Statewide Classification of Riparian and Wetland Dominance Types and Plant Communities - Bighorn Basin Segment

A report submitted to the
Wyoming Department of Environmental Quality
Water Quality Division

by

Gillian M. Walford
Wyoming Natural Diversity Database
(The Nature Conservancy)
1604 Grand Avenue
Laramie, Wyoming 82070

June 28, 1996

Cooperative Agreement # WET04
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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I greatly appreciate the private landowners who allowed us to gather information on their lands. Many people realize the long term benefit of gaining better understanding of their lands and its vegetation. I hope that the results of this project will be useful to all landowners in the Bighorn Basin.

Others contributed to the completion of this project: Laura Gianokos, of the Wyoming Natural Diversity Database, assisted in editing the text and formatting tables. Kelly Belden, of the University of Wyoming's Plant, Soil, and Insect Sciences Department, conducted and/or oversaw the analyses of soil pH and electric conductivity. Ron Hartman, curator, and Ernie Nelson, manager, of the Rocky Mountain Herbarium, provided work space and assistance in identifying plants.

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INTRODUCTION

The classification of riparian and wetland dominance types and plant communities in the Bighorn Basin was a cooperative project between The Wyoming Natural Diversity Database (WYNDD) of The Nature Conservancy and the Wyoming Department of Environmental Quality. The classification of riparian vegetation is the process of analyzing vegetation and environmental data to identify community types (or plant associations) which are groups of species commonly associated together in a particular environmental setting. These vegetation units are repeated and maintained over the landscape.

This project has allowed both cooperating agencies to make progress on a long-term goal. Both agencies recognize that information on riparian plant communities across the state is limited and that the completion of the statewide riparian classification is essential to the development of a comprehensive wetland planning program. WYNDD has been systematically working toward development of a statewide riparian vegetation classification system since 1990. Riparian vegetation types of eastern Wyoming's plains and basins have been identified and described (Jones and Walford 1995). Description of riparian vegetation communities of the Shoshone National Forest is in progress by WYNDD. Other vegetation classification projects are complete or in progress covering other areas of the state. Among other reports, the U.S. Forest Service has published a classification of riparian communities which includes western Wyoming (Youngblood et. al. 1985) and a draft publication which provides a riparian classification for the Bighorn National Forest (Girard et. al. 1995). Our intent is to eventually produce, through cooperation of state and federal agencies and private organizations, a statewide classification of riparian vegetation types by combining the results from these and other studies. Classification of riparian and wetland dominance types and plant communities of the Bighorn Basin will be incorporated into the statewide classification and will move us further toward completion of statewide inventory.

WYNDD is also concerned with identifying high-quality or representative stands of the riparian communities which exist in Wyoming. These stands are important in determining special management designations or in providing baseline data for monitoring the effects of different management strategies. It is necessary that people involved in the various activities of wetland protection, including inventory, research, implementing best management practices, or designing mitigation projects, are able to identify the different wetland types and their respective differences in physical environment, structure, and ecological processes. This will allow better success of the various protection plans for a particular area.

This report provides descriptions of riparian plant communities identified in the Bighorn Basin. A key to these communities has been included to allow easy identification of

these communities in the field. When possible, each plant community is described in relation to the hydrological factors, substrate, and land use which shapes the vegetation of the riparian zone. Many of the Bighorn Basin communities have been described in other classifications, primarily those of the Rocky Mountain region. A comparison is made of the communities identified in Bighorn Basin with existing descriptions. This also allows us to include a more complete picture of each community and its ecological attributes. This information will prove useful to land managers by allowing identification of riparian plant communities and providing relevant ecological information important in determining management and conservation plans.

STUDY AREA

The Bighorn Basin is a surface topographic depression in the north-central part of Wyoming which covers approximately 10,000 square miles (Fig. 1). The basin lies within the Bighorn River drainage and is bounded on three sides by mountains: the Beartooth, Absarokas, and Washakie mountains to the west; the Owl Creek and Bridger mountains to the south; and the Bighorn and Pryor mountains to the east. At its north end the Bighorn Basin is open and merges into the Crazy Mountain Basin of south-central Montana. Four major rivers drain the mountains surrounding the basin: the Bighorn River, Shoshoni River, Greybull River and Clarks Fork Yellowstone River. These eventually empty into the Yellowstone River in Montana. The study area is the section of the Bighorn River drainage basin north of Boysen Reservoir. Our study area lies within most of Hot Springs county, and part of Washakie, Big Horn and Park counties (Fig. 2). The Bighorn Basin study area ranges in elevation from approximately 7,000 ft to a low of 3,600 ft where the Bighorn River enters Montana. Snowmelt from the surrounding 12,500 ft peaks drain into the Bighorn Basin.

Following the late Cretaceous period, 66 million years ago, the Bighorn Basin experienced profound down folding of the crust. Today, compound downfolds in which the layered sedimentary rocks dip toward the lowest point create the surface topographic depression of the basin (Glass and Blackstone 1990). The central portion of the Bighorn Basin is recognized by outcrops of the Paleocene Fort Union formation and Eocene Willwood formation (Lageson and Spearing 1988). Claystones, siltstones and some sandstones from Eocene deposits create the floor of the Bighorn Basin. Soils in the Bighorn Basin are entisols (Bailey 1995) and aridisols (Ostresch et al. 1990).

Mean annual precipitation of the Bighorn Basin ranges from 4 to 10 inches. A mean annual snowfall of 30 inches contributes to this annual precipitation (Martner 1986). The mean annual potential evapotranspiration in this area ranges from 21 to 25 inches. This is the water lost through evaporation from the soil or open water surfaces and through transpiration from the surface of plants. The mean annual water balance calculates to a potential water deficit in soils and other materials. Water balance deficits are common for most of Wyoming. The Bighorn Basin is an extensive area having a negative water balance of minus 10 to minus 17 inches (Ostresh et al. 1990). The greater annual loss of water through evaporation at the earth's surface than annual water gains from precipitation places the Bighorn Basin in the dry domain climate zone. The Bighorn Basin lies within the Dry Domain; Temperate Desert Division; Intermountain Semi-Desert Province of Robert Bailey's ecoregions of the United States (Bailey 1995).

Figure 1. Bighorn Basin study area within Wyoming.

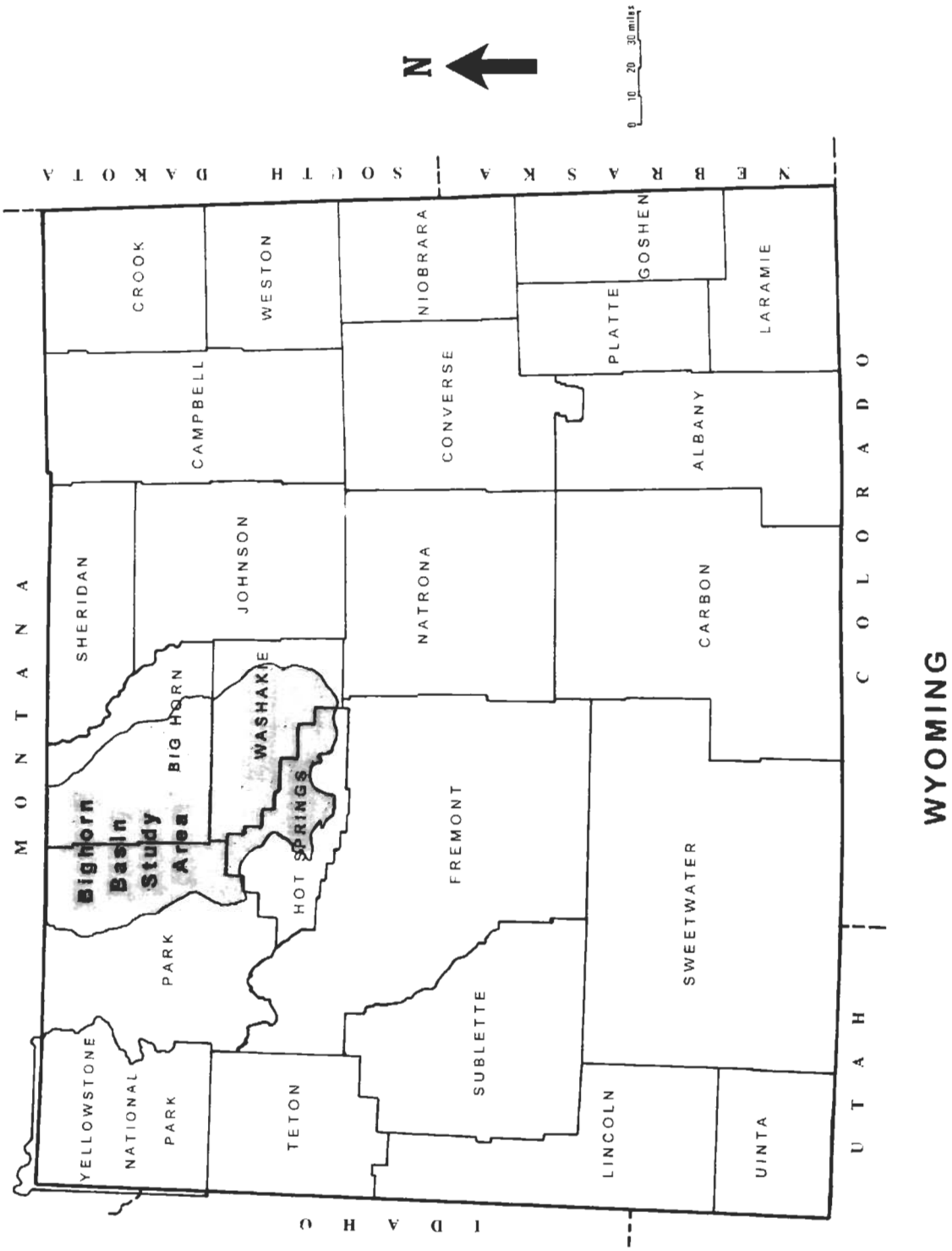
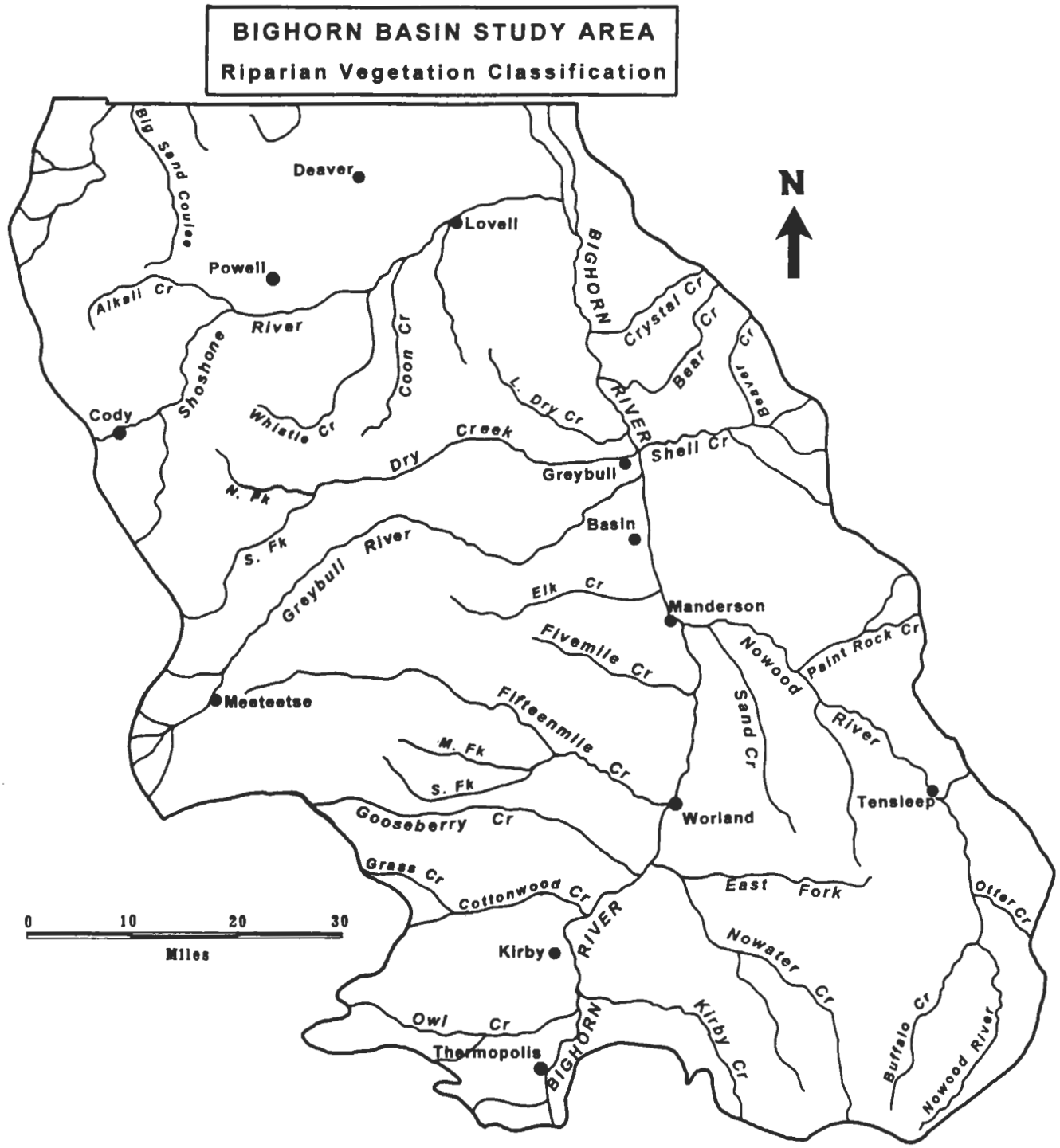


Figure 2. Bighorn Basin study area.



Dominant vegetation in the Bighorn Basin is comprised of a mosaic of shrublands. Sagebrush steppe and desert shrublands are the characteristic vegetation types. Greasewood (*Sarcobatus vermiculatus)* and Gardner saltbush (*Atriplex gardneri*) are common on fine textured, alkaline soils (Knight 1995). Along small ephemeral channels the soils are suitable for basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) or silver sagebrush (*Artemisia cana* var. *cana*), the most common of the Wyoming species of sagebrush. The major drainages of the basin are lined with plains cottonwood *(Populus deltoides)* groves or remnants of cottonwood woodlands being replaced by the introduced Russian olive *(Elaeagnus angustifolia)*. As the basin merges into the foothills, ponderosa pine (*Pinus ponderosa*), limber pine (*Pinus flexilus*), or Rocky Mountain juniper *(Juniperu scopulorum)* woodlands appear.

Historically, immense herds of buffalo were native to the Bighorn Basin, and bighorn mountain sheep inhabited the rocky ledges above the Bighorn River. The basin was important to fur trappers as it was surrounded by rich beaver streams on every side. Cattlemen moved into the basin area in the late 1870's (Lageson and Spearing 1988). Today, large mammals of Bighorn Basin include pronghorn antelope, deer, elk, coyote, mountain lion and bobcat.

The Bighorn Basin provides a major source of bentonite and has been an important source of oil. Recreation opportunities are available at the natural hot springs at Thermopolis and at the Bighorn Canyon National Recreation Area at the north end of the Bighorn Basin.

METHODS

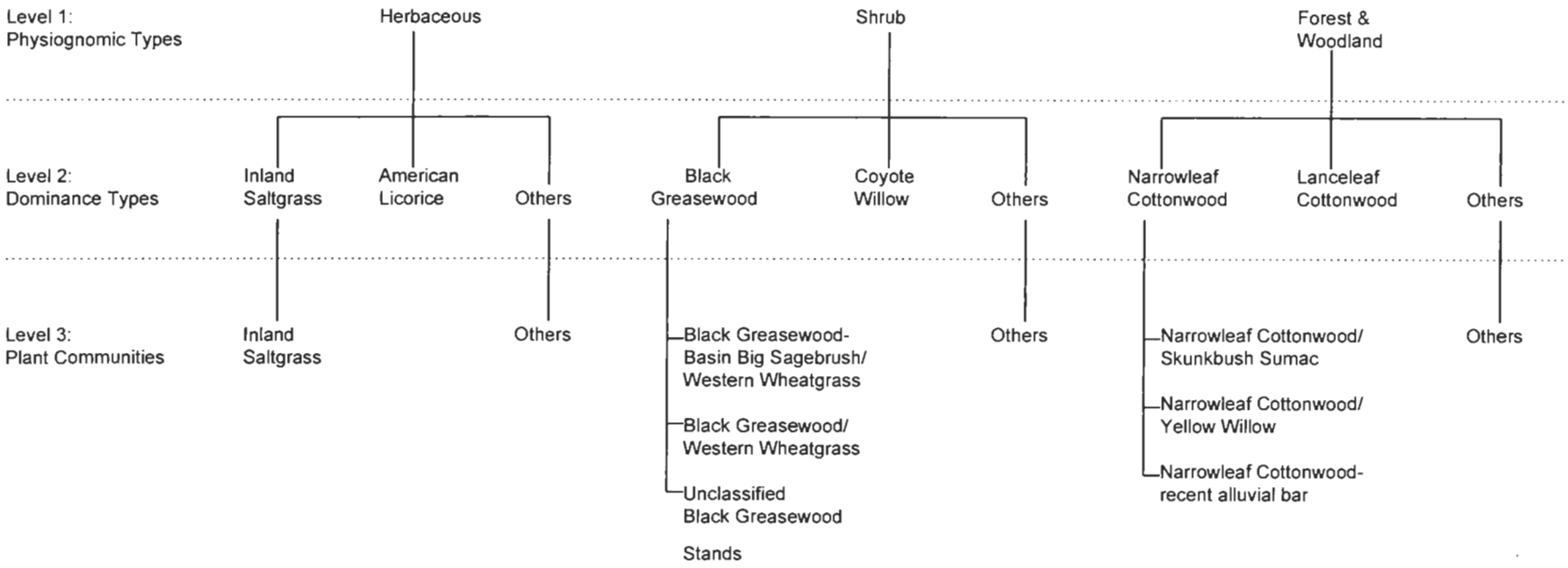
GENERAL APPROACH

The objective of this study was to characterize the riparian vegetation types that occur in the Bighorn Basin. During the summer of 1994, one team of two ecologists from The Nature Conservancy's Wyoming Natural Diversity Database visited sites throughout the Basin to collect information on the riparian vegetation, the physical environment, and when possible, the history and management of each site. For the purpose of this project, a riparian site was defined as a length of stream at least one-quarter mile long, and includes the land between the channel and the adjacent upland ecosystem. Riparian vegeation refers to the plants growing along ephemeral, intermittent, or perennial water courses, where surface or subsurface water provides more moisture throughout the growing season than precipitation provides to upland plants. Riparian vegetation typically grows within 100 yards of stream courses, but it may extend farther and some of the vegetation within 100 yards of a stream course may not be riparian. Riparian vegetation may be submerged during periods of high water, and it may emerge from shallow water for much of the year.

Most of the sites contain more than one type of riparian vegetation. We usually collected information on the vegetation and physical characteristics from one stand of each vegetation type at a site. A stand is one representative example of a plant community; it is relatively uniform in species composition and structure. We did not include sites with planted vegetation, or sites with bridges or gravel pits, or other sites which appeared to have been drastically altered by human activity. Preferred sites were those dominated by native vegetation and/or natural ecological processes, in order to further our understanding of ecological influences on riparian vegetation.

The process of classification in this project uses attributes of the vegetation (physiognomy, structure and floristics) as well as some non-vegetation attributes such as soil properties and landform position. Classification of riparian vegetation into plant associations is based on existing vegetation structure and composition, with no indication of successional status. The classification is a hierarchical product reflecting the organization of the vegetation (Fig. 3). On the most general level, the physiognomic type contains stands having dominant vegetation of the same life-form: trees, shrubs, or herbaceous plants. Within each physiognomic type, stands are grouped into series (also called dominance types or alliances) defined by the dominant or diagnostic species, which is usually found in the uppermost layer of the vegetation. The finest level of the classification is the plant community which is defined

Figure 3. The three levels in the hierarchical classification of vegetation types.
(Only a portion of the vegetation types in each level are shown for illustration.)



as "a plant community of definite floristic composition, presenting a uniform physiognomy, and growing in uniform habitat conditions" (Third International Botanical Congress 1910 *in* Bourgeron and Engelking 1994).

SITE SELECTION

Sampling sites are the locations at which we collected information on vegetation, environment, and when possible, land use. We wanted to determine as many riparian vegetation types as possible; this required a method of site selection which would allow us to visit the range of riparian types in the Bighorn Basin.

The assumptions on which we based our design were: 1) the riparian vegetation at a particular place is shaped primarily by the climate, the flora (i.e. the collection of nearby plants that can contribute seed), the soil texture and chemistry, the hydrology, the fire regime, and the intensity and timing of grazing and browsing; and 2) if we visited sites representing the variation in those factors, we would be more likely to sample the variation in riparian vegetation types. To increase our chance of sampling a large variation of the riparian types, we used a system of selecting study sites known as a stratified random sampling design. This design was stratified by dividing elevation and upstream channel length into zones. It was random by selecting sites within zones on a random basis.

Temperature and precipitation vary with elevation (Martner, 1986), so the study area was stratified into 500-foot elevation zones. We traced elevation lines at 500 feet contour intervals onto overlays of the 1:500,000 scale Wyoming map. Each stream within the Bighorn Basin study area was divided into segments of up to 20 miles in length on the 1:500,000 scale map. We then used an indirect approach to estimate the hydrologic characteristics of the stream segments. We assumed that, at a point, drainage basin area is correlated with the length of the stream and its tributaries above that point. For each segment, its upstream length was calculated by measuring and adding the length of the stream and all its tributaries upstream from the segment. Each stream segment was placed into one of five upstream length classes (0 to 5 miles, 5.1 to 10 miles, 10.1 to 30 miles, 30.1 to 270 miles, and longer than 270 miles) and into one of six elevation zones (between 3,500 and 6,500 feet).

For each combination of elevation zone and upstream length class, we calculated the miles of stream which belonged to that combination. We also calculated the total miles of stream in the Bighorn Basin study area. Using this information, we were able to apportion the number of sampling sites to each elevation/upstream length combination according to the proportion of total stream miles that fell into that combination. Within each elevation/stream length combination, we randomly selected the appropriate number of sampling sites.

We assumed that the other factors that shape the vegetation at a site -- soil texture and chemistry, fire regime, intensity and timing of grazing and browsing -- did not vary with latitude and longitude across the study area, but instead varied between sites. We collected information on these variables when we visited sites in order to look for a relationship between those factors and the vegetation.

Having randomly selected stream segments as potential sampling sites, we reviewed aerial photographs (1:24,000 scale) to see if riparian vegetation occurred along the selected stretches. A 0.5 mile stretch with riparian vegetation was selected within the 20 mile randomly selected segment. Many sampling sites were on public/BLM land. Private land sites were sampled only when permission from the landowner was received. We obtained the name of the landowner from the appropriate county assessor's office. The project was explained to the owner and permission to visit the site was requested.

DATA COLLECTION

When we visited a site, we first confirmed the presence of riparian vegetation; plant species dominant in the adjacent uplands should be absent from or minor parts of the vegetation along the stream. We collected the site information listed in Table 1. Some variables were measured or estimated in the field; others were measured later on a 1:24,000 scale topographic map.

Most sites contained more than one riparian vegetation type. We usually sampled one stand of each riparian vegetation type. A stand is an area of vegetation within which the mix of species and the structure of the vegetation is relatively uniform, and which differs from adjacent areas of vegetation in species mix and vegetation structure. Stands varied in size from about 1/10 acre to one acre. In cases of small stands, we combined information from two or three nearby stands. Size of the plot area sampled varied between stands, due to the variation in size and shape of the stands. Data on species composition and the physical environment were collected at each stand which we chose to sample (Tbl. 2). Plant specimens were collected and taken to the University of Wyoming's Rocky Mountain Herbarium in order to verify identification.

DATA ANALYSIS

Vegetation classification involves a grouping of stands with similar characteristics into the same vegetation type. The vegetation type includes stands that are similar in species composition and structure, are subject to similar ecological processes, provide similar amounts of habitat and forage, and respond similarly to management. Classification statistics, judgement, and information from other classifications were used to make final decisions on vegetation types which would be readily identifiable and useful to other people.

Table 1. Environmental variables measured at each sampling site.

FIELD OBSERVATIONS

- Stream type – perennial or intermittent
- Aspect – downstream direction of stream valley
- Width of the riparian zone (estimated)
- Channel width and depth (estimated)
- Channel entrenchment – depth to which channel has cut into valley floor (estimated)
- Size class of stream bed material – bedrock, large boulder (> 24 in), small boulder (10 - 24 in), cobble (3 - 10 in), gravel (1/16 - 3 in), sand, silt or clay
- Presence of upstream features that might affect hydrology at the site, such as dams or diversions
- Bank stability – estimated percentage of banks protected from erosion by vegetation or rock
- Presence of hydrologic features such as beaver dams or gullies
- History of use – when available from landowner or manager

MEASURED ON 1:24,000 SCALE TOPOGRAPHIC MAP

- Elevation
- Valley width – from divide to divide
- Valley depth – from the higher drainage divide to the valley floor
- Valley gradient
- Stream gradient
- Stream sinuosity – stream length/valley length
- Upstream drainage basin area

Table 2. Information collected for each stand sampled at a site.

VEGETATION

Canopy cover of each species – estimated into cover classes (< 1%, 1-5%, >5-15%, >15-25%, >25-35%, >35-45%, >45-55%, >55-65%, >65-75%, >75-85%, >85-95%, >95%)

Height of each species – estimation of typical individual

Diameter at breast height (dbh) of trees – measured at 4.5 ft from base

Surface cover – estimated percent cover of bare soil, litter, wood, gravel, rock, plant base, mosses and lichens on the ground surface

PHYSICAL ENVIRONMENT

Height of stand above bankfull stream channel

Distance of stand from the stream channel (estimated)

Riparian position – channel slope, first surface/bar, floodplain, terrace

SOILS

Number of horizons – in pit dug in each stand to depth of 3.5 ft or to the water table

Thickness of each soil horizon

Texture of each soil horizon (by hand)

Percent coarse fragments (> 1/16 in) in each horizon

Moist color of each horizon – using Munsell color sharts

Electric conductivity of each soil horizon – analyzed by the University of Wyoming Soil Science Department, Laramie, Wyoming

pH of each soil horizon – analyzed by the University of Wyoming Soil Science Department, Laramie, Wyoming

We constructed a three-level, hierarchical classification of vegetation types, in which the amount of similarity between the stands in a type increases from the highest level to the lowest. The first level of the classification contains vegetation types identified by physiognomy, or general appearance of the vegetation. At this level, we placed stands with less than 10% tree canopy cover and less than 10% shrub canopy cover into an herbaceous physiognomic type. Stands with at least 10% shrub canopy cover, but less than 10% tree canopy cover, were placed into a shrub physiognomic type. Stands with at least 10% tree canopy cover were placed into a forest/woodland physiognomic type. Then, within each physiognomic type, we grouped together the stands dominated by the same overstory species into series, the second level of the classification. Within each series, if possible, we grouped the stands with the same understory species together into a plant community, the third and most detailed level of the classification.

At the series and plant community levels, similar stands were grouped together using a classification technique called cluster analysis. Various sorting strategies and distance functions of the cluster analysis program, SYN-TAX IV (Podani 1990), were used to help identify vegetation types. The species cover data of each stand is compared to that of every other stand so that the two most similar stands can be combined into a cluster. The remaining stands are compared to each other and to the cluster, and similar stands are combined into another cluster or are added to the existing cluster. This process is repeated until all stands belong to a cluster.

Stands in the herbaceous and shrub physiognomic types were clustered into series and plant communities on the basis of the species canopy cover. The forest/woodland stands were clustered on the basis of the density and diameter of the tree species in the stands. Then within these groups, the forest/woodland stands were clustered on the basis of the species canopy cover.

The final decisions on placement of the plots into a plant community were made subjectively by comparing vegetation and environmental data to the published data of other classifications. When the data seemed to compare closely to the previously described type, that published name is used. Plant communities which are not closely similar to previously described types and were sampled with only a few plots are considered tentative plant communities or are classified to the series level only. Further data collection and analysis may help to determine the status of these tentative plant communities. After the stands had been assigned to vegetation types in the classification, we looked for relationships between each vegetation type and selected environmental factors by examining the range in those factors within the stands of the different types.

RESULTS

During the field season of June through August, 1994, we visited 45 sites and collected data from 73 plots. From those data, we identified three riparian physiognomic vegetation types, 22 vegetation series, and 21 plant communities. Names of the plant communities are based on the dominant species in the overstory and the dominant or most diagnostic indicator species in the understory. When there are co-dominants in either layer, both species are included in the name and are separated by a hyphen.

This report consists primarily of descriptions of the dominance types/series and the plant communities. Each description includes information on the major species present, the structure of the vegetation, the geographic area in which we encountered stands of the type, the environment in which the stands occurred, the soil features associated with the vegetation type, the most common adjacent riparian vegetation types, the introduced plant species most often present, the ecology of the vegetation, and similarities to other classifications. The descriptions of the vegetation and the environment come mainly from the information we collected in the Bighorn Basin, while the sections on ecology are drawn largely from the literature.

The report also includes a key to assist in determining the identification of a stand of riparian vegetation in the field. A list of all plants which occurred in the riparian stands sampled in the Bighorn Basin, including both scientific and common names, is found in the appendix.

KEY TO RIPARIAN VEGETATION TYPES
OF BIGHORN BASIN

This key can be used to place a stand of riparian/wetland vegetation into one of the types described in this report. These types include plant associations, plant communities, and plant series. Plant associations (p.a.) are identified on the basis of their existing, not potential, vegetation. Plant community types (c.t.) are disturbance induced types and often have an abundance of exotic species. Plant series are a less specific level of classification within which exist the various plant associations and/or communities. If a stand keys to a Series, we have not yet defined the plant association or community to which it belongs. It is also possible to determine that the stand being keyed has not been defined in this classification.

The key is based on the presence or absence of certain plant species. Classification of associations and communities reveals similarities in abiotic parameters as well as biotic parameters; these ecological attributes of a association's/community's site are included in the description but are not the basis of the key. Once you arrive at an identification of your stand using the key, read the description of the type in the classification. You must validate your determination by comparing the stand vegetation and site characteristics with the parameters of the p.a./c.t./series descriptions.

Begin by selecting a stand of relatively homogeneous vegetation and environmental characteristics, i.e. the stand should be relatively uniform in species composition and structure. The classification is developed from these kinds of stands; ecotonal situations are avoided and will not key out well. You will need to accurately identify and estimate the canopy cover of the indicator species used in this key. You will also need to identify other species when checking the stand against the description.

Start with the key to the physiognomic type. This will direct you to the lifeform group where you begin the next set of choices. The dichotomous key offers two choices at each junction. Read both choices before selecting the most appropriate of the two choices, then proceed to the number indicated at the end of the line of your selection. Eventually, the result of your choice will be the name of the p.a., c.t., or series identification of your stand.

Key to Physiognomic Type

1. Trees (including seedlings and saplings) dominate the overstory with at least 15% combined canopy cover.....FOREST/WOODLAND GROUP

1. Trees not present or with canopy cover less than 15% 2

2. Shrubs dominate the overstory with at least 25% canopy cover ..... SHRUBLAND GROUP

2. Shrubs with combined canopy cover less than 25% and herbaceous species with combined canopy cover greater than 25% ..... HERBACEOUS GROUP

FOREST / WOODLAND GROUP

1. Boxelder *(Acer negundo)* creates a dense canopy with at least 35% canopy cover; individual cottonwood trees may overtop the boxelder occasionally 2

1. Not as above 3

2. Common chokecherry *(Prunus virginiana)* is dominant in the shrub layer (lack of or low amounts of chokecherry may be due to site degredation; see classification description) ..... Boxelder/Common Chokecherry *(Acer negundo/Prunus virginiana)* Community

2. Not as above ..... Boxelder *(Acer negundo)* Series

3. Russian olive *(Elaeagnus angustifolia)* is abundant in the overstory with at least 20% canopy cover 4

3. Not as above 5

4. Overstory canopy is also abundant with one to three cottonwood species *(Populus deltoides, P. angustifolia, P. acuminata)* with individual or combined cover of at least 25% ..... Mixed Cottonwood/Russian Olive *(Populus* spp./*Elaeagnus angustifolia)* stands

4. Not as above ..... Russian Olive *(Elaeagnus angustifolia)* Series

5. Seedlings and/or saplings of narrowleaf cottonwood *(Populus angustifolia)* are dominant with at least 15% canopy cover (pole size trees may also be present) ..... Narrowleaf Cottonwood *(Populus angustifolia)* recent alluvial bar

5. Not as above 6

6. Pole size and larger narrowleaf cottonwood *(Populus angustifolia)* trees are dominant in the overstory canopy with at least 20% canopy cover 7

6. Not as above 9

7. Skunkbush sumac *(Rhus trilobata)* is important in the shrub layer with at least 10% canopy cover; common chokecherry *(Prunus virginiana)* may also be abundant ..... Narrowleaf Cottonwood/Skunkbush Sumac *(Populus angustifolia/Rhus trilobata)* Community

7. Not as above 8

8. Yellow willow *(Salix lutea)* and/or whiplash willow *(Salix lasiandra)* are present in the shrub layer with individual or combined canopy cover of at least 25% ..... Narrowleaf Cottonwood/Yellow Willow *(Populus angustifolia/Salix lutea)* Community

8. Not as above .....Narrowleaf Cottonwood *(Populus angustifolia)* Series

9. Lanceleaf cottonwood *(Populus acuminata)* is the most abundant tree in the overstory with at least 25% canopy cover .....Lanceleaf Cottonwood *(Populus acuminata)* Series

9. Not as above 10

10. Plains cottonwood *(Populus deltoides)* is the most abundant tree in the overstory with at least 10% canopy cover 11

10. Not as above 12

11. Basin big sagebrush *(Artemisia tridentata)* and usually rabbitbrush *(Chrysothamnus* spp.*)* are present in the shrub layer with at least 15% canopy cover .....Plains Cottonwood/Basin Big Sagebrush *(Populus deltoides/Artemisia tridentata* var. *tridentata)* Community

11. Not as above .....Plains Cottonwood *(Populus deltoides)* Series

12. Water birch *(Betula occidentalis)* dominates the overstory with at least 25% canopy cover 13

12. Not as above .....Forest/Woodland type not defined in this classification.

13. Red-osier dogwood *(Cornus sericea)* is dominant in the subcanopy .....Water Birch/Red-Osier Dogwood *(Betula occidentalis/Cornus sericea)* Community

13. Not as above .....Water Birch *(Betula occidentalis)* Series

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SHRUBLAND GROUP

1 Skunkbush sumac *(Rhus trilobata)* dominates the overstory with at least 25% canopy cover 2

1. Not as above 3

2. Coyote willow *(Salix exigua)* and/or western snowberry *(Symphoricarpos occidentalis)* present in the subcanopy.....Skunkbush Sumac-Coyote Willow *(Rhus trilobata-Salix exigua)* Community

2. Not as above ..... Skunkbush Sumac *(Rhus trilobata)* Series

3. Coyote willow (*Salix exigua*) dominates the overstory with at least 35% canopy cover 4

3. Not as above 5

4. Understory is dominated by grasses and/or sedges, usually including one or more of the following species: carpet bentgrass *(Agrostis stolonifera),* wooly sedge *(Carex lanuginosa),* tufted hairgrass *(Deschampsia cespitosa),* and Kentucky bluegrass *(Poa pratensis)* .....Coyote Willow/mesic graminoid *(Salix exigua/*mesic graminoid*)* Community

4. Not as above ..... Coyote Willow *(Salix exigua)* Series

5. Black greasewood *(Sarcobatus vermiculatus)* is a major component of the shrub layer with at least 15% canopy cover.....6

5. Not as above 8

6. Shrub layer dominance is shared with basin big sagebrush *(Artemisis tridentata* var. *tridentata),* and western wheatgrass *(Elymus smithii)* is common in the understory .....Black Greasewood-Basin Big Sagebrush/Western Wheatgrass *(Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/Elymus smithii)* Community

6. Not as above 7

7. Shrub layer is dominated by black greasewood *(Sarcobatus vermiculatus)* without significant basin big sagebrush *(Artemisis tridentata* var. *tridentata),* and western wheatgrass *(Elymus smithii)* is common in the understory ..... Black Greasewood/Western Wheatgrass *(Sarcobatus vermiculatus /Elymus smithii)* Community

7. Not as above ..... Black Greasewood *(Sarcobatus vermiculatus)* Series

8. Silver sagebrush *(Artemisia cana)* is dominant or co-dominant in the shrub layer with at least 10% canopy cover 9

8. Not as above 10

9. Flaxleaf rabbitbrush *(Chrysothamnus linifolius)* and/or basin big sagebrush *(Artemisia tridentata* var. *tridentata)* are co-dominant with the silver sagebrush, with at least 20% combined canopy cover ..... Silver Sagebrush-Flaxleaf Rabbitbrush *(Artemisia cana-Chrysothamnus linifolius)* Community

9. Not as above ..... Silver sagebrush *(Artemisia cana)* Series

10. Rabbitbrush *(Chrysothamnus* sp.) is dominant or co-dominant in the shrub layer with at least 10% canopy cover.....11

10. Not as above 14

11. Alkali dropseed *(Sporobolus airoides)* is dominant in the understory (may be co-dominant with inland saltgrass *(Distichlis stricta))* .....Rabbitbrush/Alkali Dropseed *(Chrysothamnus* sp./*Sporobolus airoides)* Community

11. Not as above 12

12. Rubber rabbitbrush *(Chrysothamnus nauseosus)* is dominant, with flaxleaf rabbitbrush (*Chrysothamnus linifolius*) present or not; herbaceous layer is sparse ..... Rubber rabbitbrush *(Chrysothamnus nauseosus)* Community

12. Not as above 13

13. Flaxleaf rabbitbrush *(Chrysothamnus linifolius)* dominates the shrub layer and Canada wild rye *(Elymus canadensis)* dominates the herbaceous layer ..... Flaxleaf Rabbitbrush/Canada Wild Rye *(Chrysothamnus linifolius/Elymus canadensis)* Community

13. Not as above ..... Rabbitbrush *(Chrysothamnus* sp.) Series

14. Basin big sagebrush *(Artemisia tridentata* var. *tridentata)* dominates the shrub layer with at least 15% canopy cover 15

14. Not as above 16

15. Basin wild rye *(Elymus cinereus)* dominates the understory with at least 20% canopy cover ....Basin Big Sagebrush/Basin Wild Rye *(Artemisia tridentata* var. *tridentata/Elymus cinereus)* Community

15. Not as above ..... Basin Big Sagebrush *(Artemisia tridentata* var. *tridentata)* Series

16. Silver buffaloberry *(Shepherdia argentea)* dominates the shrub layer (other shrubs such as red-osier dogwood *(Cornus sericea)* and common chokecherry *(Prunus virginiana)* may be present and taller, but less abundant) ..... Silver Buffaloberry *(Shepherdia argentea)* Community

16. Not as above 17

17. Chinese tamarisk *(Tamarix chinensis)* dominates the shrub layer with at least 35% canopy cover .... Chinese Tamarisk *(Tamarix chinensis)* Community

17. Not as above .....Shrubland type not defined in this classification

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HERBACEOUS GROUP

1. Graminoids (grasses, sedges and/or rushes) dominate the stand 2

1. Forbs dominate the stand 9

2. Reed canarygrass *(Phalaris arundinacea)* creates dense, nearly homogeneous canopy with at least 50% canopy cover ..... Reed Canarygrass *(Phalaris arundinacea)* Community

2. Not as above 3

3. Kellogg's sedge *(Carex lenticularis)* dominates stand with at least 45% canopy cover, other species have low cover ..... Kellogg's Sedge *(Carex lenticularis)* Community

3. Not as above 4

4. Pale bulrush *(Scirpus pallidus)* dominates stand with at least 40% canopy cover .... Pale Bulrush *(Scirpus pallidus)* Community

4. Not as above 5

5. Leafy bulrush *(Scirpus pungens)* dominates stand with at least 50% canopy cover, other species have low cover ..... Leafy Bulrush *(Scirpus pungens)* Community

5. Not as above 6

6. Kentucky bluegrass *(Poa pratensis)* and western wheatgrass *(Elymus smithii)* are both present and abundant, with combined canopy cover of at least 50% .... Kentucky Bluegrass-Western Wheatgrass *(Poa pratensis-Elymus smithii)* Community

6. Not as above 7

7. Alkali cordgrass *(Spartina gracilis)* dominates stand with at least 15% canopy cover ..... Alkali Cordgrass *(Spartina gracilis)* Community

7. Not as above 8

8. Inland saltgrass *(Distichlis stricta)* dominates these sparsely vegetated stands with at least 10% canopy cover ..... Inland Saltgrass *(Distichlis stricta)* Community

8. Not as above .....Graminoid stand not defined in this classification.

9. American licorice *(Glycyrrhiza lepidota)* is the dominant forb, grasses may be abundant as well ..... American licorice *(Glycyrrhiza lepidota)* Community

9. Not as above .....Forb stand not defined in this classification.

Herbaceous Physiognomic Type

Stands placed in the herbaceous physiognomic type are those dominated by grasses, sedges and/or forbs. They have less than 10% canopy cover by trees and less than 10% canopy cover by shrubs. Their composition ranges from strong dominance by one species to a mix of several species. Herbaceous riparian stands often occur as narrow, continuous or discontinuous, strips of grasses and forbs along the stream channel. They may also form crescent-shaped patches on the insides of bends, or they may occupy floodplain or terrace surfaces above the channel.

Stands of our herbaceous physiognomic type fit into the herbaceous vegetation class of the Land Classification Framework of Driscoll and others (1984). That classification differs from ours by including stands with up to 25% canopy cover of trees or shrubs in the herbaceous class. Within the Cowardin wetland classification (Cowardin et al. 1979), stands of our herbaceous physiognomic type belong to the palustrine system.

Fourteen riparian herbaceous stands were sampled throughout the Bighorn Basin (Fig. 4). Stands within the herbaceous physiognomic type have been classified into series defined by the dominant or diagnostic species. Within the series, we identify the plant community based on existing vegetation structure and composition. The process of classification in this project considers attributes of the vegetation (physiognomy, structure and floristics) as well as some non-vegetation attributes such as soil properties and landform position. The following graphs (Fig. 5-12) illustrate the environmental characteristics at the sites where the herbaceous plant communities or series were sampled. Each herbaceous stand is represented on the graphs and is identified by its community (or series) acronym; the value of the environmental attribute at the stand is displayed. The following acronyms used in the graphs correspond with the following plant communities or series:

DISSTR = Inland Saltgrass (*Distichlis stricta*) Series

SCIPUN = Leafy Bulrush (*Scirpus pungens*) Community

scipun = Unclassified Leafy Bulrush (*Scirpus pungens*) Stand

SCIPAL = Pale Bulrush (*Scirpus pallidus*) Series

SPAGRA = Alkali Cordgrass (*Spartina gracilis*) Community

PHAARU = Reed Canarygrass (*Phalaris arundinacea*) Community

CARLEN = Kellogg's Sedge (*Carex lenticularis*) Series

POAPRA = Kentucky Bluegrass - Western Wheatgrass (*Poa pratensis - Elymus smithii*) Community

GLYLEP = American Licorice (*Glycyrrhiza lepidota*) Series

Figure 4. Location of herbaceous stands within Bighorn Basin.

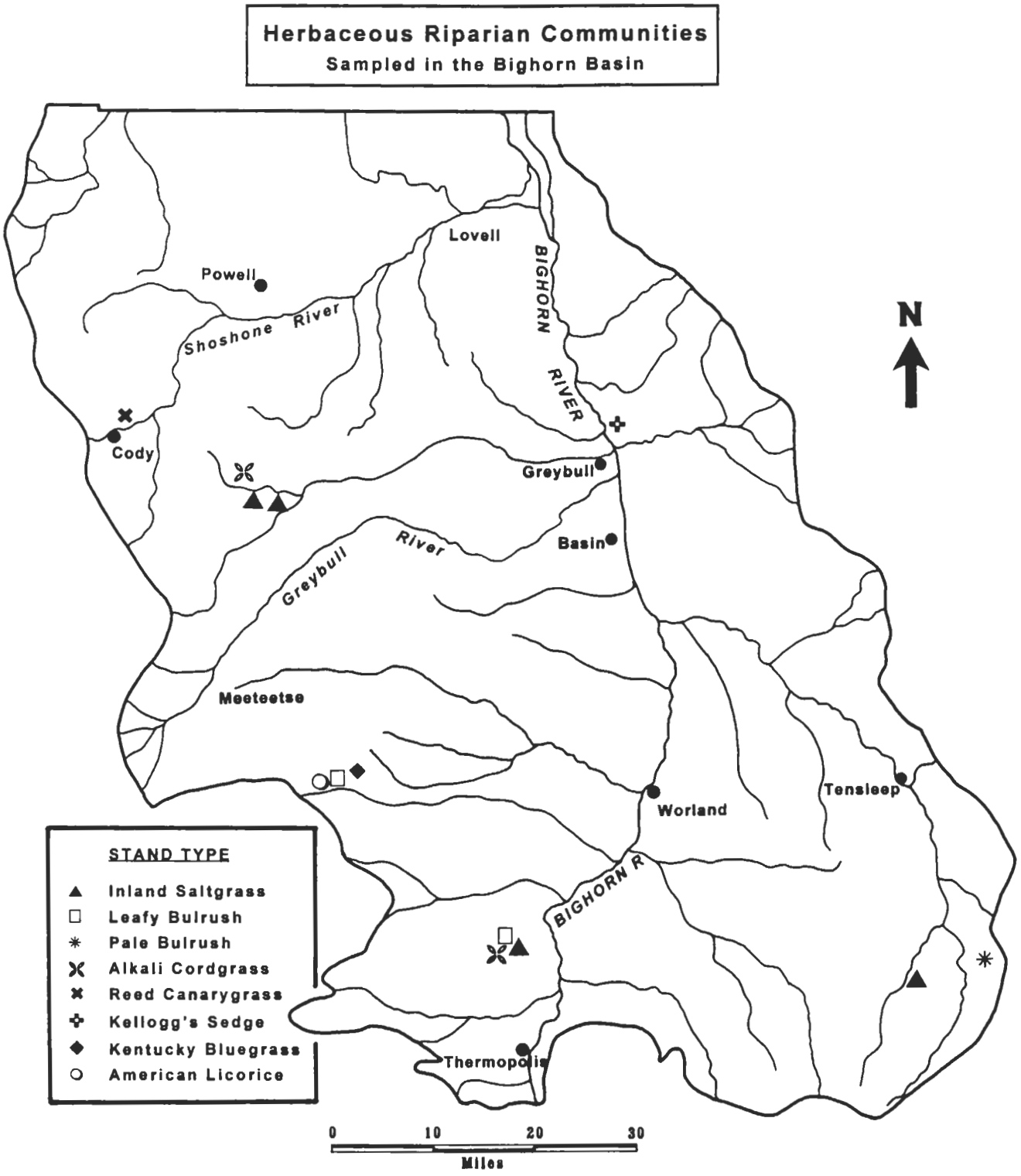


Figure 5. Elevation at sites according to the herbaceous stand type.

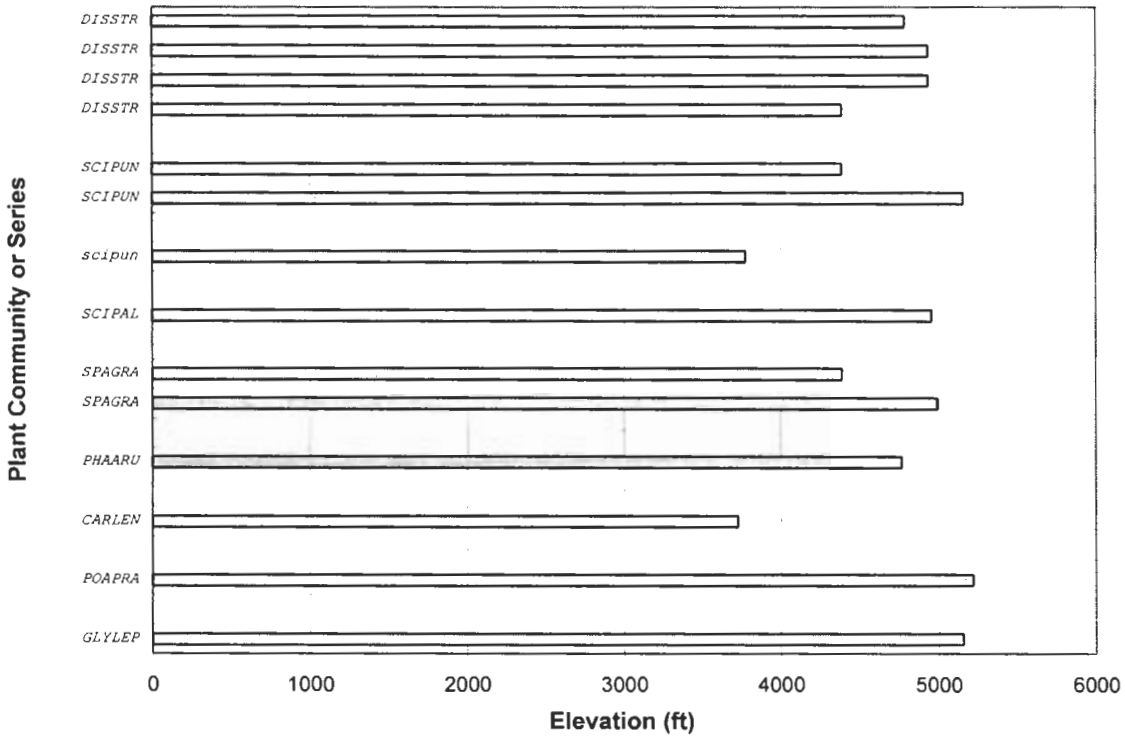


Figure 6. Drainage basin area above sites according to the herbaceous stand type.

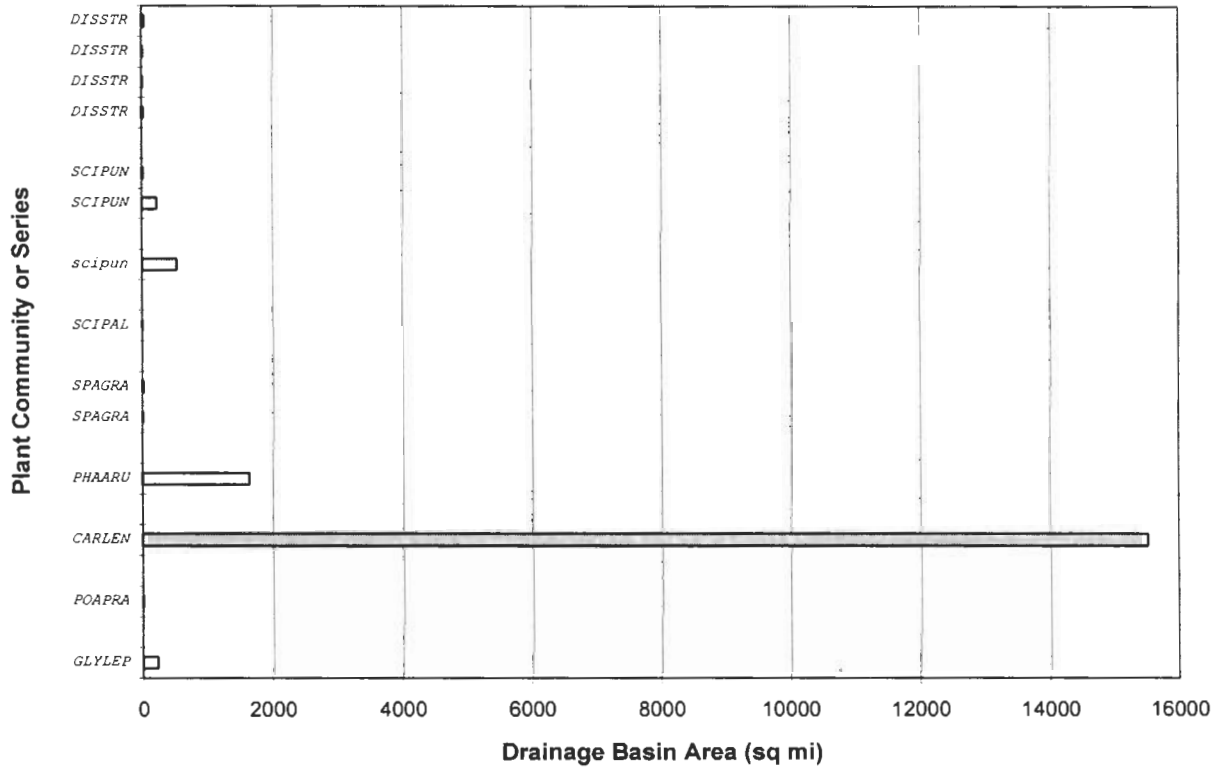


Figure 7. Channel width nearest each plot according to the herbaceous stand type.

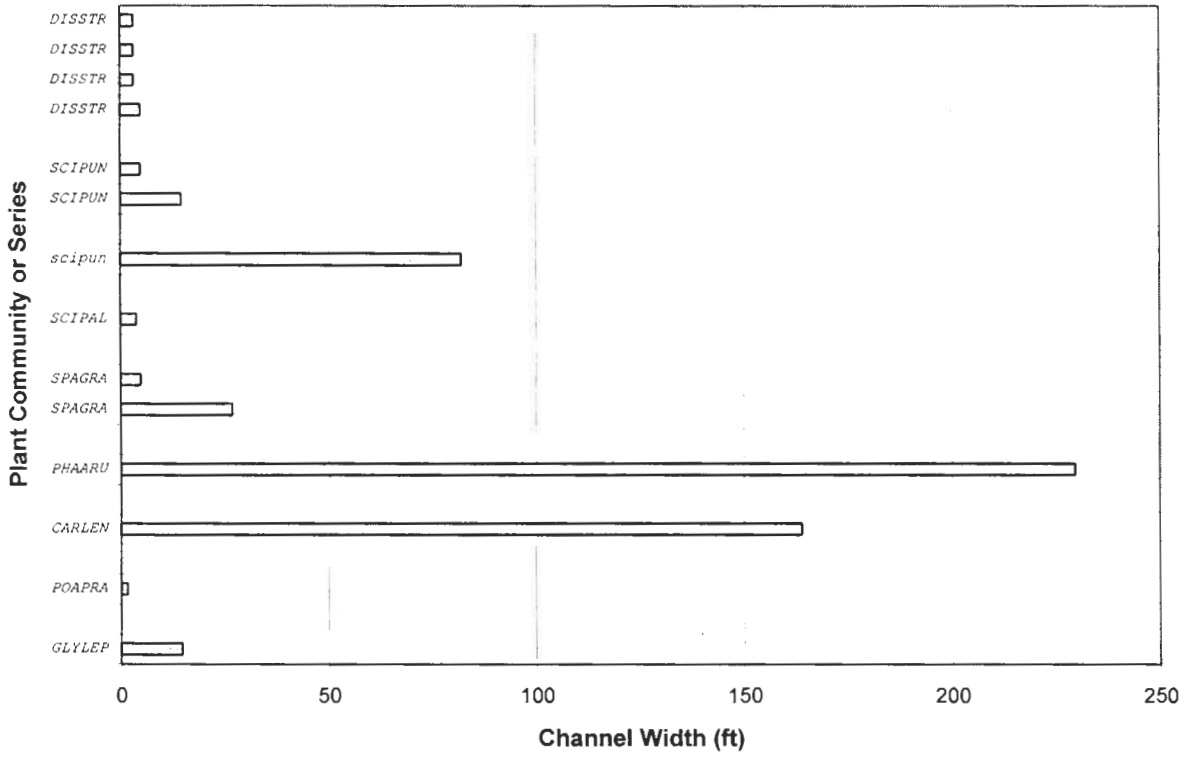


Figure 8. Channel depth nearest each plot according to the herbaceous stand type.

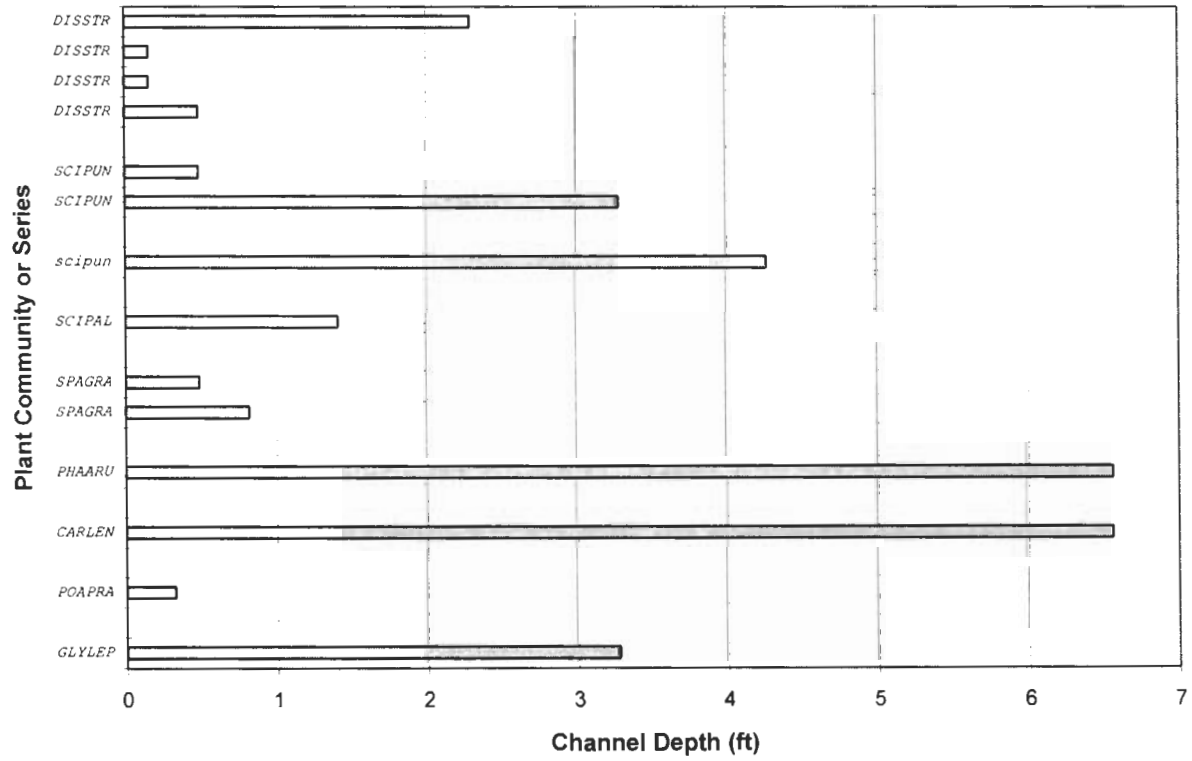


Figure 9. Distance of stands from channel according to the herbaceous stand type.

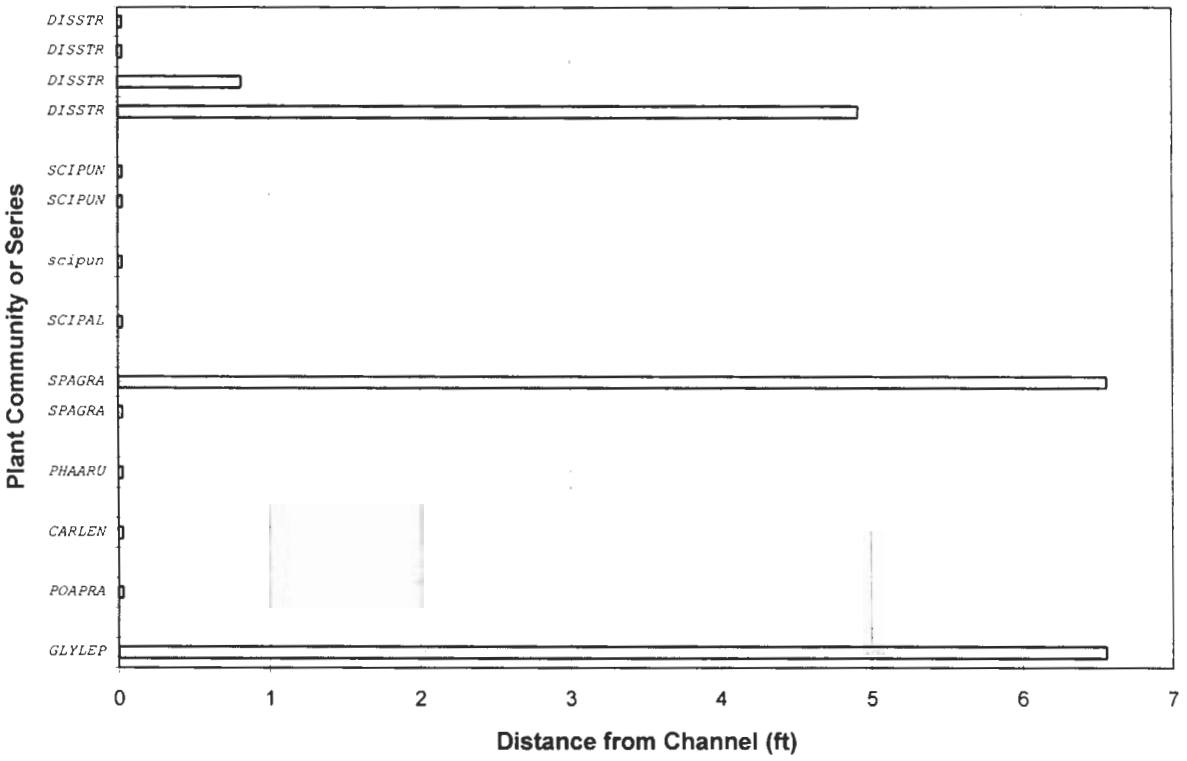


Figure 10. Height of stands above bankfull channel according to the herbaceous type.

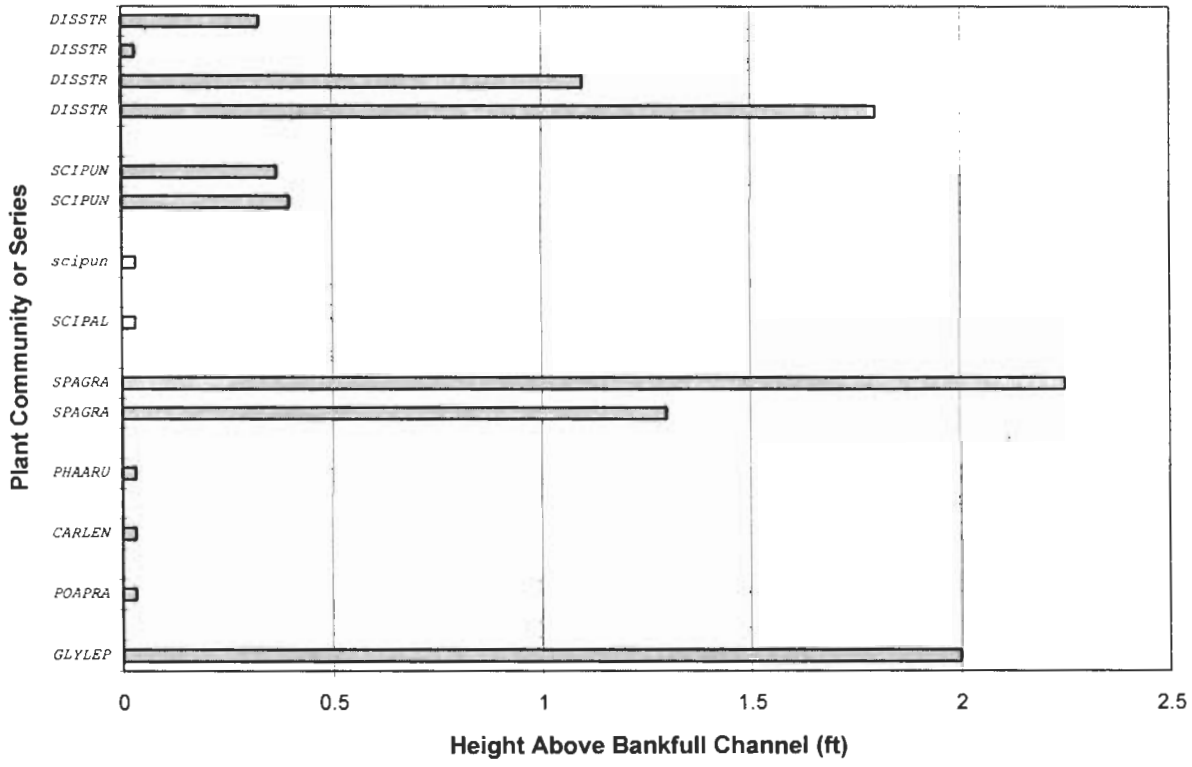


Figure 11. Electric conductivity of the surface soil horizon in stands according to the herbaceous stand type.

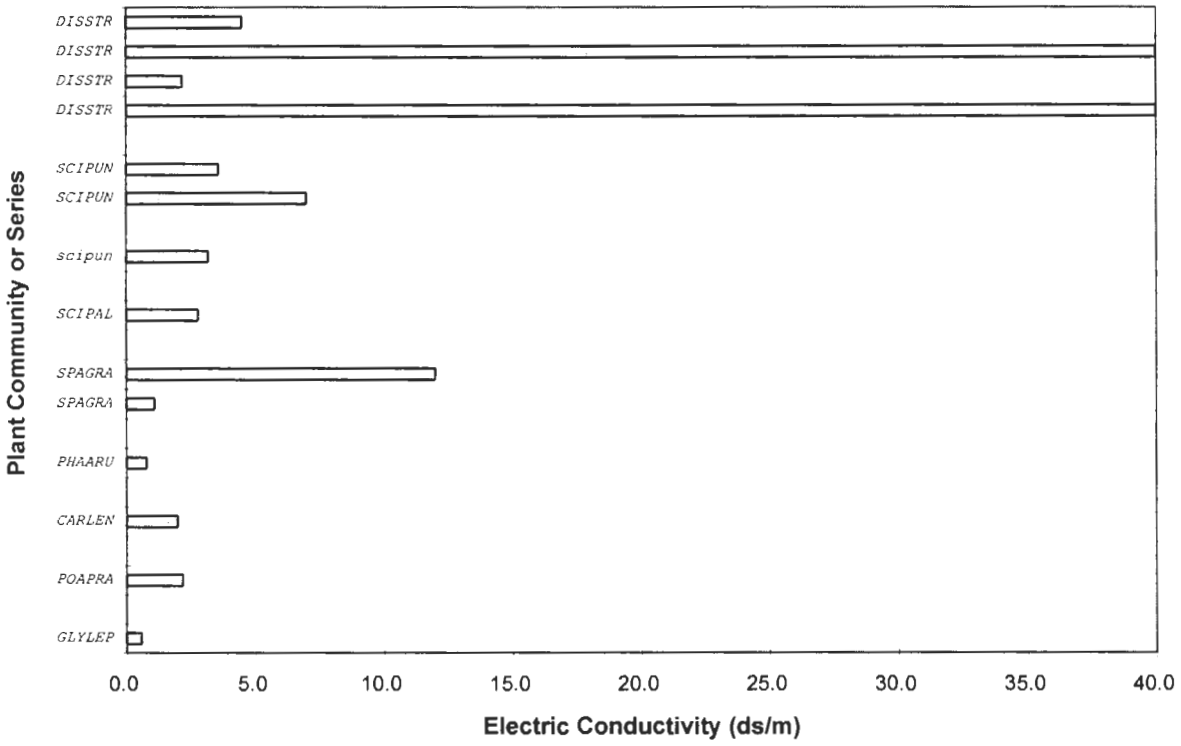
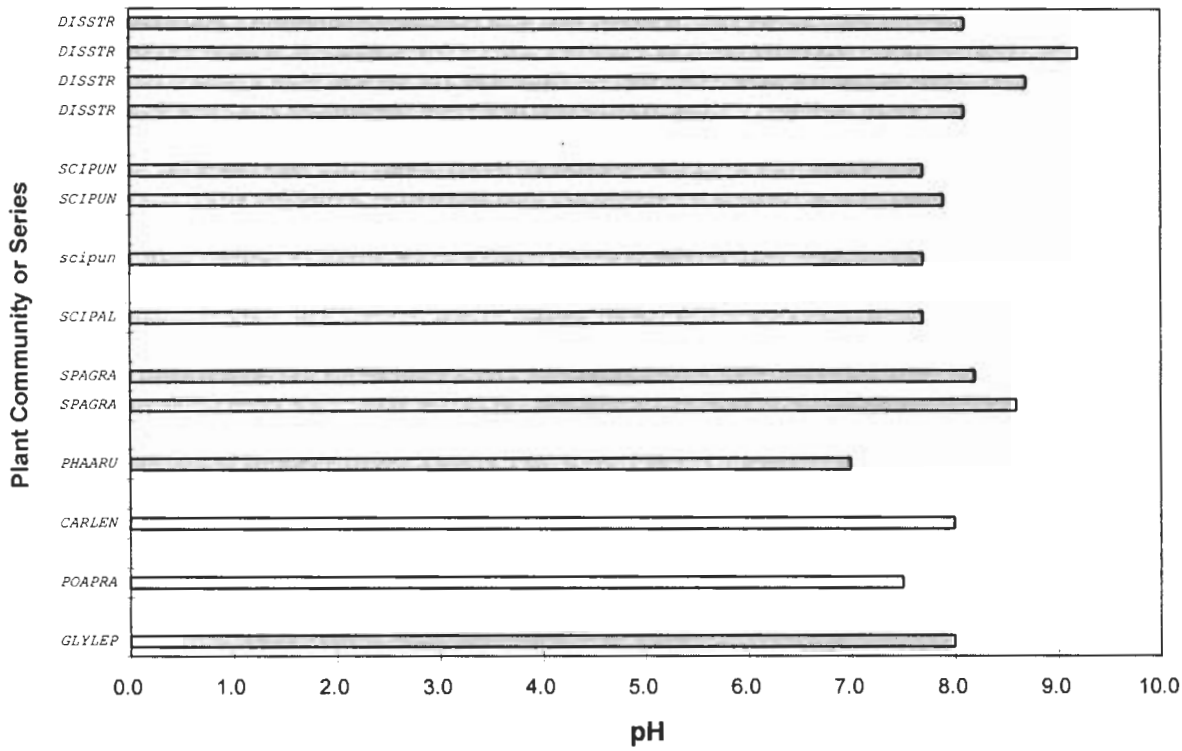


Figure 12. pH of surface soil horizon in stands according to herbaceous stand type.



Inland Saltgrass Series
(*Distichlis stricta* Series)

Stands of the inland saltgrass (*Distichlis stricta*) series are graminoid dominated and share inland saltgrass as their major component (Tbl. 3). There was not high constancy in other species present. This may be due to differences in land use. Most environmental characteristics are similar for these stands (Figs. 5-12). Since groups based on similar species composition and environmental characteristics are not clear within this series, communities are not identified. The following description applies to stands of the inland saltgrass series.

Inland Saltgrass stands
(*Distichlis stricta* stands)

(4 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Inland saltgrass is the common species of these stands with canopy cover ranging from 10% to 40% (Tbl. 3). Stands of the inland saltgrass series have almost no tree or shrub cover; they are mainly dominated by short grasses which provide up to 60% cover. Other abundant species include meadow and bobtail barley (*Hordeum brachyantherum* and *H. caespitosum*), plains bluegrass (*Poa arida*), western and slender wheatgrass (*Elymus smithii* and *E. trachycaulus*), alkali muhly (*Muhlenbergia asperifolia*), alkali dropseed (*Sporobolus airoides*), arrow-grass (*Triglochin concinnum*), and meadow fescue (*Festuca pratensis*). These plants tended to occur in only one or two of our four stands. Leafy bulrush (*Scirpus pungens*) is present in many stands in low to moderate amounts. One stand also had high cover of broadleaved peppergrass (*Lepidium latifolium*) and Swainsonpea (*Sphaerophysa salsula*).

LOCATION:

Sites with inland saltgrass stands were sampled in Washakie, Park, and Hot Springs counties (Fig. 4). Sites are located on first order intermittent and perennial streams at elevations ranging from 4,400 to 4,900 ft (1,340 - 1,505 m) (Fig. 5). The channels at these sites drain a small basin area (< 50 sq mi) (Fig. 6).

ENVIRONMENT:

Stands of the inland saltgrass series are commonly found on intermittent channels averaging 3.3 ft (1 m) in width (Fig. 7). The channel is usually shallow with stagnant pools of water at low points (Fig. 8). The narrow community occurs adjacent to, and sometimes within,

the channel (Fig. 9). It may also occur transitionally between a wetter sedge community and a drier shrub community. Its height above the channel ranges from 0 to 1.8 ft (0 - 0.5 m) (Fig. 10).

SOILS:

Two stands of inland saltgrass had the highest electric conductivity (EC) measurements in the surface soil horizon (40.0 dS/m) of any stands sampled in the Bighorn Basin (Fig. 11). High EC values are indicators of high salinity. The pH and conductivity of the surface horizon of our four stands ranged from 8.1 to 9.2 and 2.2 to 40.0 dS/m, respectively (Figs. 11 & 12). The high electric conductivity in any soil horizon of this community was at the surface horizon.

Surface soils are loams, sandy loams, sandy clays, or clays. Lower horizons included silty loams, loamy sands, silty clays, and sandy or silty clay loams.

EXOTICS:

One stand is dominated by taller exotics: broadleaved peppergrass (*Lepidium latifolium*) and Swainsonpea (*Sphaerophysa salsula*) (Tbl. 3). Chinese tamarisk (*Tamarix chinensis*) shrubs are also beginning to encroach. The three other stands have few exotics, but they do have some undesirable species such as meadow barley and bobtail barley (*Hordeum brachyantherum* and *H. caespitosum*), showy milkweed (*Asclepias speciosa*) and cocklebur (*Xanthium strumarium*).

ADJACENT COMMUNITIES:

The inland saltgrass stands are often adjacent to the channel, or may be separated from the channel by a narrow, wet sedge (*Carex* sp.) community. Away from the channel, the inland saltgrass stands are adjacent to either black greasewood (*Sarcobatus vermiculatus*) or Chinese tamarisk (*Tamarix chinensis*) communities.

ECOLOGY:

The gently sloping banks are stabilized by this community when it occurs adjacent to and within the channel. Inland saltgrass grows from early summer until fall. Reproduction occurs primarily from rhizomes. The species resists trampling and may increase when competition from other plants is reduced (Stubbendieck et al. 1992). With prolonged heavy grazing, cover of saltgrass increases and cover of other species decreases; foxtail barley may replace the saltgrass if heavy grazing persists long enough (Hansen et al. 1991).

Distichlis stricta is a facultative wetland plant. It usually occurs in wetlands (67-99% of the time), but it is occasionally found in non-wetlands.

OTHER CLASSIFICATIONS:

Stands of inland saltgrass dominance type are described from eastern Wyoming (Jones and Walford 1995). In comparing species composition of our Bighorn Basin stands with those

of eastern Wyoming, there were not consistent similarities to allow identification of communities.

An inland saltgrass habitat type is described for Montana that supports vegetation of the inland saltgrass series (Hansen et al. 1991). Johnston (1987) reports three plant associations within the inland saltgrass series (the *Distichlis spicata/Puccinellia airoides* association, the *Distichlis spicata/Elytrigia smithii* association, and the *Distichlis spicata/Sporobolus airoides-Elytrigia smithii* association) from Colorado, Utah, and Wyoming. Stands sampled in the Bighorn Basin do not fit into these associations.

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Distichlis stricta* Series belong to the Herbaceous Vegetation Class, Short Grassland Subclass, Short Grassland Without a Woody Layer Group, Sod Grass Formation, *Distichlis spicata* var. *stricta-(Hordeum jubatum)* Alliance.

Table 3. Percent canopy cover of species in plots of the Inland Saltgrass *(Distichlis stricta)* Series.

Inland Saltgrass (*Distichlis stricta*) Stands

Plots:	SAN 412	NDR 411	NDR 412	BUF 413
Shrubs				
exotic				
Tamarix chinensis	1	-	-	-
Graminoids (tall)				
native				
Scirpus pungens	1	3	-	3
Spartina gracilis	1	-	1	-
exotic				
Bromus inermis	-	-	-	3
Graminoids (short)				
native				
Distichlis stricta	20	10	40	20
Eleocharis palustris	-	3	-	-
Elymus smithii	-	-	1	10
Elymus trachycaulus	10	-	-	-
Hordeum brachyantherum	-	-	-	20
Hordeum caespitosum	10	-	-	-
Hordeum jubatum	-	-	3	-
Juncus balticus	-	-	-	3
Muhlenbergia asperifolia	10	-	-	-

Table 3 (continued).

Inland Saltgrass (*Distichlis stricta*) Stands

Plots:	SAN 412	NDR 411	NDR 412	BUF 413
Poa arida	-	1	20	-
Puccinellia nuttalliana	-	-	1	-
Sporobolus airoides	-	-	10	-
Triglochin concinnum	-	10	-	-
exotic				
Festuca pratensis	10	-	-	-
Polypogon monspeliensis	-	-	-	1
Forbs (tall)				
native				
Asclepias speciosa	10	-	-	3
Helianthus nuttallii	-	-	-	3
Lactuca serriola	-	-	-	1
Solidago gigantea	-	-	-	1
Xanthium strumarium	-	-	-	3
exotic				
Lepidium latifolium	40	-	-	-
Forbs (short)				
native				
Artemisia biennis	-	-	-	1
Grindelia squarrosa	-	-	1	-
Mentha arvensis	-	-	-	3
Ranunculus cymbalaria	-	1	1	-
exotic				
Kochia scoparia	-	-	-	1
Rumex crispus	-	-	-	1
Sphaerophysa salsula	30	-	-	-
Taraxacum officinale	-	-	1	-

Leafy Bulrush Series
(*Scirpus pungens* Series)

Leafy bulrush *(Scirpus pungens)* can produce nearly pure stands, or it can grow with moderate amounts of other grass or sedge species. In both cases, we place stands in the leafy bulrush community.

Leafy Bulrush Community
(*Scirpus pungens* Community)

(2 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Stands of the leafy bulrush series are nearly homogeneous with leafy bulrush contributing 70% to 80% canopy cover (Tbl. 4). Other species are present only in small amounts (< 5% canopy cover). These do not show high constancy in this small data set.

Leafy bulrush, reaching 2 ft (0.6m) in height, tends to be the tallest vegetation of the community. A very small amount of shrubs may provide an upper layer of cover. The occurrence tends to be 7 to 10 ft (2-3 m) in width, occurring adjacent to the channel.

LOCATION:

Leafy bulrush sites were sampled in Hot Springs county (Fig. 4), located on first and second order perennial streams at 4,400 and 5,200 ft (1,340 and 1,575 m) elevation (Fig. 5). The channel may be shallow for its width or moderately incised, with gently sloping banks (Figs. 7 & 8). At sites sampled in the Bighorn Basin, channels were low gradient and moderately sinuous. Leafy bulrush stands occur in wet areas along these small, perennial streams.

ENVIRONMENT:

The leafy bulrush community grows continuously along both sides of the straight channel and only on the inside meanders of the more sinuous channel. In both locations, the leafy bulrush community provides bank stabilization by growing up the banks and onto the floodplain surface.

SOILS:

The surface and upper horizons have clay or clay loam soil textures. More sand is present deeper where sandy clay loam or loamy sand textures were found. Soils were gleyed and/or mottled in the upper 10 cm, indicating a high water table at these stands. The pH and electric conductivity of the surface horizon of our two stands ranged from 7.7 to 7.9 and 3.6 to

7.0 dS/m, respectively (Figs. 11 & 12). The high electric conductivity in any horizon of this community was at the surface.

EXOTICS:

Common exotics, which occurred in low amounts, include carpet bent grass (*Agrostis stolonifera*), and common quackgrass (*Elymus repens*). One stand also had small amounts of common timothy (*Phleum pratense*), and strawberry clover (*Trifolium fragiferum*) (Tbl. 4).

ADJACENT COMMUNITIES:

At both sites, the leafy bulrush community occurs adjacent to the channel (Fig. 9). Away from the channel the community grows adjacent to the inland saltgrass (*Distichlis stricta*) stand at one site, and adjacent to the American licorice (*Glycyrrhiza lepidota*) stand at the other site.

ECOLOGY:

The leafy bulrush community will be inundated at bankfull depth but flows may be gentle enough not to uproot the bulrush. Typically, the water table is high in the spring but drops during the growing season.

Leafy bulrush is common in the northern Great Plains; it is found in wet areas on shores, stream banks, wet meadows, ditches, and in seepage areas (Larson 1993). It is an obligate wetlands species, almost always occurring in wetlands.

OTHER CLASSIFICATIONS:

Similar stands of the leafy bulrush (*Scirpus pungens*) community are identified from eastern Wyoming (Jones and Walford 1995). A *Scirpus pungens* Habitat Type is described for central and eastern Montana (Hansen et al. 1991).

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Scirpus pungens* Community belong to the Herbaceous Vegetation Class, Medium Tall Grassland Subclass, Medium Tall Grassland Without a Woody Layer Group, Sod Grass Formation, *Scirpus pungens* Alliance.

Table 4. Percent canopy cover of species in plots of the Leafy Bulrush *(Scirpus pungens)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Leafy Bulrush (*Scirpus pungens*) Community

Plots:	SAN 411	GOO 411	AVG % COV	CONST %
Shrubs				
native				
Salix exigua	-	3	**3**	**50**
Salix lutea	-	1	**1**	**50**
exotic				
Tamarix chinensis	1	-	**1**	**50**
Graminoids (tall)				
native				
Calamagrostis inexpansa	-	3	**3**	**50**
Scirpus pungens	70	80	**75**	**100**
Spartina gracilis	1	1	**1**	**100**
Graminoids (short)				
native				
Elymus trachycaulus	1	-	**1**	**50**
Hordeum caespitosum	1	1	**1**	**100**
Hordeum jubatum	-	3	**3**	**50**
Muhlenbergia asperifolia	-	1	**1**	**50**
Puccinellia nuttalliana	-	1	**1**	**50**
exotic				
Agrostis stolonifera	-	3	**3**	**50**
Elymus repens	-	3	**3**	**50**
Forbs (tall)				
native				
Asclepias speciosa	1	-	**1**	**50**
Chenopodium berlandieri	-	1	**1**	**50**
Glycyrrhiza lepidota	-	3	**3**	**50**
Xanthium strumarium	1	1	**1**	**100**
exotic				
Lepidium latifolium	1	-	**1**	**50**

Table 4 (continued).

Leafy Bulrush (*Scirpus pungens*) Community

Plots:	SAN 411	GOO 411	AVG % COV	CONST %
Forbs (short)				
native				
Artemisia biennis	-	1	**1**	**50**
Conyza canadensis	-	1	**1**	**50**
Equisetum arvense	-	1	**1**	**50**
Equisetum laevigatum	-	3	**3**	**50**
Iva xanthifolia	-	1	**1**	**50**
Mentha arvensis	-	1	**1**	**50**
Ranunculus cymbalaria	1	-	**1**	**50**
exotic				
Kochia scoparia	-	1	**1**	**50**
Sphaerophysa salsula	1	-	**1**	**50**

Unclassified Leafy Bulrush (*Scirpus pungens*) Stand

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

This stand differs from those of the leafy bulrush (*Scirpus pungens*) community by having wooly sedge (*Carex lanuginosa*) and creeping spikerush (*Eleocharis palustris*) in amounts equal to that of leafy bulrush (Tbl. 5). The leafy bulrush is evenly distributed throughout the stand; the wooly sedge grows in large clumps within the stand.

LOCATION AND ENVIRONMENT:

The site containing this leafy bulrush stand is located in Big Horn county (Fig. 4) on a perennial, third order stream at 3,800 ft (1,150 m) elevation (Fig. 5). The channel is low gradient with 500 sq mi of drainage basin area above the site (Fig. 6). The occurrence is a narrow fringe along the channel with wider sections at the inside of meanders.

Soil texture was consistently silty clay loam. Soils had similar pH and electric coductivity to those of the other *Scirpus pungens* stands (Figs. 11 & 12). Mottling and gleying were present in the second horizon at 10 cm.

Table 5. Percent canopy cover of species in the plot of the unclassified Leafy Bulrush *(Scirpus pungens)* stand.

Unclassified Leafy Bulrush (*Scirpus pungens*) Stand

Plot:	SHL 412
Shrubs	
native	
Salix exigua	3
Shrubs (dwarf)	
native	
Populus deltoides (seedling	1
Graminoids (tall)	
native	
Carex lanuginosa	50
Phalaris arundinacea	3
Scirpus acutus	1
Scirpus pungens	40

Table 5 (continued).

Unclassified Leafy Bulrush (*Scirpus pungens*) Stand

Plot:	SHL 412
Graminoids (short)	
native	
Echinochloa muricata	1
Eleocharis palustris	40
Hordeum jubatum	3
exotic	
Agrostis stolonifera	3
Elymus repens	1
Phleum pratense	3
Forbs (tall)	
native	
Xanthium strumarium	1
exotic	
Sonchus uliginosus	1
Forbs (short)	
native	
Equisetum nelsonii	3
Lycopus asper	3
Ranunculus sceleratus	1
exotic	
Rumex crispus	1
Taraxacum officinale	1
Trifolium fragiferum	3

Pale Bulrush Series
(*Scirpus pallidus* Series)

One stand was found in the Bighorn Basin which was dominated by pale bulrush *(Scirpus pallidus)*. No similar series or community was found in the literature. More stands will need to be located and sampled before determining communities within this series.

Pale Bulrush Stand
(*Scirpus pallidus* Stand)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Pale bulrush dominated the one occurrence which we sampled (Tbl. 6). Associated species include the following graminoids: carpet bent grass (*Agrostis stolonifera*), wooly sedge (*Carex lanuginosa*), common timothy (*Phleum pratense*), creeping spikerush (*Eleocharis palustris*), American mannagrass (*Glyceria grandis*). Forbs present include: Nuttall's sunflower (*Helianthus nuttallii*) and American licorice (*Glycyrrhiza lepidota*).

Pale bulrush, 3.3 ft (1 m) tall, and lower amounts of Nuttall's sunflower, up to 5 ft (1.5 m) tall, provide the canopy of this occurrence. Common timothy is the tallest grass in the subcanopy; the rest of the sub-canopy graminoids are generally 1.6 ft (0.5 m) tall.

LOCATION:

This stand of pale bulrush is located in Washakie county (Fig. 4), adjacent to a first order, perennial channel at 4,960 ft (1,515 m) elevation (Fig. 5). The channel is sinuous and averages 3.3 ft (1 m) wide and 1.3 ft (0.4 m) deep (Figs. 7 & 8). Old, abandoned meanders are apparent within the valley.

ENVIRONMENT:

Upstream of this occurrence, there is some beaver activity including a small dam within a willow patch. Water spreads, creating this marshy area. There is still a defined channel which runs through this pale bulrush stand.

SOILS:

The soil at this stand has two horizons to a 50 cm depth: a silty clay texture above a clay texture. Mottling is present at 10 cm depth. The pH and electric conductivity of the surface horizon of our one stand was 7.7 and 2.8 dS/m, respectively (Figs. 11 & 12). The high electric conductivity in any horizon of this community was at the surface horizon.

EXOTICS:

There is much canopy cover contributed by two exotic grasses in this pale bulrush stand: carpet bent grass (*Agrostis stolonifera*) had 40% cover and common timothy (*Phleum pratense*) had 20% cover. No other exotics were present.

ADJACENT COMMUNITIES:

This community is interspersed between patches of willow. The adjacent upstream community is coyote willow (*Salix exigua*); the downstream community is coyote willow-yellow willow (*Salix exigua-Salix lutea*). Areas away from the channel and adjacent to depressions with standing water are occupied by common cattail (*Typha latifolia*).

ECOLOGY:

Pale bulrush (*Scirpus pallidus*) grows to an average height of 3.3 ft (1 m) from robust rhizomes (Welsh et al. 1993). More common to eastern Wyoming, this rush is found in wet places such as shores, ditches and stream banks (Dorn 1992). *Scirpus pallidus* is an obligate wetland species, almost always occurring in wetlands.

OTHER CLASSIFICATIONS:

A Preliminary Vegetation Classification of the Western United States (Bourgeron and Engelking 1994) does not include references to communities of this series.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Scirpus pallidus* Series belong to the Herbaceous Vegetation Class, Medium Tall Grassland Subclass, Medium Tall Grassland Without a Woody Layer Group, Sod Grass Formation.

Table 6. Percent canopy cover of species in the plot of the Pale Bulrush *(Scirpus pallidus)* Series.

Pale Bulrush (*Scirpus pallidus*) Stand

Plot:	CRK 413
Shrubs	
native	
Salix exigua	3
Graminoids (tall)	
native	
Carex lanuginosa	20
Glyceria grandis	10
Scirpus acutus	1
Scirpus pallidus	80

Table 6 (continued).

Pale Bulrush (*Scirpus pallidus*) Stand

Plot:	CRK 413
Graminoids (short)	
native	
Eleocharis palustris	20
exotic	
Agrostis stolonifera	40
Phleum pratense	20
Forbs (tall)	
native	
Glycyrrhiza lepidota	10
Helianthus nuttallii	20
Typha latifolia	3
Forbs (short)	
native	
Mentha arvensis	1
Mimulus guttatus	1

Alkali Cordgrass Series
(*Spartina gracilis* Series)

Alkali cordgrass *(Spartina gracilis)* is the dominant plant in stands of this series. Stands of alkali cordgrass are found beside small, low gradient, meandering creeks. They are most prevalent on the inside of meanders. Bighorn Basin stands of the alkali cordgrass series are similar to those found in eastern Wyoming (Jones and Walford 1995). The stands located in the Bighorn Basin are treated as members of the same *Spartina gracilis* community.

Alkali Cordgrass Community
(*Spartina gracilis* Community)

(2 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Both stands of this community are dominated by alkali cordgrass with little cover from other species (Tbl. 7). The canopy cover of alkali cordgrass ranges from 20% to 80%. Total vegetation cover also ranges from sparse to continuous at these stands. One stand had a moderate amount of Swainsonpea (*Sphaerophysa salsula*). Other species were present in low amounts (< 5% cover), but they were not common to both stands. Species present in both stands, but at only 1% canopy cover, include slender wheatgrass (*Elymus trachycaulus*) and bobtail barley (*Hordeum caespitosum*).

The alkali cordgrass community grows in narrow strips or small patches, more often on the inside of meander bends. The community also occurs along straight stretches between meanders. The dominant plant, alkali cordgrass, grows to 1.5 ft (0.5 m) tall.

LOCATION:

The sites containing the alkali cordgrass community are located in Hot Springs and Park counties (Fig. 4) on second order intermittent and first order perennial streams. The average elevation is 4,700 ft (1,430 m) (Fig. 5). The alkali cordgrasss community occurs along shallow, low gradient, moderately sinuous streams (Fig. 8). These sites have small drainage basin areas above them (Fig. 6).

ENVIRONMENT:

The stands of alkali cordgrass may be adjacent to the channel or as much as 6.5 ft (2 m) away from the channel (Fig. 9). Height of the stands above the channel ranges from 1.3 to 2.2 ft (0.4 - 0.7 m) (Fig. 10). One stand occurs along a narrow, well-stabilized, perennial stream (Fig. 7). At the intermittent stream, the channel is wider and banks are less stabilized.

SOILS:

The alkali cordgrass community along the perennial channel is found on silty clay above clay textured soils. Along the intermittent channel, it grows on sandy clay loams above loamy sands. The electric conductivity of the surface horizon at the perennial channel was much higher than that at the intermittent channel (12.0 vs 1.1 dS/m) (Fig. 11). The pH of the surface soil horizon of the stands was 8.2 and 8.6 respectively (Fig. 12). The high electric conductivity in any horizon of this community was at the surface.

EXOTICS:

There are almost no exotics present in these stands of *Spartina gracilis*. One location had a small amount of broadleaved peppergrass (*Lepidium latifolium*).

ADJACENT COMMUNITIES:

At one site, this alkali cordgrass community is adjacent to a leafy bulrush (*Scirpus pungens*) community toward the channel. On the second level, the inland saltgrass (*Distichlis stricta*) community with high cover of broadleaved peppergrass (*Lepidium latifolium*) and Swainsonpea (*Sphaerophysa salsula*) appears to be encroaching on this *Spartina gracilis* stand. Away from the channel, a nearly homogeneous stand of Chinese tamarisk (*Tamarix chinensis*) is the adjacent community.

At the other site, the alkali cordgrass community is usually adjacent to the channel or occasionally separated from the channel by small patches of baltic rush (*Juncus balticus*). Away from the channel, large patches of basin silver sagebrush (*Artemisia cana*) occur adjacent to the alkali cordgrass.

ECOLOGY:

Alkali cordgrass is found in moist, often alkaline areas along streams, in wet meadows, and in swales. It occurs in soils with high water tables, but the sites are not permanently flooded. Livestock use is limited because alkali cordgrass is most palatable in the spring when sites are very wet and access limited (Hansen et al. 1991).

Alkali cordgrass is a facultative wetland plant; it usually occurs in wetlands (67-99% of the time), but it is occasionally found in non-wetlands.

OTHER CLASSIFICATIONS:

Hanson (1929) describes a *Spartina gracilis* community in the San Luis Valley of Colorado. In Montana, alkali cordgrass stands are described from the Prairie Cordgrass Habitat Type (Hansen et al. 1991).

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et

al. 1984), stands of the *Spartina gracilis* Community belong to the Herbaceous Vegetation Class, Medium Tall Grassland Subclass, Medium Tall Grassland Without a Woody Layer Group, Sod Grass Formation, *Spartina gracilis* Alliance, *Spartina gracilis* Plant Association.

Table 7. Percent canopy cover of species in plots of the Alkali Cordgrass *(Spartina gracilis)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Alkali Cordgrass (*Spartina gracilis*) Community

Plots:	SAN 413	NND 411	**AVG % COV**	**CONST %**
Shrubs				
native				
Chrysothamnus linifolius	-	1	**1**	**50**
exotic				
Tamarix chinensis	1	-	**1**	**50**
Graminoids (tall)				
native				
Scirpus pungens	3	-	**3**	**50**
Spartina gracilis	80	20	**50**	**100**
Graminoids (short)				
native				
Distichlis stricta	-	3	**3**	**50**
Elymus albicans	-	1	**1**	**50**
Elymus trachycaulus	1	1	**1**	**100**
Hordeum caespitosum	1	1	**1**	**100**
Poa arida	-	1	**1**	**50**
Poa juncifolia	-	1	**1**	**50**
Sporobolus airoides	3	-	**3**	**50**
Triglochin concinnum	-	1	**1**	**50**
Forbs (tall)				
native				
Asclepias speciosa	3	-	**3**	**50**
exotic				
Lepidium latifolium	3	-	**3**	**50**
Forbs (short)				
exotic				
Sphaerophysa salsula	10	-	**10**	**50**

Reed Canarygrass Series
(*Phalaris arundinacea* Series)

The *Phalaris arundinacea* habitat type is a site which supports nearly monotypic stands of reed canarygrass (Hansen et al. 1991). This means that a site having the same environmental characteristics will support that same climax vegetation. One stand in the Bighorn Basin was sampled with this vegetation; it fits into the habitat type described in Montana. We refer to it as the reed canarygrass (*Phalaris arundinacea*) community, since we are not distinguishing between seral and climax vegetation.

Reed Canarygrass Community
(*Phalaris arundinacea* Community)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

The patches that this community forms are nearly homogeneously composed of reed canarygrass (Tbl. 8). Other species present in low amounts include: American mannagrass (*Glyceria grandis*) and willow-herb (*Epilobium ciliatum*).

The reed canarygrass community forms discontinuous, but homogeneous, strips beside the channel and small linear islands within the channel. A canopy averaging 4 ft (1.2 m) tall is formed by the reed canarygrass.

LOCATION:

This site is located in Park county (Fig. 4), on a third order, perennial river at 4,700 ft (1,455 m) elevation (Fig. 5). The channel is large, 230 ft (70 m) wide (Fig. 7), with a riparian zone width of 490 ft (150 m). The site is on a large inside meander across from a cutbank.

ENVIRONMENT:

This reed canarygrass community occurs immediately adjacent to the braided channel (Fig. 9). It is more common at the smaller channel branch near the inside meander where the current is not as strong. The channel bank is well-stabilized at this site.

SOILS:

The soil has developed with silty clays over sandy clays. Cobbles, gravels, and standing water are present below 12 cm depth from the surface. The soils show very low levels of electric conductivity (< 1.0 dS/m) (Fig. 11). The pH and conductivity of the surface horizon of

our one stand was 7.0 and 0.8 dS/m, respectively (Fig. 12). The high electric conductivity in any horizon of this community was found at the surface.

EXOTICS:

A few exotic species were present in low amounts (< 5% cover). These included: Canada thistle (*Cirsium arvense*), common watercress (*Rorippa nasturtium-aquaticum*), and water speedwell (*Veronica anagallis-aquatica*).

ADJACENT COMMUNITIES:

The reed canarygrass community was located adjacent to the channel; small patches may be surrounded by water. On the side away from the channel, the reed canarygrass stand is adjacent to a wider strip of coyote willow (*Salix exigua*) community.

ECOLOGY:

Reed canarygrass grows to 5.5 ft (1.6 m) tall and forms monotypic stands along waterways and in wet meadows. Its rhizomes are submerged in water and it is useful in controlling erosion in wet areas (Welsh et al. 1993). Reed canarygrass provides good forage and readily escapes from cultivated areas. It is highly competitive with more desirable riparian and wetland species because of the dense sod formed by its rhizome (Hansen et al. 1991). It can become a problem when growing in canals and irrigation ditches (Whitson et al. 1991).

Phalaris arundinacea is a facultative wetland plant. It usually (67-99% of the time) occurs in wetlands, but it is occasionally found in non-wetlands.

OTHER CLASSIFICATIONS:

Phalaris arundinacea is reported to be a major habitat type in western Montana. It also occurs in central and eastern Montana (Hansen et al. 1991).

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Phalaris arundinacea* Community belong to the Herbaceous Vegetation Class, Tall Grassland Subclass, Tall Grassland Without a Woody Layer Group, Sod Grass Formation, *Phalaris arundinacea* Alliance, *Phalaris arundinacea* Plant Association.

Table 8. Percent canopy cover of species in the plot of the Reed Canarygrass *(Phalaris arundinacea)* Community.

Reed Canarygrass (*Phalaris arundinacea*) Community

Plot:	SHO 413
Graminoids (tall)	
native	
Glyceria grandis	3
Phalaris arundinacea	98
Forbs (tall)	
exotic	
Cirsium arvense	3
Forbs (short)	
native	
Epilobium ciliatum	3
exotic	
Rorippa nasturtium-aquaticum	3
Rumex crispus	1
Veronica anagallis-aquatica	3

Kellogg's Sedge Series
(*Carex lenticularis* Series)

One stand sampled in the Bighorn Basin was dominated by Kellogg's sedge *(Carex lenticularis)*. This species is found in the northwest and central part of the state (Dorn 1992) and is widespread throughout North America (Hitchcock and Cronquist 1973). No reference to a community within this series was found in the literature. More stands of the Kellogg's sedge series need to be located and sampled before we can identify communities within the series.

Kellogg's Sedge Stand
(*Carex lenticularis* Stand)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

This occurrence is an almost pure stand of Kellogg's sedge which overhangs the channel (Tbl. 9). The nearly monotypic stand has a small amount of coyote willow (*Salix exigua*) and creeping spikerush (*Eleocharis palustris*). Some weedy species more common to the adjacent Russian olive community are present in low amounts. In addition to the exotics listed below, there is also a small amount cocklebur (*Xanthium strumarium*) present.

A narrow fringe of this Kellogg's sedge stand occurs along most of the length of the site. It is interrupted only where the adjacent Russian olive (*Elaeagnus angustifolia*) community overhangs the bank.

LOCATION:

The site which included the Kellogg's sedge occurrence was found in Big Horn county along the largest river in the Bighorn Basin, the Bighorn River (Fig. 4). At this site the drainage basin area is over 15,500 sq mi (Fig. 6). The river is low gradient and is not very sinuous. This occurrence is found at 3,700 ft (1,140 m) elevation (Fig. 5).

ENVIRONMENT:

This Kellogg's sedge stand occurs adjacent to the large Bighorn River (Fig. 9). At bankfull water level, the dense roots of this community would be submerged.

SOILS:

A single horizon of soil to 50 cm depth had a silty clay loam texture. The pH and electric conductivity of the surface and single horizon of our one stand was 8.0 and 2.0 dS/m, respectively (Figs. 11 & 12).

EXOTICS:

Exotics were present in very low amounts. They included: Russian olive (*Elaeagnus angustifolia*), Chinese tamarisk (*Tamarix chinensis*), and Canada thistle (*Cirsium arvense*). Trace amounts of other exotic grasses and forbs were also present.

ADJACENT COMMUNITIES:

This Kellogg's sedge occurrence is found adjacent to the channel. The water level was below bankfull and areas of the cobble beach below the sedge community were covered with tamarisk seedlings. The higher, adjacent surface is occupied by a Russian olive/Chinese tamarisk (*Elaeagnus angustifolia/Tamarix chinensis*) community.

ECOLOGY:

Kellogg's sedge has a wide elevational range, occurring in wet places from sea level to high montane environments (Hitchcock and Cronquist 1973). Kellogg's sedge is not strongly rhizomatous, but the dense community appears to be a good bank stabilizer.

Carex lenticularis is a facultative wetland plant. It usually (67% to 99% of the time) occurs in wetlands, but it is occasionally found in non-wetlands.

OTHER CLASSIFICATIONS:

No references were found for a Kellogg's sedge dominance type or for communities within this series.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Carex lenticularis* Series belong to the Herbaceous Vegetation Class, Medium Tall Grassland Subclass, Medium Tall Grassland Without a Woody Layer Group, Sod Grass Formation.

Table 9. Percent canopy cover of species in the plot of the Kellogg's Sedge *(Carex lenticularis)* Series.

Kellogg's Sedge (*Carex lenticularis*) Stand

Plot:	BHR 411
Trees	
native	
Elaeagnus angustifolia	3
Shrubs	
native	
Salix exigua	3
exotic	
Tamarix chinensis	3

Table 9 (continued).

Kellogg's Sedge (*Carex lenticularis*) Stand

Plot:	BHR 411
Shrubs (dwarf)	
native	
Populus deltoides (seedling	1
Graminoids (tall)	
native	
Scirpus pungens	1
Graminoids (short)	
native	
Carex lenticularis	90
Eleocharis palustris	3
Hordeum jubatum	1
exotic	
Agrostis stolonifera	1
Polypogon monspeliensis	1
Forbs (tall)	
native	
Xanthium strumarium	3
exotic	
Cirsium arvense	3
Polygonum persicaria	1
Forbs (short)	
native	
Artemisia biennis	1
Bidens cernua	1
Iva axillaris	1
Rumex maritimus	1
exotic	
Kochia scoparia	1
Polygonum lapathifolium	1
Rumex crispus	1
Veronica anagallis-aquatica	1
Vines	
native	
Clematis ligusticifolia	1

Kentucky Bluegrass Series
(*Poa pratensis* Series)

The Kentucky bluegrass *(Poa pratensis)* Community Type is considered to represent a grazing disclimax, meaning that the recurring disturbance of overgrazing maintains the structure and composition of the non-native vegetation on a site formerly dominated by native graminoids (Volland 1978, in Hansen et al. 1995). This site, now co-dominated by Kentucky bluegrass and western wheatgrass, was probably formerly dominated by the native western wheatgrass.

Kentucky Bluegrass - Western Wheatgrass Community
(*Poa pratensis - Elymus smithii* Community)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

This stand is a moderately dense Kentucky bluegrass-western wheatgrass community with patches of Baltic rush (*Juncus balticus*) (Tbl. 10). Other species are minor components of this community. The Kentucky bluegrass and western wheatgrass both grow to approximately 1.6 ft (0.5m) tall.

This graminoid community occupies a continuous strip which lies within and alongside the channel. The channel is somewhat indistinct at times.

LOCATION:

This stand of the Kentucky bluegrass-western wheatgrass community is located in Hot Springs county (Fig. 4) on a second order, intermittent stream at 5,220 ft (1,590 m) elevation (Fig. 5). The channel is low gradient and drains a small basin area above the site (Fig. 6). The present channel is narrow 1.6 ft (0.5 m) wide (Fig. 7), and occupies a wider old channel ranging in width from 33 ft to 82 ft (10 - 25 m). At the edge of the present riparian zone, this old channel has vertical banks 5 ft to 20 ft (1.5 - 6 m) tall which meet with the upland vegetation. The current channel meanders somewhat within the more distinct meanders of the old channel.

ENVIRONMENT:

The present intermittent stream channel is spotty and is usually vegetated. It appears as a distinct channel for only 3 to 16 ft (1 - 5 m) at a stretch. The Kentucky bluegrass - western wheatgrass stand occurs adjacent to, and sometimes within, this indistinct channel (Fig. 9). Downstream of the plot, the channel had a 3 ft (1 m) deep, 8 ft (2.5 m) wide headcut.

SOILS:

Three soil horizons were present in the 50 cm deep soil pit. From top to bottom, the textures were clay, sandy clay loam, and silty clay. Soils were not saline as indicated by low electric conductivity values of each horizon. The pH and electric conductivity of the surface horizon of our one stand was 7.5 and 2.2 dS/m, respectively (Figs. 11 & 12). The high electric conductivity in any horizon of this community was 2.6 dS/m at 32 cm depth.

EXOTICS:

Kentucky bluegrass, the dominant plant of this community, was introduced from Europe and is now widespread throughout the United States and Canada, except in arid regions (Hitchcock 1950). It is commonly cultivated for lawns and pasture and easily escapes to non-cultivated areas.

ADJACENT COMMUNITIES:

The Kentucky bluegrass-western wheatgrass community occurs adjacent to the channel. A basin big sagebrush/basin wild rye (*Artemisia tridentata* var. *tridentata/Elymus cinereus*) community occurs on a slightly higher surface occupying the remainder of the riparian zone.

ECOLOGY:

Kentucky bluegrass is found in mesic to moist sites, in a wide variety of communities. It is a prolific reproducer, capable of reproducing sexually as well as asexually (Welsh et al. 1993). Kentucky bluegrass provides highly palatable and nutritious forage for livestock, deer and elk.

Western wheatgrass is common in riparian and in upland sites. In Wyoming, it is an important low elevation riparian species in moist, fine textured soils occupying draws, swales, and other sites which receive surface or subsurface water (Jones 1992). Western wheatgrass reproduces vigorously by creeping rootstocks in addition to seed produced late in the growing season (Hansen et al. 1991).

Both western wheatgrass and Kentucky bluegrass withstand grazing well. However, western wheatgrass recovers quickly from drought to re-occupy open areas, whereas Kentucky bluegrass is not drought tolerant (Jones 1992; Welsh et al. 1993). Kentucky bluegrass is considered an increaser species especially when grazing intensity is severe (Hansen et al. 1991).

Both Kentucky bluegrass and western wheatgrass are facultative upland plants. They usually occur in non-wetlands but they are occasionally found in wetlands.

OTHER CLASSIFICATIONS:

A minor *Poa pratensis* community is described in Montana riparian areas where intensive grazing has occurred (Hansen et al. 1991). It is also described in Oregon (Kovalchik 1987), Utah (Padgett et al. 1989), and Idaho (Youngblood et al. 1985).

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994), stands of the *Poa pratensis-Elymus smiithii* Community belong to *Poa pratensis* Anthropogenic Alliances and Plant Associations.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Poa pratensis-Elymus smithii* Community belong to the Herbaceous Vegetation Class, Medium Tall Grassland Subclass, Medium Tall Grassland Without a Woody Layer Group, Sod Grass Formation.

Table 10. Percent canopy cover of species in the plot of the Kentucky Bluegrass-Western Wheatgrass *(Poa pratensis-Elymus smithii)* Communtiy.

Kentucky Bluegrass-Western Wheatgrass (*Poa pratensis-Elymus smithii*) Community

Plot:	GIL 411
Shrubs	
native	
Artemisia tridentata	3
Rosa woodsii or R. sayi	1
Salix exigua	1
Graminoids (short)	
native	
Elymus smithii	40
Juncus balticus	10
Koeleria macrantha	1
Sporobolus airoides	1
Stipa viridula	3
exotic	
Poa pratensis	60
Forbs (tall)	
native	
Asclepias speciosa	3
Chenopodium berlandieri	1
exotic	
Cirsium arvense	1
Melilotus officinalis	1
Forbs (short)	
native	
Achillea millefolium	1

Table 10 (continued).

Kentucky Bluegrass-Western Wheatgrass (*Poa pratensis-Elymus smithii*) Community

Plot:	GIL 411
Artemisia ludoviciana	1
Grindelia squarrosa	3
exotic	
Kochia scoparia	1
Thlaspi arvense	1
Tragopogon dubius	1

American Licorice Series
(*Glycyrrhiza lepidota* Series)

The American licorice *(Glycyrrhiza lepidota)* series was observed throughout the Bighorn Basin. It is a minor riparian type described from small samples in Wyoming and Montana. More stands need to be sampled before determining the communities within this series.

American Licorice Stand
(*Glycyrrhiza lepidota* Stand)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

This herbaceous stand is dominated by American licorice (Tbl. 11). There is occasional taller cover of flaxleaf rabbitbrush (*Chrysothamnus linifolius*). The stand is primarily a homogeneous mix of American licorice and grasses. The dominant grass is common quackgrass (*Elymus repens*). There is also a moderate amount of alkali cordgrass (*Spartina gracilis*).

The occurrence is patchy because the surface it occurs on is discontinuous. The patch extends linearly along the channel and ranges in width from 50 ft to 80 ft (15 - 25 m).

LOCATION:

Only one stand of American licorice was sampled in the Bighorn Basin in Hot Springs county (Fig. 4). It occurred along a second order perennial channel at 5,200 ft elevation (Fig. 5). At the site the upper drainage basin area is 240 sq mi (Fig. 6) with 5,090 ft of drainage basin relief. The channel is fairly sinuous with low gradient (< 0.5% slope).

ENVIRONMENT:

The American licorice stand is found on the discontinuous floodplain surface 2 ft above the bankfull channel (Fig. 10). It is wider on the inside meanders. The streambanks are stabilized by the leafy bulrush (*Scirpus pungens*) occupying the banks and the first surface. This community has a high amount of exposed soil, with no gravel or rock size particles. There is a small amount of litter accumulating on the surface.

SOILS:

There are three horizons between surface and 55 cm deep. From the top down, the textures are: sandy clay loam, silty clay loam, then sandy loam.

The pH and electric conductivity of the surface horizon of our stand was 8.0 and 0.6 dS/m, respectively (Figs. 11 & 12). The high electric conductivity in any horizon of this stand was 1.8 dS/m at 40 cm depth.

EXOTICS:

The dominant grass, common quack grass, was introduced from the Mediterranean area (Whitson et al. 1991). Other exotic plants present in small amounts are carpet bentgrass (*Agrostis stolonifera*) and Canada thistle (*Cirsium arvense*).

ADJACENT COMMUNITIES:

The American licorice stand is separated from the channel by a leafy bulrush community. On the side away from the channel, the stand is adjacent to a flaxleaf rabbitbrush/alkali dropseed (*Chrysothamnus linifolius/Sporobolus airoides*) occurrence.

ECOLOGY:

This is the only forb-dominated stand described from our work in the Bighorn Basin. This dominance type was observed elsewhere in the Bighorn Basin, yet only one stand was sampled. American licorice is found streamside and on terraces, near seeps and other semi-moist sites (Welsh et al. 1993). It is often part of the understory of narrowleaf or plains cottonwood *(Populus angustifolia* or *P. deltoides)* stands. American licorice is rhizomatous and increases bank stabilization. In Montana, the American licorice community type is considered a grazing-induced disclimax (Hansen et al. 1991). *Glycyrrhiza lepidota* is a facultative plant; it is equally likely to occur in wetlands or in non-wetlands.

OTHER CLASSIFICATIONS:

An American Licorice community type is a minor type throughout central and eastern Montana (Hansen et al. 1991). The dominant grasses are different species, but with more stands of this type sampled in both Wyoming and Montana, we may find that our stand belongs to this community.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Glycyrrhiza lepidota* Series belong to the Herbaceous vegetation Class, Forb-dominated vegetation Subclass, Tall Forbs Group, Mainly perennial flowering forbs Formation.

Table 11. Percent canopy cover of species the plot of the American Licorice Series.

American Licorice (*Glycyrrhiza lepidota*) Stand

Plot:	GOO 412
Shrubs	
native	
Chrysothamnus linifolius	10
Chrysothamnus nauseosus	1
Salix exigua	1
Shrubs (dwarf)	
native	
Populus angustifolia (seedling	1
Graminoids (tall)	
native	
Calamagrostis inexpansa	1
Elymus cinereus	1
Spartina gracilis	10
Graminoids (short)	
native	
Hordeum jubatum	1
Juncus balticus	1
Muhlenbergia asperifolia	3
Sporobolus airoides	1
exotic	
Agrostis stolonifera	3
Elymus repens	30
Forbs (tall)	
native	
Asclepias speciosa	3
Chenopodium berlandieri	1
Glycyrrhiza lepidota	40
Helianthus nuttallii	1
exotic	
Cirsium arvense	3
Forbs (short)	
native	
Artemisia biennis	1
Equisetum laevigatum	3
Grindelia squarrosa	1

Shrub Physiognomic Type

Stands placed in the shrub physiognomic type are those dominated by any combination of shrubs in their upper canopy. They have less than 10% canopy cover of trees, pole size or larger, and they have more than 10% canopy cover of shrubs (taller than 1.6 feet) or dwarf shrubs (shorter than 1.6 feet). Stands of tree seedlings could be placed in the shrub physiognomic type, but in this classification we have placed them with the tree-dominated communities because they will grow into woodlands.

Shrub stands often occur as patches, interspersed with areas of herbaceous vegetation or with stands of trees. The shrub stands commonly form ribbons paralleling the stream channel, but they may also grow on terraces above the channel.

Stands of our shrubland physiognomic type fit into several groups of the land classification framework of Driscoll and others (1984), as described below for each series or community. Within the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979) our stands belong to the Palustrine System. Stands with 30% or more canopy cover of shrubs and with less than 30% canopy cover of trees are classified in the Scrub-Shrub Wetland class.

Thirty riparian shrub stands were sampled throughout the Bighorn Basin (Fig. 13). Stands within the shrub physiognomic type have been classified into series defined by the dominant or diagnostic species. Within the series, plant communities are named based on existing vegetation structure and composition. The process of classification in this project uses attributes of the vegetation (physiognomy, structure and floristics) as well as some non-vegetation attributes such as soil properties and landform position. The following graphs (Fig. 14-21) illustrate the environmental characteristics at the sites where the shrub plant communities or series were sampled. Each shrub stand is represented on the graphs and identified by its community (or series) acronym; the value of the environmental attribute at the stand is displayed. The following acronyms used in the graphs correspond with the following plant communities or series:

Salexi/m.g. = Coyote Willow (*Salix exigua*)/Mesic Graminoid Community

Rhutri-Salexi = Skunkbush Sumac-Coyote Willow (*Rhus trilobata-Salix exigua*) Community

Artcan-Chrlin = Silver Sagebrush - Flaxleaf Rabbitbrush (*Artemisia cana* var. *cana* - *Chrysothamnus linifolius*) Community

Chr/Spoair = Rabbitbrush/Alkali Dropseed (*Chrysothamnus* sp./*Sporobolus airoides*) Community - tentative

Chrlin/Elycan = Flaxleaf Rabbitbrush/Canada Wild Rye (*Chrysothamnus linifolius/Elymus canadensis*) Community - tentative

Chrnau = Rubber Rabbitbrush (*Chrysothamnus nauseosus)* Community

Arttri/Elycin = Basin Big Sagebrush/ Basin Wild Rye (*Artemisia tridentata* var. *tridentata/ Elymus cinereus)* Community

Arttri (uncl) = Unclassified Basin Big Sagebrush (*Artemisia tridentata* var. *tridentata*) Stands

Sarver-Arttri = Black Greasewood-Basin Big Sagebrush/Western Wheatgrass (*Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/ Elymus smithii)* Community

Sarver/Elysmi = Black Greasewood/Western Wheatgrass (*Sarcobatus vermiculatus/Elymus smithii*) Community

Shearg = Silver Buffaloberry (*Shepherdia argentea*) Community

Tamchi = Chinese Tamarisk (*Tamarix chinensis*) Community

Figure 13. Location of shrubland stands within Bighorn Basin.

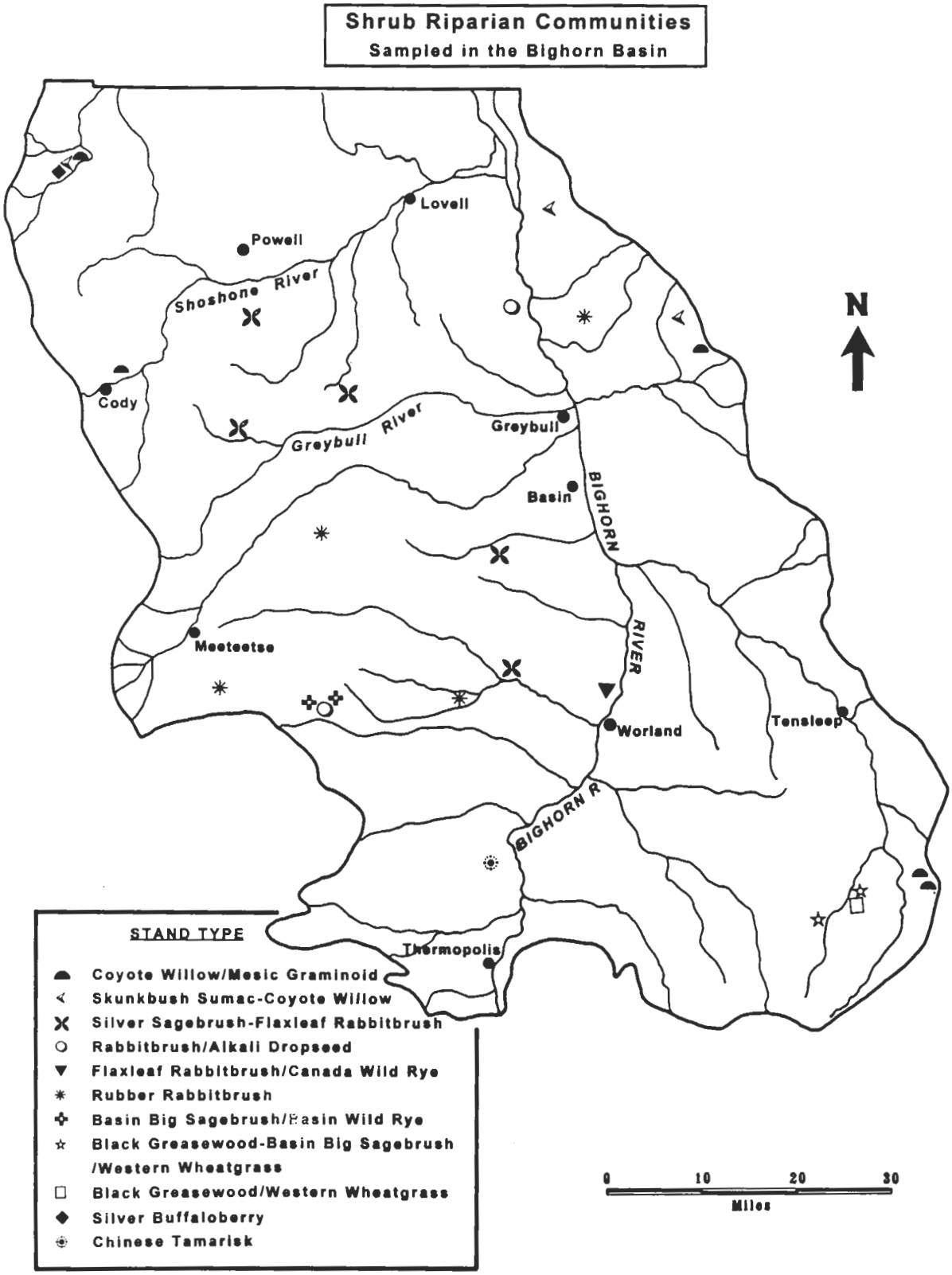


Figure 14. Elevation at sites according to the shrubland stand type.

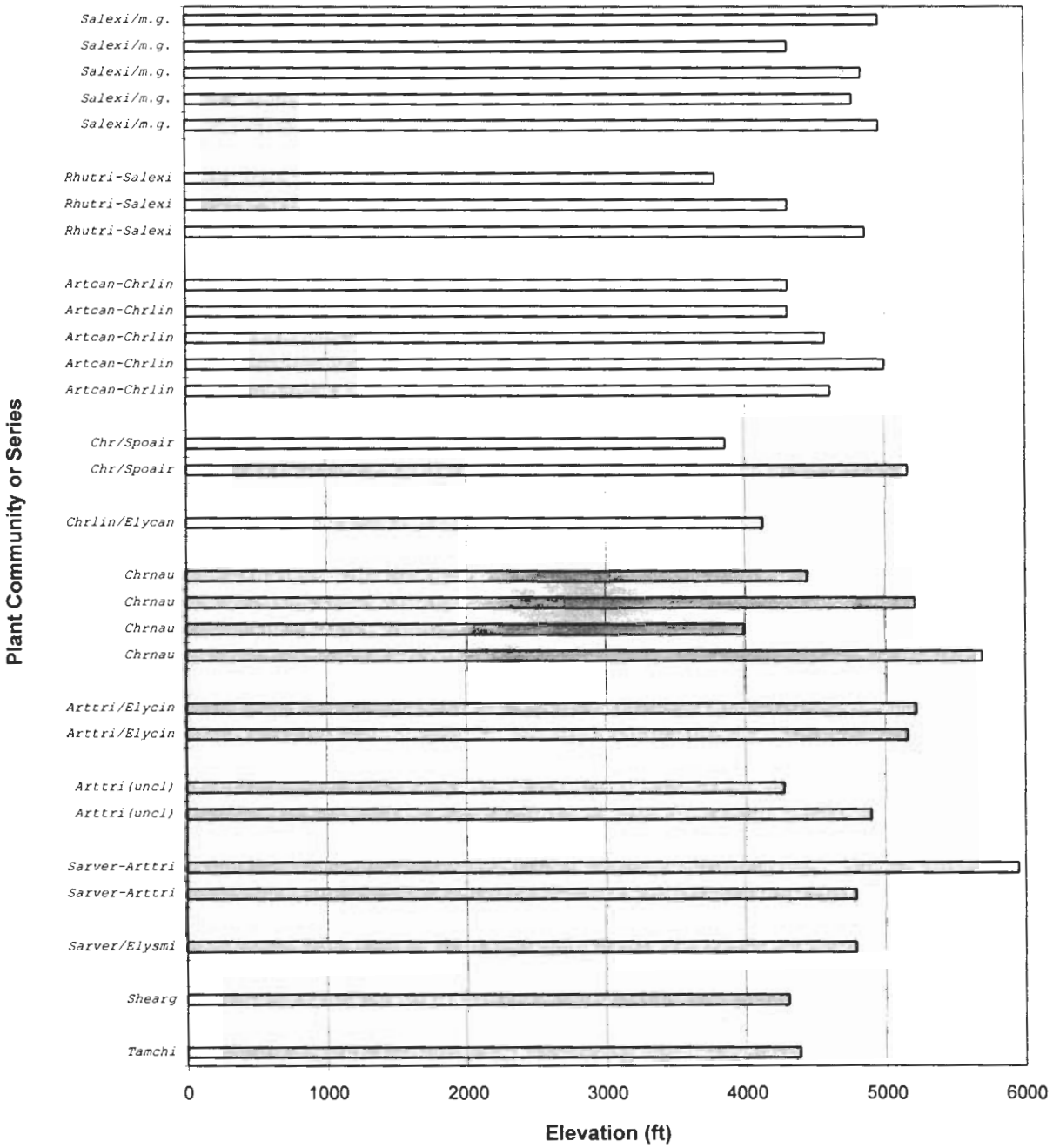


Figure 15. Drainage basin area above sites according to the shrubland stand type.

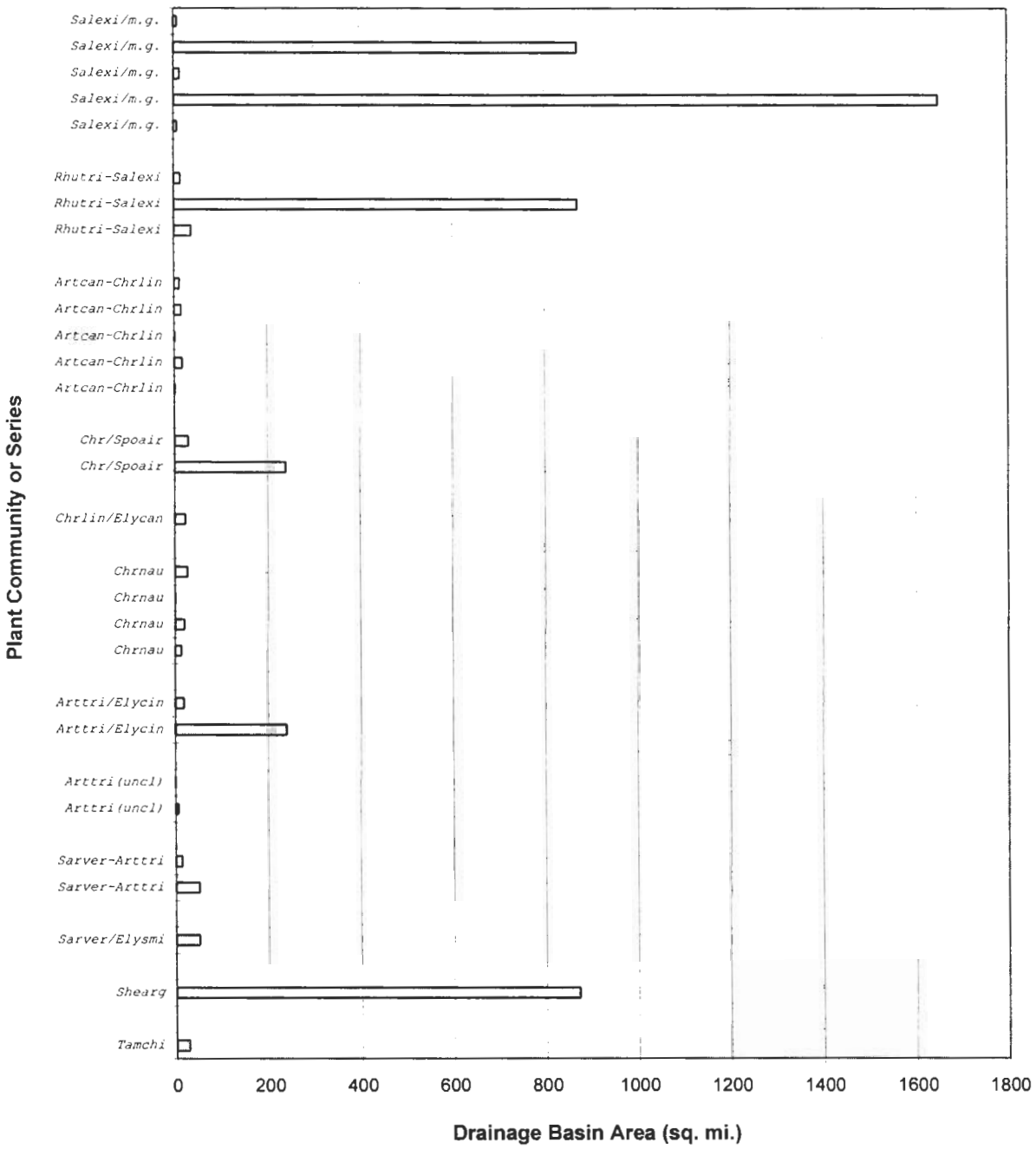


Figure 16. Channel width nearest each plot according to the shrubland stand type.

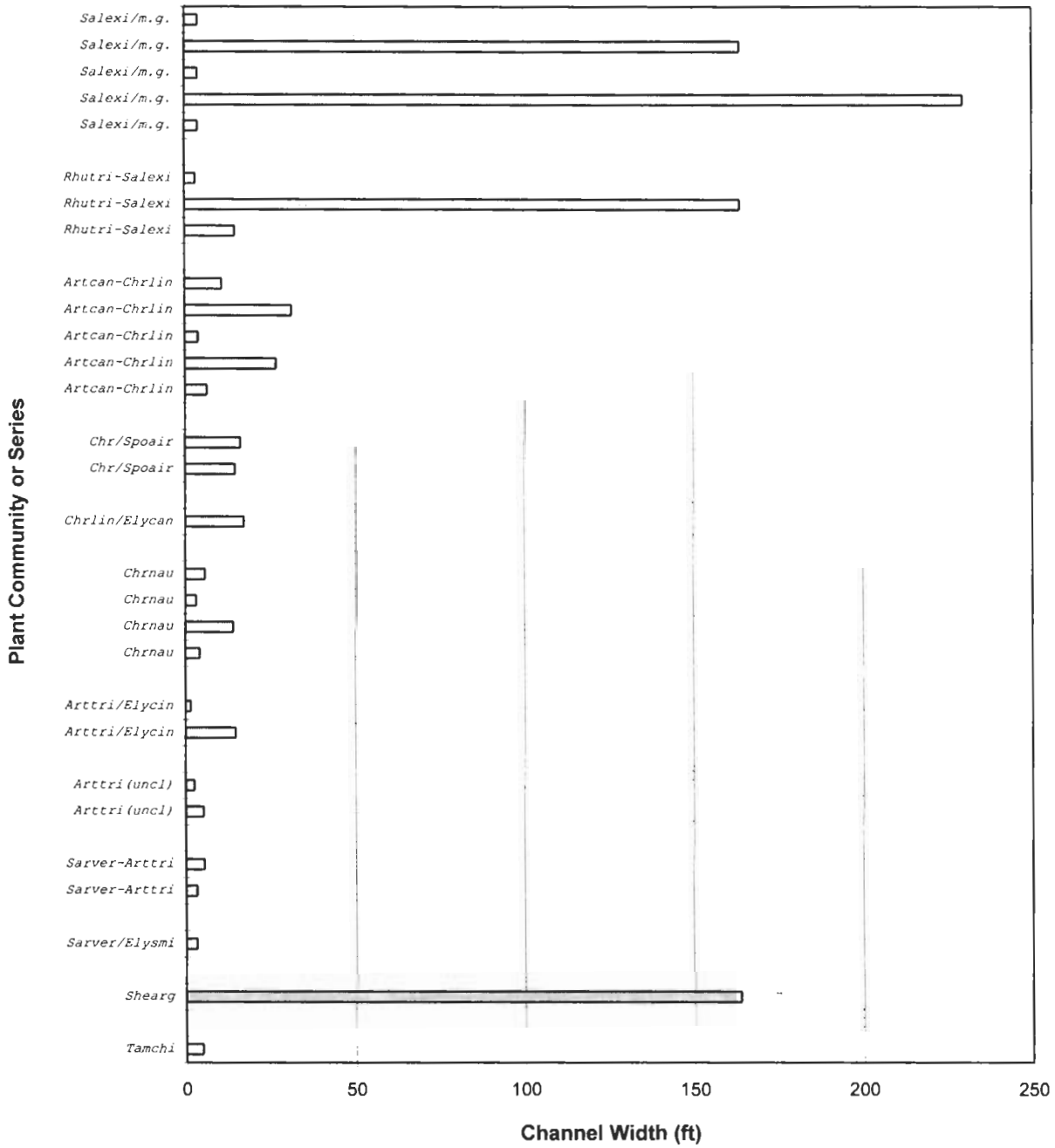


Figure 17. Channel depth nearest each plot according to the shrubland stand type.

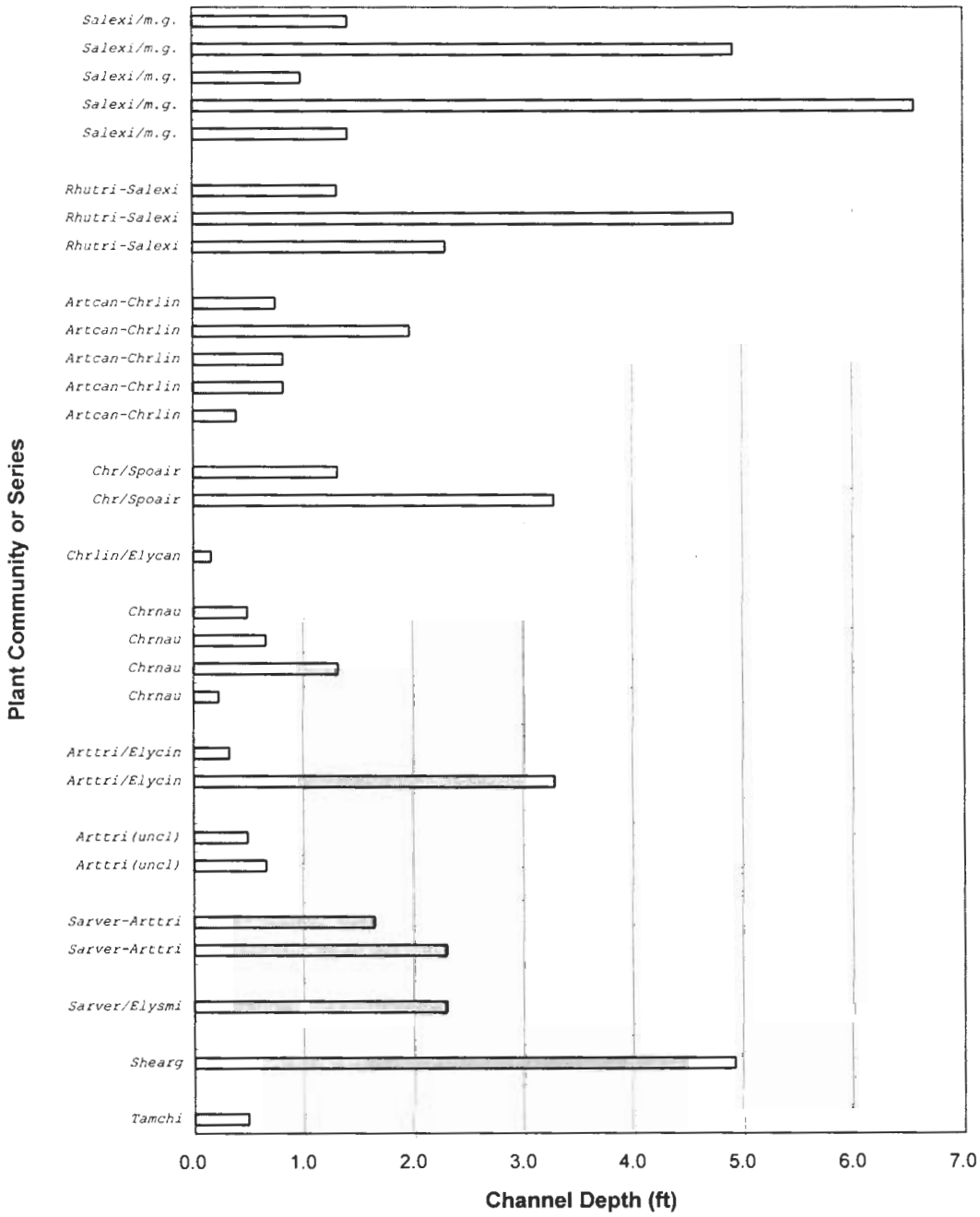


Figure 18. Distance of stands from channel according to the shrubland stand type.

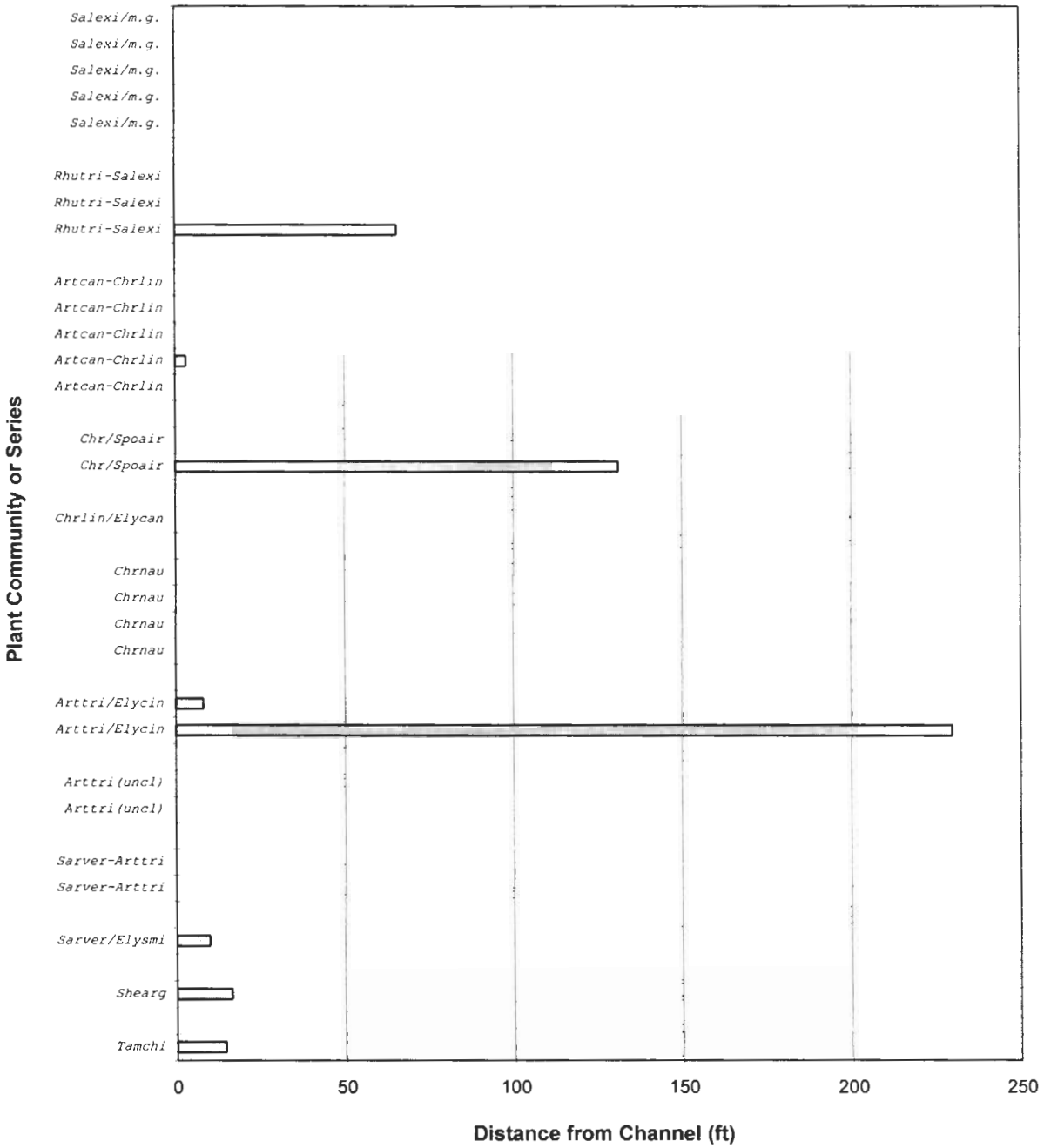


Figure 19. Height of stands above bankfull channel according to the shrubland stand type.

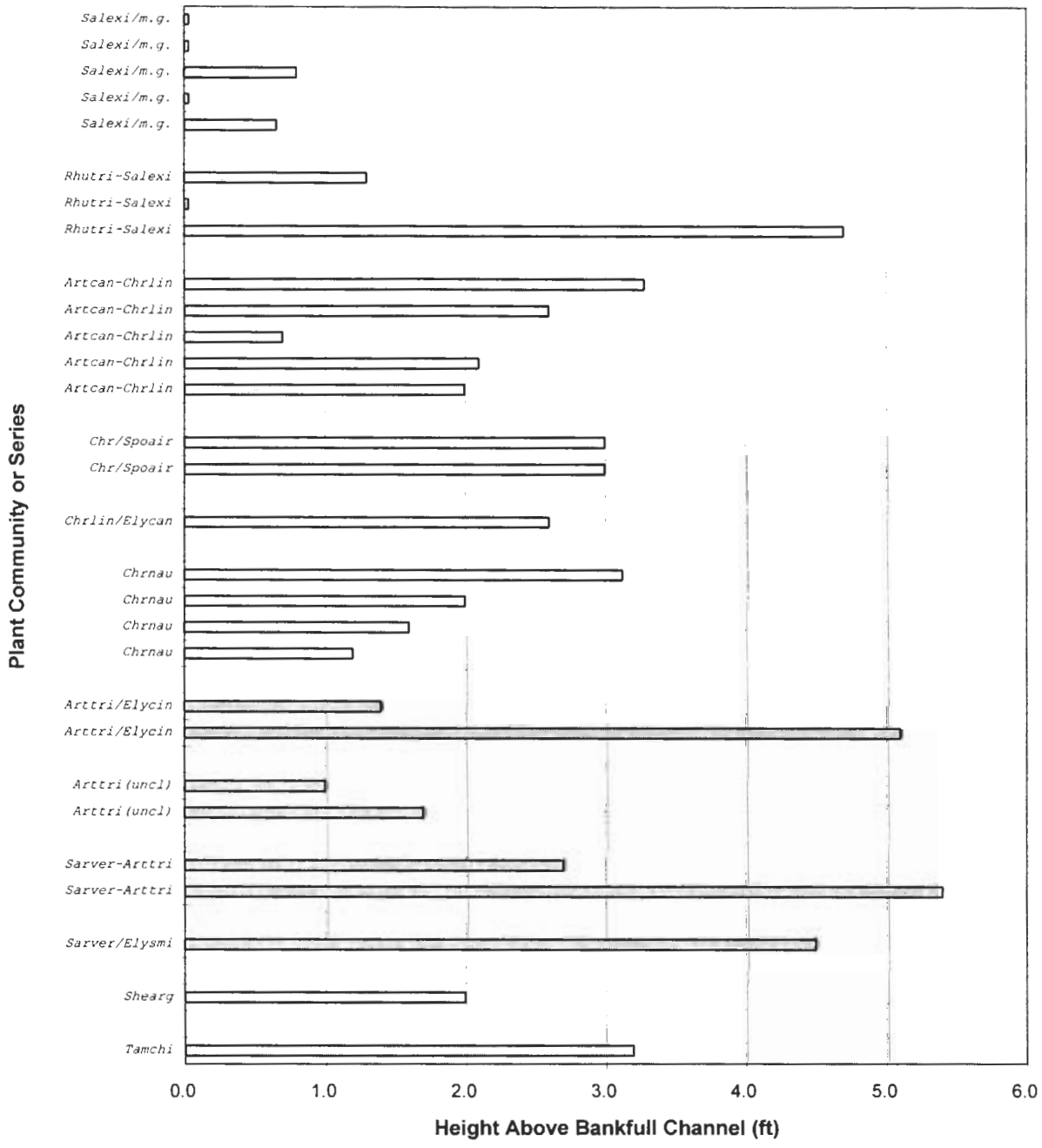


Figure 20. Electric conductivity of the surface soil horizon in stands according to the shrubland stand type.

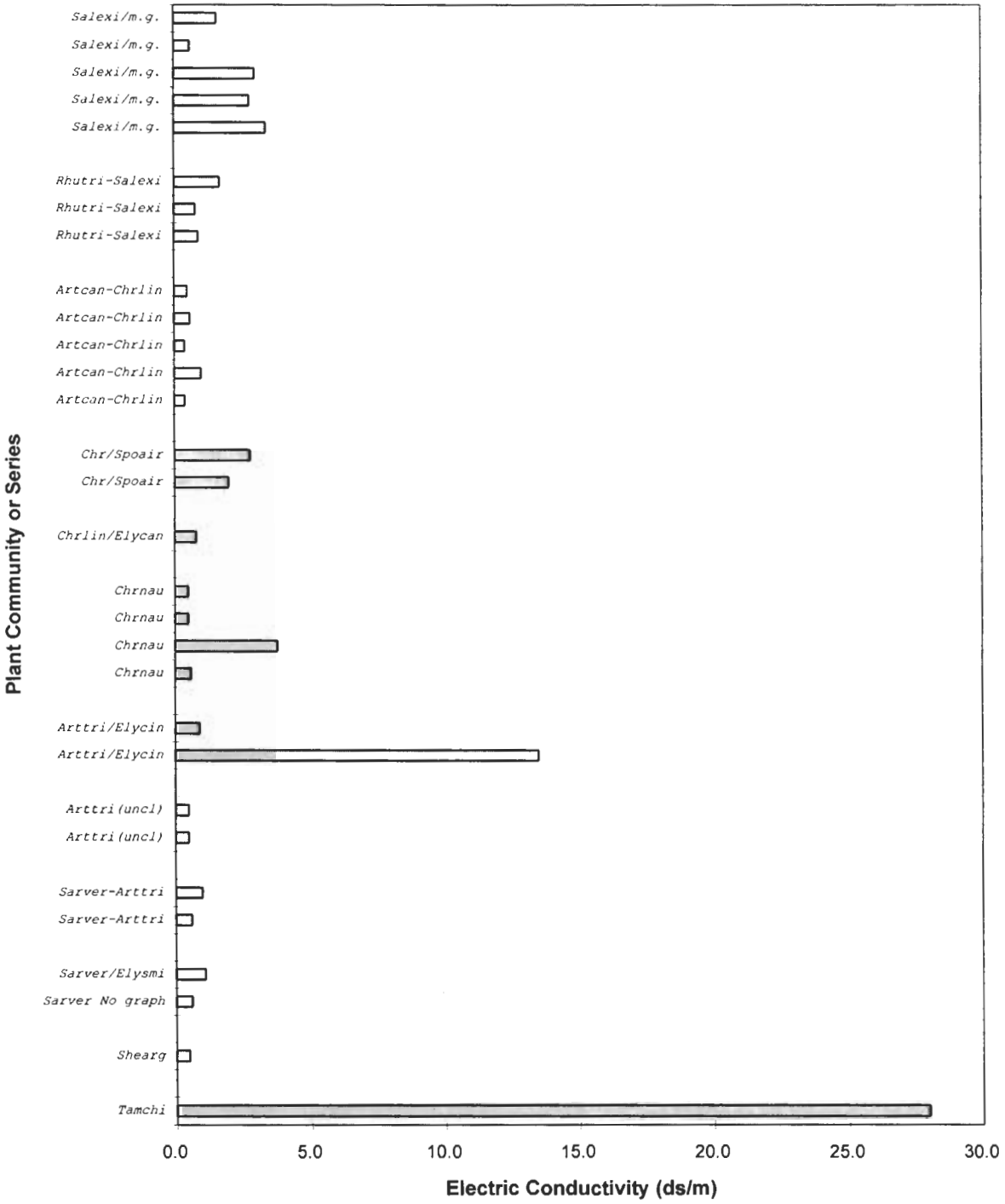
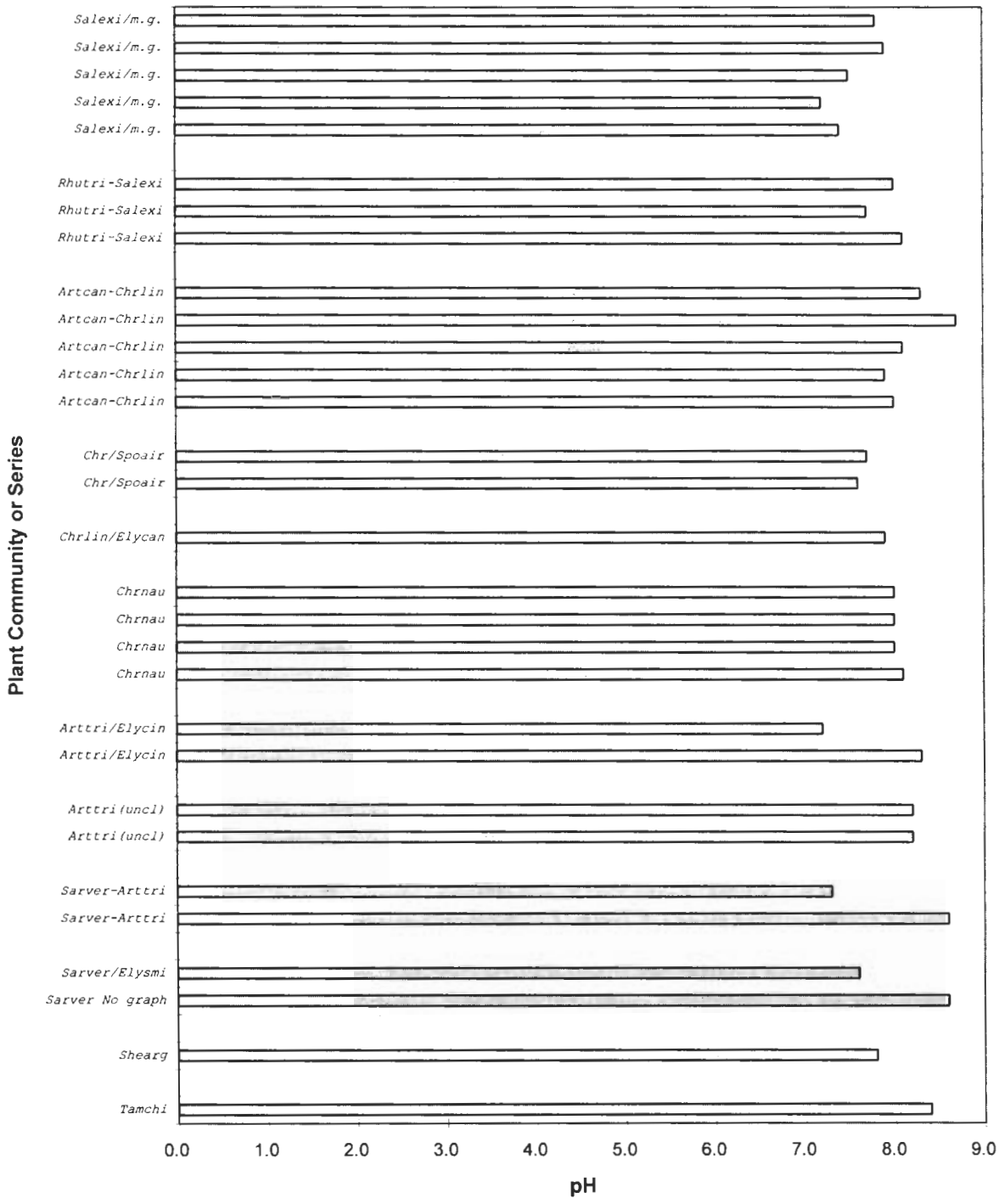


Figure 21. pH of surface soil horizon in stands according to shrubland stand type.



Coyote Willow Series
(*Salix exigua* Series)

Coyote willow is the dominant shrub in communities of this series. It is a wispy willow which is nearly always found adjacent to the channel; it may be spearated from the channel by a narrow sedge or rush community. The coyote willow is one of the early colonizers of newly scoured gravel bar sites.

In the Bighorn Basin, one community of the coyote willow series was sampled in five different locations. In agreement with previous classifications (Padgett et al. 1989), we include in the *Salix exigua* series those stands dominated by coyote willow or yellow willow *(Salix lutea)*. In our stands, the yellow willow occurred with the coyote willow, usually in lesser amounts, but was co-dominant at one stand.

Coyote Willow/Mesic Graminoid Community
(*Salix exigua*/Mesic Graminoid Community)

(5 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Coyote willow dominates the upper layer in stands of the coyote willow/mesic graminoid community (Tbl. 12). This shrub reaches heights of 4 to 8 ft (1.2 - 2.5 m). An occasional tree grows taller than the willows at one site. Other shrubs are present in all five stands in small to moderate amounts. Yellow willow (*Salix lutea*) is the most common; at one stand it is nearly co-dominant with coyote willow. Wood's rose (*Rosa woodsii*) is often present in smaller amounts.

A variety of grasses and sedges common to mesic environments characterize the understory of the coyote willow/mesic graminoid association. There is no single graminoid or forb which dominates the herbaceous layer at all five stands. The most common and usually abundant understory plant is carpet bentgrass. Other graminoids often dominant are: Kentucky blugrass (*Poa pratensis*), woolly sedge (*Carex lanuginosa*), creeping spikerush (*Eleocharis palustris*), canary reedgrass *(Phalaris arundinacea)*, and common timothy *(Phleum pratense)*. Two tall forbs are common to most stands: American licorice (*Glycyrrhiza lepidota*) and Canada thistle (*Cirsium arvense*). A variety of short forbs are present, but in very low amounts. More litter is produced in these stands than most other riparian shrub stands sampled in the Basin.

These stands are usually linear, 30 to 65 ft (10-20 m) wide, and occur along a lengthy stretch of the channel. At one site the stands were more patchy and rectangular. They were discontinuous along the channel, separated by wetter, marshy areas.

LOCATION:

The coyote willow/mesic graminoid community was found at sites in Park, Washakie and Big Horn counties (Fig. 13) between 4,000 and 5,000 ft (1,220 - 1,525 m) elevation (Fig. 14). The sites occur along a variety of perennial channels, varying in size from first to fourth order streams. The channels range from 4 ft (1.2 m) wide and less than 1.5 ft (0.5 m) deep to ca. 230 ft (70 m) wide and at least 7 ft (2 m) deep (Figs. 16 and 17). The drainage basin area above the sites has a wide range, from 8 to 1,650 sq mi.

ENVIRONMENT:

The channels at these sites are low to medium gradient with moderate sinuousity. At two sites the coyote willow/mesic graminoid community occurs along the segment of channel where the meanders are much larger. Different communities occur along the straighter stretches up and downstream. The segment of channel near the stands has high bank stability at all the sites. The coyote willow/mesic graminoid stands are adjacent to the channel and level with, or only a small height above, the channel (Fig. 19). This surface will be inundated at bankfull depth. Flood debris was on the surface of one stand, and two other stands had a coarse substrate with gravel and rock exposed at the surface.

SOILS:

The soils at the Bighorn Basin stands of coyote willow/mesic graminoid usually contained four horizons from the surface to 50 cm deep. This suggests that these sites experience periodic flooding which deposits new sediment layers at the surface . The textures of these horizons were silty clay, silty clay loam, sandy clay, sandy clay loam, clay, or clay loam in a variety of orders at the different stands. The pH and electric conductivity of the surface horizon of our five stands ranged from 7.2 to 7.9 and 0.6 to 3.4 dS/m, respectively. The high electric conductivity in any horizon of this community was 3.4 dS/m at the surface.

EXOTICS:

A major understory species of these stands, carpet bentgrass, is native to Eurasia and North Africa, but is now circumboreal (Welsh et al. 1993). Other common non-native plants present include Kentucky bluegrass, common timothy (*Phleum pratense*), Canada thistle, marsh sow thistle (*Sonchus uliginosus*), and hedge bindweed (*Calystegia sepium*).

ADJACENT COMMUNITIES:

The coyote willow/mesic graminoid community nearly always occurs adjacent to the channel. At one site it was separated from the channel by a stand of common reed canarygrass (*Phalaris arundinacea*). At another site the coyote willow/mesic graminoid stands are adjacent to the channel but they are separated from each other by wet marshes of pale bulrush (*Scirpus*

pallidus). Away from the channel these stands are usually adjacent to another riparian community such as a narrowleaf cottonwood-Russian olive (*Populus angustifolia-Eleagnus angustifolia*) stand or a skunkbush sumac (*Rhus trilobata*) stand. Some of the stands were adjacent to an upland community on the side away from the channel.

ECOLOGY:

The coyote willow series is considered a successional type because of its ability to pioneer sand and gravel bars. Coyote willows are most often found on the insides of meander bends. This suggests that deposition of sediments on the inside banks at high flow is required to establish the proper site for coyote willow establishment. The community forms patches of various sizes and shapes. Eventually the coyote willow stand will be replaced by other vegetation, unless repeated floods maintain the site as most suitable for the willow.

Creeping rootstocks of coyote willow produce numerous upright stems forming dense thickets. Coyote willow can provide much stabilization to the areas that it colonizes. The species readily sprouts if the stems are removed by grazing animals, as long as the grazing has not persisted so long that the root system is depleted of food reserves. Prolonged grazing or browsing can hasten the disappearance of the willows from a site, and can open the willow canopy leading to an increase in the cover of exotic weeds (Hansen et al. 1995).

OTHER CLASSIFICATIONS:

The coyote willow/mesic graminoid community has been found in Utah and southeast Idaho (Padgett et al. 1989), in western Colorado (Kittel 1993; Kittel and Lederer 1993) and in eastern Wyoming (Jones and Walford 1995). The type is very similar to the *Salix exigua* community type of Montana (Hansen et al. 1995).

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Salix exigua*/mesic graminoid community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation, *Salix exigua* Alliance.

Table 12. Percent canopy cover of species in plots of the Coyote Willow *(Salix exigua)*/Mesic Graminoid Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Coyote Willow/Mesic Graminoid Community
(*Salix exigua*/Mesic Graminoid)

Plots:	CRK 411	CLA 411	RED 422	SHO 412	CRK 412	**AVG % COV**	**CONST %**
Trees							
native							
Acer negundo	3	-	0	-	-	**3**	**20**
Juniperus scopulorum	-	-	1	-	-	**1**	**20**
Populus angustifoila	-	-	3	-	-	**3**	**20**
Populus deltoides	-	-	3	-	-	**3**	**20**
exotic							
Elaeagnus angustifolia	-	-	3	-	-	**3**	**20**
Shrubs							
native							
Cornus sericea ssp. sericea	1	-	1	-	1	**1**	**60**
Rhus trilobata var. trilobata	-	-	20	1	-	**11**	**40**
Ribes americanum	10	-	-	-	10	**10**	**40**
Rosa woodsii	1	-	20	3	1	**6**	**80**
Salix exigua	90	50	70	50	60	**64**	**100**
Salix lutea	10	3	20	-	50	**21**	**80**
Graminoids (tall)							
native							
Carex lanuginosa	10	3	3	-	1	**4**	**80**
Deschampsia cespitosa	-	3	-	-	-	**3**	**20**
Juncus tenuis var. dudleyi	-	-	1	-	-	**1**	**20**
Phalaris arundinacea var. arindinace	-	-	-	40	-	**40**	**20**
Phragmites australis	3	-	-	-	-	**3**	**20**
Scirpus acutus	3	-	-	-	-	**3**	**20**
Scirpus pallidus	10	-	-	-	3	**7**	**40**
exotic							
Bromus inermis	1	-	-	-	20	**11**	**40**
Graminoids (short)							
native							
Catabrosa aquatica var. aquatica	-	-	1	-	-	**1**	**20**
Eleocharis palustris	3	20	3	-	-	**9**	**60**
Elymus canadensis	-	-	1	-	-	**1**	**20**

Table 12 (continued).

Coyote Willow/Mesic Graminoid Community
(*Salix exigua*/Mesic Graminoid)

Plots:	CRK 411	CLA 411	RED 422	SHO 412	CRK 412	AVG % COV	CONST %
Muhlenbergia asperifolia	-	-	1	-	-	**1**	**20**
exotic							
Agrostis stolonifera	10	-	40	50	10	**28**	**80**
Dactylis glomerata	-	-	-	-	10	**10**	**20**
Elymus repens	-	-	-	-	3	**3**	**20**
Phleum pratense var. pratense	20	-	-	-	40	**30**	**40**
Poa pratensis	1	-	10	10	20	**10**	**80**
Forbs (tall)							
native							
Asclepias speciosa	-	-	1	-	-	**1**	**20**
Barbarea orthoceras	-	-	-	-	1	**1**	**20**
Cicuta maculata var. angustifolia	1	-	-	-	20	**11**	**40**
Glycyrrhiza lepidota	3	3	10	30	1	**9**	**100**
Helianthus nuttallii ssp. nuttallii	3	-	-	-	10	**7**	**40**
Heracleum sphondylium	-	-	-	-	3	**3**	**20**
Rudbeckia laciniata	1	-	-	-	30	**16**	**40**
Solidago canadensis	3	-	-	-	10	**7**	**40**
Typha latifolia	3	-	-	-	-	**3**	**20**
Urtica dioica	1	-	-	-	40	**21**	**40**
exotic							
Cirsium arvense	3	-	10	10	20	**11**	**80**
Melilotus albus	-	-	-	3	-	**3**	**20**
Melilotus officinalis	-	-	-	-	1	**1**	**20**
Sonchus uliginosus	-	-	10	20	-	**15**	**40**
Forbs (short)							
native							
Aster bracteolatus	-	-	1	-	-	**1**	**20**
Aster ericoides	-	-	3	-	-	**3**	**20**
Conyza canadensis var. canadensis	-	-	1	-	-	**1**	**20**
Epilobium ciliatum	1	-	-	1	1	**1**	**60**
Equisetum arvense	3	-	-	-	1	**2**	**40**
Equisetum hyemale	-	-	-	1	-	**1**	**20**
Equisetum laevigatum	-	1	-	-	-	**1**	**20**
Galium triflorum	-	-	-	-	1	**1**	**20**
Linum lewisii var. lewisii	-	-	1	-	-	**1**	**20**
Lycopus americanus	1	-	-	-	-	**1**	**20**

Table 12 (continued).

Coyote Willow/Mesic Graminoid Community
(*Salix exigua*/Mesic Graminoid)

	Plots: CRK 411	CLA 411	RED 422	SHO 412	CRK 412	AVG % COV	CONST %
Maianthemum stellatum	1	-	-	-	1	**1**	**40**
Mentha arvensis	1	-	1	-	1	**1**	**60**
Mimulus guttatus var. guttatus	1	-	-	-	-	**1**	**20**
Polygonum amphibium	-	-	-	-	3	**3**	**20**
Ranunculus macounii	-	-	1	-	-	**1**	**20**
Viola sp.1	3	-	-	-	-	**3**	**20**
exotic							
Medicago lupulina	1	-	1	-	-	**1**	**40**
Plantago major	-	-	3	-	-	**3**	**20**
Rumex crispus	-	-	-	-	1	**1**	**20**
Taraxacum officinale	1	-	-	-	-	**1**	**20**
Trifolium pratense var. pratense	-	-	-	-	1	**1**	**20**
Trifolium repens	-	-	1	-	-	**1**	**20**
Vines							
native							
Clematis ligusticifolia var. ligusticifoli	-	3	20	-	-	**12**	**40**
Humulus lupulus var neomexicanus	1	-	-	-	10	**6**	**40**
exotic							
Calystegia sepium	3	-	-	-	3	**3**	**40**

Skunkbush Sumac Series
(*Rhus trilobata* Series)

Three communities of the skunkbush sumac series have been described from the western United States (Bourgeron and Engelking 1994), but the information on these communities is limited. It is probable that the skunkbush sumac communities occur in areas less frequently studied. In Wyoming, skunkbush sumac is found in the foothills and basin areas. Our three stands fit most closely into the riparian *Rhus trilobata-Salix exigua* community described from Colorado and Idaho (Kittel and Lederer 1993). Skunkbush sumac is not strictly riparian; the *Rhus trilobata/Agrpyron spicatum* community described from the Cheyenne River Basin of eastern Wyoming is found on steep slopes and rocky outcrops (Jones 1992).

Skunkbush Sumac-Coyote Willow Community
(*Rhus trilobata-Salix exigua* Community)

(3 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Stands of the skunkbush sumac-coyote willow community have shrub layers dominated by skunkbush sumac, usually quite dense (Tbl. 13). Snowberry (*Symphoricarpos* sp.) was present at all stands and was co-dominant with the sumac at one occurrence. Other shrubs common in lower amounts include rose (*Rosa* sp.) and coyote willow (*Salix exigua*). Occasional large narrowleaf cottonwood trees (*Populus angustifolia*), which are often decadent, provide the tallest cover but at low amounts.

The herbaceous layer has more forbs present than grasses, and no sedges. There are no understory plants common to all stands sampled. Present in moderate amounts at two of the three stands are fireweed summer cypress (*Kochia scoparia*), western virginsbower (*Clematis ligusticifolia*), and Canada thistle (*Cirsium arvense*).

These stands usually parallel the channel for some length. They are usually adjacent to the channel, but sections of the occurrence may be set back from the channel as much as 65 ft (20 m). The stands range in width from 30 to 65 ft (10-20 m). They may also be non-linear patches of approximately 1.2 acres (0.5 ha) in area.

LOCATION:

Stands of the skunkbush sumac-coyote willow community were found in Big Horn and Park counties of Bighorn Basin (Fig. 13) between 3,800 and 4,900 ft (1,150-1,480 m) elevation (Fig. 14). The sites are along first order intermittent, and second and fourth order perennial

channels, so upstream drainage basin area ranges from 15 to 875 sq mi (Fig. 15). These channels have moderate and low gradients.

ENVIRONMENT:

Stands of the skunkbush sumac-coyote willow community were found along the straighter channel reaches or sometimes on the outside meanders of perennial channels. The channels tend to be incised and are often V-shaped. The occurrence may occupy the slope of the channel and the first terrace, or it may be set back from the channel 33 ft (10 m) on the first terrace 4.5 ft (1.4 m) above the bankfull channel height (Figs. 18 and 19). The surfaces of these stands have low litter cover and rather high exposed soil, with gravel and rock at the surface at some sites.

SOILS:

Clays are dominant in the soil horizons of our stands. Textures of three to four horizons at each stand were: all clay loams, silty clay and clay, or silty clay loam and sandy clay loam.

The pH and electric conductivity of the surface horizon of our three stands ranged from 7.7 to 8.1 and 0.8 to 1.7 dS/m, respectively (Figs. 20 and 21). The high electric conductivity in any horizon of this community was 10.0 dS/m at 41 cm depth.

EXOTICS:

Our three stands of the skunkbush sumac-coyote willow community varied in the amount of exotic plants each contained. One stand had no exotic species, and another had seven non-native species contributing up to 50% canopy cover to the herbaceous layer. The third stand fell between the first two mentioned.

The most common exotic plants in these stands of skunkbush sumac-coyote willow were fireweed summer cypress (*Kochia scoparia*), Candada thistle (*Cirsium arvense*), globepodded hoarycress (*Cardaria pubescens*) and common burdock (*Arctium minus*).

ADJACENT COMMUNITIES:

The skunkbush sumac-coyote willow stands sampled in the Bighorn Basin were either adjacent to the channel, or separated from the channel by one community. The adjacent riparian community was a coyote willow stand at one site and a narrowleaf cottonwood-Rocky mountain juniper-skunkbush sumac *(Populus angustifolia-Juniperis scopulorum)* stand at another site. All three sites are adjacent to upland vegetation consisting of Wyoming big sagebrush or black greasewood stands.

ECOLOGY:

Skunkbush sumac-coyote willow occurs on stream banks and terraces, seep and spring

margins, and on mesic slopes (Welsh et al. 1993). It also frequents dry rocky slopes (Mozingo 1987; Jones 1992).

It is reported that this shrub provides fair to poor browse for deer and poor to useless browse for livestock. Skunkbush sumac can regenerate by sprouting; it is capable of colonizing large areas and increasing its cover following fire (Sampson and Jespersen 1963, in Padgett et al. 1989).

Skunkbush sumac can be the understory component of narrowleaf cottonwood/skunkbush sumac communities. One of these stands appears to be a later successional stage of the narrowleaf cottonwood series. Without flood disturbance to create the suitable substrate for regeneration of narrowleaf cottonwood, these sites will probably succeed to skunkbush sumac stands.

Skunkbush sumac is known by a variety of names. The synonym for its scientific name is *Rhus aromatica*. It also goes by the following common names: squawbush, three-lobed sumac, polecat bush, squawberry, and lemonade sumac. As indicated, skunkbush sumac has a disagreeable odor, three-part leaves, and acidic fruits which can be used to produce a pink "lemonade" or they may be eaten raw or cooked (Mozingo 1987).

OTHER CLASSIFICATIONS:

Very little information is available on similar communities described within the skunkbush sumac series. The skunkbush sumac-coyote willow community is reported in Colorado and Idaho (Bourgeron and Engelking 1994), with only the Colorado stands referenced. Our stands are similar, but not identical in composition, to the skunkbrush sumac-coyote willow plant association found in the San Miguel/Dolores River Basin of Colorado (Kittel and Lederer 1993). The shrub layer, the location, and the adjacent communities are similar. The herbaceous layer differs in species composition, but there is low constancy of any herbaceous species in either group.

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Rhus trilobata-Salix exigua* Community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Temperate Deciduous Shrubland Formation, *Rhus aromatica* (syn. *R. trilobata)* Alliance.

Table 13. Percent canopy cover of species in plots of the Skunkbush Sumac-Coyote Willow *(Rhus trilobata-Salix exigua)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Skunkbush Sumac-Coyote Willow Community
(Rhus trilobata-Salix exigua)

Plots:	WIL 411	CLA 413	BEV 412	AVG % COV	CONST %
Trees					
native					
Juniperus scopulorum	-	3	10	**7**	**67**
Populus acuminata	1	-	-	**1**	**33**
Populus angustifoila	3	3	-	**3**	**67**
exotic					
Elaeagnus angustifolia	3	-	-	**3**	**33**
Shrubs					
native					
Alnus incana	-	1	-	**1**	**33**
Artemisia tridentata var. tridentata	1	-	1	**1**	**67**
Artemisia tridentata var. wyomingensis	-	1	-	**1**	**33**
Chrysothamnus nauseosus	10	-	-	**10**	**33**
Populus angustifolia (sapling)	-	10	-	**10**	**33**
Prunus virginiana var. melanocarpa	-	3	10	**7**	**67**
Rhus trilobata var. trilobata	60	70	30	**53**	**100**
Ribes aureum	-	-	3	**3**	**33**
Ribes oxyacanthoides	-	1	3	**2**	**67**
Rosa woodsii	10	3	6	**6**	**100**
Salix exigua	-	10	10	**10**	**67**
Salix lutea	-	3	-	**3**	**33**
Sarcobatus vermiculatus var. vermiculatus	1	-	-	**1**	**33**
Shepherdia argentea	-	10	-	**10**	**33**
Symphoricarpos sp.	3	10	30	**14**	**100**
Shrubs (dwarf)					
native					
Populus angustifolia (seedling)	1	3	-	**2**	**67**
Graminoids (short)					
native					
Elymus smithii	-	-	20	**20**	**33**
Elymus trachycaulus	1	-	-	**1**	**33**

Table 13 (continued).

Skunkbush Sumac-Coyote Willow Community
(*Rhus trilobata-Salix exigua*)

Plots:	WIL 411	CLA 413	BEV 412	AVG % COV	CONST %
Hordeum caespitosum	1	-	-	**1**	**33**
Hordeum jubatum	-	-	1	**1**	**33**
Leucopoa kingii	-	-	1	**1**	**33**
Oryzopsis hymenoides	-	-	1	**1**	**33**
exotic					
Bromus japonicus	-	-	10	**10**	**33**
Bromus tectorum	1	-	3	**2**	**67**
Poa pratensis	-	-	3	**3**	**33**
Forbs (tall)					
native					
Asclepias speciosa	3	-	-	**3**	**33**
Astragalus canadensis	-	3	-	**3**	**33**
Atriplex heterosperma	-	-	3	**3**	**33**
Chenopodium berlandieri var. zschackei	10	-	-	**10**	**33**
Glycyrrhiza lepidota	-	-	10	**10**	**33**
Helianthus annuus	1	-	-	**1**	**33**
Lactuca oblongifolia	3	-	-	**3**	**33**
Lactuca serriola	-	-	1	**1**	**33**
Solidago gigantea var. serotina	-	10	-	**10**	**33**
exotic					
Arctium minus	10	-	-	**10**	**33**
Cirsium arvense	10	-	3	**7**	**67**
Cirsium vulgare	-	-	1	**1**	**33**
Medicago sativa	-	-	3	**3**	**33**
Melilotus albus	1	-	-	**1**	**33**
Melilotus officinalis	-	-	1	**1**	**33**
Forbs (short)					
native					
Achillea millefolium var. lanulosa	-	-	1	**1**	**33**
Apocynum cannabinum	-	3	-	**3**	**33**
Artemisia frigida	-	1	-	**1**	**33**
Astragalus bisulcatus	-	-	1	**1**	**33**
Cirsium flodmanii	-	-	1	**1**	**33**
Iva axillaris var. robustior	20	-	-	**20**	**33**

Table 13 (continued).

Skunkbush Sumac-Coyote Willow Community
(*Rhus trilobata-Salix exigua*)

	Plots: WIL 411	CLA 413	BEV 412	AVG % COV	CONST %
Maianthemum stellatum	-	3	1	**2**	**67**
Toxicodendron rydbergii	-	3	-	**3**	**33**
exotic					
Cardaria pubescens	20	-	-	**20**	**33**
Kochia scoparia	20	-	3	**12**	**67**
Lepidium perfoliatum	-	-	3	**3**	**33**
Sisymbrium loeselii	-	-	1	**1**	**33**
Taraxacum officinale	-	-	1	**1**	**33**
Tragopogon dubius	-	-	1	**1**	**33**
Vines					
native					
Clematis ligusticifolia var. ligusticifolia	-	10	10	**10**	**67**

Silver Sagebrush Series
(*Artemisia cana* var. *cana* Series)

Stands of the silver sagebrush series are usually restricted to riparian zones, but they may occur on upland sites. One riparian community of the silver sagebrush series is described from our Bighorn Basin study area.

Silver sagebrush is distributed throughout the eastern plains and in the Bighorn Basin of Wyoming. It is most common on well-drained soils of floodplains and terraces along rivers or small channels. It is less frequently found on well-drained upland soils (Beetle and Johnson 1982). The topographic position of the communities of the silver sagebrush series must be evaluated to determine whether they are riparian/wetland types or upland types. The herbaceous species present in the stand may be obvious upland or riparian species, but they can also be species which are found in either environment, such as *Poa pratensis.*

Silver Sagebrush - Flaxleaf Rabbitbrush Community
(*Artemisia cana* var. *cana* - *Chrysothamnus linifolius* Community)

(5 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Silver sagebrush is the dominant shrub of these stands with flaxleaf rabbitbrush (*Chrysothamnus linifolius*) present, usually in large amounts (Tbl. 14). Basin big sagebrush (*Artemisia tridentata* var. *tridentata*) is often interspersed with the silver sagebrush and flaxleaf rabbitbrush; it usually extends beyond the riparian zone unlike the two dominant shrubs. The shrub layer ranges from 2 ft to 3 ft (0.6 - 1 m)tall.

Most stands of this community have a uniform, but sparse, layer of grasses in the herbaceous layer. One stand has a large amount of introduced crested wheatgrass (*Agropyron cristatum*) rather than the small amounts of various native grasses. Forbs are also sparse. Lemon scurfpea (*Psoralidium lanceolatum*) has the highest constancy and is moderately abundant at the stands of this community.

Two stands have occasional plains cottonwood (*Populus deltoides*) saplings or small trees present. Many of the trees have a large component of dead branches.

Four of the five occurrences occupy the entire riparian zone ranging from 10 to 100 ft (3 - 30 m) wide. It is often the case that the current riparian zone is contained within the width of an old channel. The present channel is shallow and narrow and occurs within the 5 to 15 ft (1.5 - 4.5 m) tall cutbanks of the old channel.

LOCATION:

Sites with the silver sagebrush-flaxleaf rabbitbrush community were sampled along five different creeks in Washakie, Big Horn and Park counties (Fig. 13) at elevations ranging from 4,310 ft to 4,995 ft (1,315 - 1,523 m) (Fig. 14). All sites are located along first or second order intermittent streams. The channels are not particularly sinuous. The sites are all near the head of the drainage basin and drain a small upstream basin area (< 18 sq mi) (Fig. 15).

ENVIRONMENT:

Stands of the silver sagebrush-flaxleaf rabbitbrush community are common to low gradient intermittent, often dry, channels within the Basin. The stream channels range from 4 ft to 30 ft (1.2 - 9.5) wide and are less than 2 ft (0.6 m) in depth (Figs. 16 & 17). Four of the five stands occur adjacent to the channel; they occupy the gently sloped channel banks at the inner meanders and between meanders, as well as extending beyond the bank onto the floodplain surface. The outer meander banks are often vertical cut banks. Height of the occurrence above the channel ranges from 0 to 3 ft (Fig. 19).

SOILS:

Stands of the silver sagebrush-flaxleaf rabbitbrush have a large amount of exposed soil below and between the dominant shrub layer. Surface soils are silty clay loams, sandy clay loams, silt loams, or clay loams. Lower horizons tend to be silty or sandy clay loams, silty clays, or loamy sands. The pH and electric conductivity of the surface horizon of our five stands ranged from 7.9 to 8.7 and 0.4 to 1.0 dS/m, respectively (Figs. 20 & 21). The high electric conductivity in any horizon of this community was 6.8 dS/m at 25 cm depth.

EXOTICS:

With the exception of a large amount of crested wheatgrass (*Agropyron cristatum*) in one stand, very few exotics are present in stands of this community. One stand contained a small amount of Chinese tamarisk (*Tamarix chinensis*) in the shrub layer. Small amounts of cheatgrass brome (*Bromus tectorum*) are common. Very small amounts of exotic forbs are also likely to be present.

ADJACENT COMMUNITIES:

Most occurrences of the silver sagebrush-flaxleaf rabbitbrush community occupy the entire riparian zone which ranges from 10 to 100 ft (3 - 30 m) wide. At one site, narrow bands of the alkali cordgrass (*Spartina gracilis*) community occur at the inside meanders and often separate the silver sagebrush-flaxleaf rabbitbrush stand from the channel.

ECOLOGY:

Silver sagebrush is common to the basins of the Bighorn River, occurring along alluvial flats and terraces. The silver sagebrush-flaxleaf rabbitbrush community provides little bank stability, less than 30%, to the channels where they were sampled in the Basin. Silver sagebrush is common to the basins of the Bighorn River occurring along alluvial flats and terraces. Root sprouting and rhizomes allow silver sagebrush to spread extensively after mowing or burning. Silver sagebrush provides valuable winter forage for game and livestock, especially sheep (Beetle and Johnson 1982).

The species of rabbitbrush found in this community, flaxleaf rabbitbrush, is more confined to riparian communities than some of the other rabbitbrush species. It is found along stream banks and terraces, irrigation canals, seeps and springs (Welsh et al. 1993). Most species of rabbitbrush are also able to resprout from the crown after a fire; they are also common invaders of disturbed areas. Rabbitbrush is of little value to cattle, but it provides important forage to deer throughout the winter. Sheep, goats, and antelope will eat the flowers and seasonal leaves in late fall and winter. Birds, rabbits, and other small mammals make use of the rabbitbrush seeds and leaves for food (Mozingo 1987).

OTHER CLASSIFICATIONS:

Communities within the silver sagebrush series are identified in A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994), including the silver sagebrush/western wheatgrass type of Wyoming (Jones and Walford 1995) and Montana (Hansen et al. 1995). But a community similar to this silver sagebrush-flaxleaf rabbitbrush type of Bighorn Basin has not been previously described.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Artemisia cana* var *cana* - *Chrysothamnus linifolius* community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation.

Table 14. Percent canopy cover of species in plots of the Silver Sagebrush-Flaxleaf Rabbitbrush *(Artemisia cana* var. *cana-Chrysothamnus linifolius)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Silver Sagebrush-Flaxleaf Rabbitbrush Community
(*Artemisia cana* var. *cana-Chrysothamnus linifolius*)

Plots:	NFF 411	ELK 411	UPC 411	NND 412	ROA 411	**AVG % COV**	**CONST %**
Trees							
native							
Populus deltoides	3	3	-	-	-	**3**	**40**
Shrubs							
native							
Artemisia cana var. *cana*	20	10	10	30	20	**18**	**100**
Artemisia tridentata var. *tridentata*	20	10	30	-	-	**20**	**60**
Artemisia tridentata var. wyomingen	-	-	-	-	3	**3**	**20**
Chrysothamnus linifolius	10	1	20	3	20	**11**	**100**
Chrysothamnus nauseosus	-	3	-	-	-	**3**	**20**
Populus angustifolia (sapling)	3	-	-	-	-	**3**	**20**
Sarcobatus vermiculatus	-	-	-	-	1	**1**	**20**
native							
Tamarix chinensis	-	3	-	-	-	**3**	**20**
Shrubs (dwarf)							
native							
Atriplex confertifolia	-	-	1	-	1	**1**	**40**
Gutierrezia sarothrae	-	-	-	-	3	**3**	**20**
Leptodactylon pungens	-	-	-	-	1	**1**	**20**
Populus angustifolia (seedling)	1	-	-	-	-	**1**	**20**
Graminoids (tall)							
native							
Elymus cinereus	-	-	-	1	-	**1**	**20**
Graminoids (short)							
native							
Bouteloua gracilis	-	-	-	1	1	**1**	**40**
Distichlis stricta	-	-	-	1	-	**1**	**20**
Elymus albicans	-	-	1	3	3	**2**	**60**
Elymus lanceolatus	-	1	-	-	1	**1**	**40**
Elymus smithii	-	-	3	3	-	**3**	**40**
Elymus spicatus	-	1	-	-	-	**1**	**20**
Elymus trachycaulus	-	1	-	-	-	**1**	**20**

Table 14 (continued).

Silver Sagebrush-Flaxleaf Rabbitbrush Community
(*Artemisia cana* var. *cana-Chrysothamnus linifolius*)

Plots:	NFF 411	ELK 411	UPC 411	NND 412	ROA 411	AVG % COV	CONST %
Hordeum caespitosum	-	-	-	1	-	**1**	**20**
Hordeum jubatum	-	1	1	-	-	**1**	**40**
Koeleria macrantha	-	-	-	-	1	**1**	**20**
Oryzopsis hymenoides	-	3	1	1	1	**2**	**80**
Poa juncifolia	-	-	-	3	-	**3**	**20**
Poa secunda	-	1	-	-	1	**1**	**40**
Sporobolus airoides var. airoides	-	1	1	-	-	**1**	**40**
Stipa comata	1	1	1	1	3	**1**	**100**
exotic							
Agropyron cristatum var. desertoru	20	-	-	-	-	**20**	**20**
Bromus tectorum	-	1	3	-	1	**2**	**60**
Elymus repens	1	-	-	-	-	**1**	**20**
Forbs (tall)							
native							
Xanthium strumarium	-	-	-	-	1	**1**	**20**
exotic							
Xanthium strumarium var. canaden	1	3	1	-	-	**2**	**60**
Melilotus officinalis	10	-	-	1	-	**6**	**40**
Forbs (short)							
native							
Allium sp.	-	-	-	-	1	**1**	**20**
Astragalus adsurgens var. robustior	-	-	1	-	1	**1**	**40**
Cryptantha celosioides	-	-	-	-	1	**1**	**20**
Grindelia squarrosa	-	-	-	1	-	**1**	**20**
Ipomopsis sp.	-	1	-	-	-	**1**	**20**
Machaeranthera canescens	-	1	-	-	-	**1**	**20**
Musineon divaricatum	-	-	-	-	1	**1**	**20**
Opuntia polyacantha	1	-	-	-	1	**1**	**40**
Psoralidium lanceolatum	-	3	1	10	10	**6**	**80**
Sphaeralcea coccinea	-	-	-	-	1	**1**	**20**
Vicia americana	-	-	-	-	1	**1**	**20**
exotic							
Rumex crispus	1	-	-	-	-	**1**	**20**
Salsola australis	-	1	-	-	-	**1**	**20**
Tragopogon dubius	-	-	-	-	1	**1**	**20**

Rabbitbrush Series
(*Chrysothamnus* sp. Series)

Rubber rabbitbrush *(Chrysothamnus nauseosus)* and flaxleaf rabbitbrush *(Chrysothamnus linifolius)* are both common to the Bighorn Basin. These shrubs commonly occur together and with species of sagebrush (*Artemisia cana* and/or *A. tridentata)*. Three communities within the rabbitbrush series are identified in the Bighorn Basin. The silver sagebrush-flaxleaf rabbitbrush *(Artemisia cana-Chrysothamnus linifolius)* community is also identified from the Basin and placed in the silver sagebrush series.

Rabbitbrush/Alkali Dropseed Community - tentative
(*Chrysothamnus* sp./*Sporobolus airoides* Community - tentative)

(2 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Stands of the rabbitbrush/alkali dropseed community are dominated by a shrub layer composed of two species of rabbitbrush, either one being more abundant. There is flaxleaf rabbitbrush (*Chrysothamnus linifloius*) and rubber rabbitbrush (*C. nauseosus*) (Tbl. 15). Basin big sagebrush (*Artemisia tridentata* var. *tridentata*) is present, sometimes in nearly equal amounts. The shrub layer ranges from 3 ft to 7 ft (1 - 2 m)tall. The herbaceous layer is fairly dense with grasses, alkali dropseed being the tallest and most abundant. Inland saltgrass (*Distichlis stricta*) is also common to both stands. In one of the stands, alkali muhly grass (*Muhlenbergia asperifolia*), and the forbs starry false Solomon's seal (*Maianthemum stellatum*) and American licorice (*Glycyrrhiza lepidota*), were also abundant.

The community occurs in long, narrow patches adjacent to the channel. The community vegetates the bank up to, and including, the floodplain. At the second site, the stand occurs in larger patches occupying the entire first terrace.

LOCATION:

Stands of the rabbitbrush/alkali dropseed community were sampled in Big Horn and Hot Springs counties. Sites were found on first order intermittent and second order perennial channels at approximately 3,900 ft and 5,200 ft (1,200 - 1,600m) elevation, respectively. The intermittent channel is confined on the outer meanders by limestone cliffs and the riparian zone is only 33 ft (10 m) wide. The perennial riparian zone is up to 330 ft (100 m) wide.

ENVIRONMENT:

The 15 ft (5 m) wide channels are sinuous with less than 1% channel gradient. The

occurrences of rabbitbrush/alkali dropseed are found at 3 ft (1m) above the bankfull channel. At one site this includes the channel bank and up the slope to the first surface at this height. At the other site the occurrence is confined to the third surface.

SOILS:

The upper soil horizon at the two stands sampled were either a clay or sandy loam texture. At both stands the second horizon, at 5 or 6 cm depth, was a silty clay loam texture. Clay loams were common in the lower horizons.

The pH and electric conductivity of the surface horizon of our two stands ranged from 7.6 to 7.7 and 2.0 to 2.8 dS/m, respectively. The high electric conductivity in any horizon of this community was 9.0 dS/m at 43 cm depth.

EXOTICS:

Canada thistle (*Cirsium arvense*) and Swainsonpea (*Sphaerophysa salsula*) are the only exotic species present in our stands of rabbitbrush/alkali dropseed. They occur in low amounts.

ADJACENT COMMUNITIES:

At one site, this community is adjacent to an American licorice (*Glycyrrhiza lepidota*) stand which occupies a slightly lower surface. Away from the channel, on an abruptly higher surface is a basin big sagebrush/basin wild rye (*Artemisia tridentata* var. *tridentata*) community. At the other site, this community is adjacent to the channel and to a black greasewood (*Sarcobatus vermiculatus*) upland community which occupies a higher surface.

ECOLOGY:

Many of the species present in the rabbitbrush/alkali dropseed stands occur in alkaline areas. The surface horizon is mildly alkaline, but the lower horizons are moderately and strongly alkaline as indicated by pH readings of 9.1 and 8.3 at the two sites.

Flaxleaf rabbitbrush is more confined to riparian communities than some of the other rabbitbrush species. It is found along stream banks and terraces, irrigation canals, seeps and springs (Welsh et al. 1993). Most species of rabbitbrush are also able to resprout from the crown after a fire. Additionally, rabbitbrush are common invaders of disturbed areas. Rabbitbrush is of little value to cattle, but it is important as forage to deer throughout the winter. Sheep, goats, and antelope will eat the flowers and seasonal leaves in late fall and winter. The leaves and seeds are important food sources to birds, rabbits, and other small mammals (Mozingo 1987).

OTHER CLASSIFICATIONS:

A Preliminary Vegetation Classification of the Western United States (Bourgeron and Engelking 1994) does not contain references for a flaxleaf or rubber rabbitbrush/alkali dropseed community, or a basin big sagebrush/alkali dropseed community. We can consider this a new, but tentative, community type until more stands are sampled.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Chrysothamnus* sp./*Sporobolus airoides* community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation.

Table 15. Percent canopy cover of species in plots of the Rabbitbrush/Alkali Dropseed *(Chrysothamnus* sp./*Sporobolus airoides)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Rabbitbrush/Alkali Dropseed Community-tentative
(Chrysothamnus linifolius/Sporobolus airoides)

Plots:	SHE 411	GOO 413	**AVG % COV**	**CONST %**
Trees				
native				
Populus angustifoila	-	3	**3**	**50**
Salix amygdaloides	-	3	**3**	**50**
Shrubs				
native				
Artemisia tridentata	10	10	**10**	**100**
Chrysothamnus linifolius	10	20	**15**	**100**
Chrysothamnus nauseosus	3	30	**17**	**100**
Ribes oxyacanthoides	-	3	**3**	**50**
Shrubs (dwarf)				
native				
Atriplex confertifolia	1	-	**1**	**50**
Graminoids (tall)				
native				
Calamagrostis inexpansa	-	1	**1**	**50**
Graminoids (short)				
native				
Distichlis stricta	10	30	**20**	**100**
Elymus canadensis	1	-	**1**	**50**

Table 15 (continued).

Rabbitbrush/Alkali Dropseed Community-tentative
(Chrysothamnus linifolius/Sporobolus airoides)

Plots:	SHE 411	GOO 413	AVG % COV	CONST %
Elymus lanceolatus	3	-	**3**	**50**
Elymus smithii	3	-	**3**	**50**
Elymus trachycaulus	-	3	**3**	**50**
Hordeum caespitosum	-	3	**3**	**50**
Hordeum jubatum	1	10	**6**	**100**
Juncus balticus	-	10	**10**	**50**
Muhlenbergia asperifolia	-	20	**20**	**50**
Oryzopsis hymenoides	1	-	**1**	**50**
Poa juncifolia	-	10	**10**	**50**
Sporobolus airoides	20	30	**25**	**100**
Forbs (tall)				
native				
Asclepias speciosa	-	1	**1**	**50**
Glycyrrhiza lepidota	-	20	**20**	**50**
Xanthium strumarium	1	-	**1**	**50**
exotic				
Cirsium arvense	-	10	**10**	**50**
Forbs (short)				
native				
Cryptantha celosioides	1	-	**1**	**50**
Equisetum laevigatum	-	1	**1**	**50**
Maianthemum stellatum	-	20	**20**	**50**
exotic				
Sphaerophysa salsula	3	-	**3**	**50**

Flaxleaf Rabbitbrush/Canada Wild Rye Community - tentative
(*Chrysothamnus linifolius/Elymus canadensis* Community - tentative)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Flaxleaf rabbitbrush dominates the shrub layer of this stand, but the upper canopy is determined by 3 ft (1m) tall Canada wild rye (Tbl. 16). Lemon scurfpea (*Psoralidium lanceolatum*) is also common and grows to a height of less than 1 ft (0.3 m) tall. Few other species occur in this stand.

The flaxleaf rabbitbrush/Canada wild rye occurrence creates narrow bands along the channel. The dominant plants grow in clumps with significant amounts of soil exposed between the shrubs.

LOCATION:

The site containing flaxleaf rabbitbrush/Canada wild rye occurs in Washakie county (Fig. 13) along an intermittent, second order channel at 4,130 ft elevation (Fig. 14). Upstream area draining into this channel is small (Fig. 15).

ENVIRONMENT:

The riparian zone containing this community is narrow and sparsely vegetated. The channel is 17 ft (5 m) wide and quite shallow (Figs. 16 & 17). Channel bed material is primarily sand with some cobbles. There are occasional mid-channel bars, one of which is 3 ft (1 m) above the channel and contains old plains cottonwoods *(Populus deltoides)*. Others are lower, mid-channel surfaces vegetated with American licorice (*Glycyrrhiza lepidota*). The flaxleaf rabbitbrush/Canada wild rye stand vegetates the steeply sloped banks and continues 5 ft (1.5 m) from the channel on the first surface.

SOILS:

The soil at this stand has a single consistent silty clay loam texture to 60 cm depth. It lacks any coarse material and has no mottling. The pH and electric conductivity of the surface horizon of our stand was 7.9 and 0.8 dS/m, respectively (Figs. 20 & 21).

EXOTICS:

This stand of flaxleaf rabbitbrush/Canada wild rye has low species diversity and few exotic plants. Very small amounts of crested wheatgrass *(Agropyron cristatum)* and yellow sweet-clover *(Melilotus officinalis)* are present.

ADJACENT COMMUNITIES:

Narrow bands of the flaxleaf rabbitbrush/Canada wild rye community occur adjacent to the channel and are sometimes interupted by smaller patches of American licorice. On the upland side, the flaxleaf rabbitbrush/Canada wild rye stands are adjacent to old sparse plains cottonwood *(Populus deltoides)* stands with upland grasses dominating the understory. Also common on this higher terrace is basin big sagebrush *(Artemisia tridentata* var. *tridentata).*

ECOLOGY:

The species of rabbitbrush found in this community, flaxleaf rabbitbrush, is more confined to riparian communities than some of the other rabbitbrush species. It is found along stream banks and terraces,irrigation canals, seeps and springs (Welsh et al. 1993). Most species of rabbitbrush are also able to resprout from the crown after a fire; they are also common invaders of disturbed areas. Rabbitbrush is of little value to cattle, but it is important to deer throughout the winter. Sheep, goats, and antelope will eat the flowers and seasonal leaves in late fall and winter. The shrub is also important to birds, rabbits, and other small mammals (Mozingo 1987).

Canada wild rye is common to stream banks and moist open ground. It is adapted to a broad range of dry and moist soils and is equally likely to occur in wetlands as in non-wetland areas. It produces good forage for cattle and horses during spring. If Canada wild rye becomes infested with ergot, it can be dangerous to livestock if eaten (Stubbendieck et al 1992).

OTHER CLASSIFICATIONS:

A Preliminary Vegetation Classification of the Western United States (Bourgeron and Engelking 1994) does not have references for a flaxleaf or rubber rabbitbrush/Canada wild rye community. We can consider this a new, but tentative, community type until more stands are sampled.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Chrysothamnus linifolius/Elymus canadensis* Community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation.

Table 16. Percent canopy cover of species in the plot of the Flaxleaf Rabbitbrush/Canada Wild Rye *(Chrysothamnus linifolius/Elymus canadensis)* Community (tentative).

Flaxleaf Rabbitbrush/Canada Wild Rye Community-tentative
(*Chrysothamnus linifolius/Elymus canadensis*)

Plot:	TMC 412
Shrubs	
native	
Artemisia cana	1
Artemisia tridentata	3
Chrysothamnus linifolius	30
Graminoids (tall)	
native	
Elymus canadensis	30
Graminoids (short)	
native	
Elymus trachycaulus	1
exotic	
Agropyron cristatum	1
Forbs (tall)	
exotic	
Melilotus officinalis	1
Forbs (short)	
native	
Comandra umbellata	1
Psoralidium lanceolatum	20

Rubber Rabbitbrush Community
(*Chrysothamnus nauseosus* Community)

(4 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

The rubber rabbitbrush community is composed of sparse vegetation (Tbl. 17). It has an average 40% canopy cover of shrubs, predominantly rubber rabbitbrush. One or two other shrub species are present in significant amounts at each stand. These include flaxleaf rabbitbrush (*Chrysothamnus linifolius*), basin big sagebrush (*Artemisia tridentata* var. *tridentata*), Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*), or Chinese tamarisk (*Tamarix chinensis*).

The herbaceous layer is usually quite sparse. Each stand has 6 to 16 species of grasses and forbs present, but each of these has 5% or less cover. Exceptions to this are three species with significant cover in two stands: slender wheatgrass (*Elymus trachycaulus*) and bobtail barley (*Hordeum caespitosum*) present in one stand, and lemon scurfpea (*Psoralidium lanceolatum*) present in another stand.

LOCATION:

The sites where we sampled the rubber rabbitbrush community were located in all four counties of our study area: Washakie, Park, Big Horn and Hot Springs (Fig. 13). They were found on first order intermittent channels throughout Bighorn Basin at elevations ranging from 4,000 to 5,700 ft (1,220 - 1,740 m) (Fig.14). The channels at all the sites drain very small basin areas (Fig. 15), which accounts for all four channels being narrow and shallow at the sites (Figs. 16 and 17).

ENVIRONMENT:

Stands of rubber rabbitbrush are found adjacent to the channel but they occur on surfaces ranging from 0.5 to 3 ft (0.1 - 1 m) above the channel (Fig. 19). The stands often occupy the channel banks as well as the floodplain surface. The stand is larger in area at the inside of meander bends where the surface slopes gently upward. At the outside meander bends, the channel usually meets up against a cut bank which is 3 to 8 ft (1 - 2.5 m) tall.

SOILS:

The surface texture at these stands was frequently a clay loam. Below that were horizons of loamy sand or sandy clay loam texture. One stand had a silty loam texture above a loam horizon.

The pH and electric conductivity of the surface horizon of our four stands ranged from 8.0 to 8.1 and 0.5 to 3.8 dS/m, respectively. The high electric conductivity in any horizon of this community was 5.0 dS/m at 12 cm depth.

EXOTICS:

Chinese tamarisk (*Tamarix chinensis*) is present in small amounts in two stands. Trace amounts of cheatgrass brome (*Bromus tectorum*), yellow sweet-clover (*Melilotus officinalis*), and yellow salsify (*Tragopogon dubius*) were present in half the stands.

ADJACENT COMMUNITIES:

At each site the rubber rabbitbrush stand is the only riparian community present. It is adjacent to upland communities of Wyoming or basin big sagebrush and upland grasses, with or without black greasewood. These upland terrace stands may be former riparian communities, as evidenced by the presence of infrequent plains cottonwood trees with upland species in the understory.

ECOLOGY:

Rubber rabbitbrush is found on dry plains and hillsides as well as along stream banks. More vigorous streamside plants result from the available water flowing into and down the channels. Rabbitbrush, having abundant, wind dispersed seeds which have a high success rate of germination, will quickly invade disturbed areas (Mozingo 1987). It will also resprout readily after a fire, allowing it to out-compete sagebrush in burned areas.

The flowers and leaves of rubber rabbitbrush are eaten by sheep and antelope in late fall and winter. Birds, rabbits and small mammals will make extensive use of the shrub (Mozingo 1987).

OTHER CLASSIFICATIONS:

Chrysothamnus nauseosus communities have been described in zeromorphic shrublands but not in deciduous alluvial shrublands (Bourgeron and Engelking 1994). In the ecological land classification framework (Driscoll et al. 1984), stands of *Chrysothamnus nauseosus* Community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation.

Table 17. Percent canopy cover of species in plots of the Rubber Rabbitbrush *(Chrysothamnus nauseosus)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Rubber Rabbitbrush (*Chrysothamnus nauseosus*) Community

Plots:	MFF 411	FEN 411	DRY 411	ELB 411	AVG % COV	CONST %
Trees						
native						
Populus deltoides	3	-	-	-	**3**	**25**
Shrubs						
native						
Artemisia cana	-	-	-	1	**1**	**25**
Artemisia tridentata	20	-	10	3	**11**	**75**
Artemisia tridentata	-	10	10	-	**10**	**50**
Chrysothamnus linifolius	10	-	-	10	**10**	**50**
Chrysothamnus nauseosus	30	20	10	20	**20**	**100**
Sarcobatus vermiculatus	-	-	1	-	**1**	**25**
Symphoricarpos sp.	-	1	-	-	**1**	**25**
exotic						
Tamarix chinensis	-	-	10	3	**7**	**50**
Shrubs (dwarf)						
native						
Gutierrezia sarothrae	-	-	3	-	**3**	**25**
Graminoids (tall)						
native						
Elymus cinereus	-	-	-	3	**3**	**25**
Scirpus pungens	-	-	-	1	**1**	**25**
Spartina gracilis	-	-	-	3	**3**	**25**
Graminoids (short)						
native						
Bouteloua gracilis	1	-	-	-	**1**	**25**
Elymus albicans	-	3	1	-	**2**	**50**
Elymus canadensis	3	-	-	-	**3**	**25**
Elymus lanceolatus	3	-	-	-	**3**	**25**
Elymus smithii	-	3	-	-	**3**	**25**
Elymus trachycaulus	-	-	1	30	**16**	**50**
Hordeum caespitosum	-	-	-	10	**10**	**25**

Table 17 (continued).

Rubber Rabbitbrush (*Chrysothamnus nauseosus*) Community

Plots:	MFF 411	FEN 411	DRY 411	ELB 411	AVG % COV	CONST %
Hordeum jubatum	-	-	1	3	**2**	**50**
Koeleria macrantha	-	1	-	-	**1**	**25**
Oryzopsis hymenoides	1	3	-	1	**2**	**75**
Poa juncifolia	-	-	1	3	**2**	**50**
Stipa comata	1	-	-	-	**1**	**25**
Stipa viridula	-	1	-	-	**1**	**25**
exotic						
Bromus tectorum	-	-	1	1	**1**	**50**
Forbs (tall)						
native						
Chenopodium berlandieri	-	-	-	1	**1**	**25**
Glycyrrhiza lepidota	-	3	-	-	**3**	**25**
Helianthus sp.	1	-	-	-	**1**	**25**
Xanthium strumarium	1	-	-	-	**1**	**25**
exotic						
Melilotus officinalis	-	1	1	-	**1**	**50**
Forbs (short)						
native						
Artemisia frigida	-	-	-	1	**1**	**25**
Astragalus miser	-	1	-	-	**1**	**25**
Castilleja sp.2	-	1	-	-	**1**	**25**
Comandra umbellata	1	-	-	-	**1**	**25**
Cryptantha celosioides	-	1	-	-	**1**	**25**
Grindelia squarrosa	-	3	-	-	**3**	**25**
Ipomopsis congesta	1	-	-	-	**1**	**25**
Lupinus argenteus	-	1	-	-	**1**	**25**
Machaeranthera canescens	1	1	-	-	**1**	**50**
Opuntia polyacantha	-	1	-	-	**1**	**25**
Psoralidium lanceolatum	3	10	-	-	**7**	**50**
Tragopogon dubius	1	1	-	1	**1**	**75**

Basin Big Sagebrush Series
(*Artemisia tridentata* var. *tridentata* Series)

Basin big sagebrush is commonly found along drainages in the Bighorn Basin. It is found on deep, well-drained soils in valley bottoms and lower foothill areas between elevations of 5,000 ft to 7,000 ft (1,525 - 2,135 m) (Beetle and Johnson 1982). Communities of basin big sagebrush include both riparian and upland types. It is necessary to evaluate the topographic position of the stands to determine whether they are riparian/wetland types or upland types. Some of the herbaceous plants included in the stand may be indicators of upland or riparian zones.

One new riparian community of the basin big sagebrush series is identified from the stands sampled in the Bighorn Basin. There are also two other stands described which are borderline between riparian and upland types.

Basin Big Sagebrush/Basin Wild Rye Community
(*Artemisia tridentata* var. *tridentata/Elymus cinereus* Community)

(2 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Stands of the basin big sagebrush/basin wild rye community have a shrub layer dominated by basin big sagebrush with or without equal amounts of rubber rabbitbrush (*Chrysothamnus nauseosus*) (Tbl. 18). Black greasewood (*Sarcobatus vermiculatus*) is present in lower amounts.

A tall herbaceous layer of basin wild rye has canopy cover equal to that of the shrub density. Short grasses such as Kentucky bluegrass (*Poa pratensis*), slender wheatgrass (*Elymus trachycaulus*) or common quackgrass (*Elymus repens*) may be present in fair amounts. Forbs are less abundant in the herbaceous layer. Those present in low amounts may include starry false Solomon's-seal (*Maianthemum stellatum*).

This community occupies the entire surface on which it is found. The patch width ranges from 33 ft to 165 ft (10 - 50 m) and continues down a length of the channel. The surface of the patch gently undulates. The shrub layer approaches 7 ft (2 m) in height and is dispersed throughout the patch. The basin wild rye is between 3.5 ft and 5 ft (1 - 1.5 m) tall and occurs in bunches.

LOCATION:

Sites containing stands of the basin big sagebrush/basin wild rye community were both sampled in Hot Springs county (Fig. 13) near 5,200 ft (1,580 m) elevation (Fig. 14). These two

sites were located on adjacent tributaries, so the drainage basin of the lower elevation site (240 sq mi) encompasses both sites. The larger, lower gradient channel is highly meandering. Both sites are on second order channels, but the upper channel is intermittent, while the channel it flows into is perennial.

ENVIRONMENT:

At the higher elevation site the riparian zone occupies the width of an old channel and is bound by cut banks 5 ft to 10 ft (1.5 - 3 m) tall. From the channel, the slopes steepens gradually to the surface of this community, 1.4 ft (0.4 m) above bankfull channel and 8 ft (2.5 m) horizontal distance away (Figs. 18 & 19). The lower elevation site is a wider, open riparian zone with distinct terraces. From the channel, the surface slopes up in steps occupied by four different communities. This community occupies the second terrace above the floodplain, 5 ft (1.5 m) above bankfull channel and 230 ft (70 m) horizontal distance away (Figs. 18 & 19).

SOILS:

The soil textures at the basin big sagebrush/basin wild rye stands are silty clay or sandy clay loam above a much thicker clay horizon. The pH and electric conductivity of the surface horizon of our two stands ranged from 7.2 to 8.3 and 0.9 to 13.5 dS/m, respectively (Figs.20 & 21). The high electric conductivity in any horizon of this community was 28.0 dS/m at 17 cm depth. There is a significant difference in electric conductivity at the two stands.

EXOTICS:

There is a fair amount of Kentucky bluegrass at one stand. The other stand had small amounts of common quackgrass (*Elymus repens*), summer cypress (*Kochia scoparia*) and broadleaved peppergrass (*Lepidium latifolium*).

ADJACENT COMMUNITIES:

On the smaller tributary, the basin big sagebrush/basin wild rye community is separated from the channel by a narrow Kentucky bluegrass-western wheatgrass (*Poa pratensis-Elymus smithii*) community. Away from the channel, this stand is adjacent to a steep cutbank.

At the larger channel the basin big sagebrush/basin wild rye community is on the second terrace above the channel. It is adjacent to a flaxleaf rabbitbrush/alkali dropseed (*Chrysothamnus linifolius/Sporobolus airoides*) community on a lower surface. Away from the channel is a black greasewood (*Sarcobatus vermiculatus*) community.

ECOLOGY:

Basin big sagebrush is common to the Bighorn drainage on deep, well-drained soils in valley bottoms and lower foothill areas (Beetle and Johnson 1982). Fire easily kills basin big

sagebrush because it is not capable of producing root or crown sprouts; it does produce an abundance of seed (Knight et al. 1987). Once established, basin big sagebrush is persistent and competitive. Its root system occupies the surface soil as well as the deeper soil, allowing the shrub to access both summer rains from surface soils and snowmelt which has percolated deep into the soil (Tabler 1964, in Mozingo 1984).

Basin wild rye is a robust perennial which often forms clumps over 3 ft (1 m) in diameter. It will occupy moist sites including river banks, ravines and moist slopes, as well as dry slopes and plains. It is a long-lived species and is effective for erosion control (Welsh et al. 1993).

OTHER CLASSIFICATIONS:

There is an *Artemisia tridentata* var. *tridentata/Elymus cinereus* association described from Piceance Basin, Colorado (Baker 1983).

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Artemisia tridentata* var. *tridentata/Elymus cinereus* community belong to the Shrubland Class, Mainly Evergreen Shrubland Subclass, Needle-Leaved and Microphyllous Shrubland Group, Evergreen Microphyllous Shrubland Formation, *Artemisia tridentata* var. *tridentata* Alliance.

Table 18. Percent canopy cover of species in plots of the Basin Big Sagebrush/Basin Wild Rye *(Artemisia tridentata* var. *tridentata/Elymus cinereus)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Basin Big Sagebrush/Basin Wild Rye Community
(*Artemisia tridentata* var. *tridentata/Elymus cinereus*)

Plots:	GIL 412	GOO 414	**AVG % COV**	**CONST %**
Shrubs				
native				
Artemisia tridentata var. tridentata	50	20	**35**	**100**
Chrysothamnus nauseosus	-	20	**20**	**50**
Rhus trilobata var. trilobata	-	1	**1**	**50**
Ribes oxyacanthoides	-	1	**1**	**50**
Rosa woodsii	-	1	**1**	**50**
Sarcobatus vermiculatus var. vermiculatus	10	1	**6**	**100**

Table 18 (continued).

Basin Big Sagebrush/Basin Wild Rye Community
(*Artemisia tridentata* var. *tridentata/Elymus cinereus*)

Plots:	GIL 412	GOO 414	**AVG % COV**	**CONST %**
Graminoids (tall)				
native				
Elymus cinereus	50	30	**40**	**100**
Graminoids (short)				
native				
Elymus trachycaulus	10	-	**10**	**50**
Hordeum brachyantherum	-	1	**1**	**50**
Hordeum caespitosum	1	-	**1**	**50**
Hordeum jubatum	-	1	**1**	**50**
Koeleria macrantha	3	-	**3**	**50**
Oryzopsis hymenoides	1	-	**1**	**50**
Poa juncifolia	-	1	**1**	**50**
Sporobolus airoides var. airoides	1	1	**1**	**100**
Agropyron cristatum var. desertorum	1	-	**1**	**50**
exotic				
Bromus tectorum	1	-	**1**	**50**
Elymus repens	-	3	**3**	**50**
Poa pratensis	20	-	**20**	**50**
Forbs (tall)				
native				
Chenopodium berlandieri var. zschackei	-	3	**3**	**50**
Forbs (short)				
native				
Achillea millefolium var. lanulosa	3	-	**3**	**50**
Artemisia frigida	1	-	**1**	**50**
Artemisia ludoviciana	1	-	**1**	**50**
Aster ascendens	-	1	**1**	**50**
Grindelia squarrosa	3	-	**3**	**50**
Maianthemum stellatum	-	10	**10**	**50**
Opuntia polyacantha	1	-	**1**	**50**
exotic				
Kochia scoparia	-	3	**3**	**50**
Lepidium perfoliatum	-	3	**3**	**50**

Unclassified Basin Big Sagebrush (*Artemisia tridentata* var. *tridentata*) Stands

(2 stands sampled)

Two unclassified stands of basin big sagebrush occupy narrow widths within dry channel bottoms, up the channel slopes and a small distance out from the channel. The riparian zone is distinct but the composition of the stands include upland species.

Basin big sagebrush dominates the shrub layer of both stands (Tbl. 19). Flaxleaf rabbitbrush (*Chrysothamnus linifolius*) may be present in significant amounts. The shrubs average 3 ft to 4 ft (~1 m) in height. Herbaceous species are sparse. A variety of short grasses are present in quite low amounts. Most of the grasses are upland species. Forbs are uncommon. Lemon scurfpea (*Psoralidium lanceolatum*) is the most abundant herbaceous plant at both stands.

These two stands have similarities, but they are difficult to classify due to their riparian location and upland species composition. There is a basin big sagebrush/lemon scurfpea community already described from sandy areas in southwest Wyoming (Jones and Fertig 1996). Our stands occur on silty clays and silty clay loams or on loamy sands; they differ from the previously described community in species composition as well. More stands of this type will need to be sampled before a classification can be assigned.

Table 19. Percent canopy cover of species in plots of the unclassified Basin Big Sagebrush (*Artemisia tridentata* var. *tridentata*) stands.

Unclassified Basin Big Sagebrush (*Artemisia tridentata* var. *tridentata*) Stands

Plots:	TAB 411	SSD 411
Shrubs		
native		
Artemisia tridentata	40	20
Artemisia tridentata	3	-
Chrysothamnus linifolius	-	10
Chrysothamnus nauseosus	1	-
Shrubs (dwarf)		
native		
Gutierrezia sarothrae	1	1
Graminoids (tall)		
native		
Elymus cinereus	1	-

Table 19 (continued).

Unclassified Basin Big Sagebrush (*Artemisia tridentata* var. *tridentata*) Stands

Plots:	TAB 411	SSD 411
Graminoids (short)		
native		
Bouteloua gracilis	-	1
Elymus albicans	3	-
Elymus lanceolatus	-	3
Elymus sp.1	3	-
Elymus spicatus	-	3
Koeleria macrantha	-	3
Oryzopsis hymenoides	1	1
Poa secunda	1	-
Schedonnardus paniculatus	1	-
Sporobolus airoides	1	-
Stipa comata	-	3
Stipa viridula	1	1
exotic		
Agropyron cristatum	1	-
Forbs (tall)		
native		
Delphinium geyeri	-	1
Helianthus petiolaris	1	-
Xanthium strumarium	1	-
exotic		
Melilotus officinalis	10	-
Forbs (short)		
native		
Castilleja sp.3	1	-
Comandra umbellata	3	-
Grindelia squarrosa	1	1
Lupinus pusillus	1	-
Machaeranthera canescens	-	1
Psoralidium lanceolatum	10	30
Vicia americana	1	-
exotic		
Alyssum desertorum	1	-
Tragopogon dubius	1	-

Black Greasewood Series
(*Sarcobatus vermiculatus* Series)

Black greasewood communities are not always riparian types. Black greasewood is a facultative upland plant, meaning 1% to 33% of the individuals occur in wetlands (Cooper 1989). Greasewood is often found on alkaline or saline flats, but it does require sufficient groundwater. Greasewood communities tend to be larger when the water table is closer to the surface (Mozingo 1987).

Black greasewood dominates the shrub layer in stands of this series; they may share dominance with basin big sagebrush (*Artemisia tridentata* var. *tridentata*). The understory is dominated by short grasses. Forbs are present in small amounts.

Stands of black greasewood generally occur on the highest riparian surface and at the outer margin of the riparian zone. They are transitional and adjacent to upland communities. Black greasewood produces taproots 20 to 55 ft (6 - 17 m) in length, allowing it to survive on surfaces up to 25 ft (7.5 m) above the water table (Mozingo 1987).

Black Greasewood-Basin Big Sagebrush/Western Wheatgrass Community (*Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/ Elymus smithii* Community)

(2 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

In these stands, black greasewood and basin big sagebrush occur in nearly equal amounts with total shrub canopy cover over 40% (Tbl. 20). The herbaceous layer is composed predominantly of short grasses, the most abundant of which is western wheatgrass (*Elymus smithii*). A small amount of clasping peppergrass (*Lepidium perfoliatum*) was found in both stands. Vegetation is sparse in these stands resulting in low litter cover and large amounts of exposed soil at the surface.

Stands of these communities can be quite large since they tend to occupy the major portion of the valley bottom which, at our sites, were up to 330 ft (100 m) wide. The mixed black greasewood and basin big sagebrush can create a shrub canopy as tall as 6 ft (2 m).

LOCATION:

Sites containing the black greasewood-basin big sagebrush/western wheatgrass community were sampled in Washakie county between 4,800 and 6,000 ft (1,460 - 1,820 m) elevation (Fig. 14). The occurrences are located along small, low gradient, highly meandering streams. These are first and second order streams high in the drainage basin.

ENVIRONMENT:

In the Bighorn Basin, these two stands of the black greasewood-basin big sagebrush/western wheatgrass community occurred on the first terrace 3 to 5 ft (1 - 1.5 m) above a highly meandering section of channel. At one of the sites, the occurrence occupied a portion of the riparian zone which encompassed a dry, side channel. The stands occur adjacent to the channel but they extend out 165 ft to 230 ft (50 - 70 m) away from the channel on a fairly flat surface.

SOILS:

The surface soil textures at the two stands were clay and silty clay. Below the surface, silty clay continued through the second horizon at one stand, sandy clay was the horizon texture below the clay layer at the other stand.

The pH and electric conductivity of the surface horizon of our two stands ranged from 7.3 to 8.6 and 0.6 to 1.0 dS/m, respectively (Figs. 20 & 21). The high electric conductivity in any horizon of this community was 1.0 dS/m at the surface.

EXOTICS:

Small amounts of non-native plant species common to both stands include cheatgrass brome (*Bromus tectorum*), Kentucky bluegrass (*Poa pratensis*), and clasping peppergrass (*Lepidium perfoliatum*).

ADJACENT COMMUNITIES:

At our sites, the black greasewood-basin big sagebrush/western wheatgrass community is either adjacent to the channel, or it can be separated from the channel by a narrow herbaceous fringe community such as the inland saltgrass (*Distichlis stricta*) stand. At one site this community is a large patch within a larger matrix of black greasewood/western wheatgrass community lacking the basin big sagebrush. Adjacent upland sites are most often composed of Wyoming big sagebrush (*Artemisia tridentata* var. *tridentata*) and upland grasses.

ECOLOGY:

Both the black greasewood-basin big sagebrush/western wheatgrass community and the black greasewood/western wheatgrass community can occupy the same riparian zone. It appears that this black greasewood-basin big sagebrush/western wheatgrass community is located in places which receive more soil moisture than the black greasewood/western wheatgrass community.

Since stands of this community occur so high above the stream channel, small changes in the depth to the water table are unlikely to have much effect on the vegetation. Changes in the vegetation are likely to come only from floods large enough to reach the higher surfaces or

from changes in management. Hansen and others (1991) note that prolonged overgrazing reduces the amount of western wheatgrass and allows the annual brome grasses to increase.

OTHER CLASSIFICATIONS:

In the Pryor Mountains of Montana, a very similar community was found along drainages on alluvial terraces from 4,000 to 4,600 ft (1,220 - 1,400 m) (DeVelice and Lesica 1993). Their community type is named *"Sarcobatus vermiculatus-Artemisia tridentata"*, and *Elymus smithii* is the most abundant native grass common to the stands. This black greasewood-basin big sagebrush/western wheatgrass community type has also been described for eastern Wyoming (Jones and Walford 1995). The eastern Wyoming stands are similar to these Bighorn Basin stands, but they tend to have a stronger component of rubber rabbitbrush (*Chrysothamnus nauseosus*). In Colorado, Baker (1984) identified an *Artemisia tridentata* var. *tridentata-Sarcobatus vermiculatus/Elymus smithii* shrub association that may be the same as this Bighorn Basin community.

A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) does not include references to this community. In the ecological land classification framework (Driscoll et al. 1984), stands of the *Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/Elymus smithii* community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation.

Table 20. Percent canopy cover of species in plots of the Black Greasewood-Basin Big Sagebrush/Western Wheatgrass *(Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/Elymus smithii)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Black Greasewood-Basin Big Sagebrush/Western Wheatgrass Community
(*Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/Elymus smithii*)

Plots:	BUS	BUF	**AVG**	**CONST**
	411	412	**% COV**	**%**
Shrubs				
native				
Artemisia tridentata	20	30	**25**	**100**
Chrysothamnus nauseosus	3	-	**3**	**50**
Sarcobatus vermiculatus	20	20	**20**	**100**
Graminoids (tall)				
native				
Elymus cinereus	1	-	**1**	**50**

Table 20 (continued).

Black Greasewood-Basin Big Sagebrush/Western Wheatgrass Community
(*Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/Elymus smithii*)

Plots:	BUS 411	BUF 412	**AVG % COV**	**CONST %**
Graminoids (short)				
native				
Elymus smithii	20	10	**15**	**100**
Hordeum jubatum	1	-	**1**	**50**
Oryzopsis hymenoides	3	3	**3**	**100**
exotic				
Bromus japonicus	-	3	**3**	**50**
Bromus tectorum	3	3	**3**	**100**
Poa pratensis	3	3	**3**	**100**
Forbs (short)				
native				
Grindelia squarrosa	1	1	**1**	**100**
Opuntia polyacantha	-	1	**1**	**50**
Rumex maritimus	1	-	**1**	**50**
exotic				
Lepidium perfoliatum	3	3	**3**	**100**

Black Greasewood/Western Wheatgrass Community
(*Sarcobatus vermiculatus/Elymus smithii* Community)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

This black greasewood/western wheatgrass stand has a high density (60% cover) of black greasewood (Tbl. 21) which may grow up to 5.5 ft (1.6 m) tall. A very small amount of basin big sagebrush (*Artemisia tridentata* var. *tridentata*) occurs adjacent to the channel. The area between the black greasewood clumps is vegetated by short grasses, predominantly western wheatgrass (*Elymus smithii*). Forbs are uncommon in these stands, with the exception of clasping peppergrass (*Lepidium perfoliatum*).

Stands of these communities can be quite large since they tend to occupy the major portion of the valley bottom, which at our site was up to 260 ft (80 m) wide. Less soil and more litter are exposed at this stand than at the adjacent black greasewood-basin big sagebrush/western wheatgrass *(Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/Elymus smithii)* stand.

LOCATION:

One stand of this previously described black greasewood/western wheatgrass community was sampled at 4,800 ft (1,460 m) elevation (Fig. 14) along a second order intermittent channel in Washakie county (Fig. 13). The occurrences are located along small, low gradient, highly meandering channels high in the drainage basin (Fig. 15).

ENVIRONMENT:

This example of the black greasewood/western wheatgrass community occurs on the first terrace 4.5 ft (1.4 m) above the channel (Fig. 19). The stand occupies a large portion of the 260 ft (80 m) wide riparian zone. This community tends to occupy sections of terrace adjacent to straighter sections of the channel.

SOILS:

The textures of the soil are silty clay at the surface and then silty clay loam over a thick clay horizon. The pH and electric conductivity of the surface horizon of our stand was 7.6 and 1.1 dS/m, respectively (Figs. 20 & 21). The high electric conductivity in any horizon of this stand was 1.2 dS/m at 29 cm depth.

EXOTICS:

Small, but relatively significant, amounts of cheatgrass brome (*Bromus tectorum*),

Kentucky bluegrass (*Poa pratensis*), and clasping peppergrass (*Lepidium perfoliatum*) are found in this stand.

ADJACENT COMMUNITIES:

This stand of the black greasewood/western wheatgrass community is separated from the channel by a narrow, lower strip of inland saltgrass (*Distichlis stricta*). On the same surface as this black greasewood/western wheatgrass community, occurs a black greasewood-basin big sagebrush/western wheatgrass (*Sarcobatus vermiculatus-Artemisia tridentata* var. *tridentata/Elymus smithii*) stand.

ECOLOGY:

This community is the driest of the riparian communities sampled in the Bighorn Basin and extends farthest from the channel. But the water table must be seasonally high in order for the greasewood to occur at the high density and in the large area that it does. Since stands of this community occur so far above the stream channel, small changes in the depth to the water table are unlikely to have much effect on the vegetation. Changes in the vegetation are likely to come only from floods large enough to reach the higher surfaces or from changes in management. Hansen and others (1991) note that prolonged overgrazing reduces the amount of western wheatgrass and allows the annual brome grasses to increase.

OTHER CLASSIFICATIONS:

Although we sampled only one stand of black greasewood/western wheatgrass in the Bighorn Basin, it is a member of the same community described in eastern Wyoming (Jones and Walford 1995) and the same habitat type described in Montana (Hansen et al. 1995). This type has also been described from other studies in the Bighorn Basin (Hamner 1964; Olson and Gerhart 1982), in the Cheyenne River Basin (Thilenius and Brown 1990), and in the Laramie and Hanna Basins (Jones 1992), all in Wyoming.

A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) does not include references to this community. In the ecological land classification framework (Driscoll et al. 1984), stands of the *Sarcobatus vermiculatus /Elymus smithii* community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation.

Table 21. Percent canopy cover of species in the plot of the Black Greasewood/Western Wheatgrass *(Sarcobatus vermiculatus/Elymus smithii)* Communtiy.

Black Greasewood/Western Wheatgrass Community
(*Sarcobatus vermiculatus/Elymus smithii*)

Plot:	BUF 411
Shrubs	
native	
Artemisia tridentata	1
Sarcobatus vermiculatus	60
Graminoids (short)	
native	
Elymus smithii	20
Oryzopsis hymenoides	3
exotic	
Bromus tectorum	10
Poa pratensis	3
Forbs (short)	
native	
Opuntia polyacantha	1
exotic	
Kochia scoparia	1
Lepidium perfoliatum	10

Unclassified Black Greasewood Stand
(Unclassified *Sarcobatus vermiculatus* Stand)

One black greasewood stand sampled in Big Horn county was located in a similar environment as the other two black greasewood communities, although it is situated higher above the channel and may be verging on an upland type. The vegetation composition was a black greasewood sparse shrubland with very little understory. It had a very high percentage of exposed soil at the surface. There is no western wheatgrass, and only nine forbs and one grass species present, each with only one percent cover.

Silver Buffaloberry Series
(*Shepherdia argentea* Series)

One community of the silver buffaloberry series has been identified as a grazing disclimax, meaning that recurring disturbance of grazing maintains the structure and composition of the vegetation (Hansen et al. 1995). Our stand may be maintained by flood disturbance rather than by grazing. It occurs on a sloped bank and shows no evidence of grazing. Our stand has similar composition and is given the same classification name. Differences may be attributable to differences in the original community composition and structure.

Silver Buffaloberry Community
(*Shepherdia argentea* Community)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Two meter tall silver buffaloberry shrubs dominate the stand of the silver buffaloberry community (Tbl. 22). There is also a lower shrub layer composed of common chokecherry (*Prunus virginiana*), red-osier dogwood (*Cornus sericea*), and snowberry (*Symphoricarpos* spp.). A few narrowleaf cottonwood seedlings and saplings are present. Small amounts of other shrubs are present as well.

The herbaceous layer is dominated by poison ivy (*Toxicodendron rydbergii*). There are also fair amounts of Indian hemp dogbane (*Apocynum cannabinum*) and western virginsbower (*Clematis ligusticifolia*). Grasses are nearly non-existent.

This silver buffaloberry stand is a 10 to 16 ft (3- 5 m) wide fringe on a slope between a newly vegetated cobble bar and the upland terrace. The stand is discontinuous and extends the length of the inside meander bend.

LOCATION:

A single stand of silver buffaloberry was sampled along a free flowing, 165 ft (50 m) wide (Fig. 16), low gradient channel at an elevation of 4,310 ft (1,315 m) (Fig. 14). At this location the river is a fourth order perennial channel, draining a fairly large basin area (Fig. 15).

ENVIRONMENT:

The silver buffaloberry occurrence occupies the inside area of a 1 mile long gradual meander. This community is found at the outer-margin of the 250 ft (75 m) wide riparian zone (this includes the width of the channel). The stand is on a 30% slope ranging from 0 to 4 ft (0-

1.2 m) above bankfull level and averaging 16 ft (5 m) horizontal distance from the channel. The surface is quite rocky and gravelly with low amounts of litter covering the stand surface.

SOILS:

The surface of the silver buffaloberry stand is covered 75% by gravels, cobbles and small boulders. The soil horizons are sandy clay loam, over sandy loam, over loamy sand. Each of the three horizons, to 50 cm depth, had at least 50% coarse material indicating regular flooding.

The pH and electric conductivity of the surface horizon at the stand was 7.8 and 0.5 dS/m, respectively (Figs. 20 & 21). The high electric conductivity in any horizon of this stand was 1.3 dS/m at 18 cm.

EXOTICS:

There were no exotic species present in this silver buffaloberry stand. Compared to a similar community described from Montana (Hansen et al. 1995), this is a big difference. The Montana stands had an average 60% canopy cover of Kentucky bluegrass *(Poa pratensis).*

ADJACENT COMMUNITIES:

The portion of this silver buffaloberry stand closest to the channel is adjacent to a coyote willow (*Salix exigua*) community establishing on a gravel bar. At the upper level, the stand is adjacent to upland vegetation of Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*) and blue grama grass (*Bouteloua gracilis*).

ECOLOGY:

Silver buffaloberry is common along streams and moist terraces where soil is not too saline (Mozingo 1987). The shrub may also occur in non-riparian sites such as moist hillsides or valleys (Hansen et al. 1991). Hansen and others (1991) state that silver buffaloberry stands are grazing- or browsing-induced stages of green ash or boxelder woodlands; repeated heavy use opens the silver buffaloberry layer and allows western snowberry to form a more dense lower shrub layer (Hansen et al. 1991). We found no evidence that our Bighorn Basin silver buffaloberry stand was formerly a woodland. The Bighorn Basin stand occurs on a free flowing river. It is possible that floods help to maintain this community, as there was no evidence of grazing.

OTHER CLASSIFICATIONS:

The silver buffaloberry community was described from Montana (Hansen et al. 1995), with a similar dominance type sampled in eastern Wyoming (Jones and Walford 1995). The major species are similar; differences are most often related to exotic species being present or not.

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Shepherdia argentea* Community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Temperate Deciduous Shrubland Formation, *Shepherdia argentea* Alliance.

Table 22. Percent canopy cover of species in the plot of the Silver Buffaloberry *(Shepherdia argentea)* Community.

Silver Buffaloberry (*Sheperdia argentea*) Community

Plot:	CLA 412
Shrubs	
native	
Alnus incana	1
Cornus sericea	10
Populus angustifolia (sapling)	3
Prunus virginiana	10
Rhus trilobata	3
Rosa woodsii	3
Salix exigua	3
Salix lutea	3
Shepherdia argentea	40
Symphoricarpos sp.	10
Yucca glauca	3
Shrubs (dwarf)	
native	
Juniperus scopulorum (seedling	1
Populus angustifolia (seedling)	1
Graminoids (short)	
native	
Elymus canadensis	3
Forbs (tall)	
native	
Glycyrrhiza lepidota	3
Solidago gigantea	3
Forbs (short)	
native	
Apocynum cannabinum	10
Artemisia frigida	1

Table 22 (continued).

Silver Buffaloberry (*Sheperdia argentea*) Community

	Plot:	CLA 412
Equisetum hyemale		1
Maianthemum stellatum		3
Toxicodendron rydbergii		30
Vines		
native		
Clematis ligusticifolia		10

Chinese Tamarisk Series
(*Tamarix chinensis* Series)

This dominance type results from the introduction and naturalization of a single exotic species: Chinese tamarisk. The shrub is a strong competitor and easily replaces native vegetation. Few shrub stands of this type were found in the Bighorn Basin, one of which is described below. In the Bighorn Basin, Chinese tamarisk was more often found to be a major component of forest/woodland stands, namely the non-native Russian olive *(Elaeagnus angustifolia)* stands and sometimes the plains cottonwood *(Populus deltoides)* stands.

Chinese Tamarisk Community
(*Tamarix chinensis* Community)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

A continuous, 16 ft (5 m) wide band of Chinese tamarisk forms this stand (Tbl. 23). The tamarisk is fairly dense and generally difficult to walk through. The average height of the tamarisk is 7 ft (2m).

The understory is sparse due to the dense canopy of tamarisk. It is composed primarily of undesirable species including bobtail barley (*Hordeum caespitosum*), broadleaved peppergrass (*Lepidium latifolium*), and Swainsonpea (*Sphaerophysa salsula*).

LOCATION:

This Chinese tamarisk stand is the dominant community along a first order intermittent channel at 4,400 ft (1,340 m) elevation (Fig. 14) in Hot Springs county (Fig. 13). The site is located high in the drainage basin. The channel is low gradient and has low sinuousity; the stream segment is nearly straight at the location of this occurrence. Bank stability is high. There is an old beaver dam found on this stretch of stream, causing the channel to widen.

ENVIRONMENT:

This Chinese tamarisk community is located 3.2 ft (1 m) above the channel and almost 15 ft (4.5 m) away from the channel. In other sections of the occurrence, the tamarisk also is found immediately adjacent to the channel. Water was flowing in the channel in June; pools and riffles were apparent. The riparian zone ranged from 50 to 215 ft (15 - 20 m) wide and contained three communities present on both sides of the channel.

SOILS:

The surface soil texture was a silty clay loam to 15 cm deep, over loamy sand to 40 cm deep. The third horizon was silty clay loam to at least 55 cm deep.

The pH and electric conductivity of the surface horizon of our stand was 8.4 and 28.0 dS/m, respectively. The high electric conductivity in any horizon of this stand was at the surface. This relatively high electric conductivity indicates high salinity.

EXOTICS:

Moderate amounts of broadleaved peppergrass (*Lepidium latifolium*), and Swainsonpea (*Sphaerophysa salsula*) are in the understory of this dense shrub stand.

ADJACENT COMMUNITIES:

This Chinese tamarisk stand is separated from the channel by one or two narrow communities. The alkali cordgrass (*Spartina gracilis*) stand is immediately adjacent to the channel. Sometimes an inland saltgrass-broadleaved peppergrass (*Distichlis stricta-Lepidium latifolium*) stand is also between the tamarisk and the channel. The adjacent upland community is primarily dominated by black greasewood *(Sarcobatus vermiculatus).*

ECOLOGY:

Tamarisk was introduced from Eurasia as a shade tree and for erosion control. It has become naturalized along streams, canals, and reservoirs in much of the western United States (Whitson et al. 1991) and it is very difficult to eradicate once it has established. Chinese tamarisk are capable of growing in saline conditions and are now abundant in wet areas primarily in the southwest, whether saline or not. Tamarisk is known as a salt accumulator because it accumulates salt from the soil and excretes the salt onto its leaf surface. This causes salt to accumulate in the surface layer of soil, making the tamarisk even better able to compete with other plants (Mozingo 1987).

As evidenced from our site, Chinese tamarisk will move into an area and replace the native species. The adjacent communities had tamarisk seedlings establishing, suggesting the tamarisk stand will fill the surface up to the channel edge. Once established, the understory becomes inhospitable to many plants because of the increases in salinity and the dense overstory canopy. The understory of our Chinese tamarisk stand is composed predominantly of exotic or undesirable species.

OTHER CLASSIFICATIONS:

A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) does not include references to communities of this series. The *Tamarix*

chinensis community should be placed in the group containing `Anthropogenic alliances and plant associations'.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Tamarix chinensis* Series belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation.

Table 23. Percent canopy cover of species in the plot of the Chinese Tamarisk *(Tamarix chinensis)* Community.

Chinese Tamarisk (*Tamarix chinensis*) Community

Plot:	SAN 414
Shrubs	
exotic	
Tamarix chinensis	90
Graminoids (tall)	
native	
Elymus cinereus	1
Graminoids (short)	
native	
Elymus trachycaulus	3
Hordeum caespitosum	20
Sporobolus airoides	1
Forbs (tall)	
native	
Epilobium angustifolium	1
exotic	
Lepidium latifolium	10
Forbs (short)	
exotic	
Sphaerophysa salsula	10

Forest and Woodland Physiognomic Types

Riparian forest and woodland types have tree canopy cover of at least 10%. The tree cover is usually patchy; a riparian woodland often consists of groves of trees separated by grassy openings or shrub stands. In the Bighorn Basin, large stands with dense, continuous canopy cover are rare along the small and medium channels. Along small streams, the woodlands may occur as small groves on the insides of meanders. Along large streams, woodlands often form long, narrow stands marking the edges of the modern channel or old channels. The structure of the vegetation varies from dense stands of young trees to open, park-like stands of old trees. Trees also occur as scattered individuals in riparian zones, but the cover may be too small to consider this a forest or a woodland. In cottonwood stands, the trees are all about the same size and the same age.

From the point of view of vegetation structure, sapling stands belong with shrub types and seedling stands belong with dwarf-shrub types. Stands of tree seedlings and saplings are discussed in this section of our report because they are the early steps in a sequence leading to forest and woodland types.

In our forest and woodland physiognomic type, we have grouped together tree-dominated stands that fall into three vegetation classes of the interagency land classification framework of Driscoll and others (1984): the forest class (tree canopy cover of 61 to 100%); the woodland class (tree canopy cover of 26 to 60%); and the herbaceous class, medium-tall grassland subclass, medium-tall grassland with a tree layer group (tree canopy cover of 11 to 25%). Within the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979), the stands of our forest and woodland physiognomic types belong to the Palustrine System, Forested Wetland Class, Broad-leaved Deciduous Subclass.

Twenty-seven forest/woodland stands were sampled throughout the Bighorn Basin (Fig. 22). Stands within the forest/woodland physiognomic type have been classified into series defined by the dominant or diagnostic species. Within the series, we identify the plant community based on existing vegetation structure and composition. The process of classification in this project uses attributes of the vegetation (physiognomy, structure and floristics) as well as some non-vegetation attributes such as soil properties and landform position. The following graphs (Fig. 23-30) illustrate the environmental characteristics at the sites where the forest/woodland plant communities or series were sampled. Each forest/woodland stand is represented on the graphs and identified by its community (or series) acronym; the value of the environmental attribute at the stand is displayed. The following acronyms used in the graphs correspond with the following plant communities or series:

BETOCC/CORSER = Water Birch/Red-Osier Dogwood (*Betula occidentalis/Cornus sericea*) Community

POPANG/RHUTRI = Narrowleaf Cottonwood/Skunkbush Sumac *(Populus angustifolia/ Rhus trilobata)* Community

POPANG/SALLUT = Narrowleaf Cottonwood/Yellow Willow *(Populus angustifolia/Salix lutea)* Community (tentative)

POPANG bar= Narrowleaf Cottonwood *(Populus angustifolia)*/ Recent Alluvial Bar

POPDEL/ARTTRI = Plains Cottonwood/Basin Big Sagebrush *(Populus deltoides/Artemisia tridentata* var. *tridentata)* Community

POPACU = Lanceleaf Cottonwood *(Populus acuminata)* Series

POPspp = Mixed Cottonwood *(Populus* spp.) Series

ACENEG/PRUVIR = Boxelder/Common Chokecherry *(Acer negundo/Prunus virginiana)* Community

ELAANG = Russian Olive *(Elaeagnus angustifolia)* Series

Figure 22. Location of forest/woodland stands within Bighorn Basin.

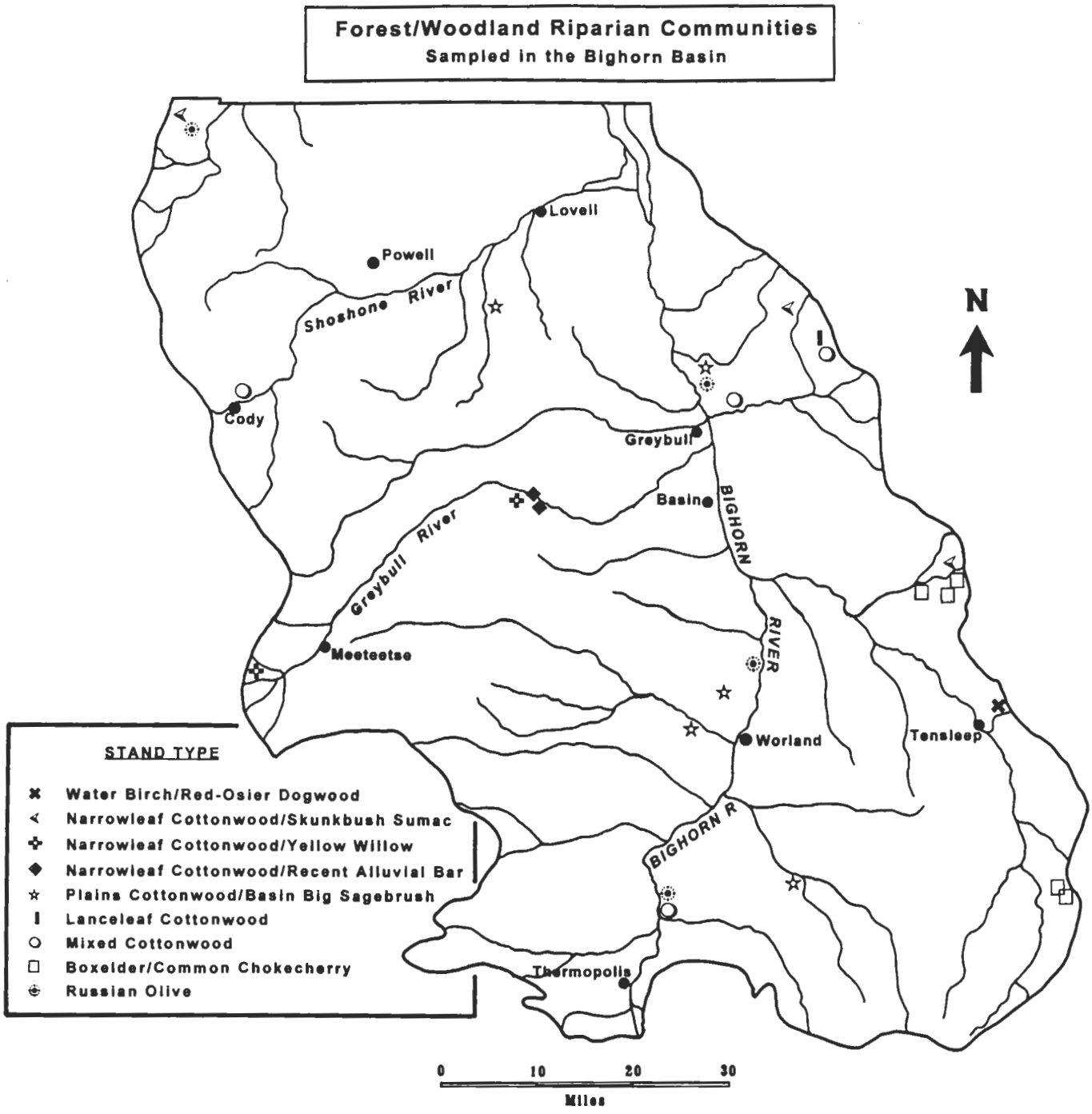


Figure 23. Elevation at sites according to the forest/woodland stand type.

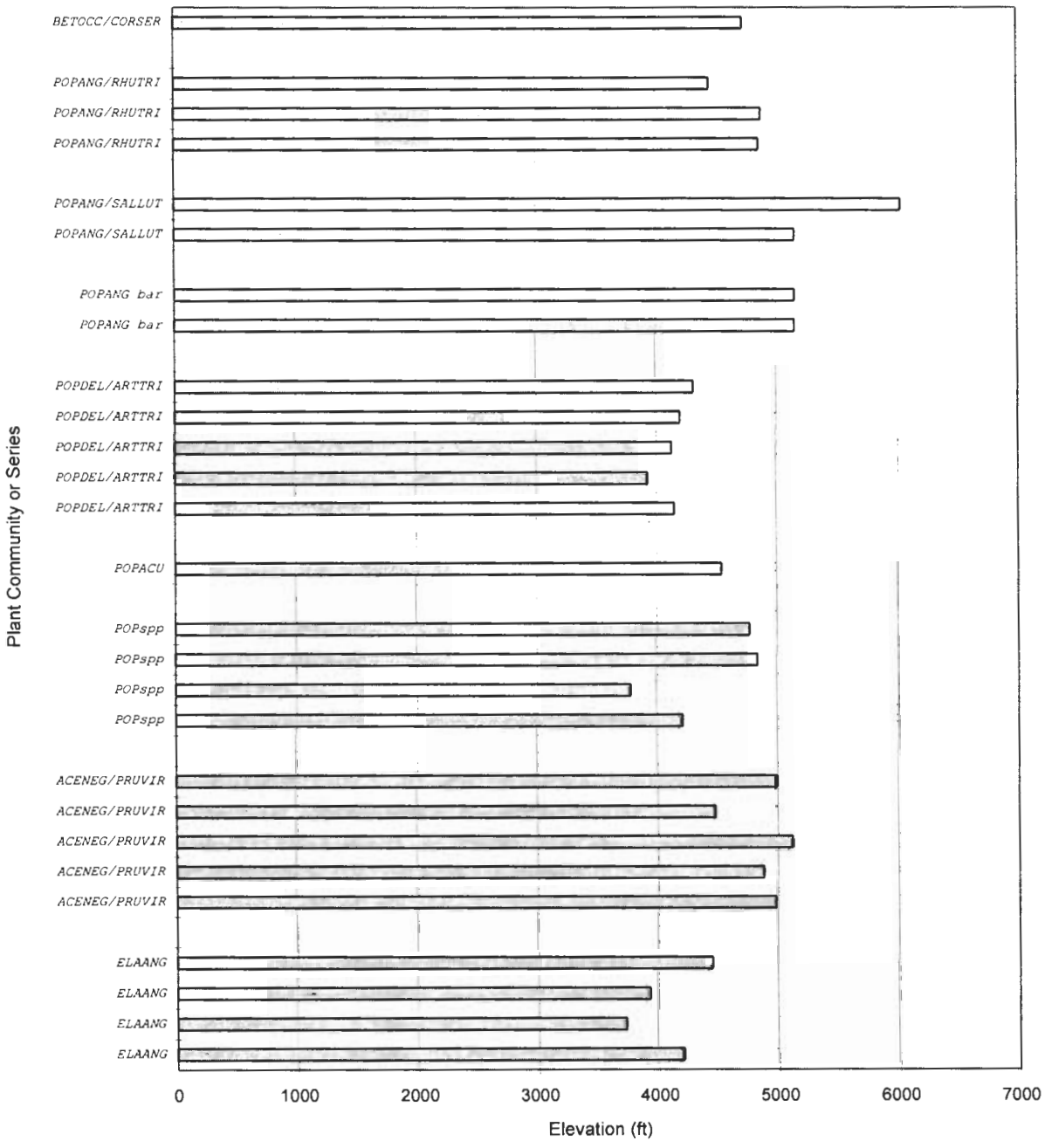


Figure 24. Drainage basin area above sites according to the forest/woodland stand type.

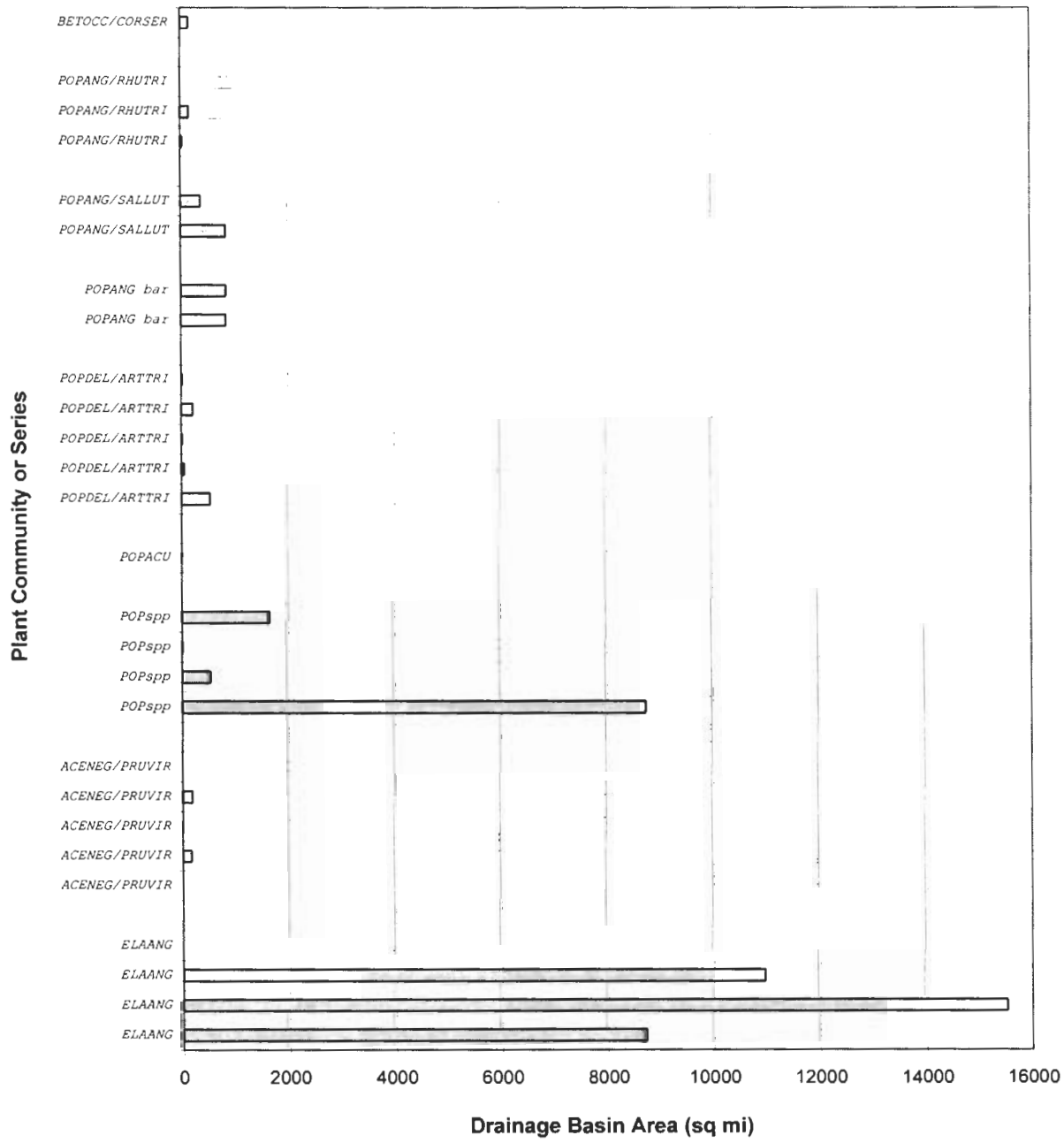


Figure 25. Channel width nearest each plot according to the forest/woodland stand type.

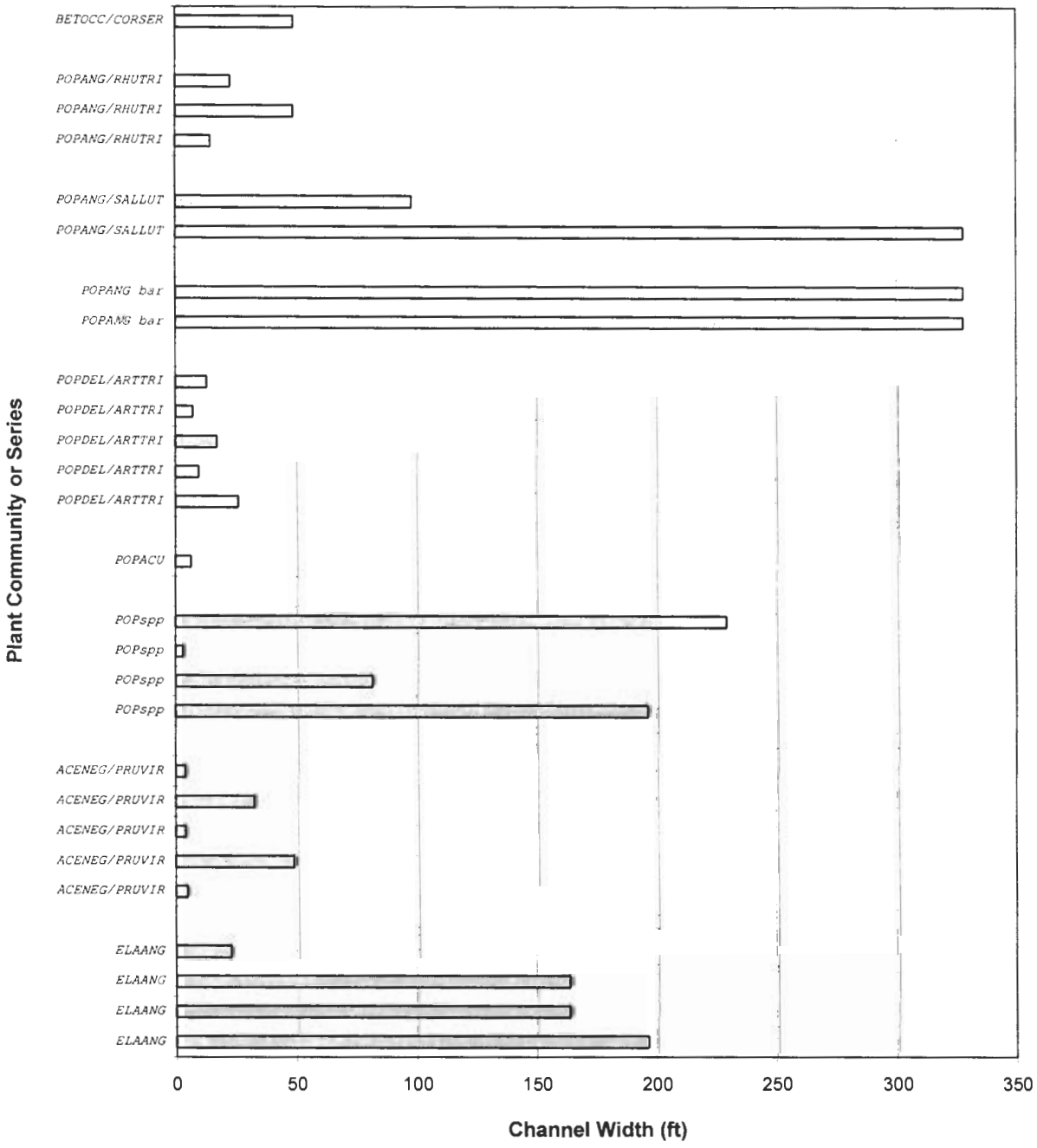


Figure 26. Channel depth nearest each plot according to the forest/woodland stand type.

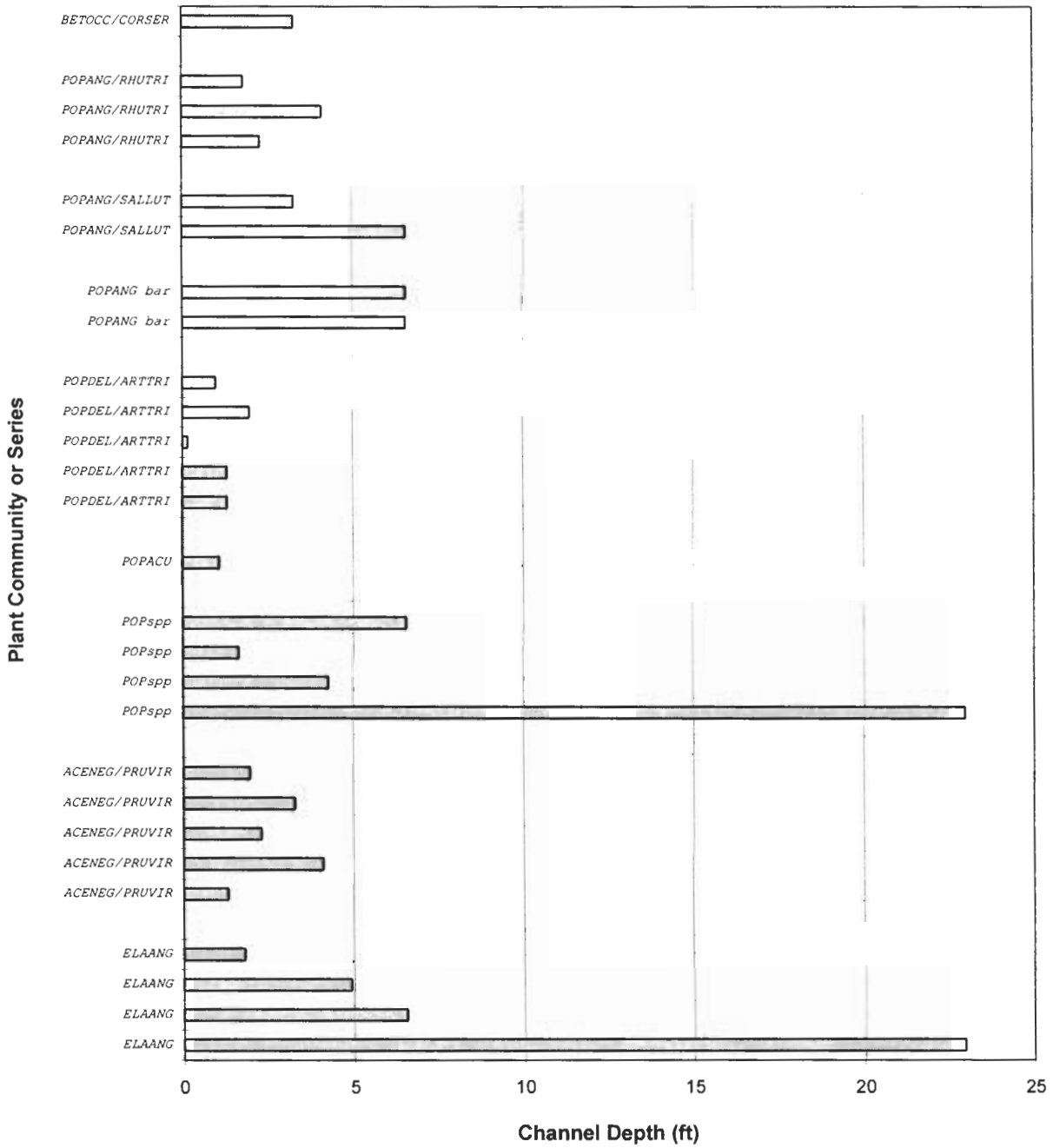


Figure 27. Distance of stands from channel according to the forest/woodland stand type.

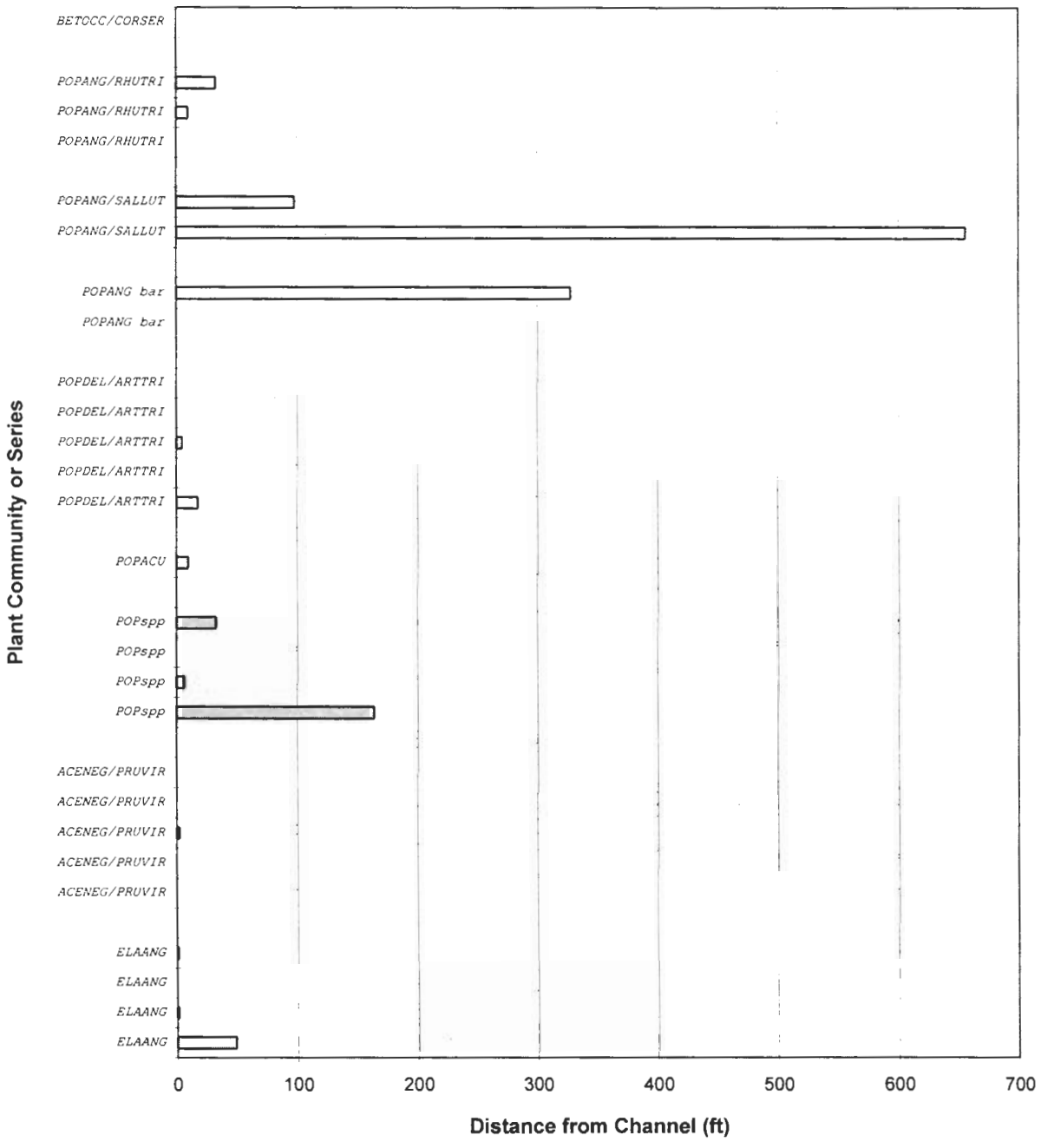


Figure 28. Height of stands above bankfull channel according to the forest/woodland stand type.

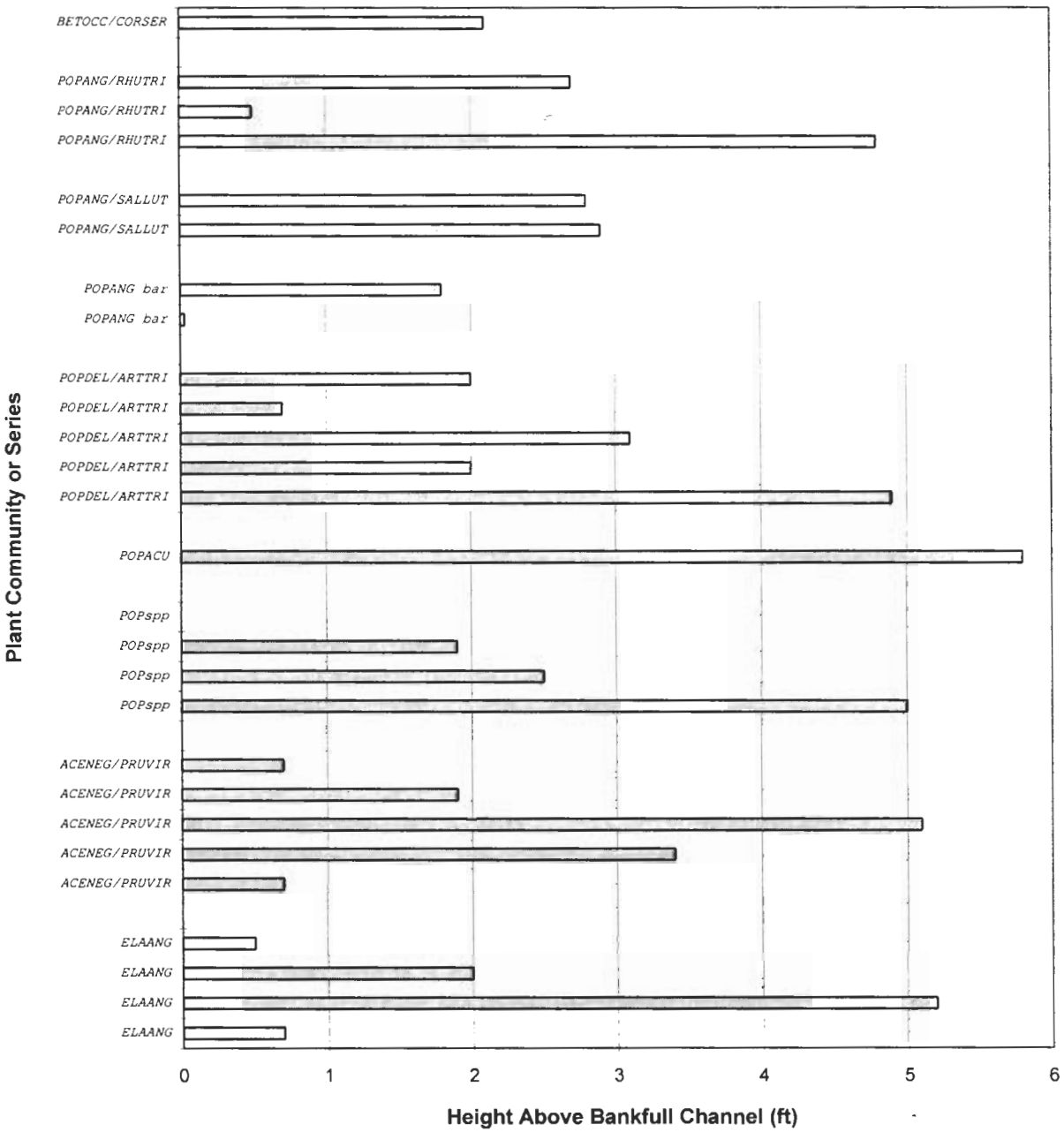


Figure 29. Electric conductivity of the surface soil horizon in stands according to the forest/woodland stand type.

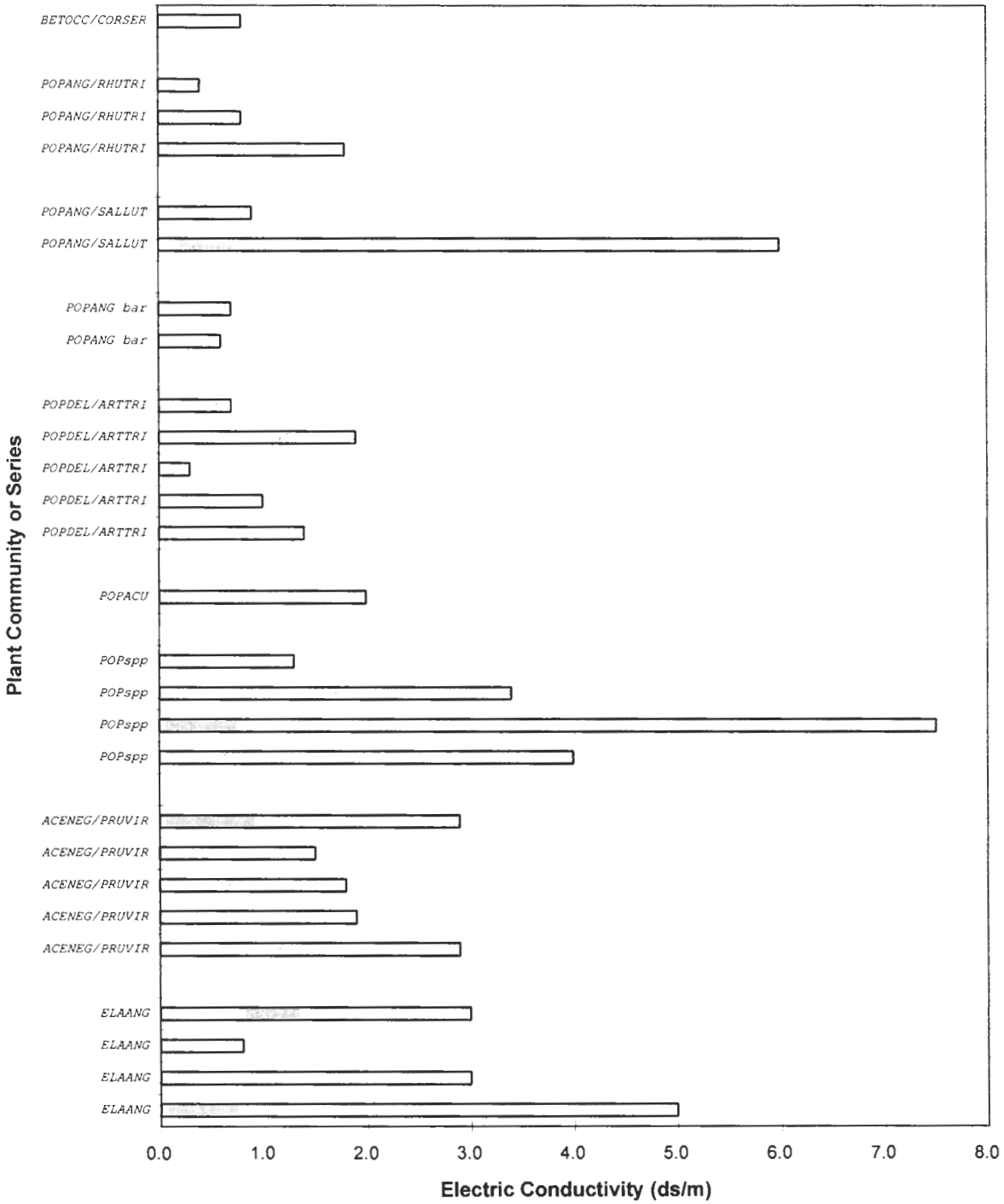
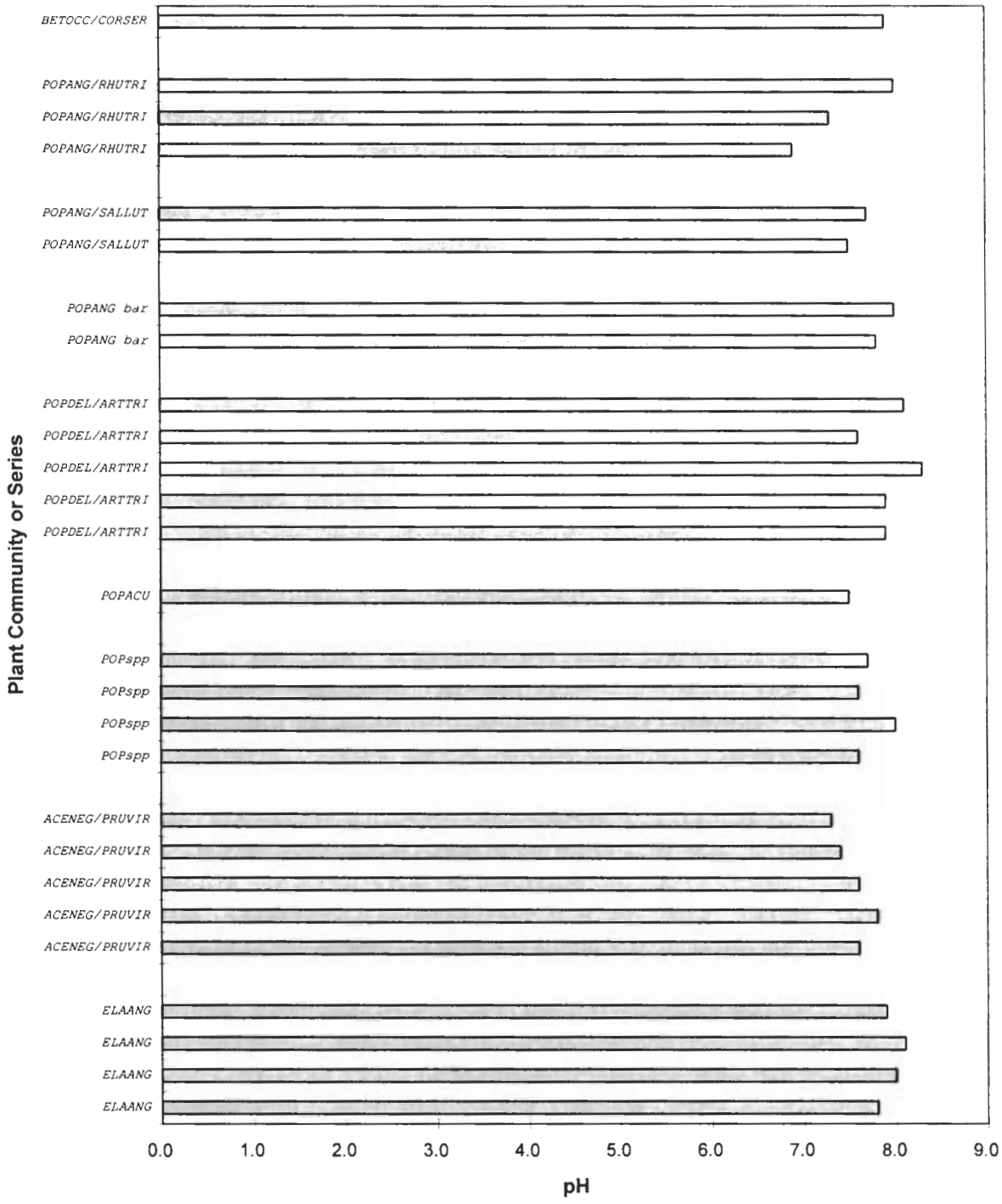


Figure 30. pH of surface soil horizon in stands according to the forest/woodland stand type.



Water Birch Series
(*Betula occidentalis* Series)

Water birch is a small, shrubby tree, growing 20 to 25 ft (6 - 7.5 m) tall and 1 ft (0.3 m) in diameter, with a broad, open crown. Communities identified within the water birch series have been placed in the shrubland class by some, and in the forest/woodland class by others. One stand of water birch/red-osier dogwood was sampled in the Bighorn Basin. It is referred to by the same name as the similar, previously described, water birch/red-osier dogwood community of Utah and Idaho (Padgett et al. 1989). The community is known to occupy streambanks and terraces immediately adjacent to streams.

Water Birch/Red-Osier Dogwood Community
(*Betula occidentalis/Cornus sericea* Community)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

The water birch/red-osier dogwood stand is densely vegetated at all levels. The overstory is dominated by 16.5 ft (5 m) tall water birch, with an occasional taller narrowleaf cottonwood *(Populus angustifolia)* tree (Tbl. 24). The few narrowleaf cottonwood trees are usually found immediately adjacent to the channel. Also within the upper layer are some boxelder (*Acer negundo*) trees.

The sub-canopy is dominated by red-osier dogwood, in amounts equal to that of the water birch. Mixed with this, there are smaller amounts of Wood's rose *(Rosa woodsii)*, whiplash willow (*Salix lasiandra*), and yellow willow (*Salix lutea*).

The herbaceous layer is also dense. It is composed of a 4 to 6 ft (1.2 - 1.8 m) tall layer of Joe Pye weed (*Eupatorium maculatum*), Canada goldenrod (*Solidago canadensis*), Canada thistle (*Cirsium arvense*), and Nuttall's sunflower (*Helianthus nuttallii*). A 2 ft (0.6 m) tall grass layer is dominated by Kentucky bluegrass (*Poa pratensis*). There is also a lot of carpet bentgrass (*Agrostis stolonifera*), and almost no other grass species to be found.

The water birch/red-osier dogwood stand occupies most of the riparian zone for over one mile of stream length. It is found on both sides of the channel as well as on the mid-channel island.

LOCATION:

One stand of water birch/red-osier dogwood was sampled at the east edge of the Bighorn Basin in Washakie county (Fig. 22), at 4,730 ft (1,440 m) elevation (Fig. 23). The stand is located adjacent to a third order perennial channel, draining 160 sq mi of basin area (Fig. 24).

The valley is constricted by bedrock outcrops of sandstone and dolomite, forcing the channel to have tight meanders. At this site, the channel has a 2% gradient, which is greater than most Bighorn Basin channels that were sampled in this project.

ENVIRONMENT:

The channel is branched at the site of this occurrence; each branch is 50 to 65 ft (15 - 20 m) wide and 3.3 ft (1 m) deep (Figs. 25 & 26). The channel bed material ranges from gravel to large, boulder size particles. The channel banks are well stabilized by vegetation and boulders.

The water birch/red-osier dogwood occurrence is found on all of the first surface, 2 ft (0.6 m) above the bankfull channel (Fig. 28). On both sides, shrubs and trees overhang the channel nearly meeting at the center.

SOILS:

There are two soil horizons from the surface to 55 cm depth. Soil textures are sandy clay over sandy loam. Coarse particles make up 5% of the lower horizon.

The pH and electric conductivity of the surface horizon of this one stand was 7.9 and 0.8 dS/m, respectively (Figs. 29 & 30). The high electric conductivity in any horizon of this stand was 0.8 dS/m at the surface.

EXOTICS:

In this stand of water birch/red-osier dogwood, the grasses primarily consist of the introduced Kentucky bluegrass and carpet bentgrass. This lack of native palatable grasses is indicative of heavy grazing. The forbs present are primarily native, with the exception of Canada thistle.

ADJACENT COMMUNITIES:

The water birch/red-osier dogwood stand occurs adjacent to the channel. The adjacent upland is steep and vegetated with yucca (*Yucca glauca*), Rocky Mountain juniper (*Juniperus scopulorum*), and upland grasses.

ECOLOGY:

The water birch/red-osier dogwood community is especially beneficial to fish. The stream is shaded and cooled by the dense overhanging vegetation. The dense rooting nature of red-osier dogwood and water birch provide much stabilization to streambanks and allows the creation of overhang habitat for fish (Padgett et al. 1989). The red-osier dogwood propagates vegetatively by rooting at intervals along horizontal stems (Mozingo 1987).

The density of the vegetation decreases use of this community by livestock and wild ungulates. The vegetation provides much perching and nesting habitat for birds (Padgett et al.

1989). Evidence of prior heavy grazing is shown by decrease in the more palatable native graminoids, with replacement by introduced or nonpalatable native species (Hansen et al. 1995).

This stand of water birch/red-osier dogwood will probably become more heavily dominated by the boxelder, with the same vegetation in the understory. In other sites, this community may be successional to conifers such as Douglas-fir (*Pseudotsuga menziesii*) or Colorado blue spruce (*Picea pungens*), or to deciduous trees such as narrowleaf cottonwood (*Populus angustifolia*), aspen (*Populus tremuloides*), or the boxelder.

OTHER CLASSIFICATIONS:

This water birch/red-osier dogwood stand is similar to the water birch/red-osier dogwood community found throughout Utah and southeastern Idaho (Padgett et al. 1989). This same community is also referred to as the *Betula occidentalis* Community Type in Montana (Hansen et al. 1995).

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Betula occidentalis/Cornus sericea* Community belong to the Shrubland Class, Mainly Deciduous Shrubland Subclass, Cold-Deciduous Shrubland Group, Deciduous Alluvial Shrubland Formation, *Betula occidentalis* Alliance.

Table 24. Percent canopy cover of species in the plot of the Water Birch/Red-Osier Dogwood *(Betula occidentalis/Cornus sericea)* Community.

Water Birch/Red-Osier Dogwood Community
(*Betula occidentalis/Cornus sericea*)

Plot:	TEN 411
Trees	
native	
Acer negundo	10
Juniperus scopulorum	1
Populus angustifoila	1
Shrubs	
native	
Betula occidentalis	40
Cornus sericea	40
Prunus virginiana	3
Ribes oxyacanthoides	3
Rosa woodsii	10

Table 24 (continued).

Water Birch/Red-Osier Dogwood Community
(*Betula occidentalis/Cornus sericea*)

	Plot: TEN 411
Salix lasiandra	10
Salix lutea	3
Symphoricarpos sp.	10
Graminoids (tall)	
native	
Scirpus pallidus	1
Graminoids (short)	
native	
Elymus glaucus	1
exotic	
Agrostis stolonifera	20
Poa pratensis	50
Forbs (tall)	
native	
Eupatorium maculatum	20
Glycyrrhiza lepidota	1
Helianthus nuttallii	3
Solidago canadensis	20
exotic	
Cirsium arvense	10
Forbs (short)	
native	
Apocynum cannabinum	3
Artemisia ludoviciana	1
Aster ciliolatus	1
Equisetum arvense	3
Equisetum hyemale	3
Habenaria hyperborea	1
Maianthemum stellatum	10
Toxicodendron rydbergii	10
exotic	
Rumex crispus	1
Vines	
native	
Vitis riparia	20

Narrowleaf Cottonwood Series
(*Populus angustifolia* Series)

Narrowleaf cottonwood occurs in the high intermountain basins. Outside the Bighorn Basin, its range continues up into the foothill and montane environments. Three communities within the narrowleaf cottonwood series were identified from the Bighorn Basin. Communities within the narrowleaf cottonwood series are dominated by fairly even-aged stands of narrowleaf cottonwood trees. We did not date trees, but used size class as an indicator of relative age. Some mixing of tree sizes occurs because narrowleaf cottonwood has the ability to sprout adventitious shoots on roots. This gives the appearance of regeneration, but this asexual reproduction is not sufficient to perpetuate or maintain the stand. In time and without flood events to create stream bars suitable for seedling establishment, the cottonwood stand will be be replaced by box-elder *(Acer negundo),* green ash *(Fraxinus pennsylvanica),* or conifers.

Narrowleaf Cottonwood/Skunkbush Sumac Community
(*Populus angustifolia/Rhus trilobata* Community)

(3 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Stands of the narrowleaf cottonwood/skunkbush sumac community, have an upper canopy dominated by narrowleaf cottonwood trees (Tbl. 25) growing 30 to 60 ft (9 -18 m) tall. This layer may be shared with lanceleaf cottonwood (*Populus acuminata*). *Populus acuminata* is considered to be a hybrid between *Populus angustifolia and P. deltoides* (Hitchcock and Cronquist 1973). The narrowleaf cottonwood trees are generally in the small to large size classes; the site on the smallest channel also has a lot of seedlings present. All three stands had dead standing or fallen cottonwood trees, contributing to the higher percent cover of wood on the plot surfaces.

The subcanopy usually has significant amounts of Rocky Mountain juniper (*Juniperus scopulorum*) averaging 15 feet tall. The next understory layer is a dense complex of shrubs which is usually dominated by skunkbush sumac (*Rhus trilobata).* The skunkbush may be more abundant at the outer edge of the occurrence. There can also be large amounts of common chokecherry (*Prunus virginiana*) or water birch (*Betula occidentalis*). Snowberry (*Symphoricarpos* sp.), a low shrub, is present in moderate amounts at two stands.

The herbaceous layer tends to have many species present in low amounts (< 5% cover). The most abundant grasses are Kentucky bluegrass (*Poa pratensis*) present in all stands, and common orchardgrass (*Dactylis glomerata*) at one stand. American licorice (*Glycyrrhiza lepidota*)

occurs in all stands. The vine, western virginsbower (*Clematis ligusticifolia*), is abundant at all our stands and possibly a stress to the juniper and chokecherry.

The stands tend to parallel the channel in continuous strips, occasionally interrupted by shrub stands. The occurrence is found on both sides of the channel and ranges from 2.5 to 25 acres (1 - 10 ha) in area.

LOCATION:

Sites containing stands of the narrowleaf cottonwood/skunkbush sumac community were located between 4,450 and 4,880 feet (1,360 - 1,490 m) elevation (Fig. 23) in Big Horn and Park counties (Fig. 22). Sites were found on first, second and third order perennial channels with small upstream drainage basin areas (Fig. 24). Channels were high gradient and ranged in width from 15 to 50 ft (5 - 15 m). One of the channels was branched.

ENVIRONMENT:

These narrowleaf cottonwood/skunkbush sumac stands occur on the second surface above the channel, which is usually the first terrace. This surface is relatively level and ranges in its height above the channel from 0.5 to 5 ft (0.2 to 1.5 m). The stands vary in being adjacent to and 4.8 ft (1.5 m) above the channel, to being 10 ft (3 m) away from the channel and 0.5 ft (0.1 m) above the channel (Figs. 27 & 28). The channels often have short, tight meanders. At one site, an old dry channel passes through the occurrence.

SOILS:

Loamy sands and clay loams were the most common textures of the two to three horizons at each narrowleaf cottonwood/skunkbush sumac stand. At one stand there were also silty loam and sandy clay loam textures.

The pH and electric conductivity of the surface horizon of our three stands ranged from 6.9 to 8.0 and 0.4 to 1.8 dS/m, respectively (Figs. 29 & 30). The high electric conductivity in any horizon of this community was 1.8 dS/m at the surface horizon.

EXOTICS:

The dominant grasses of the narrowleaf cottonwood/skunkbush sumac community are introduced species and include Kentucky bluegrass, common orchardgrass, cheatgrass brome (*Bromus tectorum*) and smooth brome (*B. inermis*). Canada thistle (*Cirsium arvense*) is present in two of the three stands. Other exotic forbs are present in very low amounts.

ADJACENT COMMUNITIES:

These narrowleaf cottonwood/skunkbush sumac stands are often adjacent to the channel. At the inside meanders there can be an adjacent, intermittent, narrow herbaceous

strip on the first surface. The stands are adjacent on the upland side to big sagebrush (*Artemisia tridentata*), some Rocky Mountain juniper, and upland grasses.

ECOLOGY:

This community of narrowleaf cottonwood/skunkbush sumac established under riparian conditions, but it is changing toward a more upland condition with some upland plants establishing. The sites are no longer suitable to the germination and establishment of new individuals of cottonwood. In the Bighorn Basin, this community is probably early successional to an upland Rocky Mountain juniper site.

Narrowleaf cottonwood are considered to be pioneer species because they colonize gravel bars. Flood events are important in creating new sites suitable for cottonwood seedling establishment (Rood and Mahoney 1990). The surface layer of soil must remain moist for development and survival of narrowleaf cottonwood seedlings, because of slow seedling root growth (Moss 1938). The communities of narrowleaf cottonwood are seral, and maintenance of the complex of different age stands requires that the stream flood enough to deposit new alluvial bars on which new trees can grow.

Asexual reproduction of narrowleaf cottonwood trees can occur by the formation of adventitious shoots on roots (suckering). This is a common form of reproduction and is stimulated by disturbances such as cutting or fire. The presence of cottonwood seedlings at one stand was likely the result of suckering. The lack of sucker establishment at the other two sites is possibly related, in part, to livestock browsing or trampling (Padgett et al. 1989).

Skunkbush sumac is reported to be fair to poor browse for deer, and poor to useless browse for livestock. Skunkbush sumac can regenerate by sprouting; it is capable of colonizing large areas and increasing its cover following fire (Sampson and Jespersen 1963 in Padgett et al. 1989).

OTHER CLASSIFICATIONS:

A similar *Populus angustifolia/Rhus aromatica* (syn. *R. trilobata*) community type is described from Utah (Padgett et al. 1989). Differences in their stands are the absence of Rocky Mountain juniper and common chokecherry. The Utah stands are adjacent to uplands often dominated by *Juniperus osteosperma*.

In Colorado this type was found frequently in the San Miguel/Dolores River Basin (Kittel and Lederer 1993). Stands were in similar habitat, adjacent to pinon-juniper forests or big sagebrush and rubber rabbitbrush.

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Populus angustifolia/Rhus trilobata* Community belong to the Closed

Forest Class, Mainly Deciduous Forest Subclass, Cold Deciduous Forest Without Evergreen Trees Group, Cold-Deciduous Alluvial Forest Formation, *Populus angustifolia* Alliance.

Table 25. Percent canopy cover of species in plots of the Narrowleaf Cottonwood/Skunkbush Sumac *(Populus angustifolia/Rhus trilobata)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Narrowleaf Cottonwood/Skunkbush Sumac Community
(*Populus angustifolia/Rhus trilobata*)

Plots:	LIN 411	PNR 412	BEV 411	**AVG % COV**	**CONST %**
Trees					
native					
Juniperus scopulorum	3	30	40	**24**	**100**
Populus acuminata	10	-	-	**10**	**33**
Populus angustifolia	20	40	20	**27**	**100**
exotic					
Elaeagnus angustifolia	-	-	1	**1**	**33**
Shrubs					
native					
Artemisia cana	1	-	-	**1**	**33**
Artemisia tridentata	3	-	-	**3**	**33**
Betula occidentalis	3	-	50	**27**	**67**
Pinus flexilis sapling	-	-	1	**1**	**33**
Populus angustifolia (sapling)	1	-	-	**1**	**33**
Prunus virginiana	-	60	10	**35**	**67**
Rhus trilobata	30	10	50	**30**	**100**
Ribes aureum	-	-	1	**1**	**33**
Ribes inerme	-	-	1	**1**	**33**
Ribes oxyacanthoides	1	3	-	**2**	**67**
Rosa sp. (R. sayi or woodsii)	3	3	3	**3**	**100**
Salix exigua	-	-	1	**1**	**33**
Salix lasiandra	-	-	1	**1**	**33**
Salix lutea	-	-	3	**3**	**33**
Shepherdia argentea	1	-	-	**1**	**33**
Symphoricarpos sp.	-	20	10	**15**	**67**
Shrubs (dwarf)					
native					
Gutierrezia sarothrae	3	-	-	**3**	**33**
Juniperus scopulorum (seedling	-	3	3	**3**	**67**
Mahonia repens	-	3	-	**3**	**33**
Populus angustifolia (seedling)	3	3	-	**3**	**67**

Table 25 (continued).

Narrowleaf Cottonwood/Skunkbush Sumac Community
(*Populus angustifolia/Rhus trilobata*)

Plots:	LIN 411	PNR 412	BEV 411	AVG % COV	CONST %
Graminoids (tall)					
native					
Elymus cinereus	-	1	-	**1**	**33**
exotic					
Bromus inermis	1	3	-	**2**	**67**
Graminoids (short)					
native					
Bouteloua gracilis	3	-	-	**3**	**33**
Elymus canadensis	-	3	-	**3**	**33**
Elymus smithii	1	-	-	**1**	**33**
Juncus balticus	1	-	1	**1**	**67**
Muhlenbergia asperifolia	3	-	-	**3**	**33**
Oryzopsis hymenoides	1	-	-	**1**	**33**
Stipa comata	1	-	-	**1**	**33**
exotic					
Bromus tectorum	3	1	-	**2**	**67**
Dactylis glomerata	-	10	-	**10**	**33**
Elymus repens	-	3	-	**3**	**33**
Poa pratensis	1	20	20	**14**	**100**
Forbs (tall)					
native					
Asclepias speciosa	-	-	1	**1**	**33**
Chenopodium rubrum	1	-	-	**1**	**33**
Glycyrrhiza lepidota	3	3	10	**5**	**100**
Oenothera villosa	1	-	-	**1**	**33**
Urtica dioica	-	1	-	**1**	**33**
exotic					
Asparagus officinalis	1	-	1	**1**	**67**
Cirsium arvense	-	3	3	**3**	**67**
Melilotus officinalis	1	-	1	**1**	**67**
Forbs (short)					
native					
Artemisia frigida	3	-	-	**3**	**33**
Aster ericoides	1	-	-	**1**	**33**
Cirsium flodmanii	1	-	-	**1**	**33**
Cleome serrulata	-	1	-	**1**	**33**

Table 25 (continued).

Narrowleaf Cottonwood/Skunkbush Sumac Community
(*Populus angustifolia/Rhus trilobata*)

Plots:	LIN 411	PNR 412	BEV 411	AVG % COV	CONST %
Conyza canadensis	1	-	-	**1**	**33**
Cryptantha celosioides	1	-	-	**1**	**33**
Cymopterus terebinthinus	1	-	-	**1**	**33**
Equisetum laevigatum	1	-	1	**1**	**67**
Fabaceae sp.2	1	-	-	**1**	**33**
Grindelia squarrosa	1	1	-	**1**	**67**
Heterotheca villosa	1	-	-	**1**	**33**
Lithospermum ruderale	-	1	-	**1**	**33**
Machaeranthera canescens	1	-	-	**1**	**33**
Maianthemum stellatum	-	3	3	**3**	**67**
Opuntia polyacantha	1	1	-	**1**	**67**
Oxytropis sericea	1	-	-	**1**	**33**
Solidago simplex	1	-	-	**1**	**33**
Toxicodendron rydbergii	-	3	-	**3**	**33**
exotic					
Taraxacum officinale	1	-	1	**1**	**67**
Tragopogon dubius	1	-	-	**1**	**33**
Trifolium repens	-	-	1	**1**	**33**
Vines					
native					
Clematis ligusticifolia	10	30	10	**17**	**100**

Narrowleaf Cottonwood/Yellow Willow Community tentative
(*Populus angustifolia/Salix lutea* Community tentative)

(2 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Narrowleaf cottonwood dominates the overstory in stands of the narrowleaf cottonwood/yellow willow community (Tbl. 26). The occurrence located on a mid-channel island is probably younger, as its trees are commonly sapling, pole and small size. The trees at the terrace occurrence are medium and large, in addition to the previous sizes. There is also some cover provided by medium size peachleaf willow trees (*Salix amygdaloides*) in the terrace stand.

The shrub layer is a mix of 5 to 6 species, with the 15 ft (4.5 m) tall yellow willow being the most abundant. Other common shrubs at both stands are: whiplash willow (*Salix lasiandra*), Canada gooseberry (*Ribes oxyacanthoides*), rose (*Rosa* sp.), and silver buffaloberry (*Shepherdia argentea*).

The herbaceous layer is dominated by American licorice (*Glycyrrhiza lepidota*) and Canada thistle (*Cirsium arvense*). Introduced grasses are most common, including carpet bentgrass (*Agrostis stolonifera*), Kentucky bluegrass (*Poa pratensis*), and smooth brome (*Bromus inermis*).

The terrace occurrence is a long linear patch averaging 60 ft (18 m) wide. The surface is hummocky, probably due to fallen trees. On the island, this is the most common community; it also has a wide linear shape. At both stands, besides the basal vegetation, the surface is primarily covered with exposed soil and litter. There is some wood covering the surface as well.

LOCATION:

Sites sampled containing the narrowleaf cottonwood/yellow willow community were located on major, third and fourth order, perennial drainages in Park county (Fig. 22) between 5,100 and 6,000 ft (1,570 - 1,840 m) elevation (Fig. 23). The river is low gradient with a wide area of multiple channels. The sites are fairly high in the drainage basins with the drainage basin area ranging from 400 to 850 sq mi.

ENVIRONMENT:

One narrowleaf cottonwood/yellow willow stand occurs on a mid-channel island; the other occurs on a terrace adjacent to uplands. Both stands were 3 ft (1 m) above the channel, but they varied in their distance from the channel (Figs. 27 & 28). The island stand was 100 ft (30 m) from the channel; the terrace stand was 650 ft (200 m) from the channel. The channels

are branched at the sites and the stands are closer to the overflow channels than to the main channels. The respective stands are 65 ft (18 m) and 100 ft (39 m) from the the overflow channel. Sediments deposited around trees and shrubs is evidence of high flows. According to landowners, both sites were flooded in 1963.

SOILS:

Soil textures ranged from sandy loams to clay loams and silty clay loams. The pH of the surface horizon of our two stands was 7.5 and 7.7, and the electric conductivity was 6.0 and 0.9 dS/m, respectively (Figs. 29 & 30). The high electric conductivity in any horizon of this community was 6.5 dS/m at 9 cm depth.

EXOTICS:

The dominant grasses in the narrowleaf cottonwood/yellow willow stands are introduced species: Kentucky bluegrass, carpet bent-grass and smooth brome. Exotic forbs with more than 5% cover and present at both stands include: Canada thistle, common dandelion (*Taraxacum officinale*), and white clover (*Trifolium repens*).

ADJACENT COMMUNITIES:

The island narrowleaf cottonwood/yellow willow occurrence is adjacent to a stand of white sweet-clover (*Melilotus albus*) and sedge, closer to the channel. The terrace stand is adjacent to a lower terrace with sapling and pole size trees; it is adjacent to a higher terrace that is primarily a hay meadow.

ECOLOGY:

Narrowleaf cottonwood are considered to be pioneer species because they colonize gravel bars. Flood events are important in creating new sites suitable for cottonwood seedling establishment (Rood and Mahoney 1990). The surface layer of soil must remain moist for development and survival of narrowleaf cottonwood seedlings, because of slow growth of the seedling root (Moss 1938).

Stands of narrowleaf cottonwood tend to be even aged because the trees establish at approximately the same time when sites become suitable. This narrowleaf cottonwood/yellow willow community is very similar in vegetation composition but the stands appear to be different ages as suggested by the tree sizes and the locations. The island trees average pole size (5-9 inch diameter) and the terrace trees average medium size (14-21 inch diameter). This suggests that the narrowleaf cottonwood/yellow willow community persists for a fair period of time. The few seedlings and saplings on the terrace site are likely root suckers (adventitious shoots on roots).

The communities of narrowleaf cottonwood are seral, and maintenance of the complex of different age stands requires that the stream flood enough to deposit new alluvial bars on which new trees can grow.

OTHER CLASSIFICATIONS:

No references were found for a narrowleaf cottonwood/yellow willow community. It is suggested that more stands of this type be looked for and sampled.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Populus angustifolia/Salix lutea* Community belong to the Closed Forest Class, Mainly Deciduous Forest Subclass, Cold Deciduous Forest Without Evergreen Trees Group, Cold-Deciduous Alluvial Forest Formation, *Populus angustifolia* Alliance.

Table 26. Percent canopy cover of species in plots of the Narrowleaf Cottonwood/Yellow Willow *(Populus angustifolia/Salix lutea)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Narrowleaf Cottonwood/Yellow Willow Community-tentative
(*Populus angustifolia/Salix lutea*)

Plots:	GRE 411	BUL 411	**AVG % COV**	**CONST %**
Trees				
native				
Populus angustifolia	70	70	**70**	**100**
Salix amygdaloides	-	10	**10**	**50**
Shrubs				
native				
Populus angustifolia (sapling)	20	1	**11**	**100**
Ribes oxyacanthoides	10	20	**15**	**100**
Rosa sp. (R. sayi or woodsii)	3	20	**12**	**100**
Salix exigua	10	-	**10**	**50**
Salix lasiandra	20	20	**20**	**100**
Salix lutea	40	40	**40**	**100**
Shepherdia argentea	10	3	**7**	**100**
Shrubs (dwarf)				
native				
Juniper sp. seedling	1	-	**1**	**50**
Populus angustifolia (seedling)	-	1	**1**	**50**

Table 26 (continued).

Narrowleaf Cottonwood/Yellow Willow Community-tentative
(*Populus angustifolia/Salix lutea*)

Plots:	GRE 411	BUL 411	AVG % COV	CONST %
Graminoids (tall)				
native				
Carex rostrata	3	-	**3**	**50**
Scirpus pungens	3	-	**3**	**50**
exotic				
Bromus inermis	3	20	**12**	**100**
Graminoids (short)				
native				
Elymus smithii	10	3	**7**	**100**
Glyceria striata	-	3	**3**	**50**
Juncus balticus	3	-	**3**	**50**
exotic				
Agrostis stolonifera	30	10	**20**	**100**
Poa pratensis	3	40	**22**	**100**
Forbs (tall)				
native				
Glycyrrhiza lepidota	30	20	**25**	**100**
Solidago canadensis	3	-	**3**	**50**
exotic				
Cirsium arvense	30	10	**20**	**100**
Melilotus albus	3	-	**3**	**50**
Melilotus officinalis	1	-	**1**	**50**
Sonchus uliginosus	3	-	**3**	**50**
Forbs (short)				
native				
Aster ascendens	3	-	**3**	**50**
Epilobium ciliatum	-	3	**3**	**50**
Equisetum arvense	10	-	**10**	**50**
Equisetum laevigatum	3	-	**3**	**50**
Fabaceae sp.1	1	-	**1**	**50**
Habenaria hyperborea	1	-	**1**	**50**
Lupinus argenteus	3	-	**3**	**50**
Maianthemum stellatum	3	3	**3**	**100**
Ranunculus sceleratus	-	3	**3**	**50**

Table 26 (continued).

Narrowleaf Cottonwood/Yellow Willow Community-tentative
(*Populus angustifolia/Salix lutea*)

Plots:	GRE 411	BUL 411	**AVG % COV**	**CONST %**
exotic				
Taraxacum officinale	1	10	**6**	**100**
Trifolium repens	3	10	**7**	**100**
Veronica anagallis-aquatica	-	3	**3**	**50**
Vines				
native				
Clematis ligusticifolia	-	10	**10**	**50**

Narrowleaf Cottonwood/Recent Alluvial Bar Community
(*Populus angustifolia*/Recent Alluvial Bar Community)

(2 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

This narrowleaf cottonwood/recent alluvial bar community is dominated by seedlings or saplings of narrowleaf cottonwood (Tbl. 27). The two stands sampled are at the two extremes of this community's development. One stand is dominated with cottonwood seedlings (trees less than 4.5 ft tall) and very few other species. The most abundant of four forbs present is white sweet-clover (*Melilotus albus*). The other stand is dominated by narrowleaf cottonwood saplings (trees taller than 4.5 ft, but less than 5 in diameter at 4.5 ft height). There are also some pole size trees. The herbaceous layer includes grasses and forbs in small amounts. The grasses having 2-5% cover are western wheatgrass (*Elymus smithii*), carpet bentgrass (*Agrostis stolonifera*), and Kentucky bluegrass (*Poa pratensis*). The dominant forb is American licorice (*Glycyrrhiza lepidota*), with five other forbs present in small amounts.

This community is linear and parallels the main channel or the overflow channel. Very little litter has accumulated on these stands.

LOCATION:

Two separate stands were sampled at the same site along a major fourth order perennial drainage in Park county (Fig. 22) at 5,150 ft (1,570 m) elevation (Fig. 23). The channel is low gradient and wide, with branches along its course. Drainage basin relief is approximately 7,000 ft (2,130 m) with an upper drainage basin area of nearly 850 sq mi (Fig. 24).

ENVIRONMENT:

This narrowleaf cottonwood/recent alluvial bar community occurs on recently deposited cobble and gravel bars. Some of the multiple channels were dry the day we sampled, but these are regularly filled overflow channels. The seedling stand is adjacent to the main channel and the sapling stand is adjacent to the overflow channel (Fig. 27). The seedling bar is at almost the same level as the channel. The sapling stand is 1.8 ft (0.5 m) above the main channel's bankfull height (Fig. 28).

SOILS:

There was 60% to 90% coarse material in the first horizon of each stand. Digging was difficult because of the high volume of cobbles regularly deposited on the surface. The soil surface is dominated by gravel and cobble size particles at the seedling stand. More sand has accumulated on this coarse substrate at the sapling stand.

The electric conductivity at these stands is low. The conductivity of the surface horizon of our two stands was 0.6 and 0.7 dS/m (Fig. 29). The pH was 7.8 and 8.0 at the surface (Fig. 30).

EXOTICS:

The understory of the narrowleaf cottonwood/recent alluvial bar stand is very sparse and few exotic species have occurred. Those present in low amounts at both stands include the white and yellow sweet-clovers (*Melilotus albus* and *M. officinalis*). At the sapling stand, carpet bentgrass and Kentucky bluegrass are the exotic grasses present.

ADJACENT COMMUNITIES:

Stands are adjacent to the channel or to the overflow channel. On higher levels the stands are adjacent to older cottonwood communities such as the narrowleaf cottonwood/yellow willow (*Populus angustifolia/Salix lutea*).

ECOLOGY:

The narrowleaf cottonwood/recent alluvial bar sapling stand is possibly 16 years old since these surfaces were said to have experienced flooding in 1978. The sapling stand is younger, possibly just two or three years old.

Flood events are important in creating new sites suitable for cottonwood seedling establishment (Rood and Mahoney 1990). Narrowleaf cottonwood is a pioneer species that requires newly established gravel bars which are moist and sparsely-vegetated to become established from seed. Stands of the narrowleaf cottonwood/recent alluvial bar community represent the earliest stages of cottonwood succession. If these stands remain moist for development, and survive browsing and future floods, they will develope into stands of other narrowleaf cottonwood communities. Floodwaters will deposit sediment onto the current alluvial bars therby raising the soil surface farther above the stream channel and out of reach of many floods. Seedlings and saplings will have a better chance of growing into trees.

The complex of narrowleaf cottonwood communities is comprised of patches of even-aged stands found at different heights above the channel. The communities of narrowleaf cottonwood are seral, and maintenance of the complex of different age stands requires that the stream flood enough to deposit new alluvial bars on which new trees can grow.

OTHER CLASSIFICATIONS:

This narrowleaf cottonwood/recent alluvial bar community is described from Montana (Hansen et al. 1991). It is also mentioned as the *Populus angustifolia* bar community type in Idaho (Padgett et al. 1989).

A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) does not include references to communities of this series.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Populus angustifolia*/ Recent Alluvial Bar Community belong to the Shrubland Class, Deciduous Shrubland Subclass, Cold Deciduous Srhubland Group, Deciduous Alluvial Shrubland Formation.

Table 27. Percent canopy cover of species in plots of the Narrowleaf Cottonwood *(Populus angustifolia)* recent alluvial bar Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Narrowleaf Cottonwood/Recent Alluvial Bar Community
(*Populus angustifolia*/Recent Alluvial Bar)

Plots:	BUL 413	BUL 412	**AVG % COV**	**CONST %**
Trees				
native				
Populus angustifolia	-	30	**30**	**50**
Shrubs				
native				
Populus angustifolia (sapling)	-	50	**50**	**50**
Ribes oxyacanthoides	-	3	**3**	**50**
Rosa sp. (R. sayi or woodsii)	-	1	**1**	**50**
Shrubs (dwarf)				
native				
Populus angustifolia (seedling)	20	-	**20**	**50**
Graminoids (short)				
native				
Elymus smithii	-	3	**3**	**50**
Muhlenbergia asperifolia	-	1	**1**	**50**
exotic				
Agrostis stolonifera	-	3	**3**	**50**
Bromus tectorum	-	1	**1**	**50**
Poa pratensis	-	3	**3**	**50**
Forbs (tall)				
native				
Chenopodium pratericola	1	-	**1**	**50**
Glycyrrhiza lepidota	-	10	**10**	**50**

Table 27 (continued).

Narrowleaf Cottonwood/Recent Alluvial Bar Community
(*Populus angustifolia*/Recent Alluvial Bar)

	Plots:	BUL 413	BUL 412	**AVG % COV**	**CONST %**
exotic					
Melilotus albus		10	3	**7**	**100**
Melilotus officinalis		1	1	**1**	**100**
Forbs (short)					
native					
Aster ascendens		-	1	**1**	**50**
Oxytropis deflexa		1	-	**1**	**50**
exotic					
Medicago lupulina		-	1	**1**	**50**
Vines					
native					
Clematis ligusticifolia		-	3	**3**	**50**

Plains Cottonwood Series
(*Populus deltoides* Series)

Plains cottonwood is the common deciduous tree of lower elevation riparian zones. Vegetation structure ranges from dense stands of poles and small trees to open, park-like stands of scattered large trees. A shrub layer may range from dense to non-existant, depending on the seral stage of the community. The herbaceous layer is usually dominated by grasses (Jones and Walford 1995).

Along small streams, the plains cottonwood series usually occurs as small groves of trees on the insides of meanders. Along large rivers, plains cottonwoods often form large, open groves or narrow bands of trees along the modern channel or along abandoned channels.

The community of the plains cottonwood series described from five Bighorn Basin stands appears to be transitional toward an upland type. The community consists of mature to decadent cottonwoods, with an understory dominated by basin big sagebrush *(Artemisia tridentata* var. *tridentata)* and rabbitbrush *(Chrysothamnus* spp.*)*.

Plains Cottonwood/Basin Big Sagebrush Community
Populus deltoides/Artemisia tridentata var. *tridentata* Community

(5 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Plains cottonwood is the dominant tree of the overstory, with cover ranging from 10% to 40% (Tbl. 28). Lanceleaf cottonwood (*Populus acuminata*) and Russian olive (*Elaeagnus angustifolia*) trees were sometimes present in small amounts. The range of total tree canopy cover at these five stands was also 10% to 40%, meaning that some plots belong to the sparse woodland category (10-25% tree cover) and others belong to the woodland category (25-60% tree cover).

The plains cottonwood trees at these stands are similar sizes: primarily in pole, small, and medium size classes (14 - 36 in. diameter). Two plots had numerous seedlings and saplings as well, but these were likely root suckers (adventitious shoots on roots). It was noted that deep silt had deposited above the root crowns; the smaller stems were probably sucker shoots of the larger trees.

The understory is similar at the stands, with basin big sagebrush (*Artemisia tridentata* var. *tridentata*) and flaxleaf rabbitbrush (*Chrysothamnus linifolius*) always present in the shrub layer. The herbaceous layer is sparse. At some stands there are moderate amounts of inland saltgrass (*Distichlis stricta*) or Canada wild rye (*Elymus canadensis*). The most common forb is lemon scurfpea (*Psoralidium lanceolatum*).

The tree canopy is generally patchy and open; trees reach 20 to 30 ft (6 - 9 m) in height. The shrub layer is usually less than 3 ft (1 m) tall. The stands are narrow bands averaging 33 ft (10 m) wide and parallelling the channel. The surface of these stands is primarily exposed soil with small amounts of litter and wood.

LOCATION:

Five stands of the plains cottonwood/basin big sagebrush community were sampled between 3,900 and 4,300 ft (1,200 - 1,315 m) elevation (Fig. 23) in Washakie and Big Horn counties (Fig. 22). Sites were primarily on low gradient, second and third order intermittent channels. One site occurred at a second order, perennial channel. The channels are fairly sinuous, and are located in wide valleys. The channel bottom is usually 1 to 1.5 ft (3 - 5 m) across (Fig. 25) and relatively flat. Drainage basin area ranged from 23 to 542 sq mi (Fig. 24) and and drainage basin relief extended from 270 to 6040 ft.

ENVIRONMENT:

The plains cottonwood/basin big sagebrush occurrence is found on the slope rising up from the channel and along the first terrace. The stands occur for some length (up to 5 miles or more) along the channel. The occurrence is usually adjacent to the channel and ranges in height above the channel from 0.5 to 5 ft (0.2 - 1.5 m) (Fig. 28).

The channels at most of these sites are dry during parts of the summer. The channel banks vary from steep slopes to vertical cut banks. If the slope is less than 45%, it is sparsely vegetated with moderate bank stabilization.

SOILS:

Half of the plains cottonwood/basin big sagebrush stands have a lot of layering in the soil profiles, usually three to six horizons from surface to 50 cm depth. This is created by occasional flooding which deposits new layers of sediment at the stand. There was sometimes other evidence of flooding as well, such as flood debris piled up against the trees. Two stands had a single horizon to the 50 cm depth.

The pH and electric conductivity of the surface horizon of our five stands ranged from 7.6 to 8.3 and 0.3 to 1.9 dS/m, respectively (Figs. 29 & 30). The high electric conductivity in any horizon of this community was 7.0 dS/m at 40 cm depth.

EXOTICS:

Small amounts of Russian olive are present at two stands. At another stand, the understory is dominated by Chinese tamarisk (*Tamarix chinensis*). There are very small amounts of introduced grasses and forbs present at each stand.

ADJACENT COMMUNITIES:

This plains cottonwood/basin big sagebrush community occurs adjacent to the channel. On the upland side, the adjacent vegetation is basin big sagebrush, upland grasses, and sometimes black greasewood (*Sarcobatus vermiculatus*).

ECOLOGY:

Plains cottonwood is a pioneer species that requires moist, sparsely-vegetated alluvium to become established from seed (Johnson 1992). Consequently, stands of this community are seral; a stand does not persist for longer than the lifespan of the original trees that become established after a flood, and the stand becomes another vegetation type as the trees die. Maintenance of the plains cottonwood vegetation along a stream requires that the stream flood enough to deposit new alluvial bars on which new trees can grow.

These stands of the plains cottonwood/basin big sagebrush community are a late seral community of the plains cottonwood series in which the cottonwood trees are not regenerating. Site conditions were different at the time the cottonwood trees established. The stands will become shrubland stands dominated by basin big sagebrush and rabbitbrush (*Chrysothamnus linifolius* or *C. nauseosus*). This transition is evidenced by the decadence of the cottonwood trees and the consistency of the shrub and herbaceous composition.

OTHER CLASSIFICATIONS:

No references were found for a plains cottonwood/basin big sagebrush community. In the ecological land classification framework (Driscoll et al. 1984), stands of the *Populus deltoides/Artemisia tridentata* var. *tridentata* Community belong to the Woodland Class, Deciduous Woodland Subclass, Cold-Deciduous Woodland Group, Broad-Leaved Deciduous Woodland Formation.

Table 28. Percent canopy cover of species in plots of the Plains Cottonwood/Basin Big Sagebrush *(Populus deltoides/Artemisia tridentata* var. *tridentata)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Plains Cottonwood/Basin Big Sagebrush Community
(*Populus deltoides/Artemisia tridentata* var. *tridentata*)

Plots:	FMC 411	BEA 411	TMC 411	NWT 411	COO 411	**AVG % COV**	**CONST %**
Trees							
native							
Populus acuminata	-	-	-	3	3	**3**	**40**
Populus deltoides	40	10	20	20	10	**20**	**100**
Salix amygdaloides	-	1	-	-	-	**1**	**20**
exotic							
Elaeagnus angustifolia	1	-	-	3	-	**2**	**40**
Shrubs							
native							
Artemisia cana	3	-	3	-	-	**3**	**40**
Artemisia tridentata	10	10	30	1	10	**12**	**100**
Chrysothamnus linifolius	3	3	1	10	10	**5**	**100**
Chrysothamnus nauseosus	1	10	-	-	10	**7**	**60**
Populus acuminata (sapling)	-	-	-	-	1	**1**	**20**
Populus deltoides (sapling)	1	1	1	1	3	**1**	**100**
Salix exigua	-	1	-	-	-	**1**	**20**
Sarcobatus vermiculatus	-	-	-	1	-	**1**	**20**
exotic							
Tamarix chinensis	-	10	-	-	-	**10**	**20**
Shrubs (dwarf)							
native							
Atriplex confertifolia	-	-	1	-	-	**1**	**20**
Gutierrezia sarothrae	-	1	-	-	3	**2**	**40**
Populus acuminata (seedling	-	-	-	-	1	**1**	**20**
Populus deltoides (seedling)	1	-	-	-	3	**2**	**40**
Graminoids (tall)							
native							
Spartina gracilis	-	-	-	3	-	**3**	**20**

Table 28 (continued).

Plains Cottonwood/Basin Big Sagebrush Community
(*Populus deltoides/Artemisia tridentata* var. *tridentata*)

Plots:	FMC 411	BEA 411	TMC 411	NWT 411	COO 411	AVG % COV	CONST %
Graminoids (short)							
native							
Distichlis stricta	-	3	-	20	10	**11**	**60**
Elymus albicans	3	-	-	-	-	**3**	**20**
Elymus canadensis	10	-	3	20	-	**11**	**60**
Elymus lanceolatus	-	-	3	-	3	**3**	**40**
Elymus smithii	3	1	-	3	3	**3**	**80**
Hordeum brachyantherum	-	-	-	3	-	**3**	**20**
Oryzopsis hymenoides	3	-	1	-	-	**2**	**40**
Poa juncifolia	-	-	-	-	3	**3**	**20**
Poa secunda	-	-	1	-	-	**1**	**20**
Sporobolus airoides	1	3	-	-	-	**2**	**40**
exotic							
Agrostis stolonifera	-	-	-	-	-		
Bromus tectorum	-	1	-	-	-	**1**	**20**
Forbs (tall)							
native							
Asclepias speciosa	-	-	-	1	-	**1**	**20**
Xanthium strumarium	3	-	3	3	1	**3**	**80**
Forbs (short)							
native							
Comandra umbellata	-	-	3	-	-	**3**	**20**
Grindelia squarrosa	-	1	-	3	-	**2**	**40**
Lygodesmia juncea	1	-	-	-	-	**1**	**20**
Machaeranthera canescens	-	-	1	-	-	**1**	**20**
Opuntia polyacantha	-	-	1	-	-	**1**	**20**
Psoralidium lanceolatum	20	3	3	-	3	**7**	**80**
exotic							
Alyssum desertorum	-	-	1	-	-	**1**	**20**
Halogeton glomeratus	-	1	-	-	-	**1**	**20**
Salsola australis	-	-	1	-	-	**1**	**20**
Tragopogon dubius	-	-	1	-	-	**1**	**20**

Lanceleaf Cottonwood Series
(*Populus acuminata* Series)

Lanceleaf cottonwood is a hybrid between narrowleaf cottonwood *(Populus angustifolia)* and plains cottonwood *(P. deltoides)* (Hitchcock and Cronquist 1973). In our Bighorn Basin sites, the lanceleaf cottonwood-dominated stand occurred at elevations intermediate between the higher narrowleaf cottonwood sites and the lower plains cottonwood sites. At the lanceleaf cottonwood site, some narrowleaf cottonwood and some plains cottonwood were both present in low amounts. And, small amounts of lanceleaf cottonwood were present in some of the narrowleaf cottonwood stands and in some of the plains cottonwood stands.

Aside from elevational range, these three species are ecologically similar in many ways. In some classifications, lanceleaf cottonwood types are combined with narrowleaf cottonwood stands (Padgett et al. 1989). One stand dominated by lanceleaf cottonwood is presented, in order to be able to compare it with stands which may be sampled in the future.

Lanceleaf Cottonwood Stand
(*Populus acuminata* Stand)

(1 stand sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Lanceleaf cottonwood dominates the upper canopy of this stand (Tbl. 29). Narrowleaf cottonwood (*Populus angustifolia*) and plains cottonwood (*P. deltoides*) are also present. The cottonwood trees are in size classes ranging from small to very large (9 in. diameter to greater than 36 in. diameter). The couple lanceleaf cottonwood saplings appear to be root suckers. There are also dead standing cottonwood trees ranging in size from 5 to 36 in. diameter.

A small amount of Wood's rose (*Rosa woodsii*) is present in the understory. The herbaceous layer is dominated by smooth brome (*Bromus inermis*) and common quackgrass (*Elymus repens*). The most common forb is two-seed orach (*Atriplex heterosperma*). There is some deadfall wood on the surface, but litter is the primary cover of the plot surface.

The surface of this occurrence averages 80 ft (25 m) wide and continues along the channel for a 1/2 mi length. The cottonwood overstory offers almost continuous shade to the first and second surfaces for its entire length.

LOCATION:

The lanceleaf cottonwood occurrence is found in a narrow riparian zone (25 m wide) within a 1/2 mi wide valley bottom. The channel is a first order perennial stream at 4,500 ft (1,380 m) elevation (Fig. 23). It has fairly high stream gradient of nearly 3%. The channel is 6.5

ft (2 m) wide (Fig. 25) with gravel and cobble bed material. At this site the upper drainage basin area is small (12.5 sq mi) (Fig. 24) with a relief of 5,500 ft (1,675 m).

ENVIRONMENT:

At the lanceleaf cottonwood site, the 80 ft (25 m) wide riparian zone consists of two surfaces above the channel. The first surface is narrow and discontinuous. The lanceleaf cottonwood stand is found on the second surface which is also the first terrace. The upper terrace, occupying most of the 1/2 mi wide valley, is a hay field.

The lanceleaf cottonwood series occurs 6 ft (2 m) above the channel and 10 ft (3 m) away from the channel (Figs. 27 & 28). The surface slopes gradually toward the first surface. A steep bank slopes up to the third surface. The channel banks are well stabilized.

SOILS:

There are six soil horizons within a 70 cm depth at the lanceleaf cottonwood stand. No coarse material was present in any layer. Textures were various loams with clay loam in the upper 20 cm. Below this was silty clay loam over sandy loam, followed by clay loam, sandy loam, and silty clay loam.

The pH and electric conductivity of the surface horizon 7.5 and 2.0 dS/m, respectively (Figs. 29 & 30). The high electric conductivity in any horizon of this stand was 2.6 dS/m at 21 cm depth.

EXOTICS:

The dominant grasses at the lanceleaf cottonwood stand, smooth brome and common quackgrass, are introduced species.

ADJACENT COMMUNITIES:

The lanceleaf cottonwood occurrence is often separated from the channel by a lower surface occupied by common timothy (*Phleum pratense*) and occasional young Russian olive (*Elaeagnus angustifolia*) trees. The upper terrace, 33 ft (10 m) above the lanceleaf cottonwood stand, is a hay meadow. Upstream and downstream of this occurence are Russian olive trees, found both mixed in with the cottonwood species and in nearly pure stands.

ECOLOGY:

The elevation of this community, 4,540 ft (1,380 m), is midway between that of the plains cottonwood sites and that of the narrowleaf cottonwood sites in the Bighorn Basin. The average elevation of our narrowleaf cottonwood sites in the Bighorn Basin is 5,030 ft (1,530 m) with a range from 4,450 - 6,030 ft (1,355 - 1,840 m). The average elevation of our plains cottonwood sites in the Bighorn Basin is 4,100 ft (1,250 m) with a range from 3,780 - 4,310 ft

(1,150 - 1,315 m). The lanceleaf cottonwood is a hybrid between narrowleaf cottonwood and plains cottonwood (or *Populus fremontii* farther south) (Hitchcock and Cronquist 1973), and this elevation is possibly suitable for all three cottonwood species. See the ecology discussions of both narrowleaf cottonwood and the plains cottonwood within their respective communities; the establishment requirements for lanceleaf cottonwood is likely the same.

OTHER CLASSIFICATIONS:

A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) does not include references to communities of this series. No other references were found for a lanceleaf cottonwood series.

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Populus acuminata* Series belong to the Shrubland Class, Deciduous Shrubland Subclass, Cold Deciduous Srhubland Group, Deciduous Alluvial Shrubland Formation.

Table 29. Percent canopy cover of species in the plot of the Lanceleaf Cottonwood *(Populus acuminata)* Series.

Lanceleaf Cottonwood (*Populus acuminata*) Stand

Plot:	RED 411
Trees	
native	
Populus acuminata	50
Populus angustifoila	10
Populus deltoides	10
Shrubs	
native	
Populus acuminata (sapling)	1
Rosa sp. (R. sayi or woodsii)	3
Graminoids (tall)	
native	
Elymus cinereus	3
exotic	
Bromus inermis	50
Graminoids (short)	
exotic	
Elymus repens	20

Table 29 (continued).

Lanceleaf Cottonwood (*Populus acuminata*) Stand

Plot:	RED 411
Forbs (tall)	
native	
Atriplex heterosperma	10
Lactuca serriola	1
Vines	
native	
Clematis ligusticifolia	1

Assorted Mixed Cottonwood Stands
Populus spp.

The following stands are transitional cottonwood types in which the cottonwood trees are being replaced by Russian olive *(Elaeagnus angustifolia)* trees. The stands belong to assorted cottonwood communities, as evidenced by the variety of trees and shrubs present. As succession to Russian olive types occurs, the understories will probably become more similar to each other and perhaps more weedy, due to the potentially dense canopy of the Russian olive community (see Russian olive series discussion).

Mixed Cottonwood-Russian Olive Stands
Populus spp.-*Elaeagnus angustifolia* Stands

(4 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Two to three species of cottonwood trees occupy the canopy of these patchy deciduous forests. Plains cottonwood (*Populus deltoides*), lanceleaf cottonwood (*P. acuminata*), and narrowleaf cottonwood (*P. angustifolia*) are the largest and tallest trees in these stands (Tbl. 30). The subcanopy is dominated by Russian olive trees which can be moderately to very dense.

Two stands are nearly without any shrubs, and the other two stands have a mixture of shrubs giving 25% to 80% cover at the shrub layer. At the latter stands, the common shrubs are rose (*Rosa* sp.), silver buffaloberry (*Shepherdia argentea*), skunkbush sumac (*Rhus trilobata*), coyote willow (*Salix exigua*), and whiplash willow (*S. lasiandra*). One of the stands with shrubs also had significant amounts of narrowleaf cottonwood seedlings and saplings.

There is low constancy of species present in the herbaceous layer. Grasses which are abundant at individual stands are: smooth brome (*Bromus inermis*), common quackgrass (*Elymus repens*), carpet bentgrass (*Agrostis stolonifera*), Kentucky bluegrass (*Poa pratensis*), and reed canarygrass (*Phalaris arundinacea*). American licorice (*Glycyrrhiza lepidota*) and showy milkweed (*Asclepias speciosa*) are common to most stands. Other forbs with significant cover at one or two stands are: two-seed orach (*Atriplex heterosperma*), giant goldenrod (*Solidago gigantea*), lens-padded hoary cress (*Cardaria chalepensis*), Russian knapweed (*Centaurea repens*), Canada thistle (*Cirsium arvense*), and black medic (*Medicago lupulina*). The vine western virginsbower (*Clematis ligusticifolia*) is often present.

The cottonwood trees average 100 ft (30 m) tall with 15 ft (4.5 m) tall Russian olive trees below. At sites on meandering channels, the occurrence is crescent shaped on the inside meander, and approximately 1.2 acres (0.5 ha) in size. At straighter reaches, the occurrence continues along both sides of the channel with a 33 ft (10 m) width on each side.

LOCATION:

The mixed cottonwood-Russian olive stands were sampled at sites in Big Horn, Hot Springs, and Park counties (Fig. 22), along first, third and fifth order perennial channels. Sites with narrowleaf and lanceleaf cottonwoods were located at approximately 4,800 ft (1,460 m) elevation (Fig. 23); sites with plains and lanceleaf cottonwoods were located at an average elevation of 4,000 ft (1,220 m) (Fig. 23). The upstream drainage basin area varies with the stream order. Most of the channels were low gradient, except the first order channel. The lower the gradient, the more sinuous the channels at these sites.

ENVIRONMENT:

These mixed cottonwood-Russian olive stands are found on the inside meanders of sinuous channels. The patches vary in being adjacent to the channel, to being 165 feet away from the channel (Fig. 27). Their heights above the channel range from bankfull height to 5 ft above bankfull (Fig. 28). All the stands are located near well stabilized sections of channels. There is some dead wood cover on the surface of these plots, but primarily there is litter covering the plot surfaces.

SOILS:

Most stands had 3 to 5 soil horizons within a 50 cm depth. This is evidence of periodic flooding. The textures are most often clay loams or sandy or silty clay loams.

The pH and electric conductivity of the surface horizon of our four stands ranged from 7.6 to 8.0 and 1.3 to 7.5 dS/m, respectively. The high electric conductivity in any horizon of this community was 11.0 dS/m at 36 cm depth.

EXOTICS:

Russian olive trees were introduced to North America from southern Europe and western Asia as shade trees. Many of the grasses are exotic, including carpet bentgrass, common quackgrass, Kentucky bluegrass, and Japanese brome *(Bromus japonicus)*. There are also a lot of exotic forbs at all the stands. These include: Russian knapweed *(Centaurea repens)*, lens-padded hoary cress *(Cardaria chalepensis)*, Canada thistle *(Cirsium arvense)*, fireweed summer cypress *(Kochia scoparia)*, heart-podded whitetop *(Cardaria draba)*, and marsh sow-thistle *(Sonchus uliginosus)*.

ADJACENT COMMUNITIES:

These mixed cottonwood-Russian olive stands stands are generally set back from the channel and are adjacent to coyote willow (*Salix exigua*), or Russian olive (*Elaeagnus angustifolia*), or leafy bulrush (*Scirpus pungens*) stands. On the upland side of these occurrences,

stands are adjacent to agricultural land or to basin big sagebrush (*Artemisia tridentata* var. *tridentata*) uplands.

ECOLOGY:

With the control of streams and rivers to prevent flooding, suitable sites are not being created for the establishment of new cottonwood stands. Cottonwoods in many present stands are large and old. Russian olive trees are able to establish in the understory of mature cottonwoods. When the cottonwoods reach the end of their lifespan, the stands often give way to the Russian olives if they are already established in the understory (see ecology sections of the Russian olive community and the other cottonwood communities of Bighorn Basin for more information on those species).

OTHER CLASSIFICATIONS:

These stands do not fit into existing classification descriptions. When they develop into the Russian olive community, they will fall into the Anthropogenic Alliances and Plant Associations group (Bourgeron and Engelking 1994).

In the ecological land classification framework (Driscoll et al. 1984), stands of the *Populus* spp.-*Elaeagnus angustifolia* Stands belong to the Closed Forest Class, Mainly Deciduous Forest Subclass, Cold Deciduous Forest Without Evergreen Trees Group, Cold-Deciduous Alluvial Forest Formation.

Table 30. Percent canopy cover of species in plots of the Mixed Cottonwood *(Populus* spp.*)* stands.

Mixed Cottonwood-Russian Olive Stands
(*Populus* spp.- *Elaeagnus angustifolia)*

Plots:	BIG	SHL	RED	SHO
	411	411	421	411
Trees				
native				
Juniperus osteosperma	-	-	10	-
Juniperus scopulorum	-	-	3	-
Populus acuminata	-	20	3	30
Populus angustifolia	-	-	30	30
Populus deltoides	60	10	20	-
exotic				
Elaeagnus angustifolia	40	70	30	40

Table 30 (continued).

Mixed Cottonwood-Russian Olive Stands
(*Populus* spp.- *Elaeagnus angustifolia*)

Plots:	BIG 411	SHL 411	RED 421	SHO 411
Shrubs				
native				
Artemisia tridentata	-	-	3	-
Cornus sericea	-	-	3	-
Populus acuminata (sapling)	-	-	-	1
Populus angustifolia (sapling)	-	-	10	1
Rhus trilobata	-	-	10	10
Rosa sp. (R. sayi or woodsii)	-	1	20	20
Salix exigua	-	1	3	10
Salix lasiandra	-	-	3	10
Salix lutea	-	-	-	10
Sarcobatus vermiculatus	1	-	-	-
Shepherdia argentea	-	-	3	60
exotic				
Tamarix chinensis	-	3	-	-
Shrubs (dwarf)				
native				
Gutierrezia sarothrae	-	-	1	-
Populus angustifolia (seedling)	-	-	10	-
Graminoids (tall)				
native				
Carex nebrascensis	-	-	-	1
Juncus tenuis	-	-	1	-
Phalaris arundinacea	-	-	-	30
Bromus inermis	70	-	-	-
Eleocharis palustris	-	-	1	-
Elymus canadensis	-	-	1	-
Elymus smithii	10	-	-	-
Elymus trachycaulus	-	-	10	-
Hordeum jubatum	-	3	-	-
Juncus balticus	-	-	1	-
Juncus longistylis	-	-	1	-
Juncus torreyi	-	-	3	-
Sporobolus airoides	1	10	-	-

Table 30 (continued).

Mixed Cottonwood-Russian Olive Stands
(*Populus* spp.- *Elaeagnus angustifolia)*

Plots:	BIG 411	SHL 411	RED 421	SHO 411
exotic				
Agrostis stolonifera	-	-	10	50
Bromus japonicus	-	-	10	-
Elymus repens	-	70	-	-
Phleum pratense	-	-	1	-
Poa pratensis	-	20	10	-
Forbs (tall)				
native				
Asclepias speciosa	3	3	1	-
Atriplex heterosperma	-	30	-	-
Glycyrrhiza lepidota	-	3	3	30
Helianthus nuttallii	-	-	3	-
Lactuca serriola	-	-	1	-
Solidago gigantea	-	-	-	20
Typha latifolia	-	-	-	1
exotic				
Asparagus officinalis	3	-	-	-
Cardaria draba	10	-	-	-
Cirsium arvense	1	-	-	20
Cirsium vulgare	-	-	1	-
Medicago sativa	1	-	1	-
Melilotus albus	1	-	3	-
Melilotus officinalis	1	-	3	-
Sonchus uliginosus	-	-	-	10
Forbs (short)				
native				
Aster ascendens	-	-	1	-
Aster bracteolatus	-	-	1	-
Aster ericoides	-	-	1	-
Equisetum arvense	-	-	-	3
Grindelia squarrosa	-	1	1	-
Linum lewisii	-	-	1	-
Maianthemum stellatum	3	-	-	3
Mentha arvensis	-	-	1	-

Table 30 (continued).

Mixed Cottonwood-Russian Olive Stands
(*Populus* spp.- *Elaeagnus angustifolia)*

Plots:	BIG 411	SHL 411	RED 421	SHO 411
exotic				
Cardaria chalepensis	-	30	-	-
Centaurea repens	30	20	-	-
Kochia scoparia	10	10	-	-
Medicago lupulina	-	-	1	-
Plantago major	-	-	1	-
Taraxacum officinale	-	-	1	-
Tragopogon dubius	-	-	1	-
Trifolium repens	-	-	3	-
Vines				
native				
Clematis ligusticifolia	-	10	10	-

Boxelder Series
(*Acer negundo* Series)

Five stands of the boxelder series were sampled in the Bighorn Basin. They are generally similar to the plant association occurring on the Boxelder/Common Chokecherry (*Acer negundo/Prunus virginiana)* Habitat Type described by Hansen and others (1995).

The earlier successional stages are indicated by the presence of mature narrowleaf cottonwood (*Populus angustifolia*), plains cottonwood *(Populus deltoides)*, or peachleaf willow (*Salix amygdaloides*) trees. The stands have become too dense for the cottonwood to regenerate and the boxelder are currently replacing them. Stands of boxelder, with little to no cottonwood or peachleaf willow, would be at the climax plant association stage. Our five stands all have some narrowleaf or plains cottonwood, or peachleaf willow present. Three of the five stands have significant amounts of common chokecherry *(Prunus virginiana)*. The differences are suggestive of varied levels of degradation due to overgrazing. The presence of common chokecherry is not consistent with the presence or absence of cottonwoods or peachleaf willows.

Boxelder/Common Chokecherry Community
(*Acer negundo/Prunus virginiana* Community)

(5 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Boxelder is the dominant tree of the upper layer of vegetation (Tbl. 31). There are often a few medium and large size narrowleaf cottonwood *(Populus angustifolia)* trees. Their canopy cover is spotty, but taller than that of the boxelder. One stand has some Rocky Mountain juniper (*Juniperus scopulorum*) mixed in that are equal in size to the boxelder, or slightly taller.

The subcanopy is dominated by common chokecherry at most stands. These stands also have low amounts of rose (*Rosa* sp.) and Canada gooseberry (*Ribes oxyacanthoides*).

The herbaceous layer varies in cover density. Grasses are most commonly exotic. Forbs include the tall, large leaved common burdock (*Arctium minus*) and the western virginsbower (*Clematis ligusticifolia*) vine which provide significant cover at nearly all stands. Also common in low amounts are: stinging nettle (*Urtica dioica*), starry false Solomon's-seal (*Maianthemum stellatum*), and spreading sweetroot (*Osmorhiza chilensis*).

The boxelder/common chokecherry stands may be patchy or continuous. They are generally linear and narrow alongside the channel. The community may be wider when it occupies mid-channel islands, as well as the areas beyond the channel.

LOCATION:

The stands of boxelder/common chokecherry community were sampled in Big Horn and Washakie counties, on first to third order perennial channels. Sites were located at 4,500 ft to 5,100 ft (1,370 - 1,560 m) elevation. Upper drainage basin areas are less than 200 sq mi and have less than 6,100 ft (1,860 m) basin relief.

ENVIRONMENT:

At the stands occurring on first order streams, the channel slopes are steep and create a V-shaped ravine. Stands are found on the first surface at the bottom of the ravine, up the slope, and sometimes on the terrace above the slope. The channel is shaded by overhanging vegetation most of the length of the occurrence. The riparian zone tends to be rather narrow, not extending far from the channel slope.

On third order channels, the occurrence was found occupying mid-channel islands as well as the slopes adjacent to the channel. On these third order channels, the bank's slope to the terrrace is more gradual.

The channels where these stands are located are nearly all high gradient (ca. 2-3 %) and vary in their sinuosity. Channel size ranges from 4 to 50 ft (1.3 to 15 m) wide (Fig. 25), and 0.4 to 1.3 ft (1.3 - 4 m) deep (Fig. 26). Stands are found adjacent to the channel, but they may be up to 5 ft (13 m) above bankfull channel (Figs. 27 & 28). The streambanks are well stabilized by vegetation, cobbles or boulders.

SOILS:

There are an average of four horizons between the surface and 50 cm depth at the stands of the boxelder/common chokecherry community. The dominant textures of the horizons are clay loam, silty clay loam, and sandy clay loam.

The pH and electric conductivity of the surface horizon of our five stands ranged from 7.3 to 7.8 and 1.5 to 2.9 dS/m, respectively (Figs. 29 & 30). The high electric conductivity in any horizon of this community was 3.0 dS/m at 25 cm depth.

EXOTICS:

The grasses in the boxelder/common chokecherry stands are dominated by exotic species. These vary at each site, but each is abundant where present. Included are: smooth brome (*Bromus inermis*), carpet bentgrass (*Agrostis stolonifera*), common orchardgrass (*Dactylis glomerata*), cheatgrass brome (*Bromus tectorum*), common timothy (*Phleum pratense*), and Kentucky bluegrass (*Poa pratensis*).

ADJACENT COMMUNITIES:

The boxelder/common chokecherry community is the single riparian stand at these

sites. The stands occur between the channel and an upland surface of pasture or upland vegetation. The adjacent upland is often vegetated with Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*) and Rocky Mountain juniper (*Juniperus scopulorum*).

ECOLOGY:

Boxelder seedlings can become established in the shade of tree canopies (Johnson 1992). Cottonwood seedlings generally require a recently deposited alluvial bar for establishment. As cottonwood stands become decadent, the boxelder may be well-developed in the understory and able to replace the cottonwood stands (Johnson 1992; Hansen et al. 1995).

According to Hansen and others (1991), heavy grazing pressure can lead to decreased reproduction of boxelder, eliminating younger age classes. When this happens, stands open up and more sun tolerant species move into the understory. Stands with a lot of invasive and exotic species are indicators of disturbance or grazing pressure.

The size structure of trees in a stand can give an indication of age structure of the stand. Boxelder trees are difficult to put into a size class because multiple small to large size stems appear to grow from a single root crown. Also, many sapling or pole size stems may grow from fallen or cut trees.

Our stands of the boxelder/common chokecherry community appear to be of a mixed age class. But disturbance is evident at two stands in particular by their near lack of a shrub layer, and the abundance of exotics in their understory.

OTHER CLASSIFICATIONS:

Hansen and others (1991) describes the Boxelder/Common Chokecherry Habitat Type in central and eastern Montana. Habitat type is the land area which has the potential to support the same climax vegetation, in this case the boxelder/common chokecherry plant association. Stands of the boxelder series have also been sampled in eastern Wyoming (Jones and Walford 1995).

In A preliminary vegetation classification of the Western United States (Bourgeron and Engelking 1994) and in agreement with the ecological land classification framework (Driscoll et al. 1984), stands of the *Acer negundo/Prunus virginiana* Community belong to the Closed Forest Class, Mainly Deciduous Forest Subclass, Cold-Deciduous Forest Group, Cold-Deciduous Alluvial Forest Formation, *Acer negundo* Alliance.

Table 31. Percent canopy cover of species in plots of the Boxelder/Common Chokecherry *(Acer negundo/Prunus virginiana)* Community.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Boxelder/Common Chokecherry Community
(*Acer negundo/Prunus virginiana*)

Plots:	CRK 431	PNR 411	LUM 411	PAI 411	CRK 421	AVG % COV	CONST %
Trees							
native							
Acer negundo	90	90	80	50	60	**74**	**100**
Juniperus scopulorum	-	3	-	-	40	**22**	**40**
Populus acuminata	3	3	-	-	-	**3**	**40**
Populus angustifoli+E32a	-	30	20	50	-	**33**	**60**
Populus deltoides	3	-	-	-	-	**3**	**20**
Salix amygdaloides	-	-	-	3	10	**7**	**40**
Shrubs							
native							
Artemisia cana	-	-	3	-	-	**3**	**20**
Betula occidentalis	-	-	-	1	-	**1**	**20**
Cornus sericea	-	1	-	10	-	**6**	**40**
Populus acuminata (sapling)	-	1	-	-	-	**1**	**20**
Prunus virginiana	-	50	-	50	20	**40**	**60**
Rhus trilobata	-	3	-	-	-	**3**	**20**
Ribes americanum	-	-	-	3	-	**3**	**20**
Ribes oxyacanthoides	-	3	-	3	1	**2**	**60**
Rosa sp. (R. sayi or woodsii)	-	3	-	3	10	**5**	**60**
Salix lasiandra	-	-	-	1	-	**1**	**20**
Salix lutea	-	-	-	-	10	**10**	**20**
Symphoricarpos sp.	-	3	-	10	-	**7**	**40**
Shrubs (dwarf)							
native							
Acer negundo (seedling)	-	-	3	-	-	**3**	**20**
Juniperus scopulorum (seedling	-	-	-	-	3	**3**	**20**
Populus acuminata (seedling)	-	1	-	-	-	**1**	**20**
Populus angustifolia (seedling)	-	1	-	-	-	**1**	**20**
Graminoids (tall)							
native							
Calamagrostis canadensis	-	-	-	1	-	**1**	**20**
Carex lanuginosa	-	-	-	1	-	**1**	**20**

Table 31 (continued).

Boxelder/Common Chokecherry Community
(*Acer negundo/Prunus virginiana*)

Plots:	CRK 431	PNR 411	LUM 411	PAI 411	CRK 421	AVG % COV	CONST %
Phalaris arundinacea	3	-	-	-	-	**3**	**20**
exotic							
Bromus inermis	3	-	-	40	-	**22**	**40**
Graminoids (short)							
native							
Elymus smithii	-	1	3	-	3	**2**	**60**
Elymus virginicus	-	-	-	3	-	**3**	**20**
exotic							
Agrostis stolonifera	3	3	-	1	30	**9**	**80**
Bromus tectorum	-	3	10	-	-	**7**	**40**
Dactylis glomerata	20	-	-	1	-	**11**	**40**
Phleum pratense	-	1	-	-	10	**6**	**40**
Poa pratensis	-	3	10	-	-	**7**	**40**
Forbs (tall)							
native							
Aster foliaceus	-	-	-	-	3	**3**	**20**
Barbarea orthoceras	1	-	-	-	-	**1**	**20**
Glycyrrhiza lepidota	-	-	3	3	-	**3**	**40**
Hackelia deflexa	-	3	-	-	-	**3**	**20**
Helianthus nuttallii	-	-	-	-	3	**3**	**20**
Heracleum sphondylium	10	-	-	-	3	**7**	**40**
Lactuca serriola	-	1	3	-	3	**2**	**60**
Rudbeckia laciniata	3	-	-	3	3	**3**	**60**
Solidago gigantea	-	-	-	3	-	**3**	**20**
Urtica dioica	10	1	-	1	3	**4**	**80**
exotic							
Arctium minus	40	1	-	3	10	**14**	**80**
Cirsium arvense	3	-	-	3	10	**5**	**60**
Forbs (short)							
native							
Epilobium ciliatum	3	-	-	-	3	**3**	**40**
Equisetum arvense	-	-	-	-	1	**1**	**20**
Equisetum nelsonii	-	-	-	-	3	**3**	**20**
Galium aparine	-	-	1	-	-	**1**	**20**
Galium triflorum	3	-	-	1	3	**2**	**60**
Grindelia squarrosa	-	1	-	-	1	**1**	**40**

Table 31 (continued).

Boxelder/Common Chokecherry Community
(*Acer negundo/Prunus virginiana*)

Plots:	CRK 431	PNR 411	LUM 411	PAI 411	CRK 421	AVG % COV	CONST %
Iva xanthifolia	-	-	10	-	3	**7**	**40**
Maianthemum stellatum	1	1	-	10	1	**3**	**80**
Mentha arvensis	3	-	-	-	3	**3**	**40**
Mimulus guttatus	-	-	-	-	1	**1**	**20**
Monarda fistulosa	-	-	-	-	3	**3**	**20**
Osmorhiza chilensis	10	1	-	1	3	**4**	**80**
Thalictrum dasycarpum	-	-	-	10	-	**10**	**20**
Toxicodendron rydbergii	-	-	-	3	-	**3**	**20**
Viola sp.	1	3	-	1	-	**2**	**60**
exotic							
Alyssum alyssoides	-	-	1	-	-	**1**	**20**
Kochia scoparia	-	1	-	-	-	**1**	**20**
Medicago lupulina	-	-	-	-	3	**3**	**20**
Nepeta cataria	-	-	-	-	1	**1**	**20**
Plantago major	-	-	-	-	3	**3**	**20**
Rorippa nasturtium-aquaticum	3	-	-	-	10	**7**	**40**
Rumex crispus	-	1	-	-	-	**1**	**20**
Taraxacum officinale	-	1	-	-	3	**2**	**40**
Trifolium repens	-	-	-	-	1	**1**	**20**
Vines							
native							
Clematis ligusticifolia	-	50	3	20	10	**21**	**80**
Humulus lupulus	-	-	-	1	-	**1**	**20**
Parthenocissus vitacea	-	-	-	1	-	**1**	**20**
exotic							
Calystegia sepium	-	-	-	1	-	**1**	**20**

Russian Olive Series
(*Elaeagnus angustifolia* Series)

Russian olive is an introduced tree that, in Wyoming, has become common along the Bighorn River and some of its tributaries. The Russian olives often establish in the understory of mature cottonwood stands. As the Russian olive stands mature and dominate an area, the understory changes by becoming more sparse and weedy. We sampled four stands in the Bighorn Basin belonging to the Russian olive series. The stands were at different stages of development, and at different levels of encroachment on the native cottonwood stands. One description of a Russian olive community, based on four Montana stands, has been compared to our Bighorn Basin stands. Most of the stands from our study differ from the previous community but there is too little information to describe our stands as new communities. Our stands are described within the series hierarchical level.

Russian Olive Stands
(*Elaeagnus angustifolia* Stands)

(4 stands sampled)

VEGETATION COMPOSITION AND STRUCTURE:

Russian olive trees dominates the upper layer of vegetation of these four stands (Tbl. 32). Their canopy cover has a wide range, from 20% to 90%. The composition and structure of the lower layers depend on the density to which the Russian olive have established. Eventually the stand becomes so dense that the herbaceous layer is quite sparse, with only shade tolerant species. Our four stands represent different stages of developement within the Russian olive series.

The stand with 20% cover of Russian olive appears to be transitional, and its development will depend on the hydrologic factors and beaver activity in the area. Presently, the stand has a single peachleaf willow tree (*Salix amygdaloides*), a low shrub layer of scattered water birch (*Betula accidentalis*), and narrowleaf cottonwood (*Populus angustifolia*) seedlings and saplings. The herbaceous layer of this stand has the most diversity of our Russian olive stands sampled, however it is not densely vegetated. Alkali muhly (*Muhlenbergia asperifolia*) is the dominant native grass, but there is even more introduced carpet bentgrass (*Agrostis stolonifera*) in the stand. Torrey rush (*Juncus torreyi*) and inland saltgrass (*Distichlis stricta*) are also present in moderate amounts. The most common forbs are: American licorice (*Glycyrrhiza lepidota*), giant goldenrod (*Solidago gigantea*), marsh sow-thistle (*Sonchus uliginosus*), and heath aster (*Aster ericoides*).

Two other stands are similar in that they have medium amounts of Russian olive trees with a dense shrub layer of Chinese tamarisk (*Tamarix chinensis*). The trees are approximately 14 ft (4 m) tall. The herbaceous layer is sparse with few grasses and forbs, tolerant of low light. Present in moderate amounts are: Japanese brome (*Bromus japonicus*), common quackgrass (*Elymus repens*), two-seed orach (*Atriplex heterosperma*), heart-podded whitetop (*Cardaria draba*), and Canada thistle (*Cirsium arvense*).

The final stand is dominated by a continuous, dense band of Russian olive trees, approximately 18 ft (5.5 m) tall. No shrubs are present in this stand. Slender wheatgrass (*Elymus trachycaulus*) is the most common herbaceous plant along with smooth brome (*Bromus inermis*). Little else is present in the herbaceous layer. Most other species of grasses and forbs present are exotic but they occur in very low amounts.

LOCATION:

All the Russian olive stands which we sampled occurred between 3,700 and 4,500 ft (1,130 - 1,370m) elevation (Fig. 23), in Big Horn and Hot Springs counties (Fig.22). Most were located in riparian zones of large, fifth order, perennial, low gradient rivers with very large drainage basin areas above the sites (Fig. 24). One stand was sampled on a first order, perennial, higher gradient channel.

ENVIRONMENT:

The surfaces occupied by Russian olive are usually the first terrace, which is 0.5 to 5 ft (0.2 - 1.5 m) above the channel (Fig. 28). Most stands are situated close to the channel and extend approximately 35 ft (10 m) away from the channel (Fig. 27).

SOILS:

The soil pits dug at the Russian olive stands usually had four horizons to 50 cm depth. The textures were commonly sandy clay loam or silty clay loams. Gravels or cobbles were usually present in one of the lower horizons.

The pH and electric conductivity of the surface horizon of our four stands ranged from 7.8 to 8.1 and 0.8 to 5.0 dS/m, respectively. The high electric conductivity in any horizon of this community was 5.5 dS/m at two plots at 35 and 18 and cm depth.

EXOTICS:

These Russian olive stands are dominated primarily by exotic species. In the tree layer, Russian olive is dominant and exotic. Two stands are dominated by Chinese tamarisk in the shrub layer. Abundant exotic grasses include: carpet bentgrass, Japanese brome, common quackgrass, and smooth brome. Canada thistle and marsh sow-thistle *(Sonchus uliginosus)* are exotic forbs present in moderate amounts.

ADJACENT COMMUNITIES:

Along a stretch of an inside meander bend, one Russian olive stand is adjacent to an herbaceous strip of sedges on the lower surface, which separates the stand from the channel. On the straight reaches or the outside meanders, the Russian olive stand is often adjacent to the channel. Away from the channel, the stand may be adjacent to a plains cottonwood-Russian olive community *(Populus deltoides-Elaeagnus angustifolia)*, plains cottonwood/skunkbush sumac community *(Populus deltoides/Rhus trilobata)*, or adjacent to the upland vegetation.

ECOLOGY:

The Russian olive tree is native to southern Europe and western Asia. It was introduced to North America and promoted as a desirable ornamental shade tree (Whitson et al. 1991), and is becoming very common along some rivers. Spring moisture and slightly alkaline soils seem to favor establishment of Russian olive seedlings (Olson and Knopf 1986, in Knight 1994). Many stands of older plains cottonwood or narrowleaf cottonwood trees are being replaced by Russian olive trees along low elevation rivers (Currier 1982, in Knight 1994).

In our work in the Bighorn Basin, we repeatedly saw examples of the replacement of cottonwood stands by Russian olive stands, especially along the Bighorn River. In some places, the Russian olive has become the major understory component of the cottonwood stands. From a distance, the Russian olive is not very noticable when the cottonwood canopy is continuous. In other places, the cottonwood have been almost totally replaced by the Russian olives and the different color of the stand (more the color of sagebrush) is noticable from a distance.

The change in hydrology and control of floods have affected the regeneration of the cottonwood stands (see ecology sections of plains cottonwood and narrowleaf cottonwood communities); there is frequently not the proper substrate available for seedling establishment. The Russian olive grows rapidly and can be a serious weed problem when it invades waterways (Whitson et al. 1991). The stems are armed with 1 to 2 inch woody thorns and the branches grow low to the ground. This makes it difficult for livestock and most wildlife to pass through the dense stands. Cavity nesting birds are in need of the cottonwood rather than Russian olive trees for habitat. The displacement of native floodplain forests by Russian olive can result in a 30% reduction of breeding bird species (Knopf 1991) in affected areas. The understory changes as the Russian olive establishes and becomes more dense. A sparse cover of shade tolerant species replace the more lush vegetation of cottonwood stands. An average of 75% of the surface had exposed soil at our four stands.

Hansen and others (1991) think that the Russian olive community type seems to represent a seral stage of the green ash/common chokecherry (*Fraxinus pennsylvanica/Prunus virginiana*) habitat type or the boxelder/common chokecherry (*Acer negundo/Prunus virginiana*) habitat type in Montana. These are the two communities which eventually replace cottonwood stands, but there was no evidence of boxelder or green ash in any of these stands. The Russian

olive re-sprouts when cut, forms very dense stands, and seems capable of persisting a very long time.

OTHER CLASSIFICATIONS:

A Russian olive communtiy type is identified in Montana (Hansen et al. 1991). Some of their stands had a greater shrub component with different species than ours.
The *Elaeagnus angustifolia* alliance is included without reference in A preliminary vegetation classification of the Western United States. This is within the section of Anthropogenic Alliances and Plant Associations.

Table 32. Percent canopy cover of species in plots of the Russian Olive *(Elaeagnus angustifoloa)* Series.

The average cover is calculated only for the plots in which the species occurred. Constancy is the percent of plots in which the species occurred.

Russian Olive (*Elaeagnus angustifolia*) Stands

Plots:	BIG 412	BHR 412	SIN 411	LIN 412
Trees				
native				
Salix amygdaloides	-	-	-	10
exotic				
Elaeagnus angustifolia	90	50	30	20
Shrubs				
native				
Artemisia tridentata	-	10	-	3
Betula occidentalis	-	-	-	20
Populus angustifolia (sapling)	-	-	-	3
Rhus trilobata	-	-	-	1
Ribes inerme	-	-	3	-
Rosa sp. (R. sayi or woodsii)	-	-	3	3
Salix exigua	-	-	-	3
Shepherdia argentea	-	-	-	3
Symphoricarpos sp.	-	-	-	1
exotic				
Tamarix chinensis	-	60	90	-
Shrubs (dwarf)				
native				
Populus angustifolia (seedling)	-	-	-	3

Table 32 (continued).

Russian Olive (*Elaeagnus angustifolia*) Stands

Plots:	BIG 412	BHR 412	SIN 411	LIN 412
Graminoids (tall)				
native				
Calamagrostis inexpansa	-	-	-	1
Carex lanuginosa	-	-	-	3
Carex nebrascensis	-	-	-	3
Phalaris arundinacea	1	-	-	-
Phragmites australis	-	3	-	-
exotic				
Bromus inermis	10	-	-	-
Elymus elongatus	-	-	3	-
Graminoids (short)				
native				
Distichlis stricta	-	10	-	10
Elymus canadensis	-	-	-	3
Elymus trachycaulus	30	-	-	3
Hordeum jubatum	1	-	3	-
Juncus balticus	-	-	-	1
Juncus compressus	1	-	-	-
Juncus longistylis	-	-	-	1
Juncus torreyi	-	-	-	10
Muhlenbergia asperifolia	-	-	-	20
Sporobolus airoides	1	3	-	-
exotic				
Agrostis stolonifera	1	-	1	30
Bromus japonicus	-	-	20	-
Elymus repens	-	-	20	-
Phleum pratense	3	-	-	-
Poa pratensis	1	-	3	-
Forbs (tall)				
native				
Asclepias speciosa	1	3	-	-
Atriplex heterosperma	-	-	20	-
Glycyrrhiza lepidota	-	-	-	10
Lactuca serriola	-	-	3	-
Oenothera villosa	-	-	-	1

Table 30 (continued).

Russian Olive (*Elaeagnus angustifolia*) Stands

Plots:	BIG 412	BHR 412	SIN 411	LIN 412
Solidago gigantea	-	-	-	10
Solidago occidentalis (= Euthamia occ.)	-	-	3	-
Xanthium strumarium	-	-	3	1
exotic				
Asparagus officinalis	1	-	-	-
Cardaria draba	1	20	-	-
Cirsium arvense	-	10	-	-
Medicago sativa	-	-	-	1
Melilotus albus	1	-	-	3
Melilotus officinalis	1	-	-	3
Sonchus uliginosus	-	-	3	10
Cirsium sp.	-	-	10	-
Forbs (short)				
native				
Artemisia biennis	-	-	3	-
Aster ericoides	-	-	-	10
Cirsium flodmanii	-	-	-	1
Conyza canadensis	-	-	1	-
Equisetum laevigatum	-	-	-	3
Grindelia squarrosa	-	-	1	3
Habenaria hyperborea	-	-	-	3
Iva xanthifolia	-	-	3	-
Lupinus argenteus	-	-	-	1
Maianthemum stellatum	1	-	-	-
exotic				
Centaurea repens	3	3	1	-
Kochia scoparia	3	1	1	-
Medicago lupulina	-	-	-	1
Plantago major	-	-	3	-
Sphaerophysa salsula	-	-	1	-
Taraxacum officinale	-	-	1	-
Fabaceae sp.3	-	-	-	1
Fabaceae sp.4	-	-	-	1
Vines				
native				
Clematis ligusticifolia	-	-	3	3

DISCUSSION

This classification provides descriptions of the major herbaceous, shrub, and forest/woodland riparian types of the Bighorn Basin study area. The classification is based on the existing vegetation regardless of successional status. Sites with low levels disturbance were preferentially chosen. We have attempted to determine the relationships between the physical environment and the vegetation in the riparian stands. This task is not complete, as more study of the effects of various land uses on the vegetation and the environment are needed. It is possible that land use may have obscured the vegetation/environment patterns to the point that soil salinity, height above the water table, elevation, and other factors are now poor predictors of what vegetation type will occur in a location.

The Bighorn Basin is an area where little work has emphasized the riparian vegetation, aside from studies along the Bighorn River (Knight et al. 1987, Akashi 1988, Bray 1996). This classification works toward filling that void. However, no classification is ever complete. This project weighted sampling site selection on stream segments with the more common elevation zone/upstream length class combinations. This actually allowed us to collect information in uncommonly studied areas. However, because there are a greater variety of stand types found along the larger channels such as the Greybull River, it would be good to collect more information than we have from stands of natural riparian vegetation along the larger channels. This classification should prove useful to land owners and managers because it helps to tie Wyoming's riparian areas into a large body of literature on ecology and management of riparian zones. Much of that information has been summarized in the detailed report on Montana riparian areas published by the Montana Riparian Association (Hansen et al. 1995). We have related our riparian types to theirs whenever possible. We are working toward development of a similar statewide riparian vegetation classification for Wyoming. We hope to continue our work into the Green River Basin sometime in the near future.

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APPENDIX

PLANT SPECIES LIST: Ordered by life forms and alphabetized within life form groups. Common names are included.

Scientific name	Common name
TREES	
native	
Acer negundo	boxelder
Juniperus osteosperma	Utah juniper
Juniperus scopulorum	Rocky Mountain juniper
Populus acuminata	lanceleaf cottonwood
Populus angustifoila	narrowleaf cottonwood
Populus deltoides	plains cottonwood
Salix amygdaloides	peachleaf willow
exotic	
Elaeagnus angustifolia	Russian olive
SHRUBS	
Shrub (> 0.5 m tall) or Tree Sapling	
native	
Alnus incana	mountain alder
Artemisia cana var. *cana*	basin silver sagebrush
Artemisia tridentata var. *tridentata*	basin big sagebrush
Artemisia tridentata var. *wyomingensis*	Wyoming big sagebrush
Atriplex canescens	fourwing saltbush
Betula occidentalis	water birch
Chrysothamnus linifolius	flaxleaf rabbitbrush
Chrysothamnus nauseosus	rubber rabbitbrush
Cornus sericea	red-osier dogwood
Pinus flexilis sapling	limber pine sapling
Populus angustifolia (sapling)	narrowleaf cottonwood
Prunus virginiana	common chokecherry
Rhus trilobata	skunkbush sumac
Ribes americanum	American black currant
Ribes aureum	golden currant
Ribes inerme	whitestem gooseberry
Ribes oxyacanthoides	Canada gooseberry
Rosa sayi	prickly rose

Scientific name	Common name
Shrub (> 0.5 m tall) or Tree Sapling	
native	
Rosa woodsii	Wood's rose
Salix exigua	coyote willow
Salix lasiandra	whiplash willow
Salix lutea	yellow willow
Sarcobatus vermiculatus	black greasewood
Shepherdia argentea	silver buffaloberry
Symphoricarpos occidentalis	western snowberry
Symphoricarpos sp.	snowberry
Yucca glauca	yucca
exotic	
Tamarix chinensis	Chinese tamarisk
Dwarf Shrubs (< 0.5 m tall) or Tree Seedlings	
native	
Acer negundo (seedling)	boxelder
Atriplex confertifolia	shadscale saltbush
Gutierrezia sarothrae	broom snakeweed
Juniper sp. seedling	juniper seedling
Juniperus scopulorum seedling	Rocky Mountain juniper seedling
Leptodactylon pungens	prickly phlox
Mahonia repens	creeping barberry
Populus angustifolia (seedling)	narrowleaf cottonwood
Populus deltoides (seedling)	plains cottonwood
HERBACEOUS	
Tall Graminoids (> 0.5 m tall)	
native	
Calamagrostis canadensis	bluejoint reedgrass
Calamagrostis inexpansa	northern reedgrass
Carex lanuginosa	woolly sedge
Carex nebrascensis	Nebraska sedge
Carex rostrata	beaked sedge
Deschampsia cespitosa	tufted hairgrass
Elymus canadensis	Canada wild rye
Elymus cinereus	basin wild rye
Glyceria grandis	American mannagrass

Scientific name	Common name
Tall Graminoids (> 0.5 m tall)	
native	
Juncus tenuis	poverty rush
Phalaris arundinacea	reed canarygrass
Phragmites australis	common reed
Scirpus acutus	hardstem bulrush
Scirpus pallidus	pale bulrush
Scirpus pungens	leafy bulrush
Spartina gracilis	alkali cordgrass
Tall Graminoids (> 0.5 m tall)	
exotic	
Bromus inermis	smooth brome
Elymus elongatus	tall wheatgrass
Short Graminoids (< 0.5 m tall)	
native	
Bouteloua gracilis	blue grama
Carex lenticularis	Kellogg's sedge
Catabrosa aquatica	common brookgrass
Distichlis stricta	inland saltgrass
Echinochloa muricata	cockspur/barnyard grass
Eleocharis palustris	creeping spikerush
Elymus albicans	Montana wheatgrass
Elymus glaucus	blue wild rye
Elymus lanceolatus	thick-spiked wheatgrass
Elymus smithii	western wheatgrass
Elymus sp1	wild rye
Elymus spicatus	bluebunch wheatgrass
Elymus trachycaulus	slender wheatgrass
Elymus virginicus	Virginia wild rye
Glyceria striata	fowl mannagrass
Hordeum brachyantherum	meadow barley
Hordeum caespitosum	bobtail barley
Hordeum jubatum	foxtail barley
Juncus balticus	baltic rush
Juncus compressus	rush

Scientific name	Common name
Short Graminoids (< 0.5 m tall)	
native	
Juncus longistylis	longstyle rush
Juncus torreyi	Torrey rush
Koeleria macrantha	Junegrass
Leucopoa kingii	King spikefescue
Muhlenbergia asperifolia	alkali muhly
Oryzopsis hymenoides	Indian ricegrass
Poa arida	plains bluegrass
Poa juncifolia	alkali bluegrass
Poa secunda	Sandberg bluegrass
Puccinellia nuttalliana	Nuttall's alkali grass
Schedonnardus paniculatus	tumblegrass
Sporobolus airoides	alkali dropseed
Stipa comata	needle-and-thread
Stipa viridula	green needlegrass
Triglochin concinnum	graceful arrow-grass
exotic	
Agropyron cristatum	crested wheatgrass
Agrostis stolonifera	carpet bent
Bromus japonicus	Japanese brome
Bromus tectorum	cheatgrass brome
Dactylis glomerata	common orchardgrass
Elymus repens	common quackgrass
Festuca pratensis	meadow fescue
Phleum pratense	common timothy
Poa pratensis	Kentucky bluegrass
Polypogon monspeliensis	rabbitfoot beardgrass
Unknown Graminoids	
unknown grass	unknown grass
unknown sedge	unknown sedge
Tall Forbs (> 0.5 m tall)	
native	
Ambrosia acanthicarpa	bur ragweed
Asclepias speciosa	showy milkweed
Aster foliaceus	leafy aster

Scientific name	Common name
Tall Forbs (> 0.5 m tall)	
native	
Astragalus canadensis	Canadian milk-vetch
Atriplex heterosperma	two-seed orach
Barbarea orthoceras	American wintercress
Chenopodium berlandieri	pitseed goosefoot
Chenopodium pratericola	desert goosefoot
Chenopodium rubrum	red goosefoot
Cicuta maculata	spotted waterhemlock
Delphinium geyeri	Geyer's larkspur
Epilobium angustifolium	fireweed willow-herb
Eupatorium maculatum	Joe Pye weed
Glycyrrhiza lepidota	American licorice
Hackelia deflexa	nodding stickseed
Helianthus annuus	common sunflower (weed)
Helianthus nuttallii	Nuttall's sunflower
Helianthus petiolaris	prairie sunflower
Helianthus sp.	sunflower
Heracleum sphondylium	hogweed cowparsnip
Lactuca oblongifolia	blue lettuce
Lactuca serriola	prickly lettuce
Oenothera villosa	biennial evening-primrose
Rudbeckia laciniata	cutleaf coneflower
Solidago canadensis	Canada goldenrod
Solidago gigantea	giant goldenrod
Solidago occidentalis	western goldenrod
Typha latifolia	common cattail
Urtica dioica	stinging nettle
Xanthium strumarium	cocklebur
exotic	
Arctium minus	common burdock
Asparagus officinalis	asparagus
Cardaria draba	heart-podded whitetop
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Lepidium latifolium	broadleaved peppergrass

Scientific name	Common name
Tall Forbs (> 0.5 m tall)	
exotic	
Medicago sativa	alfalfa
Melilotus albus	white sweet-clover
Melilotus officinalis	yellow sweet-clover
Polygonum persicaria	ladysthumb
Sonchus uliginosus	marsh sow-thistle
Cirsium sp.	thistle
Short Forbs (< 0.5 m tall)	
native	
Achillea millefolium	common yarrow
Allium sp.	onion
Allium textile	prairie onion
Apocynum cannabinum	Indian hemp dogbane
Artemisia biennis	biennial wormwood
Artemisia frigida	fringed sagewort
Artemisia ludoviciana	Louisiana sagewort
Aster ascendens	longleaf aster
Aster bracteolatus	Eaton's aster (= A. eatonii)
Aster ciliolatus	Lindley aster
Aster ericoides	heath aster
Astragalus adsurgens	standing milkvetch
Astragalus bisulcatus	two grooved milkvetch
Astragalus grayi	Gray's milk-vetch
Astragalus miser	weedy milkvetch
Bidens cernua	nodding beggarticks
Calochortus nuttallii	Nuttall's sego-lily
Castilleja sp.1	Indian paintbrush
Castilleja sp.2	Indian paintbrush
Castilleja sp.3	Indian paintbrush
Cirsium flodmanii	Flodman thistle
Cleome serrulata	Rocky Mountain beeplant
Comandra umbellata	bastard toad-flax
Conyza canadensis	Canada horseweed
Crepis occidentalis	western hawksbeard
Cryptantha celosioides	northern cryptantha

Scientific name	Common name
Short Forbs (< 0.5 m tall)	
native	
Cryptantha minima	little miner's candle
Cymopterus terebinthinus	rock parsley
Descurainia pinnata	pinnate tansymustard
Epilobium ciliatum	willow-herb
Equisetum arvense	field horsetail
Equisetum hyemale	common scouringrush
Equisetum laevigatum	smooth horsetail
Equisetum nelsonii	Nelson variegated horsetail
Galium aparine	catchweed bedstraw
Galium triflorum	fragrant bedstraw
Grindelia squarrosa	curlycup gumweed
Habenaria hyperborea	northern green bog-orchid
Heterotheca villosa	hairy golden aster
Ipomopsis congesta	ballhead ipomopsis
Ipomopsis sp.	unknown ipomopsis
Iva axillaris	poverty sumpweed
Iva xanthifolia	marshelder sumpweed
Linum lewisii	Lewis flax
Lithospermum ruderale	wayside gromwell
Lomatium foeniculaceum	fennel-leaved desert-parsley
Lupinus argenteus	silvery lupine
Lupinus pusillus	rusty lupine
Lycopus americanus	American bugleweed
Lycopus asper	rough bugleweed
Lygodesmia juncea	rush-like skeletonweed
Machaeranthera canescens	hoary aster
Machaeranthera tanacetifolia	tansy aster
Maianthemum stellatum	starry false Solomon's-seal
Mentha arvensis	field mint
Mimulus guttatus	common yellow monkey-flower
Monarda fistulosa	wild bergamot beebalm
Musineon divaricatum	leafy musineon
Opuntia polyacantha	plains pricklypear
Osmorhiza chilensis	spreading sweetroot

Scientific name	Common name
Short Forbs (< 0.5 m tall)	
native	
Oxytropis deflexa	hangpod crazyweed
Oxytropis sericea	silky locoweed
Penstemon nitidus	shining penstemon
Polygonum amphibium	water smartweed
Psoralidium lanceolatum	lemon scurfpea
Ranunculus cymbalaria	shore buttercup
Ranunculus macounii	Macoun's buttercup
Ranunculus sceleratus	celeryleaved buttercup
Rumex maritimus	golden dock
Rumex salicifolius	willowleaf dock
Solidago simplex	Mt. Albert goldenrod
Sphaeralcea coccinea	common globemallow
Thalictrum dasycarpum	purple meadowrue
Toxicodendron rydbergii	poison ivy
Vicia americana	American vetch
Viola sp.1	violet 1
Viola sp.2	violet 2
Viola sp.3	violet 3
Viola sp.4	violet 4
Xylorhiza glabriuscula	woodyaster
Short Forbs (< 0.5 m tall)	
exotic	
Alyssum alyssoides	pale alyssum
Alyssum desertorum	desert alyssum
Cardaria chalepensis	lens-padded hoary cress
Cardaria pubescens	globepodded hoarycress
Centaurea repens	Russian knapweed
Filago arvensis	field fluffweed
Halogeton glomeratus	common halogeton
Kochia scoparia	fireweed summer cypress
Lepidium perfoliatum	clasping peppergrass
Medicago lupulina	black medic
Nepeta cataria	common catnip
Plantago major	common plantain

Scientific name	Common name
Short Forbs (< 0.5 m tall)	
exotic	
Polygonum lapathifolium	curlthumb knotweed
Rorippa nasturtium-aquaticum	common watercress
Rumex crispus	curly dock
Salsola australis	common Russian thistle
Sisymbrium loeselii	tall hedgemustard
Sphaerophysa salsula	Swainsonpea
Taraxacum officinale	common dandelion
Thlaspi arvense	field pennycress
Tragopogon dubius	yellow salsify
Trifolium fragiferum	strawberry clover
Trifolium pratense	red clover
Trifolium repens	white clover
Veronica anagallis-aquatica	water speedwell
Unknown Forbs	
Fabaceae sp.1	unknown pea
Fabaceae sp.2	unknown pea
Fabaceae sp.3	unknown pea
Fabaceae sp.4	unknown pea
unknown forb	unknown forb
Vines	
native	
Clematis ligusticifolia	western virginsbower
Humulus lupulus	common hops
Parthenocissus vitacea	Virginia creeper
Vitis riparia	wild grape
exotic	
Calystegia sepium	hedge bindweed