Fort Union Trading Post National Historic Site
2002 VEGETATION MAPPING PROJECT

FINAL REPORT November 10, 2002

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Remote Sensing and GIS Group
Technical Service Center
U.S. Department of the Interior
Bureau of Reclamation
Denver, CO

U.S. Department of the Interior
Mission Statement

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

Mission of the
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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

USGS-NPS VEGETATION MAPPING

FORT UNION TRADING POST NATIONAL HISTORIC SITE

David E. Salas
CST Inc.

Michael J. Pucherelli
Bureau of Reclamation

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LIST OF CONTACTS

Bureau of Reclamation

	Remote Sensing and Geographic Information Group (RSGIG) P.O. Box 25007 Mail Code D-8260 Denver Federal Center, Bldg 56 Denver, CO 80225 Phone: 303 445-2266 Fax: 303 445-6337
• **Mike Pucherelli**	RSGIG Group Manager Phone: (303) 445-2267 E-mail: mpucherelli@do.usbr.gov
• **David E. Salas**	FOUS Mapping Project Leader Phone: (303) 445-3619 E-mail: desalas@do.usbr.gov

United States Geological Survey Biological Resources Division

	Center for Biological Informatics Denver Federal Center, Bldg. 810 Room 8000, MS 302 Denver, CO 80225 – 0046
• **Karl Brown**	Project Coordinator USGS-NPS Vegetation Mapping Program Phone: (303) 202-4240 E-mail: karl_brown@usgs.gov
• **Susan Stitt**	Geospatial Technology Specialist Phone: (303) 202-4232 E-mail: susan_stitt@usgs.gov

National Park Service

	Fort Union Trading Post NHS 15550 Hwy 1804 Williston, ND 58801 Phone: (701) 572 7622 Website: www.nps.gov/fous
• **Mike Story** (Located at CBI)	NPS Vegetation Mapping Program Liaison Phone: (303) 202-4236 E-mail: mike_story@nps.gov
• **Terry Halveron**	Superintendent Fort Union Trading Post National Historic Site 15550 Hwy 1804 Williston, ND 58801 Phone: (701) 572 9083 E-mail: FOUS_Superintendent@nps.gov

NatureServe

	Minneapolis Satellite Office 1313 Fifth Street, S.E., # 314 Minneapolis, MN 55414 Phone: (612) 331-0710 Fax: (612) 331-0770 Web site: www.natureserve.org
• **Dennis Grossman**	Chief Ecologist Phone: (703) 841-5305 E-mail: dgrossman@tnc.org
• **Jim Drake**	Project Manager Phone: (612) 331-0729 E-mail: jdrake@tnc.org
• **Shannon Menard**	Regional Ecologist Phone: (518) 673-0921 E-mail: dfaber-lang@tnc.org

LIST OF CONTRIBUTORS

Shannon Menard, Senior Regional Ecologist, NatureServe
Jim Drake, Project Manager, NatureServe
Dan Cogan, Project Manager, USBR

EXECUTIVE SUMMARY

The 2002 Fort Union Trading Post National Historic Site Vegetation Mapping Project was conducted as part of and in accordance with the U.S. Geological Survey/National Park Service (USGS/NPS) Vegetation Mapping Program. This Program is being administered by the Center for Biological Informatics (CBI), Biological Resources Division of the USGS, Denver, Colorado and was initiated as part of the NPS Inventory & Monitoring Program. The primary goal of the Program is to classify, describe, and map vegetation for approximately 270 NPS units.

The Remote Sensing and GIS Group (RSGIG), Technical Service Center, Bureau of Reclamation, Department of Interior, Denver, Colorado performed this mapping project.

In addition to the main contractor, NatureServe provided initial descriptions and methodology for the vegetation classification.

Seventeen land cover classes were used for interpretation of approximately 2084 acres encompassing the Park and surrounding environs. Of these land cover classes, 12 are native or semi-native classes. Vegetation map classes were determined through field reconnaissance and reference to the preliminary list of potential vegetation types provided by NatureServe. The vegetation map was created from photographic interpretation of June 20, 2002, 1:12,000 scale color aerial photographs (0.5 hectare minimum mapping unit). All vegetation and land-use information was then transferred to a GIS database using the latest grayscale USGS digital orthophoto quarter-quads as the base map and a combination of on-screen digitizing and scanning techniques. Overall thematic map accuracy for the Park is considered 100% as all interpreted polygons received a field visit for verification.

Field work was conducted during the last week in August, 2002.

Final products described in this report and on the accompanying CD-ROM disk include the following:

- Vegetation Classification Descriptions;
- Representative Photographs (including digital files) from field visits (hard copy photographs only in report delivered to FOUS);
- Digital and Hard Copy Vegetation Map;
- Digital Vegetation Coverage;
- FGDC-compliant Spatial Metadata;
- Aerial Photography acquired for the project (only in report delivered to FOUS)
- Final Report.

INTRODUCTION

This mapping effort originates from a long-term vegetation monitoring program that is part of a larger Inventory and Monitoring (I&M) program started by the National Park Service (NPS). I&M goals are, among others, to map the vegetation of all national parks and monuments and provide a baseline inventory of vegetation. The I&M program currently works in close cooperation with the Biological Resources Division (BRD) of the United States Geological Survey (USGS). The USGS/BRD continues overall management and oversight of ongoing mapping efforts in close cooperation with the NPS. Contractors for each park vary. For Fort Union Trading Post National Historic Site the principal contractor is the U.S. Bureau of Reclamation (BOR), Denver Technical Center, Remote Sensing and Geographic Information Group (D-8260).

Objectives and Scope

The purposes of the mapping effort are varied and include the following:

- Provides support for NPS Resources Management;
- Promotes vegetation-related research for both NPS and USGS/BRD;
- Provides support for NPS Planning and Compliance;
- Adds to the information base for NPS Interpretation;
- Assists in NPS Operations.

PROJECT AREA

Location

Fort Union Trading Post National Historic Site (FOUS) is located in eastern North Dakota and straddles the border with Montana. The largest portion of FOUS lies on the northern side of the Missouri River. A smaller section lies on the southern bank (Figures 1a and b).

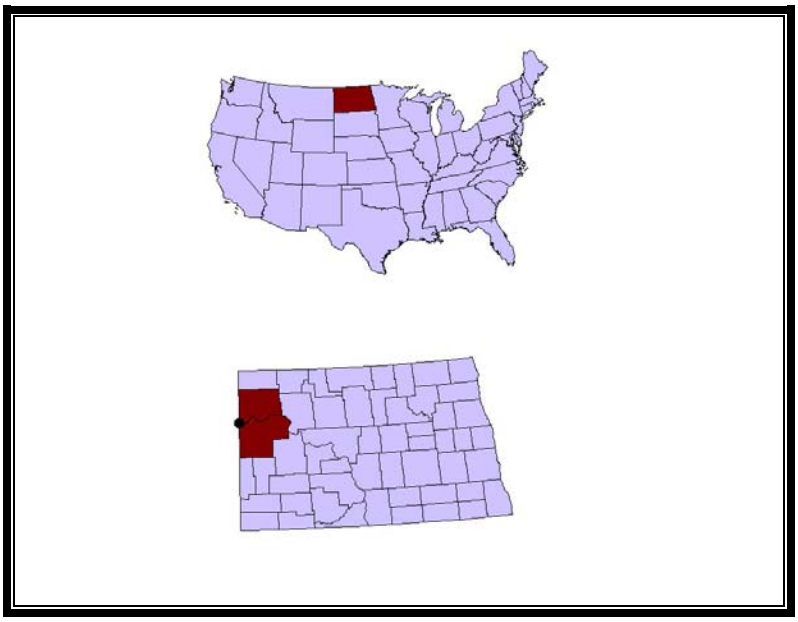

Figure 1a. Location map for Fort Union Trading Post National Historic Site

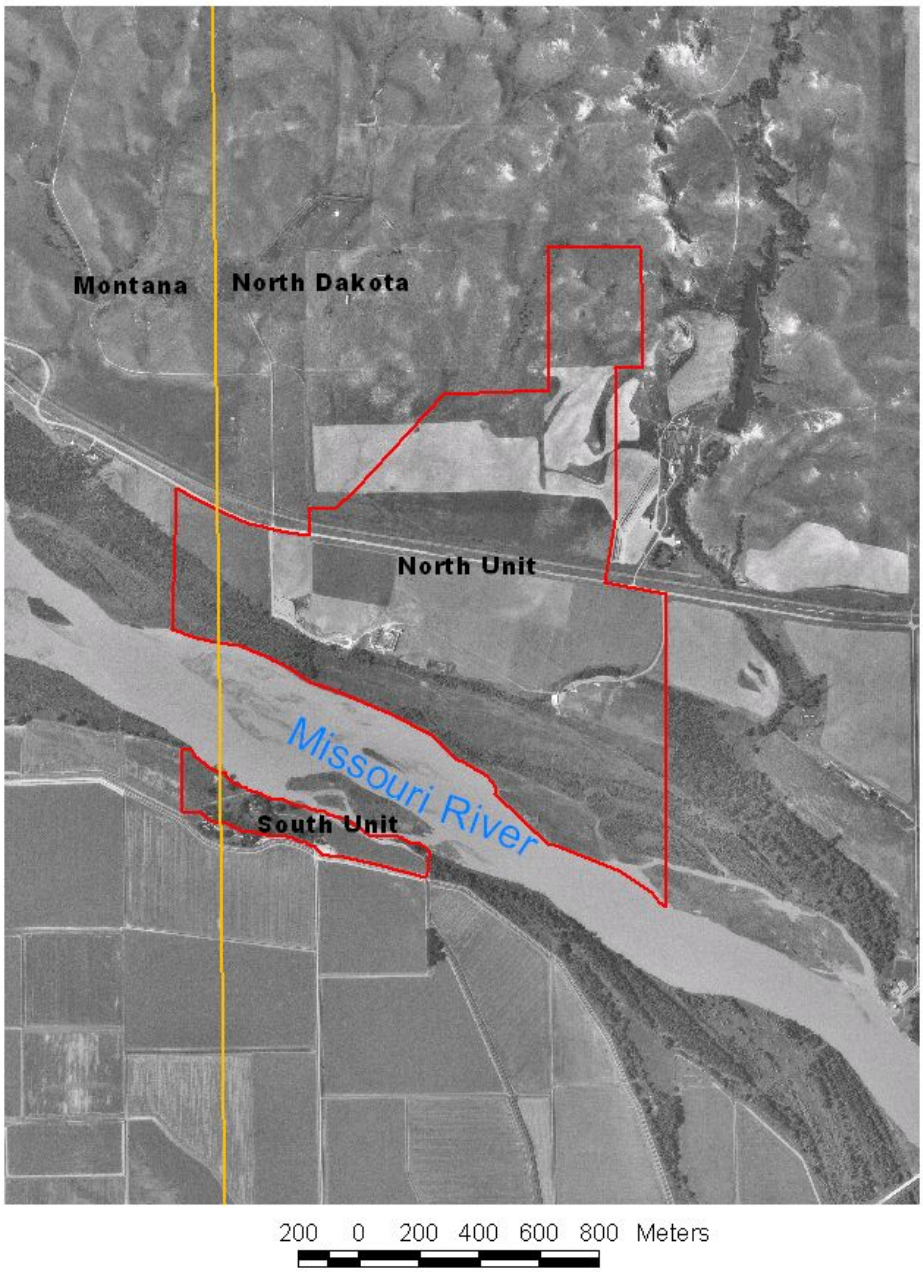

Figure 2b. Location map for Fort Union Trading Post National Historic Site.

Climate

North Dakota lies in the center of the North American continent and has a typical continental semi-arid climate. Cold, dry arctic air masses create a severe winter climate with temperatures dropping to 0° F on a regular basis. The summers are hot and dry. In both winter and summer one can expect large temperature fluctuations during the day and low relative humidity.

The historical precipitation trend has not changed since record keeping began in (1985) (Figure 3). During August 2002, an average of 3.53 inches of precipitation fell in the state. This was 1.42 inches more than the 1895 - 2002 average, the 7th wettest month on record. The precipitation trend for 1895 to present is 0.00 inches per decade. Historical temperature shows an increase since 1985 (Figure 4). The average temperature in August 2002 was 66.9 F. This was +0.3 F warmer than the 1895-2002 average, the 52nd warmest August in 108 years. The temperature trend for 1895 to present is +0.1 degrees Fahrenheit per decade (Climate Monitoring Reports and Products National Climatic Data Center http://lwf.ncdc.noaa.gov/oa/climate/research/monitoring.html).

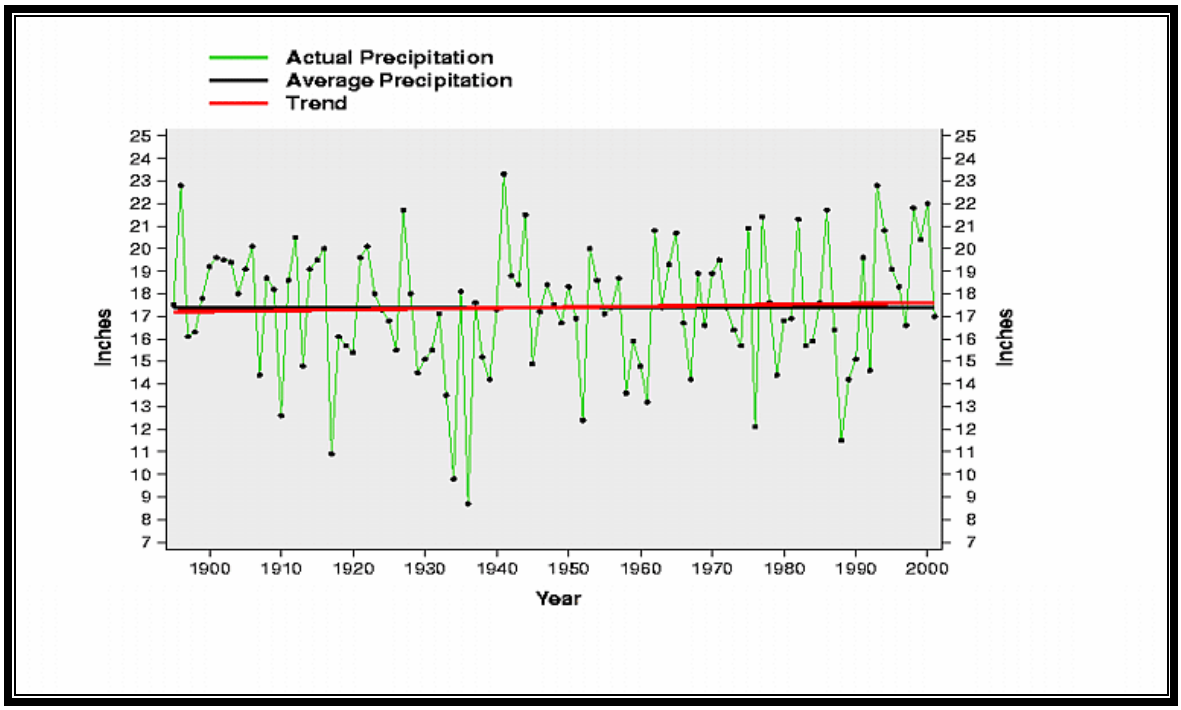

Figure 3. Historical precipitation trend 1895 – 2002, North Dakota (National Climatic Data Center).

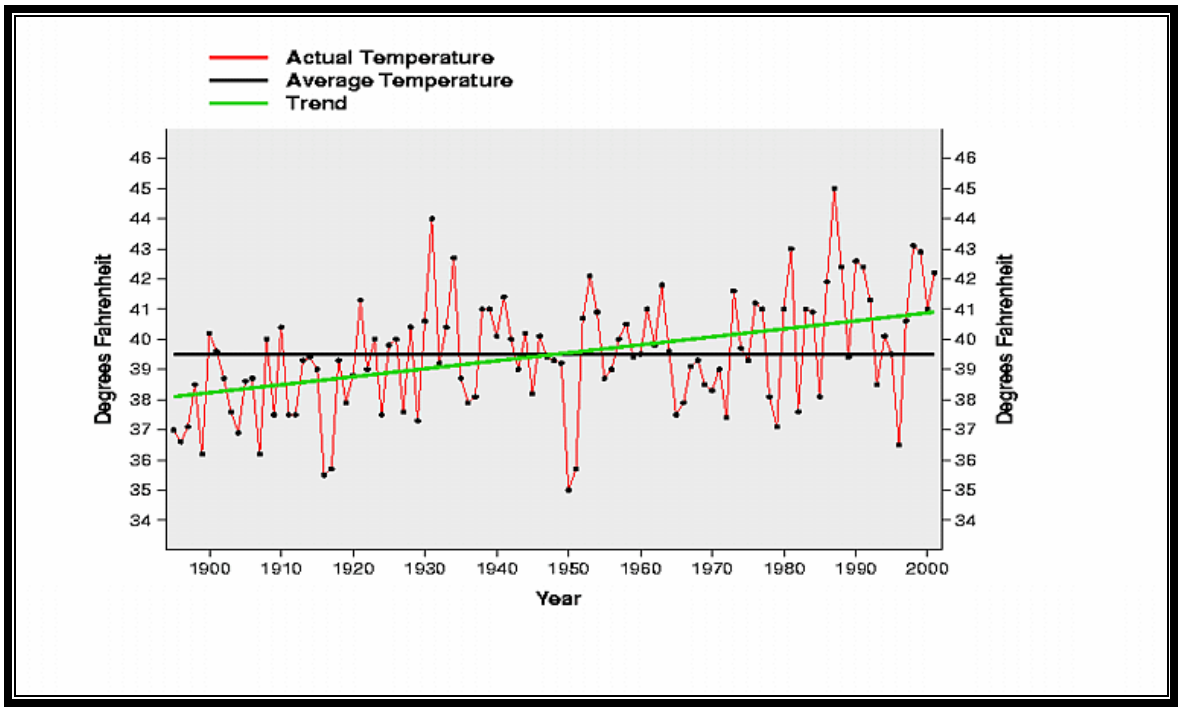

Figure 4. Historical temperature trend 1895 – 2002, North Dakota (National Climatic Data Center).

Geology

FOUS lies within the Williston basin, which encompasses most of North Dakota. The Williston Basin is a structural and sedimentary basin located on the western edge of the craton in central North America (Flores and Keighin 1999). Most of FOUS lies on recent alluvium from the Missouri River. However, the northern upland section of the Park lies within the Bullion Creek Formation. Capping the Bullion Creek Formation is the Sentinel Butte Formation, which lies just outside the Park to the northeast. Both these formations are typical of the area and also occur within the nearby north unit of Theodore Roosevelt National Park (Figure 5). The Bullion Creek Formation is a Paleocene deposit and forms part of the Fort Union Group.

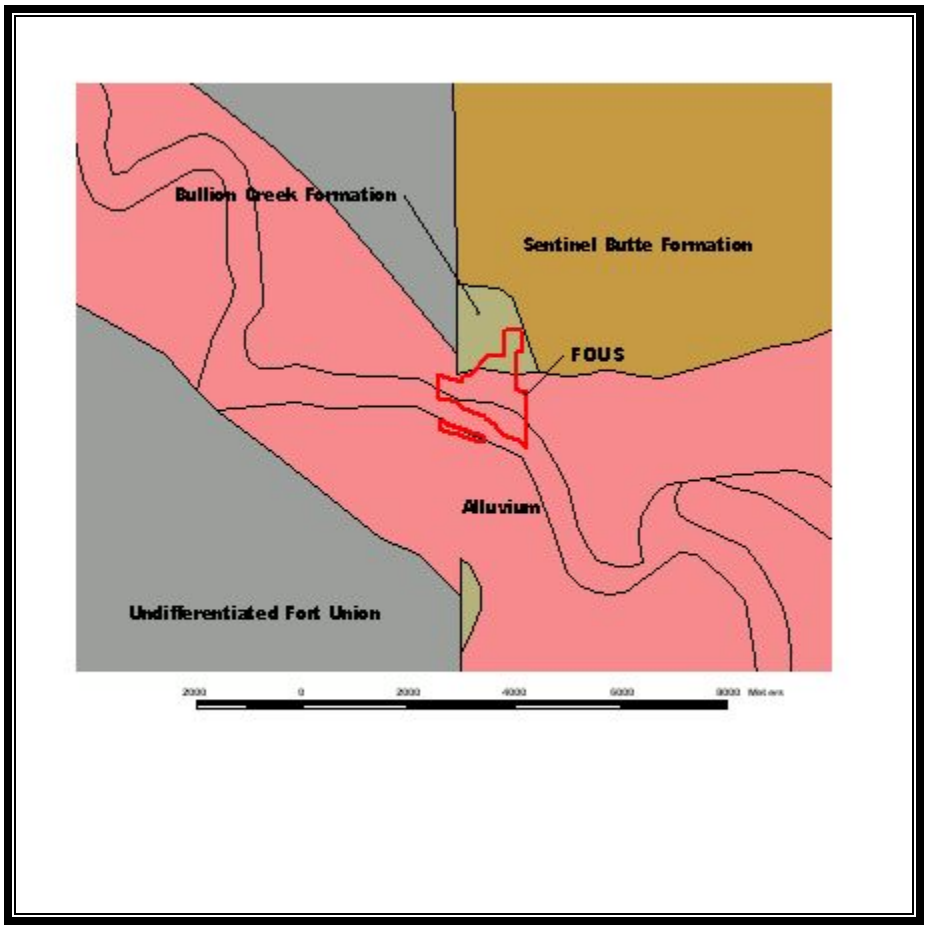

Figure 5. Geology map of FOUS end surroundings.

Topography

FOUS lies adjacent to the Missouri River and encompasses both upland and bottomland topography. The main visitation area is on a bench at 1870 ft and the highest point is on Boomer Ridge at 2083 ft above mean sea level. North of the State Highway 1804 the bench transitions into sloping upland that gradually transitions into more rugged hill and swale topography (Figures 6 and 7).

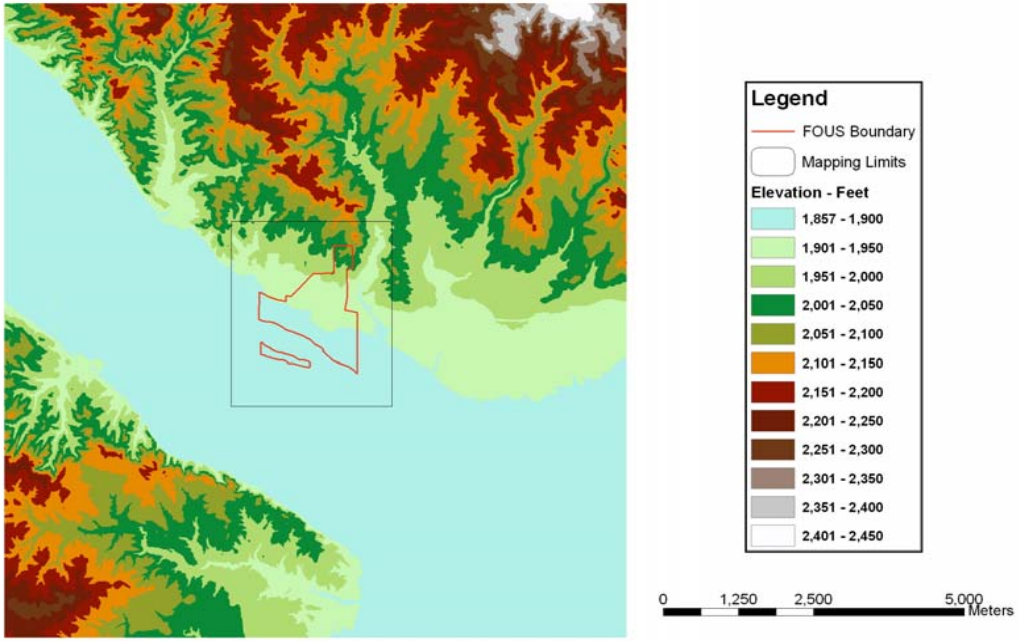

Figure 6. Topographic view of FOUS and surrounding areas.

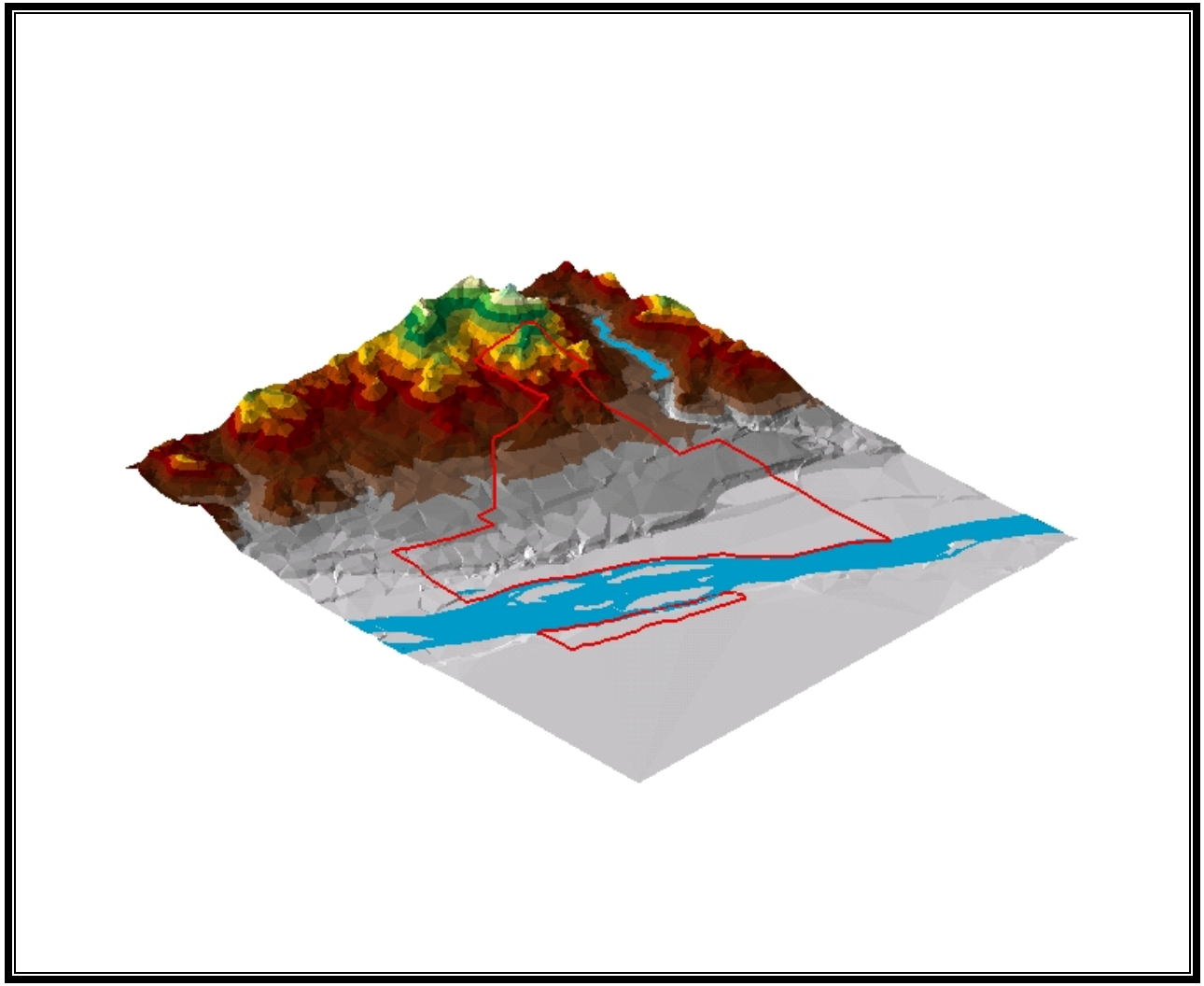

Figure 7. Three dimensional view of FOUS and surrounding areas.

Soils

Soils within the mapping boundary vary and are distinct from one side of the Missouri River to the other. Loams, silt loams, silty clays and some rock outcrop in the northwest section dominate the northern portion. Silty clay loams, clays, and fine sandy loams dominate south of the river (Figure 6). The south bank unit of FOUS is made up of very fine sandy loam, poorly drained phase of river bottoms and terraces. Water table is typically within a few feet of the surface and is characterized by dense brush (Edwards and Ableiter 1933). The Park itself is dominated by silt loam, loam, and silty clay in the northern section and fine sandy loams in the southern section. Table 1 details the acreage for each soil type for the mapping area and within the park boundary.

Figure 8 and Table 1 were compiled from Soil Conservation Service reports. This entailed combining data from two states and four counties. These included Williams County, North Dakota (Sucik 2000), McKenzie County North Dakota (Edwards and Ableiter 1942), Roosevelt County, Montana (Smetana 1985) and Richland County, Montana (1980). The digital database contains a soil code from the original report, the soil name and texture. Figure 8 was created by dissolving boundaries between like textures. Differences in soil descriptions produce an edge effect when crossing county boundaries. This is apparent in the northern portion of the mapping area where definitions of Silt Loam and Loam differ. These “edge” effects are typical for all soil surveys.

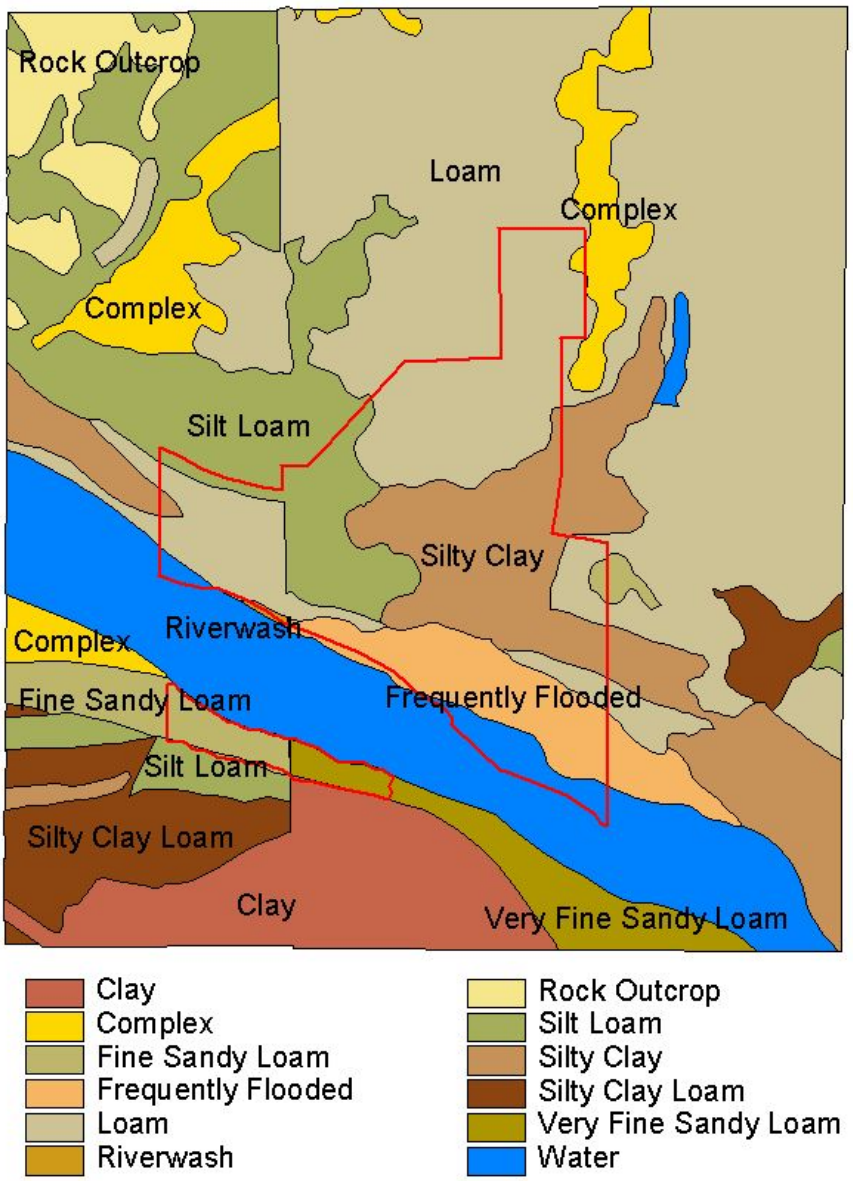

Figure 8. Soil texture map of FOUS and surrounding areas.

Soil Texture	Mapping Boundary	FOUS
Clay	163.7	0.3
Complex	135.4	1.0
Fine Sandy Loam	51.3	17.5
Frequently Flooded	81.7	59.9
Loam	975.9	166.7
Riverwash	1.3	0.6
Rock Outcrop	75.8	-
Silt Loam	345.1	56.3
Silty Clay	259.7	104.3
Silty Clay Loam	125.6	-
Very Fine Sandy Loam	61.9	9.7
Open Water	299.6	21.3
Total	**2576.9**	**437.7**

Table 1. Soil textures and acreages within mapping boundary and FOUS boundary.

Vegetation

FOUS lies within the Dry Domain, Temperate Steppe Division, Great Plains – Palouse Dry Steppe Province (Province 331) as described by Bailey (1994). The area is dominated by shortgrass prairie, as is most of this region. Given the proximity to the Missouri River, a wooded component is also present.

Grasslands in the vicinity of FOUS are typically made up of mixed grass prairies that are dominated by midgrasses, shortgrasses, and upland sedges. Tall grasses dominated by Big Bluestem exist in the western portion of the state but only in isolated patches (Whitman and Wali 1975). Within the mixed grass prairie are a number of alliances and associations. NatureServe (2001) recognizes 15 associations within the Great Plains mixedgrass, shortgrass and sand prairies. Tall grass prairie components also are present within the mapping area but represent a small percent of the mapped area.

The wooded component is made up of *Fraxinus pennsylvanica*, *Ulmus americana* and *Populus deltoides*. There are three associations within two alliances. These are found along the Missouri River and within woody draws. These typically include a shrub component that may include *Symphoricarpos occidentalis* and *Prunus virginiana*.

Much of the vegetation surrounding Fort Union can be typified as northern Great Plains short grass prairie or mixed-grass prairie. The species composition varies according to habitat however one will often encounter species such as *Pascopyrum smithii*, *Hesperostipa comata*, *Bouteloua gracilis*, *Koeleria pyramidata*, and *Buchloe dactyloides*. Various species of *Artemisia* spp., *Ribes* spp. and *Symphoricarpos occidentalis* are the most common shrub species mixed with different grassland types.

The vegetation of the area has been significantly altered since Fort Union was first established and perhaps even prior to that by local tribes that inhabited and used the resources. Weber (1859) and Catlin (1891) both reported extensive use of the area by both horses and cattle. This would have seriously impacted the native vegetation. In addition, bison also probably used the area extensively and may have helped to maintain a short grass prairie (Larson 1940, England and Devos (1969). Given the extensive use of the area by European settlers, natural vegetation probably does not exist. However, Willard (in Weist et. al. 1980) developed a plant list of potential native species after a review of the literature and survey of the general area. Willard has subdivided the FOUS into eight ecologically distinct types. These are:

- Hardwood Draws;
- Upland Hills;
- Upland Prairie;
- Lowland Prairie;
- Hardwood Bottomland;
- Willow Bottomland;
- Wet Bottomland;
- South Bank of the Missouri River.

Dominant and subdominant species for each type are described and include both native and exotic vegetation. The species list is lengthy (Appendix 1) however the most common upland species include *Bouteloua gracilis*, *Hesperostipa comata*, and *Pascopyrum smithii.* Lowland or bottomland species include *Pascopyrum smithii*, *Poa* spp., *Salix* spp., *Populus* spp., *Rosa* spp., *Artemesia cana*, *Chrysothamnus nauseosus*, *Symphoricarpus albus* and others (Payne 1973).

Species List

No new survey was conducted to produce a species list as Willard (1985) produced a rather complete list. Some modifications were made to the list. These include updating the species name, providing a reference for the name, providing a common name and reordering the species by family. The updates to species name include the following:

Agropyron dasystachyum = Elymus lanceolatus
Poa sandbergii = Poa secunda
Agropyron smithii = Pascopyrum smithii
Phragmites communis = Phragmites australis
Koeleria cristata = Koeleria macrantha
Ceratoides lanata = Krascheninnikivia lanata
Atriplex nuttallii = Atriplex canescens

Willard (1985) listed *Rhus americana* however no reference to this exists in the literature. I assume he meant *R. aromatica*. *R. aromatica* is common for the area so this was substituted in his list.

All species were compared to the USDA Plants database (USDA, NRCS 2002) which was accessed over the internet. In addition, Willard's (1985) was compared to "Species in Parks Flora and Fauna Database Online Query System" (http://ice.ucdavis.edu/nps/sbypark.html) and omissions were updated. Scientific names and references were also updated. Included in the list are the USDA common names. Appendix 1 contains the nomenclature for common names followed by the USDA's nomenclature if different. A total of 34 families, 84 genera and 103 species have been catalogued for FOUS.

Fire History

The recorded fire history of Fort Union is scant however historically the entire area has probably been affected by or manipulated by fire. It has been known for some time now that fires where a regular part of the landscape ecology and are considered in large part to have maintained the grasslands (Cutright 1969, Wells 1965, Sauer 1950, Tester and Marshall 1962, Kirsch and Kruse 1972). The invasion of former grassland sites by shrubs and trees is a well-known result of fire reduction and may also have affected the native vegetation of the area.

METHODS

Development of Programmatic and Technical Team: This project required the combined expertise and oversight of several organizations. Oversight and programmatic considerations are managed by the Center for Biological Informatics of the Biological Resources Division of the U.S. Geological Survey. The National Park Service provided additional guidance.

The technical responsibilities for the mapping effort were divided between NatureServe and BOR.

NatureServe responsibilities and deliverables included the following:

- A preliminary vegetation classification system based upon field species level data and consistent with the Standard National Classification System at the Alliance or Community Element level
- Documentation that describes the national classes at the global level.
- Technical opinion to BOR as the mapping portion of the project proceeds.

BOR responsibilities and deliverables included the following:

- Digital files of vegetation on Compact (CD) including topology and labeling for height, density, and pattern subclasses; location of field sample sites;
- Ancillary digital files developed during the mapping process;
- Digital FGDC compliant metadata file for each digital file;
- Annotated field site photographs;
- Hard copy vegetation map;
- Final report describing all procedures used in developing the final map;
- Documentation that describes the local vegetation;

Planning and Scoping

This project incorporated the combined expertise and oversight of several organizations. Oversight and programmatic considerations were managed by the Center for Biological Informatics (CBI) of the USGS/BRD. NPS and FOUS personnel provided additional guidance on specific Park needs. The technical mapping portion was contracted to the BOR RSGIG in Denver, CO. NatureServe contracted separately to provide a preliminary list of potential plant associations that might exist in the area.

BOR Responsibilities and Deliverables:

- Interpret aerial photographs;

- Transfer interpreted information to a digital spatial database and produce hard copy (paper) vegetation maps;
- Create digital vegetation coverages including relevant attribute information;
- Produce Arc/Info export file for observation points locations;
- Provide an annotated list of representative field site photographs/slides;
- Provide any ancillary digital files developed during the mapping process;
- Document and record digital FGDC compliant metadata files (*.html) for all created spatial data;
- Final report and CD-ROM describing procedures used in preparing all products

Scoping Meeting:

A scoping meeting was held at the Knife River Indian Village Historical Site to discuss both the Knife River and Fort Union vegetation mapping efforts on March 28, 2002. The purpose of this meeting was to determine the project mapping extent, discuss logistics, and develop a sampling approach.

Preliminary Data Collection and Review of Existing Information

To minimize duplication of previous work and to aid in the overall mapping project, existing maps and reports were obtained from various sources. The staff at Theodore Roosevelt National Park provided digital material for numerous themes including geology. Digital elevation models (DEM's), digital line graphics (DLG's), and digital raster graphics (DRG's) were obtained from the USGS. The DEM's were further manipulated to create slope and aspect maps.

A preliminary list of community types thought to have a high likelihood of being in the mapping area was used to develop the preliminary vegetation classification. Modifications were made to the list through a literature review and by contacting knowledgeable experts.

Aerial Photography Acquisition

The aerial photo contract to Horizons, Incorporated of Rapid City, South Dakota was for the acquisition of color aerial photography for FOUS and vicinity using 1:12,000 scale photography typically used for photointerpretation. The project area is covered by 9 1:12,000 scale aerial photographs. (Figure 9) printed on 9"x9" stock. Overlap for these photos were approximately 50-60% and sidelap between flight lines was approximately 20-30%.

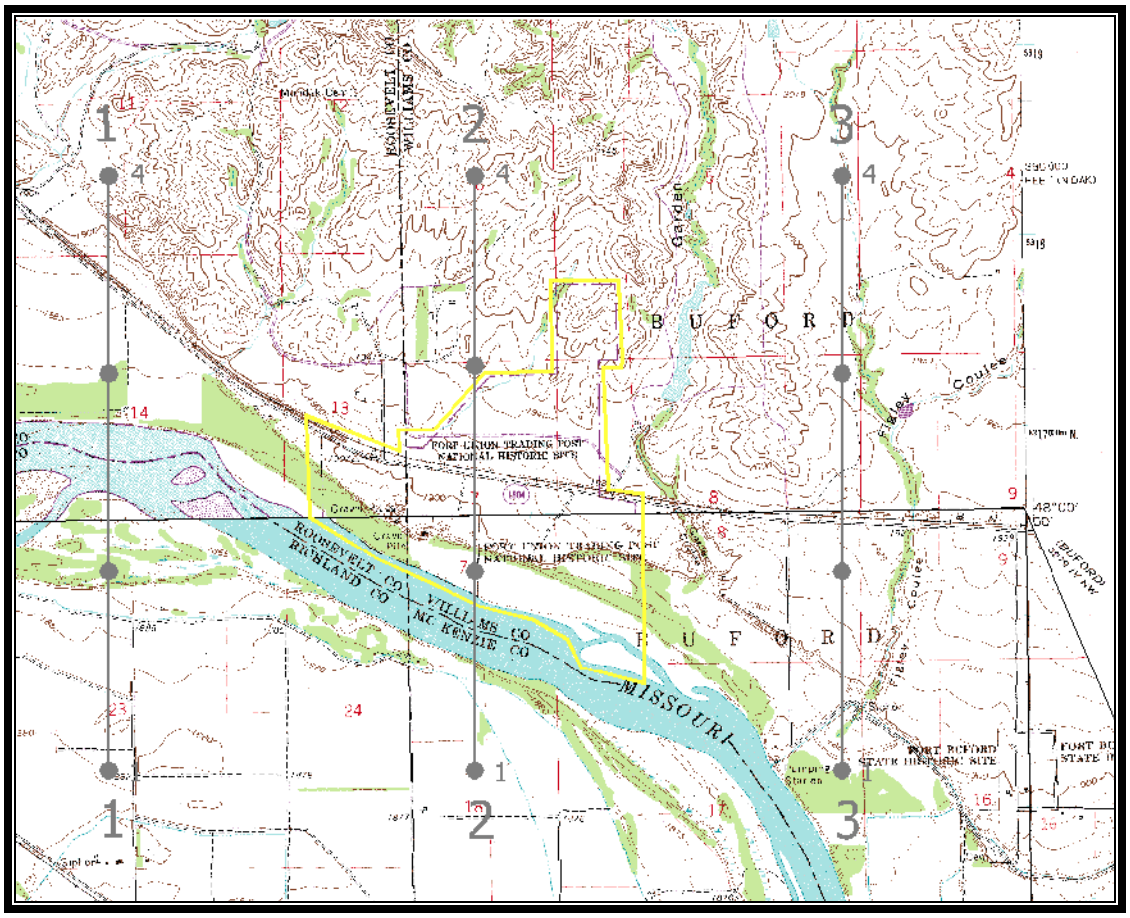

Figure 9. Flight line and photograph centers for Fort Union Trading Post National Historic Site

Field Survey

The field survey for this Park differs from other larger parks primarily in the vegetation characterization and ground survey. Vegetation for larger parks typically includes large numbers of vegetation plots which extensively document the species and their cover values. These data are then subjected to numerical analysis and comparison to existing vegetation types. New vegetation types may be described and existing vegetation types are updated with the information obtained from the new survey. Observation plots are also collected. Observation plots provide the data analysis with more data and are designed to provide a quick overview. These observation plots are extremely useful but are less complete. Both plot and observation data provide support to the photointerpretive effort.

Ground surveys for larger parks are conducted using a statistical approach given that not all delineated polygons can receive a field visit to verify their vegetation classification. In addition, larger parks are also subjected to an accuracy assessment, again using a

statistical sampling approach. Given FOUS's small size, almost all delineated polygons received a visit to verify its classification. Because almost all delineated polygons were visited, no accuracy assessment was required. In spite of the differences in field technique the protocols employed for this park do comply with those described in "Field Methods for Vegetation Mapping NBS/NPS Vegetation Mapping Program**" (**1994) with one exception. The document calls for one plot per delineated polygon within very small parks. It was decided at the scoping meeting that the area most likely did not contain any unknown vegetation types and that it would suffice to create a list of potential associations that could be used as reference to determine the vegetation type within the delineated polygons. NatureServe provided a preliminary list of potential types that was used as a reference during the field visit. To assist in the field visit the photointerpreter also collected observation points whose primary use was as a photointerpretive tool. However, they also proved useful to clarify any unknown or different associations encountered. Deviations from the supplied vegetation descriptions were discussed with Mr. Jim Drake (NatureServe Minneapolis, MN) and changes were made accordingly.

Field surveys began in the last week of August 2002. Data from 26 observation points were collected between August 25 and August 29, 2002 (Figure 10). Points were recorded subjectively, and were chosen to sample the range of habitat and vegetation variability observed on aerial photography, on preliminary maps, and in the field (Figure 12). Observation points were collected and used indicators such as dominant species within strata and cover values. Observation point datasheets are included in Appendix 4. Areas that were previously cultivated or planted were avoided. The observation point data were then compared to NatureServe (2002) community descriptions and appropriate labels were attached. Almost all polygons delineated were visited and received a label based upon NatureServe alliance and association descriptions.

The UTM coordinates and elevation of all observation points were logged using a hand-held Precision Light-weight Global Positioning System (GPS) Receiver (PLGR) unit. Photographs were taken at most sites and are included in the attached data set.

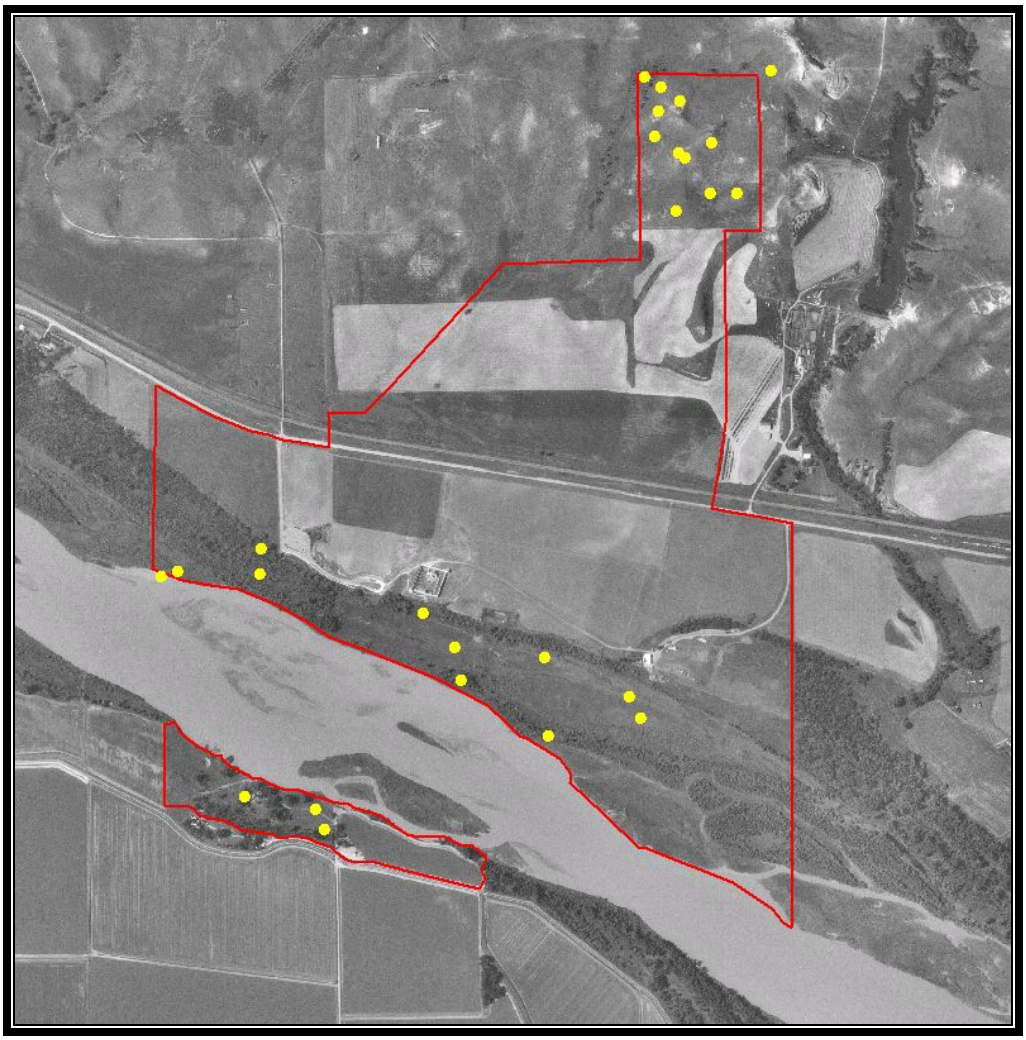

Figure 10. Observation points collected for vegetation characterization.

Vegetation Map Preparation

Vegetation map development for FOUS has somewhat different protocols than for other Parks. Normally photointerpretation is preceded by extensive field work which includes plot selection and vegetation sampling using detailed descriptions which are subsequently analyzed using ordination and other statistical techniques. The data are then summarized and association descriptions are assigned to each plot or, if the association is previously unrecognized, then a new association name is assigned. Subsequently, the plots locations are compared to its photographic signature and a photointerpretive key is developed. Given the very small size of FOUS and the extensive historical impact and alteration of the vegetation a simplified technique was used. NatureServe developed a list of potential vegetation types prior to any field work. This list was referenced during the field visit and modified after comparison of site characteristics and vegetation descriptions. Aerial photographs were viewed prior to the field visit and areas of like signature were

differentiated. There are other subtle differences including map validation assumptions and these are described below.

Map Units

In previous vegetation mapping projects, map units are derived from the NVCS classification and are often, but not always equivalent. In this particular case every polygon within the Park boundaries was visited and assigned its respective vegetation association. In addition to classification by vegetation association, tree height and density where included as mapping parameters for wooded polygons.

Aerial Photography Interpretation

After receiving the aerial photography from the contractor, all distinguishing ground features were delineated on clear mylar overlays registered to each photograph. Each photograph was then viewed under magnification and a stereoscope so that subtle features could be discerned and mapped.

Map Validation

Given that that the entire Park was visited by the photointerpreters and all polygons were visited no post mapping validation was conducted. Ground truth was 100%. Few areas outside the Park were visited therefore these areas / polygons have no map validation.

Digital Transfer

Digital products produced specifically for this mapping effort include a digital vegetation polygon coverage and a digital point coverage for observation point locations.

Photo-interpreted polygons and label information were transferred to a digital format by first consolidating all interpreted mylars to a single mylar sheet which overlaid a plot of the DOQ. The DOQ provided geo-reference information. The DOQ was plotted at the same scale as the photos/interpreted mylars therefore the transfer was roughly 1:1. The single sheet of mylar with all the line work was subsequently scanned and vectorized. The vector coverage was edited and transformed into a polygon coverage using ArcInfo software. Finally, data regarding vegetation classes were then linked digitally to each polygon by “joining” a .dbf file created separately.

Digital point coverages were created by creating a .dbf file using GPS point locations collected in the field. The .dbf file was then used to create a point coverage using ArcInfo scripts. The subsequent point file was then attributed with the field data sheets as reference for the attribute. Coordinate system descriptions were added after creation of the digital files.

Classification System

Vegetation Classification and Characterization

Vegetation classification was done using existing descriptions compiled by NatureServe using the International Classification of Ecological Communities: Terrestrial Vegetation (NatureServe 2002). Given the small size of the Park and the history of vegetation alteration and impact no new survey was conducted. However, observation points were collected to qualify field observations.

NatureServe compiled a preliminary list of potential vegetation associations prior to any fieldwork (NatureServe 2002). This list was later reduced to the following descriptions after further literature search and field observations. Each description includes local observations compiled during this and previous surveys. NatureServe (2002) provided the following "Introduction to the International Classification of Ecological Communities (ICEC) and global descriptions."

During the course of the ground survey 13 vegetation alliances and 13 vegetation associations are described (Table 2). Planted or former croplands are not included in this list. These are described later in the report.

The current alliance and association descriptions are compiled using current data. However, the information from this report has yet to be reviewed by NatureServe. Consequently, the information provided by the local descriptions in this report has not been included in the global descriptions. For example, one will not find FOUS listed as a site within "federal lands" where we now know a particular vegetation type exists. The NatureServe database is being continually updated and information from this survey will be included in the future.

The following discussion describes in detail the classification system.

Introduction to the International Classification of Ecological Communities (ICEC)

PREFACE

This is a subset of communities defined in the International Classification of Ecological Communities (ICEC), presented in a hierarchical arrangement consistent with that of the ICEC system. The ICEC was developed by ecologists at NatureServe (formerly "ABI") and The Nature Conservancy (TNC)[1], in conjunction with the network of state Natural

1 In 2000, TNC decided to form a new organization that could focus its energies more tightly on developing and providing Heritage network data to Natural Resources decision makers (including those in TNC). Many of the ecologists and other scientists and data managers formerly in TNC's Conservation Science Division are now part of this new organization, called NatureServe (but called "Association for

Heritage programs and International Conservation Data Centers (CDCs). What follows is a brief introduction to the classification. Considerably more information on the ICEC's development and its uses has been published by the NatureServe/TNC Ecology Working Group (Grossman et al. 1998, Maybury 1999) and is available at <http://www.natureserve.org> under the Biodiversity Information, Ecological Communities link.

The classification presented here is a snapshot of a work in progress. As the classification is applied in various places and for various purposes there will be additions, modifications, and revisions. For this reason, **printed reports have a suggested shelf life of one year from the "data current as of" date** that you should see in the footer of the document. Please request an updated version if the data in your document are more than one year old.

DEVELOPMENT OF THE CLASSIFICATION

The ICEC grew out of a longstanding recognition on the part of The Nature Conservancy and the Natural Heritage network that ecological communities were important elements of conservation. These organizations employ what is often referred to as a "coarse filter/fine filter" approach to preserving biological diversity (Jenkins 1976, Hunter 1991). This approach involves the identification and protection of the best examples of all ecological communities (coarse filter) as well as rare species (fine filter). Identifying and protecting representative examples of ecological communities assures the conservation and maintenance of biotic interactions and ecological processes, in addition to conservation of most species. Certain species, however, usually the rarest ones, may fall through the community filter. Very rare species often have specialized life histories, or are simply so rare and restricted that their conservation requires explicit planning based on species-specific information. Identification and protection of viable occurrences of rare species served as the fine filter for preserving biological diversity. Using both filters for identifying conservation targets ensures that the most complete spectrum of biological diversity is protected.

In the U.S., state community classifications were developed for many states by the Heritage ecologist(s), with each state using its own classification scheme. This approach works effectively at a state level to assure protection of ecological communities. However, a major obstacle to using communities as conservation units at the regional, national, and global levels was the lack of a consistent classification system developed through analysis of data from a range-wide perspective. To overcome this problem, TNC and the Natural Heritage/CDC network began working to develop a standardized, hierarchical system to classify vegetated terrestrial communities across the U.S.

The first steps taken by TNC regional ecologists were to begin compiling an enormous amount of fine-scale state and local information on vegetation pattern into four regional classifications spanning the U.S. and to decide upon a single, standardized framework for the classifications they were developing. The U.S. regional classifications were of

Biodiversity Information" ("ABI") until November 2001). NatureServe and TNC ecologists continue to work together, and to work with Heritage, federal and state agencies, and academic partners, on ICEC development.

necessity developed somewhat independently. In the western U.S., for example, most of the existing state classifications were based on vegetation and were strongly influenced by the habitat type approach, which allowed a relatively straightforward compilation into a regional classification for the west. In the Midwest, East, and Southeast, there was less of a tradition of floristically-based classifications, and as a result, there was more emphasis on a synthesis of descriptive information on vegetation, often done with close consultation and review by Heritage program ecologists, along with other partner in state and federal agencies, and university scientists.

Synthesis of the four regional classifications into a U.S. National Vegetation Classification was completed and the first iteration of that classification was published (Anderson et al. 1998).

While classification development has so far focused on the United States (and is ongoing there), classification of Canadian vegetation using the ICEC system is proceeding on a relatively fast track, as is classification of the vegetation of portions of northern Mexico. Caribbean vegetation has also been an area of recent classification development.

THE ICEC: FOUNDATIONS AND SCOPE

The following basic tenets underlie the terrestrial portion of the ICEC:

1. The ICEC is based primarily on vegetation, rather than soils, landforms or other non-biologic features.

This was decided upon mainly because plants are easily measured biological expressions of environmental conditions and are directly relevant to biological diversity. Vegetation is complex and continuously variable, with species forming only loosely repeating assemblages in ecologically similar habitats. The ICEC does not solve the problems inherent in any effort to categorize the continuum of vegetation pattern, but it presents a practical set of methods to bring consistency to the description, modeling, and conservation of vegetation.

2. The ICEC system applies to all terrestrial vegetation. In addition to upland vegetation, “terrestrial vegetation” is defined to include all wetland vegetation with rooted vascular plants. It also includes communities characterized by sparse to nearly absent vegetation cover, such as those found on boulder fields or talus.

3. The ICEC focuses on existing vegetation rather than potential natural or climax vegetation.

The vegetation types described in the classification range from the ephemeral to the stable and persistent. Recognizing and accommodating this variation is fundamental to protecting biodiversity. The manner in which a community occurs is, in part, an intrinsic property of the vegetation itself. A classification that is not restricted to static vegetation types ensures that the units are useful both for inventory/site description, and as the basis for building dynamic ecological models.

The following tenets reflect the current scope of the ICEC:

1. While the ICEC framework can be used to classify all vegetation, emphasis has been given to vegetation types that are natural or near-natural, i.e., those that appear to be unmodified or only marginally impacted by human activities. Where anthropogenic impacts are apparent, the resulting physiognomic and floristic patterns have a clear, naturally-maintained analog.

2. Classification development at the finest levels of the system has so far focused on the contiguous United States and Hawaii. Some classification at finer levels has also been done for southeastern Alaska, parts of Canada, the Caribbean, and a few areas in northern Mexico.

THE ICEC: THE HIERARCHY
SYSTEM LEVEL

The top division of the classification hierarchy separates vegetated communities (Terrestrial System) from those of unvegetated deepwater habitats (Aquatic System) and unvegetated subterranean habitats (Subterranean System). The Terrestrial System is broadly defined to include areas with rooted submerged vegetation of lakes, ponds, rivers, and marine shorelines, as well as the vegetation of uplands.

The hierarchy for the Terrestrial System has seven levels: the five highest (coarsest) levels are physiognomic and the two lowest (finest) levels are floristic. The levels of the terrestrial classification system are listed and described below.

VEGETATION CLASSIFICATION SYSTEM

	FORMATION CLASS
	FORMATION SUBCLASS
	FORMATION GROUP
	FORMATION SUBGROUP
physiognomic levels	FORMATION
floristic levels	ALLIANCE
	ASSOCIATION

PHYSIOGNOMIC LEVELS

The physiognomic portion of the ICEC hierarchy is a modification of the UNESCO world physiognomic classification of vegetation (1973) and incorporates some of the revisions made by Driscoll et al. (1984) for the United States.

Formation class

The physiognomic class is based on the structure of the vegetation as defined by the type, height, and relative percentage of cover of the dominant, uppermost life-forms. There are seven mutually exclusive classes:

Forest: Trees with their crowns overlapping (generally forming 60% - 100% cover).

Woodland: Open stands of trees with crowns not usually touching (generally forming 25% - 60% cover).

Shrubland: Shrubs generally greater than 0.5 meter tall with individuals or clumps overlapping to not touching (generally forming greater than 25% cover, with trees generally less than 25% cover). Vegetation dominated by woody vines is generally treated in this class.

Dwarf-shrubland: Low-growing shrubs, usually less than 0.5 meter tall. Individuals or clumps overlapping to not touching (generally forming greater than 25% cover; with trees and tall shrubs generally less than 25% cover).

Herbaceous: Herbaceous plants dominant (generally forming at least 25% cover, with trees, shrubs, and dwarf-shrubs generally with less than 25% cover).

Nonvascular: Nonvascular cover (bryophytes, non-crustose lichens, and algae) dominant (generally forming at least 25% cover).

Sparse Vegetation: Abiotic substrate features dominant. Vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources (total vegetation cover is typically less than 25%).

Formation subclass

The physiognomic subclass is determined by the predominant leaf phenology of the forest, woodland, shrubland and dwarf-shrubland classes. Subclass is determined by the persistence (perennial or annual) and growth form (graminoid, forb, hydromorphic) of the vegetation for the herbaceous vegetation class. The relative dominance of lichens, mosses, or algae is the determining factor in the nonvascular class, and particle size of the substrate is the determining factor for the sparse vegetation class Examples include: Evergreen Forest, Deciduous Forest, Deciduous Shrubland, Perennial Graminoid Vegetation, Annual Graminoid or Forb Vegetation, Lichen Vegetation, and Consolidated Rock Sparse Vegetation.

Formation group

The group generally represents vegetation units defined based on leaf characters, such as broad-leaf, needle-leaf, microphyllous, and xeromorphic. These units are identified and named with broadly defined macroclimatic types to provide a structural-geographic orientation, but the ecological climate terms do not define the groups *per se*. Examples include: Temperate or subpolar needle-leaved evergreen forest, Cold-deciduous forest, Cold-deciduous shrubland, Temperate or subpolar grassland, Sparsely vegetated cliffs.

Formation subgroup

The subgroup (or formation subgroup) represents a distinction between planted/cultivated vegetation and natural/semi-natural vegetation. The latter is broadly defined to include all vegetation not actively planted or maintained through intensive management activities by humans. Examples of subgroups include: Natural temperate and subpolar needle-leaved evergreen forest; Cultural temperate and subpolar needle-leaved evergreen forest (e.g., pine and spruce plantations).

Formation

The formation represents a grouping of community types that share a definite physiognomy or structure and broadly defined environmental factors, such as elevation and hydrologic regime. Structural factors such as crown shape and lifeform of the dominant lower stratum are used in addition to the physiognomic characters already specified at the higher levels. The hydrologic regime modifiers were adapted from Cowardin et al. (1979). Examples include: Rounded-crowned temperate or subpolar needle-leaved evergreen forest, Seasonally flooded cold-deciduous forest, Semipermanently flooded cold-deciduous shrubland, Tall sod temperate grassland, Cliffs with sparse vascular vegetation.

FLORISTIC LEVELS

Alliance

The alliance is a physiognomically uniform group of plant associations (see association below) sharing one or more dominant or diagnostic species, which as a rule are found in the uppermost strata of the vegetation (see Mueller-Dombois and Ellenberg 1974). Dominant species are often emphasized in the absence of detailed floristic information (such as quantitative plot data), whereas diagnostic species (including characteristic species, dominant differential, and other species groupings based on constancy) are used where detailed floristic data are available (Moravec 1993).

For forested communities, the alliance is roughly equivalent to the "cover type" of the Society of American Foresters (Eyre 1980), developed for use primarily by foresters to describe the forest types of North America. The alliance may be finer in detail than a cover type when the dominant tree species extend over large geographic areas and varied environmental conditions (e.g. the *Pinus ponderosa* Forest Alliance, *Pinus ponderosa* Woodland Alliance, and *Pinus ponderosa* Temporarily Flooded Woodland Alliance are all within the *Pinus ponderosa* Cover Type of the SAF). Alliances, of course, have also been developed for non-forested vegetation.

The alliance is similar in concept to the "*series*," as developed for the Habitat Type System to group habitat types that share the same dominant species under "climax" conditions (Daubenmire 1952, Pfister and Arno 1980). Alliances, however, are described by the dominant or diagnostic species for *all* existing vegetation types, whereas series are generally restricted to potential "climax" types and are described by the primary dominant species.

Association

The association is the lowest level, as well as the basic unit for vegetation classification, in the ICEC. The association is defined as "a plant community of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (see Flahault and Schroter 1910 in Moravec 1993). This basic concept has been used by most of the schools of floristic classification (Whittaker 1962, Braun-Blanquet 1965, Westhoff and van der Maarel 1973, Moravec 1993).

The plant association is differentiated from the alliance level by additional plant species, found in any stratum, which indicate finer scale environmental patterns and disturbance regimes. This level is derived from analyzing complete floristic composition of the vegetation unit when plot data are available. In the absence of a complete data set,

approximation of this level is reached by using available information on the dominant species or environmental modifiers, and their hypothesized indicator species.

Nomenclature for Alliances and Associations

Alliances are named for constant dominants, codominants, or diagnostic species identified from the dominant and/or top strata of the vegetation. Associations are named with one or more species from the alliance name, and have additional species that represent dominants or indicators from any layer of the vegetation. Species occurring in the same stratum are separated by a hyphen (-); those occurring in different strata are separated by a forward slash (/). Parentheses around one or more species in a name indicate that the species may or may not occur within all associations in the alliance, or an all occurrences (stands) of the association are placed within parentheses.

Vascular plant species nomenclature in the alliance names follows the nationally standardized list, Kartesz (1994), with very few exceptions. Nomenclature for nonvascular plants follows Anderson (1990), Anderson et al. (1990), Egan (1987, 1989, 1990), Esslinger and Egan (1995), and Stotler and Crandall-Stotler (1977).
Association and Alliance names include the formation class (Forest, Woodland, etc.) in which they are placed. Alliances also include the word "alliance" to distinguish them from associations (e.g., *Pinus ponderosa* Woodland **Alliance**. For wetland alliances, the hydrologic regime that the alliance is found in is always provided for clarity, e.g. *Populus fremontii* **Temporarily Flooded** Woodland Alliance. All alliances that have no hydrological modifier are upland alliances.

Environmental or geographic descriptors (e.g., serpentine, Interior Plateau) are used sparingly, when species composition for a type is not known well enough to distinguish it using only species in a name. When an environmental/geographic descriptor is used, it is inserted between the floristic nominals and the class descriptor (e.g., *Quercus palustris - Quercus bicolor - Quercus macrocarpa - Acer rubrum* **Sand Flatwoods** Forest).

THREE EXAMPLES OF THE CLASSIFICATION SYSTEM HIERARCHY

CLASS	FOREST	WOODLAND	SHRUBLAND
SUBCLASS	Deciduous Forest	Evergreen Woodland	Deciduous Shrubland
GROUP	Cold-deciduous Forest	Temperate or Subpolar Needle-leaved Evergreen Woodland	Temperate Broad-leaved Evergreen Shrubland
SUBGROUP	Natural/Semi-natural	Natural/Semi-natural	Natural/Semi-natural
FORMATION	Lowland or Submontane Cold-deciduous Forest	Saturated Temperate or Subpolar Needle-leaved Evergreen Woodland	Sclerophyllous Temperate Broad-leaved Evergreen Shrubland
ALLIANCE	*Quercus stellata - Quercus marilandica* Forest Alliance	*Pinus palustris* Saturated Woodland Alliance	*Quercus havardii* Shrubland Alliance
ASSOCIATION	*Quercus stellata - Quercus marilandica - Carya (glabra, texana) / Vaccinium arboreum* Forest	*Pinus palustris / Leiophyllum buxifolium / Aristida stricta* Woodland	*Quercus havardii - (Penstemon ambiguus, Croton dioicus) / Sporobolus giganteus* Shrubland

ECOLOGICAL GROUPS

Ecological groups are separate from the the "standard" ICEC hierarchy. They are aggregations of associations that are being developed by ecologists in the different NatureServe regions. Also known as ecological systems, these aggregations are "mid-scale" units—there are about 225 in 25 southeastern and midwestern states as compared

to about 800 alliances and 2000 associations in the same area. Each is unified by similar ecological conditions and processes (e.g., fire, riverine flooding), underlying environmental features (e.g., shallow soils, serpentine geology), and/or environmental gradients (e.g., elevation). Their distributions are bounded by broad biogeographic provinces. For example, low elevation riparian forests of the desert Southwestern United States, the Great Plains, the Southeastern Coastal Plain, and the Chaco would each constitute a different ecological group.

The groups are intended as landscape-scale conservation planning tools and as categories that will be more intuitively understandable and will facilitate communication. They can also be used to develop viability and ranking criteria in a more efficient way. Separate groups have been developed for the midwestern, southeastern, and eastern NatureServe regions. However, eventually, the groups will be crosswalked among NatureServe regions to achieve a single, non-duplicative set.

KNOWN DATA GAPS – GEOGRAPHIC

The ICEC is primarily comprised of a classification of the vegetation of the contiguous U.S. and Hawaii. Most of the vegetation of Alaska has not yet been incorporated into the ICEC.

Even within the contiguous U.S. and Hawaii, regional differences endure in the U.S. National classification due to regional differences in inventory data and in classification history. Some states or regions have focused their efforts on those alliances and associations that are considered to be imperiled (conservation ranks G1 or G2), while others, like the western U.S. Forest Service Districts, focused on more common communities. Also, while the classification system is intended to develop units with consistent scale, associations are more narrowly defined in some areas, resulting in a greater number of associations per alliance than average. On the other hand, limited inventory and classification work in areas such as the Great Basin area of the southwestern United States might lead a casual observer of the classification to believe that it is an area with low ecological diversity. In fact, it is an area about which little is known.

In the near term, significant refinements to the classification are anticipated with further integration of local and state classification work from Alaska, California, and Canadian provinces. Future classification refinement will also focus on underclassified portions of the U.S. interior southwest and adjacent Mexico.

KNOWN DATA GAPS - TAXONOMIC

In general, more information is available for Forest, Woodland, Shrubland, and Herbaceous classes than for Dwarf-Shrubland, Nonvascular, and Sparse Vegetation classes. Shortgrass prairie vegetation and many riparian types have not been consistently classified. In addition, the degree of classification confidence for upland types is generally higher than for wetland types. The classification of communities that occur as vegetation complexes will also require additional research and analysis.

CAVEATS ABOUT DISTIBUTION DATA

In general: Absence of a state or ecoregion from any list of the distribution of a type cannot be interpreted to be a definitive statement that the type does not occur there.

Federal Lands: Some data may be available listing federal land units (such as National Park Service units, individual National Forests, etc.) within which an association occurs. However, this field is *extremely incompletely populated* and absence of a federal land management unit should not be considered to indicate that the type is absent on that unit.

CONSERVATION STATUS RANKING

Associations are given a conservation status rank based on factors such as present geographic extent, threats, number of distinct occurrences, degree of decline from historic extent, and degree of alteration of natural processes affecting the dynamics, composition, or function of the type. Ranks are customarily assigned by the various members of the Natural Heritage programs and the regional offices of NatureServe.

Associations are ranked on a global (G), national (N), and subnational (S) scale of 1 to 5, with 1 indicating critical imperilment and 5 indicating little or no risk of extirpation or elimination. For example, a rank of G1 indicates critical imperilment on a rangewide basis, i.e., a great risk of "extinction" of the type worldwide; S1 indicates critical imperilment in the specific state, province, or other subnational unit, i.e., a great risk of extirpation of the type from the subnation.

Special attention is generally given to taxa of high endangerment, as opportunities for their conservation may be limited in space and time. However, occurrences of relatively secure communities can also be of critical conservation importance. In eastern North America, for example, a large tract of a common forest type in pristine condition that occurs in an intact landscape and with relatively intact ecological processes would be of high priority for conservation. Though the type itself is common, the opportunity to conserve such a high quality example may be very limited.

Global conservation status ranks for natural/near-natural communities are defined as follows:

GX **ELIMINATED** throughout its range, with no restoration potential due to extinction of dominant or characteristic species.

GH **PRESUMED ELIMINATED (HISTORIC)** throughout its range, with no or virtually no likelihood that it will be rediscovered, but with the potential for restoration (e.g., *Castanea dentata* Forest).

G1 **CRITICALLY IMPERILED** Generally 5 or fewer occurrences and/or very few remaining acres or very vulnerable to elimination throughout its range due to other factor(s).

G2 **IMPERILED** Generally 6-20 occurrences and/or few remaining acres or very vulnerable to elimination throughout its range due to other factor(s).

G3 **VULNERABLE** Generally 21-100 occurrences. Either very rare and local throughout its range or found locally, even abundantly, within a restricted range or vulnerable to elimination throughout its range due to specific factors.

G4 **APPARENTLY SECURE** Uncommon, but not rare (although it may be quite rare in parts of its range, especially at the periphery). Apparently not vulnerable in most of its range.

G5 **SECURE** Common, widespread, and abundant (though it may be quite rare in parts of its range, especially at the periphery). Not vulnerable in most of its range.

GU **UNRANKABLE** Status cannot be determined at this time.

G? **UNRANKED** Status has not yet been assessed**.**

Modifiers and Rank Ranges

? A question mark added to a rank expresses an uncertainty about the rank in the range of 1 either way on the 1-5 scale. For example a G2? rank indicates that the rank is thought to be a G2, but could be a G1 or a G3.

G#G# Greater uncertainty about a rank is expressed by indicating the full range of ranks which may be appropriate. For example, a G1G3 rank indicates the rank could be a G1, G2, or a G3.

Q A"Q" added to a rank denotes questionable taxonomy. It modifies the degree of imperilment and is *only* used in cases where the type would have a *less imperiled* rank if it were not recognized as a valid type (i.e., if it were combined with a more common type). A GUQ rank often indicates that the type is unrankable *because of* daunting taxonomic/definitional questions.

ranks indicating semi-natural/altered communities:

GD **RUDERAL** Vegetation resulting from succession following anthropogenic disturbance of an area. Generally characterized by unnatural combinations of species (primarily native species, though often containing slight to substantial numbers and amounts of species alien to the region as well).

GM **MODIFIED/MANAGED** Vegetation resulting from the management or modification of natural/near natural vegetation, but producing a structural and floristic combination not clearly known to have a natural analogue.

GW **INVASIVE** Vegetation dominated by invasive alien species; the vegetation is spontaneous, self-perpetuating, and is not the (immediate) result of planting, cultivation, or human maintenance.

rank indicating planted/cultivated communities

GC **PLANTED/CULTIVATED** Areas dominated by vegetation that has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation.

DATA SETS

The primary data set for this project is a digital GIS file of the vegetation in and around FOUS. However, during the course of the study a number of files are generated and collected from various sources that are helpful for further work. All these data are included on the accompanying CD. The GIS data is in ArcGIS Shape format.

Vector

- Vegetation – This coverage contains the following fields:

  Veg_Id
  Veg_code
  Formation Class
  Formation Subclass
  Formation Group
  Formation Subgroup
  Formation
  Alliance
  Density
  Height
  Area meters
  Perimeter meters
  Acres

The description of each field with vegetative information (Formation Class through Association) are described in "Vegetation Description and Characterization" in this document. Veg_Id and Veg_code are numeric and string identifiers for each polygon. Area and Acres are calculated using tools within ArcView.

- FOUS Boundary - This coverage contains the following fields:

  Park
  Name
  Area meters
  Perimeter meters
  Acres

The original ArcView shapefile provided by the GIS staff at Theodore Roosevelt National Park was replaced by this file that was updated with a GPS in the field and ArcView software. Area and Acres are calculated using tools within ArcView.

- Soils - This coverage contains the following fields:

Soil_code
Soil Description
Soil Texture
Area meters
Perimeter meters
Acres

This coverage was build using SCS Soil reports from four counties. Hence, the soil codes are not equivalent. The Soil Description is the name given to each unit and the soil Texture is the texture of each unit. Area and Acres are calculated using tools within ArcView. There is significantly more information associated with each soil type than one will see in this coverage. This information may be accessed by reference to the soil reports.

- Soil Texture - This coverage contains the following fields:

  Texture

This shapefile is derived from the soils shapefile and is a compilation of all soil types of the same soil texture.

Point

- Field Data - This coverage contains the following fields:

  Veg_Id
  Veg_code
  Formation Class
  Formation Subclass
  Formation Group
  Formation Subgroup
  Formation
  Alliance
  Association

These data points are informal observation points collected while in the field the last week of August 2002. The Veg_code are the names associated with each observation. All other codes are equivalent to those for the vegetation polygon coverage.

Raster

- DRG Mosaic

Seamless mosaic of two USGS quadrangles for the areas intersecting FOUS. Original data is in Datum NAD27 and reprojected into NAD83

- DRG Individual

Digital Raster Graphics for the two quads intersecting FOUS. Original data is in Datum NAD27 and reprojected into NAD83

- DOQQ

DOQ provided by GIS staff at Theodore Roosevelt National Park

- DEM and TIN

The DEM is a subset of the original provided by the GIS group at Theodore Roosevelt National Park. The TIN was created from this using a z-value tolerance of 1 meter.

RESULTS

Vegetation Classification and Characterization

Given the small size of the Park and the history of vegetation alteration and impact no new survey was conducted for FOUS. Vegetation classification was done using existing descriptions compiled by NatureServe. However, observation points were collected to quantify field observations.

NatureServe compiled a preliminary list of potential vegetation associations prior to any fieldwork (NatureServe 2002). This list was later reduced to the following descriptions after additional literature search and field observations. Each description includes local observations compiled during this survey. During the course of the ground survey 13 vegetation alliances and 13 vegetation associations where found (Table 2). Of these, only the Western Snowberry Alliance was not mapped due to its very small aerial coverage.

Green Ash – (American Elm) Temporarily Flooded Forest Alliance
- Fraxinus pennsylvanica – (Ulmus americana) / Symphoricarpos occidentalis Forest

Green Ash – (American Elm) Woodland Alliance
- Fraxinus pennsylvanica – Ulmus americana / Prunus virginiana Woodland

Eastern Cottonwood Temporarily Flooded Forest Alliance
- Populus deltoides – (Salix amygdaloides) / Salix (exigua, interior) Woodland

Western Snowberry Temporarily Flooded Shrubland Alliance
- Symphoricarpos occidentalis Shrubland

(Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance
- Salix exigua Temporarily Flooded Shrubland

Needle-and-Thread – Blue Grama Herbaceous Alliance
- Hesperostipa comata – Bouteloua gracilis – Carex filifolia Herbaceous Vegetation

Western Wheatgrass Herbaceous Alliance
- Pascopyrum smithii – Bouteloua gracilis – Carex filifolia Herbaceous Vegetation

Smooth Brome Semi-natural Herbaceous Alliance
- Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation

Crested Wheatgrass Semi-natural Herbaceous Alliance
- Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata) Semi-natural Herbaceous Vegetation

Reed Canary Grass Seasonally Flooded Herbaceous Alliance
- Phalaris arundinacea Western Herbaceous Vegetation

(Narrowleaf Cattail, Broadleaf Cattail) - (Clubrush species) Semipermanently Flooded Herbaceous Alliance
- Typha spp. Great Plains Herbaceous Vegetation

Open Cliff Sparse Vegetation Alliance
- Sandstone Great Plains Xeric Butte - Bluff Sparse Vegetation

Sand Flats Temporarily Flooded Sparse Vegetation Alliance
- Riverine Sand Flats - Bars Sparse Vegetation

Table 2. Vegetation alliances and associations within FOUS.

Acreages for the vegetation mapping include 2084 total mapped vegetation and 437 acres within the Park boundaries (Table 3.)

Map Unit	Total Acres	Acres Within Park
Agriculture	662.3	92.3
Fraxinus pennsylvanica - (Ulmus americana) / Symphoricarpos occidentalis Forest	42.5	15.9
Fraxinus pennsylvanica - Ulmus americana / Prunus virginiana Woodland	162.4	14.2
Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior) Woodland	42.0	25.9
Salix exigua Temporarily Flooded Shrubland	54.7	19.3
Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	16.9	7.2
Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata) Semi-natural Herbaceous Vegetation	219.4	27.2
Hesperostipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation	132.8	5.0
Phalaris arundinacea Western Herbaceous Vegetation	33.3	18.8
Pascopyrum smithii - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation	229.6	17.9
Riverine Sand Flats - Bars Sparse Vegetation	29.5	1.0
Typha spp. Great Plains Herbaceous Vegetation	24.4	19.8
Open Cliff Sparse Vegetation Alliance	23.8	0.4
Restoration Lands	138.4	137.6
Roads and Right-of-ways	55.8	23.4
Undifferentiated Urban	24.5	5.8
Water	191.9	5.9
Total	**2084.2**	**437.7**

Table 3. Acres of map units within mapping boundary and FOUS boundary.

The NVCS classes noted for the Park include five formation classes. These are; forest, woodland, shrub, herbaceous, and sparse vegetation. Details of their alliance and associations are detailed below. All global descriptions are derived from NatureServe (2002).

I. Forest

I.B.2.N.d. Temporarily flooded cold-deciduous forest

I.B.2.N.d.33. FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) TEMPORARILY FLOODED FOREST ALLIANCE

Green Ash - (American Elm) Temporarily Flooded Forest Alliance

Concept:
Comments: The single association in this alliance that is reported for the western U.S. (in eastern Montana and Wyoming) is *Fraxinus pennsylvanica / Prunus virginiana* Forest (CEGL000642). In Montana, this association is considered synonymous with *Fraxinus pennsylvanica - Ulmus americana / Prunus virginiana* Woodland (CEGL000643). The relationship between these two associations needs to be reviewed, and they will likely be merged into one association and placed in the *Fraxinus pennsylvanica - (Ulmus americana*) Woodland Alliance (A.629). Until this review is completed, the *Fraxinus pennsylvanica - (Ulmus americana)* Temporarily Flooded Forest Alliance (A.308) will not be described and may not occur in the West.
Range: This alliance is found in Wyoming, Montana, Minnesota, and North Dakota. It is also found in Manitoba and Ontario, Canada.
States/Provinces: MB MT ND SD SK WY
TNC Ecoregions: 26:C, 34:C, 35:C, 46:C, 47:C
USFS Ecoregions: 251Aa:CCC, 331D:CC, 331F:CC, 331G:CC, 332:P
Federal Lands: NPS (Theodore Roosevelt)
References: Hansen and Hoffman 1988, Hansen et al. 1991, Hansen et al. 1995, Jones 1990
Authors: M.S. REID, WCS **Identifier:** A.308

Fraxinus pennsylvanica / Prunus virginiana Forest
Green Ash / Choke Cherry Forest
Green Ash / Choke Cherry Forest **G3? (96-02-01)**

Concept:
States/Provinces: MT:S2S3, WY:S2
TNC Ecoregions: 26:C
USFS Ecoregions: 331D:CC, 331F:CC, 331G:CC
Synonymy: DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) B, *Fraxinus pennsylvanica/Prunus virginiana* (Bourgeron and Engelking 1994) =
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Hansen and Hoffman 1988, Hansen et al. 1991, Hansen et al. 1995, Jones 1990

Authors: WCS **Confidence:** 1 **Identifier:** CEGL000642

Local Description: These forests occur at the transition between the current floodplain and the old flood plain upon which the fort lies. The topography includes both the flat lying floodplain and the sloping transition zone to the older floodplain. The canopy is fairly dense and dominated by *Fraxinus pennsylvanica* and a leser amount of *Ulmus americana*. The taller trees may reach 35 to 40 feet but the typical range is between 20 and 35 feet. The understory may or may not have *Prunus virginiana* present. *Salix exigua* occurs irregularly but sometimes in large patches. Other shrubs present include *Rosa woodsii*, *Symphoriocarpos occidentalis*, *Artemisia ludoviciana* and *Crataegus douglasii*. The forb layer can be quite dense and include *Cirsium arvense*, *Xanthium strumarium*, *Poa pratensis*, *Nassella viridula* and *Agropyron cristatum.* This association is found primarily on Silty Clay (63%) and Loam (24.7%).

II. Woodland

II.B.2.N.a. Cold-deciduous woodland

II.B.2.N.a.29. FRAXINUS PENNSYLVANICA - (ULMUS AMERICANA) WOODLAND ALLIANCE

Green Ash - (American Elm) Woodland Alliance

Concept: This alliance is found along streams and rivers and in draws and canyons across much of the northern Great Plains. Stands often have an overstory that is more dense than typical woodland physiognomy. The canopy can be moderately closed to closed. Most of the canopy trees are 6-10 m tall, and they allow significant light to penetrate to the understory. The shrub layer is usually well-developed while the herbaceous layer is moderately to well-developed. The canopy is dominated by *Fraxinus pennsylvanica* and sometimes *Ulmus americana*. Individuals of *Populus deltoides* and *Acer negundo* are often scattered throughout. The shrub layer is typically dominated by *Prunus virginiana, Symphoricarpos occidentalis, Symphoricarpos albus*, and *Ribes* spp. The herbaceous layer often contains *Maianthemum stellatum, Galium aparine*, and *Elymus canadensis*.

Stands of this alliance are usually on flat to moderately steep slopes near permanent or ephemeral streams. Rarely, it can be found on steep north-facing escarpments. These sites create more mesic microclimates in which the woodland can develop in landscapes otherwise dominated by grasslands. The soils are typically deep and loamy, but in places they can be rocky. Stands are common along riparian areas but are usually distant enough from larger streams that they do not flood or do so for very short periods.
Comments: In places, the elements within the *Populus deltoides* Woodland Alliance (A.1493) border on and succeed to *Fraxinus pennsylvanica - (Ulmus americana)* Woodland Alliance (A.629). Sites that are temporal or spatial transition zones can be difficult to classify.
Range: This alliance is found in the central and western parts of Nebraska, South Dakota, and North Dakota, and in southeastern Montana.
States/Provinces: MT ND NE SD
TNC Ecoregions: 26:C
USFS Ecoregions: 331E:CC, 331F:CC, 332A:C?, 332C:CP, 332D:C?
Federal Lands: NPS (Badlands, Theodore Roosevelt)
Synonymy: Northern floodplain forest, # 98, in part (Kuchler 1964)
References: Faber-Langendoen et al. 1996, Girard et al. 1989, Hansen et al. 1984, Kuchler 1964, MTNHP n.d., Steinauer 1989
Authors: MCS, MOD. M.S. REID, MCS **Identifier:** A.629

Fraxinus pennsylvanica - Ulmus americana / Prunus virginiana Woodland
Green Ash - American Elm / Choke Cherry Woodland
Green Ash - Elm Woody Draw **G2G3 (98-06-22)**
Ecological Group (SCS;MCS): Northern Great Plains Ash-Elm Forests and Woodlands (n/a; 2.5.5.3)

Concept: This community type occurs in the northwestern Great Plains of the United States. Stands occur in upland ravines and broad valleys or on moderately steep slopes. They also occurs along small permanent or ephemeral streams, including deep mesic ravines and canyon bottoms that are not flooded or saturated. On these sites, soil and topography permit greater than normal moisture. The soils are clay loams, sandy clay loam, and sandy loam, dry to moist, and moderately well-drained. The parent material is typically colluvium or alluvium. This community is an open- to closed-canopy woodland dominated by *Fraxinus pennsylvanica*. *Ulmus americana* or *Acer negundo* sometimes achieve codominance. In undisturbed stands, the understory is composed of two layers. The taller and more conspicuous layer is a shrub layer 2-3 m tall. This layer is dominated by *Prunus virginiana* with smaller amounts of *Symphoricarpos occidentalis* or more rarely *Ostrya virginiana*. The lower layer is dominated by grasses and sedges such as *Elymus virginicus*, *Elymus villosus*, and *Carex sprengelii*. Common herbaceous species include *Aquilegia canadensis*, *Cerastium arvense*, *Thalictrum dasycarpum*, *Galium boreale*, *Galium aparine*, *Maianthemum stellatum*, and *Thalictrum dasycarpum*. The continuation of the status of *Ulmus americana* as a prominent part of this community is uncertain due to the effects of Dutch elm disease.
Comments: The community described by Girard et al. (1989) in southwestern North Dakota was very dense for a woodland (700 trees/ha); however, the basal area was fairly low (18 m2/ha) and the trees averaged 9 m tall. This appears to be a dense woodland and may overlap with *Fraxinus pennsylvanica / Prunus virginiana* Forest (CEGL000642) that occurs in Montana and Wyoming. For example, the *Fraxinus pennsylvanica - Prunus virginiana* habitat type in Theodore Roosevelt National Park, western North Dakota (Hansen et al. 1985) was expanded in Hansen et al. (1990) to include this community in eastern Montana. Wali et al. (1980) also described a green ash-American elm forest in western North Dakota. Montana lumps most stands with *Ulmus americana* into *Fraxinus pennsylvanica / Prunus virginiana* Forest (CEGL000642).
Range: This community type occurs in the northwestern Great Plains of the United States, from northern and western Nebraska to the Dakotas and Montana.
States/Provinces: MT:S1Q, ND:SU, NE:S2, SD:SU
TNC Ecoregions: 26:C
USFS Ecoregions: 331E:CC, 331F:CC, 332A:P?, 332C:PP, 332D:P?
Federal Lands: NPS (Badlands, Theodore Roosevelt)
Synonymy: DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) B, *Fraxinus pennsylvanica - Zanthoxylum americanum* (USACE 1979). Similar. In south-central South Dakota along the east bank of the Lake Francis Case Reservoir on the Missouri River. This type was trampled heavily as domestic animals and wildlife commonly use it for shade from the mid-day sun., Deciduous woods (Tolstead 1947) B
References: Daubenmire 1970, Daubenmire and Daubenmire 1968, Driscoll et al. 1984, Girard et al. 1989, Godfread 1976, Godfread 1994, Hansen and Hoffman 1988, Hansen et

al. 1984, Hansen et al. 1985, Hansen et al. 1990, MTNHP n.d., Mack 1981, Nixon 1967, Steinauer 1989, Steinauer and Rolfsmeier 2000, Tolstead 1947, USACE 1979, Wali et al. 1980, Williams 1979
Authors: Faber-Langendoen, D., MCS **Confidence:** 2 **Identifier:** CEGL000643

Local Description: This association occurs in two distinct ecological zones within the mapping area. These include the floodplain below the fort and the wooded draws outside the park boundary.

The floodplain woodland is very dense with a canopy coverage that often closes and a very dense understory (Figures 11 and 12). Shrub species include *Salix exigua, Rosa woodsii, Symphoriocarpos occidentialis* and *Prunus virginiana*. The understory forb layer has a considerable amount of exotics in varying abundances including *Bromus inermis, Poa pratensis, Medicago sativa* and *Agropyron cristatum*.

Figure 11. Green Ash / Chokecherry Woodland on floodplain.

Figure 12. Green Ash / Chokecherry Woodland on floodplain.

The wooded draws outside the park boundary are not well known as these are within private lands and access was not possible. Nonetheless, there is a small draw on the west side of Bodmer Overlook that provides some information. This area is heavily impacted by grazing and as a result has a number of weedy understory species. The overstory is *Ulmus americana* with heights ranging from 15 to 20 feet. The tree cover is sparse (Figures 13, 14, 15). *Prunus virginiana* and *Symphoricarpos occidentalis* are codominant in the understory although their presence is low. The understory is very open with forbs dominating the cover. *Agropyron cristatum* is the dominant grass followed by *Bromus inermis*. Some *Nassella viridula* is present. *Salsola* sp. is also present, sometimes in monotypic patches. Other areas to the east of Bodmer Overlook and the south bank of the Missouri River mapped as this type were not visited and a description is not available. However, canopy cover is considerably more than that just described. This type typically occurs on Loam (45.7%) and Silty clay (18.9%). Slopes range from flat to moderate.

Figure 13. Green Ash / Chokecherry Woodland in upland.

Figure 14. Green Ash / Chokecherry Woodland in upland.

Figure 15. Green Ash / Chokecherry Woodland in upland.

II.B.2.N.b. Temporarily flooded cold-deciduous woodland

II.B.2.N.b.4. POPULUS DELTOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE

Eastern Cottonwood Temporarily Flooded Woodland Alliance

Concept: This alliance occurs throughout the Great Plains near rivers and large streams. It is dominated by *Populus deltoides* throughout its range. Secondary canopy species include *Acer negundo* throughout, *Salix nigra* (in the eastern part of its range), *Fraxinus pennsylvanica* and *Ulmus americana* (central and eastern), and *Salix amygdaloides* (central and western). *Fraxinus pennsylvanica* and *Ulmus americana* often increase in abundance and dominance as stands of this alliance age. *Populus deltoides* does not reproduce well in established stands. The understory composition and structure are variable. A shrub layer may be present, with species such as *Salix* spp., *Symphoricarpos occidentalis*, and *Prunus virginiana* predominating. Sites experience seasonal floods, which, after receding, leave areas available for colonization. This process often favors the establishment of aggressive native and exotic plants. Among the species that are common in this alliance are *Carex* spp., *Juncus* spp., *Spartina pectinata* (in the east), *Pascopyrum smithii* (in the west), *Elymus* spp., *Cenchrus longispinus*, *Melilotus officinalis*, and *Equisetum* spp. Typical exotics found in this alliance are *Poa pratensis* and *Bromus* spp.

Stands of this alliance are found on level to gently sloping topography near rivers, streams, lakes, and ponds. The areas may have been very recently deposited by water action, or they may have been deposited earlier and occupied by other communities. The water table fluctuates with the level of the adjacent water body. This can lead to periods of flooding and soil saturation in the spring and after heavy rains and also to periods of drought when the water level falls in the summer and fall. The soils are silts, loams, and sands, and are derived from alluvial material.

Comments: In many parts of the Great Plains, stands within this alliance border on and succeed to stands belonging to less flood-prone mesic alliances such as II.B.2.N.a *Fraxinus pennsylvanica - (Ulmus americana)* Woodland Alliance (A.629), I.B.2.N.a *Fraxinus pennsylvanica - (Ulmus americana)* Forest Alliance (A.259), and I.B.2.N.d *Fraxinus pennsylvanica - Ulmus americana - Celtis (occidentalis, laevigata)* Temporarily Flooded Forest Alliance (A.286). Flood control also appears to hasten this successional process (Johnston et al. 1976). Sites that are temporal or spatial transition zones can be difficult to classify. The former *Populus deltoides* Temporarily Flooded Wooded Herbaceous Alliance (A.1507) has been merged with this alliance.

Range: This alliance is found in North Dakota, South Dakota, Nebraska, Kansas, Missouri, Wyoming, Colorado, New Mexico (?), Texas (?), Oklahoma, and in Canada in Manitoba.

States/Provinces: CO IA KS MB? MO? ND NE NM OK SD SK? TX WY

TNC Ecoregions: 10:C, 19:C, 20:C, 25:C, 26:C, 27:C, 32:C, 33:C, 34:C, 37:C, 39:P

USFS Ecoregions: 222Ak:???, 251Cd:C??, 251Eb:CCC, 255:C, 311:C, 313A:CC, 315A:CC, 331B:C?, 331C:CC, 331F:CC, 331G:CC, 331H:CC, 331I:CC, 331J:CC, 341B:CC, M313B:CC, M334A:CC, M341B:CC

Federal Lands: NPS (Theodore Roosevelt, Wind Cave)

Synonymy: Northern floodplain forest, # 98, in part (Kuchler 1964); *Populus deltoides* woodland alliance (Hoagland 1998a); Cottonwood: 63, in part (Eyre 1980)

References: Bunin 1985, Christy 1973, Cooper 1988, Crouch 1961a, Crouch 1961b, Crouch 1978, Crouch 1979a, Crouch 1979b, Diamond 1993, Eyre 1980, Faber-Langendoen et al. 1996, Fitzgerald 1978, Hansen et al. 1984, Hansen et al. 1995, Hoagland 1998a, Jackson 1972, Jackson and Lindauer 1978, Johnson et al. 1976, Keammerer 1974a, Keammerer 1974b, Kittel and Lederer 1993, Kittel et al. 1996, Kittel et al. 1997, Kittel et al. 1999, Knopf 1985, Kuchler 1964, Lindauer 1970, Lindauer 1978, Lindauer and Christy 1972, Lindauer and Fitzgerald 1974, Lindauer and Ward 1968, Lindauer et al. 1973, Masek 1979, McEachern 1979, Moulton et al. 1981, TNC 1995a, Thilenius and Smith 1985, Thilenius et al. 1995, U.S. Bureau of Reclamation 1976, Wilson 1970

Authors: GREAT PLAINS PROGRAM 1-95, MP, MCS **Identifier:** A.636

Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior) Woodland
Eastern Cottonwood - (Peachleaf Willow) / (Coyote Willow, Sandbar Willow) Woodland
Cottonwood - Peach-Leaf Willow Floodplain Woodland **G3G4 (98-06-22)**
Ecological Group (SCS;MCS): Northern and Central Great Plains Wooded Riparian Vegetation (560-05; 1.6.5.1)

Concept: This cottonwood - willow woodland is found widely in the central Great Plains of the United States. Stands occur on recently deposited alluvial material along rivers and streams. The soils are derived from alluvial sand, silt, and clay and are poorly developed. The water table fluctuates with the level of the adjacent river or stream. *Populus deltoides* is the dominant species in this community, although *Salix exigua* and/or *Salix interior* is generally more dominant in the initial stage following a major flood event. *Salix amygdaloides* is rare to codominant. The shrub/sapling layer is conspicuous, especially near the streambank, and consists mainly of *Salix exigua, Populus deltoides*, and *Salix amygdaloides*, or occasionally *Salix lutea*. In the more easterly parts of the range, *Salix interior* may replace *Salix exigua*. On the older margins of this community *Fraxinus pennsylvanica* is often found as a sapling or small canopy tree. The herbaceous stratum is variable. Graminoids typical of undisturbed sites include *Carex emoryi, Carex pellita (= Carex lanuginosa), Pascopyrum smithii*, and *Spartina pectinata*. *Equisetum arvense* and *Glycyrrhiza lepidota* are common forbs in these sites. Widely distributed species that are adapted to these sites include *Ambrosia psilostachya, Artemisia campestris ssp. caudata, Artemisia ludoviciana, Calamovilfa longifolia, Cenchrus longispinus, Chamaesyce serpyllifolia (= Euphorbia serpyllifolia), Euphorbia esula, Grindelia squarrosa, Helianthus petiolaris, Heterotheca villosa, Phyla lanceolata (= Lippia lanceolata), Opuntia macrorhiza, Poa pratensis*, and *Sporobolus cryptandrus*. These sites are prone to invasion by exotic grasses and forbs, the most widely established being *Agrostis stolonifera, Bromus tectorum, Cirsium arvense, Bassia scoparia (= Kochia scoparia), Melilotus* spp., *Taraxacum officinale*, and *Tragopogon dubius*.
Comments: This community's range into North Dakota and Manitoba needs review. It apparently does not occur in South Dakota. Check with other midwestern states regarding woodland status. Species nomenclature is *Populus deltoides ssp. monilifera* in Colorado. *Salix interior and Salix exigua* are treated as separate species in Kartesz (1999), with Salix exigua restricted to western North America.
Range: This cottonwood - willow woodland is found widely in the central Great Plains, especially Colorado, Nebraska, Kansas, and Oklahoma, and possibly both north and south of this region.
States/Provinces: CO:S2S3, KS:SU, MB?, ND:S?, NE:S?, NM?, OK?, SD:S?, SK?, TX?, WY?
TNC Ecoregions: 19:C, 20:C, 25:C, 26:C, 27:C, 33:C, 34:C
USFS Ecoregions: 331H:CC, 331I:CC, M334A:CC
Federal Lands: NPS (Badlands, Theodore Roosevelt)
Synonymy: Willow wetland community (Currier 1982) F, DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) B, *Populus-Salix* Associes (Hefley 1937) B, *Populus sargentii / Ribes americanum* Plant Association (Johnston 1987) =, Plains Cottonwood/Western wheatgrass Community (Jones and Walford 1995) B, Willow-Poplar Community (Ramaley 1939b) =

References: Baalman 1965, Bellah and Hulbert 1974, Blair and Hubbell 1938, Bunin 1985, Burgess et al. 1973, Christy 1973, Cooper 1988, Crouch 1961a, Crouch 1961b, Crouch 1978, Crouch 1979a, Crouch 1979b, Currier 1982, Driscoll et al. 1984, Fitzgerald 1978, Hefley 1937, Hoagland 2000, Jackson 1972, Jackson and Lindauer 1978, Johnson 1994, Johnston 1987, Jones and Walford 1995, Kartesz 1999, Knopf 1985, Lindauer 1970, Lindauer 1978, Lindauer and Christy 1972, Lindauer and Fitzgerald 1974, Lindauer et al. 1973, McAdams et al. 1998, Penfound 1953, Ramaley 1939b, Rogers 1949, Rogers 1953, Steinauer 1989
Authors: J.F. Drake and S.B. Rolfsmeier, MCS **Confidence:** 2 **Identifier:** CEGL000659

Local Description: This association has two distinct types within the park and are separated by the Missouri River.

The northern type lies on the floodplain adjacent to the fort. This area is characterized by a moderately dense canopy that sometimes approaches 80% in places. The Cottonwoods are tall ranging from 30 to 50 feet. *Ulmus americana* and *Fraxinus pennsylvanica* also occur sporadically. *Salix exigua* is common in the understory and reach heights up to 20 feet. This forms a rather distinct high shrub layer that often includes younger cohorts of Cottonwood. *Elaeagnus angustifolia, Cornus stoloifera* and *Rosa woodsii* are present put rare. The forb layer is moderate and includes *Glycyrrhiza lepidota, Equisetum hyemale, Smilacina stellata*, and *Bromus inermis*. This association occurs primarily on frequently flooded soils (Figures 16, 17, 18, 19).

The Cottonwoods on the south side of the Missouri River are considerbly older and drier than the more mesic north side. The south Cottonwood associations may be split into two subtypes. The bench occupied by these cottonwoods has a sloping transition area from the higher bench currently under cultivation. This sloping area is characterized by a shrubby layer that includes *Symphoricarpus occidentalis* and *Prunus virginiana* in addition to lesser amounts of small *Fraxinus pennsylvanica*, *Juniper scopulorum*, *Rosa woodsii*, *Elaeagnus angustifolia*, and *Toxicodendron rydbergii (*Figures 20 and 21). Grasses and forbs include *Bromus inermis, Cirsium arvense* and *Euphorbia esula*. The remaining Cottonwood areas are dominated by old 50 to 60 foot tall cottonwoods with only *Artemesia frigida* as the shrub understory. The grass and forbs beneath these trees are almost exclusively exotic invaders such as *Agropyron cristatum, Euphorbia esula*, and *Bromus inermis*. *Achillea millefolium* is also common (Figures 22, 23, and 24). Soils for the more shrubby type are Silt Loams and the remaining areas Fine Sandy Loams.

Figure 16. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the north bank of the Missouri River.

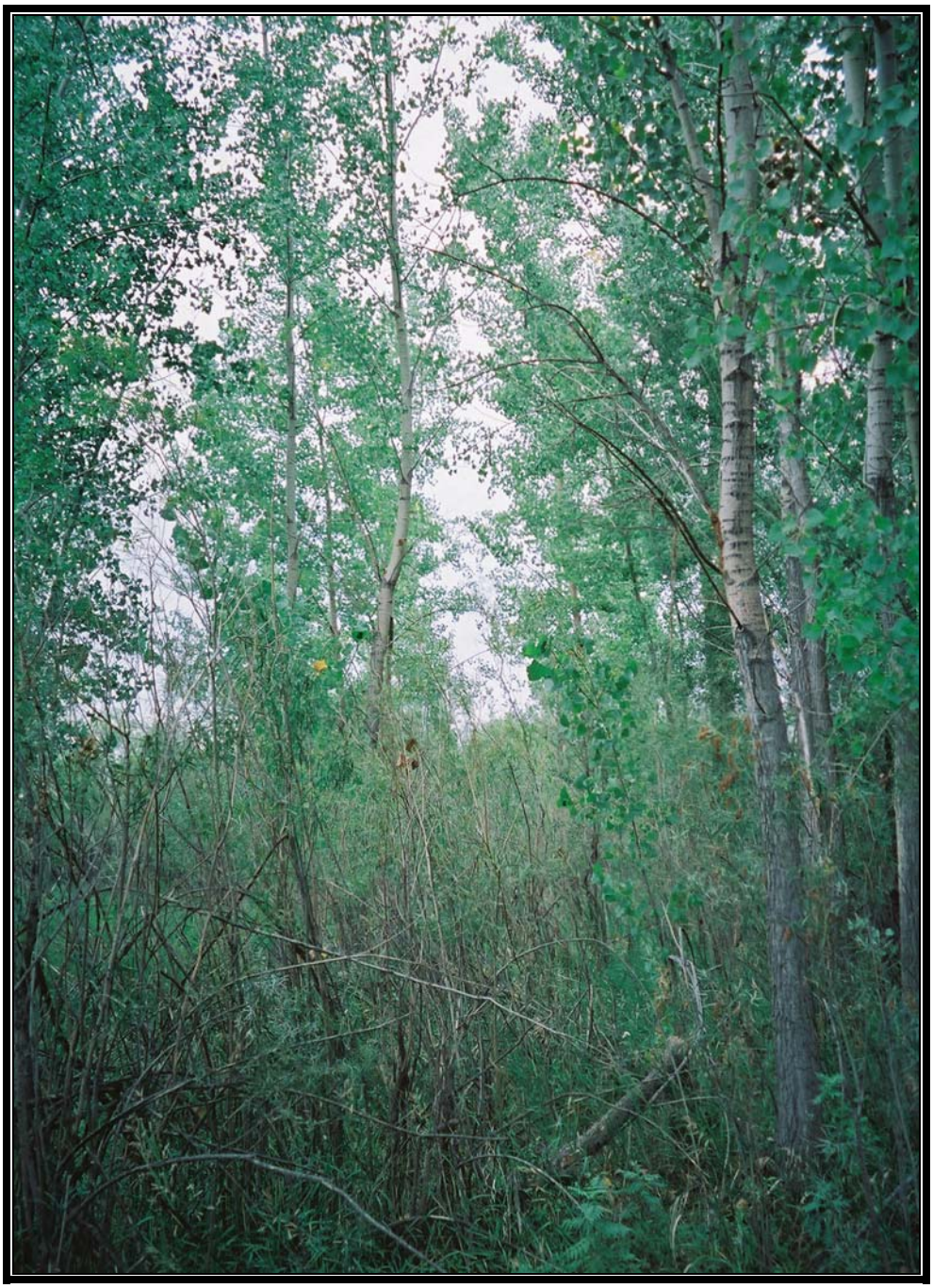

Figure 17. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the north bank of the Missouri River.

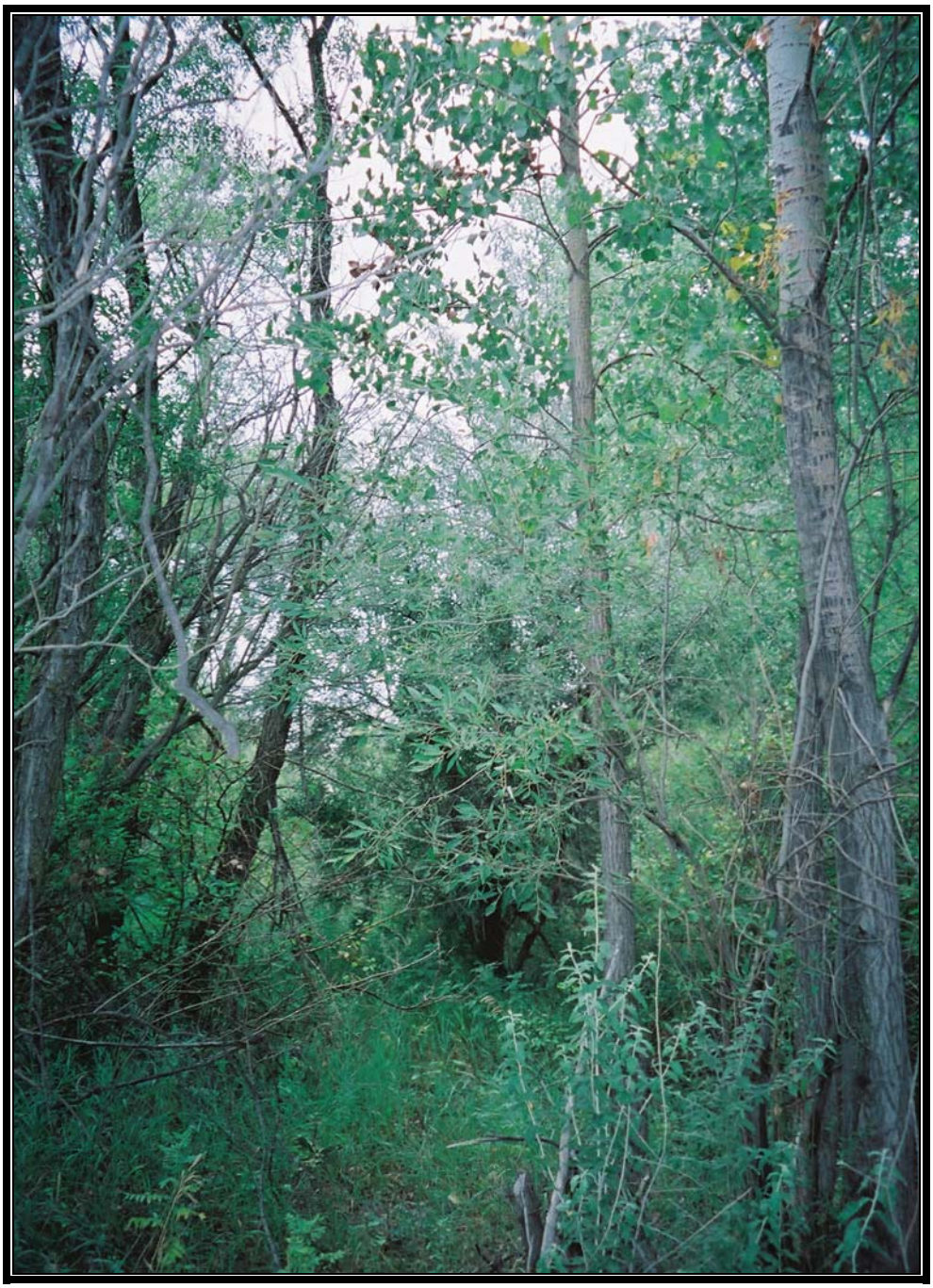

Figure 18. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the north bank of the Missouri River.

Figure 19. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the north bank of the Missouri River.

Figure 20. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the south bank of the Missouri River.

Figure 21. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the south bank of the Missouri River.

Figure 22. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the south bank of the Missouri River.

Figure 23. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the south bank of the Missouri River.

Figure 24. Eastern Cottonwood – (Peachleaf Willow) / Coyote Willow, Sandbar Willow) Woodland on the south bank of the Missouri River.

III. Shrubland

III.B.2.N.d. Temporarily flooded cold-deciduous shrubland

III.B.2.N.d.6. SALIX (EXIGUA, INTERIOR) TEMPORARILY FLOODED SHRUBLAND ALLIANCE

(Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance

Concept: Plant associations within this temporarily flooded shrubland alliance are located on floodplains and gravel bars between 780-1760 m in the western U.S., and at lower elevations (to below 100 m) in the midwestern and southeastern U.S. Stands may be dominated either by *Salix exigua* (in the West) or *Salix interior* (in the Midwest and East). Both species or intermediates may occur in stands in the region where the range of the two species overlap. These shrublands are found on open sandbars without canopy shading on larger, well-developed drainages and along larger sandy rivers, or on coarser-textured substrates. They are associated with annual flooding and inundation and will grow well into the channel, where it is flooded, even in drier years. Even though flooding is frequent, surface water is not present for much of the growing season, and the water table is well below the surface. Some stands form large, wide stands on mid-channel islands on larger rivers, or narrow stringer bands on small, rocky tributaries. Stream reaches range widely from moderately sinuous and moderate-gradient reaches to broad, meandering rivers with wide floodplains or broad, braided channels. Many stands also occur within highly entrenched or eroding gullies. Soils of this alliance are typically coarse alluvial deposits of sand, silt and cobbles that are highly stratified with depth from flooding scour and deposition. The stratified profiles consist of alternating layers of clay loam and organic material with coarser sand or thin layers of sandy loam over very coarse alluvium. Occasionally, stands may occur on deep pockets of sand. The pH of the substrate ranges from 6.0-6.8. The canopy is dominated by a tall, 2- to 5-m, broad-leaved deciduous shrub that is typically many-branched with continuous cover of 60-100%. The herbaceous stratum has sparse to moderate cover including a variety of pioneering species. Plant associations within this alliance are characterized as temporarily flooded, cold-deciduous shrubland dominated by *Salix exigua* or *Salix interior*. The tall-shrub layer has 15-90% cover, ranging in height between 2-5 m. Other willows can occur in the canopy including *Salix eriocephala, Salix lutea, Salix ligulifolia*, and/or *Salix monticola*. Occasionally taller *Salix amygdaloides* or *Populus deltoides* occur within the tree subcanopy. The herbaceous layer varies greatly over the broad range of the alliance. It typically has at least 20-35% cover of various graminoid species including *Carex nebrascensis, Carex pellita (= Carex lanuginosa), Spartina pectinata, Phalaris arundinacea, Equisetum arvense, Panicum bulbosum*, and *Muhlenbergia rigens*. The forb cover is usually sparse. The understory can be dominated by barren ground or gravel bar. This alliance represents an early seral, primary successional stage on newly deposited sediments that may persist under a regime of repeated fluvial disturbance. *Salix exigua*

and *Salix interior* are highly adapted to most forms of disturbance. Both species are prolific sprouters and will reestablish themselves on sites dominated by other disturbance-associated species, e.g., *Glycyrrhiza lepidota* and *Pascopyrum smithii (= Agropyron smithii)*. Associations in this shrubland alliance are common and widespread.

Shrublands dominated solely by *Salix exigua* (*sensu stricto*) extend from the Pacific Northwest and California east into the Rocky Mountains and onto the Great Plains. Stands of possibly mixed or ambiguous composition may occur from the northern Great Plains south to the Colorado plains, possibly extending into northeastern New Mexico and the western portions of the Dakotas, Nebraska, Kansas, and Oklahoma. Examples dominated by *Salix interior* occur in the Midwest in Iowa, Illinois, Indiana, Ohio, and the eastern portions of North Dakota, South Dakota, Nebraska, and Kansas. They also extend into Arkansas, Tennessee, Kentucky, Texas, and eastern Oklahoma, and possibly in Pennsylvania and West Virginia, as well as in Manitoba and other provinces of Canada. In western Oklahoma and throughout the Ozarks the associations are local along major streams. In the West, adjacent upland plains communities include agricultural fields and rolling hills of *Artemisia filifolia*, xeric tallgrass prairies, and *Bouteloua gracilis* shortgrass prairies. In the steep canyons of the foothills, upslope vegetation includes *Pseudotsuga menziesii* and *Pinus ponderosa* forests, *Pinus edulis* and *Juniperus* spp. woodlands, oak, sagebrush, and greasewood scrub. In the lower montane, upslope vegetation includes *Pinus contorta* and *Populus tremuloides* forests.

Comments: In the West, *Salix exigua* alliances differ due to the structure of the vegetation and hydrologic regimes. The woodland alliances contain open stands of trees with crowns not touching (generally forming 25-60% cover). The hydrologic regimes differ due to the length of time that the surface water is present and depth to the water table. The surface water in the seasonally flooded alliance is present for extended periods during the growing season, and the water table is typically near the surface. It occurs in interdune depressions. On the other hand, the surface water in the temporarily flooded alliance is only present for brief periods during the growing season, and the water table is well below the surface. Its habitat is strictly riverine. In contrast, *Salix interior* does not develop stands which would be considered to have a woodland physiognomy, and all examples are considered to be temporarily flooded (e.g., riverine).

Range: Associations in this alliance are common and widespread. Their range extends from the Pacific Northwest and California, east to the Rocky Mountains (these dominated solely by *Salix exigua sensu stricto*); in the northern Great Plains and south to the Colorado plains and New Mexico (these associations possibly of mixed or ambiguous composition). The western portions of the Dakotas, Nebraska, Kansas, and Oklahoma are also in this apparent zone of ambiguity or intermediacy. Stands dominated by *Salix interior* occur in the Midwest in Iowa, Illinois, Indiana, Ohio, and the eastern portions of North Dakota, South Dakota, Nebraska, and Kansas. They also extend into Arkansas, Tennessee, Kentucky, Texas, and eastern Oklahoma, and possibly in Pennsylvania and West Virginia, as well as in Manitoba and other provinces of Canada. The alliance is also found in the Mexican state of Tamaulipas.

States/Provinces: AR CA? CO IA ID IL IN KS KY? MB MT MXTM ND NE NM OH? OK ON OR PA? SD TN? TX UT WA WY

TNC Ecoregions: 10:C, 17:C, 18:C, 19:C, 20:C, 25:C, 26:C, 27:C, 30:C, 32:?, 33:?, 35:C, 36:C, 37:C, 38:C, 39:C, 40:C, 42:C, 44:?, 48:C, 49:?, 6:C
USFS Ecoregions: 221Ec:PPP, 221Ed:PPP, 221Ef:PPP, 222A:CC, 222Df:C??, 222Ek:C??, 222Fc:C??, 231G:CC, 234Aa:CCP, 234Ai:CC?, 251Aa:CCC, 251B:CP, 251C:CC, 251D:CC, 251E:CC, 311A:C?, 313A:CC, 313B:CC, 313E:CC, 315C:C?, 315E:CC, 321A:CC, 322A:CC, 331B:CP, 331C:CC, 331F:CC, 331G:CC, 331H:CC, 331I:CC, 331J:CC, 332C:CC, 332E:CP, 341B:CC, 341C:CC, 342A:CC, 342B:CC, 342C:CC, 342D:CC, 342E:CC, 342F:CC, 342G:CC, 342H:C?, 342I:CC, M222A:CC, M231A:CC, M313B:CC, M331A:CC, M331B:CC, M331D:CC, M331E:CC, M331F:CC, M331G:CC, M331H:CC, M331I:CC, M331J:CC, M332A:CC, M332E:CC, M332G:CC, M333C:CC, M334A:CC, M341B:CC, M341C:CC
Federal Lands: NPS (Buffalo, Theodore Roosevelt, Zion); USFWS (Lower Rio Grande Valley, Ouray, Santa Ana)
Synonymy: *Salix* spp. Series (Johnston 1987); Plains and Great Basin Riparian Wetlands (Brown 1982); *Salix exigua* shrubland alliance (Hoagland 1998a); R4B3cI2a. *Salix exigua* (Foti et al. 1994); No equivalent (Allard 1990)
References: Brown 1982, Brown et al. 1979, Christy 1973, Cooper and Cottrell 1990, Dick-Peddie et al. 1984, Dorn 1997, Evenden 1990, Faber-Langendoen et al. 1996, Foti et al. 1994, Hansen et al. 1989, Hansen et al. 1991, Hansen et al. 1995, Hoagland 1998a, Johnston 1987, Jones and Walford 1995, Kagan 1997, Kittel 1994, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1996, Kittel et al. 1999, Kovalchik 1987, Muldavin et al. 1993a, Muldavin et al. 1994a, Muldavin et al. 2000a, Myhre and Clements 1972, Padgett et al. 1988b, Padgett et al. 1989, Phillips 1977, Sawyer and Keeler-Wolf 1995, Shelford 1954, Tuhy and Jensen 1982, Youngblood et al. 1985a
Authors: GREAT PLAINS PROGRAM 1-95, JT, WCS **Identifier:** A.947

Salix exigua Temporarily Flooded Shrubland
Coyote Willow Temporarily Flooded Shrubland
Sandbar Willow Shrubland **G5 (99-05-06)**
Ecological Group (SCS;MCS): Northern and Central Great Plains Wooded Riparian Vegetation (560-05; 1.6.5.1) Montane Riparian Shrublands (n/a; n/a)

Concept: This willow shrubland community is found along rivers and streams at lower elevations throughout the northwestern United States and Great Plains. This type is an early successional stage that occurs on recently flooded riparian areas. Stands occur most commonly on alluvial sand, but silt, clay, or gravel may also be present. *Salix exigua* is the dominant canopy species (*Salix interior* or intermediates of the two willow species may be present in the eastern part of the range). It can form dense stands up to 4 m tall, but there are often patches where the shrub layer is absent. Seedlings and small saplings of *Populus deltoides* and *Salix amygdaloides* may be present. The herbaceous cover is sparse to moderate, but rarely exceeds 30%. Species present include *Cenchrus longispinus, Polygonum lapathifolium, Schoenoplectus americanus (= Scirpus americanus), Triglochin maritima*, and *Xanthium strumarium*. The composition of this community, especially the herbaceous layer, varies from year to year with succession or renewed disturbance.
Comments: This type may be an early successional shrubland that develops into *Salix exigua* / Mesic Graminoids Shrubland (CEGL001203), or the two types may be

essentially synonymous. This plant association occupies a wide geographic range. The range of this type was reviewed and it was split into eastern, *Salix interior* Temporarily Flooded Shrubland (CEGL008562), and western components. The western stands may all be composed of *Salix exigua* (*sensu stricto*) and Great Plains stands may contain either *Salix exigua, Salix interior*, or intermediates of the two willow species, the *Salix exigua* being an entirely Great Plains and eastwardly distributed species (Kartesz 1999).

Range: This sandbar willow shrubland community is found along rivers and streams at lower elevations throughout the northwestern United States and Great Plains, ranging sporadically from Oklahoma northwest to the Dakotas and Manitoba, and west to Washington. Part of this type's former range in the Great Plains and eastward is actually occupied, at least in part, by *Salix interior* [see *Salix interior* Temporarily Flooded Shrubland (CEGL008562)].

States/Provinces: ID:S3?, MB:S?, MT:S5, ND:S?, NE:S4S5, OK:S?, OR:S1, SD:S2, WA:S?, WY:S3Q

TNC Ecoregions: 10:C, 20:C, 25:C, 26:C, 27:C, 6:C

USFS Ecoregions: 251Aa:CCC, 251C:CC, 331C:C?, 331F:CC, 331G:CC, 331H:CC, 331I:CC, 331J:CC, 332C:PP, 332E:PP, 342A:CC, 342B:CC, 342F:CC, 342G:CC, M331A:CC, M331B:CC, M331C:CC, M331D:CC, M331E:CC, M331F:CC, M331G:CC, M331H:CC, M331I:CC, M331J:CC, M332A:CC, M333C:CC, M334A:CC

Federal Lands: NPS (Badlands, Theodore Roosevelt)

Synonymy: DRISCOLL FORMATION CODE:III.B.3.c. (Driscoll et al. 1984) B, *Salix exigua* (Bourgeron and Engelking 1994) =, R4B3cI2a. *Salix exigua* (Foti et al. 1994)

References: Bellah and Hulbert 1974, Bourgeron and Engelking 1994, Driscoll et al. 1984, Evenden 1990, Foti et al. 1994, Hansen et al. 1989, Hansen et al. 1991, Hansen et al. 1995, Hoagland 1998c, Hoagland 2000, Kartesz 1999, Kittel and Lederer 1993, Kovalchik 1987, Phillips 1977, Steinauer 1989, Steinauer and Rolfsmeier 2000, Wilson 1970

Authors: J.F. Drake, WCS **Confidence:** 1 **Identifier:** CEGL001197

Local Description: This association is dominated by an overstory of both *Salix exigua* and *S. amygdaloides*. The shrub heights vary from 10 to 20 feet. The area has patches of *Salix* of different sizes representing different cohorts. The farther one gets from the river the larger are the *Salix* (Figures 25, 26, 27 and 28). Some *Populus deltoides* seedlings are also found. The forb and grass layer vary but includes *Phragmites australis*, *Equisetum arvense, E. hyemale*, *Juncus* spp. and in the wetter swales within the vegetation type are the occasional *Typha latifolia*. Soil type is typically Frequently Flooded on the northern bank and a Complex on the southern bank.

Figure 25. Coyote Willow Temporarily Flooded Shrubland.

Figure 26. Coyote Willow Temporarily Flooded Shrubland.

Figure 27. Coyote Willow Temporarily Flooded Shrubland.

Figure 28. Coyote Willow Temporarily Flooded Shrubland.

III.B.2.N.d.20. SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE

Western Snowberry Temporarily Flooded Shrubland Alliance

Concept: This alliance is found in the northern Great Plains in mesic swales, depressions, ravines and floodplains. Some sites experience intermittent and brief flooding. The soils are fertile and well-drained to imperfectly drained silts and loams. The upper soil horizon is usually deep, although a thin layer of sand may be present if the site has been recently flooded This alliance is dominated by shrubs approximately 1 m tall. Shrub cover is typically greater than 50%, and in places it can approach 100%. These shrubs form dense clumps that exclude most other species. *Symphoricarpos occidentalis* is the most common shrub. *Rhus aromatica* and *Prunus virginiana* can be locally abundant, and both can grow to 2-3 m in places . Rarely, scattered small trees are present. These are most often *Fraxinus americana* or *Populus deltoides*. Herbaceous species and smaller shrubs are most abundant at the edge of stands of this alliance and in gaps between the taller shrubs where the shading is less complete. *Rosa woodsii* is a typical smaller shrub. *Achillea millefolium, Artemisia ludoviciana, Galium boreale*, and *Pascopyrum smithii* are common herbaceous species. Woody vines sometimes occur, most commonly *Parthenocissus vitacea*. *Symphoricarpos occidentalis* shrublands often have a significant component of exotic species, especially where grazing has been intense *Bromus inermis, Cirsium arvense*, and *Poa pratensis* are the most abundant of these exotics. Overgrazing of prairies can lead to the expansion of degraded forms of this alliance.

Comments: This alliance may grade into *Fraxinus pennsylvanica - (Ulmus americana)* Woodland Alliance (A.629) or *Populus deltoides* Temporarily Flooded Woodland Alliance (A.636). Some communities within the latter woodland alliances contain significant amounts of *Symphoricarpos occidentalis* and may be difficult to distinguish from the shrubland where the two meet. This alliance includes grassland areas that are near or between shrub-covered areas. Establishing the boundaries between this alliance and surrounding grasslands is problematic and may be somewhat arbitrary.

Range: This alliance occurs in riparian areas in the northern Great Plains and the foothills of the Rocky Mountains. The alliance is found from southern Saskatchewan, Canada, south through Montana and the Dakotas, and into eastern Wyoming and Colorado.

States/Provinces: CO IA? MB? MT ND NE SD SK WY

TNC Ecoregions: 10:C, 20:C, 25:C, 26:C, 27:C, 35:C

USFS Ecoregions: 251Bb:CPP, 331C:CC, 331D:CC, 331E:CC, 331F:CC, 331G:CC, 331H:CC, 332A:CP, 332B:CP, 332C:CP, 332D:CP, 342A:CC, M331B:??, M332B:CC, M332D:CC, M332E:CC, M334A:CC

Federal Lands: NPS (Theodore Roosevelt, Wind Cave); USFS (Pawnee)

Synonymy: *Symphoricarpos occidentalis* Community (Hansen et al. 1984); *Symphoricarpos occidentalis* Community (Hansen and Hoffman 1988); *Symphoricarpos occidentalis/Elytrigia smithii* Shrubland (Johnston 1987); Western Snowberry Dominance Type (Jones and Walford 1995)

References: Christy 1973, Clark 1977b, Clark et al. 1980, Faber-Langendoen et al. 1996, Hansen and Hoffman 1988, Hansen et al. 1984, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, Johnston 1987, Jones and Walford 1995, Kittel et al. 1994, Kittel et al. 1996, Kittel et al. 1999, Meyer 1985, Welsh et al. 1987
Authors: M.S. REID, WCS **Identifier:** A.961

Symphoricarpos occidentalis Shrubland
Western Snowberry Shrubland
Western Snowberry Shrubland **G4G5 (96-02-01)**
Ecological Group (SCS;MCS): Northern and Central Great Plains Mesic Shrublands (510-55; 2.6.3.2)

Concept: This western snowberry shrubland is found in the western tallgrass and northern Great Plains of the United States and Canada. Stands occur in mesic depressions and swales, typically surrounded by upland grassland communities. The soils are silts and loams. This type has three distinct vegetation layers, a shrub layer (approximately 80 cm tall), a graminoid-dominated layer (approximately 30 cm tall), and a forb-dominated layer (<20 cm tall). *Symphoricarpos occidentalis* is the predominant species in the shrub layer and at times forms almost monospecific stands. *Rosa woodsii* commonly occurs interspersed with the *Symphoricarpos occidentalis*. Other shrubs, such as *Rhus aromatica* and *Prunus virginiana*, often occur as thickets on the fringe of this community. *Rhus aromatica* and *Prunus virginiana* can reach 2 m or more. The herbaceous layer is poorly represented where the shrubs are dense, although *Poa pratensis* occurs in many stands. Common forbs include *Artemisia ludoviciana, Solidago* spp., and *Achillea millefolium*. Vines, such as *Parthenocissus vitacea*, are often found climbing through the shrubs. This type is frequently observed in heavily grazed meadows and prairies.
Comments: This type often occurs in heavily disturbed areas in conjunction with exotic species such as *Poa pratensis* and *Cirsium arvense*. Because it occurs in mesic swales, depressions, ravine bottoms and floodplains, some stands are occasionally flooded whereas others are just very moist. Thus it tends to fall on both sides of the upland/wetland division.
Range: This western snowberry shrubland is found in the western tallgrass and northern Great Plains of the United States and Canada.
States/Provinces: CO:S3, IA?, MB?, MT:S4S5, ND:S4?, NE:S4, SD:SU, SK:S?, WY:SR
TNC Ecoregions: 10:C, 20:C, 25:C, 26:C, 27:C, 35:C
USFS Ecoregions: 251Bb:CPP, 331C:CC, 331D:CC, 331E:CC, 331F:CC, 331G:CC, 331H:CC, 332A:CP, 332B:CP, 332C:CP, 332D:CP, 342A:CC, M331B:??, M332B:CC, M332D:CC, M332E:CC, M334A:CC
Federal Lands: NPS (Badlands, Theodore Roosevelt, Wind Cave)
Synonymy: DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) B, *Symphoricarpos occidentalis* (Bourgeron and Engelking 1994) =, *Symphoricarpos ocidentalis* Community (Hansen et al. 1984) =, Low Shrub (Meyer 1985) =, *Symphoricarpos occidentalis / Elytrigia smithii* Plant Association (Johnston 1987) =, *Symphoricarpos occidentalis* Community (Hansen et al. 1984) =, *Symphoricarpos*

occidentalis Community (Jones and Walford 1995) =, *Symphoricarpos occidentalis* Series (Jones 1992b)

References: Bourgeron and Engelking 1994, Christy 1973, Clark 1977b, Clark et al. 1980, Driscoll et al. 1984, Hansen and Hoffman 1988, Hansen et al. 1984, Hansen et al. 1991, Hansen et al. 1995, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kittel et al. 1994, Kittel et al. 1999, McAdams et al. 1998, Meyer 1985, Steinauer and Rolfsmeier 2000

Authors: Drake, J. F., WCS **Confidence:** 3 **Identifier:** CEGL001131

Local Description: This classification was not mapped given the very small size of each occurrence. However, because of its common occurrence it is included here for reference. This type forms almost monotypic stands in the upland Bodmer Overlook area and typically on hill slopes or in swales (Figure 29).

Figure 29. Western Snowberry Shrubland.

V. Herbaceous Vegetation

V.A.5.N.c. Medium-tall sod temperate or subpolar grassland

V.A.5.N.c.27. PASCOPYRUM SMITHII HERBACEOUS ALLIANCE

Western Wheatgrass Herbaceous Alliance

Concept: This alliance is common and widespread in the Great Plains, especially the northern portions, and parts of the intermountain western U.S. and possibly Canada. The communities in it range from dry or dry-mesic to wet-mesic. Mid grasses are the dominant vegetation in most communities, although short grasses and sedges can be codominant. The vegetation tends to be denser where the mid grasses are predominant and more open where shorter graminoids are abundant. The mid grasses grow to 0.5-1.0 m on favorable sites, while the short grasses and sedges are less than 0.5 m tall. The most abundant midgrass is *Pascopyrum smithii*. Common associates include *Hesperostipa comata (= Stipa comata), Nassella viridula, Koeleria macrantha, Schizachyrium scoparium, Hesperostipa spartea (= Stipa spartea),* and *Poa* spp. In the drier communities of this alliance *Bouteloua gracilis* is the most common shortgrass. Other short graminoids typically found in the drier communities include *Carex inops ssp. heliophila, Carex duriuscula (= Carex eleocharis), Carex filifolia*, and *Bouteloua curtipendula* (in the northern portion of this alliance's range), *Aristida purpurea*, and *Buchloe dactyloides* (in the southern half of this alliance's range). In the wetter communities within this alliance, *Distichlis spicata, Hordeum jubatum, Elymus trachycaulus*, and *Iva annua* are common. Forbs and shrubs are generally minor components of communities within this alliance. If shrubs are present they are rarely taller than 1 m. Some forbs that are usually scattered about are *Gaura coccinea, Sphaeralcea coccinea, Amorpha canescens, Astragalus* spp., and *Tragopogon dubius*. Shrubs include *Symphoricarpos occidentalis, Artemisia cana, Artemisia frigida*, and *Opuntia* spp.

Communities within this alliance occur on several different soil types. The soil is most often clay or clay loam, however. it can be loam or sandy loam. In the east and central part of this alliance's range, these communities can be found on flat or rolling uplands, hillslopes, or along streams or depressions. In the western part of this alliance's range, its communities are found where local conditions are wetter than the average. This includes such areas as the base of slopes or along rivers or streams.

Comments: *Pascopyrum smithii* is a common constituent in many communities in the Great Plains. Its presence in so many communities can make it difficult to distinguish communities within this alliance from other dry-mesic midgrass communities in other alliances. The dominance of *Pascopyrum smithii* is typically a good diagnostic feature. Stands that have other species as codominants or even dominants may be difficult to classify. These stands will most likely be similar to stands within the *Bouteloua gracilis* Herbaceous Alliance (A.1282), *Hesperostipa comata* Bunch Herbaceous Alliance

(A.1270), *Distichlis spicata - (Hordeum jubatum)* Temporarily Flooded Herbaceous Alliance (A.1341), or *Distichlis spicata* Intermittently Flooded Herbaceous Alliance (A.1332). Associations in this alliance differ from those in the *Hesperostipa comata - Bouteloua gracilis* Herbaceous Alliance (A.1234) in having cover of *Pascopyrum smithii* exceeding that of *Hesperostipa comata*. In some stands of this association, *Distichlis spicata* may dominate, but contribution of at least 25% of the canopy cover by *Pascopyrum smithii* is diagnostic; stands with <25% of the cover contributed by *Pascopyrum smithii* belong to the *Distichlis spicata* alliance. In general a stand must have at least 25% cover of *Pascopyrum smithii* to be included in this alliance.

Range: Grasslands included in this alliance are found in the western Great Plains, from New Mexico north into Colorado, Wyoming and Montana, as well as Kansas north into Saskatchewan and Manitoba. It is also found in scattered locations in Idaho and Utah, and possibly Alberta, Canada.

States/Provinces: AB AZ CO ID KS MB MT ND NE NM SD SK UT WY

TNC Ecoregions: 10:C, 11:C, 20:C, 21:C, 25:C, 26:C, 27:C, 34:C, 35:C, 6:C, 9:C

USFS Ecoregions: 251Aa:CCC, 313D:CC, 315A:CC, 321A:PP, 331D:CC, 331E:CC, 331F:CC, 331G:CC, 331H:CC, 331I:CC, 332A:CC, 332B:CC, 332D:CC, 341A:CC, 341C:CC, 342F:CC, M313A:CC, M313B:CC, M331A:CC, M331F:CC, M332D:C?, M332E:CC, M334A:CC

Federal Lands: NPS (Jewel Cave, Sunset Crater, Theodore Roosevelt, Wind Cave); USFWS (Ouray)

Synonymy: *Elytrigia smithii* Series, in part (Johnston 1987)

References: Baker 1983c, Baker and Kennedy 1985, Bear Creek Uranium Mine Application n.d., Boutton et al. 1980, Branson et al. 1961, Branson et al. 1964, Branson et al. 1965, Bujakiewicz 1975, Bunin 1985, Cacek 1973, Christensen and Welsh 1963, Costello 1944b, Culwell and Scow 1982, DeVelice et al. 1991, Dick-Peddie 1986, Donart et al. 1978a, Faber-Langendoen et al. 1996, Hadley and Branson 1965, Hansen 1985, Hansen and Hoffman 1988, Hansen et al. 1984, Hansen et al. 1991, Hanson 1957, Hanson and Ball 1928, Hanson and Dahl 1956, Hanson and Whitman 1938, Hanson et al. 1931, Hyder et al. 1966, Johnston 1987, Jones 1992b, Kahler 1973, Keammerer and Stoecker 1975, Marr and Buckner 1974, Moir 1969b, Muldavin and Mehlhop 1992, Mutel 1976, Ramaley 1916b, Ramaley 1919b, Ramaley 1927, Ramaley 1942, Rogers 1953, Shanks 1977, Shantz 1906, Shantz 1911, Shantz 1923, Soil Conservation Service 1978, Stoecker-Keammerer Consultants n.d.(b), USFS 1992, Vestal 1913, Vestal 1914, Vestal 1919, Weaver and Albertson 1956, Western Resources Development Corporation n.d. (a), Wooten 1980

Authors: MCS, MOD. M.S. REID, MOD., MCS **Identifier:** A.1232

Pascopyrum smithii - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation

Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation

Western Wheatgrass - Blue Grama - Threadleaf Sedge Prairie **G4 (96-02-01)**

Ecological Group (SCS;MCS): Great Plains Mixedgrass Prairies (521-10; 2.9.3.2)

Concept: This western wheatgrass prairie community occurs throughout much of the northwestern Great Plains of the United States and Canada, on flat or gently sloping terrain. Many stands are on floodplains or gentle valley slopes. Some are on uplands. The

soils are clay loam, silt loam, or loam and usually deep and fertile. This community is dominated by medium and short graminoids. The midgrass stratum is dominated by *Pascopyrum smithii* or *Elymus lanceolatus*. Common associates include *Koeleria macrantha, Hesperostipa comata (= Stipa comata),* and *Nassella viridula*. *Hesperostipa comata* is more common on the upper slopes and drier upland sites with sandier soils, whereas *Nassella viridula* is more common on the lower slopes and floodplains with finer-textured soils. The most common short graminoid is *Bouteloua gracilis*. Other common graminoids include *Carex filifolia, Carex inops ssp. heliophila, Carex duriuscula (= Carex eleocharis),* and *Carex pensylvanica*. Forbs do not contribute much of the canopy cover but they are scattered throughout this community. Typical forbs are *Tragopogon dubius, Gaura coccinea, Hedeoma hispida, Phlox hoodii* and *Sphaeralcea coccinea*.

Comments: Almost any combination of *Pascopyrum smithii, Bouteloua gracilis, Carex filifolia,* and *Hesperostipa comata (= Stipa comata)* can be found in the northern and northwestern Great Plains, and the relative amounts of these species apparently depend at least in part on soil texture and grazing history. Moreover, drought or wet weather can cause the relative amounts of these species in one stand to change markedly in a few years (Ellison and Woolfolk 1937, Weaver and Albertson 1956). Consequently, differentiating between plant associations based solely on the relative amounts of these species is extremely difficult. This *Pascopyrum smithii - Bouteloua gracilis - Carex filifolia* association is found on soils in textural classes finer than loam in which *Pascopyrum smithii* and/or *Elymus lanceolatus* (which is similar morphologically and ecologically) contribute at least as much cover as does *Hesperostipa comata*. *Bouteloua gracilis, Elymus lanceolatus* and *Carex filifolia* may be patchily distributed, so areas of several acres should be examined to determine whether the vegetation belongs to this association. This association shares major graminoid species with *Hesperostipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation (CEGL002037) but in the latter association, *Hesperostipa comata* contributes more cover than do *Pascopyrum smithii* or *Elymus lanceolatus*, and the latter association grows on soils of loam or coarser textural classes.

Range: This western wheatgrass prairie community occurs throughout much of the northwestern Great Plains of the United States and Canada on flat or gently sloping terrain, ranging from Alberta and Saskatchewan in Canada south to Nebraska and possibly Colorado.

States/Provinces: AB:S?, CO?, MT:S4, ND:S3?, NE:S3S4, SD:S4, SK:S?, WY?

TNC Ecoregions: 10:C, 26:C, 27:C

USFS Ecoregions: 331D:CC, 331E:CC, 331F:CC, 331G:CC, 331H:CC

Federal Lands: NPS (Badlands, Jewel Cave, Theodore Roosevelt)

Synonymy: DRISCOLL FORMATION CODE:V.B.4.a. (Driscoll et al. 1984), *Pascopyrum smithii-Bouteloua gracilis-Carex filifolia* (Bourgeron and Engelking 1994) =, Western Wheatgrass - Grama - Sedge Type (Hanson and Whitman 1938) =. Types previously separated as *Pascopyrum smithii / Bouteloua gracilis* or *Pascopyrum smithii / Carex filifolia* in the literature are now lumped together as *Pascopyrum smithii / Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation (CEGL001579)., *Bromus tectorum - Agropyron smithii - Bouteloua gracilis* Association (Hanson and Dahl 1956) =, *Agropyron smithii / Carex filifolia* Habitat Type (Hansen et al. 1984) =, *Elytrigia*

smithii / Bouteloua gracilis Plant Association (Johnston 1987) B, *Elytrigia smithii / Carex filifolia* Plant Association (Johnston 1987) =, *Agropyron smithii / Bouteloua gracilis* Community (Jones 1992b) F, *Agropyron smithii / Carex filifolia* Community (Jones 1992b) F

References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Ellison and Woolfolk 1937, Hansen 1985, Hansen and Hoffman 1988, Hansen et al. 1984, Hanson and Dahl 1956, Hanson and Whitman 1938, Johnston 1987, Jones 1992b, Ode pers. comm., Steinauer and Rolfsmeier 2000, Weaver and Albertson 1956

Authors: H.C. Hanson and W. Whitman, mod. J. Drake and D. Faber-Langendoen, WCS **Confidence:** 2 **Identifier:** CEGL001579

Local Description: This type typically was found on thin soils on ridge crests or sideslopes. Total herbaceous cover ranged from 50 to 70%. Other species present include *Artemesia frigida, A. cana, Opuntia* spp. *Lupinus argenteus* (also an increaser under grazing), *Yucca glauca*, *Hesperostipa comata*, *Sporobolus cryptandrus*, *Rosa woodsii*, *Symphoricarpus occidentalis*, *Aristida* spp. and *Eriogonum flavum* (Figures 30 – 37). The soils are predominantly Loams (72.4%) and Silt Loams (15.0%). This contrasts with the ICEC description in that this type typically prefers soils of a finer texture. The current grazing pressure may be affecting the relative amounts of the principal species such that the natural occurrence and abundances of the species are altered.

Figure 30. Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation.

Figure 31. Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation.

Figure 32. Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation.

Figure 33. Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation.

Figure 34. Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation.

Figure 35. Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation.

Figure 36. Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation.

Figure 37. Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation.

V.A.5.N.c.29. HESPEROSTIPA COMATA - BOUTELOUA GRACILIS HERBACEOUS ALLIANCE

Needle-and-Thread - Blue Grama Herbaceous Alliance

Concept: This alliance is widespread across upland sites in the northern Great Plains. Its communities tend to be the climax communities on fertile dry-mesic sites across much of its range. It is dominated by mid and short grass species; woody species do not regularly achieve prominence. Few of the species exceed 1 m while many, including *Bouteloua gracilis*, do not exceed 50 cm. The most abundant species are *Hesperostipa comata (= Stipa comata)* and *Bouteloua gracilis*. On more mesic sites *Hesperostipa comata* is predominant, while on areas that are drier or subject to light grazing *Bouteloua gracilis* takes precedence. Other graminoid species that are commonly found in communities of this alliance are *Aristida purpurea var. longiseta (= Aristida longiseta), Carex duriuscula (= Carex eleocharis), Carex filifolia, Koeleria macrantha, Nassella viridula*, and *Pascopyrum smithii*. Sites in the southern half of the range of this alliance may have significant amounts of *Bouteloua curtipendula*. Forbs are common but not usually abundant. Forb species that are regularly found are *Artemisia frigida, Gaura coccinea, Gutierrezia sarothrae (= Gutierrezia diversifolia), Liatris punctata, Sphaeralcea coccinea (= Malvastrum coccineum), Phlox hoodii*, and *Sphaeralcea coccinea*. The clubmoss *Selaginella densa* is present in many stands in this alliance. Scattered shrubs are sometimes present. These include *Prunus virginiana, Rhus aromatica*, and *Symphoricarpos occidentalis*. In the western and southwestern portions of its range, *Cercocarpus montanus* may be found where this alliance occurs on slopes.

Communities in this alliance are found on flat to moderately steep topography. The soils are sandy loam, loam, or sometimes clay loam. They are often well-developed and derived from either glacial deposits or sometimes limestone or sandstone (Hanson and Whitman 1938, Coupland 1950, Hanson 1955).

Comments: Communities in this alliance can be confused with communities of the *Bouteloua gracilis* Herbaceous Alliance (A.1282), especially in Wyoming. More classification work is needed to clarify the concept boundaries between stands in this alliances.

Range: This alliance is found in the western Great Plains, from western Kansas to North Dakota, west into Colorado, Wyoming and Montana. The alliance also extends north into Canada in Saskatchewan, Manitoba, and probably Alberta.

States/Provinces: AB CO KS MB MT ND NE SD SK WY

TNC Ecoregions: 10:C, 20:C, 25:C, 26:C, 27:C, 33:C, 34:C, 35:C

USFS Ecoregions: 251Ab:CCC, 251Ba:CCC, 331C:CC, 331D:CC, 331E:C?, 331F:CC, 331G:CC, 331H:CC, 331I:CC, 332C:CC, M331A:CC, M331H:CC, M331I:CC, M332B:CC, M332C:CC, M332D:CC, M332E:CC, M334A:CC

Federal Lands: NPS (Theodore Roosevelt, Wind Cave)

Synonymy: *Stipa-Bouteloua* Faciation, in part (Coupland 1950); *Bouteloua-Stipa* Faciation, in part (Coupland 1950); Western Needlegrass, Sedge, Blue Grama community

(Tolstead 1941); Mixed Prairie climax, in part (Tolstead 1942); *Bouteloua-Stipa-Agropyron* Type, in part (Kuchler 1964); *Agropyron-Stipa* Type, in part (Kuchler 1964)
References: Aldous and Shantz 1924, Badaracco 1971, Bear Creek Uranium Mine Application n.d., Clements and Goldsmith 1924, Comer et al. 1999, Cooper et al. 1995, Cotter-Ferguson Project n.d., Coupland 1950, Coupland 1992a, Davis 1959, DeVelice et al. 1995, FEIS 1998, Faber-Langendoen et al. 1996, Hansen 1985, Hansen and Hoffman 1988, Hansen et al. 1984, Hanson 1955, Hanson 1957, Hanson and Dahl 1956, Hanson and Whitman 1938, Hardy Ranch Mine Application n.d., Hess 1981, Hubbard 1950, Johnston 1987, Kuchler 1964, Laurenroth et al. 1994, Livingston 1947, Moir 1969b, Mueggler and Stewart 1980, Ramaley 1916b, Smoliak 1965, Smoliak et al. 1972, Soil Conservation Service 1978, Stearns-Roger Inc. 1978, Stoecker-Keammerer Consultants n.d.(a), Tolstead 1941, Trammell and Trammell 1977, Vestal 1914, Weaver and Albertson 1956
Authors: MCS, MOD. M.S. REID, MCS **Identifier:** A.1234

Hesperostipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation
Needle-and-Thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation
Needle-and-Thread - Blue Grama Mixedgrass Prairie **G5 (99-02-25)**
Ecological Group (SCS;MCS): Great Plains Mixedgrass Prairies (521-10; 2.9.3.2)

Concept: This needlegrass - grama grass prairie community is common in the northern and central Great Plains of the United States. Stands occur on flat to rolling topography with deep (40-100 cm), sandy loam to loam, coarser-textured soils. They are typically associated with uplands, though they may also occur lower in the landscape, such as coulee and draw bottoms, if soils are sufficiently coarse (usually sandstone-derived). The type is found at elevations ranging from 600-1700 m (2000-5500 feet); average annual precipitation associated with these elevation param ranges from slightly less than 25 cm to over 50 cm (10-20 inches). The vegetation is dominated by moderate to moderately dense medium-tall grasses. *Hesperostipa comata (= Stipa comata)* is the tallest of the dominant species, sending seed heads to a maximum height of approximately 1 m. The rhizomatous graminoids *Bouteloua gracilis* and *Carex filifolia*, the other two dominant/codominant species, do not usually exceed 0.5 m. *Calamovilfa longifolia* is often found with high cover values on sandier soils, and *Koeleria macrantha* cover increases on degraded sites. There are regionalized expressions of variability with *Carex inops ssp. heliophila* surpassing *Carex filifolia* in Colorado and *Calamagrostis montanensis* being at least as important as the diagnostic species in north-central Montana. *Pascopyrum smithii* is consistently present. For woody species, subshrub forms (*Artemisia frigida, Gutierrezia sarothrae, Rosa arkansana*) have the highest cover and constancy, but their total cover does not sum to more than 5%, except on overgrazed sites. Cover values for forbs are low (the exception being *Selaginella densa*). Geographic setting influences forb composition to some degree, with *Sphaeralcea coccinea, Phlox hoodii, Heterotheca villosa, Gaura coccinea*, and *Liatris punctata* common in the northern areas, and *Lygodesmia juncea, Opuntia polyacantha, Artemisia dracunculus*, and *Ratibida columnifera* seeming to increase to the eastern and southern areas.

Comments: *Carex filifolia* is lacking or highly reduced in importance southward. Southern stands were once classified separately (CEGL001699), and further review of their characteristics compared to more northern stands is needed. Weaver and Albertson (1956) also remark on the fact that low sedges are present as far south as Texas but are important only north of Colorado. However, a phase of the *Stipa comata - Bouteloua gracilis* type of Mueggler and Stewart (1980) in western Montana is apparently quite similar to communities of the southern and southeastern portions or the Northern Great Plains, and both lack *Carex filifolia*. There are a welter of named community types, mostly seral representations of grazing or fire impacts, that vary by having one or another of the defining species (or even other graminoids, e.g., *Carex inops ssp. heliophila*) dominant. This assemblage of types is also defined by having relatively low cover of both *Pascopyrum smithii* and *Elymus lanceolatus (= Agropyron dasystachyum).* To accommodate these permutations within the concept of the type (as lesser-ranked occurrences) or to recognize them as independent vegetation types recognized by existing vegetation composition is one question. Another is, what cover value or degree of dominance of *Pascopyrum smithii* or *Elymus lanceolatus* will serve to establish the distinction between *Pascopyrum smithii - Stipa comata - Carex filifolia* (and allied *Pascopyrum smithii*-"dominated" communities) from the community under consideration.
Range: This needlegrass - grama grass prairie community is common in the northern and central Great Plains of the United States and Canada, ranging from Manitoba west to Alberta, south to Kansas and possibly Colorado.
States/Provinces: AB:S?, CO?, KS:S?, MB:S3, MT:S?, ND:S3?, NE:S?, SD:S?, SK:S?, WY:S3
TNC Ecoregions: 10:C, 20:C, 25:C, 26:C, 27:C, 34:C, 35:C
USFS Ecoregions: 251Ab:CCC, 251Ba:CCC, 331C:CC, 331E:C?, 331F:CC, 331G:CC, 331H:CC, 332C:CC, M334A:CC
Federal Lands: NPS (Badlands?, Theodore Roosevelt, Wind Cave)
Synonymy: *Stipa comata - Carex filifolia* Habitat Type (Hansen et al. 1984) =, Gramagrass - Needlegrass - Sedge (Hanson and Whitman 1938) =, *Stipa-Boutleoua* (Hubbard 1950) =, *Bouteloua-Stipa* (Hubbard 1950) =, *Stipa comata / Bouteloua gracilis* Plant Association (Johnston 1987) B, *Stipa comata / Carex filifolia* Plant Association (Johnston 1987) =, Association *Rumicetum venosi, subassoc. Boutelouetsum* (Looman 1980) =, Mixed prairie (Tolstead 1941) B
References: Hansen et al. 1984, Hanson and Whitman 1938, Hubbard 1950, Johnston 1987, Looman 1980, Mueggler and Stewart 1980, Steinauer and Rolfsmeier 2000, Thilenius et al. 1995, Tolstead 1941, Tolstead 1942, Weaver and Albertson 1956
Authors: J. Drake, MCS **Confidence:** 1 **Identifier:** CEGL002037

Local Description: This class was dominated by *Bouteloua gracilis* followed by *Hesperostipa comata* and was found on both ridges and slopes. Other species present in order of abundance included *Pascopyrum smithii, Artemesia frigida, Schizachyrium scoparium, Symphoricarpus occidentalis, Bouteloua curtipendula, Agropyron cristatum, Yucca* spp., *Opuntia* spp. and *Aristida* spp (Figure 38) .

Figure 38. Needle-and-Thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation

V.A.5.N.d.400. BROMUS INERMIS SEMI-NATURAL HERBACEOUS ALLIANCE

Smooth Brome Semi-natural Herbaceous Alliance

Concept:
Range: This alliance is found in Montana, Wyoming, and North and South Dakota.
States/Provinces: MT ND SD UT WY
USFS Ecoregions: 313A:CC, M341C:CC
Federal Lands: NPS (Theodore Roosevelt, Zion)
References:
Authors: D. FABER-LANGENDOEN, MCS **Identifier:** A.3561

Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation
Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation
Smooth Brome Semi-natural Grassland **GW (99-06-17)**
Ecological Group (SCS;MCS): Exotic Species-Dominated Herbaceous Upland Vegetation (900-60; 8.0.0.4)

Concept: This smooth brome grassland type occurs widely throughout the northern Great Plains and on relatively mesic sites in the semi-arid interior western United States, and perhaps more widely in the midwestern U.S. and Canada. Stands can occur in a wide

variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. The type is also widely planted for revegetating disturbed land, pasture, and hay fields, and has escaped into a variety of habitats including prairie, riparian grasslands, and mesic mountain meadows. In Montana, this community types occurs on elevation ranges from 1100-2050 m (3590-6700 feet) with best examples on mesic alluvial terraces. This grass grows best on moist, well-drained, finer-textured loam and clay loams and does not tolerate prolonged flooding. The vegetation is dominated by medium-tall (0.5-1 m) graminoids. The dominant grass is *Bromus inermis*, a naturalized species from Eurasia, that forms moderately dense to dense stands that often develop into monocultures. Other weedy species such as *Cirsium arvense* may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie and montane meadow grasses, such as *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Hesperostipa comata (= Stipa comata)* and sparse, scattered mesic shrubs such as *Symphoricarpos* spp. as well as many others. However, the native species are not conspicuous enough to identify the native plant association that could occupy the site or the stand would be typed as such.
Comments: Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such. *Bromus inermis* occurs widely throughout the midwestern and western U.S., and perhaps this association should be broadened to include almost any stand dominated almost exclusively by *Bromus inermis*.
Range: This type occurs widely throughout the northern Great Plains and in relatively mesic sites in the semi-arid interior western United States, and perhaps more widely in the midwestern U.S. and Canada, depending on how the type is defined.
States/Provinces: MT:S?, ND:S?, SD:S?, UT:S?, WY:S?
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions: 313A:CC, M341C:CC
Federal Lands: NPS (Badlands, Theodore Roosevelt, Zion)
Synonymy: *Bromus inermis* Community Type (Hansen et al. 1995) =
References: Cronquist et al. 1977, Hansen et al. 1995
Authors: D. Faber-Langendoen, mod. K.A. Schulz, MCS **Confidence:** 3 **Identifier:** CEGL005264

Local Description: This class occurs sporadically around the park and appears to be invading the Prairie Restoration areas. It often includes not only *Bromus inermis* but also *Agropyron cristatum* and in the more disturbed areas, *Salsola* spp. An area on the south bank is also mapped as this class but it lies outside the park boundary and remains unconfirmed.

V.A.5.N.d.402. AGROPYRON CRISTATUM SEMI-NATURAL HERBACEOUS ALLIANCE

Crested Wheatgrass Semi-natural Herbaceous Alliance

Concept:
Range: This alliance is found in Montana, Wyoming, and North and South Dakota, and in Canada in Manitoba and Saskatchewan.
States/Provinces: MB MT ND SD SK WY
Federal Lands: NPS (Theodore Roosevelt)
References:
Authors: D. FABER-LANGENDOEN, MCS **Identifier:** A.3563

Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata) Semi-natural Herbaceous Vegetation
Crested Wheatgrass - (Western Wheatgrass, Needle-and-Thread) Semi-natural Herbaceous Vegetation
Crested Wheatgrass Semi-natural Grassland **GW (99-06-17)**
Ecological Group (SCS;MCS): Exotic Species-Dominated Herbaceous Upland Vegetation 900-60; 8.0.0.4)

Concept: This crested wheatgrass type occurs most commonly in the northern Great Plains of the United States and Canada. Stands occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. It is also widely planted to revegetate pastures and rangelands. The vegetation is dominated by medium-tall (0.5-1 m) graminoids. The dominant grass is *Agropyron cristatum*, a naturalized species from Europe. Other weedy species may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata (= Stipa comata)*, as well as others. Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such.
Comments: Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such.
Range: This type occurs most commonly in the northern Great Plains of the United States and Canada.
States/Provinces: MB:S?, MT:S?, ND:S?, SD:S?, SK:S?, WY:S?
Federal Lands: NPS (Badlands, Theodore Roosevelt)
References: Hansen et al. 1984
Authors: D. Faber-Langendoen, MCS **Confidence:** 3 **Identifier:** CEGL005266

Local Description: This class occurs regularly in all drainages in the upland areas. It's extent is widespread and makes up the understory grass vegetation in upland *Fraxinus pennsylvanica – Prunus virginiana* woodland (Figures 39 and 40) and the south bank of the Missouri River where it is the dominant understory within the Cottonwood (Figures 41 and 42). Other common species in order of abundance include *Pascopyrum smithii,*

Hesperostipa comata, *Artemesia frigida*, *A. cana*, *Salsola* spp., *Rumex* spp., and *Symphoricarpos occidentalis*.

Figure 39. Crested Wheatgrass (Western Wheatgrass - Needle-and-Thread) Semi-natural Herbaceous Vegetation – Bodmor ridge area.

Figure 40. Crested Wheatgrass (Western Wheatgrass - Needle-and-Thread) Semi-natural Herbaceous Vegetation– Bodmor ridge area.

Figure 41. Crested Wheatgrass (Western Wheatgrass - Needle-and-Thread) Semi-natural Herbaceous Vegetation– South bank of the Missouri River.

Figure 42. Crested Wheatgrass (Western Wheatgrass - Needle-and-Thread) Semi-natural Herbaceous Vegetation– South bank of the Missouri River.

V.A.5.N.k Seasonally flooded temperate or subpolar grassland

V.A.5.N.k.20 PHALARIS ARUNDINACEA SEASONALLY FLOODED HERBACEOUS ALLIANCE

Reed Canary Grass Seasonally Flooded Herbaceous Alliance

Concept: This alliance is found throughout the northeastern United States, but its distribution as a natural type is complicated elsewhere. Stands are dominated by *Phalaris arundinacea*, which tends to occur in monocultures or associated with *Calamagrostis canadensis*. Other associates in the Northeast include *Viburnum nudum, Alnus incana* or *Alnus serrulata, Viburnum dentatum*, and *Agrostis gigantea*. Further work is required to resolve the natural versus introduced nature of this type in North American before a complete alliance description can be completed. Stands are typically minerotrophic wetlands rather than river shores.

This association is reported from throughout Montana, Idaho, northeastern Utah, and the Columbia Basin of Washington, but is likely more widespread in the western United States. Its distribution as a natural type is complicated because this native species is widely cultivated as a forage crop and has escaped and established in wetlands and riparian areas, displacing the local flora. Elevations range from near sea level to 1700 m. Stands are found along riparian areas, pond and lake margins, wet meadows, and intermittent drainages. Soils are commonly fine-textured and may be flooded for brief to extended periods. The vegetation is characterized by a dense, tall herbaceous layer (often

>80% canopy cover and1.5-2 m tall) that is dominated by *Phalaris arundinacea*, which tends to occur in monocultures. Associated species may include *Equisetum arvense, Muhlenbergia asperifolia, Mentha arvensis, Schoenoplectus acutus (= Scirpus acutus)*, and many other species in trace amounts where disturbed. Introduced species such as *Lepidium latifolium, Cirsium arvense, Sonchus oleraceus, Euphorbia esula*, and *Phleum pratense* are common in some stands.

United States Distribution: ID, MT, NM, UT

Global Range Comments: This association is reported from throughout Montana and Idaho and into northeastern Utah and is likely more widespread in the western United States. Its distribution as a natural type is complicated because this native species is widely cultivated as a forage crop and has escaped and established in many wetlands and riparian areas.

References: Bourgeron and Engelking, 1994, Cooper et al. 1995, Crawford 2001, Driscoll et al. 1984, Hall and Hansen. 1997, Hansen et al. 1995. Muldavin et al. 2000a, Von Loh, 2000.

Phalaris arundinacea Western Herbaceous Vegetation
Reed Canary Grass Western Herbaceous Vegetation
Reed Canary Grass Wet Meadow G5
CEGL001474

Association Summary: This association is reported from throughout Montana, Idaho, northeastern Utah, and the Columbia Basin of Washington, but is likely more widespread in the western United States. Its distribution as a natural type is complicated because this native species is widely cultivated as a forage crop and has escaped and established in wetlands and riparian areas, displacing the local flora. Elevations range from near sea level to 1700 m. Stands are found along riparian areas, pond and lake margins, wet meadows, and intermittent drainages. Soils are commonly fine-textured and may be flooded for brief to extended periods. The vegetation is characterized by a dense, tall herbaceous layer (often >80% canopy cover and1.5-2 m tall) that is dominated by *Phalaris arundinacea*, which tends to occur in monocultures. Associated species may include *Equisetum arvense, Muhlenbergia asperifolia, Mentha arvensis, Schoenoplectus acutus (= Scirpus acutus)*, and many other species in trace amounts where disturbed. Introduced species such as *Lepidium latifolium, Cirsium arvense, Sonchus oleraceus, Euphorbia esula*, and *Phleum pratense* are common in some stands.
States / Provinces: ID, MT, NM, UT

Global Range Comments: This association is reported from throughout Montana and Idaho and into northeastern Utah and is likely more widespread in the western United States. Its distribution as a natural type is complicated because this native species is widely cultivated as a forage crop and has escaped and established in many wetlands and riparian areas.

Element Description Author(s): K. Schulz
References: Bourgeron and Engelking 1994, Cooper et al. 1995, Crawford 2001, Driscoll et al. 1984, Hall and Hansen 1997, Muldavin et al. 2000a, Von Loh 2000.

NatureServe and TNC Regional Ecologists, Western Region.

Local Description: This class only occurs on the floodplain and forms monotypic or almost monotypic stands. Other species, when present may include *Carex* spp., *Phragmites australis*, *Juncus* spp., *Hordeum jubatum* and *Pascopyrum smithii* and traces of *Typha latifolia, Equisetum arvense and Salix exigua* (Figures 43 - 45). This association shares the floodplain with Cottonwood, Willow and Cattail associations and will share portions of these at its periphery.

Figure 43. Reed Canary Grass Western Herbaceous Vegetation.

Figure 44. Reed Canary Grass Western Herbaceous Vegetation.

Figure 45. Reed Canary Grass Western Herbaceous Vegetation.

V.A.5.N.l. Semipermanently flooded temperate or subpolar grassland

V.A.5.N.l.9. TYPHA (ANGUSTIFOLIA, LATIFOLIA) - (SCHOENOPLECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

(Narrowleaf Cattail, Broadleaf Cattail) - (Clubrush species) Semipermanently Flooded Herbaceous Alliance

Concept: This alliance, found in virtually every state in the United States and probably most Canadian provinces, contains stands dominated by *Typha angustifolia* and/or *Typha latifolia*, either alone or in combination with other tall emergent marsh species. Associated species vary widely; in the Midwest they include many sedges such as *Carex aquatilis, Carex rostrata, Carex pellita (= Carex lanuginosa),* bulrushes such as *Schoenoplectus americanus (= Scirpus americanus), Schoenoplectus acutus (= Scirpus acutus),* and *Schoenoplectus heterochaetus (= Scirpus heterochaetus),* and broad-leaved herbs such as *Thelypteris palustris, Asclepias incarnata, Impatiens capensis, Sagittaria latifolia, Scutellaria lateriflora, Sparganium eurycarpum, Hibiscus moscheutos,* and *Verbena hastata*. Floating aquatics such as *Lemna minor* may predominate in deeper zones.

This alliance is found most commonly along lake margins and in shallow basins, and occasionally in river backwaters. Lacustrine cattail marshes typically have a muck-bottom zone bordering the shoreline, where cattails are rooted in the bottom substrate, and a floating mat zone, where the roots grow suspended in a buoyant peaty mat. *Typha angustifolia* can grow in deeper water compared to *Typha latifolia*, although both species reach maximum growth at a water depth of 50 cm. *Typha* often occurs in pure stands, and can colonize areas recently exposed by either natural or human causes. *Lythrum salicaria*, an exotic species from Europe, has become a common associate of many eastern *Typha* marshes. In the Southeast, this alliance is widespread and currently representative of a wide variety of mixed marshes with no clear dominants. Vegetation in this alliance may be natural or semi-natural and includes mixed stands of the nominal species, as well as essentially monospecific stands of *Typha latifolia*. These monospecific stands occur especially in artificial wetlands, such as borrow pits or ponds. This alliance occurs on hydric soils in wetlands, ditches, ponds, lakes, and rivers, as well as on shorelines and streambanks. Inundation is commonly 3-6 dm (1-2 feet) in depth. These marshes have hydric soils and are flooded with water levels ranging from several centimeters to more than 1 m for a significant part of the growing season. Occurrences may display areas of open water, but emergent vegetation dominates (80% cover). Seasonal flooding during winter and spring or flooding during heavy rains help maintain these marshes by causing water exchange which replenishes freshwater and circulates nutrients and organic debris. Soils which support this community can be mineral or organic but are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part. Vegetative diversity and density is highly variable in response to water depth, water chemistry, and natural forces.

Comments: It has been suggested that mixed emergent marshes tend to occur on harder pond, lake, or river bottoms and are less likely to contain a peaty mat with its diverse mixture of forbs (MNNHP 1993). Alliances that describe marshes dominated by mixed emergents other than cattails and the associates listed above include the V.A.5.N.l *Phragmites australis* Semipermanently Flooded Herbaceous Alliance (A.1431), the V.A.5.N.l *Schoenoplectus acutus - (Schoenoplectus tabernaemontani)* Semipermanently Flooded Herbaceous Alliance (A.1443), the V.A.5.N.l *Schoenoplectus americanus* Semipermanently Flooded Herbaceous Alliance (A.1432), and the V.A.5.N.l *Zizania (aquatica, palustris)* Semipermanently Flooded Herbaceous Alliance (A.1441). In shallow flooded conditions this alliance grades into the V.A.5.N.k *Typha spp. - (Schoenoplectus spp., Juncus spp.)* Seasonally Flooded Herbaceous Alliance (A.1394), as well as V.A.5.N.k *Schoenoplectus fluviatilis* Seasonally Flooded Herbaceous Alliance (A.1387). *Typha latifolia* can hybridize with *Typha angustifolia*, and the hybrid, *Typha X glauca*, may be more invasive of disturbed areas than the parent species. In the West, some studies have classified marshes dominated by *Typha domingensis* as phases of *Typha latifolia* marshes. This alliance now includes wetland communities dominated by *Typha latifolia*, often in disturbed or sedimented situations. The concept and distribution of this alliance in the Southeast needs reassessment. Many of the presettlement occurrences of this alliance have been drained and converted to cropland or destroyed by siltation, which greatly accelerates the natural successional process from shallow inundation to moist soil. *Lythrum salicaria* is an aggressive exotic species that threatens this vegetation type in Canada, the Northeast, and more recently in the Midwest.

Range: This alliance is found in virtually every state in the United States and is likely to be found in most Canadian provinces. In the southeastern United States, it is found in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

States/Provinces: AL AR AZ BC? CA CO CT DE FL? GA IA ID IL IN KS KY LA MA MB MD ME MI MN MO MS MT NC ND NE NH NJ NM NV NY OH OK ON OR PA QC RI SC SD TN TX UT VA VT WA WI WV WY

TNC Ecoregions: 10:C, 11:C, 17:C, 19:C, 20:C, 25:C, 26:C, 27:C, 2:C, 31:C, 32:C, 33:C, 34:C, 35:C, 36:C, 37:C, 38:C, 39:C, 41:C, 42:P, 43:C, 44:C, 45:C, 46:C, 47:C, 48:C, 49:C, 50:P, 51:P, 52:C, 53:C, 56:P, 57:C, 58:C, 59:C, 61:C, 62:C, 63:C, 64:C, 6:C

USFS Ecoregions: 212Aa:C??, 212Ab:C??, 212Ba:C??, 212Bb:C??, 212Ca:CC?, 212Cb:CCC, 212Da:C??, 212Db:C??, 212Dc:C??, 212Ea:CCC, 212Ec:CCP, 212Ed:CCP, 212Ee:CCP, 212Fa:C??, 212Fb:C??, 212Fc:C??, 212Fd:C??, 212Ga:CPP, 212Gb:CP?, 212Ha:CCP, 212Hb:CCP, 212He:CCC, 212Hh:CCP, 212Hi:CCP, 212Hj:CCC, 212Hk:CCC, 212Hl:CCC, 212Hm:CCP, 212Hn:CCP, 212Ho:CCC, 212Hp:CCP, 212Hq:CCP, 212Hr:CCP, 212Hs:CCP, 212Ht:CCC, 212Hu:CCC, 212Hv:CCC, 212Hw:CCC, 212Hx:CCC, 212Hy:CCP, 212Ia:CCC, 212Ib:CCP, 212Ja:CCC, 212Jb:CCP, 212Jc:CCP, 212Jf:CCP, 212Jj:CCP, 212Jk:CCP, 212Jl:CCP, 212Jm:CCP, 212Jn:CCC, 212Jo:CCP, 212Jr:CCC, 212Ka:CCP, 212Kb:CCC, 212La:CPP, 212Lb:CPP, 212Lc:CPP, 212Ld:CPP, 212Ma:CPP, 212Mb:CPP, 212Na:CCP, 212Nb:CCP, 212Nc:CCC, 212Nd:CCP, 212Oa:CCC, 212Ob:CCC, 212Pa:CCC, 212Pb:CCC, 221Aa:C??, 221Ab:C??, 221Ac:C??, 221Ad:C??, 221Ae:C??, 221Af:C??, 221Ag:C??, 221Ah:C??, 221Ai:C??, 221Aj:C??, 221Ak:C??, 221Al:C??, 221Am:C??, 221Ba:C??, 221Bb:C??, 221Bc:C??, 221Bd:C??, 221Da:C??, 221Db:C??,

221Dc:C??, 221Ea:CC?, 221Eb:CC?, 221Ec:CCC, 221Eg:CCC, 221Fa:C??, 221Fb:C??, 221H:CC, 221Ja:CC?, 221Jc:CC?, 222Ab:CCC, 222Ag:CCC, 222Ah:CCC, 222Am:CCC, 222An:CCC, 222Cf:CCP, 222Cg:CCP, 222D:CC, 222Eb:CCC, 222Eg:CCP, 222Eh:CCP, 222F:CC, 222Ge:CCC, 222Ha:CCC, 222Hb:CCC, 222Ia:CCC, 222Ib:CCP, 222Ic:CC?, 222Id:CC?, 222Ie:CCP, 222If:CCC, 222Ja:CCC, 222Jc:CCC, 222Je:CCC, 222Jg:CCC, 222Jh:CCC, 222Ji:CCC, 222Jj:CCC, 222Kd:CCC, 222Ke:CCC, 222Kf:CCC, 222Kg:CCC, 222Kj:CCC, 222Lc:CCC, 222Mb:CCC, 222Mc:CCC, 222Md:CCC, 222Me:CCC, 222Na:CCC, 222Q:CC, 231Aa:C??, 231Ae:C??, 231Af:C??, 231Ak:C??, 231Al:C??, 231Am:C??, 231An:C??, 231Ao:C??, 231Ap:C??, 231C:CC, 231Fb:CCC, 231Ga:CCC, 231Gb:CCC, 231Gc:CCC, 232Aa:C??, 232Ac:C??, 232Ad:C??, 232Bc:C??, 232Bd:C??, 232Br:C??, 232Ce:CCC, 232Ch:CC?, 232Cj:CC?, 234A:PP, 251Aa:CCC, 251Ab:CCC, 251Ba:CCC, 251Bb:CCC, 251Bd:CCC, 251Be:CCC, 251Cb:CCC, 251Cc:CCC, 251Cd:CC?, 251Cf:CCC, 251Cg:CCC, 251Ch:CCC, 251Cm:CCC, 251Cp:CCC, 251Dc:CCC, 251Dg:CCC, 251Ea:CCC, 251Eb:CCC, 251Ed:CCC, 251F:CC, 255Aa:CCC, 255C:CC, 255Da:CCC, 255Dc:CCC, 261A:CC, 262A:CC, 263A:CC, 311A:CC, 331C:CC, 331F:CP, 331H:CC, 331I:CC, 332A:CP, 332B:C?, 332C:CC, 332D:CP, 332E:CC, 341C:CC, 342:C, M212Aa:C??, M212Ab:C??, M212Ac:C??, M212Ad:C??, M212Ba:C??, M212Bb:C??, M212Ca:CP?, M212Cb:CPP, M212Cc:CP?, M212Cd:CP?, M212Da:C??, M212Db:C??, M212Dc:C??, M212Ea:C??, M212Eb:C??, M212Fa:C??, M212Fb:C??, M221Aa:CCC, M221Ab:CCC, M221Ac:CCC, M221Ad:CCC, M221Ba:CCC, M221Bb:CCC, M221Bc:CCC, M221Bd:CCC, M221Be:CCC, M221Bf:CCC, M221Ca:C??, M221Cb:C??, M221Cc:C??, M221Cd:C??, M221Da:CCC, M221Db:CCP, M221Dc:CCP, M221Dd:CCP, M222Aa:CCC, M222Ab:CCC, M231Aa:CCC, M231Ab:CCC, M231Ac:CCC, M231Ad:CCC, M331F:CC, M331I:CC, M333C:CC, M334A:CC

Federal Lands: DOD (Arnold, Fort Benning); NPS (Acadia, Badlands, Isle Royale, Shiloh?, Theodore Roosevelt, Voyageurs); USFS (Daniel Boone, Kisatchie, Oconee?, Ouachita, Ozark, Pisgah, Talladega?, Tuskegee?); USFWS (Anahuac, Brazoria, Ouray, San Bernard)

Synonymy: Cattail Marsh, in part (Foti 1994b); *Typha (angustifolia, latifolia)* herbaceous alliance (Hoagland 1998a); P5A4bII2a. *Typha latifolia* (Foti et al. 1994); L5D2aI2a. *Typha latifolia* (Foti et al. 1994); *Typha latifolia* Habitat Type (Hansen et al. 1995); Cattail Series, in part (Sawyer and Keeler-Wolf 1995)

References: Anderson 1982, Apfelbaum 1985, Bundy et al. 1996, Bunin 1985, Christy 1973, Eggers and Reed 1987, Faber-Langendoen et al. 1996, Foti 1994b, Foti et al. 1994, Grace and Wetzel 1981, Great Plains Flora Association 1986, Hansen et al. 1991, Hansen et al. 1995, Hoagland 1998a, Jones and Walford 1995, Kittel et al. 1996, Kittel et al. 1999, Komarkova 1976, Komarkova 1986, Kovalchik 1993, Lindauer 1978, Lindauer and Christy 1972, MNNHP 1993, Masek 1979, McEachern 1979, Mitsch and Gosselink 1993, Mohlenbrock 1959, Muldavin et al. 1993b, Muldavin et al. 2000a, Padgett et al. 1989, Sawyer and Keeler-Wolf 1995, Segadas-Vianna 1951, Simkins 1931, TNC 1995b, Tolstead 1942, Wharton 1978, Youngblood et al. 1985a

Authors: MCS, MOD. M.S. REID, MP, MCS **Identifier:** A.1436

Typha spp. Great Plains Herbaceous Vegetation
Cattail species Great Plains Herbaceous Vegetation
Northern Great Plains Cattail Marsh **G4G5 (96-10-03)**
Ecological Group (SCS;MCS): Great Plains Saline Emergent Marshes (580-25 1.4.2.3)

Concept: This cattail community type is found throughout the Northern Great Plains of the United States and Canada. Stands occur in shallow (<0.5 m) or deep depressions, stock ponds, and seepy drainages. The vegetation is dominated by relatively pure stands of *Typha* spp., either *Typha latifolia* or *Typha angustifolia* or both. Many associates can occur, including *Eleocharis* spp. and *Sagittaria latifolia*. This type may simply be a less diverse variation of *Typha* spp. - *Schoenoplectus* spp. - Mixed Herbs Great Plains Herbaceous Vegetation (CEGL002228) that arises in disturbed wetland areas.
Comments: Where this type extends into western states, see *Typha latifolia* Western Herbaceous Vegetation (CEGL002010); where type extends into Southeast, see *Typha latifolia* Southern Herbaceous Vegetation (CEGL004150), and where type extends into the Midwest see *Typha* spp. Midwest Herbaceous Vegetation (CEGL002233). Bailey's province lines (Bailey et al. 1994) influence these association definitions. It is unclear whether a separate *Typha*-dominated type is needed in addition to the mixed *Typha* - *Scirpus* types, namely *Typha* spp. - *Schoenoplectus* spp. - Mixed Herbs Great Plains Herbaceous Vegetation (CEGL002228) and *Schoenoplectus acutus* - *Typha latifolia* - *(Schoenoplectus tabernaemontani)* Sandhills Herbaceous Vegetation (CEGL002030). Pure *Typha* stands, depending on site conditions, are often perceived as degraded examples of the mixed type.
Range: This cattail community type is found throughout the Northern Great Plains and adjacent Canada, ranging from Kansas to Manitoba.
States/Provinces: KS:SU, MB:S5, ND:S3, NE:S?, SD:S4
TNC Ecoregions: 25:C, 26:C, 27:C, 34:C
USFS Ecoregions: 251Aa:CCC, 331C:PP, 331F:PP, 331H:P?, 332A:PP, 332B:P?, 332D:PP, M334A:CC
Federal Lands: NPS (Badlands?, Theodore Roosevelt)
References: Bailey et al. 1994
Authors: D. Faber-Langendoen, MCS **Confidence:** 2 **Identifier:** CEGL002389

Local Description: This association occurs only on the floodplain below the fort and is bounded by Cottonwood, Reed Canary Grass and Willow associations and will share some of these elements at its periphery. The main cover species is *Typha latifolia* but *Phalaris arundinacea, Phragmites australis, Juncus* spp and *Carex* spp. are often found (Figures 46 – 50).

Figure 46. Cattail species Great Plains Herbaceous Vegetation.

Figure 47. Cattail species Great Plains Herbaceous Vegetation.

Figure 48. Cattail species Great Plains Herbaceous Vegetation.

Figure 49. Cattail species Great Plains Herbaceous Vegetation.

Figure 50. Cattail species Great Plains Herbaceous Vegetation.

VII. Sparse Vegetation

VII.A.1.N.a. Cliffs with sparse vascular vegetation

VII.A.1.N.a.6. OPEN CLIFF SPARSE VEGETATION ALLIANCE

Open Cliff Sparse Vegetation Alliance

Concept: This is technically not an alliance. It is a placeholder for a group of sparsely vegetated associations that do not have adequate vegetation descriptions, but do share certain substrate characteristics.
Range: This alliance is found in Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, Wisconsin, South Dakota, Kentucky, Tennessee, North Dakota (?), Pennsylvania (?),Colorado (?), and Wyoming (?). It is also found in Ontario and Manitoba, Canada.
States/Provinces: AR? CO? IA IL IN KS KY MB MI MN MO MT? ND NE OH ON PA? SD TN WI WY?
TNC Ecoregions: 25:?, 26:C, 27:C, 34:C, 35:C, 36:C, 37:C, 38:C, 44:C, 45:C, 46:C, 47:C, 48:C, 49:C, 63:C
USFS Ecoregions: 212Ha:CCC, 212Hb:CCC, 212He:CCC, 212Hh:CCC, 212Hi:CCP, 212Hj:CCC, 212Hl:CCC, 212Ia:CCC, 212Ib:CCC, 212Ja:CCC, 212Jb:CCC, 212Jc:CCP, 212Jf:CCP, 212Jj:CCP, 212Jl:CCP, 212Jn:CCC, 212Jo:CCP, 212Jr:CCC, 212Kb:CCC, 212La:CCP, 212Lb:CCC, 212Ma:C??, 212Ob:CCC, 212Pa:CCC, 221Ea:CCC, 221Ec:CCC, 221Ed:CCP, 221Ee:CCP, 221Ef:CCC, 221Eg:CCC, 221Fa:CCC, 222Aa:CCC, 222Ac:CCC, 222Ad:CCC, 222Ae:CCC, 222Af:CCC, 222Ag:CCC, 222Ah:CCC, 222Aj:CCC, 222Ak:CCC, 222Am:CCC, 222Ap:CCC, 222Aq:CCC, 222Dc:CCP, 222De:CCC, 222Df:CCC, 222Dh:CCC, 222Di:CCP, 222Ek:CCC, 222Fc:CCC, 222Fd:CCC, 222Fe:CCC, 222Ga:CCC, 222Gb:CCC, 222Gc:CCC, 222Hb:CCC, 222Hc:CCC, 222Hf:CCC, 222Jc:CCC, 222Ka:CCC, 222Kf:CCC, 222Kg:CCC, 222Lc:CCC, 222Ld:CCC, 222Lf:CCC, 222Md:CCC, 222Me:CCC, 251Aa:CCC, 251Cc:CCC, 251Ce:CCC, 251Ci:CCC, 251Cj:CCC, 251Dd:CCC, 331C:C?, 331F:CC, 332:P, M221:?, M334A:CC
Federal Lands: NPS (Wind Cave); USFS (Ozark?)
References:
Authors: MP, MCS **Identifier:** A.1836

Sandstone Great Plains Xeric Butte - Bluff Sparse Vegetation

Sandstone Great Plains Xeric Butte - Bluff Sparse Vegetation
Great Plains Xeric Sandstone Butte **G? (96-10-03)**
Ecological Group (SCS;MCS): Great Plains Acid Cliffs and Buttes (n/a; 2.4.4.2)

Concept: This sandstone butte type occurs in the United States in northwestern South Dakota, and possibly elsewhere in the Great Plains. The Fox Hills sandstone is a fairly widespread exposure in northwestern South Dakota. Exposures at the Slim Buttes include a lot of volcanic ash that texturally may be more like siltstones, but there are also

exposures of rather coarse sand/gravel stones. The North and South Cave Hills are clearly sandstone outcrops and are quite famous for their pictographs, some of which date to the ice age. Further characterization of this type is needed.
Comments: More information is needed to determine the characteristics of this type. There are a variety of sandstone outcrops in northwestern South Dakota and most certainly in southeastern Montana (D. Ode pers. comm. 2000). Whether these need to be split from other sedimentary outcrops is unclear. See also Sandstone Butte Sparse Vegetation (CEGL002297).
Range: This sandstone butte type occurs in the United States in northwestern South Dakota, and possibly elsewhere in the Great Plains.
States/Provinces: MT?, SD:SU
TNC Ecoregions: 26:C
USFS Ecoregions: 331F:CC
References:
Authors: D. Ode and D. Faber-Langendoen, MCS **Confidence:** 3 **Identifier:** CEGL002290

Local Description: These areas are mapped as such based soley on their photographic signature and have received no field visit as these lie outside the park boundaries.

VII.C.2.N.c. Temporarily flooded sand flats

VII.C.2.N.c.1. SAND FLATS TEMPORARILY FLOODED SPARSE VEGETATION ALLIANCE

Sand Flats Temporarily Flooded Sparse Vegetation Alliance

Concept: This is technically not an alliance. It is a placeholder for a group of sparsely vegetated associations that do not have adequate vegetation descriptions, but do share certain substrate characteristics.
Range: This alliance is found in Illinois (?), Indiana, Kansas (?), Minnesota, Missouri, Nebraska, Wyoming (?), Wisconsin (?), and Michigan. It is also found in Manitoba, Saskatchewan, and Ontario, Canada.
States/Provinces: IL IN KS MB MN MO NE ON SK? WY?
TNC Ecoregions: 36:C, 37:C, 38:C, 46:C, 47:C, 48:C
USFS Ecoregions: 212Ha:CPP, 212Hb:CPP, 212He:CPP, 212Hh:CPP, 212Hi:CPP, 212Hj:CPP, 212Hk:CPP, 212Hl:CPP, 212Hm:CPP, 212Hn:CPP, 212Ho:CPP, 212Hq:CPP, 212Hw:CPP, 212Hx:CPP, 212Ia:CCC, 212Ja:CCC, 212Jb:CCP, 212Jc:CCP, 212Jk:CCP, 212Jl:CCP, 212Jn:CCP, 212Jo:CCP, 212Jr:CCP, 212La:CPP, 212Lb:CPP, 212Mb:CPP, 212Na:CCP, 212Nb:CCP, 212Nc:CCC, 222Ad:CC?, 222Ae:CC?, 222Af:CC?, 222Ak:CC?, 222Ap:CCC, 222Jj:CCC, 222Lc:CCC, 222Mc:CCC, 222Md:CCC, 251Cg:CCC, 251D:CC, 331:C, 332C:CC, 332E:CC
Federal Lands: NPS (Theodore Roosevelt)
References:
Authors: MCS **Identifier:** A.1864

Riverine Sand Flats - Bars Sparse Vegetation
Riverine Sand Flats - Bars Sparse Vegetation
Riverine Sand Flats **G4G5 (98-06-22)**
Ecological Group (SCS;MCS): Midwestern Sand and Gravel Strands (n/a; 2.1.2.1)

Concept: This community ranges from the western Great Plains to the eastern parts of the midwestern United States and Canada. It is a sparsely vegetated community that occurs along river shorelines, islands, pointbars, and flats. These sandbars form when receding floodwaters deposit sand and lesser amounts of clay, silt, and cobbles in the stream bed. Soils are often undeveloped due to the ephemeral nature of the stands. Drainage depends on depth above the water level. Herbaceous species shared in Missouri and Nebraska include *Cyperus* spp. (*Cyperus erythrorhizos, Cyperus odoratus, Cyperus squarrosus), Eragrostis hypnoides, Eragrostis trichodes, Leptochloa fusca ssp. fascicularis (= Leptochloa fascicularis), Polygonum* spp. (including *Polygonum lapathifolium), Rorippa sinuata, Sporobolus cryptandrus*, and *Xanthium strumarium*.
Comments: This type will need to be separated into at least a Great Plains versus a Midwest type. The current description is based primarily on work available in Missouri (Nelson 1985) and Nebraska (Steinauer and Rolfsmeier 2000). See also the Riverine Gravel Flats Great Plains Sparse Vegetation (CEGL005223).
Range: This community is found from the western Great Plains to the eastern parts of the midwestern United States and Canada, ranging from Indiana northwest to Saskatchewan, and south to Kansas.
States/Provinces: IL:S?, IN:S?, KS:S?, MB?, MN:SU, MO:S1, NE:S5, ON:S?, SK?, WY?
TNC Ecoregions: 36:C, 37:C, 38:C, 46:C, 47:P, 48:C
USFS Ecoregions: 212Mb:CPP, 212Na:CPP, 212Nb:CPP, 212Nc:CPP, 222Ad:CC?, 222Ae:CC?, 222Af:CC?, 222Ak:CC?, 222Ap:CCC, 222Md:CCC, 251Cg:CCC, 251D:CC, 331:C, 332C:CC, 332E:CC
Federal Lands: NPS (Theodore Roosevelt)
References: Nelson 1985, Steinauer and Rolfsmeier 2000
Authors: D. Faber-Langendoen, MCS **Confidence:** 3 **Identifier:** CEGL002049

Local Description: These areas are sparsely vegetated but do have some elements of the adjacent Willow stands. These include *Salix exigua, Polygonum* spp., *Equisetum arvense* and *Xanthium* spp.

Prairie Restoration Areas

In 1993 the Park embarked on a reseeding program to reestablish natural vegetation in heavily impacted and previously farmed areas (Figure 51). The seed mixtures varied between fields but primarily consisted of Blue Grama, Western Wheatgrass and Green Needlegrass. Table 4 details the field restoration program.

Field	Field Alteration	Year Seeded
1	Plowed September 1993	1996
2		1990
3	Plowed June 1993	1996
4		1994
5		
6	Plowed August 1994	1998
7	Plowed July 1995	1994
8	Plowed 1996	2000
9	Herbicide Treatment 2000, 2001, 2002	2002
10	No information	No information
South Field 1	No information	No information
South Field 2	No information	No information

Table 4. FOUS Prairie restoration treatments.

The seed mixtures for each field are as follows and were determined from seed supply invoices:

Field 1	Blue Grama	50%
	Lodorm Green Needle	17%
	Rosana Western	33%
Field 2	Lodorm Green Needle	17%
	Rosana Western	21%
	Native Blue Grama	27%
	Native Needle-and-Thread	5%
	Native Junegrass	4%
	Native Winterfat	6%
	Native Sunflower	3%
	Native Saltbush	2%
	Native Silversage	2%
	Critana Thickspike	6%
	Native Blue Flax	3%
	Native Wild Rose	1%
	Native Prairie Coneflower	3%
Field 3	Identical to field 1	

Field 4	No information	
Field 5	No information	
Field 6	Rosana Western	16%
	Lodorm Green Needle	16%
	Goldbar Bluebunch	16%
	Killdeer Sideoats	9.9
	Purple Prairie Clover	7%
	Badriver Blue Grama	7%
Field 7	Blue Grama	32%
	Lodorm Green Needle	21%
	Rosana Western	21%
	Side Oats Grama	11%
	Bluebunch Wheatgrass	5%
	Purple/White Prairie Clover	5%
	Needle-and-Thread	3%
Field 8	Bad River Blue Grama	16.5%
	Lodorm Green Needle	11.4%
	Rosana Western Wheat	14.2%
	Pierre Sideoats Grama	14.2%
	Goldbar Blubunch Wheat	9.5%
	Purple Prairie Clover	2.8%
	Needle-and-Thread	10.1%
	Critana Thickspike	12%
	Prairie Junegrass	13.4%
Field 9	Prairie Junegrass	1.9%
	Bad River Blue Grama	14.9%
	Lodorm Green Needlegrass	22.5%
	Rosana Western	27.9%
	Pierre Sideoats Grama	12%
	Needle-and-Thread	2.7%
	Critana Thickspike Wheat	17%
Field 10	No information	
South Field 1	No information	
South Field 2	No information	

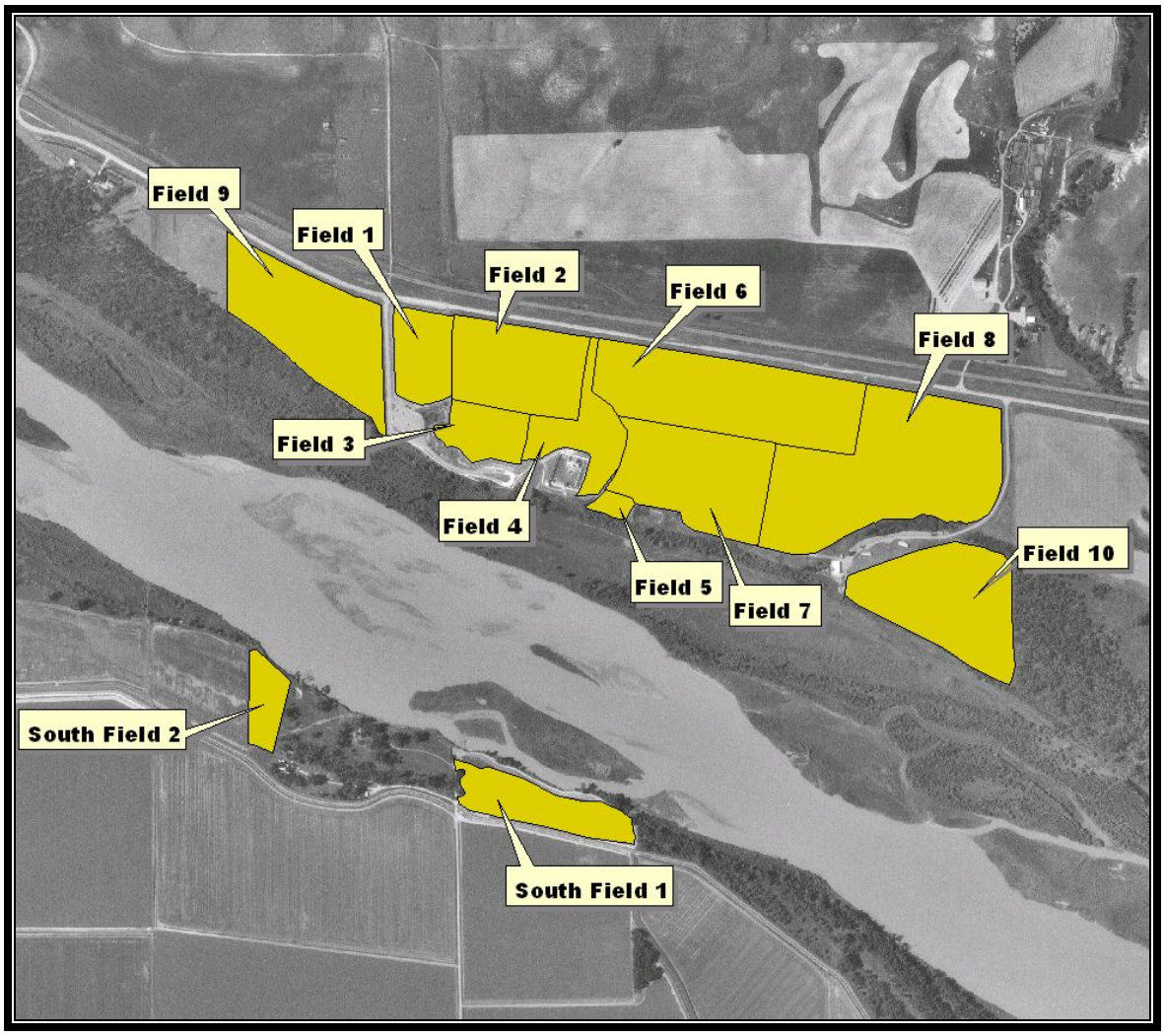

Figure 51. Restoration fields within FOUS.

All prairie restoration areas are becoming heavily infested with *Bromus inermis* as well as *Agropyron cristatum*. *Cirsium arvense*, *Salsola* spp. and *Euphorbia esula* are also very common in these areas.

Vegetation Relation to Soil Texture

Soils and vegetation tend to occur in certain types and this relationship can be seen in Table 5. Vegetation and Soils texture shape coverages were intersected. The resulting table was then manipulated such that the relationship between vegetation and soil texture becomes clear. Each of these relationships is discussed in the local description for each vegetation type.

Vegetation Association	Clay	Complex	Fine Sandy Loam	Frequently Flooded	Loam	Riverwash	Rock Outcrop	Silt Loam	Silty Clay	Silty Clay Loam	Very Fine Sandy Loam	Grand Total
Fraxinus pennsylvanica – (Ulmus americana) / Symphoricarpos occidentalis Forest	-	-	-	4.6%	24.7%	0.5%	-	7.2%	63.0%	-	-	100.0%
Fraxinus pennsylvanica – Ulmus americana / Prunus virginiana Woodland	1.3%	1.0%	0.3%	1.2%	45.7%	0.3%	3.7%	3.8%	18.9%	0.4%	23.5%	100.0%
Populus deltoides – (Salix amygdaloides) / Salix (exigua, interior) Woodland	-	-	8.4%	87.1%	0.2%	-	-	4.1%	-	-	0.2%	100.0%
Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	3.2%	-	-	8.8%	12.0%	-	-	5.1%	24.5%	-	46.4%	100.0%
Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata) Semi-natural Herbaceous Vegetation	0.1%	11.9%	3.4%	-	65.8%	-	3.1%	11.7%	2.7%	-	1.3%	100.0%
Hesperostipa comata – Bouteloua gracilis – Carex filifolia Herbaceous Vegetation	-	25.9%	-	-	43.4%	-	4.5%	26.2%	-	-	-	100.0%
Phalaris arundinacea Western Herbaceous Vegetation	-	23.4%	0.5%	58.7%	14.7%	-	-	2.8%	-	-	-	100.0%
Pascopyrum smithii – Bouteloua gracilis – Carex filifolia Herbaceous Vegetation	-	7.8%	-	-	72.4%	-	3.8%	15.0%	1.0%	-	-	100.0%
Riverine Sand Flats - Bars Sparse Vegetation	-	-	-	7.7%	-	-	-	-	-	-	92.3%	100.0%
Typha spp. Great Plains Herbaceous Vegetation	-	-	-	85.5%	5.8%	-	-	4.1%	4.6%	-	-	100.0%
Sandstone Great Plains Xeric Butte - Bluff Sparse Vegetation	-	52.0%	-	-	47.8%	-	0.2%	-	-	-	-	100.0%
Salix exigua Temporarily Flooded Shrubland	-	27.2%	-	64.2%	0.8%	0.6%	-	-	-	-	7.2%	100.0%
Restoration Prairies	0.2%	-	3.2%	-	24.0%	-	-	22.2%	45.3%	-	5.1%	100.0%

Table 5. Percent of soil textures within vegetation class.

Discussion

Fort Union Trading Post National Historic Site lies within the Northern Great Plains. The undeveloped areas within the Park reflect the general nature of Northern Great Plains Vegetation and is often referred to as mixed prairie. FOUS also has a significant portion of its vegetation within the riparian corridor and therefore, has representative vegetation of a very small percentage of total woody corridors in North Dakota.

Wooded areas: These areas include both forest and woodland Green Ash and American Elm associations in addition to cottonwood. The Green Ash and American Elm forest type is described here as the Green Ash – (American Elm) / Western Snowberry Forest however it might just as easily fall into the Green Ash / Choke Cherry Forest. Both Western Snowberry and Chokecherry are present but not in abundance. The relative amounts of these two shrubs vary. The Green Ash – American Elm / Chokecherry Woodland also has varying amounts of both Chokecherry and Western Snowberry. In addition, the canopy of the woodland type is extremely closed and approximates the forest association. It was classified as woodland given the low basal area and notable difference in overall tree height. Both the forest and woodland types often have some Coyote Willow as part of the shrub layer which may just be part of the Cottowood Woodlands and Coyote Willow Shrublands that share the floodplain and are in close proximity. The wooded draw to the east of Bodmer Overlook is included in the Green Ash – American Elm / Chokecherry Woodland but was not visited because it is on private property. A similar but less dense woody draw lies just to the west of Bodmer Overlook and may have similarities. The woody draws lie above the floodplain and the understory is very different. The shrub layer is almost nonexistent and the understory is dominated by invasive grasses such as Smooth Brome and Crested Wheatgrass. When shrubs are present it is usually Western Snowberry.

The cottowood areas are typical of the global descriptions for Eastern Cottowood – (Peachleaf Willow) / (Coyote Willow, Sandbar Willow) Woodlands. The shrub layer is dominated by Coyote Willow. This shrub may vary in height from 3 – 4 feet to a second shrub / Coyote Willow layer at about 20 feet. The forbs and grass layer includes a fair component of invasive species such as Smooth Brome and Leafy Spurge.

Shrubby areas: There are two described shrub types for the Park. These include the dominant Coyote Willow Temporarily Flooded Shrubland and the Western Snowberry Shrubland. The Coyote Willow shrubland occupies a significant amount of the floodplain and varies as to its compostion and structure. Given the dynamic nature of its environment this is to be expected. Some of the mapped areas have very small willows and are just colonizing while other areas have a dense and tall community of willows.

The Western Snowberry Shrubland was not mapped given its very aerial coverage but it does occur frequently in the upland areas and is included in the descriptions. Most of the

snowberry shrublands seen were almost monotypic and were found either on hill slopes with small swales or valley bottoms.

Herbaceous areas: These areas may be broadly split into floodplain / wetland and upland types. The floodplain has large portions dominated by Canary Reed Grass and Cattail and are relativiely straight forward and uncomplicated. Both these types will have a component of Coyote Willow Shrubland and Cottonwood Woodland as they share a large common border. Upland grasses are are composed of three types: Needle-and-Thread, Blue Grama, Threadleaf Sedge Herbaceous Vegetation, Western Wheatgrass, Blue Grama Threadleaf Sedge Herbaceous Vegetation and Crested Wheatgrass Herbaceous Vegetation. This area is a bit more complex. The area is currently being grazed. This will affect relative amounts of *Pascopyrum smithii, Bouteloua gracilis* and *Carex filifolia* as these species respond differently to grazing pressure. The altered relative amounts of these principal species makes this a difficult decision as to what association they might truly belong to. In addition, the grazing also made it difficult to determine relative amounts of these species. The dominant species in these areas are *Pascopyrum smithii* and *Bouteloua gracilis*. In some areas *Bouteloua gracilis* was the dominant cover which also may be a sign of overgrazing. *Bouteloua gracilis* is an increaser under heavy grazing. In some areas *Schizachyrium scoparium* was in greater abundance on the side slopes as was *Bouteloua curtipendula*. *Carex filifolia* was not apparent in any great amount and this may be a result of the grazing pressure as this species will decline when heavily grazed. *Carex filifolia* reproduces by seed and if the grasses do not grow enough to create seed heads they will decline overtime. The southeast corner of Bodmor Lookout is so heavily impacted by cattle that little herbaceous cover exists. Within the draws is the Crested Wheatgrass Herbaceous Vegetation. The cover is usually dense and may extend up the sideslopes to intersect either Needle-and-Thread, Blue Grama, Threadleaf Sedge Herbaceous Vegetation or Western Wheatgrass, Blue Grama Threadleaf Sedge Herbaceous Vegetation.

The photographic signature differentiating Needle-and-Thread, Blue Grama, Threadleaf Sedge Herbaceous Vegetation and Western Wheatgrass, Blue Grama Threadleaf Sedge Herbaceous Vegetation is a bit tenuous as only a small area within the total mapping area was visited. The photographic signature for Needle-and-Thread, Blue Grama, Threadleaf Sedge Herbaceous Vegetation tended towards a smoother, more continuous tone than Western Wheatgrass, Blue Grama Threadleaf Sedge Herbaceous Vegetation. Differentiating grassland types that often share different percentages of the same species may sometimes be very complicated hence, the mapping accuracy outside the boundary remains unclear. This is further excacerbated by the effects of grazing not only on the photographic signature but also species composition. In addition, other areas outside the mapping boundary may have other vegetation types that were not seen within Bodmer Overlook.

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