitats and settings as *P. angustifolia*. One stand sampled (96GK08) was classified only to the *Populus* x *acuminata* Alliance level. It has an overstory of 51% *Populus* x *acuminata*, 19% *P. angustifolia* and 9% *Malus domestica*. The shrub layer has *Prunus virginiana* and *P. americana*, mostly covered in *Clematis ligusticifolia*. The herbaceous undergrowth consists mostly of non-native grasses, such as *Poa pratensis* (53%), *Bromus inermis* (5%), and *B. tectorum* (10%). The few scattered forbs include *Taraxacum officinale* (8%) and *Melilotus officinale* (3%) (Table 14). This site is either near an old homestead, or the crab-apple washed downstream from a known homestead further upstream, and became established on the stream bank of the Cache la Poudre River.

Along West Kiowa Creek (plot 95GK09) within the lower South Platte watershed at 2,040 m (6,760 ft) in elevation a large stand of young pole-sized *Populus x acuminata*, approximately 12 cm in diameter (58% canopy cover). This stand has a diverse understory of *Salix eriocephala* (12%), *S. exigua* (18%), *S. monticola* (4%), and *Symphoricarpos occidentalis* (4%). The herbaceous undergrowth is mesic and was under flood waters at the time of sampling. *Poa pratensis* is abundant (56%), but native graminoids, such as *Carex lanuginosa* (10%) *C. nebrascensis* (1%), *Juncus balticus* (16%), and *Eleocharis palustris* (1%) (Table 14), are also present. The abundance of *Poa pratensis* and *Juncus balticus* suggests disturbance by horses or cattle.

Populus angustifolia Alliance

Unclassified *Populus angustifolia* Stands:

Two stands dominated by *Populus angustifolia* were classified only to the Alliance level. Both are in heavily altered condition, with a high abundance of non-native herbaceous species.

One stand (96LS05) on Buckhorn Creek in the Buckhorn Canyon is dominated by *Populus angustifolia* (50%), *Salix amygdaloides* (31%) and *Acer negundo* (4%). The shrub understory is very open and consists of patches of *Prunus americana* (7%) and *Symphoricarpos albus* (1%). The herbaceous undergrowth is nearly completely replaced by non-native species: *Poa pratensis* (40%), *Bromus tectorum* (32%), *Festuca pratensis* (1%), *Taraxacum officinale* (7%), and *Melilotus officinale* (5%) (Table 14). Historically, this creek has been heavily grazed. Current management for the riparian pasture is cattle grazing in the winter and horses year round.

Lone Pine Creek (96LS04) runs through a deep, wide foothill valley within the Cherokee State Wildlife Area. It is an old ranch that once had irrigated hay meadows on the immediate floodplains adjacent to the moderately wide, meandering creek. *Populus angustifolia* dominates much of the reach with 32% cover. An intermittent line of *Alnus incana* and *Salix lucida* spp. *caudata* occurs at the stream edge, with 7% and 27% cover, respectively. The herbaceous undergrowth is dominated by *Bromus inermis* (smooth brome) (Table 14). The old converted floodplain has not been grazed or hayed in many years. The area is currently managed for fishing and wildlife habitat.

Table 14. *Populus* x *acuminata* and *P. angustifolia* Alliance Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Alliance	*P.* x *acuminata*		*P. angustifolia*	
Plot Number	96GK08	95GK05	96LS05	96LS04
Condition Rank	C	C	D	C
TREES				
Populus angustifolia - tree			49	14
Populus angustifolia - sapling	19		3	32
Populus x *acuminata*- tree	51	58		
Salix amygdaloides -tree			31	
SHRUBS				
Prunus americana	2		7	
Salix eriocephala		18		
Salix exigua		13		
Salix lucida ssp. *caudata*				27
FORBS				
Maianthemum stellatum	11	1		
Taraxacum officinale	8		7	
GRAMINOIDES				
Bromopsis inermis	5	4		12
Bromus tectorum	11	11	32	
Poa pratensis	53	56	39	12
Scirpus microcarpus				23
Equisetum arvense			2	16

Narrowleaf cottonwood/thinleaf alder (*Populus angustifolia/Alnus incana*) Plant Association
CNHP Rank: G3/S3
28 Quantitative Plots:
Arkansas River Basin--4 plots (95AM11, 95AM46, 95AM51, 95RR03)
Yampa River Basin--4 plots (66, 74, 77, 81)
Gunnison River Basin--6 plots (94JB09, 94MD20, 94MD21, 94RR13, 94RR23, 94RR50)
San Juan National Forest--10 plots (5, 26, 118, 126, 160, 258, 268, 269, 271, 272)
South Platte River Basin--4 plots (96LS25, 96GK48, 96AM17, 96AM19).

South Platte River Basin Reference Reach: A good example of this association can be seen along Deer Creek, in Golden Gate Canyon State Park, Jefferson County, T2S, R71W, Sec 20.

General Description and Comments: The *Populus angustifolia/Alnus incana* (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 overstory canopy of *Populus angustifolia*. It occurs along narrow, fast-moving stream reaches in montane areas. Stream reaches with at least 20% *Populus angustifolia* (narrowleaf cottonwood) and no more than 10% *Picea pungens* or other conifer species are placed into the *Populus angustifolia* dominated Alliances. If *Picea pungens*, or other conifer species, combined or individually have greater than 10% cover, or are at least equal to the amount of *Populus angustifolia* along a reach, then the stand is placed into the *Populus angustifolia*-mixed conifer Alliances.

Regional Distribution: This and similar plant associations occur in western Wyoming (Johnston 1987), New Mexico (Durkin *et al.* 1994), and Colorado (Colorado Natural Heritage Program 1996).

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

Vegetation: This plant association has an open to dense canopy of 5-80% 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. The shrub understory is dominated by a dense band of 10-80% cover of *Alnus incana* (thinleaf alder) lining the stream bank. A wide variety of other shrubs may be present including 0-40% cover of *Salix bebbiana* (Bebb willow), *S. monticola* (Rocky Mountain willow), *S. eriocephala* (yellow willow), or *S. exigua* (coyote willow), 0-30% cover of *Cornus sericea* (red-osier dogwood), 0-20% cover of *Rosa woodsii* (woods rose), 0-15% cover of *Acer glabrum* (Rocky Mountain maple), and 0-10% cover of *Betula occidentalis* (river birch). The herbaceous undergrowth is generally sparse due to the dense overstory (Table 15).

Elevation Range: 6200-8900 ft. (1900-2700 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.

Rosgen's Stream Classification: Stream gradient and channel width are highly variable. Some sites occur along steep, narrow reaches with little sinuosity (A2-A4). Other sites occur along low gradient, moderately sinuous, broad channel reaches (B2-B5) or low gradient, sinuous reaches (C3, C4).

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).

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), *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce), *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood), or *Quercus gambelii* (Gambel oak). Younger *Populus angustifolia* stands often occur on adjacent point bars and fresh alluvial deposits. *Salix* spp. (willow), *Alnus incana-Salix* spp. (thinleaf alder-willow), *Betula occidentalis* (water birch) shrublands, or *Carex utriculata* (beaked sedge) meadows occur in patches 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 slopes occur on adjacent slopes.

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 landsurface 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.

The *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) plant association is considered mid-seral. *Alnus incana* appears to thrive along steeper gradient streams due to more highly oxygenated water (Padgett *et al.* 1989). *Alnus incana* also appears to do well along more gradual stream reaches where flooding creates frequent scouring. *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). Without flooding the stream banks may become dominated by north-facing upslope communities such as *Pseudotsuga menziesii* (Douglas-fir) and *Juniperus* spp.(juniper).

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

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

Related Types/Synonyms: An identical *Populus angustifolia/Alnus incana* community type is described by Durkin *et al.*(1994) and a similar *Populus angustifolia/Alnus oblongifolia* community type is also described by Durkin *et al.* (1994). The latter type is very similar in structural and floristic characteristics, but includes a different species of *Alnus*. This association is not well documented elsewhere in the literature and similar stands may be included in other plant associations such as the *Populus angustifolia/Cornus sericea* described by Padgett *et al.*(1989) and Hansen *et al.* (1995) or the *Populus angustifolia/Alnus incana-Cornus sericea* listed by Johnston (1987). This last association differs by having significant cover of *Cornus sericea*. Another *Populus angustifolia/Alnus incana* is described from the Animas River in southwestern Colorado, however, it has almost no shrub layer and a sparse herbaceous undergrowth (Walford 1993). It appears to be more closely aligned with the *Populus angustifolia/Salix exigua* plant association as it occurs on very coarse alluvium, and consists of mostly young trees.

Table 15. *Populus angustifolia/Alnus incana* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96LS25	96GK48	96AM19	96AM17
Condition Rank	C	B	C	B
TREES				
Pinus ponderosa - tree	13			
Populus angustifolia - tree	25	39	32	28
Populus angustifolia - sapling		6		
Populus x *acuminata*- tree				48
Pseudotsuga menziesii - tree	8	5		
Salix amygdaloides -tree			22	
SHRUBS				
Acer glabrum	10	1		
Alnus incana	56	46	36	80
Betula occidentalis	16	28		
Prunus virginiana	2	2	3	7
Salix bebbiana	14	3		
Salix monticola		2	9	
FORBS				
Heracleum sphondylium		12		
Rudbeckia laciniata var. *ampla*		20		
GRAMINOIDES				
Agrostis stolonifera		10		
Bromopsis inermis			13	
Dactylis glomerata	5	7		1
Glyceria striata		2		
Poa pratensis		6	6	4
Equisetum arvense	1		1	2

Narrowleaf cottonwood/river birch (*Populus angustifolia/Betula occidentalis*) Plant Association
CNHP Rank:G3?/S2
11 Quantitative Plots:
Colorado River Basin--5 plots (92NL22, 93RR26, 93GK21, 93GK23, 93RR54)
Arkansas River Basin--5 plots (95AM06, 95RR05, 95RR09, 95RR12, 95RR13)
South Platte River Basin--1 plot (96LS09).

South Platte River Basin Reference Reach: No references reaches were located within the South Platte watershed, however a diverse, steep and narrow occurrence can be seen on Young Gulch, Arapaho-Roosevelt National Forest, Larimer County, T8N, R71W, Sec 9.

General Description and Comments: This plant association is a lush deciduous community of *Populus angustifolia* (narrowleaf cottonwood) and *Betula occidentalis* (river birch) growing in a thick band along the stream bank. This is one of the wetter *Populus angustifolia* (narrowleaf cottonwood) plant associations which indicates a perennial source of water and possibly a lateral seepage. Some stands may occur on hillside seeps.

Regional Distribution: The *Populus angustifolia/Betula occidentalis* (narrowleaf cottonwood/river birch) plant association occurs in Utah and Colorado (Padgett *et al.* 1989, Colorado Natural Heritage Program 1996). Similar types occur in Nevada (Manning and Padgett 1995), Montana (Hansen *et al.* 1995), Idaho and Wyoming (Youngblood *et al.* 1985, Gerard *et al.*1995).

Distribution in Colorado: This plant association occurs in the Colorado River Basin (Kittel *et al.* 1994), the Arkansas, and South Platte River Basins (Cooper and Cottrel 1990, Rondeau 1995, Kittel *et al.* 1996).

Vegetation: This plant association is characterized by an overstory of 35-80% cover of *Populus angustifolia* (narrowleaf cottonwood) and a thick shrub understory of 25-70% cover of *Betula occidentalis* (river birch) and 0-60% cover of *Alnus incana* (thinleaf alder). One stand in the South Platte watershed has *Pseudotsuga menziesii* (21%), *Acer glabrum* (19%), *Cornus sericea* (11%), and *Prunus virginiana* (11%) (Table 16). Graminoid and forb cover is minor.

Elevation Range: 7400-8400 ft. (2300-2600 m).

Site Geomorphology: This plant association typically occurs on stream banks and benches along narrow, somewhat steep streams with little to moderate floodplain development. It also occurs on immediate stream banks or steep-sided overflow channel areas along larger streams with well-developed floodplains.

Rosgen's Stream Classification: This association occurs on narrow and steep stream channels with rocky beds (A3, A4) or broad and slightly meandering channels (B3, C3).

Soil: Soils have a surface layer of partially decomposed organic matter 2-4 inches (5-10 cm) thick. Subsurface layers are very coarse with 10-60% gravel or cobbles. Subsurface textures range from clay loams to loamy sands. One profile had 40% mottles at 4 inches (10 cm) depth with a strong anoxic odor.

Adjacent Riparian Vegetation: This plant association is usually the only riparian community along a narrow stream reach. This association generally does not form a mosaic with other communities, but occasionally there may be adjacent stands of *Pseudotsuga menziesii* (Douglas-fir) or shrublands of *Alnus incana* (thinleaf alder) or *Salix exigua* (coyote willow).

Adjacent Upland Vegetation: South-facing canyon slopes have *Pinus edulis* (pinyon pine) and *Juniperus monosperma* (one-seed juniper) woodlands. North-facing slopes have *Pinus ponderosa* (ponderosa pine) or *Pseudotsuga menziesii* (Douglas-fir) forests.

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 landsurface 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.

The *Populus angustifolia/Betula occidentalis* plant association is considered to be early to mid-seral. *Betula occidentalis* (river birch) becomes abundant along stream banks with perennial stream flow and well-aerated soils. With continued aggradation of the alluvial surface and shading from a thick shrub canopy, successful *Populus angustifolia* (narrowleaf cottonwood) reproduction may cease and the stand may become a *Betula occidentalis* dominated shrubland with a graminoid undergrowth (Hansen *et al.* 1995). *Populus angustifolia* appears to be successfully reproducing in two of the stands sampled, however, the individuals may be sprouting from roots rather than developing from seeds.

Management: Because the regeneration and establishment of new stands of cottonwood are dependent upon flooding events, any alteration to the natural flow regime of a river can affect the cottonwood ecosystem. Upstream dams stabilize stream flows, reducing flooding frequency and magnitude, resulting 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 is high and very palatable to livestock. Cottonwood seedlings and saplings as well as *Betula occidentalis* shrubs are frequently browsed by cattle. Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage. Moist soils also make this community susceptible to soil compaction. 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).

Related Types/Synonyms: Identical types include: the *Betula occidentalis* phase of a *Populus angustifolia/Cornus sericea* plant association (Kittel *et al.* 1994), the *Populus angustifolia/Salix exigua-Betula occidentalis* plant association (Komarkova 1986), and the *Populus angustifolia/ Betula occidentalis* community type (Padgett *et al.* 1989). A similar *Populus angustifolia/Poa pratensis* plant association is described from the Colorado Front Range by Cooper and Cottrell (1990) but lacks *Betula occidentalis* in the shrub canopy. Another similar type is the *Populus/Betula occidentalis* community type described from Nevada (Manning and Padgett 1995), but some stands are mixed with *Populus trichocarpa* (black cottonwood), a species that does not occur in Colorado. Gerard *et al.* (1995) describe a similar *Populus angustifolia/Prunus virginiana* community type with scattered *Betula occidentalis* in the understory as well as a *Betula occidentalis/Cornus stolonifera* community type with 1-5% cover of *Populus angustifolia* from the eastern slope of the Big Horn Mountains in Wyoming. Other, similar *Betula occidentalis* dominated community types have been described from Utah, Montana, and Idaho (Padgett *et al.* 1989, Hansen *et al.* 1995, and Youngblood *et al.* 1985, respectively), however they lack a tree-dominated overstory.

Table 16. *Populus angustifolia/Betula occidentalis* Plant Association Stand with Percent Cover of Dominant Species.

Plot Number	96LS09
Condition Rank	B
TREES	
Juniperus scopulorum	3
Populus angustifolia - tree	39
Populus angustifolia - sapling	1
Pseudotsuga menziesii - tree	21
SHRUBS	
Betula occidentalis	14
Cornus sericea	11
Corylus cornuta	2
Jamesia americana	1
Prunus virginiana	11
Rosa woodsii	6
Clematis ligusticifolia	5
Arnica cordifolia	2
Aster lanceolatus ssp. *hesperius*	1
Heracleum sphondylium	1
Ranunculus sp.	16
GRAMINOIDES	1
Unknown grasses	1

Narrowleaf cottonwood/common choke cherry (*Populus angustifolia/Prunus virginiana*) Plant Association
CNHP Rank: G2G3/S1
1 Quantitative Plot:
South Platte River Basin--1 plot (96GK18)

South Platte River Basin Reference Reaches: No reference reaches were found in the study area. However, one good occurrence was found on private land. The exact location is withheld to respect land owner privacy.

General Description and Comments: The *Populus angustifolia/Prunus virginiana* plant association only occurs on foothill streams. It is characterized by a thick growth of *Prunus virginiana* with an open overstory of *Populus angustifolia*. It often has *Populus* x *acuminata* and/or *Populus deltoides* also in the upper canopy. *Prunus virginiana* is considered a "marginal" riparian species because it grows on the outer edge of the riparian area, on well drained terraces, side slopes, and steep stream banks.

Regional Distribution: This type is reported from southeastern Wyoming (WYNDD 1989) and Colorado (Colorado Natural Heritage Program 1996).

Colorado Distribution: This association is documented to occur in the Colorado River basin (Kittel *et al.* 1994) and along the Colorado Front Range (Colorado Natural Heritage Program 1996).

Vegetation: *Populus angustifolia* is present with 7% cover, with *Populus acuminata* (31%) and/or *P. deltoides* (15%), indicative of foothill/plains environments. The shrub layer is thick with *Prunus virginiana* 40%, *Symphoricarpos occidentalis* (25%), *Alnus incana* (8%), and *Clematis ligusticifolia* (3%). The herbaceous undergrowth includes *Poa pratensis* (15%), *Agrostis stolonifera* (13%), *Carex lanuginosa* (8%), and *Solidago canadensis* (25%) (Table 17).

Elevation Range: 5600-8100 ft. (1700-2500 m).

Site Geomorphology: This association occurs on narrow, elevated , or steeply sloping stream banks and benches in narrow to moderately broad valleys (100-400 ft).

Rosgen's Stream Classification: This association grows on slightly sinuous, broad, flat stream reaches (B3).

Soils: Soils are shallow sandy clay loams with many fine layers of fluvial deposition evident in the profile. The shallow soil becomes skeletal by 20 cm.

Adjacent Riparian Vegetation: Adjacent communities within the riparian areas include other *Populus angustifolia* forests, *Salix exigua* shrublands, and irrigated hay meadows.

Adjacent Upslope Vegetation: Adjacent hillslopes support *Cercocarpus montanus* (mountain mahogany) and *Pinus edulis-Juniperius osteosperma* (pinyon-juniper) woodlands.

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 during lesser flows. 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 landsurface 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.

The *Populus angustifolia/Prunus virginiana* plant association is a late-seral type. With time the *Populus angustifolia* die, leaving patches of *Prunus virginiana*, which will persist as long as there is a source of water at its tap roots.

Management: Thick stands of *Prunus virginiana* may preclude use by livestock (Hansen *et al.* 1989). Open stands may provide grazing opportunities, however season-long grazing increases the abundance and vigor of non-native grasses and, with excessive browsing, may reduce shrub densities.

Related Types/Synonyms: The *Populus angustifolia/Prunus virginiana* type is reported to occur along Tapper Creek and in Medicine Lodge Wilderness Study Area and the Spanish Mountains in southeastern Wyoming (WYNDD 1989). No other literature has reported this combination, and indeed it is difficult type because *Prunus virginiana* is a "marginal" riparian species (at the outer edge of the riparian area) and can form communities on hill slopes without *Populus angustifolia.* An *Acer negundo/Prunus virginiana* type is reported to occur with stands of *Populus angustifolia* along the same reach in the Colorado River Basin (Kittel *et al.* 1994). Other, closely related types have *Populus deltoides* in the overstory instead of *Populus angustifolia*, these include: Knopf (1986) reports a riparian area near Livermore with *Populus sargentii* (=*P. deltoides* ssp. *monilifera*), scattered willows, and *Prunus virginiana*; Hansen *et al.* (1988) report that the *Prunus virginiana* dominance type can occur as an understory layer within stands of *Populus deltoides*; and Cooper and Cottrell (1990) report a *Populus deltoides/ Bromopsis inermis* plant association that has two stands with 5 and 20% cover of *Prunus virginiana*.

Table 17. *Populus angustifolia/Prunus virginiana* Plant Association Stand From the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96GK18
Condition Rank	B
TREES	
Acer negundo	1
Juniperus scopulorum	4
Populus angustifolia - tree	7
Populus angustifolia - seedling	1
Populus x *acuminata*- tree	31
Salix amygdaloides -tree	6
SHRUBS	
Alnus incana	7
Prunus virginiana	40
Symphoricarpos occidentalis	25
Clematis ligusticifolia	3
FORBS	
Solidago canadensis	25
Thalictrum dasycarpum	4
Thermopsis divaricarpa	2
GRAMINOIDES	
Agropyron dasystachya	4
Agrostis stolonifera	13
Carex lanuginosa	8
Poa pratensis	15
Equisetum arvense	1

Narrowleaf cottonwood/coyote willow (*Populus angustifolia/Salix exigua*) Plant Association
CNHP Rank: G4/S4
13 Quantitative Plots:
Yampa River Basin-- 2 plots (63, 108)
White River Basin--3 plots (92GK13, 92NL41, 92NL25)
Arkansas River Basin-- 5 plots (95AM16, 95GK70, 95AM08, 95AM10, 95AM49)
San Juan National Forest--1 plot (17)
South Platte River Basin-- 2 plots (96AM20, 96AM14).

South Platte Reference Reach: No reference reaches were located within the study area, but one moderately good occurrence can be viewed from Highway 6, west of Golden, on Clear Creek, between tunnels 3 and 4, Clear Creek County, T4S, R71W, Sec 6. Please respect private landowner rights and do not access site without written permission from the owner.

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

Regional Distribution: The *Populus angustifolia/Salix exigua* plant association and similar types occur in Wyoming (Jones 1990), Montana (Hansen *et al.* 1995), Idaho, Utah (Johnston 1987), New Mexico (Durkin *et al.* 1994, Durkin *et al.* 1995), and Colorado (Colorado Natural Heritage Program 1996).

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

Vegetation: This plant association is characterized by an open to somewhat dense stand of *Populus angustifolia* (15-65%) seedlings (< 1.5 m in height), saplings (< 12 cm in diameter), and a nearly pure shrub layer of *Salix exigua* (5-50%). Foothill stands can have *P.* x *acuminata* (42%) and *P. deltoides* (5%) may be present as well. The herbaceous undergrowth is generally weedy and sparse due to frequent flooding disturbance. Weedy species including 0-40% cover of *Trifolium repens* (white clover), 0-20% cover of *Agrostis stolonifera* (redtop), and 0-15% cover each of *Poa pratensis* (Kentucky bluegrass) and *Linaria vulgaris* (butter-and-eggs) may be present (Table 18).

Elevation Range: 5700-7500 ft (1740-2300 m).

Site Geomorphology: This plant association occurs on recently flooded point bars, low terraces, and stream benches. It is usually well within the flood-prone area of the stream channel and does not occur more than 3-7 feet (1-2 m) above the high-water mark.

Rosgen's Stream Classification: This association occurs on stream channels that are wide and moderately sinuous (B3, B4), wide and highly sinuous (C4), or are very steep and straight (A3, F3).

Soil: Surface layers have an average depth of 35 cm and consist sands, sandy loams, sandy clay loams, or silty clays, and are skeletal with 40% gravel and 10-20% cobbles. Deeper layers consist of coarse alluvial material.

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), *Pseudotsuga menziesii* (Douglas-fir) 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.

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 during lesser flows. 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 landsurface 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.

Populus angustifolia/Salix exigua (narrowleaf cottonwood/coyote willow) is one of the earliest successional stages of a cottonwood-dominated plant association. *Salix exigua* seeds germinate after *Populus angustifolia* individuals become established on bare moist new deposited alluvium. If the stream channel migrates away from the site of the young community, the *Populus angustifolia* saplings mature, but the *Salix exigua* declines as the amount of shade increases. The association converts to later seral stages such as the *Populus angustifolia/Alnus incana* (narrowleaf cottonwood/thinleaf alder) and *Populus angustifolia/Cornus sericea* (narrowleaf cottonwood/red-osier dogwood) associations.

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 (Gwen Kittel *personal observation*).

Related Types/Synonyms: Much of the literature does not describe a plant association of young *Populus angustifolia* and *Salix exigua* contained on an immediate stream bank or point bar. Rather, cottonwood stands with abundant *Salix exigua* are often included in plant associations with a variety of other shrubs. Because *Salix exigua* occupies the low-water line of a channel, it is easily visible in riparian areas and often has the appearance of co-dominance with mature *Populus angustifolia*, *Alnus* or *Betula* spp. in the “background”. Upon closer inspection, researchers have found that the “background” stand is a different plant association occupying an environment quite different from the point bar.

Johnston (1987) describes a *Populus angustifolia/Salix exigua-Betula fontinalis* plant association which includes stands with *Salix exigua* as a clear dominant, but not the only shrub present. Johnston (1987) includes the following communities from various sources in the *Populus* *angustifolia/Salix exigua-Betula fontinalis* plant association: *Populus angustifolia/Salix* spp. habitat type, *Populus angustifolia/Salix exigua* habitat type, *Populus angustifolia/Salix exigua-Salix* spp. plant association, and *Populus angustifolia/Cornus sericea* plant association.

Baker (1984) lists similar *Populus angustifolia/Salix exigua* and *Populus angustifolia/Salix scouleriana* plant associations for Colorado, but stand descriptions were not available. A similar *Populus angustifolia/Salix exigua* habitat type is described for the Arapaho National Forest as a climax community with other shrub species (Hess 1981). A similar *Populus angustifolia/Salix exigua* community type occurs in New Mexico's Rio Grande and Pecos River Basins, but includes other shrub species (Durkin *et al.* 1994; 1995). A similar *Populus angustifolia/*recent alluvial bar community type occurs in Wyoming and Montana (Jones 1990, Hansen *et al*. 1995). This type has narrowleaf cottonwood seedlings and saplings, but does not always include *Salix exigua*.

Table 18. *Populus angustifolia/Salix exigua* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM14	96AM20
Condition Rank	C	B
TREES		
Populus angustifolia - tree		50
Populus angustifolia - seedling	38	
Populus deltoides spp. *monilifera*-tree		5
Populus x *acuminata*- tree		42
SHRUBS		
Alnus incana	2	
Betula occidentalis	12	
Salix eriocephala ssp. *ligulifolia*	3	
Salix exigua	9	5
Salix irrorata		1
FORBS		
Erigeron sp.		1
Taraxacum officinale		1
Thermopsis divaricarpa	1	
GRAMINOIDES		
Agropyron sp.		1
Agrostis stolonifera	19	1
Bromopsis inermis	1	1
Dactylis glomerata		7
Eleocharis palustris		1
Juncus balticus	6	
Poa compressa	1	1
Equisetum arvense	1	

Narrowleaf cottonwood/bluestem willow (*Populus angustifolia/Salix irrorata*) Plant Association
CNHP Rank: G2?/S2
5 Quantitative Plots:
Arkansas River Basin--1 plot (95RR20)
South Platte River Basin--4 plots (96GK34, 96GK17, 96GK46, 96GK47)

South Platte Reference Reach: No reference reaches were located within the study area, however a fairly good example of the type can be seen on Coal Creek, Boulder County Open Space, Boulder County, T1S, R70W, Sec 24.

General Description and Comments: The *Populus angustifolia/Salix irrorata* (narrowleaf cottonwood/bluestem willow) plant association is a young, early-seral stage of other *Populus angustifolia* dominated associations. It occurs along foothill reaches, at the transition between foothill and plains environments. *Populus deltoides* (plains cottonwood) and *Populus angustifolia* (narrowleaf) cottonwood intermix at this transition zone, so it is not uncommon to find the hybrid, *Populus* x *acuminata* within the *Populus angustifolia/Salix irrorata* association. *Salix irrorata* appears to replace *Salix exigua* further south in the state.

Regional Distribution: The *Populus angustifolia/Salix irrorata* plant association occurs in the Rio Grande Valley in New Mexico (Durkin *et al.* 1995) and along the Colorado Front Range (Kittel *et al.* 1996).

Distribution in Colorado: This plant association occurs along foothill streams of the Colorado Front Range. It is likely to occur further east along the Arkansas and Purgatory Rivers (Kittel *et al.* 1996).

Vegetation: This plant association is characterized by 5-40% cover of all age classes of *Populus angustifolia* (narrowleaf cottonwood). *Populus deltoides* (plains cottonwood) is present in some stands with 0-60% cover. *Salix irrorata* (bluestem willow) creates a dense band of 10-70% cover along the stream bank. *Salix exigua* (coyote willow), with 0-20% cover, and *Alnus incana* (thinleaf alder), with 0-5% cover, intermix at the stand edge. The undergrowth is sparse due to frequent flooding. However, the graminoid cover can be high with introduced grasses such as 0-30% cover of *Agrostis stolonifera* (redtop), and 0-20% cover each of *Poa pratensis* (Kentucky bluegrass) and *Bromis inermis* (smooth brome) (Table 19).

Elevation Range: 5600-7300 ft. (1700-2200 m).

Site Geomorphology: This plant association occupies immediate stream banks and point bars of meandering rivers. It is usually located very close to or well within the high-water level of a stream.

Rosgen's Stream Classification: Steam channels can be moderately steep (8-9% gradient) and sinuous with a narrow, but distinct floodplain (A2, B4), or less steep (1-2% gradient) and highly sinuous (F3, F5), or there can be braided channels (D4).

Soil: The soils are shallow and skeletal (30-50% cobbles by 15 cm depth) sandy clay loams alternating with loamy sands and silty clay loams.

Adjacent Riparian Vegetation: Stands of older *Populus angustifolia* (narrowleaf cottonwood) occur on higher terraces. *Salix irrorata* (bluestem willow) or *Salix exigua* (coyote willow) shrublands occur upstream and downstream.

Adjacent Upland Vegetation: Steep, south facing canyon slopes typically have *Pinus edulis-Juniperus monosperma* (pinyon pine-one-seed juniper) woodlands.

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 during lesser flows. 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 landsurface 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.

The *Populus angustifolia/Salix irrorata* (narrowleaf cottonwood/bluestem willow) plant association is considered an early-seral community following the establishment of *Populus angustifolia.* A dense cover of *Salix irrorata* or *Salix exigua* (coyote willow) indicates frequent flooding. Over time, this floodplain vegetation will decrease water velocities and cause deposition of fine materials, allowing for site aggradation. With continued flooding and sediment deposition, this plant association will shift to a more mature, floodplain community.

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 in the canopy layer of this plant association can be high and very palatable to livestock. Cottonwood and willow seedlings and saplings are frequently browsed. Herbaceous productivity is low due to the coarse substrate and frequent flooding disturbance. Excessive grazing and browsing will reduce plant vigor and allow non-native plant species to gain a competitive advantage. This can keep the stand in an early-seral stage, and may cause stream erosion instead of deposition. 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).

Related Types/Synonyms: An identical *Populus angustifolia/Salix irrorata* (narrowleaf cottonwood/bluestem willow) community type occurs in the Rio Grande River Valley in New Mexico (Durkin *et al.* 1995).

Table 19. *Populus angustifolia/Salix irrorata* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96GK17	96GK47	96GK34	96GK46
Condition Rank	C	C	B	C
TREES				
Populus angustifolia - tree	39		4	
Populus angustifolia - sapling	12	4		13
Populus deltoides spp. *monilifera*-tree		4		
Populus deltoides spp. *monilifera*-sapling		9		14
Salix amygdaloides -tree		1		1
SHRUBS				
Alnus incana			5	
Salix exigua		22		1
Salix irrorata	25	26	70	51
Salix monticola		24		
FORBS				
Centaurea diffusa		1		1
Cirsium sp.			1	
Epilobium ciliatum	6		2	
Rudbeckia laciniata var. *ampla*			6	
Solidago canadensis			3	
Taraxacum officinale				1
GRAMINOIDES				
Agropyron dasystachya	2	8		11
Agropyron sp.	4			
Agrostis stolonifera	37	27		
Carex lanuginosa		14		
Carex nebrascensis		5		
Eleocharis palustris		6		
Glyceria grandis		7		
Poa pratensis	10	9		17
Equisetum arvense		1		

Balsam poplar *(Populus balsamifera*) Plant Association
CNHP Rank: GU/SU
4 Quantitative Plots:
Gunnison River Basin-- 2 plots (94RR16 and 94RR27)
Routt National Forest-- 1 plot (539)
South Platte River Basin-- 1 plot (96GK02).

South Platte Reference Reaches: Only one stand of this type was sampled in the study area, along West Fork Creek, in Arapaho-Roosevelt National Forest, Larimer County, T11N, R 74W, Sec 15.

General Description and Comments: The *Populus balsamifera* (balsam poplar) plant association is a minor type in Colorado. *Populus balsamifera* has a limited distribution and rarely forms stands larger than a few yards long. *Populus balsamifera* is distinguished from *Populus angustifolia* (narrowleaf cottonwood) by its broad leaves and large, sticky-resinous buds.

This plant association may be overlooked because *Populus balsamifera* (balsam poplar) is easily misidentified as *Populus angustifolia* (narrowleaf cottonwood). Because *Populus balsamifera* (balsam poplar) is so limited, all stands, regardless of understory species composition, are included within this single plant association.

Regional Distribution: Valley bottoms and floodplains dominated by *Populus balsamifera* (balsam poplar) occur in Alaska (Vierteck *et al.* 1992), the northern contiguous U.S., and New England (Gleason and Conquist 1963). This deciduous tree species forms extensive floodplain forests north and east of the Great Plains Region and extends sparingly into the Rocky Mountains (McGregor *et al.* 1986).

Distribution in Colorado: *Populus balsamifera* has a limited distribution in Colorado and is somewhat restricted to the north-central regions of the state (Harrington 1954, McGregor *et al.* 1986). Colorado may be the southern limit of the range of *Populus balsamifera* (USDA PLANTS database). Stands observed in the Gunnison River Basin expand the distribution south to a latitude of approximately 38.5°. Other stands occur in the Routt National Forest (Kettler and McMullen 1996), on tributaries of the Colorado River near Eagle, and along the Cache la Poudre River (Gwen Kittel, *personal observation*) and its smaller tributaries.

Vegetation: Mature trees and saplings of *Populus balsamifera* (balsam poplar) create an overstory canopy of 25-50% cover. Other trees include 0-10% cover of *Picea pungens* (Colorado blue spruce), *Picea engelmannii* (Engelman spruce) and 0-1% cover of *Populus tremuloides* (quaking aspen). A thick band of shrubs occurs along the stream edge and consists primarily of 0-60% cover of *Alnus incana* (thinleaf alder), 0-30% cover of *Salix drummondiana*

(Drummond willow), *Salix geyeriana* (Geyer willow) and 0-10% cover of *Rosa woodsii* (woods rose). Other shrubs present with less than 5% cover each include *Lonicera involucrata* (honeysuckle), *Ribes inerme* (whitestem gooseberry), *Sambucus racemosa* (red elderberry), *Salix monticola* (Rocky Mountain willow), *S. bebbiana* (Bebb willow), and *Juniperus communis* (common juniper). The herbaceous undergrowth includes mesic forbs such as 0-20% cover of *Heracleum lanatum* (cow parsnip), 1-10% cover of *Geranium richardsonii* (Richardson's geranium), 0-10% cover of *Osmorhiza depauperata* (blunt-fruit sweet-cicely), and 3-5% cover of *Equisetum arvense* (field horsetail). Graminoid cover is insignificant (Table 20).

Elevation Range: 7700-8700 ft (2300-2700 m).

Site Geomorphology: This plant association occurs along a variety of streams (first through fourth order) in moderate to wide, 200-600 feet (60-180 m), glacial out-wash valleys. This association appears to be limited to immediate stream banks, overflow channels, and floodplains.

Rosgen's Stream Classification: Stream channels are broad and slightly meandering (B2, B4 and B6).

Soils: Soils are fairly deep, fine sand, silty loams and sandy clay loams over skeletal alluvial deposits. Pale mottles may be present within the top 12 inches (30 cm).

Adjacent Riparian Vegetation: *Picea engelmannii/Alnus incana-Salix drummondiana* (Engelmann spruce/thinleaf alder-Drummond willow) forests occur on adjacent narrow floodplains and stream banks. *Alnus incana* (thinleaf alder) shrublands occur along adjacent steep-sided stream banks.

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

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 during lesser flows. 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 landsurface 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.

Populus balsamifera (balsam poplar) is a common horticultural addition to urban landscapes and may become established from cultivated areas. Careful observation is required to determine if stands in the wild are dominated by the native species.

Management: Because the regeneration and establishment of new stands of cottonwood are 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 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).

Related Types/Synonyms: Kittel *et al.* (1995) describe an identical *Populus balsamifera/Alnus incana* ssp. *tenuifolia* plant association occurring in the Gunnison River Basin. A similar *Populus balsamifera/Cornus sericea* type occurs in southern Saskatchewan, but has significant cover of *Cornus sericea* (Jones and Peterson 1970).

Table 20. *Populus balsamifera* Plant Association Stand with Percent Cover of Dominant Species.

Plot Number	96GK02
Condition Rank	C
TREES	
Abies lasiocarpa - sapling	2
Picea englemannii - tree	5
Picea englemannii - seedling	1
Populus balsamifera-tree	40
SHRUBS	
Lonicera involucrata	1
Salix bebbiana	4
Salix drummondiana	3
Salix geyeriana	9
Salix monticola	3
FORBS	
Antennaria parvifolia	1
Aster sp.	1
Epilobium sp.	1
Fragaria virginiana	2
Geum macrophyllum	2
Heracleum sphondylium	1
Maianthemum racemosa var. *amplexicaule*	1
Mertensia ciliata	2
Oxypolis fendleri	1
Potentilla sp.	3
Pyrola americana	1
Taraxacum officinale	7
Viola canadensis var. *scopulorum*	1
GRAMINOIDES	
Agropyron dasystachya	1
Carex aquatilis	4
Carex utriculata	4
Poa pratensis	1
Equisetum arvense	1

Populus deltoides ssp. *monilifera* Alliance

Plains cottonwood/smooth brome (*Populus deltoides* spp. *monilifera/Bromus inermis*) Plant Association
CNHP Rank: not ranked (anthropomorphic disturbance-induced type)
3 Quantitative Plots
South Platte River Basin-- 3 plots (95LS09, 96LS10, 95GK12).

Reference Reaches: N/A.

General Description and Comments: The *Populus deltoides/Bromus inermis* plant association is a grazing-induced type of riparian woodland with a closed to open canopy of large plains cottonwood trees (*Populus deltoides*). There is little to no shrub understory canopy, and a near mono-typic carpet of smooth brome (*Bromus inermis*). The native undergrowth has been completely replaced by introduced hay-meadow grasses.

Regional Distribution: This plant association is a common disturbance-induced type reported to occur throughout the western edge of the Great Plains (Midwest Heritage Task Force 1994, Hansen *et al*. 1995, Jones and Walford 1995).

Distribution in Colorado: Several stands occur along perennial streams and rivers of the eastern foothills and plains (Cooper and Cottrell 1990, Bourgeron and Engelking 1994).

Vegetation: This plant association is characterized by a dominance of non-native hay-meadow grasses, namely *Bromus inermis* (19-52%), under a canopy of widely spaced to nearly closed *Populus deltoides* (30-80%). Few other species are present; shrubs are sparse, and forbs are insignificant. When other shrubs and forbs are present in some abundance (>10%), the stand may be a degraded occurrence of a different *Populus deltoides* plant association (Table 21).

Elevation: 1,650-2,075 m (5,435-6820 ft).

Site Geomorphology: This plant association occupies broad alluvial floodplains and upper terraces of meandering streams.

Rosgen's Channel Type: This association occurs on narrow to broad meandering streams as well as ephemeral washes (C4, G4).

Soil: The soils of this plant association are deep, pale in color, and have mostly sandy loam to silty clay textures, alternating with slightly coarser sands. No coarse fragments were observed.

Adjacent Riparian Vegetation: This plant association occurs with thin bands of *Salix exigua* along the immediate stream channel. Usually this is the only plant association in the riparian corridor.

Adjacent Upland Vegetation: Uplands are generally open range lands or agricultural fields.

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 during lesser flows. 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 landsurface 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.

Management: Unless the area has been seeded with *Bromus inermis* or other hay-meadow grasses, changing the grazing regime to winter-only, short-duration, or rotation, may allow native grasses, forbs and shrubs to return.

Related Types/Synonyms: Identical types have been described from Wyoming, Nebraska, Kansas, Oklahoma, and Colorado (Hansen *et al.* 1995, Jones and Walford 1995, Padgett *et al*. 1989, Bourgeron and Engelking 1994, Midwest Heritage Task Force 1994, Cooper and Cottrell 1990).

Table 21. *Populus deltoides/Bromus inermis* Plant Association Stands from the South Platte Watershed with Percent Cover for Dominant Species.

Plot Numbers	95LS09	95LS10	95GK12
Riparian Condition Rank	D/C	C	D
TREES			
Populus deltoides spp. *monilifera*--mature trees	85	29	83
Populus x *acuminata*--mature trees		19	
Salix amygdaloides--mature trees	11	13	1
SHRUBS			
Rosa woodsii		2	
Salix lucida ssp. *caudata*		25	
Symphoricarpos occidentalis	2		
FORBS			
Ambrosia dumosa		2	2
Artemisia ludoviciana	2	4	
Glycyrrhiza lepidota	2		
Ipomopsis sp.	2	1	
Medicago lupulina	2	1	
Medicago sativa	2		7
Melilotus officinalis			2
Rudbeckia laciniata var. *ampla*			4
Taraxacum officinale	16	2	2
Trifolium repens	11		
Urtica dioica ssp. *gracilis*		2	
Verbascum thapsus		2	
GRAMINOIDES			
Bromus inermis	42	19	52
Poa pratensis	43	37	26
Equisetum arvense		2	
Equisetum laevigatum	1	3	1

Plains cottonwood/woolly sedge (*Populus deltoides* ssp. *monilifera/Carex lanuginosa*) Plant Association
CNHP Rank:G1?/S1?
5 Quantitative Plots:
South Platte River Basin--5 plots (95LS40, 95LS45, 95GK42, 95GK55, 96LS39)

South Platte Reference Reaches: The best examples of the plains cottonwood riparian mosaic can be seen on the South Platte River at the Tamarack Ranch State Wildlife Area, Logan County, T10N, R49 W.

General Description and Comments: The *Populus deltoides/Carex lanuginosa* (plains cottonwood/woolly sedge) plant association is an open to closed canopy woodland of large *Populus deltoides* trees with a dense layer of *Carex lanuginosa* covering the ground. It occurs in swales and other depressions on the floodplains of larger rivers.

Regional Distribution: This plant association has been observed as part of the riparian mosaic of the North Platte River near Scottsbluff, Nebraska (Nebraska Natural Heritage Program Ecologist, *personal communication*). It may also occur in western Kansas, but has not been inventoried.

Distribution in Colorado: This association is only known to occur along the floodplain of the lower Cache la Poudre River and along the South Platte River from Greeley, CO to Julesburg, CO.

Vegetation: Mature *Populus deltoides* ssp. *monilifera* (plains cottonwood) trees form a nearly closed canopy with 50-85% cover with an occasional *Salix amygdaloides* (0-27%). Shrub cover is very minor with <5% cover of *Ribes* spp. (gooseberry) or *Vitis riparia* (wild grape). The undergrowth in undisturbed sites is predominately *Carex lanuginosa* (woolly sedge) with 15-75% cover. Non-native grasses may be abundant in degraded areas, with *Bromus inermis* (13%) and *Phalaris arundinacea* (40%). Few other herbaceous species are present (Table 22).

Elevation Range: 3800-4850 ft (1100-1470m).

Site Geomorphology: This association occurs in low-lying swales, overflow channels and low-lying stream banks of broad floodplains of large, plains rivers. It occurs in small, easily overlooked patches or it can form long bands in the bottoms of overflow troughs and along stream banks adjacent to slow-moving reaches.

Rosgen's Stream Classification: This plant association occurs along broad, braided channels (D5) and confined and somewhat entrenched, slightly sinuous river channels (B6).

Soil: Soils are predominately deep (60+ cm) heavy clays and sandy loams with signs of mottling

often present at 20-40 cm.
Adjacent Riparian Vegetation: *Populus deltoides-(Salix amygdaloides)/Spartina pectinata* (plains cottonwood-(peach-leaved willow)/prairie cordgrass) often occurs on adjacent areas of the same swale or overflow channel. Older stands of *Populus deltoides* occur on higher ridges.

Adjacent Upland Vegetation: Adjacent non-riparian communities bordering the South Platte River are sand-sage rolling hills, native short-grass prairies, and agricultural fields. Lands adjacent to the Cache la Poudre River riparian corridor are agricultural fields.

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 during lesser flows. 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 landsurface 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.

Little is known about the *Populus deltoides/Carex lanuginosa* (plains cottonwood/woolly sedge) plant association. It appears to be a product of over-bank flooding that deposits very fine clays and silts. It seems to occur under similar environmental conditions, with exception of soil textures, as the *Spartina pectinata* (prairie cordgrass) plant associations.

Management: Because the regeneration and establishment of new stands of cottonwood are 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.

Along the South Platte River, however, the removal of frequent flooding and ice-flows has encouraged riparian woody growth. Historically the South Platte River was a wide, shallow braided channel. It experienced significant floods every spring due to spring snow-melt runoff. In addition, the shallow waters of the South Platte would freeze in the winter. These shallow sheets of ice would breakup and flow downstream in the early spring, damaging any plant life it its path. Finally, in late summer, the S. Platte would slow to barely a trickle, dropping the water table well below the ground surface of the well-drained sandy bed-material. This combination of flood, ice-flows and drought kept the S. Platte River bed clear of woody vegetation for much of the braided channel and stream banks. The present-day expanse of woody riparian growth along the South Platte River is due to human-caused changes to the hydrologic character of the river.

Riparian forage productivity can be 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.

Carex lanuginosa (woolly sedge) is palatable to livestock (Hermann 1970) which may result in this community being overgrazed. Kovalchik (1987) suggests that livestock be removed when 40% of the forage has been utilized in order to insure an upward trend in ecological status. Alternatively, the presence in abundance of *Carex lanuginosa* (woolly sedge) may indicate a lack of heavy grazing by livestock. This sedge species may also be useful in improving degraded sites due to its sprouting from long rhizomes which can form a dense mat and effectively stabilize stream banks (Hansen *et al.* 1988).

Related Types/Synonyms: This plant association is new to the literature. However, it has been observed by Wyoming and Nebraska Natural Heritage Program ecologists (*personal communication*).

Table 22. *Populus deltoides/Carex lanuginosa* Plant Association Stands with Percent Cover of Dominant Species.

Plot Number	95LS40	95LD45	95GK42	95GK55	96LS39
Occurrence Rank	A/B	C	B	C/D	B
TREES					
Acer negundo--mature trees				1	
Populus deltoides spp. *monilifera*--mature trees	76	86	59		65
Populus deltoides spp. *monilifera*--saplings				51	
Populus deltoides spp. *monilifera*--seedlings				1	
Salix amygdaloides--mature trees				4	27
Ulmus pumila				1	
SHRUBS					
Vitis riparia	2		3		
FORBS					
Apocynum androsaemifolium	2				
Cirsium arvense	3				
Glycyrrhiza lepidota		8			
Plantago major				2	
Polygonum pensylvanicum		4		2	
Veronica sp.				1	
GRAMINOIDES					
Carex lanuginosa	69	52	76	14	46
Elymus lanceolatus		42		3	
Phalaris arundinacea				5	40
Scirpus pungens			2		
Spartina pectinata	1	2	2	1	

Plains cottonwood/switch grass (*Populus deltoides* spp. *monilifera/Panicum virgatum*) Plant Association
CNHP Rank: G1G2/S1
5 Quantitative Plots:
Republican River Basin--5 plots (95LS25, 95GK25, 95GK26, 95GK30, 95GK31).

Reference Reaches: The only known occurrence in Colorado is along the Arikaree River, Yuma County (specific location withheld in respect of landowner privacy).

General Description and Comments: This is a mature plains cottonwood (*Populus deltoides*) woodland with close to widely spaced trees and little to no shrub canopy. The undergrowth is a thick prairie of several tall-grass species.

Regional Distribution: This plant association is known from the North Platte River in eastern Wyoming, south to the Republican River Basin in eastern Colorado (Jones and Walford 1995, Colorado Natural Heritage Program Database 1996). Historically, the range may have included western Nebraska, Kansas, and Oklahoma.

Distribution in Colorado: This association is known only from the Arikaree River in north-eastern Colorado (Colorado Natural Heritage Program Database, 1996).

Vegetation: This plant association is characterized by scattered *Populus deltoides* (14-76%), either as individuals or small and large stands. *Salix amygdaloides* is always present (1-87%), although it can be widely spaced, and in some stands it is outnumbered by cottonwoods 50:1. The most distinguishing feature, however, is the lush undergrowth of *Panicum virgatum* (2-47%). Other graminoides present may include *Carex lanuginosa* (0-34%), *C. nebrascensis* (0-12%), and *Spartina pectinata* (0-18%) (Table 23). *Toxicodendron rydbergii* (poison ivy) is also common is most stands (Table 23). *Schizachyrium scoparium* and *Bouteloua curtipendula* are reported to occur in drier stands in Colorado near the Nebraska and Kansas border and in Wyoming. Kansas and Nebraska ecologists report that *Schizachyrium scoparium* is more common within this plant association further east (Steve Kettler, personnel communication).

Elevation: 1,030-1,200 m (3,370-3,925 ft).

Site Geomorphology: This plant association occurs on low floodplain ridges, slightly elevated point bars, and along stream banks.

Rosgen's Channel Type: This association occurs along strongly meandering rivers with moderate to low gradients (C6). Channel substrates range form heavy clays to sandy banks. In Wyoming this association occurs on sandy river banks.

Soil: Soil textures of this association range from fine sandy loams to silty clay. The soils are deep (80 cm +) and stratified by depositional layers. One profile had mottling from 21 to 89 cm depth. Soil pH is 8.0. The soil with the heaviest texture (silt clay to 83 cm) had the highest *Spartina pectinata* cover (25%), although other stands had sandy clay loams and silt loams.

Adjacent Riparian Vegetation: Other riparian types within the floodplain mosaic are *Salix exigua* stands, patches of nearly pure *Salix amygdaloides*, and *Scirpus* wetlands. Open meadows of the tall-grass prairie species (*Panicum virgatum* and *Sorghastrum nutans*) also occur on the floodplain.

Adjacent Upland Vegetation: Uplands consist of short grass prairies, dominated by *Bouteloua gracilis* and *Buchloë dactyloides*, and sandsage prairies (Daley 1972).

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 during lesser flows. 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 landsurface 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.

The *Populus deltoides/Panicum virgatum* plant association occurs at the transition of short grass and sandsage prairie and more mesic riparian areas dominated by mixed tall and short grass prairie species. The moist environment of the Arikaree River floodplain supports a tall-grass prairie on the floodplain surface. The tall-grass prairie species are likely to remain if periodic fire is allowed to occur (Nebraska Heritage ecologist personnel communication) and the current management of winter-only grazing is maintained. Other sites in northeastern Colorado that experience season-long grazing have shown a strong reduction in the native tall-grass species (see plot 95GK31). The hydrology of the Arikaree River in northeastern Colorado is driven by summer thunderstorms, and flooding events are episodic. Present stands of cottonwoods date back to a few years following 1935 when a large flood occurred. Landowners note that there were very few trees prior to that flood, and that they hayed the rich floodplain meadows. It is likely that the current cottonwood groves may reach maturity and die before another regenerating storm event occurs given the cyclical nature of this disturbance driven ecosystem.

Management: Winter-only grazing by livestock works very well in maintaining the vigor of native tall-grass species.

Related Types/Synonyms: An identical type has been described from one location in Wyoming (Jones and Walford 1995). Originally described from Colorado by Kettler (Colorado Natural Heritage Program Database 1996).

Table 23. *Populus deltoides/Panicum virgatum* Plant Association Stands from the Republican River Basin with Percent Cover for Dominant Species.

Plot Number	95LS25	95GK25	95GK26	95GK30	95GK31
Riparian Condition Rank	A	A	B	B	C
TREES					
Elaeagnus angustifolia					2
Populus deltoides spp. *monilifera*--mature	14	32	76	40	64
Salix amygdaloides--mature	69	31	87	37	48
Salix amygdaloides--seedlings	1				
SHRUBS and VINES					
Toxicodendron rydbergii	5	1	7	6	2
FORBS					
Glycyrrhiza lepidota	2		1	10	
Taraxacum officinale		1		1	2
GRAMINOIDES					
Agrostis stolonifera					23
Bromus japonicus	3	8		1	
Carex lanuginosa		11	34		
Carex microptera	1				
Carex nebrascensis		12			
Carex sp.	1			40	
Eleocharis palustris		11	1		33
Elymus lanceolatus ssp. *lanceolatus*	1			19	10
Leersia oryzoides		10			
Panicum virgatum	33	22	47	41	2
Poa palustris		8	2		
Poa pratensis		3	43	29	1
Scirpus americanus		18	1		
Scirpus microcarpus					22
Spartina pectinata	4	7	18	6	25

Plains cottonwood/choke cherry (*Populus deltoides* spp. *monilifera/Prunus virginiana*) Plant Association
CNHP Rank: G1Q/S1Q
3 Quantitative Plots:
South Platte River Basin-- 3 plots (95LS16, 95GK16, 95GK17).

South Platte River Basin Reference Reaches: No reference reaches were located in the study area.

General Description and Comments: This is a mature plains cottonwood (*Populus deltoides*) association with large, widely spaced trees and a closed to open canopy. Open grassy areas dotted with small but thick pockets of shrubs characterize the understory.

Regional Distribution: Similar communities (see above) have been reported from Montana (Hansen *et al.* 1988) and northeastern Colorado (Cooper and Cottrell 1990, Knopf 1985).

Distribution in Colorado: This association is only known from northeastern Colorado (Cooper and Cottrell 1990, Knopf 1985).

Vegetation: This plant association is characterized by an open canopy of tall, mature *Populus deltoides* (19-77%). The shrub understory occurs in clumps that are about 5 feet tall and 10 to 25 feet long with *Prunus virginiana* 27-36%, *Celtis laevigata* 0-11%, and *Symphoricarpos occidentalis* 4-44%. *Symphoricarpos* occurs under other, taller, shrubs. The shrub patches are interspersed with meadow of mostly non-native grasses, such as *Bromus inermis* (3-26%), *Elytrigia intermedia* (0-23%), and *Elymus canadensis* (0-53%) (Table 24).

Elevation: 1,700 m (5,600 ft)

Site Geomorphology: This plant association occurs on upper terraces and elevated stream banks. This type was found only once, along the Plum Creek, on a terrace that ranged from 1.75 to 3.75 meters above the channel.

Rosgen's Channel Type: Plum creek is a narrow, braided channel with shifting islands and point bars (D5).

Soil: The soil is deep (70-80+ cm) loamy sands with alternating layers of coarse sands and silty clays with high organic content.

Adjacent Riparian Vegetation: Open stands of *Populus deltoides/Bromus inermis* and the introduced crack-willow, *Salix fragilis*, also occupy the upper terraces. Within the riparian mosaic closer to the stream are stands of *Salix exigua,* and open dry meadows of *Pascopyrum smithii, Dactylis glomerata,* and other introduced grasses.

Adjacent Upland Vegetation: Surrounding uplands consist of rolling hills of *Quercus gambelii* shrublands and open dry grasslands.

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 during lesser flows. 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 landsurface 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.

Other plant associations reported from Montana, *Fraxinus pennsylvania/Prunus virginiana* and *Acer negundo/Prunus virginiana*, indicate that the *Populus deltoides/Prunus virginiana* may be a southern extension of this association with *Populus deltoides* replacing the overstory tree species. The large tree size and elevated position above the current stream channel indicate this is a late-seral association. The area appears historically disturbed, and the presence of *Salix fragilis* confirms the area was once a homestead (Dupont plant-manager personal communication). *Prunus* may have been planted at that time, and the terraces graded and planted for hay.

Management: Because the regeneration and establishment of new stands of cottonwood are 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.

Along the South Platte River, however, the removal of frequent flooding and ice-flows has encouraged riparian woody growth. Historically the South Platte River was a wide, shallow braided channel. It experienced significant floods every spring due to spring snow-melt runoff. In addition, the shallow waters of the South Platte would freeze in the winter. These shallow sheets of ice would breakup and flow downstream in the early spring, damaging any plant life it its path. Finally, in late summer, the S. Platte would slow to barely a trickle, dropping the water table well below the ground surface of the well-drained sandy bed-material. This combination of flood, ice-flows and drought kept the S. Platte River bed clear of woody vegetation for much of the braided channel and stream banks. The present-day expanse of woody riparian growth along the South Platte River is due to human-caused changes to the hydrologic character of the river.

Thick stands of *Prunus virginiana* may preclude use by livestock (Hansen *et al.* 1989). Open stands may provide grazing opportunities, however season-long grazing increases the abundance and vigor of non-native grasses and, with excessive browsing, may reduce shrub densities.

Related Types/Synonyms: Knopf (1985) studied riparian bird populations within the Platte River watershed, and reported a riparian area near Livermore with *Populus sargentii* (=*P. deltoides* ssp. *monilifera*), scattered willows, and *Prunus virginiana*. Hansen *et al.* (1988) report that the *Prunus virginiana* dominance type can occur as an understory layer within stands of *Populus deltoides*. Cooper and Cottrell (1990) reported a *Populus deltoides/Bromopsis inermis* plant association that has two stands with 5 and 20% cover of *Prunus virginiana*.

Table 24. *Populus deltoides/Prunus virginiana* Plant Association Stands from the South Platte Watershed with Percent Cover for Dominant Species.

Plot Number	95LS16	95GK16	95GK17
Riparian Condition Rank	B/C	B	B/C
TREES			
Populus deltoides spp. *monilifera*--mature	76	77	19
Populus deltoides spp. *monilifera* --saplings	2		
Populus x *acuminata*--tree			70
Salix amygdaloides--mature trees		1	
Salix fragilis	6		53
SHRUBS			
Celtis laevigata var. *reticulata*			11
Parthenocissus quinquefolia	1	3	2
Prunus americana		7	1
Prunus virginiana	27	29	36
Rhus trilobata var. *trilobata*	1		1
Ribes aureum			1
Ribes cereum			1
Rosa woodsii		18	
Symphoricarpos occidentalis	13	44	4
FORBS			
Cynoglossum officinale	8	21	13
Galium triflorum	2		19
Glycyrrhiza lepidota		2	
GRAMINOIDES			
Bromus inermis	12	26	3
Carex lanuginosa		8	
Elymus canadensis		16	
Elytrigia intermedia			53
Pascopyrum smithii	23		
Poa pratensis	3	10	

Plains cottonwood/western snowberry (*Populus deltoides* ssp. *monilifera/Symphoricarpos occidentalis*) Plant Association
CNHP Rank:G2G3/S2
14 Quantitative Plots:
South Platte River Basin--14 plots (95LS29, 95LS30, 95LS35, 95LS36, 95LS39, 95LS43, 95LS44, 95GK38, 95GK39, 95GK49, 95GK53, 95GK58, 96AM86, 96GK42)

South Platte Reference Reaches: The best examples of the plains cottonwood riparian mosaic can be seen on the South Platte River at the Tamarack Ranch State Wildlife Area, Logan County, T10N, R49 W.

General Description and Comments: This is a mature *Populus deltoides* (plains cottonwood) plant association with widely-spaced, large trees and low-stature thickets 2-3 feet high (0.5-1 m) of *Symphoricarpos occidentalis* (snowberry) underneath the cottonwood canopy. Open areas of dry, weedy grasses occur between clumps of shrubs. Dips and swales of the floodplain may hold other wet plant associations such as stands of *Salix exigua* (coyote willow) or *Carex lanuginosa* (wooly sedge).

Regional Distribution: This plant association occurs on the western edge of the Great Plains, in eastern Montana, Wyoming, and Colorado (Hansen *et al.* 1989, Jones and Walford 1995, Johnston 1987, Knopf 1985, Christy 1973, and Kittel *et al*. 1996).

Distribution in Colorado: This plant association occurs along the South Platte River, and some of its smaller tributaries (Christy 1973 and Kittel *et al*. 1996).

Vegetation: This plant association has 30-90% cover of mature, widely spaced *Populus deltoides* ssp. *monilifera* (plains cottonwood). *Salix amygdaloides* (peach-leaved willow) is also occasionally present with 0-15% cover. The understory is relatively open with 3-65% cover of *Symphoricarpos occidentalis* (western snowberry). Herbaceous cover is low and scattered. Many weeds and non-native species may be present due to the relatively dry, open nature of this association (Table 25).

Elevation Range: 3600-4200 ft (1000-1300 m).

Site Geomorphology: This plant association occupies elevated ridges and flat areas of the floodplain that are well-drained and slightly higher than most of the other surfaces. These sites can be at some distance (10-45 m) from the main channel, or close to the main channel on an elevated (0.5-3 m) terrace or island.

Rosgen's Stream Classification: The stream channel is broad and braided (Rosgen's Channel Type: D5).

Soil: Soils of this plant association show the most development of all the low elevation floodplain vegetation types. Typically, the profile is highly stratified, but with distinct soil development (B) layers. Soil textures range from silty clays to loamy sands. Following the 1995 spring flooding on the South Platte River, this association had a fresh sediment on the surface. Mottling is evident at 15 inches (40 cm) depth. A thin clay lens in each layer indicates that floods can reach heights up to 7 feet (2m) above the active channel.

Adjacent Riparian Vegetation: Adjacent overflow channels have *Salix exigua*/mesic graminoid (coyote willow/mesic graminoid) stands or open meadows of *Spartina pectinata* (prairie cordgrass).

Adjacent Upland Vegetation: Adjacent upland communities include *Salix geyeriana* (Geyer willow) on rolling hills of sand, native short-grass prairie, or agricultural fields.

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 during lesser flows. 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 landsurface 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.

The *Populus deltoides* spp. *monilifera/Symphoricarpos occidentalis* (plains cottonwood/western snowberry) plant association appears to be one of the last stages of cottonwood dominance on the South Platte River floodplain. The trees are large and widely spaced. As they topple and die, *Symphoricarpos occidentalis* (western snowberry) becomes the remaining dominant woody species. This late-seral plant association is located on the highest surfaces within the floodplain. Its lateral position varies greatly. Presumably, as islands throughout the wide braided channel become more stable and vegetated, thereby aggregating more sediments and experiencing fewer floods, succession advances to this late stage.

Management: Because the regeneration and establishment of new stands of cottonwood are 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.

Along the South Platte River, however, the removal of frequent flooding and ice-flows has encouraged riparian woody growth. Historically the South Platte River was a wide, shallow braided channel. It experienced significant floods every spring due to spring snow-melt runoff. In addition, the shallow waters of the South Platte would freeze in the winter. These shallow sheets of ice would breakup and flow downstream in the early spring, damaging any plant life it its path. Finally, in late summer, the S. Platte would slow to barely a trickle, dropping the water table well below the ground surface of the well-drained sandy bed-material. This combination of flood, ice-flows and drought kept the S. Platte River bed clear of woody vegetation for much of the braided channel and stream banks. The present-day expanse of woody riparian growth along the South Platte River is due to human-caused changes to the hydrologic character of the river.

Riparian forage productivity can be 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.

Symphoricarpos occidentalis (western snowberry) occurs on the floodplain of the South Platte River under a light to no grazing management regime. In Wyoming, it has been noted that *Symphoricarpos* (snowberry) becomes abundant in ungrazed areas (Thilenius and Brown 1990, as cited in Jones 1995). In Montana, *Symphoricarpos* sp. (snowberry) understories are thought to be grazing induced phases of wetter riparian woodland community types (Hansen *et al.* 1989).

The palatability of *Symphoricarpos occidentalis* (western snowberry) for livestock is considered to be low to fair, but good for deer and elk (Hess and Wasser 1982, Johnson and Nichols 1982, as cited in Hansen *et al*. 1995). *Symphoricarpos occidentalis* is also considered to be excellent for streambank stabilization due to its formation of dense stands and its spreading rhizomes.

Symphoricarpos occidentalis (western snowberry) is tolerant of fire and will usually sprout afterwards and grow into an even denser stand (Hansen *et al*. 1995).

Related Types/Synonyms: The *Populus deltoides* ssp. *monilifera/Symphoricarpos occidentalis*) plant association is identical to community types described in Montana and Wyoming under the same name (Hansen *et al.* 1995 and Jones and Walford 1995). *Populus sargentii* is a synonym for *Populus deltoides* ssp. *monilifera*. A similar *Populus sargentii/ Symphoricarpos occidentalis/Leymus cinereus* plant association occurs in the Thunder Basin National Grassland in eastern Wyoming, central Montana, South Dakota, and North Dakota. This association differs in that it has a very diverse woody overstory with *Leymus cinereus* dominating the undergrowth (Johnston 1987). A community of *Populus deltoides*/ *Symphoricarpos occidentalis* and *Salix exigua* has been described in a riparian bird study along the South Platte River (Knopf 1985).

Table 25. *Populus deltoides/ Symphoricarpos occidentalis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	95 LS 29	95 LS 30	95 LS 35	95 LS 36	95 LS 39	95 LS 43	95 LS 44	95 GK3 8	95 GK3 9	95 GK 49	95 GK 53	95 GK 58	96 GK 42	96 AM 86
Riparian Condition Rank	B/C	B	B	B	A	B	C	B	B	C	D	B/C	B	B
TREES														
Fraxinus pennsylvanica –trees	16	8					8				11			
Populus deltoides spp. *monilifera*--trees	33	52	30	47	19	31	70	58	34	54	89	81	58	39
Salix amygdaloides --trees	1				1	14				10			1	
SHRUBS and VINES														
Prunus virginiana													1	
Rosa woodsii			3	7				1	1			1	1	
Salix exigua		4	7		8	16	1		1					2
Salix irrorata													10	
Symphoricarpos occidentalis	15	8	12	32	23	28	66	32	49	40	3	22	12	7
Vitis riparia	2	35	4				6							3
FORBS														
Cirsium arvense	12				12	1	9		1				6	
Glycyrrhiza lepidota		3							1	1	9			
Mahonia repens														14
Epilobium sp.													10	
Solidago canadensis													5	
GRAMINOIDES														
Carex brevior	25	6	1	1				1	2					
Cyperus strigosis					22	2								
Elymus lanceolatus	1	2				38	2	12		1	33	38		14
Panicum sp.	1	1	25						5					
Pascopyrum smithii		16	1				3		3	11	8	20		
Poa pratensis	5	1		12			26	1		37	15	21	1	

Plains cottonwood-(peach-leaved willow)/coyote willow (*Populus deltoides* ssp. *monilifera-(Salix amygdaloides)/Salix exigua*) Plant Association
CNHP Rank: G4?/S3
11 Quantitative Plots:
South Platte River Basin--11 plots (95LS06, 95LS11, 95LS31, 95LS41, 95LS42, 95GK07, 95GK43, 95GK50, 95GK52, 96AM18, 96LS12).

South Platte Reference Reaches: The best examples of the plains cottonwood riparian mosaic can be seen on the South Platte River at the Tamarack Ranch State Wildlife Area, Logan County, T10N, R49 W.

General Description and Comments: This is an early-seral association with a mix of sapling and pole sized *Populus deltoides* ssp. *monilifera* (plains cottonwood) and *Salix amygdaloides* (peach-leaved willow) intermixed with multiple stems of *Salix exigua* (coyote willow). It is recognized as the younger stage of older plains cottonwood associations that have more widely spaced trees. This association is often located on low stream banks and islands, but can also occur on overflow channels away from the main stream channel. It typically has a fairly dense tree canopy with little herbaceous ground cover.

Regional Distribution: This and similar plant associations are located on the western Great Plains in Nebraska, Kansas, Oklahoma (Midwestern Heritage Task Force 1994), eastern Wyoming (Jones and Walford 1995), eastern Colorado (Christy 1973, Johnston 1987, Kittel *et al.* 1996), and northeastern New Mexico (Dick-Peddie 1993) and Oregon (Bourgeron and Engelking 1994).

Distribution in Colorado: In Colorado this plant association occurs along streams and rivers at the base of the Front Range foothills east to the Nebraska state line (Christy 1973, Johnston 1987, Kittel *et al.* 1996).

Vegetation: The canopy of this plant association is an open stand of 1-5% cover of sapling to pole-sized *Populus deltoides* ssp. *monilifera* (plains cottonwood) and *Salix amygdaloides* (peach-leaved willow) trees. *Salix exigua* (coyote willow) is always present in the understory with 1-75% cover. The undergrowth can be scarce and is characterized by scattered cover of a variety of graminoid species and insignificant forb cover. If the stand is very moist, *Carex lanuginosa* (wooly sedge) may be abundant with 0-25% cover (Table 26).

Elevation Range: 3500-6500 ft (1000-2000 m)

Site Geomorphology: This plant association occurs on young, alluvial surfaces such as point bars, low stream banks, and overflow areas. On the mainstem of the South Platte River, it occurs only on immediate stream banks and low overflow areas near the main channel.

Rosgen's Stream Classification: This association can be found on broad, braided channels

(D5), or along smaller washes and incised reaches (*e.g.,* Kiowa and West Bijou Creeks), on higher terraces, where periodic summer flash floods disturb the entire floodplain, and have flat-bottomed sandy beds (F5). On higher reaches in the watershed, this association occurs on broad and slightly meandering (B3), to more sinuous river channels (C5).

Soil: Soils are typically fresh, alluvial material with little soil development. Textures are predominately loose, friable sands interspersed with narrow bands of clay loams and sandy clays. One plot (96LS12) had a hard pan of silty clay between a depth of 16-26 cm.

Adjacent Riparian Vegetation: Older stands of *Populus deltoides* (plains cottonwood) often occur on higher terraces, while pure stands of other *Salix* (willow) and *Carex* (sedge) species occur within the riparian mosaic of the channel and floodplain.

Adjacent Upland Vegetation: Foothill streams often have stands of *Pinus ponderosa* (ponderosa pine), or *Juniperius osteosperma* (one-seeded juniper) woodlands, or *Quercus gambelii* (Gambel oak) shrublands on outcrops. The mainstem of the South Platte River has sand sage grasslands on adjacent rolling hills, and agricultural fields on lands adjacent to the riparian corridor.

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 during lesser flows. 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 landsurface 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.

Maintenance of *Salix amygdaloides* (peach-leaved willow) also requires stream flooding in order to deposit new alluvial bars where new trees can grow. This is because *Salix amygdaloides* is a pioneer species that needs moist, sparsely-vegetated alluvium to become established from seed (Johnson 1992, as cited by Jones and Walford 1995).

The *Populus deltoides* spp. *monilifera-(Salix amygdaloides)/Salix exigua* (plains cottonwood-(peach-leaved willow)/coyote willow) plant association are early to mid-seral stage. With time and tree growth, *Salix exigua* (coyote willow) becomes less important. Christy (1973) suggests that this vegetation type may be transitional between an all *Salix exigua* (coyote willow) dominated association and an all *Populus deltoides* (plains cottonwood) dominated association. However, he considers this plant association to be a response to intermediate environmental conditions, namely intermediate soil moisture where *Salix exigua* dominates the wettest soils and *Populus deltoides* dominates the driest.

Management: Because the regeneration and establishment of new stands of *Populus deltoides* (plains cottonwood) and *Salix amygdaloides* (peach-leaved willow) are dependent upon flooding events, any alterations to the natural flow regime of a river can affect the cottonwood ecosystems and 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.

Along the South Platte River, however, the removal of frequent flooding and ice-flows has encouraged riparian woody growth. Historically the South Platte River was a wide, shallow braided channel. It experienced significant floods every spring due to spring snow-melt runoff. In addition, the shallow waters of the South Platte would freeze in the winter. These shallow sheets of ice would breakup and flow downstream in the early spring, damaging any plant life it its path. Finally, in late summer, the S. Platte would slow to barely a trickle, dropping the water table well below the ground surface of the well-drained sandy bed-material. This combination of flood, ice-flows and drought kept the S. Platte River bed clear of woody vegetation for much of the braided channel and stream banks. The present-day expanse of woody riparian growth along the South Platte River is due to human-caused changes to the hydrologic character of the river.

Riparian forage productivity can be high and very palatable to livestock. Cottonwood seedlings and saplings are frequently browsed by cattle. However, thick willow stands of this plant association may actually prevent livestock use. 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.

Once established, *Salix amygdaloides* is a very good streambank stabilizer and should be protected by managers (Hansen *et al*. 1995). *Salix exigua* is also very useful in streambank stabilization in that it can rapidly colonize and spread on disturbed areas (Hansen *et al*. 1995). It is believed that fire in this type will result in the willow species vigorously sprouting afterward.

Related Types/Synonyms: A similar type called by the same name has been documented in eastern Wyoming (Jones and Walford 1995). On the eastern plains of New Mexico, the *Populus fremontii/Salix amygdaloides*)/mesic shrub/mesic graminoid-forb plant association (Dick-Peddie 1993) has been documented as having similar structure and plant species as the Colorado association, however the dominant cottonwood is not the same species. In eastern Nebraska, Kansas, and Oklahoma there is a similar *Populus deltoides/Salix amygdaloides-Salix nigra* plant association (Midwestern Heritage Task Force 1994) and in Oregon, there is a similar *Salix amygdaloides-Salix exigua-Salix lucida* ssp. *caudata* association (Bourgeron and Engelking 1994). These two associations have different *Salix* species in the understory.

The *Populus deltoides* ssp. *monilifera-(Salix amygdaloides)/Salix exigua* plant association is identical to stands described on the South Platte River in northeastern Colorado by Christy (1973) and Johnston (1987). Christy (1973) describes a "mixed community" consisting of *Populus sargentii, Salix amygdaloides* and *Salix interior* (coyote willow). Johnston (1987) describes a *Populus sargentii/Salix* spp. plant association with *Salix amygdaloides* and *Salix exigua*. *Populus sargentii* is a synonym for *Populus deltoides* ssp. *monilifera* (Kartesz 1994).

Table 26. *Populus deltoides-(Salix amygdaloides)/Salix exigua* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	95 LS 06	95 LS 11	95 LS 31	95 LS 41	95 LS 42	95 GK 07	95 GK 43	95 GK 50	95 GK 52	96 AM 18	96 LS 12
Riparian Condition Rank	C	C	B	B/C	B/C	C	B	C	C	B	D
TREES											
Acer negundo—trees										26	
Elaeagnus angustifolia—trees											4
Fraxinus pennsylvanica--mature trees			5	19			1				
Populus deltoides spp. *monilifera*--mature	5	45				46	41			22	25
Populus deltoides spp. *monilifera*--saplings			1	36	38			32	20		
Populus deltoides spp. *monilifera*--seedlings					11		1	8	1		
Salix amygdaloides--mature trees	2	9	27		2	17	5			1	28
Salix amygdaloides --saplings								18			
SHRUBS											
Salix exigua	19	34	52	20	10	22	30	33	47	17	3
Vitis riparia			8								
FORBS											
Bidens frondosa							5	1	1		
Chenopodium glaucum							1	8	1		
Glycyrrhiza lepidota		3				17					
Melilotus officinalis	1	26									
Urtica dioica ssp. *gracilis*		21									
Xanthium strumarium			4	10	1		1		10		
GRAMINOIDES											
Agrostis stolonifera										20	7
Bromus inermis	14	16				2					
Bromus tectorum	19	2									
Carex lanuginosa							17		1		1
Carex nebrascensis						22					
Elymus lanceolatus											37
Eragrostis pilosa				5	6		7				
Poa pratensis	1	19				7				10	3
Scirpus pungens		1				12		2			
Spartina pectinata			5				3				

Plains cottonwood-(Peach-leaved willow)/Prairie slough grass (*Populus deltoides* spp. *monilifera-(Salix amygdaloides)/Spartina pectinata* Plant Association
CNHP Rank: G1G2/S1
12 Quantitative Plots
South Platte River Basin-- 12 plots (95LS32, 95LS38, 95GK32, 95GK33, 95GK34, 95GK35, 95GK36, 95GK4, 95GK41, 95GK44, 95GK51, 95GK57).

South Platte River Basin Reference Reaches: Good examples of this association can be seen along the South Platte River on the Tamarack Ranch State Wildlife Area, CDOW land, T8N, R52W, Sec 14.

General Description and Comments: This is a mature plains cottonwood (*Populus deltoides*) association with widely spaced trees including an occasional peach-leaved willow (*Salix amygdaloides*). It is largely confined to swales and low areas on the floodplain where soils are fine- textured and water accumulates in early summer. There is little to no shrub canopy present, and the herbaceous undergrowth is a dense layer of tall (0.5-1 m) slough grass (*Spartina pectinata*).

Regional Distribution: This plant association is known only from the North and South Platte Rivers in western Nebraska and eastern Colorado (Midwest Heritage Task Force 1994, Knopf 1985, Christy 1973). It may have been historically present but is now degraded in Kansas (personnel communication, Kansas Natural Heritage ecologist).

Distribution in Colorado: This combination of species has been reported previously from the lower South Platter River in northeastern Colorado by Knopf (1985) and Christy (1973).

Vegetation: This plant association is characterized by a nearly closed canopy of mostly mature *Populus deltoides* trees (32-78%) with *Salix amygdaloides* in the mature canopy (1-53%), and a nearly pure undergrowth of *Spartina pectinata* (2-55%). *Carex lanuginosa* may be present in some abundance (0-36%), but for the most part, canopy cover by other herbaceous species is insignificant (Table 27).

Elevation: 1,060-1,280 m (3,470-4,180 ft).

Site Geomorphology: This plant association occurs on wet but well drained low-lying areas such as swales and low spots within overflow channels on broad floodplains, often alternating between higher ridges.

Rosgen's Channel Type: Broad shallow braided channels (D5).

Soil: Soils of this plant association show signs of continual flooding and fine sediment deposition. They are stratified with alternating layers of fine and coarse layers. Nearly all of the profiles sampled had between 14-26 cm of silty loam, clay loam, or fine sandy loam at the surface. Most soils had signs of faint to moderate mottling with moderate soil development.

Adjacent Riparian Vegetation: In adjacent lower and wetter areas where water tends to pond, *Typha latifolia* or *T. angustifolia* stands can be found, along with *Phragmites australis*. This plant association may grade into the *Populus deltoides/Carex lanuginosa* type, and dryer ridges may have open stands of *Populus deltoides/Symphoricarpos occidentalis*. Other areas may have stands of *Salix exigua.*

Adjacent Upland Vegetation: Adjacent non-riparian communities bordering the South Platte River are sandsage rolling hills, native mixed short-grass prairies, or agricultural fields.

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 during lesser flows. 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 landsurface 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.

Spartina pectinata is adapted to wet soils and can grow quickly after burial by sedimentation (Weaver 1965). This plant association appears to be secondary successional with both the cottonwoods and the slough grass surviving burial through re-growth. In 1995, a 25-year return flood left a layer of silt from a few centimeters to several decimeters deep on the soil surface (*personnel observation*). By late August, the *Spartina* had grown vigorously. It is likely that other herbaceous species will invade this new substrate, and the importance of *Spartina* may be diminished with time.

Management: Because the regeneration and establishment of new stands of *Populus deltoides* (plains cottonwood) and *Salix amygdaloides* (peach-leaved willow) is dependent upon flooding events, any alterations to the natural flow regime of a river can affect the cottonwood ecosystems and 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.

Along the South Platte River, however, the removal of frequent flooding and ice-flows has encouraged riparian woody growth. Historically the South Platte River was a wide, shallow braided channel. It experienced significant floods every spring due to spring snow-melt runoff. In addition, the shallow waters of the South Platte would freeze in the winter. These shallow sheets of ice would breakup and flow downstream in the early spring, damaging any plant life it its path. Finally, in late summer, the S. Platte would slow to barely a trickle, dropping the water table well below the ground surface of the well-drained sandy bed-material. This combination of flood, ice-flows and drought kept the S. Platte River bed clear of woody vegetation for much of the braided channel and stream banks. The present-day expanse of woody riparian growth along the South Platte River is due to human-caused changes to the hydrologic character of the river.

Riparian forage productivity can be high and very palatable to livestock. Cottonwood seedlings and saplings are frequently browsed by cattle. However, thick willow stands of this plant association may actually prevent livestock use. 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.

Once established, *Salix amygdaloides* is a very good streambank stabilizer and should be protected by managers (Hansen *et al*. 1995). Stands of *Spartina pectinata* have high production rates, however the rough-edged leaves create poor forage quality, and it is not readily eaten by livestock or wildlife. Its tall height and thick growth provide shade and cover for wildlife and certain bird species (Hansen *et al.* 1988). It can make excellent hay if cut two or three times each growing season, thereby reducing forage coarseness (Weaver 1965, Hansen *et al.* 1988).

Related Types/Synonyms: This combination of species has been reported previously from the lower South Platte River in northeastern Colorado by Knopf (1985) and Christy (1973). This association is also similar to the *Populus deltoides-(Salix nigra)/Spartina pectinata-Carex.* spp. plant association described from eastern Nebraska (Midwest Heritage Task Force 1994). *Salix amygdaloides* apparently replaces *S. nigra* in western Nebraska (Great Plains Flora 1977 and personnel communication with the Nebraska Heritage ecologist).

Table 27. *Populus deltoides-(Salix amygdaloides)/Spartina pectinata* Plant Association Stands From the South Platte Watershed with Percent Cover for Dominant Species.

Plot Number (95----)	LS32	LS38	GK32	GK33	GK34	GK35	GK36	GK40	GK41	GK44	GK51	GK57
Riparian Condition Rank	B	B	C	C	B	B	B	B	B	B/C	C	C
TREES												
Celtis laevigata var. *reticulata*			15	5								
Fraxinus pennsylvanica-trees				7				3	12			1
Populus deltoides – trees		59	32	49	78	42	56	65	68	69	59	
Populus deltoides-saplings	1						2					49
Salix amygdaloides --trees	53	1	4	1	1	1	2	15	5	4	2	3
SHRUBS												
Salix exigua	10	2		8	1	6	6	3		1		
Symphoricarpos occidentalis			1		1				2		4	3
Vitis riparia	1	7	1	2	2	17		3				
FORBS												
Glycyrrhiza lepidota		3			1						26	4
Xanthium strumarium	3		2	7		4	2	2			1	
GRAMINOIDES												
Carex lanuginosa	12	36			12				15		7	3
Carex sp.	5	4				7	1	1	1			
Elymus lanceolatus			1					1	2	35		42
Poa pratensis			7								1	9
Spartina pectinata	47	25	26	21	39	27	37	37	31	32	55	26
Unknown graminoid			2	14		5	1		4			

Other Populus deltoides ssp. *monilifera* Stands

One stand dominated in part by *Populus deltoides* ssp. *monilifera* is in severely degraded condition, and remains unclassified. This stands is on the Cache la Poudre River (plot 95GK54), just upstream of the confluence with the South Platte River. The Poudre River is entrenched at this point and tiny stands of *Populus deltoides* (35%) and *Salix amygdaloides* (43%) were widely scatted along the narrow and steep banks. The undergrowth is largely weedy with non-natives like *Agropyron cristatum* (34%) and *Phalaroides arundinacea* (11%) (Table 28). Agricultural fields (mostly corn) were planted within 10 meters of the stream bank. It could probably be placed into the *Populus deltoides-(Salix amygdaloides)/Salix exigua* Plant Association.

Table 28. *Populus deltoides* ssp. *monilifera* Alliance Unclassified Stand from the South Platte Watershed with Percent Canopy of Dominated Species.

Plot No.	95GK54
Riparian Condition Rank	D
TREES	
Populus deltoides	35
Salix amygdaloides	43
Ulmus pumila	5
GRAMINOIDES	
Bromus inermis	7
Phalaroides arundinacea	11

Salix amygdaloides Alliance

No plant associations were found within this Alliance. *Salix amygdaloides* becomes more common on small tributary streams draining the Black Forest, however, these are for the most part scattered individuals or small clumps. Large stands of any significant size are rare, and in general, when the creek becomes large enough to support many trees, *Populus deltoides* or *Populus x acuminata* are also present.

Two stands sampled along West Kiowa Creek (plots 95GK08, 95GK09) have a diverse overstory canopy of *Salix amygdaloides* (55-60%), *Populus angustifolia* (0-14%), and *Salix fragilis* (0-6%). A sparse canopy of shrubs consists of *Salix ligulifolia* (12%), *S. lucida* ssp. *caudata* (17%), *Symphoricarpos occidentalis* (2%), and *Ribes inerme* (1%) (Table 27). The floodplain was under about 6 inches of water during sampling, and a significant amount of *Carex lanuginosa* (10-31%) in the undergrowth indicates this site is wet for much of the growing season. The stands are located near the confluence of West Kiowa Creek with Kiowa Creek. A nearby rock outcrop to the west may contribute run off, as the site is a low, entrenched floodplain pooling runoff from several directions before draining to the north.

Table 29. *Salix amygdaloides* Alliance Stands from the South Platte Watershed with Percent Cover for Dominant Species.

Plot Number	95GK08	95LS12
Riparian Condition Rank	C	B/C
TREES		
Populus angustifolia --mature trees		14
Salix amygdaloides--mature trees	55	61
Salix amygdaloides--seedlings		3
Salix fragilis	6	
SHRUBS and VINES		
Ribes inerme	1	1
Salix lucida ssp. *caudata*	17	
Salix eriocephala var. *ligulifolia*	12	
Symphoricarpos occidentalis		2
GRAMINOIDES		
Bromus inermis	9	32
Carex lanuginosa	31	38
Carex nebrascensis	5	
Pascopyrum smithii		5
Poa pratensis	26	3

Quaking aspen/tall forb (*Populus tremuloides/*tall forb) Plant Association
CNHP Rank: G5/S5
6 Quantitative Plots:
Colorado River Basin--3 plots (93GK13, 93GK14, 93GK30)
Routt National Forest--1 plot (525)
South Platte River Basin--2 plots (96GK27, 96AM07)

South Platte Reference Reaches: No excellent examples were sampled in the study area, but a fairly good representative stand can be seen on Lamping Creek, Pike-San Isabel National Forest, Park County, T6S, R75W, Sec 33.

General Description and Comments: *Populus tremuloides* (quaking aspen) is a non-obligate riparian species. *Populus tremuloides* plant associations are often found on upslopes, but can also dominate riparian areas. The *Populus tremuloides*/tall forb riparian plant association is distinguished by the obligate riparian forbs in the undergrowth. It is wide spread on the western slope. Occurrences within the South Platte River Basin are poor examples of the type.

Regional Distribution: This plant association occurs in Nevada, Idaho, Montana, Wyoming, North Dakota, Colorado, and Utah (Reid and Bourgeron 1991, Alexander 1981, Johnston 1987).

Distribution in Colorado: This association occurs in the White and South Platte River Basins and the Routt National Forest (Johnston 1987, Kittel *et al.* 1994, Kettler and McMullen 1996).

Vegetation: *Populus tremuloides* is the dominant tree species in this plant association with 10-20% cover. Shrub cover is 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 0-50% *Hydrophyllum fendleri* (waterleaf), 0-40% *Heracleum lanatum* (cow parsnip), 0-30% *Osmorhiza occidentalis* (western sweet-cicely), and 0-10% each of *Delphinium barbeyi* (western larkspur) and *Senecio triangularis* (arrowleaf groundsel). Other 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's geranium), *Maianthemum stellatum* (false Solomon's seal), *Thalictrum fendleri* (Fendler meadowrue), and *Viola* spp.(violet). Graminoid cover includes 5-20% cover of *Poa pratensis* (Kentucky bluegrass) and 0-15% cover of *Equisetum arvense* (field horsetail). Other graminoid cover includes *Calamagrostis canadensis* (bluejoint reedgrass), *Carex* spp. (sedge), and *Elymus glaucus* (blue wildrye) (Table 30).

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

Site Geomorphology: This plant association occurs on broad, gently sloping hillsides and valley bottoms or along high gradient, narrow streams.

Rosgen's Stream Classification: This association typically occurs along very steep steams (A2-A4) and occasionally on more moderate gradient stream (B3, B4).

Soil: The soils of the *Populus tremuloides*/tall forb plant association 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.

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.

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, Alexander 1988). *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 found on adjacent mesic hillslopes. The *Populus tremuloides*/tall forb plant association is considered a climax type (Alexander 1988).

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. Extreme overgrazing 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 cattle, deer and elk, 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. Clearcutting 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 clearcut in large blocks (Hoffman and Alexander 1980). Large clearcuts will also result in a higher water table and reduced regeneration of aspen. If cutting is done to stimulate aspen suckering, diseased trees should be removed first to avoid infection of young shoots (Powell 1988).

The use of 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).

Related Types/Synonyms: An identical *Populus tremuloides/*tall forb plant association is described from Nevada, Idaho, Montana, Wyoming, Colorado, and Utah (Reid and Bourgeron 1994). An identical *Populus tremuloides*/*Ligusticum* spp. plant association is described from Wyoming, Colorado, and Utah (Johnston 1987). A similar *Populus tremuloides/Heracleum sphondylium* plant association occurs in Wyoming, Colorado, and Utah (Johnston 1987). It differs slightly by having significant shrub cover. A similar *Populus tremuloides*/*Heracleum sphondylium* plant association occurs in the Routt National Forest of Colorado, but the mesic forb species are slightly different (Hoffman and Alexander 1980). *Heracleum lanatum* is a synonym for *Heracleum sphondylium* (Kartesz 1994).

Table 30. *Populus tremuloides* Alliance and *Populus tremuloides*/Tall Mesic Forb Plant Association Stands with Percent Canopy Cover of Dominant Species.

Plant Association	*Populus tremuloides*/Tall Forbs		*Populus tremuloides* Alliance	
Plot Number	96GK27	96AM07	96GK33	96AM13
Riparian Condition Rank	A	A	B	B
TREES				
Picea englemannii - tree		42	7	
Picea englemannii - sapling		2		
Picea englemannii - seedling		6	1	
Pinus contorta - tree		18	11	
Populus tremuloides - tree	65	36	34	90
Populus tremuloides - sapling				6
Pseudotsuga menziesii - tree			5	
SHRUBS				
Acer glabrum				6
Juniperus communis	14	6	10	2
Lonicera involucrata		10		10
Rosa woodsii	3	1	5	17
Salix bebbiana			11	
Salix drummondiana			1	9
Salix monticola	8	3	42	2
Vaccinium sp.	14	1		
FORBS				
Epilobium angustifolium	19	1	2	2
Fragaria virginiana	1	1	1	1
Heracleum sphondylium	2		13	
Mertensia ciliata	12	1	20	
Oxypolis fendleri	2	1	1	
Senecio triangularis	2		2	
Taraxacum officinale	4	1		1
Viola canadensis var. *scopulorum*			5	
GRAMINOIDES				
Calamagrostis canadensis		3	16	
Carex norvegica			2	
Poa compressa		1		3
HORSETAILS				
Equisetum arvense				12

Unclassified *Populus tremuloides* stands:

Two stands remain unclassified with a dominant overstory of *Populus tremuloides*. One stand (plot 96GK33) along Blue Creek, has a mixed overstory of 34% *Populus tremuloides* and approximately 10% cover each of *Pinus contorta* and *Picea engelmannii*, with a narrow thick band of *Salix monticola* (42%) running along the stream bank. Blue Creek is very steep, running down an aspen dominated south-facing hillside above the I-70 Highway corridor. The riparian vegetation could be classified as a *Salix monticola* or *Populus tremuloides* type.

Another stand (plot 96AM13) along South Clear Creek has a very dense (90%) cover of *Populus tremuloides*. Very little shrub or herbaceous cover occurs underneath this canopy along the stream banks except 12% *Equisetum arvense*, indicating recent and/or frequent flooding disturbance. This stand could be classified as a *Populus tremuloides/Equisetum arvense* type.

Quaking aspen/river birch (*Populus tremuloides/Betula occidentalis*) Plant Association
CNHP Rank: G2G3/S2
5 Quantitative Plots:
South Platte River Basin--5 plots (96GK16, 96GK23, 96AM01, 96AM28, 96AM76)

South Platte Reference Reaches: A good example of this type can be seen on Pike-San Isabel National Forest on Cabin Creek, just south of Sugarloaf Peak, Jefferson County, T9S R71W Sec 23 and 26.

General Description: The *Populus tremuloides/Betula occidentalis* plant association is a dense deciduous riparian woodland with high structural diversity of tall and short shrubs, as well as a diverse overstory canopy of conifers and aspen trees. The herbaceous undergrowth can be a thick carpet of grasses and forbs or it can be very sparse under heavily shaded reaches. It grows in narrow foothill and montane canyons of the Colorado Front Range.

Regional Distribution: This plant association is reported from eastern Nevada (Manning and Padgett 1995) and Colorado (Colorado Natural Heritage Program 1996).

Colorado Distribution: This association is known only from the Colorado Front Range (Colorado Natural Heritage Program 1996).

Vegetation: *Populus tremuloides* forms a thick to open overstory cover (20-40%), and *Betula occidentalis* forms a thick line along the stream banks with 40-50% cover. Associated conifer species varies with elevation, with *Pinus ponderosa* and *Populus acuminata* at lower occurrences and *Abies lasiocarpa* at the higher sites. Other co-dominant shrub species vary widely and include *Salix monticola* (0-30%), *Acer glabrum* (0-10%), *Alnus incana* (0-2%), and *Salix bebbiana* (0-12%). The undergrowth is sparse to thick, depending on the amount of sunlight reaching the ground surface (Table 31).

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

Site Geomorphology: This association occurs in narrow valleys (40-200 ft, 130-660 m) and steep, first order gulches on stream banks, benches and narrow floodplains.

Rosgen's Stream Channel Type: Streams channels where this association is found are steep and straight with armored banks (G2-G4, A4), or are less steep and slightly meandering (B3).

Soils: The soils of this association are uniformly sandy loams becoming skeletal within 1 m depth. A sandy clay layer consistently appears at an average depth of 12 cm.

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

Adjacent Upland Vegetation: Adjacent uplands are heavily forested with stands of *Pinus ponderosa, Pseudotsuga menziesii*, or *Populus tremuloides.*

Succession and other Ecological processes: The presence of conifers in some stands indicates a potential to become a conifer dominated stand such as the Conifer/*Betula occidentalis* type in Nevada (Manning and Padgett 1995). This appears to be the case in Colorado stands as well as many stands have sapling and seedling conifer species. Fire suppression may allow this successional pathway to proceed. Periodic fires may maintain the *Populus tremuloides/Betula occidentalis* plant association, as both *Populus tremuloides* and *Betula occidentalis* can sprout after a fire (Manning and Padgett 1995).

Management: Forage for livestock grazing is limited within this association due to low productivity along heavily shaded reaches. The multiple canopy structure is excellent for wildlife. Strong root systems of *Betula occidentalis* and *Populus tremuloides* help maintain bank stability.

Related Types/Synonyms: Manning and Padgett (1995) describe a very similar *Populus tremuloides/Betula occidentalis* community type. The environmental setting of these two associations is very similar, except that Colorado stands have a higher elevational range. In addition, *Acer glabrum* appears to have replaced *Amelanchier* of the Nevada stands and Colorado stands have abundant *Salix monticola*, while the Nevada stands have none.

Table 31. *Populus tremuloides/Betula occidentalis* Plant Association Stands with Percent Cover by Dominant Species.

Plot Number	96GK23	96AM01	96AM28	96AM76	96GK16
Riparian Condition Rank	B	B	A	A	C
TREES					
Abies lasiocarpa - tree		10			
Abies lasiocarpa - sapling		3			
Picea pungens - tree				2	
Pinus ponderosa - tree			50	5	
Populus tremuloides - tree	20	40	41	26	21
Populus tremuloides – sapling			2	1	
Populus x *acuminata*- tree			5		
Pseudotsuga menziesii – tree		10	1	17	
SHRUBS					
Acer glabrum	12	10			5
Alnus incana			2		2
Betula occidentalis	48	36	46	24	41
Juniperus communis	34		1	3	
Rosa woodsii	2	2	3	10	1
Salix bebbiana			3	1	12
Salix monticola	1			4	30
FORBS					
Aconitum columbianum	12				
Epilobium angustifolium	8	1	1	7	
Fragaria virginiana	7	1	2	1	1
Heracleum sphondylium	5		1		15
Ligusticum porteri				8	
Mertensia ciliata		5	2	4	1
GRAMINOIDES					
Agrostis stolonifera			4		3
Calamagrostis canadensis				7	1
Carex disperma			6	8	
Dactylis glomerata					15
Poa pratensis		1	5		11

UNESCO: **III.B.2.c. COLD-DECIDUOUS, SEASONALLY FLOODED/SATURATED, SHRUBLANDS**
COWARDIN: **PALUSTRINE-SCRUB-SHRUB SHRUBLAND, DECIDUOUS**

Alnus incana Alliance

Thinleaf alder/Mesic Graminoids (*Alnus incana* ssp. *tenuifolia*/Mesic Graminoids) Plant Association
CNHP Rank: G5Q/S3
17 Quantitative Plots:
Routt National Forest-- 3 plots (11, 597, 598)
Arkansas River Basin-- 7 plots (95AM04, 95AM17, 95AM26, 95AM28, 95RR17, 95GK71, 95GK72)
South Platte River Basin--7 plots (96AM26, 96LS07, 96AM90, 96AM11, 96GK38, 96GK19,96LS18)

South Platte River Basin Reference Reaches: An excellent example of this type can be seen on Bear Creek, Mt. Evans State Wildlife Area, Clear Creek County, T5S, R72W, Sec 18, and R73W, Sec 13.

General Description and Comments: The *Alnus incana* ssp. *tenuifolia*/Mesic Graminoids plant association is a stand of medium-tall deciduous shrubs with thick herbaceous cover of mostly native forb and grass cover and little to no overstory tree canopy. Heavily disturbed stands have abundant introduced 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). However, several stands in Colorado are undisturbed and the undergrowth is dominated by native graminoid cover.

Regional Distribution: This plant association and similar types occur in Alaska (Viereck *et al.* 1992), Montana (Hansen et al. 1995), Wyoming (Jones 1992), Idaho and Utah (Padgett *et al.* 1989), Nevada (Manning and Padgett 1995), and Colorado (Johnston 1987, Colorado Natural Heritage Program 1996).

Distribution in Colorado: This plant association occurs in the Routt National Forest and in the Arkansas and South Platte River Basins (Kettler and McMullen 1996, Kittel *et al*. 1996, Colorado Natural Heritage Program 1996).

Vegetation: *Alnus incana* ssp. *tenuifolia* (thinleaf alder) dominates the upper canopy with 10-90% cover. Other shrubs include 0-20% cover of *Rubus deliciosus* (delicious raspberry), and 0-15% cover of *Salix exigua* (coyote willow). The undergrowth is a thick carpet of grasses. Native graminoids include 0-35% cover of *Calamagrostis canadensis* (bluejoint reedgrass), 0-30% cover of *Carex* spp. (sedge), and 0-25% cover each of *Glyceria striata* (fowl mannagrass) and *Festuca rubra* (red fescue). Some stands are dominated by introduced, non-native grasses including 0-35% cover of *Poa pratensis* (Kentucky bluegrass), and 0-25% cover each of *Agrostis stolonifera* (redtop) and *Bromus inermis* (smooth brome). Forb cover is sparse (Table 32).

Elevation Range: 6400-9400 ft (2000-2900 m).

Site Geomorphology: This plant association occurs on narrow to moderately wide floodplains and stream benches that are flat with little micro-topography. Open stands with significant cover of *Salix* (willow) species occur on frequently flooded point bars, recently deposited islands, as well as on dredged stream banks. Two stands (#597, 598) in the Routt National Forest occur on seeps not associated with a distinct stream channel.

Rosgen's Stream Classification: This association occurs on stream channels that tend to be steep with a 3-8% gradient and straight to moderately sinuous (A3-A4, B2- B3 and F3). Where this association occurs on point bars, stream channels are low gradient (<1% gradient) and highly sinuous (C5).

Soil: Soils of this association 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.

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), *Pinus contorta* (lodgepole pine), *Populus tremuloides* (quaking aspen) and *Pinus edulis* (pinyon pine) woodlands occur on adjacent hill slopes.

Successional and Ecological Processes: *Alnus incana ssp. tenuifolia* (thinleaf alder) is a long-lived, early-seral species. *Alnus incana* is shade-intolerant and is thought to require well-aerated water (Viereck 1970, Hansen *et al*. 1988, Padgett *et al.* 1989). *Alnus incana* is one of the first species to establish on bare mineral soils left behind by retreating glaciers or flooded streams (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994). *Alnus incana* can also colonizes fresh alluvial soils (Brayshaw 1978 as cited in Hansen *et al.* 1988) and soils disturbed by placer mining (Hansen *et al*. 1989).

Alnus incana fixes atmospheric nitrogen through a symbiotic relationship with mychorizae (Binkley 1986). On a primary successional site in Alaska, the annual input of nitrogen to soils from *Alnus incana* ranged from 57 to 313 kg/ha annually (Van Cleve *et al.* 1971), compared to 1 to 9 kg/ha/yr deposited by bulk precipitation in the western U.S. (Bowman and Steltzer 1997, Boring *et al.* 1988). Twenty years after alder establishment in Alaska, the total increase in soil nitrogen was approximately six-fold (Van Cleve *et al*. 1971).

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).

If sites remain undisturbed, it is thought that *Alnus incana* stands will become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). However, it has been documented in Alaska that thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). On more xeric sites, *Acer negundo* (box elder) may become the dominant canopy species (Padgett *et al.* 1989).

On more xeric sites, *Acer negundo* (box elder) may become the dominant canopy species (Padgett *et al.* 1989). 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). Most stands in Colorado appear to disturbed by heavy grazing and have an abundance on non-native graminoid species. A few stands, however, appeared undisturbed and have an undergrowth dominated by native grasses.

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). *Salix drummondiana* (Drummond willow) is highly palatable to cattle, deer and elk, as well as beaver (Kovalchik 1987). Open stands may provide moderate forage and shade in the summer (Hansen *et al*. 1995).

Stands of the *Alnus incana*/Mesic Graminoids 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 plant 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), several *Carex* (sedge) and *Equisetum* (horsetail) (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 undergrowth.

Fires, except for light ground fires, will kill *Alnus incana* (Hansen *et al.* 1995). After a fire, roots die and ground cover is a sparse, making the site highly susceptible to bank destabilization and soil erosion.

Alnus incana sprouts quickly when cut at 4-5 year intervals and can be used for re-stabilizing 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).

Related Types/Synonyms: Identical *Alnus incana*/Mesic Graminoids plant associations are described by (Jones 1992), Padgett *et al.* (1989), Manning and Padgett (1995), Kettler and McMullen (1996) and Kittel *et al*. (1996).

Table 32. *Alnus incana*/Mesic Graminoids Plant Association Stands with Percent Cover of Dominant Species.

Plot Number	96AM26	96LS07	96AM90	96AM11	96GK38	96GK19	96LS18
Riparian Condition Rank	A	B	A	C	C	B	B
TREES							
Acer negundo ssp. *violaceus**				21			
Picea engelmannii - sapling	17						
Pinus ponderosa - tree			7				10
Populus tremuloides - tree		8	13				
Populus tremuloides - sapling		5					
Salix amygdaloides -tree					13		
SHRUBS							
Alnus incana	19	53	29	68	91	30	42
Betula occidentalis			10		19	7	23
Prunus virginiana				22			
Rosa woodsii	1	1		3	7		12
Salix bebbiana		1	3				29
Salix eriocephala ssp. *ligulifolia*			1		9		
Salix exigua				3	3	26	
FORBS							
Anemone canadensis					12		
Claytonia sp.		10					
Dodecatheon pulchellum		13					20
Ligusticum porteri		17	1				
Mertensia ciliata	9	7	9				
Thalictrum dasycarpum				24			
Viola canadensis var. *scopulorum*		11					
GRAMINOIDS							
Calamagrostis canadensis	29	13	21			1	27
Carex aquatilis	6					9	
Carex canescens		30					
Carex disperma		19	16				
Carex nebraskensis							10
Carex norvegica		15					
Poa pratensis	1	2		1	26	11	2
Equisetum arvense	1	4					6

**Acer negundo ssp. violaceus* is an introduced shade tree.

Thinleaf alder-red-osier dogwood (*Alnus incana* ssp. *tenuifolia-Cornus sericea*) Plant Association
CNHP Rank: G3G4/S3
21 Quantitative Plots:
Yampa River Basin--4 plots (31, 34, 68, 78, GK10)
Colorado River Basin--6 plots (93RR23, 93RR28, 93RR36, 93RR41, 93RR42, 93SS50)
Gunnison River Basin--3 plots (94GK01, 94GK23, 94GK38)
San Juan National Forest--6 plots (#6, 21, 36, 52, 140, 142)
Arkansas River Basin--1 plot (95GK74)
South Platte River Basin--1 plot (96AM93)

South Platte River Basin Reference Reaches: An excellent quality example of this association can be seen on Bear Creek, north of Indian Creek Campground, Pike-San Isabel National Forest, Douglas County, T7S, R69W, Sec 28 and 33.

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.

Regional Distribution: This plant association occurs in eastern Nevada (Manning and Padgett 1995), the La Sal Mountains and high plateaus of central Utah (Padgett *et al.* 1989) and Colorado (Johnston 1987, Colorado Natural Heritage Program 1996).

Distribution in Colorado: This plant association occurs in the Yampa, Colorado, Gunnison, San Juan, the Arkansas and South Platte River Basins (Johnston 1987, Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Richard *et al.* 1996, Kittel *et al.* 1996).

Vegetation: This plant association is characterized by a dense thicket of shrubs dominated by 10-70% 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 0-30% cover each of *Salix eriocephala* var. *ligulifolia* (yellow willow) and *Salix lucida* ssp. *caudata* (Pacific willow), 0-20% cover each of *Salix monticola* (Rocky Mountain willow), *Lonicera involucrata* (honeysuckle), *Rosa woodsii* (woods rose), *Salix bebbiana* (Bebb willow) and *Betula occidentalis* (river birch), and 0-10% cover of *Rubus idaeus* (raspberry). One stand in the Yampa River Basin had 70% cover of *Salix bebbiana*. Tree cover is usually not present (Table 33).

Forb cover is highly variable depending on the amount of light that penetrates through the canopy. Forb species include 0-20% cover of *Rudbeckia laciniata* (cutleaf coneflower), 0-10% cover each of *Maianthemum stellatum* (false Solomon's seal) and *Ozmorhiza depauperata* (blunt-fruit sweet cicely), and 0-5% cover each of *Ligusticum porteri* (southern ligusticum) and

Heracleum lanatum (cow parsnip). Graminoid cover is usually low, but can include 0-45% cover of *Poa pratensis* (Kentucky bluegrass) and 0-10% cover of *Equisetum arvense* (meadow horsetail) (Table 33).

Elevation Range: 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.

Rosgen's Stream Classification: This association is found on stream channels that are steep and narrow (A2, A3, A4), wide and moderately sinuous (B3), or wide and highly sinuous (C2, C3).

Soils: Soils of this plant association range from loamy sand to sandy clay loam. Mottling is evident at approximately 12 inches (30 cm) depth 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.

Adjacent Riparian Vegetation: The *Alnus incana-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-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce) and *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 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.

Successional and Ecological Processes: *Alnus incana ssp. tenuifolia* (thinleaf alder) is a long-lived, early-seral species. *Alnus incana* is shade-intolerant and is thought to require well-aerated water (Viereck 1970, Hansen *et al*. 1988, Padgett *et al.* 1989). *Alnus incana* is one of the first species to establish on bare mineral soils left behind by retreating glaciers or flooded streams (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994). *Alnus incana* can also colonizes fresh alluvial soils (Brayshaw 1978 as cited in Hansen *et al.* 1988) and soils disturbed by placer mining (Hansen *et al*. 1989).

Alnus incana fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia*, which lives in the root nodules of *Alnus* (Binkley 1986). On a primary successional site in Alaska, the annual input of nitrogen to soils from *Alnus incana* ranged from 57 to 313 kg/ha annually (Van Cleve *et al.* 1971), compared to 1 to 9 kg/ha/yr deposited by bulk precipitation in the western U.S. (Bowman and Steltzer 1997, Boring *et al.* 1988). Twenty years after alder establishment in Alaska, the total increase in soil nitrogen was approximately six-fold (Van Cleve *et al*. 1971).

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).

If sites remain undisturbed, it is thought that *Alnus incana* stands will become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). However, it has been documented in Alaska that thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). On more xeric sites, *Acer negundo* (boxelder) may become the dominant canopy species (Padgett *et al.* 1989).

In Colorado, the *Alnus incana-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).

Management: *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). *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* 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).

Fires, except for light ground fires, will kill *Alnus incana* (Hansen et al. 1995). After a fire, roots die and ground cover is sparse, making the site highly susceptible to stream bank and soil erosion. *Cornus sericea* can survive all but the hottest fires. After fire, new shoots sprout from the surviving rhizomes (Hansen *et al.* 1995).

Both *Alnus incana* and *Cornus sericea* are capable of sprouting and have rhizomatous roots which provide good stream bank stabilization. *Alnus incana* 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. *Alnus incana* and *Cornus sericea* may be useful for re-vegetating higher gradient streams where seasonal, scouring floods occur (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 stream banks (Hansen *et al*. 1995).

These communities require minimal management because the terrain provides intrinsic protection. Browsing of this species can be high if the stands are open enough for animals to walk through (Hansen *et al*. 1995).

Related Types/Synonyms: Identical *Alnus incana/Cornus sericea* community types are described by Manning and Padgett (1995) and Padgett *et al.* (1989). An identical *Alnus incana* ssp. *tenuifolia/Swida sericea* plant association is described by Komarkova (1986) as cited in Johnston (1987). *Swida sericea* and *Cornus stolonifera* are synonyms for *Cornus sericea* (Kartesz 1994, Weber and Whittman 1996).

In eastern Idaho and western Wyoming, a similar *Alnus incana* ssp. *tenuifolia/Ribes hudsonianum* community type is described, but has a significant cover of *Ribes hudsonianum* (Youngblood *et al.* 1985). Also in eastern Idaho and western Wyoming, a similar *Cornus sericea/Galium triflorum* community type is described which sometimes includes *Alnus* species in the canopy, but not consistently (Youngblood *et al.* 1985). A similar *Alnus incana/Rudbeckia laciniata* association is described by Cooper and Cottrell (1990) with a more diverse forb undergrowth. A similar *Alnus oblongifolia-Cornus sericea* (Arizona alder-red-osier dogwood) community types is described from New Mexico (Durkin *et al.* 1994), but has a different *Alnus* species and a more diverse and dense understory than Colorado stands.

Table 33. *Alnus incana-Cornus sericea* Plant Association Stand from the South Platte Watershed with Percent Cover by Dominant Species.

Plot Number	96AM93
Riparian Condition Rank	A
SHRUBS	
Alnus incana	86
Cornus sericea	6
Prunus virginiana	1
Rosa woodsii	4
Salix bebbiana	15
Salix irrorata	4
FORBS	
Angelica ampla	9
Fragaria virginiana	1
Heracleum sphondylium	4
Mertensia ciliata	2
Taraxacum officinale	2
GRAMINOIDS	
Agrostis gigantea	9
Glyceria striata	1
Juncus saximontanus	1
Poa pratensis	4
Equisetum pratense	7

Thinleaf alder-Drummond willow(*Alnus incana* ssp. *tenuifolia-Salix drummondiana*) Plant Association
CNHP Rank: G3/S3
17 Quantitative Plots:
Gunnison River Basin--7 plots (94GK02, 94GK15, 94GK27, 94JB12, 94JB43, 94JB45, 94RR11)
San Juan National Forest-- 6 plots (#127, 134, 136, 205, 262, 264)
South Platte River Basin-- 4 plots (96GK24, 96GK31, 96GK26, 96AM42)

South Platte River Basin Reference Reaches: No references reaches were identified within the study area, however a fairly good stand can be seen on Ellsworth Creek, Arapaho-Roosevelt National Forest, Gilpen County, T2S, R72W, Sec 7. This creek is recovering from past mining activities. Another fairly good stand can be seen along Beaver Creek, just below Beaver Reservoir, Arapaho-Roosevelt National Forest, Boulder County, T2N, T73W, Sec 24.

General Description and Comments: This plant association is a medium-tall to tall (10-15 ft, 2.5-3.5 m) deciduous shrubland thickly lining steep stream banks adjacent to lodgepole pine and spruce-fir covered hill slopes, or along the tops of steep beaver dams. It naturally occurs as small patches.

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

Distribution in Colorado: This association occurs in the Gunnison and South Platte River Basins and the San Juan National Forest (Kittel *et al*. 1995, Richard *et al*. 1996). This is a small association that is often overlooked, and is likely to occur throughout the Rocky Mountain Province of Colorado.

Vegetation: This plant association is characterized by a dense, closed canopy of 20-100% cover of *Alnus incana* ssp. *tenuifolia* (thinleaf alder) and 0-60% cover of *Salix drummondiana* (Drummond willow) or *Salix monticola* (Rocky Mountain willow) bordering the stream. Other shrubs include 0-20% cover each of *Rosa woodsii* (woods rose) and *Ribes innerve* (whitest gooseberry), and 0-10% cover of *Lonicera involucrata* (honeysuckle).

Some stands have a rich herbaceous understory, that include 0-20% cover of *Heracleum lanatum* (cow parsnip), 0-15% cover of *Equisetum arvense* (meadow horsetail), and 0-10% 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 (Table 34).

Stands that have a high percentage of *Salix monticola* (Rocky Mountain willow), instead of *S. drummondiana* (Drummond willow), are included in this association. In the San Juan Mountains, *Salix monticola* occupies habitats similar to those of *Salix drummondiana* (Drummond willow) and the two species often co-dominate. Stands with a high cover of both

Alnus incana and *Salix monticola* have a similar herbaceous understory as stands with *Alnus incana* and *Salix drummondiana*. Three stands sampled in the Gunnison River Basin had a dense canopy of 40-60% cover of *Alnus incana* (thinleaf alder) and 20-40% cover of *Salix monticola* (Kittel *et al.* 1995).

Elevation Range: 7300-9400 ft (2200-2900 m).

Site Geomorphology: This association occurs along 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, as well as along the tops of large beaver dams.

Rosgen's Stream Classification: This association occurs on stream channels that are steep and rocky (A2, A3), flat with limited floodplains and gravel and cobble bottoms (B3 and B4), wide and sinuous (C3), or braided due to beaver activity (D-8).

Soils: Soils of this association are highly variable, ranging from shallow coarse, skeletal alluvium to deep organic peat, but most are stratified alluvium with sandy loam and silty clay loams, often with buried A horizons. Stands with a rich, herbaceous undergrowth have a thick layer (5-10 in. 10-30 cm) of fine sandy loam over a coarse alluvial deposit. Stands with low shrub cover and little herbaceous undergrowth have coarse, skeletal soils without an accumulated fine layer at the surface.

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 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 hill slopes. At lower elevations, *Pinus ponderosa* (ponderosa pine) and *Pseudotsuga menziesii* (Douglas-fir) forests and *Quercus gambelii* shrublands are present.

Successional and Ecological Processes: *Alnus incana ssp. tenuifolia* (thinleaf alder) is a long-lived, early-seral species. *Alnus incana* is shade-intolerant and is thought to require well-aerated water (Viereck 1970, Hansen *et al*. 1988, Padgett *et al.* 1989). *Alnus incana* is one of the first species to establish on bare mineral soils left behind by retreating glaciers or flooded streams (Viereck 1970, Van Cleve *et al*. 1971, Chapin *et al*. 1994). *Alnus incana* can also colonizes fresh alluvial soils (Brayshaw 1978 as cited in Hansen *et al.* 1988) and soils disturbed by placer mining (Hansen *et al*. 1989).

Alnus incana fixes atmospheric nitrogen through a symbiotic relationship with the bacteria *Frankia*, which lives in the root nodules of *Alnus* (Binkley 1986). On a primary successional site in Alaska, the annual input of nitrogen to soils from *Alnus incana* ranged from 57 to 313 kg/ha annually (Van Cleve *et al.* 1971), compared to 1 to 9 kg/ha/yr deposited by bulk precipitation in the western U.S. (Bowman and Steltzer 1997, Boring *et al.* 1988). Twenty years after alder establishment in Alaska, the total increase in soil nitrogen was approximately six-fold (Van Cleve *et al*. 1971).

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).

If sites remain undisturbed, it is thought that *Alnus incana* stands will become dominated by *Salix* (willow) species or conifer stands (Hansen *et al.* 1989). However, it has been documented in Alaska that thick stands of alders inhibit succession by competing with spruce for nutrients and light (Chapin *et al.* 1994). On Colorado's western slope, *Acer negundo* (boxelder) may become the dominant canopy species on more xeric sites (Padgett *et al.* 1989).

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. 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* (Kittel *et al*. 1995).

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). *Salix drummondiana* (Drummond willow) is highly palatable to cattle, deer and elk, as well as beaver (Kovalchik 1987). Open stands may provide moderate forage and shade in the summer (Hansen *et al*. 1995).

Fires, except for light ground fires, will kill *Alnus incana* (Hansen *et al.* 1995). After a fire, roots die and ground cover is sparse, making the site highly susceptible to stream bank and soil erosion.

Related Types/Synonyms: A similar *Alnus incana* ssp. *tenuifolia-Salix drummondiana/ Equisetum arvense* plant association occurs in the Gunnison National Forest, but has a slightly different herbaceous understory (Komarkova 1986, as cited in Johnston 1987). A similar *Alnus incana* spp. *tenuifolia/Equisetum arvense* plant association occurs in Colorado, but does not necessarily have *Salix drummondiana* in the shrub canopy (Hess 1981, Reid and Bourgeron 1991).

Table 34. *Alnus incana-Salix drummondiana* Plant Association Stands from the South Platte Watershed with Percent Cover by Dominant Species.

Plot Number	96GK31	96GK24	96GK26	96AM43
Riparian Condition Rank	B	B	C	B
TREES				
Picea pungens - tree		1		12
Pinus contorta - tree			14	
Populus tremuloides - tree			8	
SHRUBS				
Alnus incana	17	22	23	59
Salix bebbiana	7		4	5
Salix drummondiana	13	51	18	7
Salix eriocephala ssp. *ligulifolia*	8			
Salix lucida ssp. *lasiandra*	1		5	1
Salix monticola	16	3	20	12
Salix planifolia	16			
FORBS				
Aconitum columbianum		4	1	1
Angeliga ampla				5
Cardamine cordifolia			5	
Conioselinum scopulorum	2	2		
Heracleum sphondylium		6	21	16
Hydrophyllum fendleri			11	
Ligusticum porteri			7	
Mertensia ciliata	1	2	2	4
Oxypolis fendleri			9	
Saxifraga sp.		12		
Taraxacum officinale	3	1	2	2
GRAMINOIDES				
Calamagrostis canadensis	5	23		
Carex aquatilis	27			
Carex utriculata	30	3		
Glyceria elata		3		2
Equisetum arvense	4	6	5	5

Unclassified *Alnus incana* Dominated Stands

Two stands along West Plum Creek (95LS14, 95GK14) occur on raised banks or ridges adjacent to the channel. The ground is steeply sloping so the vegetation changes rapidly from streamside to higher ground that is dominated by more xeric species. Significant amounts of *Symphoricarpos* may represent transitional stands from immediate mesic river banks to the drier upland habitats (Table 35).

Table 35. Unclassified *Alnus incana* Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	95GK14	95LS14
Riparian Condition Rank	B	C
TREES		
Populus deltoides ssp. *monilifera*--mature trees		2
Quercus gambelii	2	
Salix amygdaloides--mature trees	1	3
SHRUBS		
Alnus incana ssp. *tenuifolia*	18	25
Crataegus succulenta	16	
Humulus lupulus	4	
Ribes aureum	2	
Rosa woodsii	7	2
Salix exigua	15	14
Salix eriocephala var. *ligulifolia*	1	45
Symphoricarpos occidentalis	42	20
Toxicodendron rydbergii	5	
GRAMINOIDES		
Bromus inermis	20	40
Carex lanuginosa	40	10
Eleocharis palustris	3	
Poa pratensis	17	12
FORBS		
Ambrosia dumosa	5	
Cirsium arvense	4	
Euphorbia esula var. *uralinsis*		6
Mentha arvensis	3	

River birch (*Betula occidentalis*) Plant Association
CNHP Rank: G3/S2
12 Quantitative Plots:
Colorado River Basin--3 plots (92NL34, 93RR44, 93GK09)
Gunnison River Basin--4 plots (94MD01, 94RR01, 94RR03, 94RR08)
San Juan National Forest--1 plot (# 4)
South Platte River Basin--4 plots (96LS34, 96AM36, 96AM33, 96AM34)

South Platte River Basin References Reaches: A large stand of this association can be seen on the South Platte River below Elevenmile Canyon Reservoir, Pike-San Isabel National Forest, Park County, T13S, R72W, Sec 15, 16, and 20. Another good example can be seen on Crystal Creek, Pike-San Isabel National Forest, Teller County, T12S, R 71W, Sec 11.

General Description and Comments: This is a tall deciduous shrublands of nearly pure stands of *Betula occidentalis*. It occurs at slightly lower elevation range than *Alnus incana*, and therefore is a more heavily impacted and threatened riparian community. Large, near pristine stands of *Betula occidentalis* (river birch) are rare in Colorado. Regardless of the associated herbaceous undergrowth, all stands of *Betula occidentalis* are placed in one *Betula occidentalis* dominated plant association. This combines the *Betula occidentalis*/mesic forb and *Betula occidentalis*/Mesic Graminoids of previous Colorado Natural Heritage Program unpublished reports.

Regional Distribution: This plant association and similar types occur in Montana (Hansen *et al*. 1995), Nevada (Manning and Padgett 1995), Utah (Padgett *et al*. 1989), and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This association occurs on the San Juan National Forest (Richard *et al.* 1996) and in the Colorado, Gunnison and South Platte River Basins (Kittel *et al.* 1994, Kittel *et al.* 1995, Colorado Natural Heritage Program 1996).

Vegetation: *Betula occidentalis* (river birch) forms a dense canopy of 60% cover with 10% cover of *Ribes inerme* (whitestem gooseberry) and <5% cover of *Salix bebbiana* (Bebb willow). *Picea pungens* (Colorado blue spruce) and *Juniperus scopulorum* (Rocky Mountain juniper) are present, but sparse with 1% cover each. Due to the dense shrub canopy, the herbaceous undergrowth is limited in cover (<10%), but contains a diversity of species. Forb cover includes 1% cover each of *Achellia millefolium* (yarrow), *Carmine cordifolia* (bittercress), *Heracleum lanatum* (cow parsnip), *Maianthemum stellatum* (false Solomon's seal), and *Vicia americana* (American vetch). Graminoid cover, especially *Carex* (sedge) species, is high. *Carex lanuginosa* (woolly sedge) can be dominate with 40% cover. Other *Carex* species include <5% cover each of *Carex deweyana* (Dewey sedge) and *Carex utriculata* (beaked sedge) (Table 36).
Elevation Range: 6640-8600 ft (1980-2600 m).

Site Geomorphology: This plant association generally occurs on moderately wide to wide floodplains in bands up to 115 feet (35 m) wide, that often extend well away from the channel edge (Manning and Padgett 1995, Kittel *et al.* 1994, Kittel *et al.* 1995). This association also occurs in small patches at higher elevations and around seeps and isolated springs on hillslopes away from the valley bottom.

Rosgen's Stream Classification: This association occurs along stream channels that are wide, meandering, and cobble-bottomed (C3).

Soil: Soils of this association are deep pockets of sandy loams with signs of mottling within the top 12 inches (30 cm).

Adjacent riparian vegetation: Adjacent riparian vegetation can include *Populus angustifolia* (narrowleaf cottonwood) woodlands or *Amelanchier alnifolia* (serviceberry) shrublands along narrow reaches with limited floodplains. *Salix monticola* (Rocky Mountain willow) shrublands can occur on wider floodplains.

Adjacent Upslope vegetation: At higher elevations, *Pseudotsuga menziesii* (Douglas-fir) and *Pinus ponderosa* (ponderosa pine) forests occur on adjacent hillslopes. At lower elevations, *Pinus edulis-Juniperus osteosperma* (pinyon pine-Utah juniper) woodlands are present.

Successional and Ecological Processes: The *Betula occidentalis* (river birch) plant association is a stable and long-lived climax riparian type. According to Manning and Padgett (1995), in Nevada, *Betula occidentalis* (river birch) communities with abundant *Carex lanuginosa* (woolly sedge) or *Carex deweyana* (Dewey sedge) in the undergrowth indicate undisturbed sites. Grazing pressure can convert the native sedges to non-native grasses, including *Agrostis stolonifera* (redtop) and *Poa pratensis* (Kentucky bluegrass). In Utah, the presence of scattered deciduous and coniferous trees in the canopy of *Betula occidentalis* (river birch) stands may indicate that the stand will become a tree-dominated type (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 with less aerated water than *Alnus incana* (thinleaf alder) (Kittel *personal observation).*

Because *Betula occidentalis* communities occupy low elevation, foothill habitats in Colorado, they are more threatened by development and stream impoundments than *Alnus incana* (thinleaf alder) or *Cornus sericea* (red-osier dogwood) riparian communities. Consequently, few undisturbed and unaltered stands exist today.

Management: With season-long grazing, non-native grasses, such as *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop), may begin to dominate the undergrowth of this plant association. Livestock grazing can also reduce stream bank stability and cause sloughing when soils are wet. *Betula occidentalis* (river birch) provides shade, organic matter, and overhanging banks for fish habitat (Hansen *et al.* 1988).

Betula occidentalis is an effective stream bank 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).

Related Types/Synonyms: Because pure stands of *Betula occidentalis* are relatively rare in Colorado, all stands, regardless of their undergrowth species composition have been lumped into one type. Colorado stands therefore closely aligned with several *Betula occidentalis* types described in the literature, including the *Betula occidentalis/*Mesic Graminoids type described by Manning and Padgett (1995) and Richard *et al*. (1996), the similar *Betula occidentalis/Poa pratensis* community type described by Padgett *et al.* (1989) and the similar *Betula occidentalis* community type described by Hansen *et al*. (1995). Stands that are dominated by non-native graminoid species are considered grazing induced.

Table 36. *Betula occidentalis* Plant Association Stands from the South Platte Watershed with Percent cover by Dominant Species.

Plot Number	96LS34	96AM36	96AM33	96AM34
Riparian Condition Rank	B	A	B	B
TREES				
Picea pungens - sapling		9		
Populus tremuloides - tree		9		
SHRUBS				
Betula occidentalis	40	50	27	30
Cornus sericea	3		53	5
Juniperus communis		9		
Ribes montegeum		2		
Rosa woodsii	7	1	18	6
Salix bebbiana		35		
Salix drummondiana		4		
Salix lucida ssp. *caudata*	5			
Salix monticola	34	38		
Salix planifolia	31			
FORBS				
Angelica ampla		9	1	2
Epilobium angustifolium		3		
Fragaria virginiana	2	2	1	
Maianthemum stellatum		1	18	28
Solidago canadensis	8			
Taraxacum officinale	1	2	1	1
Thermopsis rhombifolia var. *montana*				1
GRAMINOIDES				
Carex aquatilis	7			
Carex utriculata	10	3		2
Carex sp.	6	1	3	9
Glyceria grandis	12			
Glyceria striata	9			
Juncus balticus		2		15
Poa compressa		4		1
Poa pratensis	41	1	3	25

Corylus cornuta Alliance

Hazelnut (*Corylus cornuta*) Plant Association
CNHP Rank: G3/S1
4 Quantitative Plots:
Arkansas River Basin--1 plot (95AM24)
South Platte River Basin--3 plots (96GK28, 96GK05, 96LS17)

South Platte River Basin Reference Reaches: An excellent, near pristine occurrence of this type can be seen on Sheep Creek, 1 mile above its confluence with Buckhorn Creek, Arapaho-Roosevelt National Forest, Larimer County, T7N, T71W, Sec 20 and 21.

General Description and Comments: The *Corylus cornuta* plant association is a thicket of shrubby growth found in narrow, cool foothill canyons along the Colorado Front Range. Stands usually have an overstory canopy of *Pseudotsuga menziesii* (Douglas-fir) or *Populus tremuloides* (quaking aspen). *Corylus cornuta* and other shrub species have a total shrub cover of 80-98%, while the total overstory tree cover ranges form 40-65%. *Corylus cornuta* (hazelnut) is a relict eastern species in Colorado. It commonly occurs in eastern and northwestern U.S. and in patches across the Great Plains states and lower Canada (Weber 1990, Gleason and Conquest 1963).

Related Types/Synonyms: Three associations dominated or co-dominated by *Corylus cornuta* are considered identical to the one described here. These are: the *Corylus cornuta/Viola canadensis* (hazelnut/violet) plant association (Cooper and Cottrell 1990), the *Pseudotsuga menziesii/Corylus cornuta* plant association (Kittel 1994), and the *Populus tremuloides/Corylus cornuta* plant association (Kittel *et al.* 1996 and Alexander 1988). Other, similar associations include the *Betula papyrifera/Corylus cornuta* (paper birch/hazelnut) plant association found in southwestern North Dakota (Johnston 1987) and the *Acer macrophyllum-Pseudotsuga menziesii/Corylus cornuta* (maple-Douglas-fir/hazelnut) plant association described from Oregon and Washington (Bourgeron and Engelking 1994). These types have associated species that do not occur in Colorado stands.

Regional Distribution: This plant association and similar associations have been found in Oregon, Washington, eastern Wyoming, North Dakota and Colorado (Bourgeron and Engelking 1994, Alexander 1988, Colorado Natural Heritage Program 1996).

Distribution in Colorado: This association occurs only in narrow canyons of the Colorado Front Range (Cooper and Cottrell 1990, Kittel 1994, Kittel *et al.* 1996).

Vegetation: This plant association occurs in small stands with a canopy cover of 10-45% *Pseudotsuga menziesii* (Douglas-fir), *Populus tremuloides* (quaking aspen), or *Picea pungens* (Colorado blue spruce). One atypical stand had 24% *Populus deltoides* (Plains cottonwood) at 7500 ft (2300 m)! The dense shrub layer is dominated by *Corylus cornuta* (hazelnut) with 65-90% cover. It can also include 0-25% cover each of *Betula occidentalis* (river birch) and

Prunus americana (American plum), 0-20% *Acer glabrum* (Rocky Mountain maple), 0-15% *Alnus incana* (thinleaf alder), 0-10% *Physocarpus monogynus* (ninebark), 0-5% cover each of *Cornus sericea* (red-osier dogwood) and *Rubus idaeus* (red raspberry), and 0-2% *Prunus virginiana* (chokecherry) (Table 37). Few herbaceous species occur in the undergrowth due to the dense shrub cover, thick coniferous litter, and rocky soils.

Elevation Range: 6500-7500 ft (2000-2300 m).

Site Geomorphology: This association occurs on steep, well defined stream banks in deep narrow (<50 m), cool foothill canyons and ravines.

Rosgen's Stream Classification: This association occurs on steep (5% gradient) and rocky stream channels with little sinuosity (A2, B2).

Soil: The soils of this association are moist, dark-colored fine sandy clay loams and sandy clays with a high organic matter content (up to 40% in one profile), often covered in thick litter or moss, becoming skeletal at 40-60 cm depth.

Adjacent Riparian Vegetation: Stands of *Pseudotsuga menziesii* (Douglas-fir) or *Populus tremuloides* (quaking aspen) with various shrub understories occur along adjacent stream banks.

Adjacent Upland Vegetation: South-facing slopes have stands of *Pinus ponderosa* (ponderosa pine), *Quercus gambelii* (Gambel oak), or *Cercocarpos montanus* (mountain mahogany). North facing slopes usually have stands of *Pseudotsuga menziesii* (Douglas-fir), *Populus tremuloides* (quaking aspen) or *Pinus contorta* (lodgepole pine).

Successional and Ecological Processes: *Corylus cornuta* is a eastern relict species in Colorado (Weber 1990). It grows in large thickets in the eastern and northwestern U.S. (Gleason and Conquest 1963). In Colorado, it is limited to riparian areas in deep, cool canyons where there is relatively more moisture and high humidity. Stands appear to be long-lived and stable. Thickets will increase in size under the right growing condition with little disturbance. Stands dominated by *Pseudotsuga menziesii* (Douglas-fir) are also late-seral. Pseudotsuga menziesii is intolerant of overly wet soils. In riparian areas, these trees may be restricted to moist toe slopes, benches, and bottom lands adjacent to streams and rivers (Hansen *et al.* 1988). Nearly all *Pseudotsuga menziesii* riparian communities observed occur adjacent to north-facing hill slopes with *Pseudotsuga menziesii* communities as well. In Montana, this tree species is considered to be the climax species when it is successfully reproducing (Hansen *et al.* 1995).

Stands dominated by *Populus tremuloides* may be maintained by infrequent fire or flooding as *Populus tremuloides* can resprout after disturbance. *Corylus cornuta* response to fire, flooding and browsing is unknown. In the northwest U.S. *Corylus cornuta* it is widespread at lower elevations on well drained soils (Hitchcock and Cronquist 1973). In the Great Plains area (North Dakota, southeast South Dakota, Minnesota) it occurs in upland forests and thickets (Great

Plains Flora Association 1986). In Wyoming, is occurs in woods and thickets in the Black Hills (Dorn 1992).

Management: *Corylus cornuta* can form large, impenetrable thickets that restrict grazing to the out edges. Information on *Corylus* response to fire, flooding, cutting, and grazing is unavailable. *Pseudotsuga menziesii* (Douglas-fir) regeneration benefits from fire which creates favorable seed beds and eliminates competition. Mature trees are relatively fire resistant, but seedlings and saplings are vulnerable to surface fires. With disturbance such as livestock grazing, the shrub understory may shift to more xeric species including *Symphoricarpos* spp. (snowberry) and *Prunus virginiana* (chokecherry). With severe disturbance, all shrubs may be eliminated and the understory may become dominated by introduced herbaceous species such as *Poa pratensis* (Kentucky bluegrass) (Hansen *et al.* 1995).

Table 37. *Corylus cornuta* Plant Association Stands with Percent Cover of Dominant Species.

Plot Number	96GK28	96GK05	96LS17
Riparian Condition Rank	C	A	B
TREES			
Total Tree Cover	49	44	64
Juniperus scopulorum	10		1
Picea pungens		32	10
Pinus contorta	9		
Pinus ponderosa			10
Populus deltoides spp. *monilifera*	24		
Populus tremuloides		21	44
Pseudotsuga menziesii	16		6
SHRUBS			
Total Shrub Cover	81	98	98
Acer glabrum	26		3
Alnus incana	3	37	12
Betula occidentalis	11	4	
Cornus sericea	3	14	5
Corylus cornuta	17	53	85
Jamesia americana			2
Lonicera involucrata	4		
Mahonia repens			1
Prunus virginiana	3	11	10
Rosa woodsii	11	4	4
Salix bebbiana	19		
FORBS			
Aralia nudacaulis	17	8	
Arnica cordifolia			10
Maianthemum stellatum	2	1	3
Rudbeckia laciniata var. *ampla*	5	8	
GRAMINOIDES			
Calamagrostis canadensis	3	2	2
Carex sp.		3	7
Poa pratensis	9		
Equisetum arvense			1

Cratageaus macracantha Alliance

Red Hawthorne (*Cratageaus macracantha* var. *occidentalis*) Plant Association
Tentative type
CNHP Rank: GUQ/SUQ
1 Quantitative Plot:
South Platte River Basin--1 plot (96LS38).

South Platte River Basin Reference Reaches: The *Crataegus macracantha* var. *occidentalis* plant association was found at only one location within the study area, along Coal Creek on Boulder County Open Space, Boulder County, T1S, R70W, Sec 24.

General Description and Comments: The *Cratageaus macracantha* var. *occidentalis* plant association is a dense narrow deciduous shrubland, forming small patches within the riparian mosaic.

Regional Distribution: This association is known only from Colorado.

Distribution in Colorado: This association is only known from Boulder County, Colorado.

Vegetation: *Crataegus macracantha* var. *occidentalis* is the dominate shrub with 55% cover. Associated shrubs include *Prunus americanus* (13%) *Salix exigua* (4%) and *Rosa woodsii* (4%). The herbaceous undergrowth is thick along the moist stream bank with *Eleocharis palustris* (11%) and introduced noxious weeds such as *Agrostis stolonifera* (12%), *Leersia orysoides* (17%) and *Centuera diffusa* (21%) (Table 38).

Elevation Range: 5560 ft (1700 m).

Site Geomorphology: This association grows on steep banks of an entrenched channel, about 1-2 meters above the stream water level.

Rosgen's Stream Classification: The stream channel is an entrenched, box-shaped ravine. Annual flood levels fill the entire bottom of the entrenched area (F3).

Soils: Soils of this association are deep (91 cm) loam to sandy clay loam with mottles present at 28 cm and again at 79 cm, over coarse alluvial material.

Adjacent Riparian Vegetation: Adjacent riparian vegetation includes mixed *Populus deltoides* and *Populus angustifolia* woodlands and *Salix exigua* and *Salix irrorata* shrublands.

Adjacent Upland Vegetation: The one site where this association occurs is surrounded by *Bromus inermis* (smooth brome) irrigated hay meadows.

Succession and other Ecological processes: The *Crataegus macracantha* var. *occidentals* plant association appears to be a stable, late-seral type. It occurs above the annual flood level of the stream. Little is known about the establishment requirements or successional pathways of this association.

Management: *Crataegus* spp. berries are highly favored by avian wildlife species. The thick growth of *Crataegus* thickets prohibit grazing by livestock. The strong root structure of *Crataegus* spp. is important for stream bank stability.

Related Types: The taxonomy of *Crataegus* has not been completely resolved. In Colorado literature, *Crataegus macracantha* var. *occidentalis* is the accepted name (Weber and Wittmann 1992). In the Great Plains Flora (Great Plains Flora Association 1986), the accepted name is *Crataegus succulenta* var. *occidentalis*, and in Wyoming it is called *C. columbiana* var. *occidentalis* (Dorn 1992). According to the Utah flora (Welsh *et al.* 1987) and Kartez (1994), all of the above mentioned names are included in *C. succulenta*. Further, Weber and Whitman (1992) state that *C. succulenta* is a cultivated shrub and occurs only as an escapee in Colorado, and that *C. macracantha* var. *occidentalis* is native. Welsh *et al.* (1987) state that *C. succulenta* is indigenous in riparian habitats, and includes Colorado populations in its distribution range of the species. For these reasons we reject the Kartez (1994) treatment and accept Weber and Whitman (1992) and Welsh (1987) treatment, keeping *Crataegus macranthera* var. *occidentalis* as the indigenous species of Colorado. The *Crataegus macracantha* var. *occidentalis* plant association has not been previously described in the literature.

Table 38. *Crataegus macracantha* var. *occidentalis* Plant Association stand from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96LS38
Riparian Condition Rank	C
TREES	
Populus deltoides spp. *monilifera*-tree	7
SHRUBS	
Crataegus macracantha var. *occidentalis*	55
Prunus americana	13
Salix exigua	4
Salix monticola	1
Clematis ligusticifolia	2
FORBS	
Centaurea diffusa	21
Epilobium ciliatum	1
GRAMIODES	
Agropyron dasystachya	2
Agrostis stolonifera	12
Bromopsis inermis	6
Dactylis glomerata	5
Eleocharis palustris	11
Leersia oryzoides	17

Pentaphylloides floribunda Alliance

Shrubby cinquefoil/tufted hairgrass (*Pentaphylloides floribunda/Deschampsia cespitosa*) Plant Association
CNHP Rank: G4/S3S4
2 Quantitative Plots:
Routt National Forest--1 plot (241)
South Platte River Basin --1 plot (96AM48)
and three qualitative records from the South Park Fen Inventory (Colorado Natural Heritage Program 1996).

South Platte River Basin Reference Reaches: No reference reaches were located within the South Platte drainage. A small but excellent condition example of this type with other high quality riparian associations can be seen on Rock Creek, Routt National Forest, Routt County, T1N, R83W, Sec 23 and 26.

General Description and Comments: This is an open, low-stature shrubland (1-3 ft, 0.3-1 m) with widely spaced shrubs and a predominantly grassy undergrowth. It occurs on broad alluvial bottoms and elevated stream terraces. Colorado stands appear to impacted by historic or current heavy grazing. *Deschampsia cespitosa* and other native graminoids in the understory are highly palatable to livestock and wildlife. With heavy grazing pressure, the native graminoids are reduced and less palatable species such as *Juncus balticus* (arctic rush) and *Pentaphylloides floribunda* (shrubby cinquefoil) increase in abundance (Stubbendieck *et al*. 1982).

Regional Distribution: This plant association has been found in Utah (Padgett *et al*. 1989), southeastern Idaho, western Wyoming (Youngblood *et al*. 1985, Johnston 1987) and Montana (Hansen *et al.* 1995).

Distribution in Colorado: This plant association occurs in South Park within the South Platte watershed and on Routt National Forest (Sanderson and March 1996, Kettler and McMullen 1996).

Vegetation: *Pentaphylloides floribunda* (shrubby cinquefoil) dominates the overstory of this plant association with 30% cover. Increaser species, such as *Juncus balticus* and *Poa pratensis* are abundant in degraded stands. Presence of other native graminoids indicated stand recovery and can include 30% cover of *Poa secunda* (Sandberg bluegrass), 20% cover of *Festuca rubra* (red fescue), and 10% cover of *Deschampsia cespitosa* (tufted hairgrass). Forbs may include *Rumex aquaticus* (western dock) and *Fragaria virginiana* (Virginia strawberry), also indicating past disturbance. In stands adjacent to wetland fens in South Park, *Salix brachycarpa* (barren ground willow) is a co-dominant in the shrub layer and *Kobresia myosuroides* (kobresia) is present in the undergrowth. Degraded stands can have up to 50% bare ground exposed. Table 39 illustrates the composition of one stand in the South Platte watershed.
Elevation Range: 8400-9900 ft (2500-3000 m).

Site Geomorphology: This association occurs on elevated stream terraces, narrow floodplains and at the drier edges of isolated wetlands and rich fens.

Rosgen's Stream Classification: This association can occur on a variety of stream channel types. It appears to most common on moderate gradient, meandering streams (C4).

Soils: The soils are sandy loams and silty clay loams over sand and gravel layers, overall fairly shallow (30-45 cm), become more and more skeletal with depth. One profile had mottles at 6 cm depth.

Adjacent Riparian Vegetation: *Pentaphylloides floribunda* can be the only shrubland along a stream reach. *Betula glandulosa* (bog birch shrubland) communities are found adjacent isolated wetland and boggy riparian areas.

Adjacent Upland Vegetation: Adjacent hill slopes are dominated by *Artemisia* (sagebrush) shrublands, arid grasslands, and stands of *Pinus ponderosa* (ponderosa pine).

Succession and Ecological Processes: This plant association is rarely in a late-seral or climax stage due to heavy grazing pressure, indicated by abundance of *Poa pratensis* (Kentucky bluegrass), *Juncus balticus* (Baltic rush), and *Taraxacum officinale* (dandelion) (Padgett *et al*. 1989). Extended grazing may cause this plant association to degrade further to a *Pentaphylloides floribunda*/*Poa pratensis* (shrubby cinquefoil/ Kentucky bluegrass) plant association. Stands in late-seral or climax stages in Montana have 10-60% *Pentaphylloides floribunda* (shrubby cinquefoil) and 20-80% *Deschampsia cespitosa* (tufted hairgrass), and no more than 20% each of *Juncus balticus* (Baltic rush) and *Poa pratensis* (Kentucky bluegrass) (Hansen *et al.* 1995). Undisturbed stands with abundant *Deschampsia cespitosa* have not been located in Colorado.

Management: In Colorado, stands of *Pentaphylloides floribunda/Deschampsia cespitosa* (shrubby cinquefoil/tufted hairgrass) plant association appeared to be degraded by grazing. *Pentaphylloides floribunda* is not very palatable to livestock and wildlife, and *Deschampsia cespitosa* is highly palatable and can be heavily grazed. With heavy grazing pressure, *Pentaphylloides floribunda* and the less palatable *Juncus balticus* increase in cover while the highly palatable *Deschampsia cespitosa* (tufted hairgrass) decreases in cover (Hansen *et al.* 1995).

Grazing should be on a rest/rotation basis and delayed until soils are dry to maintain vigor of the plants in this association and to prevent damage to soils (Hansen *et al.* 1988).

Pentaphylloides floribunda (shrubby cinquefoil) 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* (tufted hairgrass) 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* (tufted hairgrass) (Hansen *et al.* 1995).

Pentaphylloides floribunda (shrubby cinquefoil) is an effective streambank stabilizer. It grows fairly quickly and provides soil stability (Hansen *et al.* 1988) and has been used for erosion control and beautification projects along highways (Stubbendieck *et al*. 1982). *Deschampsia cespitosa* (tufted hairgrass) has a weak fibrous root system and is not very valuable as a streambank stabilizer (Youngblood *et al.* 1985).

Related Types/Synonyms: This plant association is identical to the *Potentilla fructicosa/ Deschampsia cespitosa* community types described by Padgett *et al*. (1989), Youngblood *et al*. (1985), Johnston (1987), and Hansen *et al*. (1995). Occurrences of the *Pentaphylloides floribunda/Salix brachycarpa/Kobresia myosuroides* (shrubby cinquefoil/barrenground willow/kobresia)described from Park County, Colorado, are considered part of the *Pentaphylloides floribunda/Deschampsia cespitosa* plant association that have intergraded with rich fens, peatlands, and wetlands (Sanderson and March 1996). *Potentilla fructicosa* is a synonym of *Pentaphylloides floribunda* (Kartesz 1994).

Table 39. *Pentaphylloides floribunda/Juncus balticus* Plant Association Stand from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM48
Riparian Condition Rank	D
SHRUBS	
Pentaphylloides floribunda	27
Salix eriocephala ssp. *ligulifolia*	1
FORBS	
Aster sp.	2
Potentilla sp.	8
Ranunculus sp.	1
Taraxacum officinale	2
GRAMINOIDES	
Carex cf. *disperma*	19
Deschampsia cespitosa	1
Eleocharis sp.	2
Juncus balticus	37
Poa pratensis	6

Snowberry *(Symphoricarpos occidentalis*) Plant Association
CNHP Rank: G4G5/S3
5 Quantitative Plots:
Arkansas River Basin--2 plots (95GK67, 95GK73)
South Platte River Basin**--**3 plots (95GK05, 95GK45, 95GK48).

South Platte River Basin Reference Reaches: No reference reaches were located in the study area, however a good example of this type can be seen along Kettle Creek, just north of the sports club firing range, U.S. Air Force Academy grounds, T12S R66W, Sec 21.

General Description and Comments: The *Symphoricarpos occidentalis* plant association is a minor type occurring in small draws and on toe slopes within foothill canyons of the Colorado Front Range. Along the S. Platte River floodplain it forms large patchy stands on higher terraces and islands. It is easily recognized as a low to medium high (0.5-1 m) shrub community forming large patches with few other shrubs present.

Regional Distribution: This type is known from Montana, Wyoming, and eastern Colorado. (Hansen *et al.* 1988, Jones and Walford 1995, Akashi 1988, Colorado Natural Heritage Program 1996).

Distribution in Colorado: This association is only known from east of the Continental Divide. It occurs in rocky draws of the Pawnee National Grassland, on terraces and floodplains of the Cache la Poudre and S. Platte Rivers, and on toe slopes and stream benches of eastern foothills streams (Christy 1973, Kittel 1994). On the western slope, *S. rotundifolius* is a very common non-riparian association (Johnson 1987).

Vegetation: *Symphoricarpos occidentalis* forms a moderately dense shrub layer about 1.5 feet tall, *Ribes aureum* (0-3%) and *Salix exigua* (0-3%) are present in small amounts. *Toxicodendron rydbergii* (0-96%) was thick in one plot growing as a very dense vine underneath and around the *Symphoricarpos* stems (Table 40).

Elevation: 1,200-2,000 m (3,940-6,590 ft.)

Site Characteristics: This association occurs on higher terraces and open rises of the broad floodplain of the S. Platte River. Along smaller tributaries, it occurs on draws and along rocky ledges. It can occur in narrow bands or as widely spaced individuals, but most often it is found in large, thick patches.

Rosgen's Channel Type: This association occurs along large braided channels (D5), and small narrow steep tributaries (B3, G5).

Soil: Soil textures are silty clay loams and silty loams with moderately deep top layers (3-5 feet).

Adjacent Riparian Vegetation: This plant association grades into stands of *Populus deltoides/Symphoricarpos occidentalis* on the broad, open floodplains of the S. Platte River. *Salix exigua/*Mesic Graminoids occurs in adjacent swales. It can be the only community in narrow gulches and small draws, or can occur with *Alnus incana* and *Populus angustifolia* stands on perennial streams.

Adjacent Upland Vegetation: Agricultural fields, range land, and *Bouteloua gracilis* grasslands occur on the upland where this plant association is found. On foothill streams, *Pinus ponderosa* and *Quercus gambelii* occur on surrounding hill slopes.

Succession and Ecological Processes: It is apparent that this plant association is one of the last successional stages of the pioneering floodplain forest of the S. Platte River. Older trees die and fall over, leaving an open shrubland of *Symphoricarpos* (*personal observation,* see also Christy 1973). This association occupies the driest sites within the riparian area and may be transitional between riverine and upland habitats.

Management: Along smaller tributaries, this type was seen growing along fences with a dramatic fence-line contrast, where *Symphoricarpos* is widely spaced and nearly hidden by the *Agropyron intermedia* on the grazed side, and thick stands of *Symphoricarpos* mixed with *Prunus virginiana* grow on the ungrazed side of the fence. In Wyoming *Symphoricarpos* is considered an indication of a lack of grazing (Jones and Walford 1995), while in Montana it is thought to be a grazing induced type (Hansen *et al.* 1988).

Related Types: A similar *Symphoricarpos occidentalis* dominance has been described by Jones and Walford (1995), however their stands contain significant amounts of *Fraxinus pennsylvanica* and *Acer negundo* saplings and seedlings while the Colorado stands do not. In Wyoming, Akashi (1988) describes a *Rhus trilobata-Symphoricarpos occidentalis* shrubland, however most of the associated shrub species do not occur within the Colorado stands. Kittel (1994) reports a *Symphoricarpos alba*/Mesic Graminoids community type from the Cache la Poudre River.

Table 40. *Symphoricarpos occidentalis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	95GK05	95GK45	95GK48
Riparian Condition Rank	C	C	C
TREES			
Populus deltoides ssp. *monilifera*--seedlings		8	
SHRUBS			
Ribes aureum			3
Salix exigua		3	1
Symphoricarpos occidentalis	30	42	85
Toxicodendron rydbergii			96
FORBS			
Brassicaceae spp.	1		32
Cirsium arvense			3
Cirsium sp.			4
Descurainia sophia	13		
Glycyrrhiza lepidota			3
GRAMINOIDES			
Agropyron cristatum	16		
Bromus tectorum	9		
Pascopyrum smithii	27		
Poa pratensis	29	6	19

Prunus virginiana Alliance

Chokecherry (*Prunus virginiana*) Plant Association
CNHP Rank: G4Q/S3
2 Quantitative Plots:
South Platte River Basin--2 plots (95LS03, 95GK04)

South Platte River Basin Reference Reaches: No references were located in the study area, but a good example can be seen in Dave's Draw on the Pawnee National Grassland, T10N, R60W, Sec 24.

General Description and Comments: This is a low to medium shrubland that is narrow and confined to gullies and arroyos and narrow stream benches. The vegetation is very thick and almost impossible to walk though.

Regional Distribution: This association is reported to occur throughout Montana, Wyoming and Colorado (Hansen *et al.* 1995, Jones and Walford 1995, Colorado Natural Heritage Program 1996). Similar types have also been reported from Nevada (Manning and Padgett 1995)

Distribution in Colorado: The *Prunus virginiana* association is a minor type found only in dry gullies and draws on the eastern plains, although similar types have been reported from the western slope (Kittel *et al.* 1994).

Vegetation: This association is characterized by a thick layer of shrubs about 1.5-4 feet tall, consisting of *Prunus virginiana* (chokecherry) (20-41%) and *Symphoricarpos occidentalis* (snowberry) (20-40%). Other shrub species present include *Ribes aureum* (golden current) (1-20%) and *Toxicodendron rydbergii* (poison ivy) (10%). A few scattered *Juniperus scopulorum* Rocky Mountain juniper) also occur within the draw. The undergrowth is dominated by *Poa pratensis* (Kentucky bluegrass) (20-40%) and *Bromus tectorum* (Cheat grass) (3-40%). Forbs are scattered and weedy (Table 41).

Elevation: 1,630-1,650 m (5,370-5,400 ft).

Site Geomorphology: This plant association occurs in entrenched washes with rock outcrops providing a strong north-south aspect.

Rosgen's Channel Type: Along the Front Range, this association appears to occur only in steep gullies and arroyos (G5).

Soil: Soils are shallow to deep alluvial deposits directly on bedrock. Textures are mostly silty loams, becoming skeletal at depth.

Adjacent Riparian Vegetation: Scattered patches of *Juniperus scopulorum* (Rocky Mountain juniper) and *Rhus trilobata* (squawbush) occur in protected pockets along the draw.

Adjacent Upland Vegetation: Adjacent uplands have *Stipa comata-Bouteloua gracilis* (needle-and-thread and blue grama) grasslands.

Successional and Ecological Processes: This association appears to be limited to small protected pockets within incised gullies and washes on the plains. These shrub species require more moisture than the surrounding uplands and occur in areas where runoff can quickly reach their roots, mainly at the bottom of rock outcrops and similar sites within the riparian zone. Manning and Padgett (1995) state that this type represents succession away from riparian conditions, and Hansen et al. (1995) suggest it may be a grazing induced disclimax from the *Fraxinus/Prunus virginiana* community. Colorado stands appear to be facultatively riparian, and probably represent site potential in ungrazed conditions.

Management: Thick stands provide little forage production for livestock (Hansen *et al.* 1995). With heavy browsing *Rosa woodsii* will increase in abundance (Manning and Padgett 1995).

Related Types/Synonyms: Hansen *et al.* (1995) describe a *Prunus virginiana* community type that is identical in species composition, environmental setting, occurrence location, and size to Colorado stands. Manning and Padgett (1995) describe a similar *Prunus virginiana/Rosa woodsii* community type, however no *Symphoricarpos* appears in their stands. Jones and Walford (1995) report a *Prunus virginiana* dominance type that is wide spread throughout Wyoming and closely resembles the type described from Montana by Hansen *et al.* (1991, 1995). A similar type is reported from the Colorado River basin, the *Prunus virginiana* plant association (Kittel *et al.* 1994), but it has wetter species such as *Cornus sericea* and *Pseudotsuga menziesii*, making it quite different from the *Prunus virginiana* stands described here from the eastern plains.

Table 41. *Prunus virginiana* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot No.	95GK03	95LS03
Riparian Condition Rank	B	B
TREES		
Juniperus scopulorum --mature trees	12	1
SHRUBS		
Prunus virginiana var. *melanocarpa*	20	42
Rhus trilobata var. *trilobata*	34	
Ribes aureum	1	20
Ribes cereum	2	1
Rosa woodsii	1	
Symphoricarpos occidentalis	20	40
Toxicodendron rydbergii	3	10
FORBS		
Artemisia ludoviciana		3
Convolvulus arvensis	1	
Descurainia sophia	1	1
Glycyrrhiza lepidota	3	3
Maianthemum stellatum	30	20
Melilotus officinalis	1	
Thlaspi arvense		3
Vicia americana	1	
GRAMINOIDES		
Bromus tectorum	3	40
Eleocharis palustris	1	
Poa pratensis	20	1
Stipa comata	3	

Salix bebbiana Alliance

Bebb willow (*Salix bebbiana*) Plant Association
CNHP Rank: G3?/S2
4 Quantitative Plots:
San Juan National Forest--2 plots (115, 216)
South Platte River Basin--2 plots (96AM30, 96AM83)

South Platte River Basin References Reaches: A large, relatively undisturbed stand in very good condition can be seen on Watson Park Creek, Pike-San Isabel National Forest, Douglas County, T9S, R69W, Sec 14 and 23.

General Description and Comments: This is a tall (5-15 ft, 1.5-3 m), deciduous shrubland of closed canopy willows. It forms small thickets in large riparian mosaics or a continuous long ticket in narrow tributary canyons.

Regional Distribution: The *Salix bebbiana* plant association occurs as a minor type in the canyonlands of southwestern Utah (Padgett *et al.* 1989) and at mid- to low-elevations in southwestern Montana (Hansen *et al.* 1988) and Colorado (Colorado Natural Heritage Program 1996). Similar types occur in eastern Wyoming (Girard *et al.* 1995)

Distribution in Colorado: This association occurs in canyon country at lower elevations in the San Juan National Forest (Richard *et al.* 1996) and in the foothill canyons of the South Platte River Basin.

Vegetation: *Salix bebbiana* (Bebb willow) commonly forms a dense overstory with 30-50% cover. Other shrubs include 0-25% cover of *Alnus incana* (thinleaf alder) and 0-10% cover each of *Cornus sericea* (red-osier dogwood), *Salix eriocephala* (yellow willow) or *Acer glabrum* (Rocky Mountain maple). The herbaceous undergrowth is sparse to moderately dense with forbs growing on raised hummocks and ridges beneath the willow canopy. Forb species include 0-5% 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). Mesic graminoid species dominate wetter swales and low-lying areas between the shrubs. Graminoid species include 0-10% cover of *Carex microptera* (small-wing sedge) and 0-5% cover each of *Carex lanuginosa* (woolly sedge), *Festuca thurberi* (Thurber fescue) and *Juncus tracyi* (swordleaf rush). Non-native forb and graminoid species include 0-15% cover of *Poa pratensis* (Kentucky bluegrass), 0-10% cover each of *Agrostis gigantea* (redtop) and *Linaria* spp. (butter-and-eggs), and 0-5% cover of *Taraxacum officinale* (dandelion) (Table 42).

Elevation Range: 7000-8000 ft (2200-2400 m).

Site Geomorphology: This plant association occurs on briefly flooded, low-gradient stream floodplains, or along narrow alluvial terraces of tributary canyons. It can also occur on broad, seep-fed meadows.

Rosgen's Stream Classification: This association occurs along steep, narrow streams (A4) and larger, less steep moderately sinuous channels (B3, B6).

Soil: Soils of this association are stratified with layers of sandy loams and clay loams with mottling near the surface. Soils can also be deep (>50 cm), dark-colored silty clay loams with high organic content and mottling, or shallow (25-50 cm), becoming skeletal at 25 cm.

Adjacent riparian vegetation: *Populus angustifolia* (narrowleaf cottonwood) 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* (ponderosa pine) forests and *Populus tremuloides* (quaking aspen) woodlands occur on adjacent hillsides.

Successional and Ecological Processes: In Utah, the *Salix bebbiana* (Bebb willow) plant association is a considered a climax, stable association. However, adjacent graminoid meadows are frequently subject to livestock grazing which inhibits the establishment of *Salix bebbiana* seedlings. Continued livestock use may lead to dominance by non-native herbaceous species including *Poa pratensis* (Kentucky bluegrass) (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* are not frequently encountered. It appears to be very sensitive to grazing, and will form the classic “mushroom” shape if repeatedly browsed each season. It rarely forms large willow carrs and is limited to small patches within larger riparian mosaics, or to protected, narrow canyon bottoms that preclude livestock grazing.

Management: *Salix bebbiana* (Bebb willow) is highly palatable to livestock and wildlife, but 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 (Hansen *et al*. 1995). Late-summer browsing will reduce willow density and vigor as cattle preferentially browse more nutritious willows over sedges and grasses in late summer (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 within 10-15 days following planting (Hansen *et al*. 1995).

Related Types/Synonyms: Identical *Salix bebbiana* types have been described by Padgett *et al.* (1989) as *Salix bebbiana*/mesic graminoid and by Hansen *et al.* (1995) as a *Salix bebbiana* community type. Two similar *Salix bebbiana* types described by Girard *et al*. (1995) have significant undergrowth cover of *Carex rostrata* (beaked sedge) or *Poa pratensis* (Kentucky bluegrass).

Table 42. *Salix bebbiana* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM30	96AM83
Riparian Condition Rank	B	A
SHRUBS		
Acer glabrum		9
Alnus incana		8
Lonicera involucrata		2
Pentaphylloides floribunda	36	
Rosa woodsii		3
Salix bebbiana	31	48
Salix eriocephala ssp. *ligulifolia*	9	
Salix exigua	13	
Salix irrorata		13
Salix lucida ssp. *lasiandra*		31
FORBS		
Anemone canadensis	12	
Angelica ampla	5	
Aster sp.	11	
Epilobium angustifolium		4
Erigeron eximius	13	
Erigeron sp.		5
Fragaria virginiana	1	2
Heracleum sphondylium		5
Rudbeckia laciniata var. *ampla*		6
Taraxacum officinale	1	1
Thermopsis rhombifolia var. *montana*	11	
GRAMINOIDES		
Agrostis gigantea		2
Calamagrostis canadensis		1
Juncus balticus	19	
Poa compressa	1	
Poa palustris		6
Poa pratensis	18	
Equisetum pratense		3

Yellow willow (*Salix eriocephala* var. *ligulifolia*) Plant Association
CNHP Rank: G2G3/S2S3
11 Quantitative Plots:
San Juan National Forest--2 plots (22, 37)
Arkansas River Basin--1 plot (95AM34)
South Platte River Basin--8 plots (95LS07, 95GK10, 95GK11, 95GK15, 95GK19, 96AM50, 96AM63, 96AM91)

South Platte River Basin Reference Reaches: A good montane stand can be seen on BLM land, along East Fork Arkansas River, T8S, R79 W, Sec 33. An excellent montane example occurs on Elkhorn Creek, Larimer County (specific location withheld to respect landowner privacy).

General Description and Comments: The *Salix eriocephala* var. *ligulifolia* plant association is a medium to tall (5-15 ft, 1.5-3 m) willow shrubland occurring in saturated areas in the foothills, where it is often mixed with *Salix exigua* and *S. lucida*. At higher elevations it forms relatively broad areas mixed with *S. monticola* and *S. drummondiana*. *Salix eriocephala* var. *ligulifolia* is a new name for specimens identified as *Salix lutea* and *Salix ligulifolia* in Colorado. Dorn (1995 and his review and annotation of *Salix* specimens at the University of Colorado herbarium) states that the species *S. lutea* (as used in Colorado literature) is actually *S. eriocephala* var. *watsonii*, which is known only from the extreme northwestern corner of the state, and that *S. eriocephala* var. *ligulifolia* should be applied to most of the specimens identified as *S. lutea* and *S. ligulifolia* in Colorado.

Regional Distribution: Similar community types are found in Montana (Hansen *et al*. 1995), eastern Wyoming, western Idaho (Youngblood *et al.* 1985) and Nevada (Manning and Padgett 1995). However, these types are dominated by different subspecies of *Salix eriocephala*.

Distribution in Colorado: This association occurs along the Colorado Front Range in the South Platte and Arkansas River Basins.

Vegetation: In the foothills, this plant association is predominantly tall stands of 20-70% cover of *Salix eriocephala* var. *ligulifolia* (yellow willow) mixed with 10-60% cover of *Salix lucida* ssp. *caudata* (Pacific willow) and 0-25% cover of *Salix exigua* (coyote willow). The graminoid undergrowth is lush, dominated by 5-45% cover of *Carex lanuginosa* (woolly sedge), 10-35% cover each of *Carex nebrascensis* (Nebraska sedge) and *Eleocharis palustris* (spike rush). Forb cover is insignificant (Table 43).

Higher elevation stands of this association have a canopy dominated by 30-50% cover of *Salix eriocephala* var. *ligulifolia* mixed with 0-40% cover each of *Salix monticola* (serviceberry willow) and *Salix lucida* ssp. *lasiandra* (Pacific willow), and 0-10-% cover each of *Salix wolfii* (wolf willow), *Salix planifolia* (planeleaf willow) and *Alnus incana* (thinleaf alder). Several other willows may be present with less than 5% cover, including *Salix bebbiana* (Bebb willow), *Salix drummondiana* (blue willow), and *Salix geyeriana* (Geyer willow). 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.

Elevation Range: 6400-10200 ft (2000-3000 m).

Site Geomorphology: In the foothills, 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. At higher elevations, it can be associated with beaver activity.

Rosgen's Stream Classification: This association occurs on streams that are broad and meandering with sandy beds (C5, D5). At higher elevations, this association occurs in moderately wide valleys along braided channels below active beaver ponds and dams or along gullies (D, G3). It also occurs in moderately wide valleys along terraces and stream channels of moderately sinuous to meandering reaches (B4 and C3).

Soil: Soils of foothill sites are shallow sandy clay loams and sands over unconsolidated alluvial material with thin buried layers of organic material. Soils of higher elevation stands are saturated (water table within 36 cm of surface) sandy loams and clay loams with a high organic matter content in the upper layers.

Adjacent Riparian Vegetation: In the foothills, 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). At higher elevations, this association is often adjacent to and intermixes with *Carex aquatilis* (aquatic sedge) or *Carex utriculata* (beaked sedge) meadows. *Populus angustifolia-Amelanchier alnifolia* (narrowleaf cottonwood-serviceberry) woodlands also occur nearby.

Adjacent Upland Vegetation: In the foothills, 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. Higher elevation stands have *Artemisia* (sagebrush) species shrublands, *Pinus ponderosa* stands, and mixed conifer-*Populus tremuloides* (quaking aspen) and *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests on surrounding hillsides.

Succession and Ecological Processes: This newly described plant association appears to be an early- to mid-seral community found along foothill streams. It occupies point bars and low stream banks that are flooded annually in the spring. *Salix exigua*, a low elevation willow, occurs in foothill stands of this association. *Salix eriocephala* var. *ligulifolia* favors middle elevations. Montane stands appear to be longer-lived since they are associated with beaver activity and saturated soils throughout the growing season.

Management: Foothills occurrences of this plant association are highly productive and provide 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 damage (Kovalchik *et al.* 1988). However, over-grazing and over-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) (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. The 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 regenerating *Salix eriocephala* var. *ligulifolia* 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 re-stabilization projects and re-vegetation purposes (Hansen *et al.* 1995, Padgett *et al.* 1989).

Related Types/Synonyms: Dorn (1995) has combined *Salix lutea* and *Salix ligulifolia* (as used in Colorado literature) into *Salix eriocephala* var. *ligulifolia*.. An exception is *Salix lutea* specimens found in the extreme northwestern part of Colorado that have been renamed *Salix eriocephala* var. *watsonii*. Northwestern Colorado is the southern boundary for this variety. No specimens previously known as *Salix lutea* occur in Colorado according to Dorn (1995). (See also the annotation of *Salix* specimens at the University of Colorado herbarium.) All plant associations from Colorado dominated by *Salix lutea* or *S. ligulifolia* are considered identical to this type.

Table 43. *Salix eriocephala* var. *ligulifolia* Plant Association Stands from the South Platte Watershed with Percent Cover by Dominant Species.

Plot Number	95 GK10	95 GK11	95 GK15	95 LS07	95 GK19	95 AM34	96 AM50	96 AM63	96 AM91
Riparian Condition Rank	C	C	B	C	A	B	B	C	B
TREES									
Populus deltoides- trees				26					
SHRUBS									
Pentaphylloides floribunda							2	1	10
Salix eriocephala	24	20	70	68	35	48	35	29	44
Salix exigua	1	6	8	23			13		
Salix lucida ssp. *caudata*	19	35		9					10
Salix monticola					13		19	17	
Salix planifolia					6	8		21	
Salix wolfii						11			
FORBS									
Eriogonum elatum						11			
Fragaria virginiana						12			3
Mentha arvensis	5	2		3					
Solidago multiradiata						9			
Solidago sp.		1	5						
Taraxacum officinale					1	9			1
Thalictrum fendleri					1	19			1
GRAMINOIDES									
Alopecurus aequalis	1			3					
Calamagrostis canadensis					27		2		22
Carex lanuginosa	4	7	46	5					
Carex nebrascensis	15	36		10					
Carex utriculata					41		9	24	25
Juncus arcticus	1	2	6				25		
Poa pratensis	1	2	10	1	5	24	19		3
Scirpus pungens	14		1	4					
Scirpus microcarpus		16	1						8
Typha latifolia	13	3							
Equisetum arvense	3	3	3	1		2	6		7

Salix drummondiana Alliance

Drummond willow/aquatic sedge (*Salix drummondiana/Carex aquatilis*) Plant Association
CNHP Rank: G2G3/S3
1 Quantitative Plot:
South Platte River Basin--1 plot (96AM49)

South Platte River Basin Reference Reaches: One good-condition occurrence was found within the study area, within the Pike-San Isabel National Forest, on an unnamed tributary to North Fork Creek, Park County, T12S, R78W, Sec 26.

General Description: The *Salix drummondiana/Carex aquatilis* plant association is a narrow band of tall (1.4-2.4 m) willows lining a steep to moderately steep stream in the montane zone of the Rocky Mountains. The *Carex aquatilis* dominate undergrowth indicates a wet, stable site and represents one of the wettest types within the *Salix drummondiana* Alliance.

Regional Distribution: Similar plant associations have been reported from Utah (Padgett *et al.* 1989) and Montana (Hansen *et al.* 1995).

Distribution in Colorado: This association has only been documented from the Colorado Front Range (Colorado Natural Heritage Program 1996).

Vegetation: *Salix drummondiana* forms a thick band of tall (1.5-2.5 m) shrubs overhanging the stream channel with 42% canopy cover. A few other shrubs present include *Salix monticola* (12%) and *Pentaphylloides floribunda* (10%). The undergrowth is a thick carpet of grasses, grass-like plants and forbs including *Carex aquatilis* (16%), *C. utriculata* (2%), *C. microptera* (1%) and *Conioselinum scopulorum* (10%) (Table 44).

Elevation: 10,460 ft (3190 m).

Site Geomorphology: *Salix drummondiana* typically becomes the dominant willow on narrow floodplains in narrow, V-shaped valleys with high gradient streams.

Rosgen's Stream Channel Type: This association occurs along very steep, narrow streams (G4).

Soils: Soils of this association are deep sandy clays with high organic content in the top layers. Infrequent mottling (10%) occurs from 15-49 cm. The soil profile becomes skeletal by 33 cm.

Adjacent Riparian Vegetation: Adjacent riparian vegetation along the stream include *Carex utriculata* meadows and *Picea pungens* woodlands.

Adjacent Upland Vegetation: *Pinus contorta* and *Populus tremuloides* forests occur on adjacent hillslopes.

Succession and Ecological Processes: The *Salix drummondiana/Carex aquatilis* plant association is early to mid-seral. *Salix drummondiana* is a prolific seed producer and is one of the first to colonize coarse-textured cobble bars and recently scoured alluvial surfaces. *Salix drummondiana* is flexible and can tolerate most flood events, and can readily resprout. With time and flooding events, fine materials are deposited on the alluvial surface, raising the level to above the annual flood stage. With time, fine textured particles and litter deposition, soils develop under the *Salix drummondiana* canopy. If the site remains close to the water table, but is not heavily disturbed by flooding (no scouring), grasses and grass-like plants can become established. The present of abundant *Carex aquatilis* and other *Careces* are a good indication of a wet-mesic and stable site. With time the site may become dominated by conifer trees.

Management: *Salix drummondiana* is highly palatable to livestock, ungulate wildlife, and beavers (Kovalchik 1987). *Carex* (sedge) species are heavily utilized by livestock in narrow riparian sites within extensive rangelands. Overgrazing by livestock can dry the site, increase non-native grass cover, and reduce the vigor of willow root structure (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 and Kovalchik and Elmore 1992) .

Related Types/Synonyms: Padgett *et al.* (1989) describe a *Salix boothii/Carex aquatilis* community type that includes stands dominated by *Salix drummondiana*. Hansen *et al.*(1995) describe a *Salix drummondiana/Carex rostrat*a habitat type that can have abundant *Carex aquatilis* in the undergrowth.

Table 44. *Salix drummondiana/Carex aquatilis* Plant Association Stand from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM49
Riparian Condition Rank	A
TREES	
Picea engelmannii - tree	3
SHRUBS	
Pentaphylloides floribunda	10
Ribes montegeum	5
Salix brachycarpa	1
Salix drummondiana	42
Salix monticola	12
FORBS	
Conioselinum scopulorum	10
Epilobium angustifolium	1
Fragaria virginiana	6
Geum macrophylum	1
Maianthemum stellatum	1
Oxypolis fendleri	3
Taraxacum officinale	6
GRAMINOIDES	
Carex aquatilis	20
Carex utriculata	2
Juncus balticus	1
Poa compressa	1
Poa pratensis	1

Drummond willow/Mesic Forbs (*Salix drummondiana*/Mesic Forbs) Plant Association
CNHP Rank: G4/S4
47 Quantitative Plots:
White River Basin--4 plots (92GK16, 92NL48, 92NL62, 92NL52,)
Colorado River Basin--16 plots (93SS04, 93SS10, 93SS37, 93SS39, 93SS40, 93DR02, 93DR06, 93DR19, 93RR24, 93RR25, 93GK26, 93GK27, 93GK35, 93GK39, 93GK40, 93GK41)
Gunnison River Basin--3 plots (94MD18, 94MD27, 94MD28)
San Miguel/Dolores River Basin--1 plot (54),
San Juan National Forest--18 plots (55, 57, 62, 124, 135, 149, 150, 156, 164, 178, 193, 194, 204, 208, 230, 238, 239, 273),
Arkansas River Basin--1 plot (95AM42)
South Platte River Basin--4 plots (95LS18, 96GK10, 96LS40, 96AM15)

South Platte River Basin Reference Reaches: An excellent example of this association can be seen on Fish Creek, Comanche Peak Wilderness, Arapaho-Roosevelt National Forest, Larimer County, T7N, R73W, Sec 4, 5, 8 and 9.

General Description and Comments: *Salix drummondiana* (Drummond willow) generally grows along steeper stream reaches than other willows. *Salix drummondiana* becomes the dominant willow and forms dense bands on steep, narrow banks of boulder-filled streams in narrow canyons and gulches. Occasionally, *Salix drummondiana* intermixes with other willows and forms broad willow carrs or shrublands. *Salix drummondiana* can be difficult to distinguish from *Salix geyeriana* (Geyer willow) without catkins. Both are tall, at least 5 feet (2 meters), montane willows with strongly pruinose twigs (a waxy covering that rubs off, similar to the coating on a plum). Happily, there is a way to distinguished *Salix geyeriana* from *Salix drummondiana* vegetatively by the width of mature leaves. The leaves of *Salix geyeriana* are never more than 0.5 inches (13 mm) wide on non-sucker shoots (Welsh *et al*. 1987).

Regional Distribution: This plant association and similar types occur in Nevada (Manning and Padgett 1995), eastern Idaho, western Wyoming (Youngblood *et al.* 1985) and Utah (Padgett *et al.* 1989).

Distribution in Colorado: This plant association occurs throughout Colorado's Western Slope and 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 1995, Cooper and Cottrell 1990, Phillips 1977).

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 include 0-40% cover of *Salix brachycarpa* (barrenground) and 0-20% cover of *Salix planifolia* (planeleaf willow). At lower elevations, other shrub species include 0-30% cover of *Lonicera involucrata* (honeysuckle), 0-20% cover each of *Alnus incana* (thinleaf alder) and *Salix monticola* (Rocky Mountain willow), and <1% cover of *Salix bebbiana* (Bebb willow). Tree species, occasionally present in the overstory, include 0-30% cover each of

Picea engelmannii (Engelmann spruce) and *Abies lasiocarpa* (subalpine fir) and 0-20% 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 0-40% cover each of *Mertensia ciliata* (mountain bluebell) and *Heracleum lanatum* (cow parsnip), 0-30% cover of *Cardamine cordifolia* (heartleaf bittercress), 0-20% cover each of *Oxypolis fendleri* (cowbane) and *Hydrophyllum fendleri* (waterleaf), and 0-15% cover of *Saxafraga odontoloma* (brook saxifrage). Graminoid species include 0-30% cover each of *Carex utriculata* (beaked sedge) and *Equisetum arvense* (field horsetail) and 0-20% cover of *Calamagrostis canadensis* (bluejoint reedgrass) (Table 45).

Elevation Range: 7500-11,300 ft (2400-3500 m).

Site Geomorphology: This plant association commonly occurs in V-shaped valleys along narrow stream benches as a dense, narrow band. It also occurs as large willow carrs in broad (150-1000 ft, 50-300 m) valleys. It can also occur on isolated hillside seeps.

Rosgen's Stream Classification: This association is most commonly found on high gradient (1-41%) streams (A1-A4). However, it also occurs on low gradient (1-3%), moderately sinuous streams (B1-B4), broad, highly sinuous streams (C3-C5) and down cut, actively eroding channels (F6).

Soil: Soils of this association 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. Several profiles have mottles at 16-35 cm of the surface. 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.

Adjacent Riparian Vegetation: At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests or mesic forb seeps dominate adjacent stream banks along narrow reaches and *Salix planifolia* (planeleaf willow) shrublands occur in wider, sub-alpine valleys. At lower elevations, adjacent riparian communities include *Alnus incana* (thinleaf alder), *Cornus sericea* (red-osier dogwood) and *Salix monticola* (Rocky Mountain willow) shrublands, and *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce), *Picea pungens* (Colorado blue spruce) and *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 and have *Pinus ponderosa* (ponderosa pine), *Pinus contorta* (lodgepole pine) and *Populus tremuloides* (quaking aspen) forests or *Pinus edulis* (pinyon pine) woodlands. Dry, upland grasslands with *Danthonia* spp. (oatgrass) and *Festuca thurberi* (Thurber fescue) occur on steep hillsides. At lower elevations, *Pseudotsuga menziesii* (Douglas-fir) or *Pinus contorta* (lodgepole pine) forests occur on adjacent hillslopes.

Successional and Ecological Processes: The *Salix drummondiana*/mesic forb (Drummond willow/mesic forb) plant association is often an early colonizer of first-order, boulder-strewn, steep streams. This association could be an early-seral stage of the *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forest type which also occurs along steep streams and alternates with the willow carrs. In wider valleys, the *Salix drummondiana*/mesic forb 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.

Management: 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).

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 trap sediment, creating a broad wetland environment. Land managers should consider maintaining beaver activity in an area versus their removal (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 cuttings grown in a nursery. Cuttings, which should be 12-20 inches (30-50 cm) long and at least 0.5 inches (1 cm) in diameter, should be taken in the spring from dormant 2-4 year-old wood. Roots and shoots will appear 10-15 days following planting (Hansen *et al*. 1995).

Related Types/Synonyms: Identical types under slightly different names are described by Cooper and Cottrell (1990) as the *Salix drummondiana/Mertensia ciliata* type and Phillips (1977) as the *Salix drummondiana-Salix monticola* type. A similar *Salix boothii*/mesic forb community type, often dominated by *Salix drummondiana* (Drummond willow), is described by Padgett *et al.* (1989), but it includes stands dominated by *Salix boothii*. A similar *Salix boothii*/*Smilacina stellata* community type, also includes stands dominated by *Salix drummondiana*, as well as *Salix boothii,* is described by Youngblood *et al.* (1985). A similar *Salix drummondiana* community type is described by Manning and Padgett (1995), but does not have significant forb cover.

Table 45. *Salix drummondiana*/Mesic Forbs Plant Association Stands from the South Platte Watershed with Percent Cover by Dominant Species.

Plot Number	95LS18	96GK10	96LS40	96AM15
Riparian Condition Rank	D	B	C	B
TREES				
Abies lasiocarpa--trees				
Picea engelmannii--trees				
Pinus contorta - tree		4		5
Populus angustifolia - tree	3		20	
Populus tremuloides - tree		31		
SHRUBS				
Alnus incana	20	4	19	
Lonicera involucrata	5	4	7	11
Rubus deliciosus			19	
Salix bebbiana		20		6
Salix drummondiana	70	42	58	36
Salix monticola	5	3	5	34
FORBS				
Arnica cordifolia		6		
Dodecatheon pulchellum		17		3
Fragaria virginiana		12		
Geum macrophylum			7	2
Heracleum sphondylium			18	12
Mertensia ciliata	2	1		4
Oxypolis fendleri		12		
Pyrola americana		9		
Senecio integerrimus				
Taraxacum officinale	1	4		
GRAMINOIDES				
Agropyron dasystachya			7	
Agrostis stolonifera			7	
Carex aquatilis		7		
Poa pratensis	4		4	1
Equisetum arvense		10		

Coyote willow/Mesic Graminoids (*Salix exigua/*Mesic Graminoids) Plant Association
CNHP Rank: G5/S5
33 Quantitative Plots:
San Juan National Forest--6 plots (18, 30, 31, 121, 141, 257)
San Miguel/Dolores River Basin-- 10 plots (3,27, 32, 33,60, 68, 69, 74, 76, 78)
Arkansas River Basin--5 plots (95AM48, 95RR11, 95GK65, 95GK66, 95GK75).
South Platte River Basin-- 12 plots (95LS15, 95LS17, 95GK06, 95GK13, 95GK18, 95GK23, 95LS26, 95GK28, 95GK29, 96AM31, 96AM35, 96AM71).

South Platte River Basin Reference Reaches: No high quality reaches were found in the study area, however a good example can be seen on Lower East Gulch, BLM land, T18S, R73W, Sec 28.

General Description and Comments: *Salix exigua* is one of the most common willows in Colorado. The two associations, *S. exigua*/mesic graminoid and *S. exigua*/bare ground, are easy to recognize as a monotypic stand of *S. exigua.* An undergrowth of grasses and forbs with a ground cover of at least 25% falls into the mesic graminoid type, while an undergrowth with widely scattered to no forbs and grasses belongs to the bare ground association. Both are early-seral and occur on the wetter side stream banks, swales and irrigation ditches. Plots 95LS26 and 95GK29 have significant amounts of *Panicum virgatum, Sorghastrum nutans, and Spartina pectinata* in the undergrowth due to proximity to tall-grass wet meadows along the Arikaree River floodplain. We include these stands here as a variation of the *Salix exigua*/mesic graminoid type.

Regional Distribution: This is a common type reported from Oregon (Bourgeron and Engelking 1994), Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), Montana (Hansen *et al.* 1991), southeastern Idaho and Wyoming (Youngblood *et al.* 1985, Jones and Walford 1995). Several *Salix exigua* plant associations with a variety of graminoid dominated undergrowth are known to occur in New Mexico, within the Rio Grande and Pecos River basins (Durkin *et al.* 1994, Durkin *et al.* 1995).

Distribution in Colorado: In Colorado it is reported from throughout the western slope (Kittel and Lederer 1993), and appears to be a common plant association along streams of the Colorado Front Range (Friedman 1993, Koch 1994, Kittel 1994, Cooper and Cottrell 1990) and along the mainstem of the South Platte River (Christy 1973).

Vegetation: *Salix exigua* is the predominating willow (26-86%), giving this association its characteristic greyish-green color. Other willows that occur in the canopy are *S. ligulifolia* (0-23%) and *S. monticola* (0-15%). The undergrowth has at least 20-35% cover by various graminoid species such as *Carex lanuginosa* and *Juncus balticus*. Forb cover is usually low, but can have a high percentage of non-natives (e.g. *Medicago lupulina* 30%, *Poa pratensis* 41%)

(Table 46).

Elevation: 5,720- 9,100 ft. (1,750-2,700 m).

Site Geomorphology: This plant association occurs on point bars, low floodplains and terraces, along overflow channels, and is usually within 1 meter vertical distance of the channel. It can also occur in mesic swales away from stream channels.

Rosgen's Channel Type: This type occurs on broad to narrow meandering streams with sandy or cobble beds (C5) and along the margins of Beaver ponds.

Soil: Soils are typically somewhat more developed that the *Salix exigua*/bare ground plant association due to a slightly more stable environment and greater input of organic matter. However, they 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.

Adjacent Riparian Vegetation: Associated riparian communities are stands of *Populus angustifolia* or *P. deltoides-Salix amygdaloides*, with *Salix exigua* in the understory. Thickets of *Prunus virginiana* and *Ribes* spp. or irrigated hay meadows generally occur on higher terraces and adjacent elevated floodplains. Stands of *Carex aquatilis* can occur in adjacent wet areas and *Symphoricarpos* spp. shrublands occur in drier areas of the floodplain.

Adjacent Upland Vegetation: Streams cutting through steep rock gullies and canyons often have *Pinus ponderosa* or *Pinus edulis* and *Juniperus monosperma* woodlands on the uplands with *Quercus gambelii* thickets on the lower slopes. *Pseudotsuga menziesii* forests can occur on north facing canyon walls. Irrigated hay and other crops are commonly associated on the immediate uplands of more gentle streams.

Successional and Ecological Processes: This plant association is typical of recent floodplains and highly disturbed low wet areas and is considered early-seral. The degree of herbaceous growth in the understory is an indication of the amount of time since the last scouring (or depositional) flood event. *Salix exigua* is an excellent soil stabilizer and can reduce the erosive power of flood waters. It can withstand flooding with its flexible stems and reduce erosion potential by increasing the friction of streamflow and trapping sediments. The presence of cottonwood seedlings within this association indicate succession to a cottonwood stand, if seedlings survive subsequent flooding events.

Management: *Salix exigua* readily sprouts with removal by grazing if the grazing intensity and persistence does not reduce the root food reserve (Jones and Walford 1995). Prolonged grazing can remove willows from a site and increase the cover of non-native weedy species (Hansen *et al.* 1988).

Related Types/Synonyms: The *Salix exigua*/mesic graminoid community type is described by Padgett *et al.* (1989), Kittel *et al.* (1994, and 1995), Kittel and Lederer (1993), and Jones and Walford (1995). Hansen *et al.* (1988) describe a *Salix exigua* community type which includes stands similar to our *Salix exigua*/mesic graminoid plant association. Johnston (1987) describes two similar types, *S. exigua-Salix* spp./*Calamagrostis canadensis-Equisetum arvense* and *S. exigua-Salix* spp./*Poa* sp., in which he includes sparse and more diverse stands, including the similar type, *S. exigua/Poa pratensis,* described by Youngblood *et al.* (1985). Soil descriptions of this plant association from eastern Wyoming (Jones and Walford 1995) are also similar to ours.

Table 46. *Salix exigua*/Mesic Graminoids Plant Association Stands from South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	95 LS15	95 LS17	95 GK06	95 GK13	95 GK18	95 GK23	95 LS26	95 GK28	95 GK29	96 AM71	96 AM31	96 AM35
Riparian Condition Rank	B	B	B	B	B	C	B	B/A	A	A	B	C
SHRUBS												
Salix exigua	63	57	75	53	65	52	66	36	26	49	19	82
Salix ligulifolia	23	12			7							
Salix monticola		7			7	15						
FORBS												
Epilobium sp.		1			8	1						
Geum macrophyllum					6	1						
Glycyrrhiza lepidota	11			1		1	4		11			
Medicago lupulina				8		30						
GRAMINOIDES												
Carex lanuginosa	21	35		39		7	13	7				
Carex nebrascensis		20		12						4		
Eleocharis palustris		26	9		5	1		3	2			
Glyceria grandis		1			17							
Panicum virgatum							12	29	55			
Poa pratensis	3			12	6	27	1	1	3		2	
Sorghastrum nutans									41			
Scirpus pungens			24					20				
Spartina pectinata							29	6				
Typha latifolia					19							
Equisetum arvense	6					8		1		2		

Coyote willow/Barren *(Salix exigua*/Barren) Plant Association
CNHP Rank: G5/S5
30 Quantitative Plots:
San Juan National Forest - 2 plots (16, 102)
Gunnison River Basin--2 plots (94GK29, 94GK37)
White River Basin--3 plots (92GK02, 92GK03, 92NL08)
Colorado River Basin--5 plots (93RR29, 93RR30, 93RR33, 93RR47, 93RR50)
Yampa River Basin-- 4 plots (4, 6, 15, 16)
Arkansas River Basin--6 plots (95AM05, 95AM18, 95AM47, 95RR07, 95RR08, 95RR10).
South Platte River Basin-- 8 Plots (95LS04, 95LS33, 95LS34, 95LS37, 95GK37, 95GK46, 95GK56, 96AM85)

South Platte References Reaches: An excellent example of this type can be seen on the Pawnee National Grasslands, along Twomile Creek, 1.4 miles east of Highway 71, Weld Co. T11N, R56W, Sec 32.

General Description and Comments: *Salix exigua* is one of the most common willows in Colorado. The two associations, *S. exigua*/mesic graminoid and *S. exigua*/bare ground, are easy to recognize as a monotypic stand of *S. exigua.* An undergrowth of grasses and forbs with a ground cover of at least 25% falls into the mesic graminoid type, while an undergrowth with widely scattered to no forbs and grasses belongs to the bare ground association. Both are early-seral and occur on the wetter side of stream banks, swales and irrigation ditches. Plots 95LS26 and 95GK29 have significant amounts of *Panicum virgatum, Sorghastrum nutans, and Spartina pectinata* in the undergrowth due to proximity to tall-grass wet meadows along the Arikaree River floodplain. We include these stands here as a variation of the *Salix exigua*/mesic graminoid type.

Regional Distribution: This plant association is very common and is found throughout the plains and lower mountains of Montana (Hansen *et al.* 1991), Wyoming (Jones and Walford 1995), Nevada (Manning and Padgett 1995), Utah (Padgett *et al.* 1989), Colorado (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Richard *et al.* 1996), and New Mexico (Durkin *et al.* 1995).

Distribution in Colorado: The *Salix exigua*/bare ground plant association is known throughout Colorado (Colorado Natural Heritage Program 1996), on the western slope (Kittel and Lederer 1993, Kittel *et al*. 1994, 1995), on the eastern plains (Christy 1973, Culver *et al.* 1996) and along the foothills and mountains of the eastern front (Kittel 1994).

Vegetation: This association is characterized by an almost exclusive cover by *Salix exigua* (63-90%) with very low herbaceous cover (Table 47). Combined bare soil, gravel, cobble and rock ground cover estimates are typically high (55-99%).

Elevation: 3,475-7,800 ft (1,060-2,380 m).

Site Geomorphology: This plant association is usually within the active channel of a stream, and is rarely more than a few decimeters above this level in vertical distance. The site usually experiences annual flooding.

Rosgen's Channel Type: This association occurs on meandering, sand-bed streams (C5), broad sand-bed braided streams (D5), moderate gradient streams (B3, B4), meandering streams (C3, C4), and along eroding gulches (F3).

Soil: Soils of this association are typically thin layers of sandy loam over very coarse alluvium. Occasional stands occur on deep pockets of sand. Along the South Platte River, a recent deposit (1995 flood) of fine clay or silt was found on the surface of the soil. Sampled pits showed highly stratified profiles with alternating clay loams and organic materials with coarser sands, indicating frequent fluvial depositional events.

Adjacent Riparian Vegetation: *Populus angustifolia* or *P. Deltoides* woodlands are often present on a reach with *Salix exigua* shrublands. Other adjacent riparian vegetation include *Eleocharis palustris* or *Carex nebrascensis* wetlands, and *Alnus incana* or *Betula occidentalis* shrublands. Because this is one of the most abundant riparian plant associations in Colorado, nearly any type of riparian vegetation may be adjacent.

Adjacent Upland Vegetation: Adjacent uplands on the plains have agricultural fields (sugar beets, winter wheat, and others), rolling hills of silversage and xeric tall grass prairies, and *Bouteloua gracilis* (blue grama) short grass prairies. In the steep canyons of the foothills typical upslope vegetation includes *Pinus edulis* (pinyon pine) and *Juniperus monosperma* (single-seed juniper) woodlands, *Quercus gambelii* (Gambel oak) shrublands, and *Pseudotsuga menziesii* (Douglas-fir) and *Pinus ponderosa* (Ponderosa pine) forests. In the lower montane, uplands have stands of *Pinus contorta* (lodgepole pine) and *Populus tremuloides* (aspen) forests.

Successional Trends and Ecological Processes: This plant association is considered an early seral community, capable of colonizing freshly deposited sand and gravel bars. *Salix exigua* is an excellent soil stabilizer with a deep root system. It can withstand flooding with its flexible stems, and reduces erosion potential by increasing the friction of stream flow and trapping sediments. The presence of cottonwood seedlings within this association indicates succession to a cottonwood stand, if seedlings survive subsequent flooding events.

Management: Forage production is low and the dense overstory may limit livestock movement within this type (Manning and Padgett 1995). Soil compaction is generally not a problem because of high coarse fragment content of the soils. Overgrazing by livestock will reduce the vigor of the willows present, and they may eventually be eliminated from the site (Hansen *et al.* 1995). Removal of the association and stream bank exposure can lead to erosion problems.

Related Types/Synonyms: The *Salix exigua*/barren, *S. exigua*/sparse, and *S. exigua*/bench community types described by Padgett *et al.* (1989), Durkin *et al.* (1995), and Manning and

Padgett (1995), respectively, are identical to our stands. Other similar types include the *Salix exigua* type listed in Reid and Bourgeron (1991). Jones and Walford (1995) describe unclassified stands of *Salix exigua* with >30% coarse material at the surface and mostly non-native herbaceous cover with occasional young stems of *Populus deltoides* or *Salix amygdaloides*. These stands appear to be similar to the *S. exigua*/bare ground type described here.

Table 47. *Salix exigua*/Barren Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	95LS04	95LS33	95LS34	95LS37	95GK37	95GK46	95GK56	96AM85
Riparian Condition Rank	B	B	B	B	B	B	C	C
TREES								
Juniperus scopulorum								25
Populus deltoides --trees			9					
Populus deltoides --saplings		1		2			7	
Salix amygdaloides --trees		1	2		5		1	
SHRUBS and VINES								
Humulus lupulus						18		
Salix exigua	63	63	72	9	82	82	86	62
Vitis riparia		2			8			
FORBS								
Asclepias sp.		13			2			
Cirsium arvense						13		
Melilotus officinalis	2							1
Polygonum pensylvanicum			8			1	2	
Rumex crispus	1	8				1	1	
Unknown forb	1	18	1	1		14	4	
GRAMINOIDES								
Carex sp.		23	1	1	2			13
Cyperus strigosis						21		
Echinochloa crus-galli		7	2	2	5		1	
Eleocharis palustris	3							
Scirpus pungens		8						
Spartina pectinata								

Salix geyeriana Alliance

Geyer willow/beaked sedge (*Salix geyeriana/Carex utriculata*) Plant Association
CNHP Rank: G5/S3
9 quantitative plots:
Yampa River Basin--4 plots (67, 71, 93, GK16)
Routt National Forest--3 plots (71, 271, 536)
South Platte River Basin--2 plots (96LS01, 96LS03)

South Platte River Basin References Reaches: No references were found within the study area. A small occurrence in moderately good condition can be seen on West Fork Creek, Arapaho-Roosevelt National Forest, Larimer County, T 11N, R74W, Sec 15.

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.

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 1996).

Distribution in Colorado: This association occurs in north-central Colorado, in the Yampa and South Platte River Basins, on the Arapaho-Roosevelt and Routt National Forests (Johnston 1987, Kettler and McMullen 1996, Kittel and Lederer 1993).

Vegetation: *Salix geyeriana* (Geyer willow) dominates the shrub overstory with 20-60% cover. Other willow species include 0-20% cover of *Salix monticola* (Rocky Mountain willow) and 0-10% cover each of *Salix drummondiana* (Drummond willow), *Salix wolfii* (wolf's willow) and/or *Salix planifolia* (planeleaf willow). Other shrubs with less than 10% cover include *Alnus incana* spp. *tenuifolia* (thinleaf alder) and *Lonicera involucrata* (honeysuckle). The graminoid layer is dominated by 20-60% cover of *Carex utriculata* (beaked sedge). Other graminoids include 0-20% cover of *Carex aquatilis* (aquatic sedge), 0-10% cover of *Calamagrostis canadensis* (bluejoint reedgrass) and 0-5% cover each of *Carex nebrascensis* (Nebraska sedge) and *Carex praegracilis* (blackcreeper sedge). Forb cover is generally minor (Table 48).

Elevation Range: 6800-9000 ft (2100-2800 m).

Site Geomorphology: This tall-willow plant 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.

Rosgen's Stream Classification: This association occurs on broad, active flood plains of slightly meandering rivers (B4) and on channels divided by beaver activity (D6).

Soil: Soils of this association have textures of silty clay loam, clay, and sandy clay, usually forming thick, massive cohesive layers, interspersed with layers of gravel or sand. Mottling or gleying is often present.

Adjacent Riparian Vegetation: Adjacent riparian areas have *Populus tremuloides* (quaking aspen) and *Picea pungens* (Colorado blue spruce) forests, other *Salix geyeriana* (Geyer willow), *S. monticola* (Rocky mountain willow), *S. planifolia* (planeleaf willow), or *Alnus incana* (thinleaf alder) shrublands and *Carex utriculata* (beaked sedge) meadows.

Adjacent Upland Vegetation: *Pinus contorta* (lodgepole pine) forests, *Artemisia tridentata* (big sagebrush) scrub, or *Pentaphylloides floribunda* (shrubby cinqfoil) shrublands.

Successional and Ecological Processes: This plant association requires a high water table and saturated soils for much of the growing season. Padgett *et al*. (1989) suggest that the only difference between this type and the *Salix geyeriana*/*Carex aquatilis* (Geyer willow/aquatic sedge) association is that when soils are saturated, *Carex utriculata* usually establishes before *Carex aquatilis*. Hansen *et al*. (1995) suggest that with prolonged disturbance, the undergrowth may become dominated by non-native grasses including *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop). Heavy browsing by livestock and beaver will reduce willow coverage and result in more open communities. However, if beaver are eliminated from the area, the water table will be lowered and the site may convert to a slightly drier plant association such as *Salix geyeriana/Calamagrostis canadensis* (Geyer willow/bluejoint reedgrass) (Hansen *et al*. 1995).

Carex utriculata (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) are dominant understory species of several *Salix* plant associations. These graminoids indicate different microenvironments within the *Salix* communities (Padgett *et al*. 1989) and may represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata, Carex aquatilis, and *Calamagrostis canadensis* separate out along a moisture gradient related to the depth of the water table at a particular site. *Carex utriculata* occurs on the wettest sites, such as low-lying swales, with the highest water tables. *Calamagrostis canadensis* dominates the driest sites with the lowest water tables and can colonizes drying stands of *Carex utriculata* and *C. aquatilis. Carex aquatilis* occurs on intermediate sites. (Cooper 1986).

Successional shifts in species composition can be initiated by a change in the physical environment with 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 becomes less saturated, and the dominant graminoid understory can change.
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 the ground surface, often in standing water. 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).

Management: *Carex* (sedge) species are heavily utilized by livestock in narrow riparian sites within extensive 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, 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).

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 cuttings in nurseries 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) long. Roots and shoots should appear 10-15 days after planting (Hansen *et al*. 1995).

Related Types/Synonyms: An identical *Salix geyeriana/Carex rostrata* type is described by

Hansen *et al*. (1995), Youngblood *et al*. (1985), Padgett *et al*. (1989), Girard *et al*. (1995), and Jones (1992). Johnston (1987) reports a *Salix geyeriana-Salix* spp./*Carex utriculata* plant association described by Phillips (1977) and Haynes and Aird (1981, as cited in Johnston 1987) and indicates it is identical to the Youngblood *et al.* (1985) type listed above. *Carex rostrata* var. *utriculata* is a synonym for *Carex utriculata* (Kartesz 1994).

Table 48. *Salix geyeriana/Carex utriculata* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96LS01	96LS03
Riparian Condition Rank	C	C
TREES		
Pinus contorta - tree	1	
Populus balsamifera-tree	1	
SHRUBS		
Alnus incana	3	
Pentaphylloides floribunda		3
Salix geyeriana	40	25
Salix monticola	9	17
Salix planifolia	2	10
FORBS		
Antennaria parviflora		3
Geum macrophylum	3	1
Mertensia ciliata	2	
Pedicularis groenlandica	7	
Saxifraga odontoloma	3	1
Senecio triangularis	2	
Taraxacum officinale	11	11
GRAMINOIDES		
Carex aquatilis	21	27
Carex utriculata	35	21
Carex sp.	1	
Phleum pratense		16
Poa pratensis	10	18
Equisetum arvense	8	1

Geyer willow-Rocky Mountain willow (*Salix geyeriana-Salix monticola/Calamagrostis canadensis*) Plant Association
CNHP Rank: G3/S3
2 Quantitative Plots and 11 Element Occurrence Records:
South Platte River Basin--2 plots (96LS02, 96GK12)
Colorado Natural Heritage Program--11 stands

South Platte River Basin Reference Reaches: The best known example of this association occurs in the South Platte watershed, along North St. Vrain Creek, Rocky Mountain National Park, Boulder County, T3N, R 73W, Sec 22 and 23.

General Description and Comments: The *Salix geyeriana-Salix monticola/Calamagrostis canadensis* (Geyer willow-Rocky Mountain willow) plant association is a tall (4-8 ft, 1.5-2.5 m) deciduous shrubland with a patches of willow cover interspersed with wet meadows and open channels and beaver ponds. The willow canopy is nearly a homogeneous mix of the two willow species.

Regional Distribution: This association is known from Utah (Padgett *et al.* 1989) and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This association occurs on the western slope and on the Colorado Front Range (Cooper and Cottrell 1990, Colorado Natural Heritage Program 1996).

Vegetation: The shrub canopy is predominantly *Salix geyeriana* (Geyer willow) (20-25%) and *Salix monticola* (Rocky Mountain willow) (15-30%). Other shrubs present are *Salix drummondiana* (Drummond willow) (0-5%), *S. planifolia* (plane-leaf willow) (5-15%), *Lonicera involucrata* (bush honeysuckle) (0-10%), *Ribes inerme* (gooseberry) (0-1%). The undergrowth is patchy with *Calamagrostis canadensis* (bluejoint reedgrass) (30-50%), *Carex aquatilis* (water sedge) (0-12%), *Geum macrophylum* (big-leaf geum) (1-12%),and *Epilobium angustifolium* (willow herb) (1-2%) (Table 49).

Elevation: 8200--9200 ft (2500-2800 m)

Site Geomorphology: This association occurs on wide flat or hummocky floodplains, within 0.5 meters above the high water mark of the channel.

Rosgen's Stream Channel Type: This association occurs adjacent to highly sinuous and narrow channels (E4), or channels braided by beaver activity (D4).

Soils: Soils of this association have textures that range from sandy loam to silty clay. Profiles are relatively deep (65 cm +) with up to 50% organic matter in the upper layers. Water table depth ranges from 20 to 60 cm.

Adjacent Riparian Vegetation: This association often completely dominates long stream reaches, but meadows of *Carex aquatilis* (water sedge) or *Poa pratensis* (Kentucky bluegrass) may also occur nearby.

Adjacent Upland Vegetation: Adjacent hill slopes have stands of *Populus tremuloides* (aspen), *Pinus contorta* (lodgepole pine) or *Pinus ponderosa* (ponderosa pine) forests.

Succession and Ecological Processes: Stands dominated by *Salix geyeriana* appear to be stable. *Salix geyeriana* appears to grow only where the water table does not drop below 1 m of the surface. It appears to be 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 it is likely that succession to other associations would be slow (Padgett *et al.* 1989). Beaver activity is important in maintaining this association, which may be the last successional stage on naturally silted in beaver ponds, replacing stands of *Carex utriculata* and *Carex aquatilis* (Cooper and Cottrell 1990).

Carex utriculata (beaked sedge), *Carex aquatilis* (water sedge), and *Calamagrostis canadensis* (bluejoint reed grass) separate out along a moisture gradient related to the depth of the water table at a particular site. *Carex utriculata* (beaked sedge) occurs on the wettest sites, such as low-lying swales, with the highest water tables. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the driest sites with the lowest water tables and can colonizes drying stands of *Carex utriculata* (beaked sedge) and *C. aquatilis* (water sedge). *Carex aquatilis* (water sedge) occurs on intermediate sites (Cooper 1986).

Successional shifts in species composition can be initiated by a change in the physical environment with 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 becomes less saturated, and the dominant graminoid understory can change. Beaver ponds also go through a similar succession. With time, ponds become silted in, and *Carex utriculata* (beaked sedge) invades the new, saturated substrate. As the site becomes firm, and slightly raised above the old pond level, *Carex aquatilis* (water sedge) and willows move in. With further aggradation and time, *Calamagrostis canadensis* (bluejoint reedgrass) moves in.

Distance from the stream channel can also differentiate the graminoid dominance spatially within the riparian mosaic. *Carex utriculata* (beaked sedge) commonly occurs at the stream channel edge where the water table is close to the ground surface, often in standing water. 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* (water sedge), or on higher surfaces, to slightly drier meadows of *Calamagrostis canadensis*(bluejoint reedgrass) (Kittel 1994).

Management: The forage value of *Calamagrostis canadensis* (bluejoint reedgrass) is moderate to high with young foliage the most palatable to livestock. With high grazing pressure, the production of *Calamagrostis canadensis* will decrease. Livestock grazing in this plant association should be delayed until mid-summer when the soil is drier. Otherwise, the animals churn the wet soil and destroy the plant cover as well as conifer seedlings

Since soils of this plant association are easily subject to compaction, streambank stabilization may be a management concern. Compaction of the upper soil reduces infiltration thereby reduce the water storage capacity of the site (Padgett *et al.* 1989). *Calamagrostis canadensis* (bluejoint reedgrass) is a valuable species for stabilizing or rehabilitating mountain streams due to its propagation from seeds and rhizomes. Heavy equipment should not be used in this association during wet times of the year and roads and trails should be located upslope from the stream (Hansen *et al*. 1995). The wet and often saturated soils of this plant association are also vulnerable to compaction by livestock. 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).

Mid-summer and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association (Kovalchik and Elmore 1992). 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).

Related Types/Synonyms: Cooper and Cottrell (1990) describe a *Salix geyeriana/ Calamagrostis canadensis* association but do not mention the presence of *Salix monticola.* Our stands may be more closely related to the *Salix monticola/Calamagrostis canadensis* that can have stands dominated by *Salix geyeriana* (Cooper and Cottrell 1990). Padgett *et al.* (1989), Hansen *et al.* (1995) and Youngblood *et al.* (1985) describe a similar *Salix geyeriana/ Calamagrostis canadensis* habitat type, but no *Salix monticola* is mentioned, and it includes stands dominated by *Salix boothii* or *Salix drummondiana*, unlike Colorado stands.

Table 49. *Salix geyeriana-Salix monticola/Calamagrostis canadensis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96LS02	96GK12
Riparian Condition Rank	C	A
TREES		
Pinus ponderosa - tree	2	
SHRUBS		
Lonicera involucrata		11
Rosa woodsii		4
Salix drummondiana		5
Salix geyeriana	22	22
Salix monticola	28	16
Salix planifolia	13	4
FORBS		
Epilobium angustifolium	2	1
Epilobium sp.	5	1
Fragaria virginiana	5	
Geum macrophylum	12	1
Heracleum sphondylium		21
Mertensia ciliata		1
Rudbeckia laciniata var. *ampla*		5
Taraxacum officinale	1	
Viola canadensis var. *scopulorum*	4	
GRAMINOIDES		
Calamagrostis canadensis	27	47
Carex aquatilis	13	
Carex disperma	15	
Carex utriculata	4	
Equisetum arvense		1

Salix lucida var. *caudata* Alliance

The *Salix lucida* spp. *caudata* (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.

Stands dominated by Salix lucida var. caudata are highly variable. Stands of this types also occur in the Yampa River Basin (The Nature Conservancy 1990, Baker 1984).

One stand along West Kiowa Creek, near the town of Elbert at 1,650 m (5,400 ft) elevation (95LS08) is dominated by *S. lucida* spp. *caudata.* (Table 50). Nearby stands are dominated by *S. eriocephala* var. *ligulifolia.* This plant association occurs in the wettest part of the riparian area, usually adjacent to flowing water of the channel on low point bars and islands, as well as on low stream banks and overflow channels. It occurs in saturated areas on soils high in organic matter content and with reduced conditions.

Table 50. Unclassified *Salix lucida* var. *caudata* Dominated Stand from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	95LS08
Riparian Condition Rank	B
TREES	
Salix amygdaloides--mature trees	2
SHRUBS	
Salix lucida ssp. *caudata*	56
GRAMINOIDES	
Bromus inermis	1
Carex nebrascensis	36
Eleocharis palustris	5
Juncus arcticus	1
Poa pratensis	1
Scirpus microcarpus	16
Typha latifolia	3

Rocky Mountain willow/Bluejoint Reedgrass (*Salix monticola/Calamagrostis canadensis*) Plant Association
CNHP Rank: G3S3
13 Quantitative Plots:
San Juan National Forest- - 3 plots (58, 80, 95)
Colorado River Basin-- 4 plots (93SS42, 93DR09, 26C, 42E)
South Platte River Basin--6 plots (96GK15, 96LS29, 96LS14, 96GK39, 96GK22, 96AM73)

South Platte River Basin Reference Reaches: Two good examples of this association occur in the study area. One stand is along Goose Creek in the Lost Creek Wilderness Area, Pike-San Isabel National Forest, Jefferson County, T10S, R72W, Sec 12 and 13. Another stand occurs along Fall River, Horseshoe Park, Rocky Mountain National Park, Larimer County, T5N, R74W Sec 11 and 12.

General Description and Comments: This is a tall (5-8 ft, 1.5-2.5 m) deciduous shrubland with an open canopy of willows with a thick carpet of grasses and sedges in the undergrowth. It occurs on open floodplains often forming a continuous willow canopy across the valley floor. The undergrowth is clearly dominated by patches of *Calamagrostis canadensis*, distinguishing this association from the *Salix monticola/Carex utriculata* and *Salix monticola/Carex aquatilis* associations.

Regional Distribution: This association has not been reported outside Colorado. However in central and eastern Utah, *Salix monticola* dominated stands are infrequent, and, due to structural and ecological similarities, were included in *Salix boothii* associations (Padgett *et al.* 1989). *Salix monticola* also has a limited distribution in Idaho and largely associates with other *Salix* spp. (Brunsfeld and Johnson 1985). It may be that plant associations dominated by *Salix monticola* are abundant in Colorado, and become less frequent as they mix with other, more adapted species to the north and west in the Rocky Mountains.

Colorado Distribution: This association is known from San Juan National Forest (Richard *et al.* 1996), the Crested Butte area (Cooper 1993) , the Colorado River Basin (Kittel *et al.* 1994, Sanderson and Kettler 1996) and the South Platte River Basin (Colorado Natural Heritage Program 1996).

Vegetation: This association has a mixed closed canopy of willows with *Salix monticola* (Rocky Mountain willow) (20-40%) and a variety of other shrubs. These include: *Salix drummondiana* (Drummond willow), *S. wolfii* (Wolfs willow), *S. geyeriana* (Geyer willow), *S. Bebbiana* (Bebb willow), *Betula occidentalis* (river birch) and *Alnus incana* (thinleaf alder) (0-20%). *Calamagrostis canadensis* (bluejoint reedgrass)can form a dense graminoid layer (3-30%), often in association with *Carex aquatilis* (water sedge) (3-10%) and a diversity of other graminoid species. Forb cover is generally low although some plots do contain high cover of species such as *Cardamine cordifolia* (watercress), *Geranium richardsonii* (Richard's geranium), *Mertensia ciliata* (chiming bells) and *Oxypolis fendleri* (cowbane) (Table 51).

Elevation: 8000-9400 ft. (2400-2900 m).

Site Geomorphology: This community occurs on narrow to moderately wide (30-70 m) flat (2-3.5% gradient) valley bottoms and floodplains. It also occurs on broad floodplains between stream channel meanders and at the edges of beaver ponds.

Rosgen's Channel Type: This association is found on narrow, steep gradient streams (A4), moderate gradient streams in moderately wide valleys (B4), in wider valleys where beavers are active (D6), and along broad floodplains of meandering reaches (C3 and C4).

Soils: Soils are relatively deep (70+ cm), fine textured sandy clays to silty clay loams, often saturated to within 30 cm of the surface where mottles are abundant.

Adjacent Riparian Vegetation: Other *Salix monticola* (Rocky Mountain willow) and *Salix drummondiana* (Drummond willow) shrublands occur on broad floodplains up and down stream of this association. Mesic meadows often occupy adjacent floodplains area dominated by *Carex aquatilis* (water sedge) or *Carex utriculata* (beaked sedge). *Picea engelmannii-Abies lasiocarpa* (spruce-fir) forests can occur along narrow steep reaches.

Adjacent Upland Vegetation: *Abies lasiocarpa-Picea engelmannii* (spruce-fir) and *Populus tremuloides* (aspen) woodlands occur on adjacent hillslopes at higher elevations. *Pinus ponderosa* (ponderosa pine) and *Pseudotsuga menziesii* (Douglas-fir) occur on adjacent hill slopes at lower elevations.

Succession and other Ecological Processes: *Salix monticola* (Rocky Mountain willow) dominated associations appear long-lived and stable, occurring in mesic conditions that support a diversity of graminoids and forbs. *Salix monticola* appears to grow only where the water table does not drop below 1 m of the surface. It appears to be 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 it is likely that succession to other associations would be slow (Padgett *et al.* 1989). Presence of dying conifer trees may indicate an increase in the water table due to decreased transpiration rates, allowing for expansion of *Calamagrostis canadensis* and 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 dominant understory species of several *Salix* (willow) plant associations. These graminoids indicate different microenvironments within the *Salix* (willow) communities (Padgett *et al*. 1989) and may represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata (beaked sedge), *Carex aquatilis* (water sedge), and *Calamagrostis canadensis* (bluejoint reed grass) separate out along a moisture gradient related to the depth of the water table at a particular site. *Carex utriculata* (beaked sedge) occurs on the wettest sites, such as low-lying swales, with the highest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the driest sites with the lowest water tables and can colonizes drying stands of *Carex utriculata* (beaked sedge) and *C. aquatilis* (water sedge) (Cooper 1986).

Successional shifts in species composition can be initiated by a change in the physical environment with 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 becomes less saturated, and the dominant graminoid understory can change. Beaver ponds also go through a similar succession. With time, ponds become silted in, and *Carex utriculata* (beaked sedge) invades the new, saturated substrate. As the site becomes firm, and slightly raised above the old pond level, *Carex aquatilis* (water sedge) and willows move in. With further aggradation and time, *Calamagrostis canadensis* (bluejoint reedgrass) moves in.

Distance from the stream channel can also differentiate the graminoid dominance spatially within the riparian mosaic. *Carex utriculata* (beaked sedge) commonly occurs at the stream channel edge where the water table is close to the ground surface, often in standing water. 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* (water sedge), or on higher surfaces, to slightly drier meadows of *Calamagrostis canadensis*(bluejoint reedgrass) (Kittel 1994).

Management: The forage value of *Calamagrostis canadensis* (bluejoint reedgrass) is moderate to high with young foliage the most palatable to livestock. With high grazing pressure, the production of *Calamagrostis canadensis* will decrease. Livestock grazing in this plant association should be delayed until late summer when the soil is drier. Otherwise, the animals churn the wet soil and destroy the plant cover as well as conifer seedlings.

Since soils of this plant association are easily subject to compaction, streambank stabilization may be a management concern. *Calamagrostis canadensis* (bluejoint reedgrass) is a valuable species for stabilizing or rehabilitating mountain streams due to its propagation from seeds and rhizomes. Heavy equipment should not be used in this association during wet times of the year and roads and trails should be located upslope from the stream (Hansen *et al*. 1995).

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). Mid-summer and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association (Kovalchik and Elmore 1992). 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).

Related Types/Synonyms: Identical *Salix monticola/Calamagrostis canadensis* types are described by Cooper and Cottrell (1990), Cooper (1993), Sanderson and Kettler (1996). Stands described here are probably included within the broad types *Salix drummondiana-Salix monticola/Calamagrostis canadensis-Carex utriculata* or *Salix geyeriana-Salix monticola/Calamagrostis canadensis-Carex aquatilis-Carex utriculata* described by Baker (1989). Johnston (1987) lists a *Salix drummondiana/ Calamagrostis canadensis* association that includes *Salix monticola* in the species list. The *Salix geyeriana-Salix* spp./*Calamagrostis canadensis*, also described by Johnston (1987), may also be similar.

Table 51. *Salix monticola/Calamagrostis canadensis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96LS29	96GK14	96GK39	96GK22	96AM73	96GK15
Riparian Condition Rank	B	A	B	B	A	B
TREES						
Pinus ponderosa - tree						15
Populus tremuloides - tree						2
SHRUBS						
Acer glabrum						1
Alnus incana						10
Betula occidentalis	11				3	
Jamesia americana						10
Ribes montigenum	12					
Rosa woodsii					1	3
Salix bebbiana					1	17
Salix drummondiana	2	4	6			5
Salix eriocephala ssp. *ligulifolia*						4
Salix geyeriana	10	1				
Salix irrorata					27	
Salix monticola	50	49	51	66	60	21
Salix planifolia		1	1			
FORBS						
Angelica ampla				33		3
Epilobium angustifolium		8	7	2		5
Fragaria virginiana	1	8	9		1	1
Mertensia ciliata		1		8		6
Taraxacum officinale	1	1	2	1		1
GRAMINOIDES						
Calamagrostis canadensis	69	42	50	30	39	24
Carex aquatilis		11	20			14
Carex utriculata		2	1	6		
Poa arctica	10					
Poa palustris			10			
Poa pratensis	4		4	8	1	1
Scirpus microcarpus				5	1	

Rocky Mountain willow/aquatic sedge (*Salix monticola/Carex aquatilis*) Plant Association
CNHP Rank: G3/S3
4 Quantitative Plots:
Yampa River Basin--2 plots (62, 103)
South Platte River Basin--2 plots (96GK04, 96AM88)

South Platte River Basin Reference Reaches: One small but good condition stand can be seen along an unnamed tributary to Elk Creek, Pike-San Isabel National Forest, Park County, T 6S, R 73W, Sec 14.

General Description and Comments: This is a tall (5-8 ft, 1.5-2.5 m) deciduous shrubland with an open canopy of willows with a thick carpet of grasses and sedges in the undergrowth. It occurs on open floodplains often forming a continuous willow canopy across the valley floor. The undergrowth is clearly dominated by patches of *Carex aquatilis*, distinguishing this association from the *Salix monticola/Carex utriculata* and *Salix monticola/Calamagrostis canadensis* associations.

Regional Distribution: This association has not been reported outside Colorado. However in central and eastern Utah, *Salix monticola* dominated stands are infrequent, and, due to structural and ecological similarities, were included in *Salix boothii* associations (Padgett *et al.* 1989). *Salix monticola* also has a limited distribution in Idaho and largely associates with other *Salix* spp. (Brunsfeld and Johnson 1985). It may be that plant associations dominated by *Salix monticola* are abundant in Colorado, and become less frequent as they mix with other, more adapted species to the north and west in the Rocky Mountains.

Distribution in Colorado: This plant association is a minor type known only to occur in small patches in the Yampa and South Platte River Basins, but is expected to occur throughout its habitat in Colorado (Kittel and Lederer 1993, Colorado Natural Heritage Program 1996).

Vegetation: This plant association forms a narrow band or wide carrs (shrublands) dominated by 50-75% cover of *Salix monticola* (Rocky Mountain willow). Other shrubs include *Salix bebbiana* (Bebb willow) (0-20%), *Salix drummondiana* (Drummond willow) (0-5%). 0-5% cover each of *Cornus sericea* (red-osier dogwood) and *Lonicera involucrata* (honeysuckle). *Carex aquatilis* (aquatic sedge) dominates the herbaceous undergrowth with 10-50% cover. Other graminoid species include *Scirpus microcarpus* (0-12%) and *Calamagrostis canadensis* (0-1%). Forb cover is low due to shading and flooding disturbance (Table 52).

Elevation Range: 7000-9400 ft (2100-2900 m).

Site Geomorphology: *Salix monticola* (Rocky Mountain willow) is widespread throughout Colorado, but rarely forms large, dominant stands. This plant association occurs in narrow valleys on coarse-textured stream banks.

Rosgen's Stream Classification: Stands of this association occur along stream channels braided by beaver activity (D6) and narrow, highly sinuous channels (E4).

Soils: Soils of this association are generally deep (55-65+ cm) with sandy clay loam to sandy loam textures with layers of gravel and organic matter. Mottles appear at 20 cm depth.

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

Successional and Ecological Processes: *Salix monticola* (Rocky Mountain willow) dominated plant associations appear to be long-lived and stable. This association occurs as small patches and may be an early seral stage of larger, tall-willow plant associations. The present of abundant *Carex aquatilis* and other native graminoids are a good indication of a wet-mesic site. With time the site may become dominated by *Calamagrostis canadensi*s, forming the *Salix monticola/Calamagrostis canadensis* association. With continued succession, the site may become dominated by conifer trees (Padgett *et al.* 1989).

Carex utriculata (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) are dominant understory species of several *Salix* plant associations. These graminoids indicate different microenvironments within the *Salix* communities (Padgett *et al*. 1989) and can represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata (beaked sedge), *Carex aquatilis* (water sedge), and *Calamagrostis canadensis* (bluejoint reed grass) separate out along a moisture gradient related to the depth of the water table at a particular site. *Carex utriculata* (beaked sedge) occurs on the wettest sites, such as low-lying swales, with the highest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the driest sites with the lowest water tables and can colonizes drying stands of *Carex utriculata* (beaked sedge) and *C. aquatilis* (water sedge) (Cooper 1986).

Successional shifts in species composition can be initiated by a change in the physical environment with 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 becomes less saturated, and the dominant graminoid understory can change. Beaver ponds also go through a similar succession. With time, ponds become silted in, and *Carex utriculata* (beaked sedge) invades the new, saturated substrate. As the site becomes firm, and slightly raised above the old pond level, *Carex aquatilis* (water sedge) and willows move in. With further aggradation and time, *Calamagrostis canadensis* (bluejoint reedgrass) moves in.

Distance from the stream channel can also differentiate the graminoid dominance spatially within the riparian mosaic. *Carex utriculata* (beaked sedge) commonly occurs at the stream channel edge where the water table is close to the ground surface, often in standing water. 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* (water sedge), or on higher surfaces, to slightly drier meadows of *Calamagrostis canadensis* (bluejoint reedgrass) (Kittel 1994).

Management: *Carex* (sedge) species are heavily utilized by livestock in narrow riparian sites within extensive rangelands. Overgrazing by livestock can dry the site, increase non-native grass cover, and reduce the vigor of willow root structure (Hansen *et al*. 1995). In addition, wet and often saturated soils of this plant association are 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).

Mid-summer and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association (Kovalchik and Elmore 1992). 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 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 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.

Both *Salix monticola* and *Carex aquatilis* are effective stream bank stabilizers. *Carex aquatilis* is useful due to its dense network of rhizomatous roots. *Salix monticola* is valuable for stream bank protection, thermal cover and shade (Hansen *et al*. 1995).

Related Types/Synonyms: In Utah, a similar *Salix boothii/Carex aquatilis* (Booth's willow/aquatic sedge) community type occurs with *Salix monticola* occasionally in the canopy

(Padgett *et al*. 1989). However, this similar type also has significant cover of other *Salix* (willow) species as well, and it is not clear if this type includes stands of pure *Salix monticola*.

Table 52. *Salix monticola/Carex aquatilis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96GK04	96AM88
Riparian Condition Rank	C	B
TREES		
Pinus contorta - tree	1	
SHRUBS		
Pentaphylloides floribunda	1	13
Rosa woodsii	2	
Salix bebbiana	7	17
Salix exigua	1	
Salix geyeriana	1	
Salix lucida ssp. *lasiandra*	1	
Salix monticola	50	48
FORBS		
Antennaria parviflora	1	
Aster sp.	4	
Dodecatheon pulchellum	1	
Fragaria virginiana	1	
Geum macrophylum	1	
Potentilla sp.	1	
Taraxacum officinale	4	
Thermopsis divaricarpa	3	
GRAMINOIDS		
Agrostis stolonifera	2	
Calamagrostis canadensis	1	
Carex aquatilis	9	51
Carex lanuginosa	4	
Carex utriculata	5	
Juncus balticus	4	
Poa pratensis	12	
Scirpus microcarpus	12	
Equisetum arvense	1	

Rocky Mountain willow/Beaked sedge (*Salix monticola/Carex utriculata*) Plant Association
CNHP Rank: G3/S3
14 Quantitative Plots:
San Juan National Forest - 2 plots (42, 159)
Gunnison River basin--2 plots (94GK16, 94RR19)
Colorado River Basin--6 plots (93SS05, 93RR53, 93GK31, 93SS28, 93GK34, 93RR12)
South Platte River Basin--4 plots (96AM65, 96AM47, 96AM45, 96AM69)

South Platte River Basin References Reaches: An excellent example of this association can be seen on Rough and Tumbling Creek, at the Lynch Creek confluence, Pike-San Isabel National Forest, Park County, T11S, R78W, Sec 33, and T12S, R78W, Sec 4.

General Description and Comments: This is a tall (5-8 ft, 1.5-2.5 m) deciduous shrubland with an open canopy of willows with a thick carpet of grasses and sedges in the undergrowth. It occurs on open floodplains often forming a continuous willow canopy across the valley floor. The undergrowth is clearly dominated by patches of *Carex utriculata*, distinguishing this association from the *Salix monticola/Carex aquatilis* and *Salix monticola/Calamagrostis canadensis* associations.

Regional Distribution: This association has not been reported outside Colorado. However in central and eastern Utah, *Salix monticola* (Rocky Mountain willow) dominated stands are infrequent, and, due to structural and ecological similarities, were included in *Salix boothii* (Booth willow) associations (Padgett *et al.* 1989). *Salix monticola* (Rocky Mountain willow) also has a limited distribution in Idaho and largely associates with other *Salix* spp. (Brunsfeld and Johnson 1985). It may be that plant associations dominated by *Salix monticola* (Rocky Mountain willow) are abundant in Colorado, and become less frequent as they mix with other, more adapted species to the north and west in the Rocky Mountains.

Colorado Distribution: This plant association and similar types are known from the Colorado (Kittel *et al.* 1994), Gunnison (Kittel *et al.* 1995) and South Platte River Basins (Cooper and Cottrell 1990, Colorado Natural Heritage Program 1996) and from the San Juan National Forest (Richard *et al*. 1996).

Vegetation: This association is characterized by a thick, closed willow canopy dominated by *Salix monticola* (Rocky Mountain willow) (10-80%), often with *Salix drummondiana* (Drummond willow) (1-50%), *S. eriocephala* (yellow willow) (0-20%), *S. wolfii* (Wolfs willow) (0-10%) or *S. brachycarpa* (barrenground willow) (0-30%) present. *Carex utriculata* (beaked sedge) is the most abundant graminoid (10-44%). Stands appear to be too saturated for forb growth (<10%) (Table 53).

Elevation: 8300-10,050 ft. (2500-3100 m).

Site Geomorphology: This type is commonly associated with beaver ponds, the willows on

hummocks of higher ground and *Carex utriculata* at the pond margins, or along wet stream banks and terraces of low gradient (<3%), broad valley bottoms..
Rosgen's Channel Type: This association often occurs on stream reaches that are altered by beaver activity, creating multiple channels (D6), on moderately wide, gentle gradient streams (B3), and meandering reaches (C3). One stand occurs on a severely eroding reach (G6)

Soils: Soils of this association are relatively deep (60+ cm), with clay loams and sandy clay loams textures. Some profile have up to 40% organic matter in the top 50 cm. The water table is usually within 51 cm, with abundant (>20%) mottling.

Adjacent Riparian Vegetation: *Alnus incana* (thinleaf alder) shrublands and *Populus angustifolia-Picea pungens* (narrowleaf cottonwood-Colorado blue spruce) forest stands occur on adjacent, well drained reaches.

Adjacent Upslope Vegetation: *Pinus contorta* (lodgepole pine), *Populus tremuloides* (aspen) and *Abies lasiocarpa-Picea engelmannii* (subalpine-fir-Engelmann spruce) forests occur on adjacent hillslopes.

Successional and Ecological Processes: This plant association requires a high water table and saturated soils for much of the growing season. Padgett *et al*. (1989) suggest that the only difference between this type and the *Carex aquatilis* (aquatic sedge) undergrowth dominated types is that when soils are saturated, *Carex utriculata* (beaked sedge) usually establishes before *Carex aquatilis*, and may indicate an early successional stage of the *Salix monticola/Carex aquatilis* and/or the *Salix monticola/ Calamagrostis canadensis* associations (Cooper and Cottrell 1996). Hansen *et al*. (1995) suggest that with prolonged disturbance, the undergrowth may become dominated by non-native grasses including *Poa pratensis* (Kentucky bluegrass) and *Agrostis stolonifera* (redtop). Heavy browsing by livestock and beaver will reduce willow coverage and result in more open communities. However, if beaver are eliminated from the area, the water table will be lowered and the site may convert to a slightly drier plant association such as *Salix monticola/Calamagrostis canadensis* (Rocky Mountain willow/bluejoint reedgrass).

Carex utriculata (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) are dominant understory species of several *Salix* plant associations. These graminoids indicate different microenvironments within the *Salix* communities (Padgett *et al*. 1989) and can represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata (beaked sedge), *Carex aquatilis* (water sedge), and *Calamagrostis canadensis* (bluejoint reed grass) separate out along a moisture gradient related to the depth of the water table at a particular site. *Carex utriculata* (beaked sedge) occurs on the wettest sites, such as low-lying swales, with the highest water tables. *Carex aquatilis* (water sedge) occurs on intermediate sites. *Calamagrostis canadensis* (bluejoint reedgrass) dominates the driest sites with the lowest water tables and can colonizes drying stands of *Carex utriculata* (beaked sedge) and *C. aquatilis* (water sedge) (Cooper 1986).

Successional shifts in species composition can be initiated by a change in the physical environment with 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 becomes less saturated, and the dominant graminoid understory can change. Beaver ponds also go through a similar succession. With time, ponds become silted in, and *Carex utriculata* (beaked sedge) invades the new, saturated substrate. As the site becomes firm, and slightly raised above the old pond level, *Carex aquatilis* (water sedge) and willows move in. With further aggradation and time, *Calamagrostis canadensis* (bluejoint reedgrass) moves in.

Distance from the stream channel can also differentiate the graminoid dominance spatially within the riparian mosaic. *Carex utriculata* (beaked sedge) commonly occurs at the stream channel edge where the water table is close to the ground surface, often in standing water. 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* (water sedge), or on higher surfaces, to slightly drier meadows of *Calamagrostis canadensis*(bluejoint reedgrass) (Kittel 1994).

Management: *Carex* (sedge) species are heavily utilized by livestock in narrow riparian sites within extensive 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).

Mid-summer and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association (Kovalchik and Elmore 1992). 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 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).
Salix monticola (Rocky Mountain 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 monticola* can probably be grown and transplanted from nurseries cuttings in the same manner as *S. 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) long. Roots and shoots should appear 10-15 days after planting (Hansen *et al*. 1995).

Related Types/Synonyms: This association is closely related to the more broadly defined *Salix drummondiana-Salix monticola/Calamagrostis canadensis-Carex utriculata* association described by Baker (1989). Cooper and Cottrell (1990) describe a *Salix monticola/Calamagrostis canadensis* association that includes stands dominated by *Carex utriculata*. Youngblood *et al.*(1985) and Padgett *et al.* (1989) describe a similar *Salix boothii/Carex rostrata* community type, but it is unclear if it includes stands of pure (or at least clearly dominated by) *Salix monticola.* In addition, Girard *et al.* (1995). described a *Salix boothii/*sedge plant association that also has some *Salix monticola* present. It may be that *Salix monticola* occurs in nearly pure stands in Colorado, and is being replaced by other species such as *Salix boothii* and *Salix drummondiana* further north and east of the state line.

Table 53. *Salix monticola/Carex utriculata* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM65	96AM47	96AM45	96AM69
Riparian Condition Rank	B	B	A	B
TREES				
Picea pungens	6			
SHRUBS				
Betula glandulosa			1	
Lonicera involucrata	2		1	
Pentaphylloides floribunda		3	2	2
Salix brachycarpa	2		28	9
Salix drummondiana	1			
Salix eriocephala ssp. *ligulifolia*	19	6	11	3
Salix geyeriana		4		
Salix monticola	22	16	42	51
Salix planifolia	3			
Salix wolfii			4	
FORBS				
Fragaria virginiana	1	2	9	
Oxypolis fendleri	1		1	
Pedicularis groenlandica	6		1	
GRAMINOIDES				
Carex aquatilis	11	3		
Carex utriculata	27	18	6	44
Carex sp.	2		2	16
Deschampsia cespitosa	1	1	4	1
Juncus balticus		8	2	3
Poa pratensis		24	1	
Equisetum pratense	9		5	3

Rocky Mountain willow/Mesic Forbs (*Salix monticola/*Mesic Forbs) Plant Association
CNHP Rank: G3/S3
51 Quantitative Plots:
San Miguel/Dolores River Basins-- 2 plots (84, 86)
White River Basin--4 plots (92NL11, 92NL50, 92NL46, 92NL10)
Colorado River Basin--6 plots (93SS16, 93RR52, 93GK38, 93DR18, 93GK12, 93DR11)
Gunnison River Basin --8 plots (94GK03, 94GK11, 94JB01, 94JB02, 94JB13, 94JB23, 94MD02, 94RR24)
San Juan National Forest - 12 plots (11, 13, 40, 45, 51, 56, 60, 68, 79, 92, 166, 187)
Routt National Forest-- 5 plots (41, 43, 151, 530, 546)
South Platte River Basin--2 plots (96AM27, 96AM10)

South Platte River Basin Reference Reaches: No reference reaches were found in the study area, however a fairly good condition example of this association can be seen on Wigwam Creek, Pike-San Isabel National Forest, Jefferson County, T9S, R71W, Sec 25.

General Description and Comments: This association is a tall (5-10 ft, 1.5-2.5 m) deciduous willow shrubland with a fairly open canopy and an herbaceous layer predominately dominated by a variety of forbs and grasses. Total forb cover exceeds total graminoid (grasses and grass-like plants) cover.

Regional Distribution: This association has not been reported outside Colorado. However in central and eastern Utah, *Salix monticola* (Rocky Mountain willow) dominated stands are infrequent, and, due to structural and ecological similarities, were included in *Salix boothii* (Booths willow) associations (Padgett *et al.* 1989). *Salix monticola* (Rocky Mountain willow) also has a limited distribution in Idaho and largely associates with other *Salix* spp. (Brunsfeld and Johnson 1985). It may be that plant associations dominated by *Salix monticola* are abundant in Colorado, and become less frequent as they mix with other, more adapted species to the north and west in the Rocky Mountains.

Colorado Distribution: This association is a major type in the upper montane areas of San Miguel/Dolores (Kittel and Lederer 1993), Colorado and White (Kittel *et al.* 1994), Gunnison (Kittel *et al.* 1995) and South Platte River Basins (Copper and Cottrell 1990, Colorado Natural Heritage Program 1996), and the western half of the San Juan National Forest (Richard *et al.* 1996).

Vegetation: *Salix monticola* (Rocky Mountain willow) forms a dense to open canopy (20-80%) with a very diverse and rich forb layer. Other shrubs are usually present, but with no consistent associated species other than *Salix drummondiana* (Drummond willow) (0-20%). Other shrub species include a variety of other *Salix* (willow) species (0-30%), and *Lonicera involucrata (bush honeysuckle)* (0-10%). At lower elevations *Ribes inerme* (gooseberry) (0-20%), *Crataegus rivularis (hawthorn)* (0-30%), *Alnus incana (thinleaf alder)* (0-10%), and *Salix eriocephala (yellow willow)* (0-20%) are present as well. Total forb cover ranges from 10-70%, and graminoid cover from 5-40%, and includes *Calamagrostis canadensis* (bluejoint reedgrass) (0-5%), *Carex aquatilis* (water sedge) (<3%), *Mertensia ciliata* (chiming bells) (0-10%), *Heracleum lanatum* (Cow parsnip) (0-70%), *Rudbeckia laciniata* (cone flower) (0-20%) and *Fragaria virginiana* (wild strawberry) (0-10%). Graminoids dominate in the low-lying, wetter swales, while forbs concentrate under the shrubs on hummocks and ridges (Table 54). San Juan National Forest stands show a significant shift in forb species: *Rudbeckia laciniata* (cone flower) becomes more dominant with decreasing elevation, and the average cover of exotics (e.g. *Poa pratensis* (Kentucky bluegrass) (0-40%), *Taraxacum officinale* (dandelion) (0-10%), *and Trifolium repens* (sweet clover) (0-20%)) tends to increase, indicating past heavy grazing pressures.

Elevation: 6600-10,700 ft. (2000-3260 m)

Site Geomorphology: *Salix monticola* (Rocky Mountain willow) dominates stream reaches in narrow to moderately wide valleys (20-250 m) primarily with broad, swift-moving streams and active floodplains. The ground surface is usually undulating, from past flooding or beaver activity. Stands can also occur as narrow bands at streams edge, ranging from 0.1 m to 2 m above the channel elevation. In wider valley bottoms, it can occur further from the bank, but never more than 0.75 m above the annual high water mark.

Rosgen's Channel Type: Most stands occurred adjacent to fairly straight, wide, and shallow channels, that range from bedrock to silty-bottomed reaches (B1-B6). A few stands occur on meandering, cobble-bottomed reaches (C3), and streams braided by beaver activity (D6).

Soil: Soils are relatively deep (40-67+ cm), fine textured sandy clays to silty and sandy clay loams. Mottling and gleyed layers are not uncommon within 12 cm of the ground surface. Coarse material varies from zero to 80% coarse fragments in the upper horizons.

Adjacent Riparian Vegetation: *Populus angustifolia* (narrowleaf cottonwood), *Populus angustifolia-Picea pungens* (cottonwood-blue spruce) forests, *Salix planifolia* (plane leaf willow) *Salix wolfii*(wolf willow), or *Alnus* (alder) shrublands occur on well drained, adjacent floodplains. Mesic meadows of *Carex aquatilis* (aquatic sedge) or *Juncus balticus* (Baltic rush) may also occur on flat areas of the floodplain. *Abies lasiocarpa-Picea engelmannii* (spruce-fir) forests occur in narrow valleys at higher elevations.

Adjacent Upslope Vegetation: At higher elevations, *Abies lasiocarpa-Picea engelmannii* (subalpine-fir-Engelmann spruce) forests and *Populus tremuloides* (aspen) woodlands can occur on adjacent hill slopes. At lower elevations, *Pinus ponderosa* (Ponderosa pine) and mixed *Pinus contorta* (lodgepole pine) forests occur on adjacent hillsides.

Successional and Ecological Processes: The *Salix monticola*/mesic forbs association may be a grazing induced type. Stands that occur on more mesic sites support a rich diversity of forbs. On broad, hummocky floodplains it can form extensive willow carrs. This association grades into the *Salix planifolia/mesic forb* association at higher elevations.

Management: Season long (2-3 month) grazing will open the canopy and allow more sunlight to reach the ground, drying the site. Many of our stands lack significant cover of sub-alpine forbs species such as *Mertensia ciliata* and are sparse in nature. Increaser species such as *Geranium richardsonii* and *Fragaria virginiana* are among the most prevalent. Stands with abundant *Salix planifolia* present may indicate that this association is transitional between higher sites dominated by *Salix planifolia* and the wider, lower montane areas where *Salix monticola* becomes abundant. The *Salix monticola-Salix planifolia* association occupies wetter sites than *Salix monticola* stands, and saturated soils can be compacted with extended grazing.

Related Types/Synonyms: Padgett *et al.* (1989) describe a *Salix boothii*/mesic forb community that includes stands dominated by *Salix drummondiana* with *Salix monticola* occasionally present in small amounts. Johnston (1987) lists a *Salix drummondiana/Calamagrostis canadensis* association that included *Salix monticola* in the species list. Another similar plant association may be *Salix geyeriana-Salix* spp./*Calamagrostis canadensis* (Johnston 1987). Our stands are similar to some stands included in *Salix monticola/Calamagrostis canadensis* or *Salix drummondiana/Mertensia ciliata* associations described by Cooper and Cottrell (1990) from the Colorado Front Range. However, the mesic forb types tend to have low graminoid cover and higher forb cover compared to the *Calamagrostis canadensis* types.

Table 54. *Salix monticola/*Mesic Forbs Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM27	96AM10
Riparian Condition Rank	A	A
TREES		
Pinus contorta - tree		19
SHRUBS		
Alnus incana	1	
Betula occidentalis	1	
Juniperus communis		1
Lonicera involucrata		1
Pentaphylloides floribunda	4	4
Salix bebbiana	7	11
Salix drummondiana	1	9
Salix exigua	4	
Salix irrorata	45	
Salix lucida ssp. *caudata*	7	
Salix lucida ssp. *lasiandra*	14	
Salix monticola	82	60
FORBS		
Erigeron sp.	1	3
Fragaria virginiana		7
Taraxacum officinale	1	4
Thermopsis divaricarpa	8	
Veronica sp.	3	
GRAMINOIDES		
Glyceria striata		
Poa palustris		
Poa pratensis		11
Equisetum pratense		1

Rocky Mountain willow/Mesic Graminoids (*Salix monticola/*Mesic Graminoids) Plant Association
CNHP Rank: G3/S3
5 Quantitative Plots:
Gunnison River Basin--1 plot (94MD16)
South Platte River Basin--4 plots (96AM44, 96AM06, 96AM62, 96AM84)

South Platte River Basin Reference Reach: A stand in very good condition, though constricted by a road, can be seen on Jackson Creek, Pike-San Isabel National Forest, Douglas County, T9S, R69W, Sec 12.

General Description and Comments: The *Salix monticola*/mesic graminoid (Rocky Mountain willow/mesic graminoid) plant association is a tall (5-8 ft, 1.5-2.5 m) deciduous shrublands, with an open to closed canopy of willows on broad, gentle floodplains, or in narrow canyons bottoms. The herbaceous undergrowth is diverse, with a variety of grass, grass-like (graminoid), and forb species. Generally, there is more grass than forb cover.

Regional Distribution: This association has not been reported outside Colorado. However in central and eastern Utah, *Salix monticola* dominated stands are infrequent, and, due to structural and ecological similarities, were included in *Salix boothii* associations (Padgett *et al.* 1989). *Salix monticola* also has a limited distribution in Idaho and largely associates with other *Salix* spp. (Brunsfeld and Johnson 1985). It may be that plant associations dominated by *Salix monticola* are abundant in Colorado, and become less frequent as they mix with other, more adapted species to the north and west in the Rocky Mountains.

Colorado Distribution: This association has been documented in the Gunnison and South Platte River Basins (Kittel *et al.* 1995, Colorado Natural Heritage Program 1996).

Vegetation: *Salix monticola* (Rocky Mountain willow) is a dense to open canopy (15-50%) with a variety of other shrubs including *Salix planifolia* (planeleaf willow) (0-37%) and *S. brachycarpa* (barren fruit willow) (0-5%) at higher elevations, and *Salix irrorata* (bluestem willow) (0-45%) or *Alnus incana* (alder) (0-15%) at lower elevations. Other shrubs present include *Pentaphylloides floribunda* (shrubby cinqfoil) (0-10%), *Ribes inerme* (gooseberry) (0-5%) and *Salix lucida* var. *caudata* (whiplash willow) (0-25%). Total graminoid cover ranges from 10-55%, and forb cover from 5-20%. Graminoid species include *Carex aquatilis* (0-5%), *Carex lanuginosa* (0-1%), *C. utriculata* (0-7%), *Poa pratensis* (0-40%), *P. Palustris* (0-13%) and *Juncus balticus* (0-8%). Forb species include *Achillea lanulosa* (0-10%), *Heracleum lanatum* (0-30%) and *Fragaria virginiana* (0-20%) (Table 55). Graminoids dominate in the low-lying, wetter swales, while forbs concentrate under the shrubs on hummocks and ridges.

Elevation: 7800-10,200 ft. (2400-3100 m).

Site Geomorphology: *Salix monticola* dominates stream reaches in moderately wide to narrow valleys (20-120 m) with broad, swift-moving streams and active floodplains. The ground surface is usually undulating, from past flooding or beaver activity. Stands occur right at streams edge, and up to 15 m from the channel, usually >0.5 m above the channel elevation.

Rosgen's Channel Type: Most stands occurred adjacent to fairly steep, narrow channels with cobble beds (A4, F4), other stands occur on meandering, broader rivers, with a more developed floodplain (C4), and some stands occur on channel that are divided by beaver activity (D6).

Soil: Soils are fine textured clay loams and sandy clay loams of varying depths (10-45 cm). Mottling and gleyed layers are not uncommon within 12 cm of the ground surface.

Adjacent Riparian Vegetation: This association is often the only riparian vegetation along the reach, however *Pentaphylloides floribunda* shrublands occur on adjacent floodplains and Picea pungens forests may occur along adjacent, steeper canyons reaches.

Adjacent Upslope Vegetation: *Pinus ponderosa* (ponderosa pine), *Populus tremuloides* (aspen) and *Pinus contorta* (lodgepole pine) forests or arid grasslands occur on adjacent hill slopes.

Successional and Ecological Processes: The *Salix monticola/*mesic graminoid (Rocky Mountain willow/moist grasses and grass-like plants) appear to be stable, long-lived association. However, stands with an abundance of non-native grasses, such as *Poa pretenses* (Kentucky bluegrass) or *Agrostis stolonifera* (redtop), may be grazing induced disclimax of other *Salix monticola* (Rocky Mountain willow) plant associations. These sites become drier with time, and have reduced water holding capacity. Stands with abundant *Salix planifolia* (planeleaf willow) present may indicate that this association is transitional between higher sites dominated by *Salix planifolia* (planeleaf willow) and the wider, lower montane areas where *Salix monticola* (Rocky Mountain willow) becomes abundant.

Management: Season long (2-3 month) or late-summer, or deferred grazing will open the canopy and allow more sunlight to reach the ground, drying the site. In addition, late-season grazing will shift pressure from graminoids to willows, and may damage shrubs by removing all current year's growth (Kovalchik and Elmore 1992). This association has saturated soils that are compacted with extended grazing.

Related Types/Synonyms: Padgett *et al.* (1989) describe a *Salix boothii*/mesic graminoid community that includes stands dominated by *Salix drummondiana* with *Salix monticola* occasionally present in small amounts. In Colorado, *Salix monticola* is more common and an important component in the tall shrub layer. Johnston (1987) lists a *Salix drummondiana/ Calamagrostis canadensis* association that included *Salix monticola* in the species list. Another similar plant association may be *Salix geyeriana-Salix* spp./*Calamagrostis canadensis* (Johnston 1987). Our stands are similar to some stands included in *Salix monticola/Calamagrostis canadensis* or *Salix drummondiana/ Mertensia ciliata* associations described by Cooper and Cottrell (1990) from the Colorado Front Range.

Table 55. *Salix monticola*/Mesic Graminoids Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM84	96AM44	96AM06	96AM62
Riparian Condition Rank	B	C	A/B	B
TREES				
Picea pungens - tree		2		
SHRUBS				
Alnus incana	15			
Pentaphylloides floribunda		10		21
Rosa woodsii		1		
Salix bebbiana		2		3
Salix brachycarpa			1	3
Salix eriocephala ssp. *ligulifolia*				6
Salix exigua	1			
Salix irrorata	45			
Salix lucida ssp. *caudata*	25			1
Salix monticola	48	76	25	15
Salix planifolia			39	37
FORBS				
Angelica ampla	1	4		
Dodecatheon pulchellum		2		
Taraxacum officinale	1	7	1	1
Thermopsis divaricarpa				7
GRAMINOIDES				
Agrostis stolonifera	1	1		
Carex aquatilis			8	9
Carex lanuginosa				1
Carex utriculata		4		7
Carex sp.	1	3	1	7
Juncus balticus		12		8
Phleum pratense		3		
Poa compressa			1	3
Poa palustris	13			1
Poa pratensis	1	36		
Equisetum arvense	1	1		1

Unclassified *Salix monticola* Stands:

Garber Creek (plot 95LS21) is a narrow creek running through irrigated hay fields and several irrigation diversions and ponds filled with *Typha latifolia.* It is a foothills stream at 1,860 m (6100 ft) elevation. It has a mix of *Salix monticola, S. exigua*, with many stems of *Alnus incana* and *Populus angustifolia* (Table 56). The stream channel itself was nearly choked with herbaceous vegetation, indicating some effluent or other upstream pollution problem. The site has a history of over-grazing, and was once a severely down-cut channel which can be seen in downstream reaches. Today it is under new management and the abundance of woody species appears to indicate transitional recovery. The site appears to have the potential of a mosaic of *Populus angustifolia/Alnus incana* and *Salix monticola* plant associations, among others.

Table 56. Unclassified *Salix monticola* Dominated Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot No.	95LS21
Riparian Condition Rank	B/C
TREES	
Populus angustifolia	15
Salix amygdaloides	5
SHRUBS	
Alnus incana	3
Salix lucida var. *caudata*	13
Salix exigua	38
Salix monticola	35
GRAMINOIDES	
Poa pratensis	23

UNESCO: III.B.2.b. COLD-DECIDUOUS, SUBALPINE, SHRUBLAND
COWARDIN: PALUSTRINE-SCRUB-SHRUB SHRUBLAND, DECIDUOUS

Salix brachycarpa Alliance

Barren willow/water sedge (*Salix brachycarpa/Carex aquatilis*) Plant Association
CNHP Rank: G2G3/S2S3
2 Quantitative Plots:
South Platte River Basin:-- 2 plots (96AM46, 96AM49)

South Platte River Basin Reference Reaches: No references reaches of this association were found within the study area, however a stand in moderately good condition can be seen along the Middle Fork of the South Platte River, Park County, T11S, R76W, Sec 9, owned by the City of Aurora.

General Description and Comments: The *Salix brachycarpa/Carex aquatilis* is a short stature (0.4-1 m) willow shrubland with an open canopy. It grows along narrow, sinuous stream floodplains in the upper montane elevations of the Rocky Mountains. *Salix brachycarpa* is not typically associated with the moist mesic sedge *Carex aquatilis*. This combination may mean the site was once wetter and is now become drier, and the S*alix brachycarpa* becoming established.

Regional Distribution: This association has only been reported from Colorado (Colorado Natural Heritage Program 1996) and is expected to occur in Utah (Padgett *et al.* 1989).

Distribution in Colorado: This association is known only from the Colorado Front Range.

Vegetation: *Salix brachycarpa* is the dominant willow with 14-20% cover. Other shrubs present include *Pentaphylloides floribunda* (3-10%), *Salix monticola* (0-5%) and *Salix wolfii* (0-7%). The herbaceous undergrowth is a thick carpet of grasses and grass-like plants, dominated by *Carex aquatilis* (14-30%), *Carex scopulorum* (0-21%) *Deschampsia cespitosa* (0-10%) and *Juncus balticus* var. *montanus* (11-22%) (Table 57).

Elevation: 9200-10,200 ft. (2800-3100 m).

Site Geomorphology: This association occurs on low floodplains immediate adjacent to the stream channel.

Rosgen's Stream Channel Type: Streams where this association occurs are broad meandering streams with low gradients (C3) or have low gradient, braided channels (D6).

Soils: One site has deep (57+ cm) organic soils with the water table within 20 cm of the surface (on July 19, 1996). The other site had deep (65 cm) mineral soil with textures of loam, sandy clay loam, and silty clay loam. Abundant mottles (50%) are present within the first layer (20 cm) and the water table was between 0.50 and 1.0 m of the surface on Aug. 6, 1996.

Adjacent Riparian Vegetation: *Salix brachycarpa/Carex aquatilis* is the only riparian vegetation along the immediate floodplain. On slightly higher ground *Pentaphylloides floribunda* shrublands occur.

Adjacent Upland Vegetation: Adjacent stands of upland vegetation are *Picea engelmannii* and *Populus tremuloides* forests, or open grazing pastures.

Succession and Ecological Processes: The combination of *Salix brachycarpa* with *Carex aquatilis* is unusual. Soils data indicate the sites are perennially wet, or have been in the past, and it may be likely that with heavy grazing and recreational use the site has begun to dry out slightly, allowing for *Salix brachycarpa* establishment. Both sites have abundant *Pentaphylloides floribunda*, and *Juncus balticus* var. *montanus*, which are increasers under persistent heavy grazing by livestock. The site may be shifting from a *Salix monticola* or *S. planifolia* dominated type to a *Pentaphylloides floribunda* or *Salix brachycarpa* dominated site.

Management: Apparent past land use of sites indicates a drying of a once wet areas dominated by other willows, such as *Salix monticola* and *Salix planifolia*. A rest from grazing and/or a shift to short duration grazing during the mid-growing season may arrest degradation and allow for site improvement.

Related Types/Synonyms: Padgett *et al.* (1989) report that no *Salix brachycarpa* dominated stands were sampled in Utah, however they are expected to occur, especially on calcareous soils. A *Salix brachycarpa/Carex aquatilis* plant association has been described previously by Beirly (1972) from Rocky Mountain National Park, Colorado. However, studies at the same locations has since determined that no *Salix brachycarpa* occurs at the site. All of Bierly's willow specimens at Colorado State University have been annotated to be *Salix planifolia* (Cooper 1990).

Table 57. *Salix brachycarpa/Carex aquatilis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM64	96AM46
Riparian Condition Rank	B	B
TREES		
Picea engelmannii - tree		3
Picea engelmannii - sapling		
Picea pungens - tree		2
SHRUBS		
Pentaphylloides floribunda	9	3
Salix brachycarpa	14	21
Salix eriocephala ssp. *ligulifolia*		6
Salix monticola	5	
Salix planifolia		1
Salix wolfii		7
FORBS		
Cardamine cordifolia		6
Fragaria virginiana	2	1
Maianthemum stellatum	9	
Mertensia ciliata		1
Pedicularis groenlandica		1
Potentilla sp.	11	
Thermopsis divaricarpa	30	
GRAMINOIDES		
Carex aquatilis	27	14
Carex scopulorum		21
Carex utriculata	15	4
Carex sp.		8
Deschampsia cespitosa	3	10
Eleocharis palustris		14
Juncus balticus var. *montanus*	22	11
Poa compressa	12	
Equisetum arvense	1	4

Planeleaf willow/marsh marigold (*Salix planifolia/Caltha leptosepala*) Plant Association
CNHP Rank: G4/S4
72 Quantitative Plots:
San Juan National Forest--18 plots (41, 46, 69, 70, 71, 87, 94, 153, 170, 192, 195, 227, 229, 244, 245, 250, 255, 259)
San Miguel/Dolores River Basin--3 plots (56, 57, 89)
Gunnison River Basin--16 plots (08A, 09B, 10D, 20A, 94GK07, 94GK33, 94JB14, 94JB24, 94JB29, 94JB32, 94JB34, 94JB42, 94MD13, 94RR39, 94RR41)
Colorado River Basin-- 12 plots (19B, 24C, 28B, 28C, 30B, 34B, 93SS02, 93SS26, 93SS49, 93GK45, 93DR17, 93RR57)
Routt National Forest--13 plots (181, 421, 533, 534, 538, 562, 563, 565, 579, 588, 610, 615, 619)
Arkansas River Basin--1 plot (95RR26)
South Platte River Basin--9 plots (95LS19, 96GK37, 96GK20, 96LS37, 96AM66,96AM53, 96AM82, 96AM59, 96AM94).

South Platte River Basin Reference Reaches: Several high quality examples of this type were located in the study area. One stand can be seen along the Middle Fork of the South Platte River, Pike-San Isabel National Forest, Park County, T8S, R78W, Sec 9. Another large occurrence can be seen on Scott Gomer Creek, Mt. Evens Wilderness Area, Pike-San Isabel National Forest, Clear Creek County, T5S, R74W, Sec 29 and 32.

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 2 feet (0.5 m) tall, and a thick carpet of forbs in the undergrowth. There may be scattered patches of other willows present.

Regional Distribution: This plant association occurs in northwestern and north-central Wyoming (Johnston 1987) and Colorado (Colorado Natural Heritage Program 1996).

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 and South Platte River Basins (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996).

Vegetation: *Salix planifolia* (planeleaf willow) forms nearly pure stands with 30-100% cover. Other willows present at lower elevations include 0-20% cover of *Salix geyeriana* (Geyer willow) and 0-10% cover of *Salix monticola* (Rocky Mountain willow). At higher elevations, other shrubs include 0-30% cover of *Salix brachycarpa* (barrenground willow) on drier sites, and

0-15% cover of *Betula glandulosa* (glandular birch) and 0-10% cover of *Salix wolfii* (wolf's willow) on wetter sites. *Picea engelmannii* (Engelmann spruce) is occasionally scattered throughout the stand with 0-30% cover (Table 58).

Typically, the willow canopy is 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 0-60% cover of *Cardamine cordifolia* (heartleaf bittercress), 1-40% cover of *Caltha leptosepala* (marsh marigold), 0-30% cover of *Senecio triangularis* (arrowleaf groundsel), 0-20% cover of *Mertensia ciliata* (mountain bluebells), and 0-10% cover each of *Pedicularis groenlandica* (elephant-head), *Polygonum bistortoides* (American bistort), and *Sedum rhodanthum* (pink stonecrop). Graminoids include 0-40% cover of *Calamagrostis canadensis* (bluejoint reedgrass) and 0-30% cover of *Carex aquatilis* (aquatic sedge). While graminoid cover can be high, the *Salix planifolia/Caltha leptosepala* type is differentiated from the *Salix planifolia/Carex aquatilis* type by the high abundance of many forb species, including but not always dominated by, *Caltha leptosepala*.

Elevation Range: 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.

Rosgen's Stream Classification: This association occurs on stream with gradients that range from <1% in broad floodplains to 14% in steep snowmelt basins. Channels may be steep and narrow, first-order streams in snow melt basins (A3), relatively wide and straight (B3 and B4), narrow, relatively deep, and meandering in broad glaciated valleys (E3 and E4) or braided, multiple channels below beaver dams (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 gravelly alluvium. Some stands occur on well-drained, mineral soils with well-oxygenated water and no mottled or gleyed layers. Other sites include 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. 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. Many of the stands on the Routt National Forest occurred on peaty Histisols (Steve Kettler, personnel communication).

Successional and Ecological Processes: 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 considered to be a long-lived, stable association that will change with fluctuations in the water table and degree of soil saturation. Heavy grazing will open the canopy and lower the water table through increased evapotranspiration. This will dry the site and allow *Salix brachycarpa* (barrenground willow), *Salix wolfii* (wolf's willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) to become established (Kittel *et al.* 1994). Cooper and Cottrell (1990) state that it is possible, but unlikely, that this type is successional to another (presumably drier) *Salix planifolia* type, such as the *Salix planifolia*/Mesic graminoids plant association..

Adjacent Riparian Vegetation: Adjacent saturated areas have *Carex aquatilis* (aquatic sedge), *Carex utriculata* (beaked sedge) *Caltha leptosepala* (marsh marigold) and *Eleocharis palustris* (creeping spikerush) meadows or other *Salix planifolia* (planeleaf willow) shrublands. Adjacent drier areas are *Salix brachycarpa* (barrenground willow) shrublands or *Deschampsia cespitosa* (tufted hairgrass) grasslands. *Picea engelmannii* (Engelmann spruce) and *Abies lasiocarpa* (subalpine fir) forests occur in adjacent riparian areas along narrower valley reaches.

Adjacent Upland vegetation: Adjacent hillslopes are covered with *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests, *Salix brachycarpa* (barrenground willow) shrublands, or upland meadows with *Danthonia* spp. (oatgrass). At higher elevations, the surrounding slopes are alpine tundra dominated by *Acomastylis rossii* (Ross avens).

Management: The soils of this plant association are highly susceptible to compaction by livestock due to saturated conditions throughout the growing season. However, livestock will typically avoid these sites until August or September, due to the wet soils. 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 downcutting. This allows *Salix brachycarpa* (barrenground willow) or *Pentaphylloides floribunda* (shrubby cinquefoil) and drier herbaceous species to become established (Hansen *et al*. 1995).

Mid-season and rest rotation grazing systems are recommended for maintaining the vigor and productivity of this plant association (Kovalchik and Elmore 1992). 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 high water table necessary to the health of the riparian ecosystem. Beaver dams also aid in controlling channel downcutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophytic 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).

Little is known on the response of *Salix planifolia* to fire. Care should be taken when burning this association near stream banks due to the excellent erosion protection it provides (Hansen *et al*. 1995).

Salix planifolia is valuable in revegetating disturbed stream banks. Cuttings should first be rooted and grown in a nursery. Best results are obtained from cuttings taken in the spring from dormant 2-4 year old wood. The cuttings should be 12-20 inches (30-50 cm) long and greater than 0.5 inches (1 cm) in diameter. Once transplanted, roots and shoots should appear within 10-15 days (Hansen *et al*. 1995).

Related Types/Synonyms: Identical communities include the *Salix planifolia-Salix wolfii/Caltha leptosepala* (planeleaf willow-wolf's willow/marsh marigold) type and the *Salix planifolia-Salix brachycarpa/Caltha leptosepala* (planeleaf willow-barrenground willow/marsh marigold) type described by Reid and Bourgeron (1991). Other identical communities include the *Salix brachycarpa-Salix planifolia/Caltha leptosepala-Carex aquatilis* (barrenground willow-planeleaf willow/marsh marigold-aquatic sedge) type described by Baker (1986), the *Salix planifolia/ Caltha leptosepala* type described by Cooper and Cottrell (1990) and Hess and Wasser (1982), and the *Salix phylicifolia* spp. *planifolia/Caltha leptosepala* association described by Johnston (1987). *Salix phylicifolia* spp. *planifolia* is a synonym for *Salix planifolia* (Kartesz 1994). A similar *Salix planifolia/*forb community type is described by Girard *et al.* (1995), but does not include *Caltha leptosepala* in the undergrowth.

Table 58. *Salix planifolia/Caltha leptosepala* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96GK37	96GK20	96LS37	96AM66	96AM53	96AM82	96AM94	96AM59
Riparian Condition Rank	A	A	A	B	A	A	A	A
TREES								
Picea engelmannii		2					5	18
SHRUBS								
Salix brachycarpa					15	12		
Salix planifolia	91	77	71	87	62	54	47	16
Salix wolfii			8	7		1		
Vaccinium cespitosum								14
FORBS								
Anemone canadensis		12						
Antennaria coryombosa						13		
Antennaria parviflora			14					
Aster sp.	1	15	2	7	16			
Caltha leptosepala	22	33	20	1	24	15	18	25
Cardamine cordifolia	1			1	1		2	4
Conioselinum scopulorum		4	7	2				
Delphinium sp.							14	
Epilobium angustifolium				6	4		1	2
Erigeron peregrinus	9							12
Ligusticum tenuifolium					18			20
Mertensia ciliata		1		2	1			
Oxypolis fendleri				2			6	3
Pedicularis groenlandica		2		1	7	7		19
Saxifraga odontoloma							8	5
Senecio triangularis	7	6		1			2	5
Trifolium parryi						10		
Viola canadensis	2		8					
GRAMINOIDES								
Agrostis humilis			31					
Calamagrostis canadensis	4	7			1		1	
Carex aquatilis	9	3	27	3		10		31
Carex raynoldsii					18			
Carex sp.	4		2	1	2	1		16
Deschampsia cespitosa			19			7		1

Planeleaf willow/aquatic sedge (*Salix planifolia/Carex aquatilis*) Plant Association
CNHP Rank: G5/S4
14 Quantitative Plots:
Yampa River Basin--2 (GK11, GK13)
Colorado River Basin-- 7plots (92NL30, 92GL28, 93SS17, 93SS19, 93SS48, 93SS44, 93DR05),
Gunnison River Basin--3 plots (94MD30, 94RR30, 94RR43),
Arkansas River Basin--1 plot (95RR24),
South Platte River Basin--13 (95GK20, 96GK45, 96LS22, 96LS23, 96GK29, 96LS27, 96AM79, 96AM55, 96AM78, 96LS28, 96GK21, 96AM75, 96LS31)

South Platte River Basin References Reaches: Two excellent example of this type were found in the study area. One can be seen along the North Fork of the South Platte River, Pike-San Isabel National Forest, Park County, T8S, R73W, Sec 18 and 19. The other stand can be seen at Lost Park Fen, on the South Fork of the South Platte River, Pike-San Isabel National Forest, Park County, T8S, R73W, Sec 32 and 33.

General Description and Comments: *The Salix planifolia/Carex aquatilis* is a low-stature willow shrubland of nearly pure stands of *Salix planifolia* (planeleaf willow), commonly found on wet, boggy soils in subalpine valley bottoms. At higher elevations, *Salix planifolia* can mix with *Salix brachycarpa* (barrenground willow) or *Salix wolfii* (wolf's willow). At lower elevations, *Salix planifolia* grades into taller willow carrs with *Salix monticola* (Rocky Mountain willow), or *Salix geyeriana* (Geyer willow) shrublands.

Regional Distribution: This plant association and similar types occur in Montana (Hansen *et al*. 1995), Wyoming (Girard *et al.* 1995, Youngblood *et al.* 1985), Idaho (Youngblood *et al.* 1985), Utah (Padgett *et al.* 1989), and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This plant association is a common type and occurs throughout the Rocky Mountains of Colorado (Kittel and Lederer 1993, Kittel *et al*. 1994, Kittel *et al.* 1995, Kettler and McMullen 1996, Sanderson and Kettler 1996, Kittel *et al*. 1996).

Vegetation: This plant association is characterized by 10-70% cover of low-stature (.5-1.5 m) *Salix planifolia* (planeleaf willow). Other willows can intergrade with *S. planifolia*, depending on the elevation. At the upper end of its range, the association can have *Salix brachycarpa* (barrenground willow) and *Salix wolfii* (Wolf willow) up to 20% each. At lower elevations, *S. planifolia* becomes taller and can intermix with *Salix monticola* (Rocky Mountain willow), *Salix boothii* (Booth willow), *Salix geyeriana* (Geyer willow) and *Salix drummondiana* (Drummond willow) with 0-40% cover each. One stand in the Colorado River Basin had 80% cover *Salix brachycarpa* which was confined to the slightly steeper and drier edges of a *Salix planifolia* dominated wet swale.

The undergrowth is dominated by graminoids including 0-30% cover of *Carex aquatilis* (aquatic sedge), 0-50% cover of *Carex utriculata* (beaked sedge), 0-40% cover of *Calamagrostis* *canadensis* (bluejoint reedgrass), and 0-20% cover of *Deschampsia cespitosa* (tufted hairgrass). Forb cover is typically less than 20% of the total undergrowth cover and includes 0-10% cover each of *Caltha leptosepala* (marsh marigold), *Cardamine cordifolia* (heartleaf bittercress) and *Pedicularis groenlandica* (elephant-head) and 0-5% cover of *Conioselinum scopulorum* (hemlock parsley) (Table 59).

Elevation Range: 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.

Rosgen's Stream Classification: This association occurs on stream channels that are wide and moderately sinuous (B3), narrow and sinuous (E4), or highly divided by beaver activity (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 Histosols, Cryaquolls, Hemists, and Borohemists.

Adjacent riparian vegetation: Adjacent riparian wetland vegetation include *Carex aquatilis* (aquatic sedge), *Carex utriculata* (beaked sedge), or *Calamagrostis canadensis* (bluejoint reedgrass) wet meadows intergrading with the *Salix planifolia/Carex aquatilis* plant association. *Salix brachycarpa* (barrenground 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.

Successional and Ecological Processes: This plant association occurs in wet swales that are saturated throughout the growing season. The dense canopy layers and thick undergrowth indicate stable conditions. Both *Caltha leptosepala* (marsh marigold) and *Carex aquatilis* (aquatic sedge) can tolerate saturated soils, and occasionally they co-dominate the undergrowth (Padgett *et al.* 1989). Patches of *Carex utriculata* (beaked sedge) also occur (Johnston 1987). Succession towards other *Salix planifolia* types would be an extremely slow process following a drying trend and subsequent decomposition of organic material (Padgett *et al*. 1989). If the water table is lowered, other herbaceous species may become dominant in the undergrowth and with disturbance may eventually give way to non-native graminoid species such as *Poa pratensis* (Kentucky bluegrass) (Hansen *et al*. 1995).

Salix wolfii (Wolf's willow) is occasionally present in the *Salix planifolia/Carex aquatilis* plant association. *Salix wolfii* only occurs in small patches, never forming large, expansive willow carrs as does *Salix planifolia*. Mixed *Salix wolfii* and *Salix planifolia* stands represent a transition from *Salix wolfii* habitats to the more abundant and widespread *Salix planifolia* habitat.

In Montana, *Salix planifolia* occurs on wetter, finer textured soils than *Salix wolfii.* As sites become drier, *Salix wolfii* and grasses adapted to drier conditions increase in abundance (Hansen *et al.* 1988). In Idaho, the presence of *Salix wolfii* indicates a transitional habitat between wetter sites dominated by *Salix planifolia* (planeleaf willow) and drier sites dominated by *Salix geyeriana* (Geyer willow) (Brunsfeld and Johnson 1985). In Colorado, *Salix wolfii* establishes in wetter habitats and at slightly lower elevations than *Salix planifolia* (G. Kittel *personal observations*).

Carex utriculata (beaked sedge), *Carex aquatilis* (aquatic sedge), and *Calamagrostis canadensis* (bluejoint reedgrass) are dominant understory species of several *Salix* plant associations. These graminoids indicate different microenvironments within the *Salix* communities (Padgett *et al*. 1989) and may represent different stages of succession of the floodplain (Cooper 1986).

Carex utriculata, Carex aquatilis, and *Calamagrostis canadensis* separate out along a moisture gradient related to the depth of the water table at a particular site. *Carex utriculata* occurs on the wettest sites, such as low-lying swales, with the highest water tables. *Calamagrostis canadensis* dominates the driest sites with the lowest water tables and can colonizes drying stands of *Carex utriculata* and *C. aquatilis*. *Carex aquatilis* occurs on intermediate sites (Cooper 1986).

Successional shifts in species composition can be initiated by a change in the physical environment with 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 becomes less saturated, and the dominant graminoid understory can change.

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 the ground surface, often in standing water. 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).

Management: In general, graminoid and forb production is moderate in this plant association. Forage value for *Carex aquatilis* (aquatic 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). *Salix planifolia* (planeleaf willow) is highly palatable to wildlife and livestock while *Salix wolfii* (wolf's willow) is slightly less palatable.

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, depending on other forage availability. 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 downcutting. This allows *Salix brachycarpa* (barrenground 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, Kovalchik and Elmore 1992).

Salix planifolia and *Carex* (sedge) species are valuable for stabilizing or revegetating stream banks. *Carex aquatilis* and *Carex utriculata* are very effective due to their dense network of rhizomatous roots. *Salix planifolia* is valuable in revegetating disturbed stream banks. Cuttings should first be rooted and grown in a nursery. Best results are obtained from cuttings taken in the spring from dormant 2-4 year old wood. The cuttings should be 12-20 inches (30-50 cm) long and greater than 0.5 inches (1 cm) in diameter. Once transplanted, roots and shoots will appear within 10-15 days (Hansen *et al*. 1995).

Related Types/Synonyms: Several authors report identical *Salix planifolia/Carex aquatilis* habitat/community types (Padgett *et al.* 1989, Johnston 1987, Komarkova 1986, Hess 1981, Cooper and Cottrell 1990). Girard *et al.* (1995) report an identical *Salix planifolia/Carex* spp. ecological type from Bighorn National Forest. Hess and Wasser (1982) report an identical *Salix planifolia/Caltha leptosepala*-(*Carex aquatilis-Carex rostrata* phase) habitat type in Colorado. *Carex rostrata* var. *utriculata* is a synonym for *Carex utriculata* (Kartesz 1994).

A similar *Salix planifolia* community type (Youngblood *et al.* 1985) does not always have a significant cover of *Carex aquatilis*. Another, similar *Salix planifolia-Salix wolfii/Caltha leptosepala-Carex aquatilis* plant association (Baker 1989) 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.

Table 59. *Salix planifolia/Carex aquatilis* Plant Association Stands from the South Platte Watershed with Percent Cover by Dominant Species.

Plot Number (96----)	LS 27	AM 79	AM 55	AM 78	LS 28	GK 21	AM 75	LS 31	LS 22	LS 23	GK 29	GK 45	AM 81
Riparian Condition Rank	B	A	B	A	B	C	A	B/C	C	C	A	B	A
TREES													
Abies lasiocarpa - tree									4	3	2		
Abies lasiocarpa - sapling									4				
Picea engelmannii - tree			8			2	3		53	29	6		6
Picea engelmannii - seedling			3								2		
SHRUBS													
Betula glandulosa			27			4						6	
Lonicera involucrata			1						1				
Pentaphylloides floribunda			1	3			2						8
Salix brachycarpa			5						1	3	5		12
Salix drummondiana									17		24		
Salix planifolia	32	11	31	26	74	65	65	72	34	55	27	31	71
Salix wolfii			8									22	
FORBS													
Caltha leptosepala	13			4	2	14	7	18	23			11	
Cardamine cordifolia	4		1		8				4	5	1		
Conioselinum scopulorum								3	2	4	2	3	5
Epilobium ciliatum	4				4			1	14	9	1		
Heracleum sphondylium											25		
Mertensia ciliata	1				5		1	2	1		1		2
Oxypolis fendleri					3	2		1	1	9	1		
Pedicularis groenlandica			3	3					2	1	1	1	
Saxifraga odontoloma	8				4				14	13			
Senecio triangularis	4				12	10		6	5	8	5		
Viola canadensis	1				4			3	5	3	6	1	
GRAMINOIDES													
Calamagrostis canadensis	6				12	9		8	4	4	30	4	6
Carex aquatilis	84	65	46	46	43	34	51	18	40	34	34	16	8
Carex brunnescens				13									
Carex canescens	1	12							8				6
Carex disperma										26			31
Equisetum arvense			1			4			3				

Wolf's willow/aquatic sedge (*Salix wolfii*/*Carex aquatilis*) Plant Association
CNHP Rank: G4/S3
10 Quantitative Plots:
San Juan National Forest--2 plots (61, 78)
San Miguel/Dolores River Basin--1 plot (90)
Gunnison River Basin-- 1 plot (94RR48)
Colorado River Basin--1 plot (93RR63)
Routt National Forest--3 plots (331, 511, 512)
Arkansas River Basin--1 plot (95AM39, 95RR23)
South Platte River Basin--1 plot (96AM56)

South Platte River Basin References Reaches: A large, good condition example of this type can be seen on Beaver Creek, Pike-San Isabel National Forest, Park County, T9S, R77W, Sec 5 and 8.

General Description and Comments: This is a minor plant association of very wet sites in subalpine areas of Colorado. *Salix wolfii* only occurs in small patches and never forms large, expansive willow carrs common to *Salix planifolia.* *Salix wolfii* occurs in wetter sites than those dominated by *Salix planifolia* (planeleaf willow) and often forms a mosaic with stands of *Salix planifolia*, *Salix brachycarpa* (barrenground willow) and open *Carex* spp. (sedge) meadows.

Regional Distribution: The *Salix wolfii/Carex aquatilis* (wolf's willow/aquatic sedge) plant association occurs in Utah, southeastern Idaho (Padgett *et al.* 1989), Montana (Hansen *et al*. 1995), Wyoming (Youngblood *et al.* 1985), and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This association occurs on the Colorado West Slope in the San Juan and Routt National Forests, the San Miguel/Dolores, Gunnison and Colorado River Basins and on the East Slope in the Arkansas and South Platte River Basins (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Kittel *et al.* 1996, Kettler and McMullen 1996, Richard *et al.* 1996, Johnston 1987, Colorado Natural Heritage Program 1996).

Vegetation: The mid- to tall-shrub layer is dominated by 10-70% cover of *Salix wolfii* (wolf's willow). Other willow species include 0-30% cover of *Salix planifolia* (planeleaf willow), 0-10% cover each of *Salix boothii* (Booth's willow) and *Salix monticola* (Rocky Mountain willow), and on better-drained micro-sites, 0-5% cover of *Salix brachycarpa* (barrenground willow). *Betula glandulosa* (glandular birch) also occurs with 0-20% cover. The graminoid undergrowth is generally dense and rich, dominated by 10-80% cover of *Carex aquatilis* (aquatic sedge). Other graminoids include 0-30% cover of *Carex utriculata* (beaked sedge) and 0-10% cover of *Deschampsia cespitosa* (tufted hairgrass). Forb cover varies from sparse (<10%) to very dense (70%) and is generally diverse. Forb species include 0-20% cover each of *Caltha* *leptosepala* (marsh marigold), *Ligusticum tenufolium* (small ligusticum) and *Thalictrum alpinum* (arctic meadow rue) (Table 60).

Elevation Range: 8400-11,400 ft (2600-3500 m).

Site Geomorphology: The *Salix wolfii/Carex aquatilis* (wolf's willow/aquatic sedge) plant association occurs in moderately narrow to wide valleys and glacial basins. It occurs on saturated peat bogs, mesic swales and hummocks along flat to rolling floodplains with lateral seepage of ground water.

Rosgen's Stream Classification: Stream reaches can be moderately steep (gradient of 3-7%). Stream channels are deep, narrow, and sinuous (E4, E6), shallow, broad, and gently meandering (B2-B3), and highly divided by beaver activity (D4).

Soil: *Salix wolfii* (wolf's willow) appears to establish on heavier soils and wetter sites than those supporting *Salix planifolia* (planeleaf willow) associations (Kittel *personnel observation*). Soils vary from highly organic or peat to mineral-based. Soils textures include heavy silty clay loams, silty loams, and sandy clay loams with mottling. Some stands occur on deep sandy clays, often with a high organic content, and others occur on shallow silty clays over gravels and rocks. Stands in the Colorado River Basin occur on silty clay over deep peat and classify as hydric Borofibrists.

Adjacent Riparian Vegetation: Adjacent wet areas include *Salix planifolia*/*Caltha leptosepala* (planeleaf willow/marsh marigold) shrublands and *Carex aquatilis* (aquatic sedge)*, Carex utriculata* (beaked sedge)*,* or *Calamagrostis canadensis* (bluejoint reedgrass) meadows. *Deschampsia cespitosa* (tufted hairgrass) meadows and *Salix brachycarpa*/mesic forb (barrenground willow/mesic forb) shrublands occur on hummocks and side slopes.

Adjacent Upland Vegetation: At higher elevations, adjacent hillsides are covered with *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) or *Pinus contorta* (lodgepole pine) forests, subalpine meadows with *Festuca thurberi* (Thurber fescue) or alpine tundra. At lower elevations, *Artemisia tridentata* (big sagebrush) scrub is present.

Successional and Ecological Processes: The dense canopy and thick undergrowth of the *Salix wolfii/Carex aquatilis* (wolf's willow/aquatic sedge) plant association indicate stable conditions. *Carex aquatilis* is well-suited to wet, organic soils and succession will occur slowly under these conditions (Hansen *et al.* 1988). If the water table is lowered, other herbaceous species may become dominant in the undergrowth and eventually give way to non-native graminoid species such as *Poa pratensis* (Kentucky bluegrass) (Hansen *et al*. 1995).

Salix wolfii (Wolf's willow) is occasionally present in the *Salix planifolia/Carex aquatilis* plant association. *Salix wolfii* only occurs in small patches, never forming large, expansive willow carrs as does *Salix planifolia*. Mixed *Salix wolfii* and *Salix planifolia* stands represent a transition from *Salix wolfii* habitats to the more abundant and widespread *Salix planifolia* habitat. In Montana, it is believed that *Salix planifolia* occurs on wetter, finer textured soils than *Salix wolfii.* As sites become drier, *Salix wolfii* and grasses adapted to drier conditions increase in abundance (Hansen *et al.* 1988). In Idaho, the presence of *Salix wolfii* indicates a transitional habitat between wetter sites dominated by *Salix planifolia* (planeleaf willow) and drier sites dominated by *Salix geyeriana* (Geyer willow) (Brunsfeld and Johnson 1985). In Colorado, the opposite occurs. *Salix wolfii* establishes in wetter habitats and at slightly lower elevations than *Salix planifolia* (Kittel *personal observation*).

Management: Forage value for *Carex aquatilis* (aquatic 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 wolfii* willow carrs appear to be sensitive to trampling and soil compaction by livestock due to saturated conditions throughout the growing season. However, livestock will typically avoid these sites until August or September, due to the wet soils. 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 downcutting. This can result in the decrease of *Carex aquatilis* and the increase of other grasses and forbs (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 aid in controlling channel downcutting, stream bank erosion, and downstream movement of sediment. Beaver dams raise the water table and provide water for hydrophytic 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 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 consuming young, palatable regrowth. Prescribed burning can also 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 and *Carex* (sedge) species are valuable for stabilizing or rehabilitating stream banks. *Salix wolfii* is valuable in revegetating disturbed stream banks, but success in transplanting cuttings is inconsistent. Cuttings should first be rooted and grown in a nursery. Best results are obtained from cuttings taken in the spring from dormant 2-4 year old wood. The cuttings should be 12-20 inches (30-50 cm) long and greater than 0.5 inches (1 cm) in diameter. Once transplanted, roots and shoots will appear within 10-15 days. *Carex aquatilis* and *Carex utriculata* are very effective stream bank stabilizers due to their dense network of rhizomatous roots (Hansen *et al*. 1995).

Related Types/Synonyms: Identical *Salix wolfii/Carex aquatilis* types are described by Youngblood *et al.* (1985), Padgett *et al.* (1989), Johnston (1987), Girard *et al.* (1995), Hansen *et al. (*1995). Some stands dominated solely by *Salix wolfii* that are included in the broadly defined *Salix planifolia-Salix wolfii/Calamagrostis canadensis-Carex aquatilis* plant association (Baker 1989) can be included in the *Salix wolfii/Carex aquatilis* type.

Table 60. *Salix wolfii/Carex aquatilis* Plant Association Stand from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM56
Riparian Condition Rank	B
SHRUBS	
Pentaphylloides floribunda	2
Salix brachycarpa	20
Salix monticola	13
Salix planifolia	21
Salix wolfii	32
FORBS	
Fragaria virginiana	1
Taraxacum officinale	1
GRAMINOIDES	
Carex aquatilis	24
Deschampsia cespitosa	1
Juncus balticus	1
Equisetum arvense	1

UNESCO: **V.A.2.k. TEMPERATE, SEASONALLY FLOODED/SATURATED, PERENNIAL GRAMINOID DOMINATED HERBACEOUS ASSOCIATIONS**
COWARDIN: **PALUSTRINE PERSISTENT EMERGENT WETLANDS**

Carex aquatilis Alliance

Water sedge (*Carex aquatilis*) Plant Association
CNHP Rank: G5/S4
33 Quantitative Plots:
San Juan National Forest - 8 plots (61, 162, 163, 188, 246, 248, 252, 260)
Routt National Forest - 7 plots (21, 251, 411, 599, 609, 613, 620)
Gunnison River Basin--10 plots (11D, 94GK14, 94JB19, 94JB21, 94JB25, 94MD35, 94RR10, 94RR33, 94RR40, 94RR45)
Colorado River Basin-- 1 plots (24B, 34C)
San Miguel/Dolores River Basin-- 2 plots (91NL58, 91NL91)
Arkansas River Basin--2 plots (95AM12, 95AM35)
South Platte River Basin--3 plots (96AM43, 96AM03, 96AM40)

South Platte River Basin References: No reference reaches were found, however a typical, if narrow, example of this type in moderate condition can be seen along Pine Gulch, State Land/Jefferson County Open Space, Jefferson County, T6S, R 71W, Sec 17.

General Descriptions and Comments: The *Carex aquatilis* is a common, wide spread meadow association that can occur as large monotypic stands in high montane valleys or as narrow grassy areas 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 similar types.

Regional Distribution: This common type is widespread throughout the Rocky Mountain region. It is reported from mid to high-elevations in Montana (Hansen *et al.* 1988), eastern Idaho, western Wyoming (Youngblood *et al.* 1985) and Utah (Padgett *et al.* 1989 and Johnston 1987).

Distribution in Colorado: In Colorado, the *Carex aquatilis* plant association is a major type known throughout the state in subalpine environments. It has been reported from Roosevelt, Arapaho, White River, Routt, and Gunnison National Forests, and Rocky Mountain National Park (Johnston 1987, Kettler and McMullen 1996), as well as from the Yampa, San Miguel, Dolores, Colorado, White, Gunnison, Arkansas and South Platte River Basins (Kittel and Lederer 1993, Kittel *et al.* 1994, Kittel *et al.* 1995, Colorado Natural Heritage Program 1996).

Vegetation: This plant association is characterized by a dense rhizomatous sward of *Carex aquatilis* (aquatic sedge) (55-71%), usually accompanied by a few other graminoids species such as *Juncus balticus* (Baltic sedge) (0-5%) and others. *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 *Cardamine cordifolia* (watercress) (0-11%), *Galium trifidum* (bedstraw) (1%), and *Geum macrophyllum* (big-leaf geum) (1%) (Table 61).

Elevation: 8100-11,400 ft. (2460-3500 m)

Site Geomorphology: This plant association occurs in a variety of valley types, but large expanses of it 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 of lakes and beaver ponds.

Rosgen's Channel Type: The largest occurrences are found near narrow, deep, sinuous streams (E4, E5, E6). Some stands occur along steep streams (A3), others along wide, shallow streams (B3), and also where beaver dams and ponds have altered the channel morphology.

Soil: Soils are mostly deep, dark-colored heavy clays, silts or organic layers over more skeletal layers. Soils are often saturated to the surface with mottling is commonly present within 10 cm of the surface.

Adjacent riparian vegetation: This meadow association almost always occurs in a mosaic of many riparian plant associations, including *Salix planifolia* (plane-leaf willow), *Salix wolfii* (Wolf willow), and *Salix monticola* (Rocky Mountain willow) dominated shrublands, and *Carex utriculata* (beaked sedge) wetlands in adjacent standing water.

Adjacent upland vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests, or alpine fell-fields occur on adjacent hillslopes.

Successional and Ecological Processes: The presence of *Carex utriculata* in a Carex aquatilis stand may indicate the site is in transition from a wetter site (once dominated by *Carex utriculata*) to a more dry site, where *Carex aquatilis* can become dominant, replacing the *Carex utriculata*. In time, *Salix planifolia* or *Salix wolfii* may become established (Youngblood et al. 1985). Wilson (1969) reports that *Carex aquatilis* (aquatic sedge) associations can trap sediment from over bank flows which forms a clay pan, eventually raising the water table. This process drives retrogressive succession and the site may become dominated by a *Carex utriculata* (beaked sedge) plant association (Wilson 1969).

Management: The *Carex aquatilis* type occurs on soils that are typically wet throughout the growing season, and livestock grazing can often cause hummocking and pitting of the soil (Padgett *et al.* 1989). *Carex aquatilis* is highly palatable to cattle and horses and provides valuable 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.

Carex (sedge) species are heavily utilized by livestock in narrow riparian sites within extensive 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).

Mid-season 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 that may be present within the riparian mosaic 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 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 (for fuel build up) and at least 2-3 years after burning. This is necessary in order to keep livestock from consuming all the young, palatable regrowth. Prescribed burning is also an effective method of rejuvenating decadent clumps of willows that may be present. 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).

Related types/Synonyms : Identical types are 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), Youngblood *et al.* (1985). Stands of pure *Carex aquatilis* may be included within the broader type *Carex aquatilis-Carex utriculata* described by Johnston (1987) and Hess and Wasser (1982), and the *Carex aquatilis-Carex utriculata-Deschampsia cespitosa* type described by Baker (1989). Our classification is more narrowly defined by clear dominance of *Carex aquatilis* with little to no cover of *Carex utriculata.*

Table 61. *Carex aquatilis* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM43	96AM03	96AM40
Riparian Condition Rank	C	C	C
SHRUBS			
Pentaphylloides floribunda			6
Salix eriocephala ssp. *ligulifolia*	6		
Salix exigua			6
FORBS			
Angelica ampla			7
Potentilla sp.	15		2
Rumex densiflorus			11
Taraxacum officinale	1	1	4
GRAMINOIDES			
Agrostis gigantea			1
Agrostis stolonifera	7		
Carex aquatilis	25	45	13
Carex lanuginosa	2		
Carex nebraskensis	4		
Carex utriculata	6		
Deschampsia cespitosa	3		
Eleocharis sp.	14		
Glyceria grandis			3
Glyceria striata			3
Juncus balticus	10	1	1
Poa palustris	7		
Poa pratensis	2	5	6
Scirpus microcarpus	10		
Equisetum arvense	1	1	1

Carex nebrascensis Alliance

Nebraska sedge (*Carex nebrascensis*) Plant Association
CNHP Rank: G4/S3
6 Quantitative Plots:
White River Basin--1 plot (92GK26)
Colorado River Basin--1 plot (93RR11)
South Platte River Basin--4 Plots (95LS01, 95LS05, 95GK02, 95GK03).

South Platte River Basin Reference Reaches: No reference reaches were found in the study area, however an occurrence in good condition can be seen on Twomile Creek on the Pawnee National Grasslands, Weld County, T11N, R56W, Sec 32.

General Description and Comments: This is an open wetland meadow, often on saturated soils for much of the growing season. It generally occurs along the margins of stream banks and lakes.

Regional Distribution: The *Carex nebrascensis* is a widespread species, and generally forms small to medium-sized meadows where it occurs. It has been reported as a plant association from New Mexico (Durkin *et al.* 1994, Durkin *et al.* 1995), Utah (Padgett *et al.* 1989), Wyoming (Jones and Walford 1995), Montana (Hansen *et al.* 1989), Idaho, Arizona, and Washington (Johnston 1987), and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: In Colorado, it occurs in the lower montane (Kittel *et al.* 1994, Cooper and Cottrell 1990) and on the plains in the northeastern part of the state (Baker 1982, as cited in Johnston 1987).

Vegetation: This plant association is comprised of *Carex nebrascensis* (Nebraska sedge) (30-66%) with *Carex praegracilis* (clustered sedge) (0-6%), *Eleocharis palustris* (creeping spikerush) (10-40%), and *Scirpus pungens* (common threesquare) (1-10%). Forb cover is low with *Ranunculus cymbalaria* (marsh buttercup) (0-11%) and *Melilotus officinalis* (yellow sweet clover) (1-16%). *Potamogeton* sp. (pondweed) is abundant in one stand sampled (34%) (Table 62).

Elevation: 1,250- 1,580 m (4,100-5,230 ft).

Site Geomorphology: This plant association appears to be restricted to very wet soils bordering standing ponds and pools of low gradient stream channels. Stands on the Great Plains occur on undulating stream bends, forming a sort of pool-meadow sequence that, with higher stream flows, becomes a pool-riffle sequence. The *Carex nebrascensis* (Nebraska sedge) plant association occurs on wet-meadow areas between channel pools and as a narrow band around pool edges.

Rosgen's Channel Type: This plant association occurs on small meandering streams of low gradient (0.5-0.75%) with little floodplain development (C6 to F6).

Soil: Soils of this plant association are heavy clays and silty clay loams with high organic matter content. All soils sampled had signs of periodic anoxic conditions, either in the form of a gleyed layer or abundant mottling within 20 cm of the surface.

Adjacent Riparian Vegetation: Adjacent riparian associations are *Carex praegracilis* (clustered sedge), *Scirpus lacustris* (bulrush) , and *Salix exigua* (coyote willow) types.

Adjacent Upland Vegetation: Upland slopes are mostly *Bouteloua gracilis* (blue grama) short grass prairies.

Successional and Ecological Processes: In Montana, the *Carex nebrascensis (Nebraska sedge)* association is thought to represent a grazing disclimax (Hansen *et al.* 1995). *Carex nebrascensis (Nebraska sedge)* occupies some of the wettest habitats, and the soils are easily compacted by grazing when saturated in early spring and summer.

Management: *Carex nebrascensis* (*Nebraska sedge*) dominated meadows can be important forage for grazing and as cut hay (Herman 1970). It is not considered as palatable as other *Carex* spp., and may increase with heavy grazing pressure, as it can be in the late-season (Herman 1970). Moist soils are subject to compaction.

Related Types/Synonyms: The *Carex nebrascensis (Nebraska sedge)* type has been well documented in the literature, as well as a co-dominant in other plant associations including, but not limited to, *Carex aquatilis*, *Carex utriculata*, and *Juncus balticus* (Padgett *et al.* 1989, Durkin *et al.* 1994, 1995, Johnston 1987, Kittel and Lederer 1993, Kittel *et al.* 1994, Jones and Walford 1995, Hansen *et al.* 1988, 1989, Cooper and Cottrell 1990, Bourgeron and Engelking 1994).

Table 62. *Carex nebrascensis (Nebraska sedge)* Plant Association Stands from the South Platte Watershed with Percent Cover for Dominant Species.

Plot Number	95LS01	95LS05	95GK02	95GK03
Riparian Condition Rank	C	B	C	D
FORBS				
Melilotus officinalis		1	1	16
Potamogeton sp.	34		1	
Ranunculus cymbalaria	11		1	1
GRAMINOIDES				
Carex nebrascensis	67	30	63	33
Carex praegracilis		1	6	
Eleocharis palustris	43	10	10	26
Juncus balticus	1			
Poa pratensis	1	3	1	2
Scirpus pungens	13	10	1	1
Spartina gracilis		1		

Carex praegracilis Alliance

Clustered Sedge (*Carex praegracilis*) Plant Association
CNHP Rank: G4/S4
2 Quantitative Plots:
South Platte River Basin--2 Plots (95GK01, 95LS02)

South Platte River Basin Reference Reaches: No reference reaches were found, however a typical stand in moderate condition can be seen along Willow Creek, Pawnee National Grassland, Weld County, T10N, R 63W, Sec 32.

General Description and Comments: This is an open meadow in swales following stream courses on the short-grass prairie.

Regional Distribution: Plant associations dominated or co-dominated by this species have been reported from Montana (Hansen *et al.* 1988), Wyoming (Jones and Walford 1995), Idaho and Utah (Bourgeron and Engelking 1994) and New Mexico (Durkin *et al.* 1994).

Distribution in Colorado: This association has not been previously reported from Colorado, however it was found along small creeks of the Pawnee National Grassland, and is likely to occur throughout the northern plains.

Vegetation: This plant association is a narrow, moist band of *Carex praegracilis* (clustered sedge) (24-34%) with *Carex nebrascensis* (Nebraska sedge) (3-12%), *Eleocharis palustris* (creeping spikerush) (0-11%), and *Equisetum laevigata* (scouring rush) (1-3%). No shrubs or trees are present, and the ground is completely covered with standing live biomass (Table 63).

Elevation: 5000-5100 ft. (1500-1560 m).

Site Geomorphology: This association occurs along small, shallow drainages, usually no more than 2-5 meters wide, with a stream width of .5-1.0 m. The stream banks are gentle and flat.

Rosgen's Channel Type: Stream channels are wide and flat, with little sinuosity, low gradients (.5-1%), and little to no floodplain development (F6).

Soil: Soils are fairly deep (60 cm +) and ranged from heavy clays to sandy clay loams. The water table is near the surface in early June (12-44 cm depth). Sampled profiles had distinct, high contrast mottles at about 25 cm in depth.

Adjacent Riparian Vegetation: This plant association can occur with patches of *Carex nebrascensis* (Nebraska sedge) and *Agropyron smithii* (western wheatgrass). *Scirpus pungens* (common threesquare) and *S. lacustris* (softstem bulrush) stands can also occur in adjacent pools within the channel. However, the *Carex praegracilis* (clustered sedge) plant association often occurs as the only vegetation type along small streams.

Adjacent Upland Vegetation: Upland slopes have short grass *Bouteloua gracilis* (blue grama) prairies and, in the spring of 1996, large patches of *Descurainia sophia* (tansy mustard), a non-native annual mustard.

Successional and Ecological Processes: Little is known about the successional status of *C. praegracilis* (clustered sedge) dominated areas.

Management: *Carex praegracilis* (clustered sedge) is an important forage for horses and cattle and forms large meadows in southwestern Montana, where it is preferred over any grass species for its forage value (Herman 1970). In Colorado, it is not known to form extensive meadows and may be limited to more mesic habitats found within riparian areas. Soils of this association are susceptible to compaction if grazed when saturated in early spring and summer.

Related Types: A *Carex praegracilis-C. aquatilis* type has been described from Utah, and may also occur in Idaho (Bourgeron and Engelking 1994). Hansen *et al.* (1988) describes a *Carex praegracilis* dominance type that occurs throughout much of Montana. Jones and Walford (1995) describe a *Carex praegracilis* dominance type that appears very similar in species composition and environmental setting to the stands sampled in Colorado. A *Juncus balticus-Carex praegracilis* community type has been described by Durkin *et al.* (1994). Stands dominated by *C. praegracilis* have been reported from Idaho and Utah (Brotherson and Brown 1984, as cited in Jones and Walford 1995), and can be abundant in moist swales of the plains (Herman 1970).

Table 63. *Carex praegracilis* Plant Association Stands from the South Platte Watershed with Percent Cover for Dominant Species.

Plot Number	95GK01	95LS02
Riparian Condition Rank	C	C
FORBS		
Achillea millefolium var. apicola		4
Ambrosia sp.		3
Cirsium arvense		12
Cryptantha sp.	1	
Descurainia sophia	1	1
Glycyrrhiza lepidota	3	1
Heterotheca villosa	1	
Lepidium sp.	1	
Lithospermum incisum	1	
Melilotus officinalis	11	
Ranunculus trichophyllus		1
Sagittaria sp.		1
Senecio sp.	3	
Taraxacum officinale	1	
GRAMINOIDES		
Bouteloua curtipendula	1	
Bouteloua gracilis	6	
Carex nebrascensis	3	12
Carex praegracilis	34	24
Eleocharis palustris		11
Hordeum jubatum	1	
Pascopyrum smithii	7	
Poa pratensis	25	
Scirpus pungens		1

Carex lanuginosa Alliance

Wooly sedge (*Carex lanuginosa*) Plant Association
CNHP Rank: G3?/S3
2 Quantitative Plots:
Gunnison River Basin-- 1 plot (94JB38)
South Platte River Basin--1 plot (95LS13).

South Platte River Basin Reference Reaches: No reference reaches were found, however a fairly representative stand can be seen along West Plum Creek, Allis Ranch subdivision, Colorado Open Lands, Douglas County, T 8S, R68W, Sec 14.

General Description and Comments: This is a distinctive wetland-indicator sedge that forms small to medium pure stands in very wet conditions. Many small stands were observed on the S. Platte River floodplain in depressions and swales, often under the canopy of cottonwood trees, and occasionally in full sun.

Regional Distribution: This plant association has been reported from Oregon, Utah, and Idaho (Bourgeron and Engelking 1994), Montana (Hansen *et al*. 1988, 1991), North and South Dakota, Nebraska, and Kansas (Midwest Heritage Task Force 1994), and Colorado, (Kittel *et al.* 1995).

Distribution in Colorado: In Colorado, it has been observed along the Gunnison River (Kittel *et al.* 1995), the floodplain of the South Platte River in northeastern Colorado, and tributaries of the South Platte River draining the Black Forest (Palmer Divide).

Vegetation: This association is characterized by a near monotypic stand of *Carex lanuginosa* (wooly sedge) (80%) with a few other graminoids such as *Carex nebrascensis* (Nebraska sedge) (2%), *Scirpus pungens* (common three square) (<1%), and *Poa pratensis* (Kentucky bluegrass) (8%). Scattered forbs include *Cirsium arvense* (Canada thistle) (4%) and *Mentha arvense* (field mint) (8%) (Table 64).

Elevation: 5000-6000 ft. (1500-1800 m).

Site Geomorphology: This association occurs in very wet conditions, generally at the saturated edge of the stream channel, and often in standing water.

Rosgen's Channel Type: This type had been observed on many types of channels, but in general, it occurs along meandering, moderate gradient (1%) streams (C4).

Soil: Soils are deep silt loam to clays with mottling occurring throughout the profile.

Adjacent Riparian Vegetation: Stands of *Salix amygdaloides* (peach-leaved willow) and *Populus angustifolia* (narrow-leaf cottonwood) woodlands occur along foothill streams, while *Populus deltoides* (plains cottonwoods) woodlands occur along stream reaches on the plains.

Adjacent Upland Vegetation: Upland communities are *Pinus ponderosa* (Ponderosa pine) forests along foothill tributaries, and *Bouteloua gracilis* (blue grama) short grass prairies along reaches on the eastern plains.

Successional and Ecological Processes: *Carex lanuginosa* is tolerant of flooding and very palatable to most livestock, though apparently not utilized by deer (Hermann 1970). It has long creeping rhizomes that form dense mats that can effectively stabilize stream banks (Hansen *et al.* 1988).

Management: Soils of this plant association are saturated to very moist throughout most of the growing season, and are susceptible to compaction by grazing animals.

Related Types: A *Carex lanuginosa* dominance type is reported from Montana, and is considered a minor, mid-elevation type (Hansen *et al*. 1988, 1991). The *Carex lanuginosa* plant association has been reported to occur in Idaho, Oregon, and Utah (Bourgeron and Engelking 1994). Bands of *Carex lanuginosa* along stream banks have been reported from the Gunnison River, Colorado (Kittel *et al.* 1995). Two rare plant associations, ranked S1 and S1?, consisting of *Carex lanuginosa* and *Scirpus* spp., have been reported from Nebraska and Kansas (Midwest Heritage Task Force 1994). Additionally, *Carex lanuginosa* stands have been reported to occur with *Spartina pectinata* in the Dakotas, Nebraska, and Kansas (Midwest Heritage Task Force 1994).

Table 64. *Carex lanuginosa* Plant Association Stand from the South Platte Watershed with Percent Cover for Dominant Species.

Plot Number	95LS13
Riparian Condition Rank	B
FORBS	
Achillea millefolium	1
Ambrosia sp.	1
Cirsium arvense	4
Lactuca sp.	1
Mentha arvensis	8
Mentha sp.	1
Unknown forb	5
GRAMINOIDES	
Carex lanuginosa	80
Carex nebrascensis	2
Hordeum jubatum	1
Poa pratensis	8
Scirpus pungens	1

Beaked sedge (*Carex utriculata*) Plant Association
CNHP Rank: G5S4
24 Quantitative Plots:
San Juan National Forest - 4 plots (27, 38, 96, 114)
Routt National Forest - 6 plots (51, 111, 131, 203, 302, 596)
Gunnison River Basin--4 plots (94GK19, 94JB28, 94JB49, 94RR36)
San Miguel/Dolores River Basin--3 plots (91NL17, 91NL34, 91NL87)
Arkansas River Basin--1 plot (95AM37)
South Platte River Basin--6 plots (96LS14, 96AM68, 96AM37, 96AM58, 96AM32, 96AM51).

South Platte River Basin Reference Reaches: An excellent example of this association can be see on the Roaring Fork Creek, Rocky Mountain National Park, Boulder County, T3N, R73W, Sec 3.

General Description and Comments: *Carex utriculata* stands occupy the wettest meadow sites on mineral soils, while *Carex aquatilis* occurs in slightly better drained areas, often on heavy, more organic soils. These two species intermix at intermediate habitats, and thus create the confusion in the literature as to whether there are one or two plant associations. We chose to follow Padgett *et al.*'s (1989) and Youngblood *et al.*'s (1985) lead in distinguishing between plant associations which often have different environmental characteristics as well as different species composition. In Colorado, pure stands of both species occur together, as well as large stands of completely intermixed stands. In addition, both species have been observed in hummock and swale topography with *Carex utriculata* in the swales and *Carex aquatilis* on the hummocks, forming a mosaic of the two plant associations (Steve Kettler, personnel communication). Note that this species has been erroneously called *Carex rostrata* in Colorado literature (Weber and Whitman 1992).

Regional Distribution: This type has been described by many authors from central and eastern Oregon (Kovalchik 1987), central and eastern Utah (Padgett *et al.* 1989), southeastern Idaho, western Wyoming (Youngblood *et al.* 1985, Jones and Walford 1995) and Montana (Hansen *et al.* 1995).

Distribution in Colorado: In Colorado the *Carex utriculata* plant association is a major type known throughout the state in subalpine environments. It has been reported from Roosevelt, Arapaho, White River, Routt, and Gunnison National Forests, Rocky Mountain National Park (Johnston 1987, Kettler and McMullen 1996), as well as from the Yampa, San Miguel/ Dolores (Kittel and Lederer 1993), Colorado, White (Kittel *et al.* 1994), Gunnison (Kittel *et al.* 1995), Arkansas (Kittel *et al.* 1996) and South Platte River Basins (Colorado Natural Heritage Program 1996).

Vegetation: This plant association is characterized by nearly pure stands of *Carex utriculata* (beaker sedge). *Carex aquatilis* (aquatic sedge) may also be present in minor amounts (<10%) (Table 65). Willow carrs are often adjacent, and a few scattered individual willows may occur with in the stand, particularly *Salix planifolia* (plane-leaf willow) at higher elevations and *Salix monticola* (Rocky Mountain willow) at lower elevations.

Elevation: 7500-9200 ft. (2300-2800 m).

Site Geomorphology: *Carex utriculata* (beaked sedge) grows in standing water and saturated soils around lakes and beaver ponds. It also grows in wet swales and overflow channels where standing water occurs.

Soil: Soils are thick and saturated organic material, often intergrading with mineral soils.

Adjacent riparian vegetation: This association is often part of a wetland mosaic, with *Salix planifolia* (plane-leaf willow), *Salix monticola* (Rocky Mountain willow), and *Salix geyeriana* (Geyer willow) dominated shrublands. It also occurs adjacent to and intergrades with *Carex aquatilis* (aquatic sedge) meadows.

Adjacent upland vegetation: *Abies lasiocarpa-Picea engelmannii* (subalpine fir-Engelmann spruce) forests, *Populus tremuloides* (quaking aspen) woodlands, and *Quercus gambelii* (Gambel oak) shrublands occur on adjacent hillslopes.

Succession and Ecological Processes: *Carex utriculata* (beaked sedge) appears to be an early seral, colonizing species becoming abundant at the margins of newly formed beaver ponds (Padgett *et al.* 1989). With a drop in the water table, other *Carices* and willows will move in and the site may change to a *Carex aquatilis* dominated community, and with time, to a *Salix* dominated type.

Management: *Carex utriculata* occupies the wettest habitat in any riparian area. The soils are highly subject to compaction and other damage. *Carex* (sedge) species are heavily utilized by livestock in narrow riparian sites within extensive 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).

Mid-season 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 that may be present 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 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 (for fuel buildup) and for at least 2-3 years after burning. This is necessary in order to keep livestock from consuming all 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).

Related types/Synonyms: *The Carex utriculata* plant association has been described by Sanderson and Kettler (1996), Cooper and Cottrell (1990) and under the name of *Carex rostrata* by Youngblood *et al.* (1985), Padgett *et al.* (1989), Manning and Padgett (1995) and Girard *et al.* (1995). It is probably included within the broader type *Carex rostrata-Carex aquatilis*, described by Hess and Wasser (1982), and the *Carex aquatilis-Carex utriculata-Carex utriculata* Phase listed in Johnston (1987), and the *Carex aquatilis-Carex rostrata-Deschampsia cespitosa* type described by Baker (1989).

Table 65. *Carex utriculata* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96LS14	96AM68	96AM37	96AM58	96AM32	96AM51
Riparian Condition rank	A	A	B	B	B	B
SHRUBS						
Pentaphylloides floribunda					1	18
Salix geyeriana						2
GRAMINOIDES						
Calamagrostis canadensis					7	
Carex aquatilis	15	26		7	21	
Carex utriculata	65	41	42	49	35	32
Deschampsia cespitosa		1		2	7	5
Juncus balticus			1	6	9	9
Juncus saximontanus						10

Spike rush (*Eleocharis palustris*) Plant Association
CNHP Rank: G5/S4
13 Quantitative Plots:
San Juan National Forest - 3 plots (65, 66, 89)
Routt National Forest - 2 plots (564, 569)
Yampa River Basin--1 plot (24)
San Miguel/Dolores River Basin--1 plot (22)
Colorado River Basin--1 plots (38E)
Gunnison River Basin--3 plots (11C, 15A, 15B)
Republican Platte River Basin--2 Plots (95LS23, 95LS24)

South Platte River Basin Reference Reaches: An excellent example occurs along the Arikaree River, Yuma County, on private land (specific location withheld to respect landowner privacy).

General Descriptions and Comments: *Eleocharis palustris* (creeping spikerush) forms low, rhizomatous, and generally narrow grassy strips along slow-moving stretches of rivers and along pond shores. Stands of this association sampled along the Arikaree River have high species richness and more biomass than *Eleocharis palustris* (creeping spikerush) stands at higher elevations in cool, montane settings. The associated species within this plant association are more closely aligned with stands sampled on the Comanche National Grasslands and along the Rio Grande River Valley, New Mexico (see Culver *et al.* 1996, and Durkin *et al.* 1995). The presence of *Panicum virgatum* (switchgrass) appears to be unique to the Arikaree River environment and is not mentioned as a co-associate for this plant association elsewhere in the literature.

Regional Distribution: The *Eleocharis palustris* (creeping spikerush) plant association has been reported throughout the southern Rocky Mountains from Colorado (Sanderson and Kettler 1996, Kittel and Lederer 1993), Utah (Padgett *et al.* 1989), Wyoming (Jones and Walford 1995) and southwestern Idaho (Johnston 1987 and Youngblood *et al.* 1985). It is also reported from Oregon (Kovalchik 1987) and New Mexico (Durkin *et al.* 1995).

Distribution in Colorado:. This association is documented from all over the state. Cooper and Severn (1992) report an *Eleocharis palustris* plant association from the San Luis Valley. It is also documented in the high mountain regions (Sanderson and Kettler 1996, Cooper 1993), the western part of the state (Kittel and Lederer 1993) and the eastern plains (Kittel *et al*. 1996, Culver *et al.* 1996).

Vegetation: This association is characterized by thick to scattered cover of *Eleocharis palustris* (creeping spikerush). Usually few other species are present. At the lowest elevations, *Leersia oryzoides* (Rice cutgrass) (16-40%), *Scirpus pungens* (common threesquare) (17-29%), *Panicum virgatum* (switchgrass) (7-15%), *Carex lanuginosa* (wooly sedge) (7%), and *Spartina pectinata* (slough grass) (0-12%) are also present (Table 66). At higher elevations, it is also associated with *Carex aquatilis* (aquatic sedge) and *Pedicularis groenlandica* (elephants head).

Elevation: 3900-10,000 ft. (1100-3050 m).

Site Geomorphology: The *Eleocharis palustris* plant association grows on the edges of small to large ponds, lakes, reservoirs, and in back water reaches of large rivers. It is a common emergent association that occurs in shallow, mostly still water.

Rosgen's Channel Type: This association occurs along strongly meandering stream channels with moderate gradients (C4-6).

Soils: Soils of this association are fine-textured loamy sands, clays, and sandy clays. Some stands have considerable organic content in the upper 10-20 cm. Although the profiles indicated heavy, moist soil, no hydric indicators were observed.

Adjacent Riparian Vegetation: At lower elevations, adjacent stands of *Scirpus pungens* (common threesquare) and *Scirpus lacustris* (softstem bulrush) occur within the stream channel. Wet meadow prairies of *Panicum virgatum* (switchgrass) and *Sorghastrum nutans* (Indian grass) occupy the immediate stream banks and low floodplains. Large stands of *Populus deltoides* (plains cottonwood) and *Salix amygdaloides* (peach-leaved willow) also occur scattered across the floodplain. At higher elevations, *Carex aquatilis* (aquatic sedge) is a common sedge community occurring adjacent to the *Eleocharis* type. Submerged aquatic wetland types may also occur in adjacent ponds.

Adjacent upland Vegetation: On the plains, upland rolling hills are occupied by short grass *Bouteloua gracilis* (blue grama) grasslands, or sandsage shrublands. On the western slope, *Artemisia tridentata* (big sage brush) and *Sarcobatus* (greasewood) shrublands occur on the uplands.

Successional and Ecological Processes: The *Eleocharis palustris* (creeping spikerush) association is considered early seral, but it will persist on the edges of ponds and lakes that are regularly disturbed (Sanderson and Kettler 1996). *Eleocharis palustris* is a rhizomatous plant that survives both flooding and dry periods. It can also tolerate fluctuating water levels. With more stable water levels, this association may be replaced by a *Scirpus* (bulrush) dominated plant association. With continued siltation, the site may become dominated by *Carex utriculata* (beaked sedge) (Padgett *et al.* 1989).

Management: The low palatability of *Eleocharis palustris* (creeping spikerush) and seasonally wet soils limit the grazing value of type for livestock (Hansen *et al.* 1995).

Related Types: Sanderson and Kettler (1996), Jones and Walford (1995), Kittel and Lederer (1993), Johnston (1987), Padgett *et al.* (1989), and Youngblood *et al.* (1985) describe an *Eleocharis palustris* plant association. Kovalchik (1987) described a similar *Eleocharis palustris* association from Oregon. Durkin *et al.* (1995) report several similar *Eleocharis palustris* plant associations from the Rio Grande River valley, New Mexico. Cooper (1993) reports an *Eleocharis palustris* plant association from the Crested Butte region. Cooper and Severn (1992) report an *Eleocharis palustris* plant association form the San Luis Valley. Culver *et al.* (1996) describe a mixed *Eleocharis*-*Scirpus* plant association from the Comanche National Grasslands.

Table 66. *Eleocharis palustris* Plant Association Stands from the Republican Watershed with Percent Cover for Dominant Species.

Plot Number	95LS23	95LS24
Riparian Condition Rank	B	A
SHRUBS		
Salix exigua		3
FORBS		
Glycyrrhiza lepidota		4
Sagittaria sp.	1	2
Solidago sp.	5	
GRAMINOIDES		
Andropogon gerardii		1
Carex lanuginosa	7	6
Eleocharis palustris	66	12
Leersia oryzoides	40	16
Panicum virgatum	15	7
Scirpus acutus	1	23
Scirpus pungens	17	29
Spartina pectinata	12	

Wiregrass (*Juncus balticus*) Plant Association
CNHP Rank: G5/S5
9 Quantitative Plots:
White River Basin--1 plots (92GK04)
Colorado River Basin--4 plots (93RR09, 93RR13, 93GK06, 93GK11)
Yampa River Basin--2 plots (7, 94)
South Platte River Basin--2 plots (96AM70, 96AM52)

South Platte River Basin Reference Reaches: A fairly good example of this association can be seen on Buffalo Creek, Pike-San Isabel National Forest, Park County, T12S, R77W, Sec 22.

General Description and Comments: This is a distinct meadow seen along many roadsides in Colorado, where it forms a dark green zone marking the stream course (Weber 1992). It forms small and large distinct patches within other, lighter colored graminoids (grass and grass-like plants).

Regional Distribution: This association occurs in Montana (Hansen *et al.* 1995), Utah and Oregon (Padgett *et al.* 1989), Idaho and Wyoming (Johnston 1987, Youngblood *et al.* 1985) and Colorado (Colorado Natural Heritage Program 1996).

Distribution in Colorado: This is a wide-spread association. It occurs on the Western slope (Kittel and Lederer 1993), the San Luis Valley (Kittel, *person observation)*, and on the eastern plains.

Site Geomorphology: This association occurs as small, dense patches on flat stream benches, overflow channels and eddies, along lake and pond margins and at the edges of alkali flats, around springs and isolated seeps.

Vegetation: This herbaceous community type consists of a dense sward of *Juncus balticus (Baltic sedge),* with *Equisetum arvense* (scouring rush) and *Eleocharis palustris* (creeping spikerush) (Table 67). One or two *Populus angustifolia* (narrow leaf cottonwood) or *Salix* (willow) species seedlings may also be present.

Elevation: 7000-9500 ft. (2100-2900 m)

Soil: The soils in our plots were sandy to silty clay loams, often with mottled or gleyed horizons. Sometimes we found coarse textured sandy loams with a high volume of cobbles and gravel. Soils classified as sandy to clayey typic Cryoborolls, fine-loamy typic Hydraquents, and fine-clayey Aquepts.

Adjacent riparian vegetation: *Carex* spp. meadows most commonly boarder this association on broad flat floodplains. Stands of willows may boarder stands along fast moving creeks.

Adjacent upslope vegetation: A wide range of upland vegetation can occur in association with the *Juncus balticus* type, because it is so wide spread throughout the state. Sampled stands have adjacent *Pseudotsuga menziesii* (Douglas-fir) *Populus tremuloides* (quaking aspen), or *Picea engelmannii* (Engelmann spruce) forests, *Juniperus osteosperma* (oneseeded juniper) woodlands, *and Artemisia tridentata* (big sage brush) shrublands.

Succession and Ecological Processes: Padgett *et al.* 1989 consider this community type to be grazing induced in some circumstances. The rhizomatous roots of *Juncus balticus* withstand grazing pressure well, and can stabilize stream banks. As *Juncus* matures, its palatability declines. It occurs only where soils remain saturated throughout the growing season. It is known increase with heavy grazing pressure, and persist for many years after release from grazing (USFS staff, *personal communication*). *Juncus balticus* has been known to replace *Carex nebrascensis* (Nebraska sedge) and *Poa pratensis* meadows under heavy grazing pressure (Padgett *et al.* 1989). Nearly pure stands of *Juncus balticus* indicate wetter sites or grazing induced stands on more intermediate sites (Hansen *et al.* 1995)

Management: Stands of this association are productive but the forage value is low. Grazing should occur when shoots are young and tender (Hermann 1970). Continued heavy grazing will result in undesirable forb species (Hansen *et al.* 1995). *Juncus balticus* has deep fibrous root system and is an excellent stream bank stabilizer. It is apparent not harmed by cool fires (Hansen *et al.* 1995).

Relate types/Synonyms: This community type is described by many authors throughout the Rocky Mountain Region (Reid and Bourgeron 1991, Manning and Padgett 1995, Hansen *et al.* 1995, Padgett *et al.* 1989, Johnston 1987).

Table 67. *Juncus balticus* Plant Association Stands from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96AM52	96AM70
Riparian Condition Rank	B	C
FORBS		
Cirsium sp.	1	21
Potentilla sp.	3	7
GRAMINOIDES		
Agrostis gigantea	19	
Carex aquatilis	3	3
Carex utriculata	24	
Deschampsia cespitosa	7	5
Eleocharis palustris		36
Juncus balticus	50	32

Scirpus acutus Alliance

Softstem and Hardstem Bulrush (*Scirpus acutus-Scirpus tabernaemontani*) Plant Association
CNHP Rank: G3/S2S3
2 Quantitative Plots:
Colorado River Basin--1 plot (36C)
South Platte River Basin--1 plot (95GK60)

South Platte River Basin Reference Reaches: No reference reaches were found within the study area, however a typical, if small, stand can be seen at the narrows along the South Platte River, on Bureau of Reclamation Land, Morgan County, T 4N, R58W, Sec 28.

General Description and Comments: In Colorado *Scirpus acutus* and *Scirpus tabernaemontani* are considered to be two subspecies of *Schoenoplectus lacustrus* ssp. *acutus* and ssp. *creber*, respectively (Weber and Whitman 1992). The field determination between them is difficult and they are often confused. Because we have observed these two species (or subspecies) in nearly identical habitats, and other states report they can co-occur (Midwest Heritage Task Force 1994), we propose a single plant association under the name *Scirpus acutus-Scirpus tabernaemontani*, where either species can occur as the dominate, in a monoculture, or in any mixture of the two. This association often occupies sites similar to those of the *Typha* spp. plant associations, and some authors have lumped *Scirpus* and *Typha* associations together (e.g., Cooper 1988). Observations from Colorado and Montana suggest that the *Typha* and *Scirpus* associations rarely intergrade, and when adjacent stands occur, the transition from one association to another is usually abrupt (Hansen *et al.* 1988, Sanderson and Kettler 1995). Thus we propose separate *Typha* spp. and *Scirpus* spp. plant associations.

Regional Distribution: This plant association is known in small pockets and large wetland stands on the Great Plains (Hansen *et al.* 1988, 1989, Johnston 1987, Midwest Heritage Task Force 1994).

Distribution in Colorado: This association has been reported from the western slope (Kittel *et al.* 1994), Sanderson and Kettler (1995), and occurs in small pockets throughout the eastern edge of the Rocky Mountains front (Johnston 1987).

Vegetation: This association is characterized by a near mono-typic stand of *Scirpus acutus* (hardstem bulrush) (80%), with a few aquatic species including *Eleocharis rostellata* (spikerush) (10%) and *Mimulus guttatus* (common monkeyflower) (1%) (Table 68). Note that *Scirpus tabernaemontani* is the Kartez (1994) accepted name for *S. lacustris* and *S. validus.*

Elevation: 1300-2140 m (4290-7000 ft).

Site Geomorphology: The *Scirpus acutus-Scirpus tabernaemontani* (hardstem-softstem bulrush) plant association occurs in wet swales, overflow channels with standing water, ditches, and at the edges of beaver ponds. One stand occurred on a saturated floodplain where a perched water table emerged from the surrounding bedrock.

Rosgen's Channel Type: This association occurs on small slow-moving tributaries and large, meandering rivers with backwater habitats such as overflow channels, swales and other low areas of ponding water. This association also occurs in ditches and behind railroad embankments.

Soil: Soils of this association are deep heavy clays and silty loams with a high organic matter content. Profiles are made of thick black organic matter or fine clays. Soils remain saturated for most of the growing season and often have an anoxic gleyed layer within 50 cm of the soil surface.

Adjacent Riparian Vegetation: Other emergent wetland vegetation is commonly found with this plant association, such as stands of *Typha* spp. and other *Scirpus* spp. Within the riparian zone *Populus deltoides* and *Salix amygdaloides* may be present on the floodplain. On the open prairies along small streams, adjacent riparian vegetation types include stands of *Carex nebrascensis.*

Adjacent Upland Vegetation: Along the lower South Platte River adjacent upland vegetation is rangeland of sand dominated hills or agricultural fields.

Successional and Ecological Processes: *Scirpus tabernaemontani* can quickly colonize bare, muddy ground. Once established it can persist as a stable stand as long as the water regime remains constant (Hansen *et al.* 1988). It can also become established in unnatural wetlands (e.g. gravel mines). Stands of *Scirpus* are important to wildlife species, especially birds, by providing cover and nesting habitat to a number of waterfowl species.

Management: *Scirpus* is not palatable to livestock, and the wet nature of the soils precludes any grazing activities (Hansen *et al.* 1995), although cattle have been observed to graze the stuff (Kittel *personnel observation*).

Related Types/Synonyms: An identical *Scirpus tabernaemontani* plant association is described by Sanderson and Kettler (1995). The *Scirpus acutus* dominance type and riparian site type is described from Montana (Hansen *et al.* 1988, 1989), and has similar, if not identical, associated species and environmental settings. A very similar *Scirpus americanus/Carex* spp. plant association is described by Johnston (1987) and includes stands of *Scirpus acutus* reported from North Dakota (Sloan 1970, as cited in Johnston 1987). A *Scirpus acutus-Eleocharis macrostachya* community type is described from New Mexico (Durkin *et al.* 1994), but it has higher species richness and different associated species than the *Scirpus acutus* stands in Colorado. *Scirpus acutus* dominated alkaline and non-alkaline communities are reported from Nebraska, and several *Scirpus* spp.-*Typha* spp. communities are also reported from Nebraska, the Dakotas, and Kansas (Midwest Heritage Task Force 1994).

Table 68. *Scirpus acutus-Scirpus tabernaemontani* Plant Association Stands from the South Platte Watershed with Percent Cover for Dominant Species.

Plot Number	95GK60
Riparian Condition Rank	C
FORBS	
Mimulus guttatus	1
GRAMINOIDES	
Eleocharis rostellata	20
Scirpus acutus	80

Typha angustifolia Alliance

Narrow-leaf cattail (*Typha angustifolia*) Plant Association
CNHP Rank: G5/S3
2 Quantitative Plots:
South Platte River Basin--2 Plots (95GK47, 95GK59)

South Platte River Basin Reference Reaches: A large stand occurs where Bijou Creek comes into the S. Platte River at the narrows on Bureau of Reclamation Land, T4N, R58W, Sec 28. One of the largest stands in the state occurs in an oxbow of the Arikaree River just west of the Nebraska state line (specific location withheld to protect landowner privacy).

General description and Comments: *Typha angustifolia* is the most eastern of Colorado's three *Typha* species, and it can be distinguished by its narrow leaves. It forms a tall (2-3 m), mono-typic stands commonly in 2-4 feet of standing water.

Regional Distribution: This association is reported from throughout the northern and central Great Plain states, the Dakotas, Montana, Wyoming, Nebraska, Kansas, northern Texas, and northwestern Oklahoma (Johnston 1987, the Midwest Heritage Task Force 1994).

Distribution in Colorado: This association has not been documented in the Colorado literature, but the species is known to occur throughout the plains of eastern Colorado (Weber 1990). During this study it was commonly observed along overflow channels and oxbow lakes of the mainstem of the South Platte River, and it can occur in small ponded areas around stock ponds and railroad embankments.

Vegetation: *Typha angustifolia* (narrow-leaf cattail) forms near-monotypic (70-85%) stands between 3 and 6 feet tall. Other minor species include *Potamogeton* spp. (pondweed) (0-25%), *Spartina pectinata* (slough grass) (0-1%), and *Veronica* spp. (Veronica) (0-3%) (Table 69).

Elevation: 1225-1300 m (4000-4300 ft).

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 any place where water collects to at least 2-3 feet in depth and remains for two-thirds of the growing season (Great Plains Flora Association 1986).

Rosgen's Channel Type: This association can be found on nearly every type of channel, but typically along meandering, low gradient streams (C5, F5, and D5).

Soil: Soils are deep, heavy silty clay loam and organic material. Some profiles have 10-30% coarse material and are fairly well drained, others are anoxic throughout most of the year.

Adjacent Riparian Vegetation: *Scirpus* (bulrush) marshes and *Carex* (sedge) meadows can be found adjacent to the *Typha* (cattails) plant association. Stands of *Populus deltoides* (plains cottonwood) and *Salix amygdaloides* (peached-leaved willow) occur on higher terraces.

Adjacent Upland Vegetation: On the plains *Bouteloua gracilis* (blue grama) dominated short grass prairie or agricultural fields occur on the uplands.

Successional and Ecological Processes: *Typha angustifolia* (narrow-leaf cattails) occupies inundated and disturbed grounds and can tolerate deeper water and higher alkalinity levels than *T. latifolia* (broad-leaf cattail) (Great Plains Flora Association 1986). *Typha* species are early colonizers of wet mineral soil and will persist under wet conditions (Hansen *et al.* 1995). *Typha* is a prolific seed producer, and can spread rapidly to available habitats. 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).

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* (Nebraska sedge)community type in Montana (Hansen *et al.* 1995).

Related Types/Synonyms: *Typha* spp. dominated wetlands are described by Hansen *et al.* (1991), Jones and Walford (1995), Padgett *et al.* (1989) and the Midwest Heritage Task Force (1994). A *Typha latifolia/Sagittaria latifolia* plant association is reported to occur in Nebraska, north eastern Colorado, western Wyoming, eastern Idaho, and North Dakota by Johnston (1987).

Table 69. *Typha angustifolia* Plant Association Stands form the South Platte Watershed with Percent Cover for Dominant Species

Plot Number	95GK47	95GK59
Riparian Condition Rank	C	C
TREES		
Elaeagnus angustifolia		10
SHRUBS		
Salix exigua	7	
FORBS		
Ambrosia sp.	1	
Arctium minus	5	
Bidens cernua	1	
Chenopodium album	2	
Polygonum pensylvanicum	6	
Potamogeton sp.		25
Veronica sp.	1	
GRAMINOIDES		
Typha angustifolia	86	70
Cyperus oderatus	2	
Eleocharis sp.	1	
Eragrostis pilosa	1	
Leersia oryzoides	5	
Spartina pectinata	1	

Andropogon gerardii-Sorghastrum nutans Alliance

Big bluestem-Indian grass (*Andropogon gerardii-Sorghastrum nutans*) Plant Association
CNHP Rank: G2/S1S2
2 quantitative Plots:
Republican River Basin--2 Plots (95LS27, 95GK27)

Republican River Basin Reference Reaches: Excellent condition occurrences occur along the Arikaree River on private land (specific location withheld to protect landowner privacy).

General Description and Comments: The *Andropogon gerardii-Sorghastrum nutans* plant association is not an obligate riparian plant association. On the eastern plains of Colorado, areas with enough moisture year-round to support tall-grass communities mostly occur along mesic floodplains and intermittent drainages. This association is considered a mesic lowland type in Nebraska where stands receive additional run-off moisture (Weaver 1965). Colorado stands clearly represent the western-most extension of this mesic grassland. One stand sampled (plot 95GK27) may represent a degraded example of the *Andropogon gerardii-Sorghastrum nutans* plant association. It has a high amount of *Poa pratensis,* a non-native increaser species. In addition, this stand occurs in a deep swale of the floodplain and has more *Scirpus pungens* than other documented occurrences. Taxonomically our stands seem to lie between two types described in the literature, the *Andropogon gerardii-Panicum virgatum* types and the *Andropogon gerardii-Sorghastrum nutans* types (Midwest Heritage Task Force 1994). A regional approach to classification would help clarify this taxonomic issue.

Regional Distribution: The *Andropogon gerardii-Sorghastrum nutans* plant association is documented from North and South Dakota, Nebraska, Kansas, eastern Colorado, and possibly Oklahoma (Johnston 1987, Midwest Heritage Task Force 1995, Weaver 1965).

Distribution in Colorado: This association is known from the northeastern corner of the state on the plains and within Boulder County (Colorado Natural Heritage Database 1996).

Vegetation: This plant association is characterized by an thick sward of grasses dominated by *Andropogon gerardii* (big bluestem) (0-12%), *Sorghastrum nutans* (Indian grass) (9-21%), *Panicum virgatum* (switchgrass) (23-68%), *Spartina pectinata* (slough grass) (0-1%), and *Carex praegracilis* (clustered sedge) (11-35%). Other graminoids include *Scirpus pungens* (common three square) (2-12%) and *Poa pratensis* (0-43%). Forb species are scattered and include *Glycyrrhiza lepidota* (7-9%), *Cichorium intybus* (chicory) (3-8%), and *Solidago* (goldenrod) spp. (0-5%). A few shrub stems may grade in from neighboring plant associations like *Salix exigua* (coyote willow) (1%) (Table 70).

Elevation: 1125-1200 m (3692-3940 ft).

Site Geomorphology: This plant association occupies low, flat floodplains and terraces. The sites are usually within 0.2-1.5 meters of the water table and occur at some distance from the active stream channel (100-365 m).

Rosgen's Channel Type: The channel is of moderate sinuosity and low gradient (.001-1.06%), with a well developed floodplain and strong meander pattern (C6).

Soil: Soils are well drained and range from fine sands to loamy sand. Some profiles had signs of flooding (mottling), while others did not. In general the soils are coarse textured and relatively better drained than soils of the nearby floodplain environment.

Adjacent Riparian Vegetation: Adjacent stands of *Salix exigua (coyote willow), Populus deltoides* (plains cottonwood) and *Salix amygdaloides* (peached-leafed willow) are common. In low-lying areas stands of *Scirpus pungens* (common three square) or *Typha angustifolia* (narrow-leaf cattail) can also occur.

Adjacent Upland Vegetation: Adjacent uplands have short grass *Bouteloua* spp.(Blue grama) prairies, with occasional sand-sage hills.

Successional and Ecological Processes: This plant association is intermediate between palustrine and terrestrial. The water table is often near the surface and standing water may be present in winter, spring, or after heavy rains. Along the Arikaree River spring flows raise the water table, and summer precipitation with run-off flows from neighboring sand hills keep the water table within 40 cm of the surface, conducive to *Andropogon gerardii* growth (Weaver 1965).

Management: Winter-only grazing by livestock appears to keep stands in good condition. Low abundance of *Andropogon gerardii* may indicate past heavy grazing and a slow recovery of the stand (Kansas Natural Heritage Ecologist and Steve Kettler, personnel communication). Fire is likely to be an important management tool for maintaining native species vigor and reducing invasive species .

Related Types/Synonyms: Several stands of an *Andropogon gerardii-Sorghastrum nutans* plant association are reported by Johnston (1987). Several *Andropogon gerardii-Sorghastrum nutans* plant associations are listed in the Midwest Regional Classification (Midwest Heritage Task Force 1994). Stands in Colorado appear to be most closely related to the wet-prairie type described by the Nebraska Heritage Program (personnel communication), which is dominated by *Andropogon gerardii, Spartina pectinata, Panicum virgatum*, and *Sorghastrum nutans*.

Table 70. *Andropogon gerardii-Sorghastrum nutans* Plant Association Stands from the Republican Watershed with Percent Cover for Dominant Species .

Plot Number	95LS27	95GK27
Riparian Condition Rank	B	B
SHRUBS		
Salix exigua	1	1
FORBS		
Ambrosia dumosa		6
Ambrosia sp.	5	
Cichorium intybus	3	8
Geranium richardsonii	2	
Glycyrrhiza lepidota	9	7
Lactuca sp.	2	
Mentha sp.	1	
Rumex crispus		1
Solidago sp.	1	2
Equisetum laevigatum	5	1
GRAMINOIDES		
Andropogon gerardii	12	
Carex praegracilis	11	35
Eleocharis palustris	1	
Juncus balticus	2	4
Panicum virgatum	23	68
Poa pratensis		43
Schizachyrium scoparium		2
Scirpus pungens	2	12
Sorghastrum nutans	21	9
Spartina pectinata	1	
Stipa sp.	15	

Prairie Slough grass, Prairie Cordgrass (*Spartina pectinata*) Plant Association
CNHP Rank: GU/SU
1 Quantitative Plot:
South Platte River Basin--1 Plot (95LS28)

South Platte River Basin Reference Reaches: One excellent occurrence of this association can be seen along the Arikaree River, on private land, Yuma County. Specific location is not provided to respect the landowner privacy.

General Description and Comments: This is a tall-grass meadow comprised entirely of *Spartina pectinata*. It occurs in small swales and on the floodplains of larger rivers on the plains. Stands of this grass have been included in other tall-grass prairie plant associations. On large river floodplains, however, this type occurs as large patches, and is distinguished from adjacent riparian types by micro-topography and degree of soil saturation. Weaver (1965) reports that, historically, large stands of *Spartina pectinata* occurred on mud flats of the Missouri River.

Regional Distribution: The *Spartina pectinata* plant association has been reported from throughout the northern Great Plains and eastern Rocky Mountain Front (Hansen *et al.* 1988, 1991, Weaver 1965, Jones and Walford 1995, Johnston 1987, and the Midwest Heritage Task Force 1994).

Distribution in Colorado: In Colorado the *Spartina pectinata* plant association is found along the South Platte and Arikaree Rivers, their tributaries in the northeastern corner of the state and in small patches in southeastern Colorado as well (Colorado Natural Heritage Program 1996).

Vegetation: Graminoids and little else characterizes this plant association. *Spartina pectinata* (slough grass) (69%) co-dominates with *Panicum virgatum* (switchgrass) (30%). Other tall graminoids present include *Andropogon gerardii* (tall bluestem) (6%), *Carex praegracilis* (clustered sedge) (1%) and *Scirpus acutus* (hardstem bulrush) (5%). A non-native weed, *Cirsium arvense* (Canada thistle) (20%), is abundant at the site indicating chronic disturbance (Table 71).

Elevation: 3,3400 ft. (1,030 m).

Site Geomorphology: *Spartina pectinata* (slough grass) stands occur in low swales and overflow areas of large river floodplains. The stand we sampled occurs in a shallow overflow area between two slightly raised ridges with linear bands of *Populus deltoides* (plains cottonwood).

Rosgen's Channel Type: The stand is on a large meandering river with a mostly sand bed (C6).

Soil: The soil is a fine loam to silty clay with abundant mottles from 12 to 69 cm depth.

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

Adjacent Upland Vegetation: Upland slopes have mostly *Bouteloua curtipendula* (sideoats grama) short grass prairie, pasture lands, and cultivated fields.

Successional and Ecological Processes: This grass is tolerant of sediment deposition and has sharp-pointed shoots that may push their way upward through a foot of new soil (Weaver 1965). On the South Platte River floodplain it appears to be an early colonizer of the fresh sediments laid down by the 1995 flood.

Management: Stands of *Spartina pectinata* have high production rates, however the rough-edged leaves make for poor forage quality, and it is not readily eaten by livestock or wildlife. Its tall height and thick growth provide shade and cover for wildlife and certain bird species (Hansen *et al.* 1988). It can make excellent hay if cut two or three times each growing season, thereby reducing forage coarseness (Weaver 1965, Hansen *et al.* 1988). The vigorous root system suggest it may make an excellent stream bank stabilizer as well.

Related Types/Synonyms: Hansen *et al.* (1988, 1991) report a *Spartina pectinata* dominance type from central and eastern Montana, where it can form nearly pure stands in swales, meadows, and at the edges of marshes and ponds. Jones and Walford (1995) describe a community from northeastern and south eastern Wyoming. Weaver (1965) reports hundred of square miles of bottom land floodplains along the Missouri River and its tributaries covered in *Spartina pectinata*. A *Spartina pectinata/Calamagrostis canadensis* plant association has been reported from north-central Nebraska (Keim *et al.* 1932, as cited in Johnston 1987). Several *Spartina pectinata* co-dominated grassland plant associations have been reported from Nebraska, North and South Dakota, and Kansas (Midwest Heritage Task Force 1994). Bourgeron and Engelking (1994) list a *Spartina pectinata* and *S. pectinata-Scirpus pungens* from Colorado and Montana that may be similar to the Colorado stands.

Table 71. *Spartina pectinata* Plant Association Stand from the South Platte Watershed with Percent Cover for Dominant Species.

Plot Number	95LS28
Riparian Condition Rank	C/B
FORBS	
Ambrosia dumosa	10
Cirsium arvense	20
Lactuca sp.	3
Mentha sp.	2
Rumex crispus	1
Solidago sp.	2
GRAMINOIDES	
Andropogon gerardii	6
Carex praegracilis	1
Panicum virgatum	30
Scirpus pungens	5
Spartina pectinata	69

UNESCO: **V.B.2.e. SATURATED, TEMPERATE FORB DOMINATED HERBACEOUS ASSOCIATIONS**
COWARDIN: **RIVERINE-UPPER PERENNIAL PERSISTENT EMERGENT WETLANDS**

Cardamine cordifolia Alliance

Watercress-chiming bells (Cardamine cordifolia-Mertensia ciliata) Plant Association
CNHP Rank: G4/S4
8 Quantitative Plots:
Colorado River Basin--4 plots (25A, 25C, 30C, 30D)
San Juan National Forest--3 plots (74, 174, 191)
South Platte River Basin--1 plot (96GK03).

South Platte River Basin Reference Reach: No reference reaches were found in the study area, however, several stands can be seen on first order tributaries above tree line in the subalpine zone, Arapaho-Roosevelt National Forest, Laramie County.

General Description and Comments: This is a small association of a variety of forbs that occurs in and near running water of small streams seeps and springs. They can be recognized by the abundance of *Cardamine cordifolia* (watercress), *Senecio triangularis* (arrow senecio) and/or *Mertensia ciliata* (chiming bells).

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

Colorado Distribution: This association is reported to occur in the subalpine regions of the Colorado, Gunnison, and South Platte River Basins in Colorado (Sanderson and Kettler 1996, Cooper 1993, Kittel *et al.* 1994, Colorado Natural Heritage Program 1996).

Vegetation: Associated taxa may vary greatly in this plant community, but the clear dominance by *Cardamine cordifolia* (watercress) and *Mertensia ciliata* (chiming bells) is evident. As opposed to *Caltha leptosepala* dominated communities, *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* stands have relatively little graminoid cover (<3%) and an abundance of forb species such as *Mertensia ciliata* (10-20%), *Ligularia taraxacoides* (0-20%), *Saxafraga odontoloma* (0-10%), and *Primula parryi* (3-10%), and *Senecio triangularis* (0-95%) (Table 72).

Elevation: 9200-12,300 ft. (2800-3750 m).

Site Geomorphology: This plant association typically occurs along moderately steep to very steep first order streams and along wet lowland meadows.

Rosgen's Channel Type: This type usually is associated with fast flowing entrenched (A3) streams in V-shaped valleys and along narrow, deep, and sinuous streams (E5).

Soils: Soil types are typically thin highly skeletal sandy clay loams and clay loams with the water table near the surface and some organic accumulation in the upper horizon.

Adjacent Riparian Vegetation: This type is often the only association along a reach. Above and below, along broader, less steep reaches, *Salix planifolia* (planeleaf willow) and *Salix brachycarpa* (barrenground willow) occurs along the stream side and at toe slopes of avalanche runs. *Carex aquatilis* (water sedge) and *Caltha leptosepala* (marsh marigold) meadows occur in flat swale areas.

Adjacent Upland Vegetation: Adjacent upslopes are covered in alpine talus; Krumholtz stands of *Picea engelmannii* (Engelmann spruce); *and Picea engelmannii-Abies lasiocarpa* (spruce-fir) forest.

Succession and Ecological Processes: The *Cardamine cordifolia-Mertensia ciliata-Senecio triangularis* appears to be a stable plant association. It requires saturated soils, inundated by moving water during the growing season.

Management: This association has soils that are easily compacted and eroded by livestock and recreationists. Trails, roads, and livestock should be kept away from this association.

Related Types/Synonyms: The *Cardamine cordifolia*-*Caltha leptosepala* association is described by Johnston (1987), Rottman and Hartman (1985), and (Sanderson and Kettler 1996). The *Senecio triangularis* association described by Sanderson and Kettler (1996) and the closely related *Senecio triangularis-Trisetum wolfii* described by Komarkova (1986) are included within the forb dominated association described here. Cooper (1993) also describes a similar *Oxypolis fenderli-Senecio triangularis* association from central Colorado.

Table 72. *Mertensia ciliata-Cardamine cordifolia-Senecio triangularis* Plant Association Stand from the South Platte Watershed with Percent Cover of Dominant Species.

Plot Number	96GK03
Riparian Condition Rank	C
GRAMINOIDES	
Carex aquatilis	1
Carex sp.	2
FORBS	
Arnica cordifolia	1
Caltha leptosepala	1
Cardamine cordifolia	1
Hydrophyllum fendleri	11
Mertensia ciliata	1
Mitella pentandra	6
Pyrola americana	4
Saxifraga odontoloma	1
Senecio triangularis	3
Taraxacum officinale	1

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APPENDIX A. Plant Species Found in Riparian Areas in the Upper South Platte Watershed (above ~6500 feet in elevation). Nomenclature follows Kartesz (1994), except for *Salix*, which follows Dorn (1977 and 1995). Tree species were split into three age classes: seedling = < 1.25 m (4.5 ft) tall, sapling = > 1.25 m tall, < 12.6 cm (5 in) dbh, and older trees = > 12.6 cm (5 in) dbh. If no age class is listed, trees were in the oldest age class. * indicates an introduced species to Colorado (Weber and Wittmann 1992). † indicates nomenclature follows Weber and Witmann (1992).

TREES
Abies lasiocarpa (Hook.) Nutt.--saplings
Abies lasiocarpa (Hook.) Nutt.--seedlings
Abies lasiocarpa (Hook.) Nutt.--older trees
Acer negundo var. interius L.--saplings
Acer negundo var. interius L.--seedlings
Acer negundo var. interius L.--older trees
Elaeagnus angustifolia L.*
Malus sylvestris P. Mill*
Populus angustifolia James--saplings
Populus angustifolia James--seedlings
Populus angustifolia James—older trees
Populus deltoides ssp. monilifera (Ait.) Eckenwalder -- seedlings
Populus deltoides ssp. monilifera (Ait.) Eckenwalder--saplings
Populus deltoides ssp. monilifera (Ait.) Eckenwalder -- older trees
Populus tremuloides
Populus x acuminata Rydb.
Populus tremuloides (Michx.) - seedling
Populus tremuloides (Michx.) - sapling
Populus tremuloides (Michx.) - older tree
Prunus pensylvanica var. saximontana Rehd.
Pseudotsuga menziesii (Mirbel) Franco – seedling
Pseudotsuga menziesii (Mirbel) Franco – sapling
Pseudotsuga menziesii (Mirbel) Franco – older tree
Robina pseudoacacia L.*
Salix amygdaloides Andersson -seedling
Salix amygdaloides Andersson -sapling
Salix amygdaloides Andersson -older tree
Salix fragilis L.*

SHRUBS
Acer glabrum Torr.
SHRUBS, continued.
Alnus incana ssp. tenuifolia (Nutt.) Breitung
Amelanchier utahensis Koehne
Arctostaphylos uva-ursi (L.) Sprengle
Betula glandulosa Michaux†
Betula occidentalis Hooker
Cercocarpos montanus Rafinesque
Chrysothamnus nauseosus (Pallus ex Pursh) Britton
Colutea arborescens L.*
Cornus sericea L.
Corylus cornuta H. Marshall
Crataegus macracantha Loddiges var. occidentalis (Brit.) Egg.†
Holodiscus dumosus (Nutt. Ex Hook.) Heller
Jamesia americana Torrey & Gray
Juniperis communis L.
Lonicera involucrata Banks ex Sprengel
Mahonia repens (Lindely) G. Don
Pentaphylloides floribunda (Pursh) A. Love
Physocarpus monogynus (Torrey) Coulter
Prunus americana H. Marshall
Prunus virginiana L. var. melanocarp (A. Nels.) Sarg.
Quercus gambelii Nutt.
Rhus glabra L.
Rhus trilobata Nuttall ex Torrey & Gray var. trilobata
Ribes aureum Pursh.
Ribes cereum Douglas
Ribes coloradense Coville
Ribes divaricatum Douglas
Ribes inerme Rydberg
Ribes leptanthum A. Gray
Ribes lucustre (Persoon) Poiret
Ribes montegeum McClatchie
Ribes sp. L.
SHRUBS, continued.
Rosa woodsii Lindley

Rubus parviflorum (Nutt.) Rydberg
var. parviflorium
Rubus deliciosus Torrey
Rubus idaeus ssp. strigosus (Michaux)
aximovicz
Rubus sp.
Salix bebbiana Sargent
Salix brachycarpa Nuttall
Salix candida Fluegge
Salix drummondiana Barratt ex Hooker
Salix eriocephala ssp. mackensieana var.
ligulifolia (C.R. Ball) Dorn
Salix exigua Nuttall
Salix geyeriana Andersson
Salix irrorata Andersson
Salix lucida ssp. caudata (Nutt.) E. Murr.
Salix lucida ssp. lasiandra ((Bentham) E.
Murr.
Salix monticola Bebb in Coulter
Salix myrtillifolia Ansersson
Salix planifolia ssp. planifolia Pursh
Salix wolfii Bebb in Rothrock
Sambucus racemosa var. microbotrys
(Rydb.) Kearney & Peebles
Shepherdia canadensis (L.) Nuttall
Symphoricarpos albus (l.) S.F. Blake
Symphoricarpos occidentalis Hook
Symphoricarpos rotundifolius A. Gray
Symphoricarpos sp.
Toxicodendron rydbergii (Small ex
Rydberg) Greene
Vaccinium cespitosum Michaux
Vaccinium myrtilis L.
Vaccinium scoparium Leiberg ex Coville
Vaccinium sp. L.

VINES
Clematis ligusticifolia Nutt.
Echinocystis lobata (Michx.) Torr. & Gray
Parthenocissus quinquefolia (L.) Planchon*
Vitis riparia Michx.

GRAMINOIDS
Agropyron sp.*
GRAMINODS, continued.
Agrostis gigantea Roth
Agrostis humilis Vasey
Agrostis scabra Wildenow
Agrostis stolonifera L.
Agrostis sp.
Alopecurus aequalis Sobolewski
Beckmannia syzigachne
Bromus inermis Leyss.*
Bromus ciliata L.
Bromus frondosus (Shear) A.S. Hitchc.
Bromus hordeaceus ssp. hordeaceus L.*
Bromus japonicus Thunberg *
Bromus tectorum L.*
Bromus sp.
Calamagrostis canadensis (Michaux) Beauv.
Calamagrostis stricta (Timm) Koeler
Calamagrostis sp.
Carex albonigra Mackenzie
Carex aquatilis Wahlenb.
Carex aurea Nutt.
Carex bebbii (L. H. Bailey) Fernald
Carex brunnescens (Persoon) Poiret in
Lamarck
Carex canescens L.
Carex capillaris L.
Carex deweyana Schweinitz
Carex disperma Dewey
Carex filifolia Nuttall
Carex interior L. H. Bailey
Carex lanuginosa Michx.
Carex lasiocarpa Ehrhart
Carex microptera Mackenzie
Carex nebrascensis Dewey
Carex norvegica Retzius
Carex nova A. Nelson
Carex occidentalis L.H. Bailey
Carex parryana Dewey
Carex raynoldsii Dewey
Carex scopulorum Holm
Carex stipata Muhlenberg ex Willdenow
Carex utriculata F. Boott
Carex sp.
Cinna latfolia (Treviranus) Grisebach in
Ledebour
Dactylis glomerata L. *
GRAMINOIDS, continued.
Danthonia parryi Scribner

Deschampsia caespitosa (L.) P. Beauvois
Dichanthelium acuminatum (Swartz) Gould & Clark
Distichlis spicata (L.) Greene
Echinochloa crus-galli (L.) P. Beauvois*
Eleocharis palustris (L.) Roemer & J.A. Schultes
Eleocharis sp.
Elymus lanceolatus ssp. lanceolatus (Scribn. & J.G. Sm.) Gould
Elymus trachycaulis (Link) Gould ex Shinners
Elymus sp.
Elytrigia repens (L.) Desv. Ex B. D. Jackson*
Eriophorum angustifolium Honckeny
Festuca idahoensis Elmer
Festuca pratensis Hudson
Festuca saximontana Rydberg
Festuca thurberii Vasey in Rothrock
Festuca sp.
Glyceria elata (Nash ex Rydberg) Jones
Glyceria grandis S. Watson in A. Gray
Glyceria striata (Lamarck) A.S. Hitchcock var. stricta (Scibner) Fernald
Glyceria sp.
Hierochloe hirta (Schrank) Borbas ssp. arctica (J. Prel in K. Presl.) G. Weimack.
Hordeum jubatum L.
Hordeum pulsillum Nuttall*
Juncus balticus ssp. montanus Engelm.
Juncus castaneus J.E. Smith
Juncus confusus Coville
Juncus longistylis Torrey
Juncus mertensianus Bongard
Juncus saximontanus A. Nelson
Juncus tracyi Rydberg
Juncus sp.
Leersia oryzoides (L.) Swartz*
Luzula congesta (Thuill.) Lej.
Luzula parviflora (Ehrh.) Desv.
Luzula supcapitata (Rydb.) Harrington
Luzula sp.
Mulenbergia filiformis (Thur. Ex Watts)
GRAMINOID, continued.
Rydb.
Mulenbergia racemosa (Michaux) Britton, Sterns, Poggenberg
Oryzopsis asperifolia Michaux
Pascopyron smithii (Rydb.) A. Love
Phalaris arundinacea L.*
Phleum alpinum L.
Phleum pratense L.*
Poa arctica R. Brown
Poa compressa L.
Poa glauca M. Vahl
Poa leptocoma Trinius
Poa palustris L.
Poa pratensis L.*
Poa sp.
Scirpus acutus Muhl. ex Bigelow
Scirpus microcarpus J. & K. Presl.
Scirpus pallidus (Britton) Fernald
Scirpus sp.
Spartina gracilis Trin.*
Sphneopholis obtusata (Michaux) Scribner
Sporobolus airoides (Torrey) Torrey
Sporobolus sp.
Stipa comata Trin & Rupr.
Stipa sp.
Vahlodea atropurpurea (Wahl.) E. Fries

FORBS
Achillea millefolium var. apicola (Rydb) Garrett
Aconitum columbianum Nutt.
Actea rubra (Aiton) Willdenow
Ambrosia dumosa (Gray) Payne
Ambrosia sp.
Androsace occidentalis Pursh
Androsace septentrionalis L.
Androsace sp.
Anemone canadensis L.
Anemone sp.
Angelica ampla A. Nelson
Angelica grayi (Coulter & Rose) Coulter & Rose
Antennaria coryombosa E. Nelson
Antennaria parviflora Nuttall
Antennaria sp.
FORBS, continued.
Apocynum androsaemifolium L.

Apocynum cannabinum L.*
Apocynum sp.
Aquilegia coerulea James ex Torrey
Aquilegia sp.
Aralia nudacaulis L.
Arctium minus Bernh.
Arnica cordifolia Hook.
Arnica mollis Hook.
Arnica sp.
Artemisia ludoviciana Nuttall
Artemisia sp.
Asclepias speciosa Torr.
Asclepias sp.
Asparagus officianalis L.
Aster glaucodes Blake var. glaucodes
Aster lanceolatus ssp. hesperius (Gray) Semple & Chmielewski
Aster sp.
Astragalus sp.
Athyrium filix-femina (L.) Roth
Brassica napus L.
Caltha leptosepala DC.
Calypso bulbosa (L.) Oakes
Campanula rotundifolia L.
Campanula sp.
Cardimine cardifolia Gray
Carduus nutans L.
Castilleja sulphurea Rydb.
Castilleja sp.
Centaurea diffusa Lam.*
Cerastium arvense L.
Cerastium sp.
Chenopodium sp.
Cicuta douglasii (DC.) Coult. & Rose
Circaea alpina L.
Circaea alpina ssp. pacifica (Aschers. & Magnus) Raven
Cirsium arvense (L.) Scop.*
Cirsium tioganum var. coloradense (Rydb.) Dorn
Cirsium vulgare (Savi) Tenore*
Cirsium sp.
Claytonia sp.
Conioselinum scopulorum (A. Gray) Coulter
FORBS, continued.
& Rose

Convolvulus sp.
Conyza canadensis (L.) Cronq.*
Corallorrhiza trifida Chatelain
Cynoglossum officianale L.*
Delphinium barbeyi (Huth) Huth
Delphinium occidentale (S. Watson) S. Watson
Delphinium sp.
Descurainia sp.
Dipsaucus fullonum L.*
Dodecatheon pulchellum (Raf.) Merr.
Dugaldia hoopesii (A. Gray) Rydb.
Epilobium angustifolium L.
Epilobium ciliatum Raf.
Epilobium hornmannii Reich.
Epilobium leptocarpum Hauss.
Epilobium sp.
Erigeron eximius Greene
Erigeron formosissimus Greene
Erigeron peregrinus (Banks ex Pursh) Greene
Erigeron sp.
Eriogonum alatum Torr. var. alatum
Euphorbia esula var. esula (Fish ex Link) Dorn*
Fragaria virginiana Duchesne
Fragaria vesca L. ssp. bracteata (Heller) Staudt
Galium aparine L.*
Galium bifolium S. Watson
Galium boreale L.
Galium trifidum L.
Galium triflorum Michaux
Galium sp.
Gentiana affinis Griseb.
Gentiana parryi Engel.
Gentiana sp.
Gentianella amarella ssp. heterosepala (Englm.) J. Gillet
Gentianella sp.
Geranium caespitosum James & Torrey var. caespitosum
Geranium richardsonii Fischer & Trautvetter
FORBS, continued.
Geranium viscosissimum Fisher & Meyer

ssp. nervosum (Rydb.) W. A. Weber
Geranium sp .
Geum aleppicum Jacquin
Geum macrophylum Willdenow
Geum triflorum Pursh
Harbouria trachypleura (A. Gray) Coulter & Rose
Helianthus sp.
Heracleum sphondylium L. var. montanum (schleicher ex Gaudin) Birquet in Schinz & Thllung†
Heterotheca villosa (Pursh) Shinners
Hydrophyllum fendleri (Gray) Heller
Iris missouriensis Nuttall
Lactuca tatarica (L.) C.A. Meyer var. pulchella (Pursh) Stebbins
Latuca sp.
Lepidium sp.
Leucanthemum vulgare Lamarck*
Ligusticum porteri Coulter & Rose
Ligusticum tenuifolium S. Wats.
Ligusticum sp.
Linaria vulgaris P. Miller*
Linaria sp.
Linum usitatissimum L.*
Listera cordata var nephrophylla (Rydb.) Love & Love
Listeria sp.
Lomatium sp.
Lucerne sp.
Lupinus argenteus Pursh
Maianthemum racemosum L. Link ssp. amplexicaule (Nutt.) LaFrankie
Maianthemum stellatum (L.) Link
Medicago lupulina L.*
Medicago polymorpha L.
Melilotus officinalis (L.) Lam.*
Mentha arvense L.
Mentha sp.
Mertensia ciliata (James & Torrey) G. Don
Mimulus sp.
Mitella pentandra Hooker
Moehringia laterifolia (L.) Fenzl
Monarda fistulosa L.
FORBS, continued.
Moneses uniflora (L.) A. Gray
Montia chamissoi (Ledeb. Ex Spreng.) Greene
Nasturtium officinale R. Brown
Nepeta cataria L.*
Oenothera villosa Thunberg
Oenothera sp.
Orthilia secunda (L.) House
Osmorhiza berteroi DC.
Osmorhiza depauperata Philippi
Osmorhiza sp.
Oxalis corniculata L.
Oxypolis fendleri (A. Gray) Heller
Oxytropis lambertii Pursh
Oxytropis serica Nuttall
Packera sp.
Parnassia parviflora DC.
Pedicularis bracteosa Bentham
Pedicularis crenulata Bentham in DC
Pedicularis groenlandica Retzius
Pedicularis sp.
Penstemon sp.
Phacelia sericea (R. Graham) A. Gray
Plantago lanceolata L.
Plantago major L.*
Plantago sp.
Platanthera dilatata ssp. albiflora (Cham.) Ledeb.
Platanthera hyperborea (L.) Lindl. var. hyberborea
Platanthera obtusata (Banks ex Pursh) Lindl.
Platanthera sparsiflora (S. Wats.) var. sparsiflora
Platanthera stricta Lindl.
Platanthera sp.
Polemonium confertum A. Gray
Polemonium sp.
Polygonum aviculare L.*
Polygonom bistorta L.
Polygonum viviparum L.
Polygonum sp.
Potentilla hippiana Lehmann
Potentilla pensylvanica L.
Potentilla pulcherrima Lehmann
Potentilla sp.
FORBS, continued.
Primula parryi A. Gray

Pseudocymopterus montanus (A. Gray) Coutler & Rose
Pulsatilla patens (L.) P. Miller ssp. multifida (pritzel) Zamels
Pyrola asarifolia ssp. asarifolia (Michaux) A. & D. Love
Pyrola minor L.
Pyrola picta J.E. Smith
Pyrola sp.
Ranauculus macounii Britton
Ranunculus pygmaeus Wahlenberg
Ranunculus sceleratus var. sceleratus L.
Ranunculus sp.
Ratibida columnifera (Nuttall) Wooton & Standley
Rudbeckia hirta L.
Rudbeckia laciniata var. ampla (A. Nels.) Conq.
Rudbeckia sp.
Rumex acetosella L.*
Rumex crispus L.*
Rumex densiflorus Osterhout
Rumex sp.
Saponaria officinalis L.*
Saxifraga hirculus ssp. propinqua (R. Br.) A. & D. Love
Saxifraga odontoloma Piper
Saxifraga sp.
Scuttelaria sp.
Sedum integrifolium (Raf.) A. Nels ssp. integrifolium
Sedum rhodanthum Gray
Senecio amplectens Gray var. amplectens
Senecio serra Hook.
Senecio triangularis Hook.
Senecio sp.
Silene drummondii Hook. var. drummondii
Sisyrinchium montanum Greene
Solidago canadensis L.
Solidago gigantea Ait.
Solidago velutina DC.
Solidago sp.
Spiranthes romanzoffiana Cham.
Stellaria crassifolia Ehrh.
FORBS, continued.
Stellaria longipes Goldie.
Stellaria media (L.) Vill. ssp. media
Stellaria sp.
Streptopus amplexifolius var. chalazatus Fassett
Swertia perennis L.
Taraxacum officinale G.H. Weber ex Wiggers*
Teucrium canadense L.
Thalictrum alpinum L.
Thalictrum dasycarpum Fische.& Avé-Lall.
Thalictrum sparsiflorum Turcz. ex Fisch. & C.A. Mey.
Thalictrum fendleri Engelm. ex Gray
Thalictrum sp.
Thermopsis rhombifolia var. montana (A. Nels.) Isely
Thermopsis sp.
Thlaspi arvense L.*
Thlaspi montanum L.
Tragopogon dubius Scop.*
Trifolium hybridum L.*
Trifolium parryi Gray ssp. salictorum
Trifolium pratense L.*
Trifolium repens L.*
Trifolium sp.
Triglochin palustre L.
Trollius laxus ssp. albiflorus (Gray) A. & D. Love & Kapoor
Urtica diocia ssp. gracilis (Ait.) Seland.
Valeriana capitata Pallas ex Link
Verbascum thapsus L.*
Verbena sp.
Veronica americana Schwein. & Benth.
Veronica anagallis-aquatica L.
Veronica wormskjoldii Roemer & J.A. Schultz
Veronica peregrina L.
Veronica sp.
Vicia americana Muhl. ex Wildd.
Vicia sp.
Viola biflora L.
Viola canadensis var. corymbosa Nutt. ex. Torr. & Gray
Viola sp.
FORBS, continued.
Zigadenus sp.

HORESTAILS
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Equisetum arvense L
Equisetum laevigatum A. Braun
Equisetum hymale L.
Equisetum variegatum Schleich. ex F.
Weber & D.M. H. Mohr
Equisetum sp.

APPENDIX B. Plant Species Found in Riparian Areas of the Lower South Platte Watershed (below ~6500 feet in elevation). Nomenclature follows Kartesz (1994), except for *Salix*, which follows Dorn (1977 and 1995). Tree species were split into three age classes: seedling = < 1.25 m (4.5 ft) tall, sapling = > 1.25 m tall, < 12.6 cm (5 in) dbh, and older trees = > 12.6 cm (5 in) dbh. If no age class is listed, trees were in the oldest age class. * indicates an introduced species to Colorado (Weber and Wittmann 1992). † indicates nomenclature follows Weber and Wittmann (1992).

TREES

Abies lasiocarpa (Hook.) Nutt.--saplings
Abies lasiocarpa (Hook.) Nutt.--seedlings
Abies lasiocarpa (Hook.) Nutt.--older trees
Acer negundo var. interius L.--saplings
Acer negundo var. interius L.--seedlings
Acer negundo var. interius L.--older trees
Elaeagnus angustifolia L.*
Fraxinus pennsylvanica Marsh.—seedlings*
Fraxinus pennsylvanica Marsh.—saplings*
Fraxinus pennsylvanica Marsh.--older trees*
Juniperus scopulorum Sarg.--seedlings
Juniperus scopulorum Sarg.—older trees
Picea engelmannii Parry ex Engelm.—seedlings
Pinus contorta Dougl. ex Loud.--seedlings
Pinus contorta Dougl. ex Loud.-- saplings
Pinus contorta Dougl. ex Loud.-- older trees
Pinus ponderosa P. &. C. Lawson – older trees
Populus angustifolia James--saplings
Populus angustifolia James--seedlings
Populus angustifolia James—older trees
Populus deltoides ssp. monilifera (Ait.) Eckenwalder -- seedlings
Populus deltoides ssp. monilifera (Ait.) Eckenwalder--saplings
Populus deltoides ssp. monilifera (Ait.) Eckenwalder -- older trees
Populus tremuloides (Michx.)
Populus x acuminata Rydb.
Pseudotsuga menziesii (Mirbel) Franco
Salix amygdaloides Anderss.-- seedlings
Salix amygdaloides Anderss.--saplings
Salix amygdaloides Anderss.-- older trees
Salix fragilis L.*
Ulmus pumila L.*

SHRUBS

Acer glabrum Torr.
Alnus incana ssp. tenuifolia (Nutt.) Breitung
Arctostaphylos uva-ursi (L.) Spreng.
Betula glandulosa Michaux†
Betula occidentalis Hook.
Celtis laevigata var. reticulata (Torr.) L. Benson
Chrysothamnus nauseosus (Pallas ex Pursh) Britt.
Chrysothamnus sp.
Cornus sericea L.
Crataegus macracantha Loddiges var. occidentalis (Brit.) Egg.†
Holodiscus dumosus (Nutt. ex Hook.) Heller
Humulus lupulus L.
Jamesia americana Torr. & Gray
Lonicera involucrata Banks ex Spreng.
Pentaphylloides floribunda (Pursh) A. Love
Physocarpus monogynus (Torr.) Coult.
Prunus virginiana var. melanocarpa (A. Nels.) Sarg.
Quercus gambelii Nutt
Rhus trilobata Nutall ex Torr. & Gray var. trilobata
Ribes aureum Pursh
Ribes cereum Dougl.
Ribes coloradense Coville
Ribes inerme Rydb.
Ribes sp.
Rosa woodsii Lindl.
Rubus idaeus L.
Salix bebbiana Sarg.
Salix drummondiana Barratt ex Hook
Salix eriocephala ssp. mackenzieana var. ligulifolia (C.R. Ball) Dorn
Salix eriocephala ssp. eriocephala var. famelica (C.R. Ball) Dorn

SHRUBS, continued.
Salix exigua Nutt.
Salix geyeriana Anderss
Salix lucida ssp. caudata (Nutt.) E. Murr.
Salix monticola Bebb
Salix planifolia ssp. planifolia Pursh
Shepherdia canadensis (L.) Nuttall
Symphoricarpos occidentalis Hook.
Symphoricarpos sp.
Toxicodendron rydbergii (Small ex Rydb.) Greene
Vaccinium sp.

VINES
Clematis ligusticifolia Nutt.
Echinocystis lobata (Michx.) Torr. & Gray
Parthenocissus quinquefolia*
Vitis riparia Michx.

GRAMINOIDS
Agropyron cristatum (L.) Gaerth.*
Agropyron Gaertner sp.*
Agrostis scabra Willd.
Agrostis L. sp.
Agrostis stolonifera L.*
Alopecurus aequalis Sobol.
Alopecurus L. sp.
Andropogon L. sp.
Bouteloua curtipendula (Michx.) Torr.
Bouteloua gracilis (Willd. ex Kunth) Lag. Ex. Griffiths
Bouteloua hirsuta Lag.
Bromus hordeaceus ssp. hordeaceus*
Bromus inermis Leyss.*
Bromus japonicus Thunb. ex Murr.*
Bromus tectorum L.*
Calamagrostis canadensis (Michx.) Beauv.
Carex aquatilis Wahlenb.
Carex canescens L.
Carex duriuscula C.A. Mey.
Carex hystercina Muhl. ex Willd.
Carex lanuginosa Michx.
Carex microptera MacKenzie
Carex nebrascensis Dewey
Carex sp.
Carex utriculata F. Boot

GRAMINOIDS, continued.
Cyperus strigosis L.*
Dactylis glomerata L.*
Digitaria sp.
Distichlis spicata (L.) Greene
Echinochloa crus-galli (L.) P. Beauvois*
Eleocharis palustris (L.) Roemer & J.A. Schultes
Eleocharis rostellata (Torr.) Torr.
Eleocharis sp.
Elymus canadensis L.
Elymus lanceolatus ssp. lanceolatus (Scribn. & J.G. Sm.) Gould
Elytrigia repens (L.) Desv. Ex B. D. Jackson*
Eragrostis pilosa (L.) Beauv*.
Eragrostis sp.
Glyceria grandis S.Wats.
Glyceria sp.
Hordeum jubatum L.
Juncus balticus ssp. montanus Engelm.
Juncus sp.
Juncus tracyi Rydb.
Leersia oryzoides (L.) Swartz*
Luzula parviflora (Ehrh.) Desv.
Oryzopsis hymenoides (Roemer & J.A. Achultes) Ricker ex Pipe
Oryzopsis sp.
Panicum capillare L.*
Panicum virgatum L.
Panicum sp.
Pascopyrum smithii (Rydb.) A. Love
Phalaris arundinacea L.*
Phleum alpinum L.
Phleum pratense L.*
Phragmites australis
Poa compressa L.
Poa palustris L.
Poa pratensis L.*
Poa sp.
Polypogon monspeliensis (L.) Desf.*
Schizachyrium scoparium (Michx.) Nash
Scirpus acutus Muhl. ex Bigelow
Scirpus americanus Pers
Scirpus microcarpus J.& K. Presl.
Scirpus pungens Vahl.

GRAMINOIDS, continued.
Scirpus sp.
Setaris vulpiseta (Lam.) Roemer & J.A. Schultes
Sorghastrum nutans (L.) Nash
Spartina gracilis Trin.*
Spartina pectinata Link
Sporobolus sp.
Stipa comata Trin. & Rupr.
Stipa sp.
Typha angustifolia L.
Typha latifolia L.
Vulpia octoflora (Walt.) Rydb.

FORBS
Achillea millefolium var. apicola (Rydb.) Garrett
Ambrosia dumosa (Gray) Payne*
Ambrosia sp.
Anaphalis margaritacea (L.) Benth. & Hook. f.
Angelica sp.
Antennaria parvifolia Nutt.
Apocynum androsaemifolium L.
Aralia nudicaulis L.
Arctium minus Bernh*
Arnica cordifolia Hook.
Artemesia dracunculus L.
Artemesia ludoviciana ssp. ludovicinana Nutt.
Artemesia tridentata ssp. tridentata Nutt.
Asclepias sp.
Asclepias speciosa Torr.
Asparagus officinalis L.
Aster laevis var. geyeri Gray
Aster sp.
Bidens cernua L.*
Bidens frondosa L.*
Bidens sp.
Bidens tripartita L**.
Caltha leptosepala DC.
Cardamine cordifolia Gray
Cardaria sp.
Castilleja sp.
Centaurea diffusa Lam.*
Chamaesyce serpyllifolia (Pers.) Small*

FORBS, continued.
Chamaesyce sp.
Chenopodium album L.*
Chenopodium glaucum L.*
Chenopodium sp.
Cichorium intybus L.*
Cicuta sp.
Cicuta douglasii (D.C.) Coult. & Rose.
Cirsium arvense (L.) Scop.*
Cirsium sp.
Claytonia sp.
Collinsia parviflora Lindl.
Conium maculatum L.*
Convolvulus arvensis L*.
Corallorhiza maculata (Raf.) Raf.
Cornus canadense (L.) Ascherson & Grabner
Cryptantha sp.
Cynoglossum officinale L.*
Descurainia sophia (L.) Webb ex Prant*
Descurainia Webb & Berthelot sp.
Dodecatheon pulchellum (Raf.) Merr.
Echinocereus viridiflorus Engelm.
Epilobium angustifolium L.
Epilobium sp.
Erigeron sp.
Euphorbia dentata Michx.
Euphorbia esula var. uralinsis (Fish ex Link) Dorn*
Euphorbia marginata Pursh
Fragaria virginiana Duchesne
Galium boreale L.
Galium triflorum Michx.
Galium sp.
Geranium richardsonii Fisch. & Trautv.
Geum macrophyllum Willd.
Geum sp.
Glycyrrhiza lepidota Pursh
Hackelia floribunda (Lehm) I.M. Johnston
Harbouria trachypleura (Gray) Coult. & Rose
Helianthus sp.
Heracleum lanatum Michx.
Heterotheca villosa (Pursh) Shinners
Hydrophyllum fendleri (Gray) Heller
Ipomopsis sp.

FORBS, continued.
Lactuca sp.
Lappula occidentalis var. occidentalis (S.Wats) Greene
Lepidium sp.
Lithospermum incisum Lehm.
Lupinus sp.
Mahonia repens (Lindl.) G. Don
Maianthemum racemosum (L.) L.
Maianthemum stellatum (L.) Link
Medicago lupulina L.*
Medicago sativa L.*
Melilotus officinalis (L.) Lam.*
Mentha arvensis L.
Mentha sp.
Mertensia ciliata (James & Torr.) G. Don
Mimulus guttatus D.C.
Mirabilis nyctaginea (Michx.) MacM.
Opuntia polyacantha Haw.
Oxybaphus sp.
Plantago major L.*
Plantago patagonica Jacq.
Platanthera stricta Lindl.
Polanisia dodecandra (L.) DC.
Polygonum bistortoides Pursh
Polygonum pensylvanicum L.*
Potamogeton sp.
Potentilla sp.
Prunella vulgaris L.
Psoralea sp.
Pyrola picata Smith
Ranunculus cymbaliaria (Pursh) Greene
Ranunculus gmelinii D.C.
Ranunculus trichophyllus Chaix
Ranunculus sp.
Rorippa nasturnium (L.) Hayek.
Rorippa palustris spp. hispida (Desv.) Jonsell
Rudbeckia lacinata var. ampla (A.Nels) Conq.
FORBS, continued.
Rumex crispus L.*
Sagittaria sp.
Salsola collina Pallas*
Salvia sp.
Scrophularia lanceolata Pursh
Scutellaria brittonii Porter
Scutellaria sp.
Sedum integrifolium (Raf.) A. Nels.
Sedum rhodanthum Gray
Senecio sp.
Senecio triangularis Hook.
Solanum rostratum Dunal*
Solidago sp.
Stellaria sp.
Taraxacum officinale G.H. Weber ex Wiggers*
Teucrium canadense L.
Thalictrum fendleri Engelm ex. Gray
Thalictrum sp.
Thermopsis rhombifolia (Nutt. ex Pursh) Nutt ex Richards
Thlaspi arvense L.*
Thlaspi montanum L.
Tragopogon dubius Scop.*
Tragopogon sp.*
Trifolium repens L.*
Urtica dioica ssp. gracilis (Ait.) Seland.
Verbascum thapsus L.*
Veronica sp.
Vicia americana Muhl. ex Willd.
Vicia sp.
Viola canadensis L.
Viola sp.
Xanthium strumarium L.*

HORESTAILS
Equisetum arvense L.
Equisetum laevigatum A. Braun
Equisetum sp.

Appendix C is not available
Please contact the Colorado Natural Heritage Program for further information.