A Vegetation Management Plan for Fort Laramie National Historic Site

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Between the National Park Service
and the University of Wyoming.

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I. INTRODUCTION

Fort Laramie National Historic Site has never had a comprehensive vegetation management plan. Consequently, park management decisions are based on a vegetation analysis completed in 1986. Since then, a large in-holding has been added to the park and land use patterns have changed significantly. Fort Laramie National Historic Site's General Management Plan (USDI National Park Service 1993) calls for the writing of a comprehensive vegetation management plan. The 2001 amendment to the General Management Plan (USDI National Park Service 2001a) repeated the direction that a vegetation management plan be written, as one among several plans. In September 2000, the National Park Service (NPS) entered an agreement with the University of Wyoming for the University's Wyoming Natural Diversity Database to develop a comprehensive vegetation management plan for Fort Laramie National Historic Site proper, excluding the parcels of public lands managed by the Park Service but not part of the original Fort.

National Park Service documents seem to provide two different management emphases. A narrow emphasis on vegetation management is provided by the Cultural Landscape Report for Fort Laramie (USDI National Park Service, no date [a]), which suggests that the purpose of vegetation management is to maintain or restore a limited number of vegetation features that contribute to the historical setting, which that Report also defines. According to this interpretation, a vegetation management plan should concentrate on restoring and maintaining the grasslands around the historic district but pay little attention to the riparian and wetland community types along the rivers.

In contrast, Fort Laramie's General Management Plan (USDI National Park Service 1993, page 4) discusses broad natural resource management goals, calling for practices that "Reestablish and promote native plants and animals that contribute to and create the park's historic scene, to the greatest degree possible." The National Park Service's Natural Resource Management Guidelines (USDI National Park Service 2001b, Introduction) also call for a broad management view, in which the Park Service is obligated to manage natural resources (including organisms, processes, and systems) to maintain, restore, and perpetuate their inherent integrity and to allow for the public enjoyment of those resources.

These apparently contradictory management approaches seem to be reconciled by the NPS Natural Resource Management Guidelines, which point out that management goals and practices differ in different parts of each park (USDI National Park Service 2001b, Introduction, page 2). In cultural zones, management is centered on the cultural resources, and natural resource management practices must support the objectives of cultural resource management. Not surprisingly, this is the approach advocated by Fort Laramie's Cultural Landscape Report. By contrast, in natural zones, the primary objective of management is to protect the natural resources in as natural a condition as possible. These management zones are to be established in each park's general management plans.

At Fort Laramie, management zones (Figure 1) were delineated in the 1991 Statement for Management (USDI National Park Service 1991, page 19 and 20) and maintained in the later General Management Plan (USDI National Park Service 1993, p. 33) and Amendment to the General Management Plan (USDI National Park Service 2001a, p. 13). The terminology used in the Fort Laramie documents differs somewhat

from that used in the NPS's Natural Resource Management Guidelines (USDI National Park Service 2001b, Introduction, page 2). According to the Park documents, all of the lands within the Park are classified as "historic zone", a term which does not seem to be in the NPS document. The 100-acre "Development subzone" and the 63-acre "Special Use subzone" at Fort Laramie correspond to zones mentioned in the Guidelines, and the Fort's 40-acre "Natural Environment subzone" probably is synonymous with the "natural zone" of the Guidelines. No "cultural zone" is mentioned in the Fort Laramie documents.

In the face of this inconsistent terminology, language in the Fort Laramie documents provides some help to mangers. The Statement for Management (USDI National Park Service 1991, page 19) and the General Management Plan, both original (USDI National Park Service 1993, page 18) and amended (USDI National Park Service 2001a, page 14), state that historic native plant species will be encouraged to reclaim former agricultural fields and exotic plants will be controlled. Woodlands along the river will not be manipulated. In the Natural Environment subzone, the integrity of the native vegetation, which is thought to have been unmowed and ungrazed since the early 1950s, will be maintained.

Natural resource managers at Fort Laramie must recognize at least two additional, complicating points that are not necessarily addressed explicitly in the various management and planning documents (Steve Fullmer, personal communication). First, people who visit Fort Laramie, particularly those who live in the area, often have strong interests that may run counter to the strict interpretation of natural resource management as secondary to cultural resource management. For example, the picnic area along the western side of the Park is a popular recreational spot, in large part because of the cottonwood woodland along the Laramie River there. Ignoring the cottonwood woodland because the Cultural Landscape Report identifies it as a non-contributing vegetation element may meet the requirements for management of the cultural resources, but it would be unpopular with the public. Second, viewing Fort Laramie in its larger geographical context suggests that it provides a place where certain ecosystems, such as the riparian zones, can be maintained in a semi-natural condition when they are being substantially altered elsewhere. Thus the general Park Service guideline to maintain integrity of ecological processes and systems takes on greater importance.

The statement of work that forms the basis for the NPS - UW agreement provides the most specific directions for a vegetation management plan, calling for a review of the history of the vegetation, incorporating information from the cultural resources plan (which we understand to mean the Cultural Landscape Report [USDI National Park Service, no date (a)]); a review of vegetation studies on Fort Laramie; the identification of exotic plants and their effects on native plant communities, with recommendations for their removal and control; a discussion of the effects of soil disturbance and erosion on plant communities; and a discussion of strategies for restoration and maintenance of disturbed areas. Furthermore, the plan should assist NPS managers with issues such as prairie restoration, exotic/invasive species, prescribed fire, irrigation system needs, maintenance of vegetation around the historic district, irrigation canal seepage and resulting artificial riparian areas, effects of agricultural practices on adjoining lands, grazing by NPS horses, and hazardous tree management.

Obviously, vegetation management at Fort Laramie must take into account a variety of Park Service policies as well as interests of people outside the Service. Some

of these policies and interests are confusing, if not contradictory. Our intent in writing this vegetation management plan is to provide NPS managers with a document that discusses, in some detail, what management issues are presented by the vegetation types on Fort Laramie, what practices might be carried out to address those management issues, and what additional projects are needed to collect information that managers now lack. We base this plan on information from studies done at the Park and available in the literature and unpublished sources. We hope that it will help NPS managers decide what is realistic in managing the vegetation at Fort Laramie.

Throughout this document, we have generally used plant names from the database of the Natural Resources Conservation Service (USDA NRCS 2001), which is the recognized source of common and scientific names used by federal agencies. Where other authors have used other names, we include their names in parentheses.

II. VEGETATION OF FORT LARAMIE NATIONAL HISTORIC SITE

The vegetation of Fort Laramie is predominantly a mix of upland grass vegetation types, with a mix of riparian and wetland vegetation types growing in strips along the Laramie River in the southern half of the Park, the Fort Laramie Canal along the Park's southern boundary, and the North Platte River along its eastern boundary (Figure 2).

According to the USGS - NPS Mapping Project (USDI Geological Survey 1998), most of the upland grass vegetation can be placed into two more-or-less native plant community types that differ from one another in the relative amounts of the common graminoids. *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation occurs in the northwestern corner of the Park and south of the Laramie River. This mixture of short and mid-height graminoids, forbs, and scattered shrubs usually occupies sandy loam or loam soils. The common species in this community type at Fort Laramie are prairie sandreed (*Calamovilfa longifolia*), needle-and-thread (*Hesperostipa comata*), and blue grama (*Bouteloua gracilis*). Western wheatgrass (*Pascopyrum smithii*) is present in small amounts. Exotic species, primarily cheatgrass (*Bromus tectorum*) and common salsify (*Tragopogon dubius*) usually are present, but also in small amounts. This is the community-type mapped in the area identified by Davis (1959) and Olmstead and Perez (1986) as a relict site (Figure 3), by the 1991 Statement for Management (USDI National Park Service 1991) as the Natural Environment subzone (Figure 1), and by the Cultural Landscape Report (USDA National Park Service, no date [a]) as one of two areas of native perennial vegetation (Figure 4). It includes the vegetation said to represent the native grasslands typical of the Fort Laramie area.

On finer-textured soils (clays, clay loams, and silt loams), western wheatgrass is more common than needle-and-thread and blue grama, and the vegetation is mapped as the *Pascopyrum smithii* Herbaceous Vegetation type. Several exotics -- Japanese brome (*Bromus japonicus*), smooth brome (*Bromus inermis* ssp. *inermis*), Kentucky bluegrass (*Poa pratensis*), and common salsify -- usually are present and may contribute substantial cover.

Much of the upland area in the Park has been mapped as one of several disturbed community-types. The *Sporobolus cryptandrus* Disturbed Community type grows occurs on sandy soils, and is characterized by a large amount of sand dropseed (*Sporobolus cryptandrus*). Buffalo grass (*Buchloe dactyloides*) may dominate in patches. Cheatgrass

often co-dominates, especially in the spring. Needle-and-thread, blue grama, and western wheatgrass usually are present but contribute less cover. According to the USGS - NPS mapping project, the area at Fort Laramie mapped as this type has been disturbed in the past several decades, but the type of disturbance was not specified. The similarity in soils occupied by this type and the *Stipa comata - Bouteloua gracilis - Carex filifolia* type suggest that, had the *Sporobolus cryptandrus* type not been disturbed, its species composition would be very similar to the native type.

Two major community-types dominated by exotic plants have been mapped in drastically disturbed uplands on the Park. The Upland Weedy type is mapped mainly north of the Laramie River and is dominated by the exotics cheatgrass, common kochia (*Kochia scoparia*), and Russian thistle (*Salsola* sp.), and the native annual common sunflower (*Helianthus annuus*). The second exotic type, the *Bromus inermis* Disturbed Community, occupies alluvial soils on river terraces. Smooth brome (*Bromus inermis* ssp. *inermis*) dominates this vegetation strongly and is the only plant present in some areas. Plot data is scant from these two exotic vegetation types so the contribution of native species is impossible to gauge. Both types may occupy sites that, before disturbance and the subsequent invasion by exotics, supported the major native community-types.

These three disturbed community-types, and the *Pascopyrum smithii* Herbaceous Vegetation type, constitute the vegetation in the disturbed areas mapped by Olmstead and Perez (1986) on the Park (Figure 3).

Two additional, minor upland community types are shown on the USGS - NPS program's map (Figure 2). The *Stipa comata - Yucca glauca* Herbaceous Vegetation occupies a small area near the southern boundary. This vegetation type, which is more common on lands surrounding the Park, differs from the *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous vegetation type in having more cover of small soapweed or yucca (*Yucca glauca*) and sand sagebrush (*Artemisia filifolia*). Otherwise, the two types are very similar in species composition. The second minor type is the Upland Sand and Gravel Sparse Vegetation Type, which (despite its name) is described as occurring mainly on the river floodplains and only occasionally in upland draws. This vegetation type is dominated by a variety of species, with fringed sagewort (*Artemisia frigida*), hairy goldaster (*Heterotheca villosa*), plains prickleypear (*Opuntia polyacantha*), and sand dropseed being the most common.

The riparian vegetation along the Laramie and North Platte Rivers is a mosaic of cottonwood groves mixed with herbaceous vegetation and stands of shrubs or tree saplings. Along the Laramie River, the vegetation is mapped by the USGS - NPS Mapping Project (USDI Geological Survey 1998) as a mix of Riverine Sand Flats - Bars Sparse Vegetation, *Populus deltoides* / *Symphoricarpos occidentalis* Woodland, and *Salix exigua* Shrubland. The flats and bars may support a number of herbaceous species, as well as cottonwood and willow seedlings and saplings. Vegetation there often is sparse. The cottonwood woodlands consist of groves of trees, mostly *Populus deltoides* (eastern or plains cottonwood) but also *Salix amygdaloides* (peachleaf willow), *Acer negundo* (boxelder), *Fraxinus pennsylvanica* (green ash), *Populus angustifolia* (narrowleaf cottonwood), and *P. acuminata* (lanceleaf cottonwood), often with sparse overstories. A shrub undergrowth *Symphoricarpos occidentalis* (western snowberry) and a few other species often is present, and the shrubs may form patches between the groves

of trees. Western wheatgrass and smooth brome are common herbaceous species. The vegetation mapped as *Salix exigua* shrub stands are, in fact, mostly groves of cottonwood saplings; *S. exigua* (coyote willow) dominates few stands.

Spartina pectinata - Scirpus pungens Herbaceous Vegetation also is common along the rivers. This vegetation type includes dense stands of tall grass strongly dominated by *S. pectinata* (prairie cordgrass), with smaller amounts of other species.

Riparian vegetation has also been mapped along the Fort Laramie Canal, primarily as *Carex nebrascensis* Herbaceous Vegetation with patches of *Populus deltoides* / *Symphoricarpos occidentalis* Woodland. The former type includes stands of herbaceous vegetation dominated by *Carex nebrascensis* (Nebraska sedge), *Juncus* spp. (rushes), and (on drier sites) *Equisetum laevigatum* (smooth horsetail).

Except for the riparian vegetation in the wetlands along the canal, this vegetation pattern in general terms fits the description of the "native" landscape found here before the construction of trading and military posts (USDI National Park Service, no date [a], page 13). As Olmstead and Perez (1986) note, though, while the agricultural practices did not change the appearance of the land around the fort, they did deeply alter the composition of the vegetation. Alteration of the vegetation from its prehistoric state started in the fur trade period (if not earlier, with the Native American horse culture; Steve Fullmer, personal communication), increased during the early and late army periods, and increased greatly during the homestead era (USDI National Park Service, no date [a], chapter 1). The land surface in much of the disturbed area north of the Laramie River was leveled during the homestead area, with several feet of soil removed in places (Steve Fullmer, personal communication). The alteration of the native vegetation is signified by the USGS-NPS vegetation map (USDI Geological Survey 1998), on which much of the Site north of the Laramie River is shown as a mix of *Sporobolus cryptandrus* Disturbed Vegetation, *Bromus inermis* Disturbed Community, and Upland Weedy Community, with substantial amounts of *Pascopyrum smithii* Herbaceous Vegetation.

If the list of common plant species from the USGS - NPS Mapping Project (USDI Geological Survey 1998) at Fort Laramie is compared to that given by Knight (1994, page 67) for the mixed-grass prairie of eastern Wyoming, then the vegetation seems to be typical of the grasslands of the western Great Plains. And, most of the vascular plant species listed by Fertig (2001) from Fort Laramie are widespread in the western U.S. But the flora of Fort Laramie also seems to contain a Midwestern or Eastern element. For example, the dominant cottonwood at Fort Laramie, *Populus deltoides* Bartram ex Marsh (var. *occidentalis* Rydberg according to Dorn, ssp. *monilifera* (Ait.) Eckenwalder according to Kartesz 1999) is a tree of the Great Plains and the Lake States (Kartesz 1999). The range of green ash, too, is mainly to the east of Wyoming (Kartesz 1999), and the species seems to be rare in the riparian woodlands of Wyoming (Jones and Walford 1995). Fertig (2001) listed 177 vascular plant species from Fort Laramie and considered 7 as peripheral; 5 of those are plants of the Great Plains or regions farther east (Kartesz 1999). These species distributions lend credence to the view of Fort Laramie as a location where the eastern and western floras mix.

III. MANAGEMENT ISSUES AND SUGGESTED MANAGEMENT STEPS

A. EXOTIC PLANTS

1. Introduction

Hiebert and Stubbendieck (1993, p. 1) report that the National Park Service defines exotic plant species as those present in a given place "...as a result of direct or indirect, deliberate, or accidental actions of humans." Exotic plants are a concern to managers at Fort Laramie for at least three reasons. First, because most of them are thought to have reached Fort Laramie, or at least to have become common there, after the period of significance, they detract from the integrity of the Fort Laramie cultural landscape (USDI National Park Service, no date [a], page 82). The treatment plans outlined in the Cultural Landscape Report (USDI National Park Service no date [a], page 103), the Statement for Management (USDI National Park Service 1991, page 23), and the General Management Plan (USDI National Park Service 1993, page 18 and 2001, page 14) include increasing the contribution of native species to the vegetation in most of the Park east of the historic buildings because exotics have so altered the composition of the vegetation thought to have grown there during the historic period.

A second reason that exotic plants require the attention of managers is the expectation that land owners will work to control populations of weeds on their properties. The Wyoming Weed and Pest Control Act of 1973 (Wyoming Statutes Sec. 11-5-101 to 303) directs that weeds designated under that Act be controlled, and empowers weed and pest control districts to require landowners to control infestations on their lands. Although the National Park Service may be exempt from the provisions of that State law, the Park Service recognizes the need to voluntarily comply with state and local weed control efforts (USDI National Park Service 1991, page 19; 1993, page 21).

Finally, NPS policy directs park managers to implement programs to maintain or restore the components of the ecosystems on the Park Service Units (USDI National Park Service 2001b, Vegetation Management).

Given the presence of nearly 50 exotic plant species on Fort Laramie National Historic Site (as reviewed below), NPS biologists and managers are faced with the question of which species should be the targets of their management activities. Hiebert and Stubbendieck (1993) and the APRS Implementation Team (2000) recommend an Alien Plant Ranking System (APRS) for identifying the exotic plants that exert large influences on other resources at present and the exotics that are now minor species but are likely to become serious pests in the future. This system contains five steps -- determining the non-native species known or likely to be present, surveying the site to ascertain the distributions and abundances of those species, consulting APRS fact sheets or other sources of information to learn about the biology of the species, creating a data sheet for each species, and using the information from the ranking procedure to determine management priorities -- that will serve as the framework for reviewing exotic species at Fort Laramie and identifying the next steps to be taken in developing a management plan. This system also is recommended in the Park Service's recent Natural Resource Management Guidelines (USDI National Park Service 2001b, Exotic Species Management).

2. Exotic Plants Known From Fort Laramie and Vicinity

a. Exotics Known From Fort Laramie

Lists of exotic plant species on Fort Laramie are available from three studies that, combined, report 49 exotic vascular plant species (Table 1). Seven are included on Wyoming's Weed and Pest Control Act Designated List. The earliest of the studies, Olmstead and Perez (1986), reports 17 species of exotic plants, just two of which are on Wyoming's Designated list. The list from that project apparently was compiled from data collected on sampling transects at 16 locations and a general survey of the Fort Laramie flora.

The USGS - NPS mapping project (USDI Geological Survey 1998) reports data from 32 sampling plots located on the National Historic Site. Unfortunately, no plots were sampled in the Upland Weedy community-type, which might be expected to contain a large proportion of exotic plants, so the exotic species list from that project may be missing common weeds on Fort Laramie. The plot data document the presence of 16 exotic plant species, including two on the state's Designated List.

There is surprisingly little overlap in the exotic species lists between the mapping project and the earlier Olmstead and Perez project (Table 1): the two lists share only five species, 12 of the species found in the earlier project were not found in the mapping project, and the mapping project added 11 species not reported from the earlier project. Quackgrass is the only species on Wyoming's Designated List found in both projects.

The longest list of exotic plants is provided by Fertig (2000, Appendix A), who reviewed collections in the Rocky Mountain Herbarium, compiled observations by himself and other botanists, and reviewed the plot data from the USGS-NPS mapping project (USDI Geological Survey 1998). Fertig reports 34 exotic plant species, including six on the State's Designated List. For some reason, the list from Fertig (2000) is missing six of the species reported from the mapping project, even though Fertig's list is based in part on the mapping project's data. More importantly, Fertig adds four species on the Wyoming Designated List that were not reported by Olmstead and Perez (1986) or the mapping project (USDI Geological Survey 1998).

Two of the three references that list plants on Fort Laramie also provide information on the abundance of various exotics (Table 1). For 9 of the exotic plant species they documented, Olmstead and Perez (1986) report abundance data from sampling transects at 16 locations (Figure 5). Cheatgrass (*Bromus tectorum*) was recorded in more than half of those transects, and quackgrass (*Elymus repens*), prickly Russian thistle (*Salsola tragus*), timothy (*Phleum pratense*), and Kentucky bluegrass (*Poa pratensis*) in at least a quarter of the transects.

Data from the 32 sampling plots located on the National Historic Site for the USGS - NPS mapping project (USDI Geological Survey 1998) also indicate that cheatgrass is a widespread weed, occurring in 53% of the plots. Smooth brome (*Bromus inermis* spp. *inermis*) and common salsify (*Tragopogon dubius*) were the only other species found in at least a quarter of the samples, and Japanese brome (*Bromus japonicus*), Canada thistle (*Cirsium arvense*), and Kentucky bluegrass occurred in at least 15% of the sample plots.

The data from the USGS-NPS mapping project also show the canopy cover of the exotic species within the plots in which they occurred (Table 2). (It must be emphasized again that the absence of plots from the Upland Weedy community-type may drastically affect the picture of weed abundance provided by these data.) Only two of the six widespread exotic species seem to also contribute substantial amounts of canopy cover. Cheatgrass, the most widespread of the exotics reported in the study, contributed substantial cover to the plots in the *Sporobolus cryptandrus* Disturbed Herbaceous Vegetation type. It contributed far less cover in the other vegetation types sampled. Smooth brome, another widespread species, had a high amount of cover in the single plot in the *Bromus inermis* Disturbed Herbaceous Vegetation type, and it appears to be equally important in the undergrowth of the *Populus deltoides* / *Symphoricarpos occidentalis* Woodland type. The other widespread species -- common salsify, Japanese brome, Canada thistle, and Kentucky bluegrass -- contributed little canopy cover to the plots in which they occurred.

This information shows that a substantial number of exotic vascular plants (including at least 7 on Wyoming's Designated List) grow at Fort Laramie. It suggests that less than 10% of these exotics are widespread, and an even smaller percentage contribute substantial cover to the vegetation types sampled; most of the exotics seem to occur at few places and to be minor parts of the vegetation. The absence of data from the Upland Weedy community-type is a major weakness of the current information.

The plot data collected by the USGS-NPS mapping program (USDI Geological Survey 1998) in selected community-types give a limited idea of the abundance of exotic species in different habitats on Fort Laramie (Table 2). All of the community-types sampled contained at least one exotic plant species, even the three types that were each sampled with only one plot. The number of exotics, whether measured as the total in all of the sample plots of a community-type or the average number per plot, was greatest in the cottonwood (*Populus deltoides*) woodlands, followed by the *Sporobolus cryptandrus* (sand dropseed) Disturbed Herbaceous Vegetation Type. The other two major grassland community-types, the *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation type and the *Pascopyrum smithii* Herbaceous Vegetation type, each had a substantial number of exotics in total but a low average per plot, suggesting that the number of exotic species varied widely between plots within each of these types.

The contribution of exotic plants to the vegetation, measured by the average percent exotic canopy cover per plot, was highest in the *Bromus inermis* Disturbed Herbaceous type, but note that only one sample plot was placed in that type. The cottonwood woodlands also had a substantial amount of exotic canopy cover per plot, due mainly to the abundance of smooth brome. By these measures, it seems that the cottonwood woodlands have been most heavily affected by exotics of the native community-types sampled. This may be true because those woodlands grow in relatively moist sites and their soil surface probably is disturbed frequently by floods, two environmental features that should favor the success of smooth brome. Also, the trees provide roosting sites for birds, which may deposit weed seeds in their droppings. Finally, the North Platte and Laramie Rivers may carry seeds from weeds upstream and deposit them in the woodlands during floods.

b. Exotics Possibly at Fort Laramie

Fertig (2001, Table 2) assembled a list of vascular plant species known to grow in the vicinity of Fort Laramie but that he felt had not been documented from the National Historic Site proper. Table 3 lists those exotic species from Fertig's table. Several exotics that he included have been removed from Table 3 because they were reported from Fort Laramie by Olmstead and Perez (1986) or the USGS-NPS mapping project (USDI Geological Survey 1998). This list adds 31 exotic plant species that may occur on Fort Laramie (four of them on Wyoming's Designated List) to the 49 species documented there.

3. Suggested Management Steps

The information on exotic species reviewed above might seem to provide a basis for immediate treatments such as herbicide spraying, mowing, or release of biological control agents to begin reducing the weed populations on the National Historic Site. But Hiebert and Stubbendieck (1993), the APRS Implementation Team (2000), and the North American Weed Management Association (2001) all argue that, in cases like this, such action now would be premature. Instead, they urge that land managers first have a thorough understanding of the exotic plants on their properties, systematically rank those species, and then design and implement a control program. This approach has been incorporated into the Park Service's Natural Resource Management Guidelines (USDI National Park Service 2001b, Exotic Species Management). Computer programs for implementing the APRS are available on the National Park Service Wildlife and Plants Web Page (http://www.nature.nps.gov/wv/index.htm).

The species lists from Olmstead and Perez (1986), USDI Geological Survey (1998), and Fertig (2000 and 2001) provide the information needed for the first step in the procedure suggested by Hiebert and Stubbendieck (1993) and the APRS Implementation Team (2000). The remaining steps for ranking exotics and developing an exotic plant management program are described below.

a. Conduct a detailed survey of exotic plants at Fort Laramie

To identify the exotic species that require prompt management attention, managers must collect a substantial amount of information from the area: the distributions and abundance of the exotic plants, what habitats they occupy, how well they seem to be reproducing, and what effect they seem to be exerting on the vegetation and other resources. Olmstead and Perez (1986) and the USGS-NPS mapping project (USDI Geological Survey 1998) provide a very limited amount of information on distribution and abundance, and clearly a systematic survey of Fort Laramie is needed. The exact design of a survey is beyond the scope of this document, but we offer the following suggestions for the NPS biologists and managers to consider in their planning. A number of these suggestions come from Hiebert and Stubbendieck (1993), the APRS Implementation Team (2000), and the North American Weed Management Association (2001). All of those references provide helpful information and should be consulted, as should the Park Service's Natural Resource Management Guidelines (USDI National Park Service 2001b, Exotic Species Management).

(1) Purpose of the survey

The survey must collect information showing the current status of exotic species at Fort Laramie. Consequently, it must be extensive (to show the distributions of the plants) and moderately intensive (to ascertain the abundance of each species and the severity of the threat it poses to the area).

(2) Where to survey

Fort Laramie is small enough that it can be divided up in some manner into units and each unit systematically surveyed. This approach will help to assure that all of the National Historic Site is covered, and it will aid in the collection of data on abundance, habitat preference, and ecological status. The vegetation map (USDI Geological Survey 1998) and the soil map (Stephens *et al*. 1971) both can be used to help delineate units for the survey. The map of vegetation types probably is the more useful because it is more detailed and it is available as a digital layer that can be used in a geographic information system (GIS). The plot data used to produce the vegetation map already give some idea of which exotic plants will be encountered in the different community-types (Table 2), and the descriptions of the community-types can be combined with information on habitat preferences to predict where novel exotics might be found.

The survey areas needn't be based entirely on the vegetation map, and in fact, using roads, streams, and other physical features to delineate them probably is more practical. The digital orthophotoquad quarter (that is, the digital aerial photo) provides a particularly useful base map because it can be displayed in GIS and the exact coordinates of the survey area boundaries determined in that way. All of Fort Laramie National Historic Site is covered by one orthophotoquad quarter, number 42104b5ne, which can be retrieved from the web site of the University of Wyoming's Geographic Information Science Center (http://www.sdvc.uwyo.edu/doqq/).

(3) When to survey

Hiebert and Stubbendieck (1993) and the APRS Implementation Team (2000) suggest that they survey be conducted twice to find species that flower at different times. The exact dates of the survey will depend on the weather, but the earlier survey probably can be made in mid-June and the second from mid- to late August. Few of the species known from Fort Laramie or likely to be there will flower before mid-June.

(4) What information should be recorded

The Alien Plant Ranking System developed by Hiebert and Stubbendieck (1993) and modified by the APRS Implementation Team (2000) requires particular information about the exotic species. In addition, the North American Weed Management Association (2001) is developing standards that they recommend for weed surveys and inventories to assure that results from different projects can be compared with one another. All of these references should be consulted in the design of survey forms.

It goes without saying that the people conducting the survey must be able to recognize the exotic plant species that they encounter. Fortunately, a number of aids are available for training the surveyors. Whitson (2000) provides good descriptions and color photographs of all the species, and Dorn (2001) provides technical keys. Pressed specimens can be studied at the University of Wyoming's Rocky Mountain Herbarium in

Laramie. Local assistance is available from the Goshen County Weed and Pest Control District in Torrington.

If at all possible, global positioning system (GPS) receivers should be used to document locations of the exotics encountered during the survey. Even when good aerial photographs are available (as they are for Fort Laramie), a GPS receiver improves the accuracy of location, increasing the probability that the surveyors and others can find obscure features on return visits. Furthermore, receivers are available at a modest price that can be used to collect and store location data in the field and transfer that data directly to a computer for use in a geographic information system, where it can be displayed on the digital aerial photo and compared to other information such as the digital vegetation map.

b. Consult the available sources of information on the biology of the exotic species

Information on the modes of reproduction and dispersal, habitat preferences, and other autecological factors are crucial for deciding how serious a threat is posed by an exotic species. This information can be found in a variety of places, including:

-- the comprehensive book, Weeds of the West (Whitson 2000)
-- fact sheets in the APRS computer program (APRS Implementation Team 2000)
-- The Nature Conservancy's element stewardship abstracts, available at http://tncweeds.ucdavis.edu/esadocs.html
-- species profiles from the Center for Invasive Plant Management, available at http://www.weedcenter.org/info/weedlist.html

The University of Wyoming's Department of Plant Sciences maintains a web site (http://www.uwyo.edu/plants/weeds/index.htm) with links to additional sources of information on weed ecology. The Goshen County Weed and Pest Control District in Torrington and the faculty in the University of Wyoming's Department of Plant Sciences should be consulted for information of a local nature.

c. Create a data sheet for each species

Hiebert and Stubbendieck (1993) and the APRS Implementation Team (2000) have suggested an approach for consolidating the information from the field survey and the literature reviews into a format that can be used to compare the exotic species according to the impacts they have or likely will have, and the difficulty of controlling them.

d. Use the information in determining management priorities

The APRS identifies as a high priority for control efforts those species that have (or are likely to have) a large impact on the management area's resources and at the same time are relatively inexpensive to control. The management goals for Fort Laramie, which recognize remnant native grasslands as contributing elements and the riparian vegetation along the rivers as non-contributing (USDI National Park Service, no date [a]), also will influence the management priorities. Wyoming state law, which stresses the control of designated weeds (Wyoming Statutes 11-5-101), should have a role in setting management priorities.

e. Design and Implement a Program to Control Exotic Plants

Upon completing the Alien Plant Ranking System (Hiebert and Stubbendieck 1993, APRS Implementation Team 2000), the managers and biologists at Fort Laramie will be ready to begin a program to control the exotic species identified as the high-priority targets. The goals and methods of that program will depend on what is learned in the ranking exercise and what species are selected, and they are beyond the scope of this plan.

Four readily available sources of information should be consulted in the design and implement of the control program. The first is the faculty in the University of Wyoming's Department of Plant Sciences, who have broad experience in weed control and integrated pest management. Second, the Goshen County Weed and Pest Control District can provide technical assistance of various sorts. Third, The Nature Conservancy's Wildland Invasive Species Team provides comprehensive information on approaches and techniques in weed control, available on their web site (http://tncweeds.ucdavis.edu/). And fourth, the National Park Service's Wildlife and Plants Web Page (http://www.nature.nps.gov/wv/index.htm) contains links to a number of sources of information on control of exotic plants and on integrated pest management.

f. Establish a Program to Monitor Exotic Plants

Whatever control program is adopted by NPS managers at Fort Laramie, it must include a program to monitor the distribution and abundance of the exotic species on the Site and to promptly discover the arrival of new species. A monitoring program is simply a series of repeated surveys that collect enough information to reveal changes from one survey to the next. The survey recommended for the Alien Plant Ranking System (APRS Implementation Team 2000) and discussed above can provide the initial data.

Like the initial survey, the monitoring program must be extensive, to show changes in abundance, and extensive, to show changes in distribution and, especially, to reveal the arrival of new exotic species. A general program to monitor the status of exotic plants over the entire National Historic Site may also be incorporated into more specific monitoring efforts to assess the effects of particular management practices such as biological or chemical controls, but that should not be a primary goal of the general monitoring program.

A general, park-wide monitoring program can incorporate both permanent survey locations and opportunistic survey made during the course of other work by NPS staff. Moderately-detailed survey along transects or in larger areas can quickly provide information on changes in the extent of populations and reveal new populations, while more detailed survey at a subset of the permanent survey locations can provide information on trends in density, reproduction, and other measures of plant health. If possible, the monitoring program should include opportunistic surveys by NPS staff during the course of other work on the Site, to increase the chances of promptly detecting the arrival of new exotic species.

The standards being developed by the North American Weed Management Association (2001) for surveying and mapping exotic plant populations may be finished by the time Fort Laramie implements a monitoring program. Those standards should be incorporated into the program to make it compatible with other efforts and to assure that

the monitoring program is consistent from year to year. Several general points about a monitoring program can be made here. First, as in the initial survey, NPS staff performing the monitoring surveys must be trained in identifying exotics, both those already at Fort Laramie and those likely to show up. Even those staff with only rudimentary skills in plant identification can be alert to the appearance of unusual plants. For training in plant identification, emphasizing particular species, NPS managers might contact the Goshen County Weed and Pest District staff, the staff at the University of Wyoming's Rocky Mountain Herbarium, the faculty in the University's Department of Plant Sciences, and the staff at the University's Wyoming Natural Diversity Database. All of these people could train NPS biologists, maintenance employees, and others to identify plants and collect specimens for confirmation. Such training could be accomplished in a day.

Second, the use of GPS receivers will greatly increase the accuracy of location data, which is crucial to tracking changes in sizes of weed patches and to directing staff responsible for treating the exotics to newly-discovered, small patches of obscure plants. Third, while paper maps or aerial photographs are sufficient for tracking the locations and sizes of exotic plant populations, a geographic information system (GIS) will greatly simplify the job of managing and displaying the results of repeated surveys and control efforts. GIS are available now at modest cost, can easily be linked to electronic spreadsheets, and are simple enough to use that the biologist or manager who reviews the reports of exotic plants could be trained to enter the information.

Fourth, the monitoring program should include all of the habitats on Fort Laramie, as indicated by the vegetation map (USDI Geological Survey 1998) augmented by the soil map (Stephens *et al*. 1971) and the orthophotoquad available from University of Wyoming's Geographic Information Science Center (http://www.sdvc.uwyo.edu/doqq/). And finally, including a statistician in the design of the monitoring program can assure that the information collected is adequate to detect the magnitude of change important to tracking the status of exotics.

Opportunistic sightings of exotic plants by people working around Fort Laramie can be especially valuable if NPS managers provide them with a method for systematically recording and reporting information. A one-page form, perhaps on paper of an unusual color, can be designed to allow an observer to record such details as the observer's name, the date, the common or scientific name of the plant, whether a specimen was collected, the life-stage of the plant (e.g., rosette, in flower, in fruit), the size of the population of the plant, and the location. A small map of the Park could be included, on which the observer could mark the general location of the plant. The name of the NPS biologist or manager to whom the observer should give the completed form should also be included. Once that biologist or manager receives the form, she or he should be able to easily locate the suspected plants, confirm the identification or, if necessary, collect a better specimen to allow for later positive identification, and record complete information on the size of the population, habitat features, and so forth. That person also should be responsible for recording the information in a comprehensive file or electronic database, and mapping the observation on a comprehensive map of exotics.

B. MAINTENANCE OF RELICT VEGETATION

The Statement for Management (USDI National Park Service 1991, page 19) and the General Management Plan (USDI National Park Service 1998, page 18 and 2001a, page 14) cite the integrity of the vegetation in a 40-acre natural environment subzone as a focus for interpretation of the Park's historic resources. That subzone, in the Park's northwestern corner (Figure 1), overlaps one of the two relict areas on Fort Laramie identified by Davis (1959) and one of the two areas identified in the Cultural Landscape Report (USDI National Park Service, no date [a], page 57) as native perennial grass vegetation (Figure 4). It seems to match the relict area identified by Olmstead and Perez (1986) (Figure 3), which they described as containing relatively undisturbed vegetation similar to that of the historic period. Olmstead and Perez (1986) cited quantitative vegetation data collected from their transect #1 in their relict area as resembling the typical prairie. Along with Davis (1959), they found blue grama, needle-and-thread, plains prickly-pear, and fringed sagewort to be common plant species in the subzone. The USGS - NPS Mapping Project (USDI Geological Survey 1998) found the same common species, and mapped the vegetation in this area as the *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation community type (Figure 2).

The natural environment subzone is underlain by deep, well drained, fine sandy loam soils of the Manter and Anselmo Series (Figure 6) and supports the Sandy Range Site (Stephens *et al*. 1971). Different range sites have been mapped on other parts of Fort Laramie, and the vegetation of the natural environment subzone may not be a particularly good representative of the native vegetation of those areas.

Olmstead and Perez (1986) identified a roughly circular area south of the Laramie River and north of the Fort Laramie Canal as a "disturbed relict" (or "altered relict") (Figure 3). They refer to this as the Immigrant Camping Area, in which disturbances have altered the composition of the vegetation but native species still dominate. Davis (1959) also regarded this area as a relict area, and it generally matches the other area of native perennial grass vegetation identified in the Cultural Landscape Report (USDI National Park Service, no date [a], page 57) (Figure 4). The USGS - NPS Mapping Project (USDI Geological Survey 1998) mapped this area primarily as *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation community type, with smaller amounts of Upland Weedy Community (Figure 2).

In discussing management, Olmstead and Perez (1986) combined both their relict and disturbed relict disturbance units (Figure 3), plus additional lands, into their management zone 1 (relict) (Figure 7). They recommended that all of their management zone 1 be maintained in its present state, through the exclusion of disturbances (presumably disturbances to the soil) and prescribed fire every 10th year to maintain dominance by the native species. The Park's Statement for Management and General Management Plan seem to have picked up their recommendation to prevent disturbances in the natural environment subzone, but those documents do not address the rest of their management zone 1 or the use of prescribed fire.

Olmstead and Perez (1986) reviewed information on the effects of fire in grasslands and recommended that their management zone 1 be burned every 10 years (presumably between mid-March and late April, as they recommended for their other management units) to prevent shrubs and exotic grasses from increasing. Their review of fire's effects should be compared with that of Knight (1994, pages 83 and 84), which

suggests that most fires in eastern Wyoming burned later in the summer. Whatever the literature tells us about fire in eastern Wyoming grasslands, we suggest that NPS biologists and managers keep two points in mind when thinking about management of the relict areas. First, the use of prescribed fire must take into account the exotic plants present in the relict area, and a fire management program should be designed after the detailed assessment of exotics suggested above. For example, Olmstead and Perez (1986) seem to recommend burning the relict areas between mid-March and late April, but fires later in the season may be more effective in suppressing cheatgrass (Carpenter and Murray 1991). The presence of cheatgrass and other exotics may reduce the relevance of information on the timing and frequency of fires during pre-historic or historic times, before those exotics arrived.

Second, management of the relict areas probably should be directed at maintaining a mix of native species in the vegetation and minimizing the amount of exotic plants, rather than maintaining a particular composition. The species composition of grasslands is dynamic, changing in response to drought and to various disturbances (Knight 1994), so it seems to makes little sense for managers to try to maintain the relative amounts of species within narrow bounds.

C. Restoration and Maintenance of Disturbed Areas

1. Introduction

Much of the upland in Fort Laramie has been drastically disturbed and is now vegetated by exotic plants, as indicated by the extent of *Sporobolus cryptandrus* Disturbed Vegetation, the *Bromus inermis* Disturbed Community, and the Upland Weedy Community on the USGS-NPS vegetation map (Figure 2), and by the extent of Annual / Perennial Mix - Disturbed Land on the map of existing vegetation from the Cultural Landscape Report (Figure 4). Two studies have specified seeding of native species as a treatment for the disturbed lands. Olmstead and Perez (1986) recommended that their management unit 2 (manipulated)[1] (Figure 7) be superficially tilled, burned, and seeded to return native species to dominance, and that the area be burned periodically thereafter to maintain the new vegetation. Redente (1992) suggested plowing, seeding with natives, possible use of herbicides to suppress exotics, and mowing or burning after the natives become established.

The themes of prairie restoration and seeding with native species are repeated in several of the Park's management documents. The Cultural Landscape Report (USDI National Park Service, no date [a]) calls for seeding on a substantial part of the Park (Figure 8), and according to the Park's Statement for Management (USDI National Park Service 1991, page 19), the land outside of the development, natural environment, and special use subzones (Figure 1) was being returned to a condition more closely resembling the natural, historical scene. (How that change was being accomplished was not explained.) The general management plan proposed for the Park also calls for restoration of prairie (USDI National Park Service 1993, page 21 and 2001, page 16). Returning native plants to dominance has a basis in the philosophy of NPS's management

[1] Olmstead and Perez (1986) refer to this area as Management Unit 2 (manipulated) on their map, and Management Zone II in the text.

guidelines, which emphasize the maintenance, restoration, and perpetuation of natural resources, including organisms, processes, and systems and their inherent integrity.

Despite the emphasis in vegetation studies and management documents, NPS managers and biologists should, for several reasons, carefully consider whether replacing exotic vegetation with quasi-native vegetation is the right policy for Fort Laramie. First, NPS management guidelines and Park management documents do not seem to require such a policy. Fort Laramie's Cultural Landscape Report (USDI National Park Service, no date [a], page 87) and General Management Plan (USDI National Park Service 1993, page 4) recommend that the Park "Reestablish and promote native plants and animals that contribute to and enhance the park's historic scene, *to the greatest degree possible*" (emphasis added). Moreover, the Cultural Landscape Report identifies the Annual / Perennial Grass - Disturbed Land vegetation as a "non-contributing feature" (pages 55 and 57). The General Management Plan (page 18) also says this about treatment of disturbed areas:

> "In the pasture and farmlands around the historic area, where appropriate for interpretive and historic scene purposes, traditional and historic native species *could be* encouraged to reclaim the area via seeding and control measures." (emphasis added)

This part of the 1993 proposal was retained in the 2001 amendment (USDI National Park Service 2001, page 11).

Second, the species composition may be less important than the general appearance of the vegetation. Olmstead and Perez (1986) noted this distinction when they pointed out that although the agricultural practices deeply altered the composition of the vegetation, they did not change the appearance of the land around the fort. The distinction also is reflected in the language of the General Management Plan (page 59), which suggests that general appearance may be more important than species composition:

> "Regardless of the evolution of plant species over the last 200 years, what appears most important to this analysis is the relationship of the scenic values of vegetation, sense of openness, and vista views of the fort."

Third, the treatments necessary to restore native vegetation to the disturbed areas likely will be expensive and require a sustained commitment from Fort Laramie's staff. Following is a discussion of those treatments. We stress that before NPS biologists and managers examine the details of these or other treatments, they must develop a clear understanding of their goals in managing the disturbed areas. For example, replacing the exotic plants completely with natives no doubt would be far more difficult and expensive than just reducing the amount of exotics and increasing the amount of natives in the vegetation. There seems to be no point in taking any steps until managers have decided how much they want to change the vegetation, and in what manner.

2. Management Considerations

This section draws on the recommendations of Olmstead and Perez (1986) and Redente (1992). Those documents should be consulted for more details.

a. Reduction in Exotic Plants

Without doubt, exotic plants are a major component of the vegetation in the disturbed areas on the Park. Olmstead and Perez (1986) described exotics as common or dominant on their transects 2, 8, 10, 11, 12, 13, 14, and 15 (Figure 5). Plot data and descriptions of community-types (Appendix 1) from the USGS - NPS Mapping Project (USDI Geological Survey 1998) indicated that exotics are common, if not dominant, in the *Bromus inermis* Disturbed Herbaceous type, the Upland Weedy Community, and the *Sporobolus cryptandrus* Disturbed Community. This information, and Redente's (1992) description of the areas he examined, also show that the degree of dominance by exotics varies throughout the disturbed areas and that different parts of the Park are dominated by different exotic plants. The composition of the vegetation should be assessed in more detail before NPS managers can decide where, specifically, to apply treatments.

(1) Fire Ecology and Management

Because prescribed fire has been recommended as a method of reducing competition from exotic plants, a brief review of principles of fire ecology and management is useful in highlighting the factors that must be kept in mind when a prescribed fire program is considered. For more details and useful references, see Olmstead and Perez (1986), Knight (1994), and Ortmann *et al*. (1998).

The major benefits of prescribed burning in grasslands are to control undesirable shrubs and trees, reduce the amounts of litter, increase herbage yields, increase grazing on coarse grasses, increase the availability of forage, increase rates of nutrient cycling and the availability of many nutrients, and control cool season grasses where warm-season grasses are dominant.

The timing of a fire determines to a great extent which species are harmed and which benefit. If vegetation burns during early spring, the actively growing cool-season plants are damaged and the dormant warm season plants are favored. Conversely, fires in late spring are more likely to damage the actively growing warm-season plants. Consequently, the timing of a prescribed fire can be used to shift the relative amounts of species in the vegetation. For example, in the native grasslands at Fort Laramie, both cool-season species (western wheatgrass, prairie junegrass, threadleaf sedge [*Carex filifolia*], needle-and-thread) and warm-season species (blue grama) are common, and the relative amounts of those species can be determined, in part, by the timing of prescribed fires.

The biological response to fire also depends greatly on the intensity and size of individual fires and on the frequency with which the vegetation burns. A hot fire that burns in dry fuel (especially in heavy fuel) kills more plants and soil biota than does a cooler fire burning in damp or thin fuels. Frequent fires favor species that reproduce rapidly, while infrequent fires allow species to survive that take long periods to mature and produce seeds.

The most effective fires for controlling invasive plant species are typically those administered just before flower or seed set, or (for woody plants) at the young seedling or sapling stage. But in some cases, prescribed burns can unexpectedly promote an invasion of exotics, such as when their seeds are specially adapted to fire, or when they resprout vigorously after fire.

How a plant responds to fire depends on the height above ground of its growing points, which in turn is a function of plant maturity and plant-growth characteristics. If growing points are above the soil surface, within reach of lethal temperatures, the plant likely will be damaged or killed. Perennial grasses that tolerate fire when dormant have growing points at or below the soil surface. Annual grasses and broadleaf plants are damaged when burned during active growth. Biennials also can be damaged during intense fires if their growing points are raised. Perennial plants differ in their responses to burning based on reproductive strategies and position of the growing points. Perennial grasses are damaged if stems are elongated. Timing of fires can be used to favor desirable grasses and suppress undesirable grasses. Plants that reproduce solely by seed can be killed by fire if their growing points are exposed to lethal temperatures. In contrast, perennial plants that can reproduce vegetatively from subsurface buds are usually only top-killed. These plants initiate new shoots after fire.

The primary variables that affect fire behavior and that must be considered in planning a fire are the amount of fine fuels (dead grass) present, the weather conditions before and at the time of the fire, and the management objectives. Generally, the more fuel present, the hotter the fire and the wider range of weather conditions under which the fire can be ignited. At a given fuel level, a fire will be hotter in warm and dry weather. The combination of heavy fuels loads and warm, dry weather can produce conditions in which the fire will be too hot and difficult to control, in which case the manager should be prepared to postpone the fire until the conditions improve. All fires involve expense and risk, and they should not be conducted without a reasonable chance of success.

Fire should be used with caution on sandy soils because they remove the litter and vegetation that protect the soil from wind erosion. Heavier soils are less prone to wind erosion. Slopes greater than 30 percent should be burned with caution because of the danger of water erosion. Timing of the fire can minimize the erosion risk.

If prescribed burning is used as a measure to control exotic species (or for any other reason), a prescribed burn plan must be completed well before the fire is lit. The plan must specify the objectives for the fire, permits that must be obtained (such as air-quality permits), necessary pre-fire treatments, acceptable conditions for burning, details of igniting and containing the fire, sources of emergency assistance, and post-fire management practices. A post-fire monitoring program should be implemented to determine whether management objectives are being met and if the prescribed fire plan must be modified.

Prescribed fire is only one possible mechanism for controlling exotic species, and managers must decide whether its benefits justifies the risks inherent to burning. Fire must be considered in light of all available options for control of undesirable species, such as manual, mechanical, competition from native plants (restoration), herbicides, or biocontrol.

(2) Treatments

To reduce the amount of exotics in their management unit zone 2 (Figure 7), Olmstead and Perez (1986) recommended early-spring burning (which they explained in detail) followed by spring burning, with light tillage done at the time of seeding. Burning between mid-March and late April, they felt, would have the greatest effect in reducing competition between the cool-season exotic species and the natives (some of them warm-

season) that they recommended be planted. This recommendation should be reviewed after more complete information is obtained from the exotic plant survey of the Park, to assure that it makes sense in the conditions that have developed since it was made in 1986. For example, yellow toadflax (*Linaria vulgaris*) is reported from Fort Laramie but its location is unknown. This noxious weed can spread following fire (The Nature Conservancy 2002) and the fire program prescribed by Olmstead and Perez (1986) could result in yellow toadflax replacing the other, less objectionable exotics in the treatment area. Also, it is unclear if the timing and frequency of prescribed fire as proposed by Olmstead and Perez (1986) are the best for reducing the exotic brome grasses now common in the area. Smooth brome, cheatgrass, and Japanese brome are known to be common in the area (USDI Geological Survey 1998). The USDA Forest Service Fire Effects Database (USDA Forest Service 2002) describes fire's effect on these species as follows. Smooth brome survives fire by sprouting from rhizomes. It is probably top-killed by fire. Early spring (late March-April) or late-season (late summer-fall) fire can increase smooth brome productivity, especially when it has become sod-bound. Late spring fire generally damages cool-season grasses such as smooth brome. Consequently, the very early fires suggested by Olmstead and Perez (1986) may have the unintended effect of increasing, rather than decreasing, the dominance of smooth brome.

Japanese brome tends to be reduced by fire, except in wet years, but the reductions usually last for only 1 or 2 years. Some seed is killed by fire, but seedbank reserves, reproductive capacity, and competitive ability of Japanese brome are usually sufficient to allow for repopulation of an area within 2 years unless the site is reburned. The recommendation by Olmstead and Perez (1986) to burn annually for five years should take care of this problem. But, the presence of cheatgrass (*Bromus tectorum)* complicates the matter. This is a winter-annual grass able to complete its life cycle in the spring before the dry summer weather begins. Its complete drying and fine structure make it extremely flammable. Frequent fires favor cheatgrass by eliminating competing perennial vegetation. Its seeds survive in the unburned organic material on a site. Rapid growth and vigorous reproduction assure cheatgrass dominance in the post-burn stand. Because of its flammability, cheatgrass greatly increases the frequency, size, and rate of spread of fires on a site. Cheatgrass fires spread very rapidly and may extend into nearby stands of native vegetation and reduce the cover of valuable perennial species. Hence the timing of prescribed fire should be determined in light of the actual species composition of the vegetation in different areas.

Redente (1992) agreed that competition from exotics must be reduced before natives can reclaim the disturbed areas, but he prescribed tillage, rather than fire, to remove the bank of exotic seeds as well as to kill mature plants. In the areas he described as "Alfalfa Fields", where the vegetation included mainly common kochia (*Kochia scoparia*), annual mustard (*Brassica* sp.), yellow sweetclover (*Melilotus officinalis*), common salsify (*Tragopogon dubius),* and smooth brome (*Bromus inermis* var. *inermis*), the tillage should consist of spring plowing to a depth of at least one foot, late-summer disking, and a second disking in fall just before seeding. Areas with more smooth brome should be plowed twice, once in late spring and again in mid-summer. A third area (the "Farm House" area) containing less smooth brome and dominated by cheatgrass and kochia should sprayed with Roundup herbicide in late spring and again in late summer, then disked in the fall before seeding.

Either of these methods of reducing competition from exotic species would seem to require advice and assistance from people outside of the Park. A prescribed fire program can be designed with assistance from the Park Service's Regional and National Offices, and it should be sought in the review of Olmstead's and Perez's (1986) recommendations. It is unlikely that Fort Laramie has the personnel and equipment on hand to conduct prescribed fires. Similarly, the tillage recommended by Redente (1992) probably must be done by a local farmer or a reclamation contractor with the necessary equipment. Although contracting for the farming required by Redente's approach might seem expensive, its might be no more costly than paying for the personnel and equipment needed for prescribed fire.

b. Seeding of Native Plants

(1) Seed Mixtures

Olmstead and Perez (1986) and Redente (1992) concluded that native plants are too rare in the rehabilitation areas on Fort Laramie to re-establish their dominance without supplemental seeding, and they recommended similar seed mixtures (Tables Seed1 and Seed2). According to Olmstead and Perez (1986), their mixture consists of the plant species found in "...a typical prairie in this region of the plains." Redente (1992) did not explain how he determined his seed mixture but it, too, consists of species present in the grasslands at Fort Laramie. He disagreed with the recommendation that plains pricklypear be included in the seed mix, opining that it reflects "...a misunderstanding of the ecological importance of prickly pear in prairie sites in this region". Pricklypear, he said, was a major component of the vegetation at Fort Laramie in the mid-1800s because the fort was overgrazed.

This difference of opinion about whether to include plains pricklypear in a seed mix raises an important question: what should be the goal for restoration of native vegetation on the disturbed areas? Whatever goal the Park's managers adopt, it should **not** be to achieve a particular native species composition, because there is no particular species composition that characterizes the Park. One of Olmstead's and Perez's (1986) objectives (page 6) was to recommend management practices to " ... convert the existing vegetation to a close approximation of the historical vegetation." There are no data whatsoever on the composition of the historical vegetation, but were data available, they no doubt would show that the vegetation changed during the historical period. If one adopts the interpretation of the Park's Cultural Landscape Report (USDI National Park Service, no date [a]), the relevant period is the "Period of Significance" from 1834 to 1890. The Cultural Landscape Report points out that the composition of the grasslands must have changed from the beginning to the end of that period because of grazing and construction of buildings. Redente (1992) refers to a report that, by 1845, grazing had so reduced forage on the Fort that livestock were moved three miles away.

Furthermore, the composition of the vegetation depends on variables other than grazing by large animals. Drought, insects, and burrowing animals can exert major impacts on the abundance of different species (Knight 1994, pages 82 - 88). Because Park managers can have little control over these variables, they will be unable to maintain a particular species composition.

Should Park managers decide to restore native vegetation, then a practical goal might be simply to establish a vegetation composed primarily of plants native to the region and suited to the different soil types on the Park, and that contains some acceptable amount of exotic species. Elimination of exotics is, for practical purposes, impossible. The seed mixtures recommended by Olmstead and Perez (1986) and by Redente (1992) seem to be suitable for such a management goal. Cost and availability of seed will influence the decisions on the seed mixture that is actually planted. During some years, seeds of some native species are unavailable, or are in such short supply that they are prohibitively expensive (Ron Schreibeis, Rocky Mountain Reclamation Company, personal communication). Appendix 2 contains names and addresses of several companies with whom Park managers could check to determine availability and prices.

Olmstead and Perez (1986) raised a point that managers and biologist should keep in mind when setting goals for restoring native species, that being the difference in species composition that should be expected in the restored vegetation. The area contains soils of different textures (Figure 6) and those soils create different range sites (Table 7). Two more-or-less native community types, the *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation type and the *Sporobolus cryptandrus* Disturbed Community, have been mapped in the disturbed area (Figure 2), and a comparison of their major species (Appendix 1) leads one to expect that different natives will dominate on the different soil types. Consequently, management goals and monitoring programs should allow for place-to-place as well as year-to-year differences in species composition.

(2) Timing of seeding

Spring burning and seeding, between mid-March and late April, were recommended by Olmstead and Perez (1986). They concluded that most fires in the western Great Plains burned in spring and that spring burning would be most effective in controlling weeds, and presumably they recommended spring seeding to take advantage of the maximum reduction in the exotics. Redente (1992), in contrast, recommended fall seeding, following either spring tillage or spring and fall tillage. He did not explain his rationale for fall seeding.

In the absence of irrigation on the seeded areas, fall seeding might increase the chances of seedling establishment by allowing seeds to take advantage of late-winter and very early-spring moisture. Fall-sown seeds would be in a position to germinate as soon as soils warmed up. Spring-sown seeds could, too, if the seeding were done very early. The later in the spring the seeds are sown, the greater the risk of failure because the upper soil (where the seeds lie) will be drying out.

We recommend that NPS biologists and managers consult with people who have done reclamation work in the region before they decide on the timing of treatments and seeding.

c. Long-Term Management

Should NPS managers decide to restore native species to dominance in the disturbed areas, then management over the long term must be directed to maintaining the vegetation.

(1) Prescribed Burning

Olmstead and Perez (1986) recommended burning the planted areas annually for five years, primarily to exhaust the stock of exotic seeds in the soil and allow the vegetation to reach an "equilibrium". (They did not define "equilibrium", but presumably they meant that exotic species were no longer decreasing in abundance and natives were no longer increasing.) If monitoring of species composition during the sixth year after seeding showed that the vegetation had reached equilibrium, then prescribed fire frequency should be decreased to every 10th year. If monitoring in year 6 showed no equilibrium, then annual burning should be continued in years 6, 7, and 8, and the 10-year burn frequency started in year 9.

Redente (1992) also recommended prescribed fires as a long-term management practice, but for the short-term after seeding, he suggested herbicide treatment to keep down annual exotics in the alfalfa field and farm house areas. Twenty-five percent relative cover by exotic annuals there in the first year after seeding was his threshold for using herbicides, with additional herbicide applications in later years as necessary if the exotic annuals increased again. Over the long term, burning every 5 to 10 years was his preferred management practice, with mowing every 5 years as a less-desirable alternative.

The season for the long-term prescribed burns was not specified in either study. If Park managers opt for this management practice, then the burns should be conducted during the season when they are least likely to damage the native plants that become established and to favor the exotics growing there. As noted above (section III.C.a.(1), page 17), fire might be used to favor warm season grasses (blue grama, buffalo grass, sand dropseed) or cool-season grasses (western wheatgrass, needle-and-thread). But shifting the composition of the vegetation with fire should be done judiciously. If the desired type of grass is rare in the vegetation, then fire at the wrong time could damage the species that are growing there without increasing the other types of natives.

(2) Control of Exotic Plants

The restored vegetation must be monitored for exotic species as part of the Park-wide exotic plant management program recommended above (section II, page 6). Even if the burning or tillage recommended by Olmstead and Perez (1986) and Redente (1992), respectively, are used to reduce the exotics already there, some of those species will persist in the vegetation. Monitoring the distribution and abundance of exotics, both existing and new species, will allow managers to set the seasons and frequency of prescribed burns or mowing, to assure that they are not promoting those species.

Ditch water used to irrigate the parade grounds and other lawns in the Park's development subzone is sometimes allowed to run onto the adjoining disturbed areas (Steve Fullmer, personal communication, 3/12/02). This water no doubt carries weeds seeds, and unless carefully controlled it likely will serve as a vector for introducing undesirable exotics into restoration areas.

d. Grazing

Grazing of the disturbed areas on the Park should be managed in concert with the burning, tillage, or herbicide treatments. We discuss it in a separate section because it seems to have raised questions among managers.

At present (and for several years at least), the only grazing animals on the Park are NPS horses from Rocky Mountain National Park that winter at Fort Laramie (Tammy Benson, personal communication, 3/12/02). A maximum of 32 head graze on 100 acres. To reduce the chances of the horses bringing in weeds, their hooves and shoes are cleaned and they are fed weed-free hay for 1 week before going to pasture at Fort Laramie. Hay, though, is sometimes purchased on an emergency basis and it may contain weeds. People like seeing the horses grazing on the Park.

Olmstead and Perez (1986) concluded that grazing by NPS horses in the mid-1980s had a negligible effect on the vegetation because only a few head grazed over a large area. We suggest that the current level of grazing also has little effect on the, primarily because plants are dormant when the horses are there. For the same reason, we expect that the current grazing management practices should have little effect on the species composition of restored grassland vegetation, but the effect of grazing in removing fuels needed for prescribed burns should be investigated. Changes in grazing management might present problems for restoration. The introduction of grazing during the growing season could impede the re-establishment of dominance by native plants and favor unpalatable or grazing-resistant exotics. And, an increase in the number of horses grazing during the winter might remove fuels needed for prescribed burns. Grazing has been part of the ecology of Great Plains grasslands for millenia (Knight 1994), but at Fort Laramie it must be done in a way that does not interfere with other management practices, especially restoration of native species to the disturbed areas.

D. WETLANDS

The various types of wetland vegetation growing along the North Platte and Laramie Rivers and below the Fort Laramie Canal are considered here in a separate section of the management plan because they present managers with complicated management issues. Before discussing wetlands on the Park, we offer a review of salient points about wetland management and protection. We then review wetlands on the entire Park, and finally consider the riparian areas along the rivers and the seep below the canal in two separate sections.

1. Wetland Management

Since 1989, the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (the Corps) have been responsible for implementing Section 404 of the Clean Water Act to protect *jurisdictional wetlands* in the United States (Mitsch and Gosselink 1993). The Corps of Engineers (U.S. Army Corps of Engineers 2001) define wetlands as follows:

"Those areas that are inundated or saturated by surface or groundwater at frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

The final determination of whether an area is a jurisdictional wetland and whether activities pertaining to that wetland require a permit (per Section 404) must be made by the appropriate Corps District Office. Fort Laramie lies within the Northwestern Division of the U.S. Army Corps of Engineers, Omaha District. The Corps uses the presence of three characteristics to identify jurisdictional wetlands: hydrophytic vegetation, hydric soil, and hydrology. Unless an area has been altered or is a rare natural situation, all three types of wetland indicators must be present during some portion of the growing season for an area to be a jurisdictional wetland. The State of Wyoming also defines wetlands using these criteria (State of Wyoming 2002).

Hydrophytic or wetland vegetation is composed of hydrophytic plants that are listed in regional publications of the U.S. Fish and Wildlife Service (USFWS). The USFWS, in cooperation with the Corps, EPA, and the Natural Resources Conservation Service (NRCS) has also published the "National List of Plant Species That Occur in Wetlands" from a review of the scientific literature and review by wetlands experts and botanists (Reed 1988). Staff at the Corps District Office in Cheyenne, Wyoming or a trained botanist can help in the identification of hydrophytic plants.

Hydric soils possess characteristics indicating that they were developed in conditions where oxygen is limited by the presence of water for long periods during the growing season. Hydric soils are listed by the NRCS, and managers should suspect that areas with hydric soils are jurisdictional wetlands. Staff of the Corps District Office and soil scientists with the NRCS can determine whether soils qualify as hydric.

The third property of jurisdictional wetlands, hydrologic indicators, can be observed during field inspection. Wetland hydrology refers to the presence of water at or above the soil surface for a sufficient part of the year to significantly influence the plant types and soils that occur in the area. Wetland hydrology is indicated by:

- ?? Water standing on or flowing over the area during the growing season
- ?? Soils waterlogged during the growing season.
- ?? Watermarks on tress or other erect objects, indicating that water periodically covers the area to the depth shown on the objects.
- ?? Drift lines (small piles of debris oriented in the direction of water movement) along contours, representing the approximate extent of flooding in an area.
- ?? Debris lodged in trees or piled by water against other objects.
- ?? Thin layers of sediments deposited on leaves or other objects. Sometimes these become consolidated with small plant parts to form discernible crusts on the soil surface.

Some general situations suggest the presence of a jurisdictional wetland (U.S. Army Corps of Engineers 2001), and if any of these situations are observed, then managers should ask the local Corps office to determine whether the area is a wetland:

- ?? The area occurs in a floodplain or otherwise has low spots in which water stands at or above the soil surface during the growing season. Note that most wetlands lack both standing water and waterlogged soil during at least part of the growing season.

?? The area has plant communities that commonly occur in standing water for part of the growing season (e.g., cordgrass marshes, cattail marshes, bulrush and tule marshes).
?? The area has peat or muck soils

2. Wetlands on Fort Laramie

The National Wetland Inventory of the U.S. Fish and Wildlife Service maps wetlands throughout the United States according to the hierarchical system of Cowardin *et al*. (1979). The NWI maps are produced at a scale of 1:24,000 by manual photo interpretation of National High Altitude Photography (NHAP) or National Aerial Photography Program (NAPP) images, supplemented by soil survey and field checking. Figure 9 shows the wetlands on Fort Laramie as mapped by NWI. The line wetlands, shown as one type, include Palustrine emergent, Palustrine scrub-shrub, Riverine lower perennial unconsolidated bottom, and Riverine lower perennial unconsolidated shore classes. NWI wetland classes on Fort Laramie consist of:

?? Palustrine, emergent wetlands, characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.
?? Palustrine, scrub-shrub wetlands, dominated by woody vegetation less than 6 m (20 feet) tall. The species includes true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.
?? Palustrine, forested wetlands, characterized by woody vegetation 6 m (20 feet) tall or taller
?? Palustrine, unconsolidated shore wetlands have < 75% cover of stones, boulders, or bedrock, < 30% cover of vegetation other than pioneering plants, and any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded.
?? Riverine, lower perennial, unconsolidated bottom wetlands lie in stream channels and have at least 25% cover of small particles and < 30% cover of vegetation.
?? Riverine, lower perennial, unconsolidated shore wetlands also lie in channels and have < 75% cover of stones, boulders, or bedrock, < 30% cover of vegetation other than pioneering plants, and any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded.

All of these NWI wetland classes are describe in detail in Cowardin *et al.* (1979).

The USGS - NPS Mapping Project mapped 6 wetland community-types on Fort Laramie, each of which can be placed into a wetland class of the NWI classification scheme (Cowardin *et al.* 1979) (Table Wetland 1). These community types are:

?? *Carex nebrascensis* Herbaceous Vegetation community, a Palustrine, emergent wetland, is largely a product of seepage from the Fort Laramie Canal. It also occurs on intermittently saturated alluvial soils on the upper Laramie and North Platte River floodplains north of the canal.

?? *Spartina pectinata - Scirpus pungens* Herbaceous Vegetation community, a Palustrine, emergent wetland, occurs on alluvial soils as narrow bands adjacent to the Laramie River. *Spartina pectinata* also occurs under *Populus deltoides* along the east side of the Laramie River.

?? *Typha latifolia* Western Herbaceous Vegetation community, a Palustrine, emergent wetland, occurs on level, alluvial sites near the North Platte and Laramie Rivers, and in seepage areas north of the canal.

?? *Salix exigua* Shrubland community, a Palustrine, scrub-shrub wetland, occurs on level sites on alluvial soils along the Laramie and North Platte Rivers and in seepage areas north of the Fort Laramie canal.

?? *Populus deltoides/Symphoricarpos occidentalis* Woodland community, some stands of which are Palustrine, forested wetlands , occurs on the floodplain along the North Platte and Laramie Rivers, along the highway north of the park, and north of the canal on the south edge of the park.

?? Riverine Sand Flats - Bars Sparse Vegetation community, a Palustrine, unconsolidated shore wetland, occurs adjacent to the Laramie and North Platte Rivers**.**

Descriptions of these community-types from the USGS - NPS Mapping Project are provided in Appendix 1.

The distribution of wetland classes as indicated by plant community-types differs substantially from the distribution of those classes as mapped by the NWI. The NWI map (Figure 9) shows the North Platte River as mainly Riverine, lower perennial, unconsolidated bottom wetland with smaller amounts of Riverine, lower perennial, unconsolidated shore and Palustrine, scrub-shrub classes. One large patch of Palustrine, forested wetland and several small patches of Palustrine, emergent and Palustrine, scrub-shrub wetland are mapped along the Laramie River. Small patches of Palustrine, scrub-shrub and Palustrine, emergent wetland classes are mapped below the Fort Laramie Canal.

In contrast, if USGS - NPS Mapping Project community-types are used to indicate wetlands (Figure 10), then the North Platte River supports mainly Palustrine, forested class wetlands (cottonwood woodlands); a large mosaic of Palustrine, forested, Palustrine scrub-shrub, Palustrine, emergent, and Palustrine, unconsolidated shore wetlands occurs along the Laramie River; and the Palustrine, emergent class dominates extensive wetlands below the Fort Laramie Canal.

The discrepancy between these two maps is due in part to the occurrence of stands of old *Populus deltoides* / *Symphoricarpos occidentalis* Woodlands on upland sites that do not meet the criteria of jursidictional wetlands. Indeed, the USGS - NPS Mapping Project coded the cottonwood woodlands as upland vegetation in their digital files. Other reasons for the discrepancy are hard to identify. So little time elapsed between the production of the NWI maps (based on aerial photographs taken between 1971 and 1992;

USDI Fish and Wildlife Service, 1997) and the USGS - NPS map (in 1998) that it seems unlikely that the wetlands could have grown substantially in area, especially along the Laramie River. The NWI maps for treeless prairies show wetlands as small as 0.25 acre (USDI Fish and Wildlife Service, 1997), so the wetlands along the Laramie River and below the Fort Laramie Canal are large enough to appear on the NWI maps.

Both maps should be used to give managers a general idea of the location of wetlands on Fort Laramie, but neither can be the basis for decisions about where management practices that could disturb wetlands might be implemented. Regardless of whether wetlands at Fort Laramie are defined as contributing or non-contributing cultural elements (USDI National Park Service, no date [a]), any activities that might affect wetlands larger than 0.1 acre fall within the purview of section Section 404 of the Clean Water Act and must be approved by the Corps of Engineers. That approval is contingent on delineation of wetlands on the ground by someone familiar with the criteria used by the Corps **(**Matt Bilodeau, US Army Corps of Engineers Omaha District, Cheyenne WY, personal communication 1/18/02**).**

a. Riparian Areas Along the Rivers

The USGS -NPS project (USDI Geological Survey 1998) mapped substantial areas of riparian vegetation, mainly cottonwood woodlands (*Populus deltoides* / *Symphoricarpos occidentalis* community-type) and sand flats and bars, along the North Platte and Laramie Rivers (Figure 2). This vegetation, particularly the cottonwood woodlands, is a good example of the conflicting goals that managers face at Fort Laramie. The riparian vegetation is considered by the Cultural Landscape Report (USDI National Park Service, no date [a]) as a non-contributing cultural element, meaning that it contributes nothing to the interpretation of the cultural and historical roles of Fort Laramie because it was not present during the relevant historical period. Therefore, it needn't be maintained. But the cottonwood woodlands and the other riparian community-types might be considered a valuable natural ecosystem of the type that the General Management Plan (USDI National Park Service 1993 and 2001a) and NPS management guidelines (USDI National Park Service 2001b) direct the Park Service to preserve or restore. Furthermore, NPS managers must take into account the enjoyment that the public derives from these woodlands. These points, and others, are recognized in the Park's General Management Plan (USDI National Park Service 1993, page 70) when it suggests that the riparian woodlands and shrub stands be maintained and explained in interpretive exhibits.

Olmstead and Perez (1986) recommended prescribed fire every tenth year for their management unit zone 4, which includes the riparian zones along the rivers (Figure 7). The prescribed fires would remove the dense understory that had accumulated over the preceding decades and prevent another buildup of fuel that would increase the chance of a large, hot wildfire. *Populus deltoides* is a weak sprouter and fire generally kills it, whereas *Symphoricarpos occidentalis* sprouts vigorously from the root crown and rhizomes following fire (USDA Forest Service 2002). The cottonwoods should be able to survive the prescribed fires but probably would be killed in wildfires. Although Olmstead and Perez did not suggest it, Park managers ought to assess the fuel loads in the woodlands to determine if they need to remove concentrations of large fuels, such as fallen trees and piles of branches, before they start prescribed fires.

The ability of Park managers to maintain the riparian woodlands along the Laramie River may be limited over the long term by the presence of Grayrocks Dam, constructed on the river upstream from Fort Laramie in the late 1970s. Depending on the manner in which Grayrocks is operated, it could seriously reduce the floods necessary for regeneration of cottonwoods. The river has carried high spring flows even with the dam in place, though (USDI National Park Service, 1991, page 8), so the effect of the dam on the river's flows is unclear.

The effects of a dam on cottonwood woodlands depend not only on how the dam is operated, but also on the geomorphic characteristics of the river (Friedmann *et al.* 1997). Along meandering streams such as the Laramie River at Fort Laramie, reduction of high spring flows usually causes an immediate decrease in cottonwood regeneration followed soon by a reduction in the extent of cottonwood woodlands.

If Park biologists and managers want to learn whether the woodlands along the Laramie River are maintaining themselves, they will need to institute a program to monitor establishment of new cottonwood stands. Eastern cottonwood woodlands typically consist of groves, with all of the trees in one grove being about the same size because they were established during the same year. Because different groves were established in different years, they differ from one another in size and density of trees. Along meandering rivers such as the Laramie River, the sediment bars on the insides of bends provide ideal habitat for germination of seeds and establishment of seedlings, so a grove often reflects the arcuate shape of the bar on which the trees became established. The river channel migrates toward the outside of the meander and lays down successive sediment bars to the inside. Each of these bars may be occupied by a new generation of cottonwoods, producing a series of groves of larger trees with increasing distance from the river. Consequently, a monitoring program should look for newly-established patches of cottonwood seedlings and saplings on bars inside meanders and along straighter stream reaches. Unfortunately, in the absence of data on seedling establishment rates before the construction of Gray Rocks, biologists will have no baseline with which to compare current establishment rates. But they can periodically calculate the frequency of groves of trees of different sizes and see if that frequency changes (that is, if groves of small trees become rarer and groves of old trees more common) to estimate whether groves of aging trees are being replaced.

One version of this approach to studying the changes in cottonwood woodlands was used by Miller et al. (1995) on the North Platte River some 12 air miles downstream from Fort Laramie. With aerial photographs from different years and a geographic information system, they showed that flood control on that river had caused a decline in cottonwood establishment and consequently the structure of the woodland was changing, with groves of dense, smaller trees decreasing in extent and open groves of larger trees increasing. This same approach, combined with field survey for new stands of tree seedlings, could be used on the Laramie River.

Another change in the riparian woodlands that might be noticed along the Laramie River (and perhaps along the North Platte, too) is the conversion of the overstory from cottonwood and willow dominance to dominance by green ash (*Fraxinus pennsylvanica*) and boxelder (*Acer negundo*). In contrast with the pioneering cottonwoods and willows, these later-successional species can become established in closed vegetation, including cottonwood stands, and they replace the early-successional

cottonwood woodlands along the Platte River in Nebraska where they are common (Johnson 1994). Both ash and boxelder grow along the Laramie River now, but surveys would be needed to show whether they are common enough to form woodlands that replace the cottonwood woodlands. If the late-successional trees are rare, then a decline in cottonwoods will likely result simply in the riparian woodlands becoming a minor part of the landscape.

A change in composition of the woodlands probably would go unnoticed by most observers and so would have little impact on the setting for the Park's cultural values. A loss or substantial decline in riparian woodlands, on the other hand, might well be noticed by most visitors to Fort Laramie and therefore be of concern to managers, even if loss of woodlands would produce a landscape more closely mimicking that of the relevant historical period. Whether Park managers can do anything about the loss of woodlands, should a research or monitoring program suggest that it will happen, is open to question. In theory, upstream reservoirs could be regulated to allow occasional high spring flows to produce habitat for cottonwood seedling establishment. Whether this sort of management is feasible, though, is a different question. Another possibility for management is judiciously re-arranging sediments in the river channel, to allow water to flow into abandoned meanders where even the low spring flows can create habitat for cottonwood establishment. Researchers at the USGS Biological Resource Division's Fort Collins Science Center (2150 Centre Avenue, Building C, Fort Collins, CO 80526-8118) can discuss the idea with Park biologists and managers. Contact Mike Scott of the Fort Collins center (phone 970-226-9475, e-mail mike_l_scott@usgs.gov).

Given the importance of the riparian woodlands as habitat for a variety of animals, Park managers and biologists should consult with biologists from the Wyoming Game and Fish Department and the U.S. Fish and Wildlife Service before undertaking any substantial management actions. Staff of these agencies can be reached at:

Wyoming Game and Fish Department
Laramie Regional Office
528 Adams Street
Laramie, Wyoming 82070
307-745-4046

U.S. Fish and Wildlife Service
Wyoming Ecological Services Field Office
4000 Airport Parkway
Cheyenne, Wyoming 82001-1599
307-772-2374

b. Wetlands Below the Canal

According to the USGS - NPS vegetation map (Figure 2), wetlands of Nebraska sedge, cattail, and coyote willow cover a substantial part of the Park immediately north of the Fort Laramie Canal. These wetlands were created by seepage of water from the canal (Olmstead and Perez 1986), which was built in 1900 (Cultural Landscape Report, page 29), 10 years after the end of the historical period of significance that defines the contributing elements. Nevertheless, they are identified in the Cultural Landscape Report

as a contributing feature (vegetation map, page 57) but the reason for that designation is unclear. Regardless of whether they are contributing features, they may well qualify as jurisdictional wetlands. If so, then Park managers must assure that management there is allowed under the regulations of Section 404 of the Clean Water Act, and should consult with the Corps of Engineers before undertaking any activities.

A question that Park managers need to answer is whether the wetlands below the canal are growing in area. If they are, then an increasing part of the Park will come to be occupied by artificially created vegetation that was not on the landscape during the historic period. The spread of these wetlands would also mean that management of the Park is increasingly restricted by the Clean Water Act. Furthermore, the wetlands may encroach on archaeological features.

Historical changes in the extent of wetlands below the canal could be documented through comparison of aerial photographs taken at different times. Current and historical aerial photos are available from the US Geological Survey's Earth Resources Observation System Data Center at http://edc.usgs.gov/products/aerial.html. Analyzing aerial photographs in a geographic information system (GIS) would allow managers to quantify changes in the extent of wetlands. Changes in the future could also be documented by analysis of aerial photographs if they are taken frequently enough. On-the-ground monitoring of the extent of wetlands also could in at least two ways. First, permanent transects could be established and marked on the ground, from well within the wetlands out into uplands. The locations of the transects should be determined with global positioning system (GPS) receivers so that they can be accurately plotted in GIS on maps or aerial photographs of the Park. The points at which the transects intersect the boundaries of the wetlands could then be periodically documented and mapped to determine whether the boundaries are changing. If this technique is used, then enough transects (probably at least 25) should be established to cross the wetland boundaries in a number of places.

Second, the boundaries of the wetlands could be documented periodically with GPS receivers, by having people trained in use of the receivers walk along the wetland boundaries and record them as polygons or arcs in digital files. The files then could be displayed on maps in GIS to illustrate changes. This approach, while perhaps requiring more time than the use of transects, would allow managers to calculate the area covered by the wetlands and probably would be more sensitive to changes than would the transects.

E. Effects of Agricultural Practices on Adjoining Lands

In its list of major management issues (page 21) and its natural resource management objectives (page 23) Fort Laramie's Statement for Management (USDI National Park Service 1991) acknowledges that the Park cannot be managed in a vacuum. The need to coordinate with adjoining landowners is particularly important in the management of exotic plants because weed seeds crossing the Park boundary in either direction can foil control efforts made by individual land owners. Each step of the Alien Plant Ranking System, from inventory of existing weed populations, to control efforts, to designing and implementing a monitoring program, provides Park managers with an opportunity to work with nearby landowners. Including the Goshen County Weed and Pest District in the exotic species management program might make it particularly

effective because the District's staff no doubt has worked with a variety of landowners in the area.

F. Botanical Survey of Fort Laramie

Although the flora of a place (the collection of plants growing there) differs from the vegetation (the collection of plants with consideration of their relative amounts, life forms, and relationships to one another), a floristic survey of Fort Laramie would provide information important in vegetation management, so we briefly discuss floristic survey in this vegetation management plan.

Inventory of vascular plants at Fort Laramie already has been identified as a high priority in the study plan for the NPS Inventory and Monitoring Program (USDI National Park Service, no date [b]). Following the recommendation of Fertig (2001), the study plan specifies that an inventory be conducted twice, once in the spring and again in late summer, in all of the Park's vegetation types. The methods to be used in the inventory (USDI National Park Service, no date [b], pages 53 and 54) seem to us well thought-out for meeting the its objectives.

While this inventory of all the vascular plant species on Fort Laramie will overlap with the survey for exotic plants that we recommend (see page 9 above), it will not provide all of the information needed in that more extensive exotic survey. By noting the species that occur in each polygon from the USGS - NPS vegetation map (USDI Geological Survey 1998), the vascular plant inventory will provide managers with a good picture of the distribution of exotics, but it will provide no data on their abundance, and the information on habitat affinity will be limited to that which can be inferred from the vegetation and soils maps. Therefore, we urge that the inventory of vascular plants not be viewed as a substitute for the more detailed survey of exotic species.

G. Effects of Soil Disturbance and Erosion on Plant Communities

This topic was listed in the statement of work that forms the basis for the NPS - UW agreement as one that should be addressed in this vegetation management plan. There seem to be no specific problems with soil erosion and vegetation on the Park now (Tammy Benson and Steve Fullmer, personal communication, 3/12/02), so we make only three general comments.

First, disturbed areas often provide good habitat for establishment of exotic species and for the spread of existing patches of weeds. This may be a reason that the cottonwood woodlands in the riparian zones are rich in exotics; floods lay down sediment on which wind- or water-borne exotics, and those whose seeds are dispersed by birds, can germinate. Traffic on footpaths and trails may be heavy enough to create patches of bare soil that also are colonized by undesirable exotics. But, as any weed managers knows, roadsides generally are the locus for many exotics, because they are disturbed frequently by plowing and because the soil there is recharged by runoff from the road. Although the Park may be free of heavily disturbed areas now, managers should regularly monitor trails, paths and roadsides

Second, sediment deposited by the North Platte and Laramie Rivers is necessary for the establishment of early-successional riparian plants such as willows and cottonwoods. While they deposit new sediments, the rivers will erode their banks and existing bars, removing stands of trees and shrubs and patches of herbaceous vegetation.

This constant disturbance by the meandering rivers is the force behind the shifting pattern of riparian plant communities. Although flood waters, responsible for much of the erosion, may be seen as a threat to some cultural resources (USDI National Park Service 1991, page 22), they are crucial to the maintenance of some riparian vegetation types, so steps should be taken to protect cultural resources from damage, not to prevent erosion and deposition by the rivers.

Third, the sandy soils found throughout much of the Park are highly susceptible to wind erosion when the protective vegetation is removed (Stephens *et al.*, 1971), so some erosion can be expected if managers decide to plow or burn the existing exotic vegetation and restore native plants.

H. IRRIGATION SYSTEM NEEDS

The statement of work lists this as another topic to be discussed in the vegetation management plan. Irrigation on the Park apparently is limited to the grounds in the development subzone (USDI National Park Service 1991, page 7) and its impact on the vegetation of concern in this plan is limited to some flow out of the development subzone onto the adjacent exotic vegetation in old pastures (Steve Fullmer, personal communication, 3/12/02). In 1991, the National Park Service had water rights to irrigate over 300 acres (USDI National Park Service 1991, page 7) but none of the documents reviewed for this management plan suggest that it be used outside of the development subzone. None of the management steps suggested for the maintaining the native vegetation in the natural environment subzone or for restoring native species to the disturbed areas include irrigation. Consequently, discussion of the irrigation system is beyond the scope of this vegetation management plan.

I. MAINTENANCE OF VEGETATION AROUND THE HISTORIC DISTRICT

This is another topic that the NPS - UW cooperative agreement lists for inclusion in the vegetation management plan. We understand the term "historic district" to mean the are of the Park containing the historic buildings and other features, that is, the development subzone (Figure 1) of the 1991 Statement for Management (USDI National Park Service 1991). Maintenance of that vegetation, then, is of concern more to the Park's maintenance staff than to the natural resource staff and is largely beyond the scope of this vegetation management plan. Natural resource managers should be aware of the potential for impacts outside of the development subzone from irrigation water carrying weed seeds from the development subzone, from grass clippings being dumped outside of the development subzone, and from the planting of aggressively spreading exotic plants in the development subzone. Maintenance staff should work closely with natural resource staff to avoid problems of this sort.

J. HAZARDOUS TREE MANAGEMENT

This is another topic that applies mostly to the development subzone, where old trees might drop limbs onto Park visitors or staff. Dead trees in the riparian zones might be considered hazardous because they provide fuels for hot fires, and fire managers might need to remove them before lighting prescribed fires. Because these trees may provide habitat for cavity-nesting birds, biologists from the Wyoming Game and Fish Department

or the U.S. Fish and Wildlife Service ought to be consulted before those dead trees are removed.

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V. TABLES

Table 1. Exotic plant species known from three information sources to occur at Fort Laramie National Historical Site.

Bold-face type indicates species on the Wyoming noxious weed list.

Scientific Name[1]	Common Name[1]	Olmstead and Perez (1986)[2] n=16	USDI Geol. Survey (1998)[3] n=32	Fertig (2000)[4]
Agropyron cristatum	Crested wheatgrass		6%	
Agrostis stolonifera	Carpet bentgrass			X
Alyssum alyssoides	Alyssum		6%	
Bromus inermis ssp. inermis	Smooth brome		34%	X
Bromus japonicus	Japanese brome		22%	X
Bromus tectorum	Cheatgrass	56%	53%	X
Camelina microcarpa	Littlepod falseflax		9%	
Capsella bursa-pastoris	Shepherdspurse	X		
Carduus nutans	Musk thistle			X
Cirsium arvense	**Canada thistle**		**16%**	**X**
Convolvulus arvensis	**Field bindweed**			**X**
Descurainia sophia	Flaxweed tansymustard			X
Elaeagnus angustifolia	Russian olive			X
Elymus repens[5]	**Quackgrass**	**38%**	**6%**	**X**
Eragrostis cilianensis	Stinkgrass			X
Euphorbia marginata[6]	Snow on the mountain	X		
Kochia scoparia	Common kochia	19%		X
Lactuca serriola	Prickly lettuce	19%	6%	X
Lepidium perfoliatum	Clasping pepperweed	X		
Linaria vulgaris	**Yellow toadflax**	**X**		
Lolium perenne	Perennial ryegrass	X		
Medicago lupulina	Black medic			X
Melilotus albus[7]	Sweetclover			X
Melilotus officinalis	Yellow sweetclover		6%	X
Nepeta cataria	Catnip		3%	X
Onopordum acanthium	**Scotch thistle**			**X**
Pennisetum glaucum[8]	Yellow bristlegrass			X
Phleum pratense	Timothy	25%		
Plantago major	Broadlead plaintain	X		
Poa pratensis	Kentucky bluegrass	25%	19%	X
Polygonum lapathifolium	Curltop ladysthumb			X
Polygonum persicaria	Spotted smartweed			X
Polypogon monspeliensis	Rabbitfootgrass			X
Portulaca oleracea	Purslane			X
Rumex crispus	Curly dock			X
Rumex stenophyllus	Narrowleaf dock			X
Salsola collina	Slender russian thistle	X		

Table 1 (continued)

Scientific Name[1]	Common Name[1]	Olmstead and Perez (1986)[2] n=16	USDI Geol. Survey (1998)[3] n=32	Fertig (2000)[4]
Salsola tragus	Prickly russian thistle	31%		X
Setaria viridis	Green bristlegrass	13%		X
Sisymbrium altissimum	Tall tumblemustard		9%	X
***Sonchus arvensis* ssp. *uliginosus*[9]**	**Marsh sowthistle**			**X**
Tamarix chinensis	Fivestem tamarisk			X
Taraxacum	Dandelion	6%	6%	
Thlaspi arvense	Fanweed		9%	
Tragopogon dubius	Common salsify		38%	
Tribulus terrestris	**PunctureVine**			**X**
Trifolium fragiferum	Strawberry clover			X
Verbascum thapsus	Common mullein	X		
Veronica anagallis-aquatica	Water speedwell			X
49 species		17 spp.	16 spp.	34 spp.

Notes:

1. Scientific names and common names are from the NRCS PLANTS database (USDA NRCS 2000).

2. Percentages in the Olmstead and Perez column are for occurrence in the 16 sampling transects. An X indicates that the authors found the plant at Fort Laramie and in cluded it on their species list but did not encounter it on a sampling transect.

3. Percentages of 44 plots in which species were recorded. The *Pinus ponderosa* woodlands are not mapped on the National Historical Site and so the 5 plots in those types are not included herein. No plots were placed in the Upland Weedy or the *Typha latifolia* Western Herbaceous community types.

4. Fertig (2000) shows just presence.

5. Listed on the state noxious weed list as *Agropyron repens* (syn. *Elytrigia repens* var. *repens*)

6. Olmstead and Perez (1986) list *Euphorbia marginata* as *Agaloma marginata* (Pursh) Love & Love

7. PLANTS database considers *Melilotus albus* to be synonymous with *M. officinalis*.

8. Fertig (2000) lists *Pennisetum glaucum* as *Setaria glauca*.

9. Fertig (2000) lists *Sonchus arvensis* ssp. *uliginosus* as *S. uliginosus*.

Table 2. Distribution & abundance of exotic plants in the USGS-NPS mapping plots
From USDI Geological Survey (1998).

Exotic Species	Summary for Species			# of plots / Average % Cover in Plots of Occurrence in Each Community-type									
	# Community-types (of 10[1])	# of plots (of 32)	% of plots	Bouteloua gracilis - Carex filifolia Herbaceous Vegetation	Bromus inermis Disturbed Herbaceous Vegetation	Carex nebrascensis Herbaceous Vegetation	Pascopyrum smithii Herbaceous Vegetation	Populus deltoides / Symphoricarpos occidentalis Woodland	Riverine Sand Flats - Bars Sparse Vegetation	Salix exigua Shrubland	Sporobolus cryptandrus Disturbed Herbaceous Vegetation	Stipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation	Upland Sand / Gravel Sparse Vegetation
Agropyron cristatum	2	2	6.3%								1 2.5	1 0.5	
Alyssum	2	2	6.3%						1 0.5		1 0.5		
Bromus inermis ssp. *inermis*	7	11	34.4%		1 37.5		1 2.5	3 41.8	1 0.5	1 0.5	3 0.5	1 0.5	
Bromus japonicus	3	7	21.9%				4 4.6				2 1.5	1 0.5	
Bromus tectorum	7	17	53.1%	1 0.5			2 0.5	1 2.5	2 1.5		5 14.1	4 1.5	2 0.5
Camelina microcarpa	2	3	9.4%					1 0.5			2 0.5		
Cirsium arvense	2	5	15.6%					2 1.2		3 1.5			
Elymus repens	1	2	6.3%					2 1.5					
Lactuca serriola	2	2	6.3%								1 0.5	1 0.5	

Table 2 (continued)

Exotic Species	Summary for Species			# of plots / Average % Cover in Plots of Occurrence in Each Community-type									
	# Community-types (of 10[1].)	# of plots (of 32)	% of plots	Bouteloua gracilis - Carex filifolia Herbaceous Vegetation	Bromus inermis Disturbed Herbaceous Vegetation	Carex nebrascensis Herbaceous Vegetation	Pascopyrum smithii Herbaceous Vegetation	Populus deltoides / Symphoricarpos occidentalis Woodland	Riverine Sand Flats - Bars Sparse Vegetation	Salix exigua Shrubland	Sporobolus cryptandrus Disturbed Herbaceous Vegetation	Stipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation	Upland Sand / Gravel Sparse Vegetation
Melilotus officinalis	1	2	6.3%						2 0.5				
Nepeta cataria	1	1	3.1%							1 0.5			
Poa pratensis	4	6	18.8%			1 0.5	1 2.5	3 1.8		1 0.5			
Sisymbrium	2	3	9.4%					1 0.5			2 0.5		
Taraxacum	1	2	6.3%					2 0.5					
Thlaspi arvense	2	2	6.3%				1 0.5	1 2.5					
Tragopogon dubius	5	12	37.5%				1 0.5	1 0.5			5 0.5	4 0.5	1 0.5
Summary for Community Types													
# plots in type				1	1	1	5	3	4	2	5	7	3
# exotic spp in type				1	1	1	6	10	4	4	9	6	2
Ave # exotic spp/plot				1.0	1.0	1.0	2.0	6.0	1.5	2.5	4.4	1.7	1.0
Ave % exotic cover / plot of occurrence				0.5	37.5	0.5	1.9	5.3	0.8	0.8	2.3	0.7	0.5

Table 3. Exotic plants likely to occur, but not confirmed, at Fort Laramie.
From Fertig (2001), Table 2. **Bold-face type** indicates species on Wyoming's noxious weed list.

PLANTS (NRCS 2001)	Fertig (2001)[1]	Common Name (NRCS 2001)	Family	Probability[2]
Alopecurus pratensis L.		Meadow foxtail	Poaceae	Mod
Amaranthus retroflexus L.		Redroot amaranth	Amaranthaceae	High
***Arctium minus* Bernh.**		**Smaller burdock**	**Asteraceae**	**Mod**
Asparagus officinalis L.		Asparagus	Liliaceae	Mod
Bassia hyssopifolia (Pallas) Kuntz		Five-hook bassia	Brassicaceae	Mod
Bromus commutatus Schrad.		Hairy brome	Poaceae	Mod
Bromus squarrosus L.		Corn brome	Poaceae	Mod
***Cardaria chalepensis* (L.) Hand.-Maz.**		**Lens pod whitetop**	**Brassicaceae**	**Mod**
***Carduus acanthoides* L.**		**Plumeless thistle**	**Asteraceae**	**Mod**
Cirsium vulgare (Savi) Ten.		Bull thistle	Asteraceae	High
Conium maculatum L.		Poison hemlock	Apiaceae	High
***Cynoglossum officinale* L.**		**Common houndstongue**	**Boraginaceae**	**High**
Draba nemorosa L.		Woods draba	Brassicaceae	Mod
Eragrostis minor Host[3]		Little lovegrass	Poaceae	Mod
Juncus compressus Jacq.		Roundfruit rush	Juncaceae	Mod
Linum usitatissimum L.		Common flax	Linaceae	Mod
Malva rotundifolia L.		Low mallow	Malvaceae	Mod
Medicago sativa L.		Alfalfa	Fabaceae	High
Pastinaca sativa L.		Parsnip	Apiaceae	Mod
Plantago lanceolata L.		Buckhorn plantain	Plantaginaceae	Mod
Poa palustris L.		Fowl bluegrass	Poaceae	Mod
Polygonum aviculare L.		Prostrate knotweed	Polygonaceae	High
Polygonum convolvulus L.		Climbing knotweed	Polygonaceae	Mod
Populus alba L.		White poplar	Salicaceae	Mod
Rorippa nasturtium-aquaticum (L.) Hayek		Watercress	Brassicaceae	Mod
Salix fragilis L.		Crack willow	Salicaceae	Mod
Solanum dulcamara L.		Bitter nightshade	Solanaceae	Mod
Taraxacum laevigatum (Willd.) DC.		Rock dandelion	Asteraceae	High
Thinopyrum ponticum (Podp.) Z.-W. Liu & R.-C. Wang	*Elymus elongatus* var. *ponticus*	Rush wheatgrass	Poaceae	Mod
Trifolium pratense L.		Red clover	Fabaceae	Mod
Verbascum thapsus L.		Common mullein	Scrophulariaceae	High
NOTES:				
1. Name from Fertig (2001) if different from than in USDA NRCS (2001)				
2. Probability of occurrence at Ft. Laramie				
3. Species not listed in USDA NRCS (2001) so this name is from Kartesz (1999)				

Table 4. Seed Mixture Recommended by Olmstead and Perez (1986).

Scientific names from USDA NRCS (2001) are given first, followed by the synonym from Olmstead and Perez (1986), if any. Common names are from USDA NRCS (2001).

Scientific Name	Common Name	% of Seeds
Bouteloua gracilis	Blue grama	34
Hesperostipa comata (*Stipa comata*)	Needle-and-thread	34
Buchloe dactyloides	Buffalograss	10
Artemisia filifolia	Sand sagebrush	5
Opuntia polyacantha	Plains pricklypear	5
Bouteloua hirsuta	Hairy grama	3
Artemisia frigida	Fringed sagewort	3
Aristida purpurea var. *longiseta* (*Aristida longiseta*)	Fendler threeawn	3
Pascopyrum smithii (*Agropyron smithii*)	Western wheatgrass	2
Sphaeralcea coccinea	Scarlet globemallow	3

Table 5. Seed Mixture Recommended by Redente (1992).

Scientific names from USDA NRCS (2001) are given first, followed by the synonym from Redente (1992), if any. Common names are from USDA NRCS (2001).

Scientific Name	Common Name	Lbs. live seed/acre
Pascopyrum smithii (*Agropyron smithii*)	Western wheatgrass, Arriba	5
Hesperostipa comata (*Stipa comata*)	Needle-and-thread	2
Bouteloua gracilis	Blue grama	2
Buchloe dactyloides	Buffalograss	3
Sphaeralcea coccinea	Scarlet globemallow	3
Dalea purpurea var. *purpurea* (*Petalostemum purpureum*)	Purple prairie clover, Kaneb	2
Artemisia frigida	Fringed sagewort	1
Agropyron x *Triticeum*[1]	Regreen	8

1. Redente (1992) recommended that this hybrid be added to the seed mix to provide a cover crop in the an area he termed "Farm House Area".

Table 6. Correspondence between vegetation community-types and wetlands at Fort Laramie National Historic Site.

Community-Type Name [1]	**Wetland Class** [2]
Carex nebrascensis Herbaceous Vegetation	Palustrine emergent
Spartina pectinata - Scirpus pungens Herbaceous Vegetation	Palustrine emergent
Typha latifolia Western Herbaceous Vegetation	Palustrine emergent
Salix exigua Shrubland	Palustrine scrub-shrub
Populus deltoides / Symphoricarpos occidentalis Woodland	Palustrine forested
Riverine Sand Flats - Bars Sparse Vegetation [3]	Palustrine unconsolidated shore

Notes.

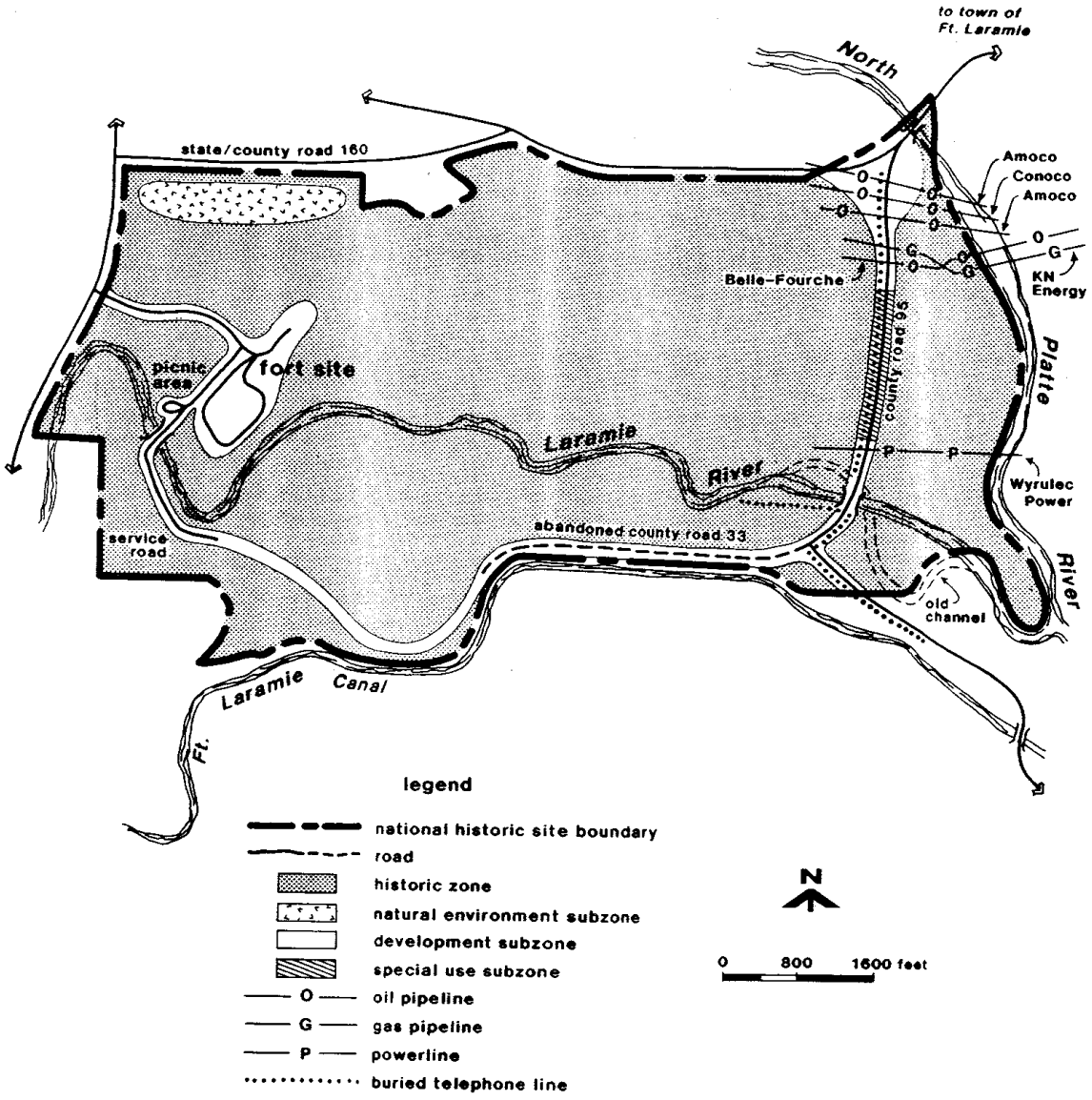
1. Community-type names are from the USGS mapping project (USDI Geological Survey 1998).
2. Wetland classes are from the U.S. Fish and Wildlife Service classification (Cowardin *et al.* 1979).
3. The USGS report describes the *Populus deltoides* woodland as an upland type, but the area supporting this woodland (as shown on the USGS map) has been mapped by the National Wetland Inventory as Palustrine forested wetland.

Table 7. Legend to Soils Map of Fort Laramie National Historic Site (Figure 6.)

Symbol	Map Unit	Range Site
Ak	Alkali and Saline Land	--
BfA	Bankard loamy fine sand, 0-3% slopes	Sandy Lowland
BoA	Bayard and Otero fine sandy loams, 0-3% slopes	Sandy
DcD	Dix complex, 0-10% slopes	Gravelly
DcE	Dix complex, 10-40% slopes	Gravelly, Choppy Sands
DwA	Dwyer loamy fine sand, 0-3% slopes	Sandy
DwC	Dwyer loamy fine sand, 3-10% slopes	Sandy
GbA	Glenberg fine sandy loam, 0-3% slopes	Sandy Lowland
HaA	Haverson loam, gravel substratum variant, 0-3% slopes	Loamy Lowland
HgA	Haverson loam, gravelly substratum variant, 0-3% slopes	Loamy Lowland
HnA	Haverson and McCook loams, 0-3% slopes	Loamy Lowland
MeA	Manter and Anselmo fine sandy loams, 0-3% slopes	Sandy
Mu	Mixed alluvial land	--

VI. FIGURES

Figure 1. Management zones at Fort Laramie National Historic Site.
From the 1991 Statement for Management (USDI National Park Service 1991, page 20).



Existing Management Zoning
Fort Laramie National Historic Site
U.S. Dept. of the Interior – National Park Service

20

375 | 80,025-B
Aug 91 | RMRO

Figure 2. Community-types at Fort Laramie National Historic Site.
From the USGS - NPS Mapping Project (USDI Geological Survey 1998). These types are described in Appendix 1.

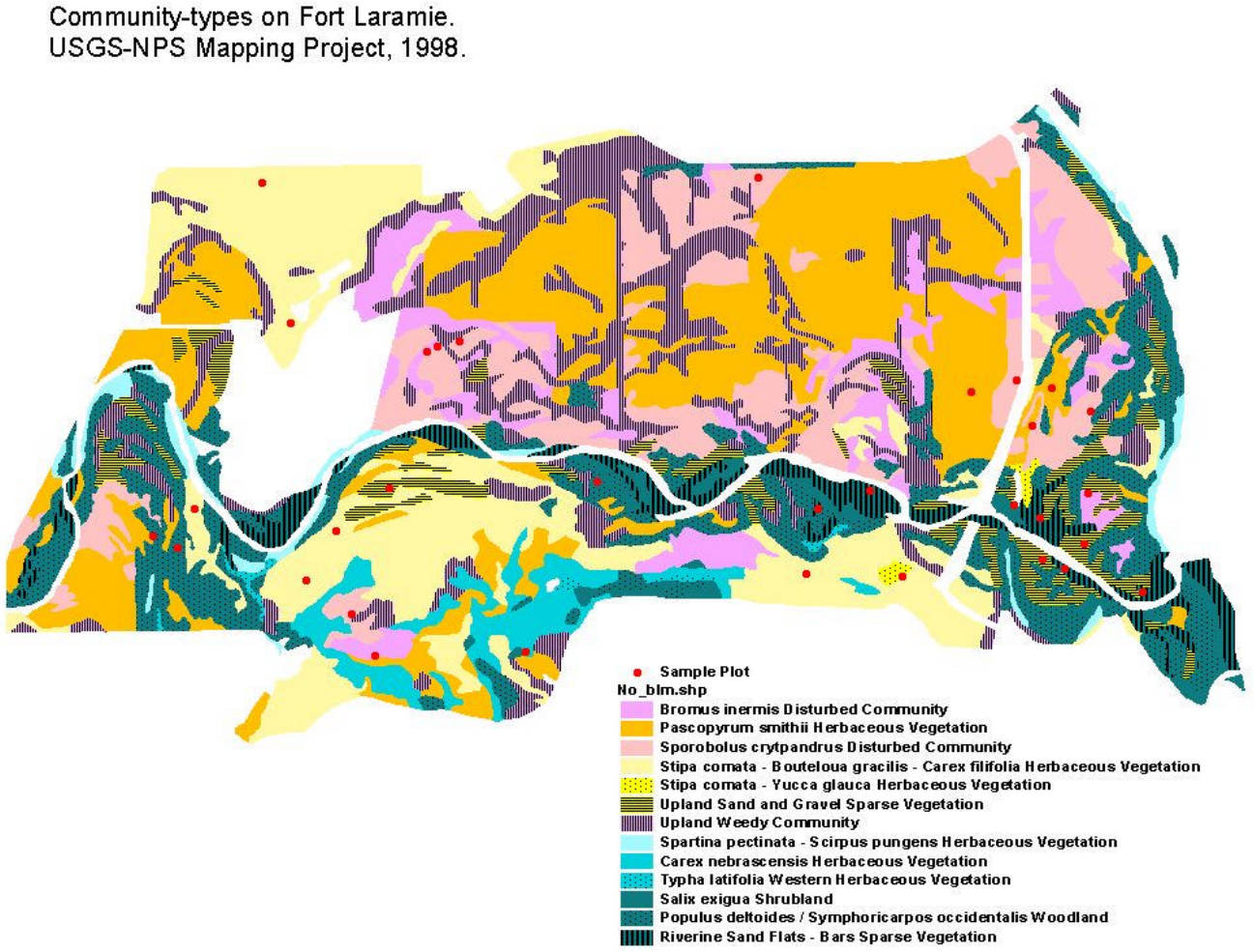


Figure 3. Olmstead's and Perez's (1986) Disturbance Units on Fort Laramie National Historic Site.
(Compare to their Management Units in Figure 7.)

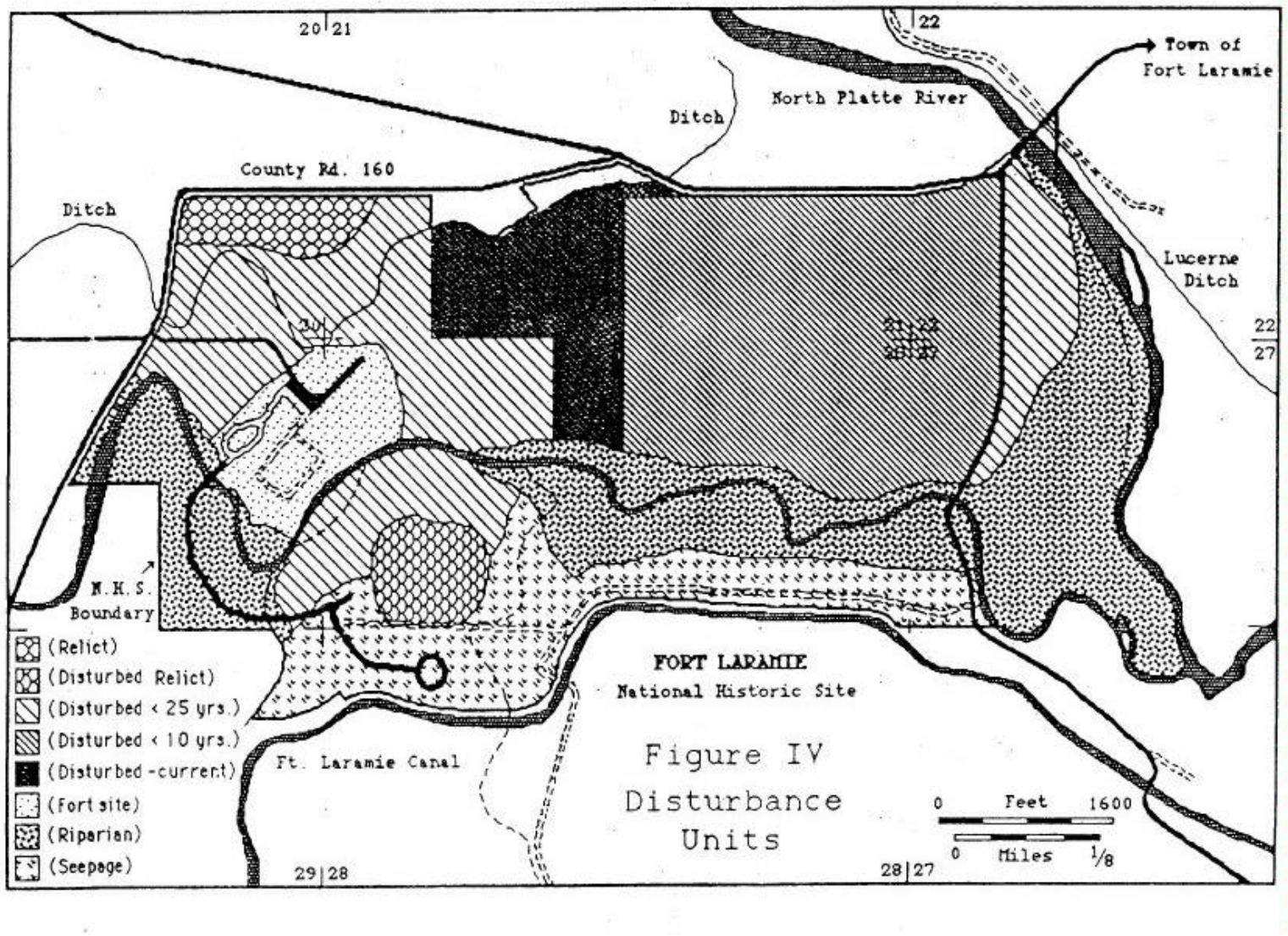
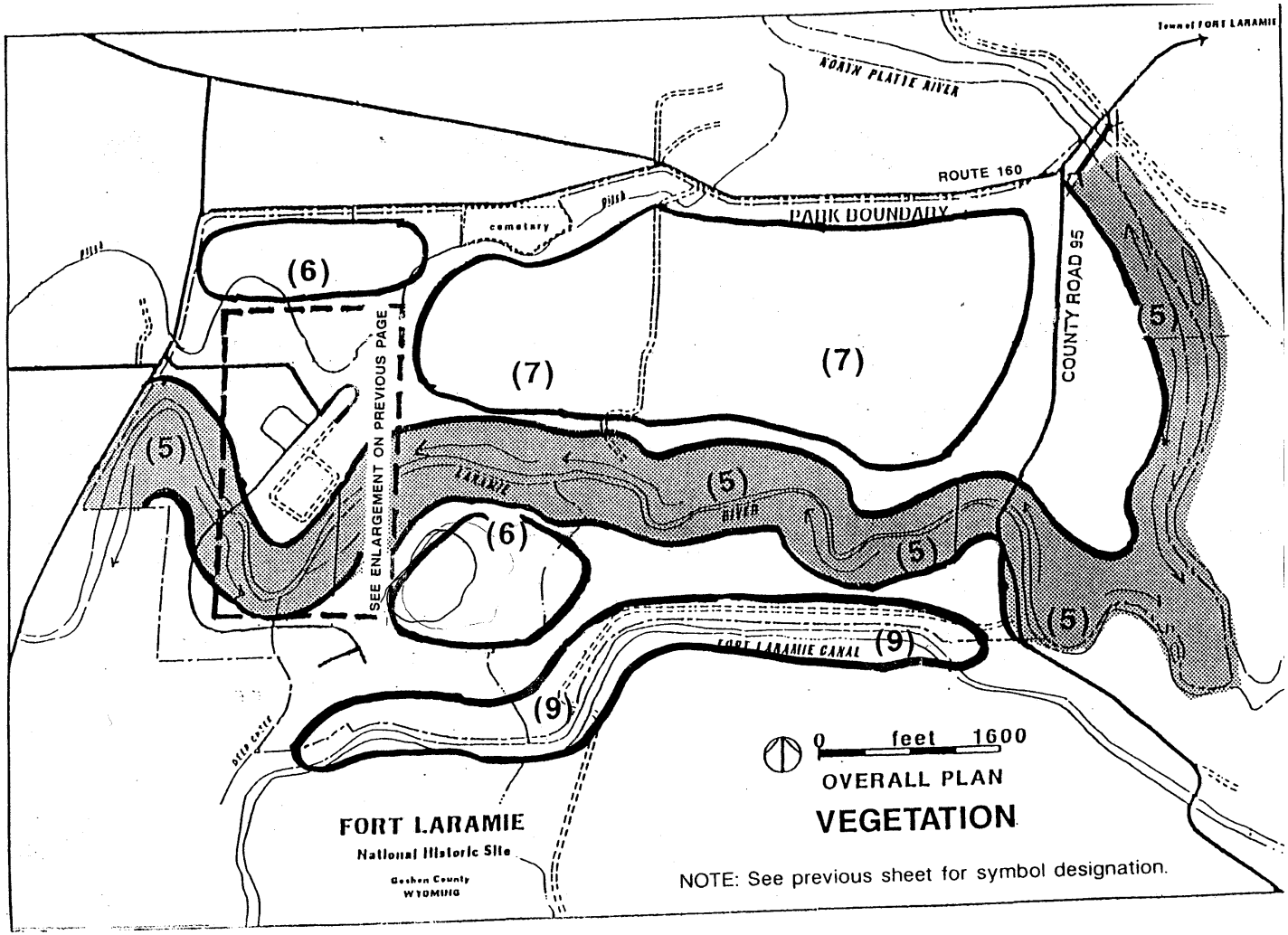


Figure 4. Existing Conditions (Vegetation) on Fort Laramie National Historic Site.
From Cultural Landscape Report (USDI National Park Service, no date [a]), page 57.



5 = Riparian Vegetation, 6 = Native Perennial Grass, 7 = Annual / Perennial Grass - Disturbed Land, 9 = Wetland Vegetation

Figure 5. Locations of Olmstead's and Perez's Vegetation Sampling Transects.
From Olmstead and Perez (1986), page 8.

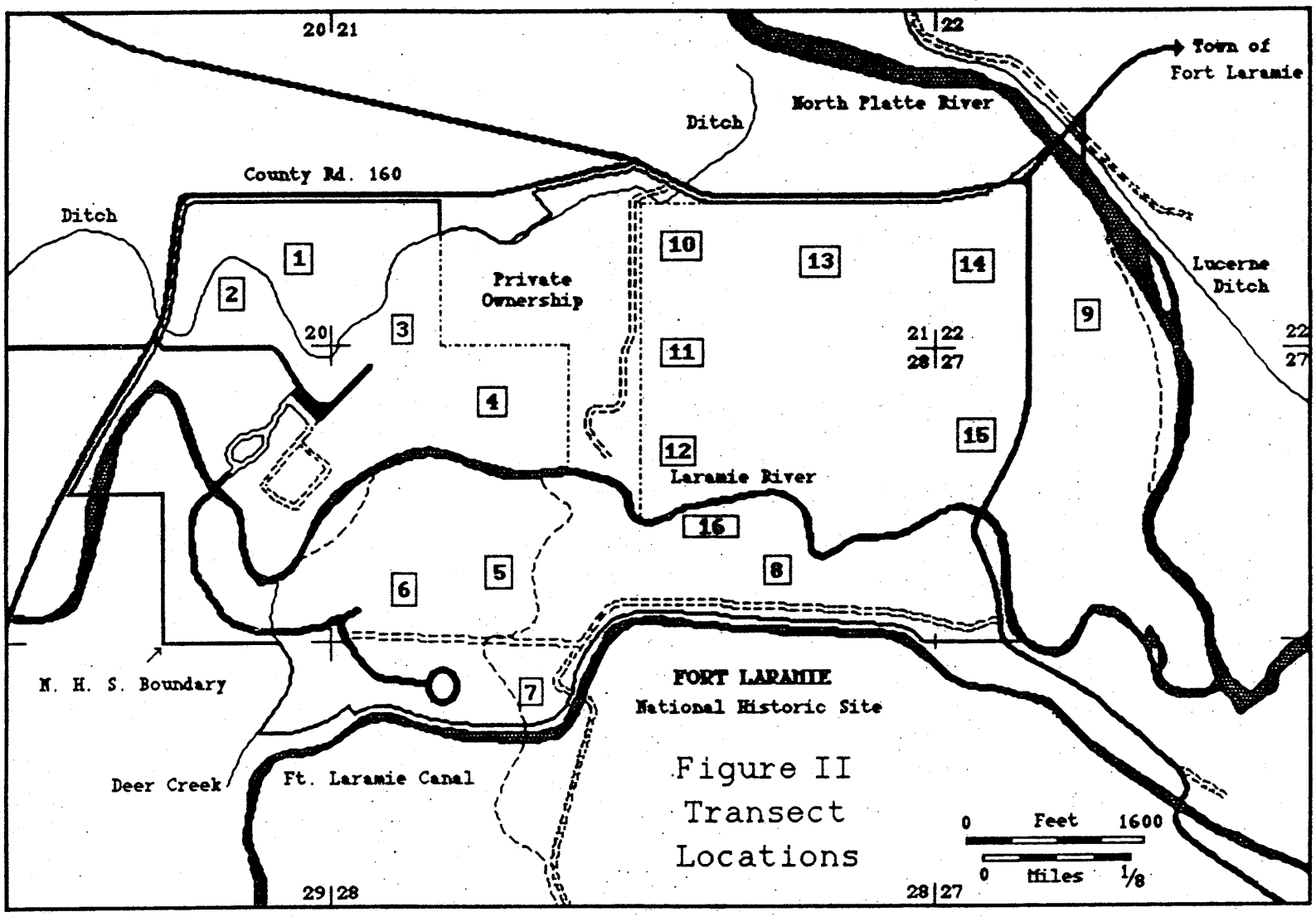


Figure 6. Soils map of Fort Laramie National Historic Site.
From Stephens *et al.* (1971). See Table 7 for legend.

Figure 7. Olmstead's and Perez's (1986) management units on Fort Laramie National Historic Site. (Compare to their Disturbance Units in Figure 3.)

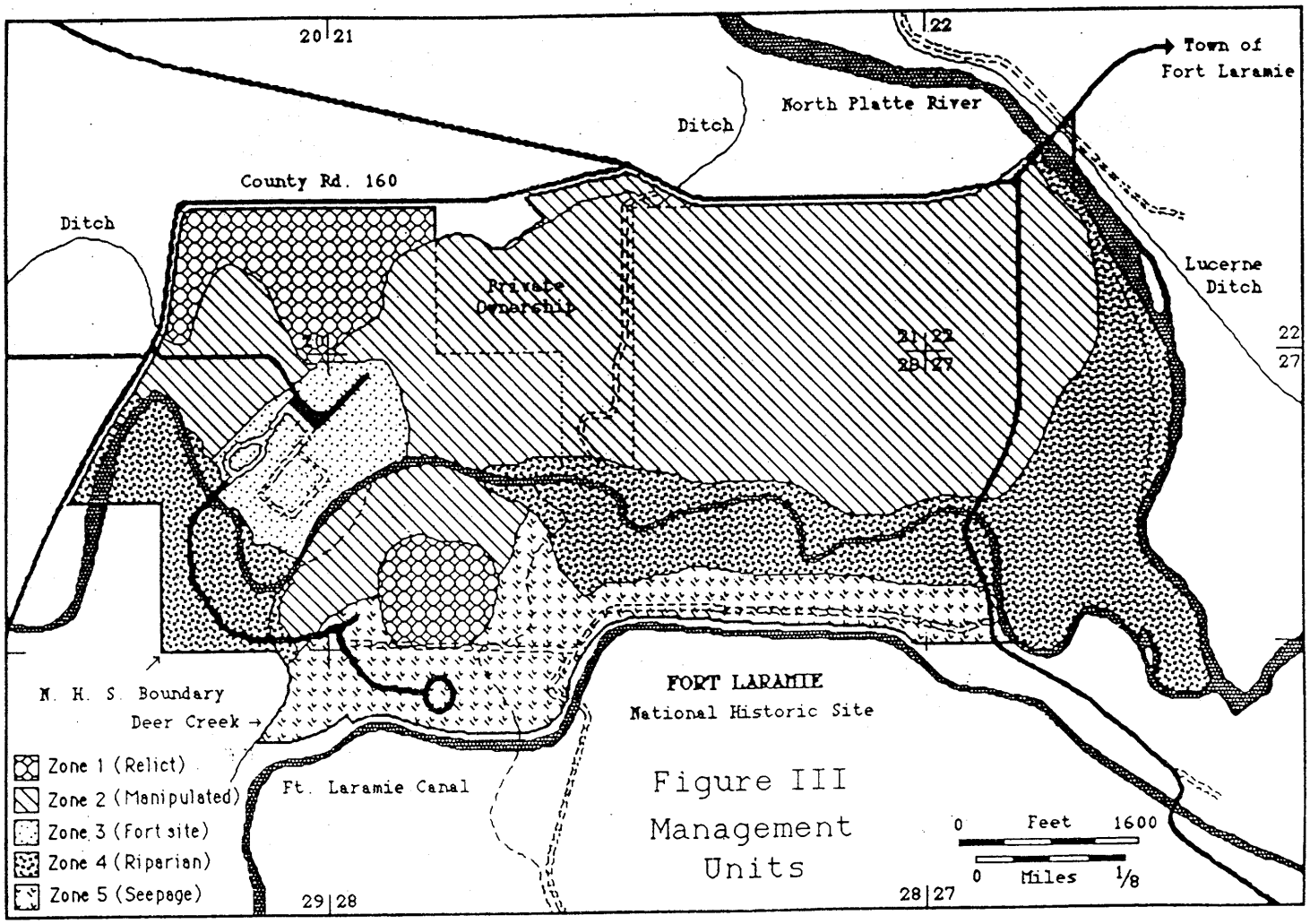


Figure 8. Treatment Plan for Fort Laramie National Historic Site.
From Cultural Landscape Report (USDI National Park Service, no date [a]), page 99.

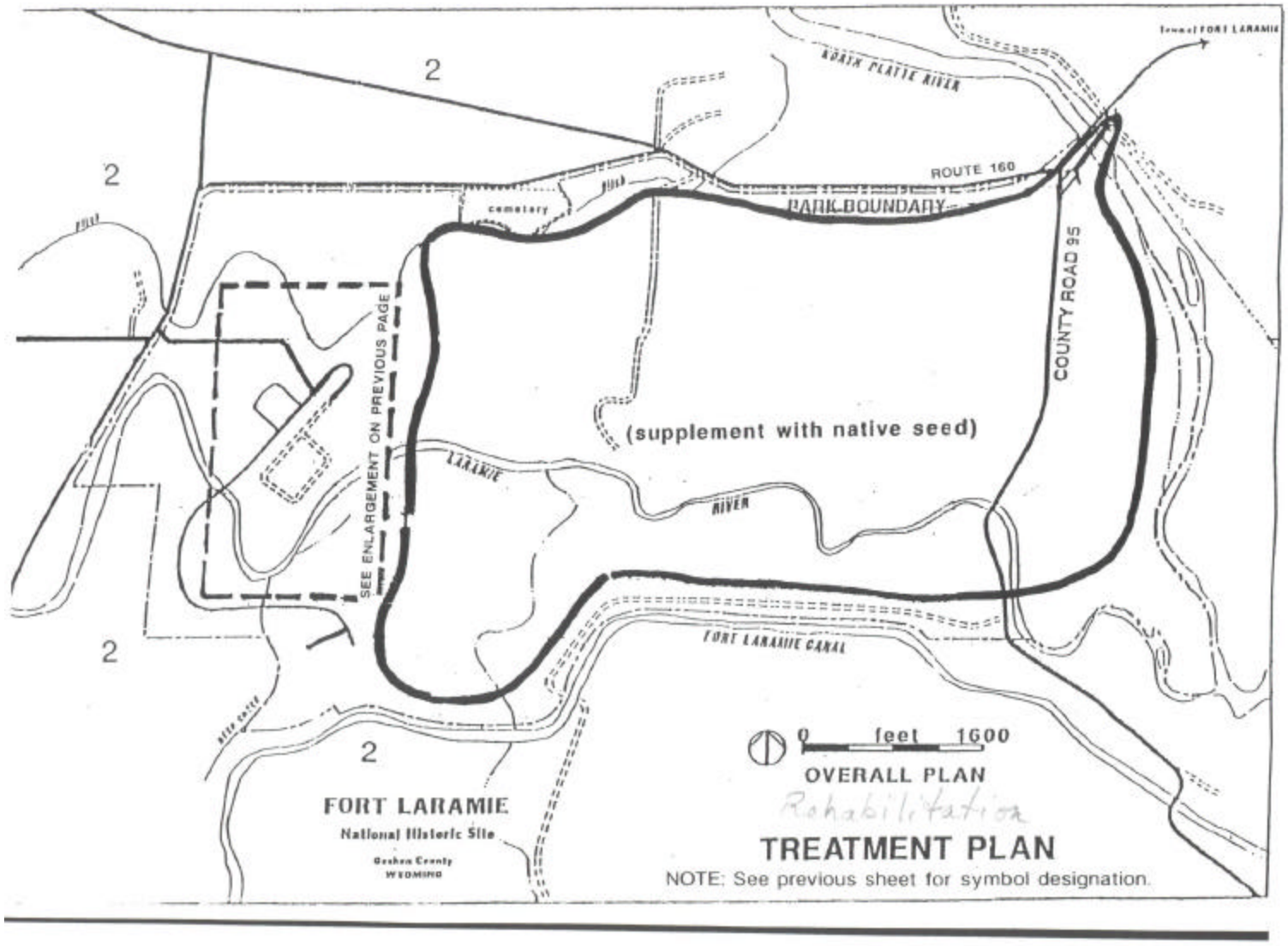


Figure 9. National Wetland Inventory map of wetlands on Fort Laramie NHS.

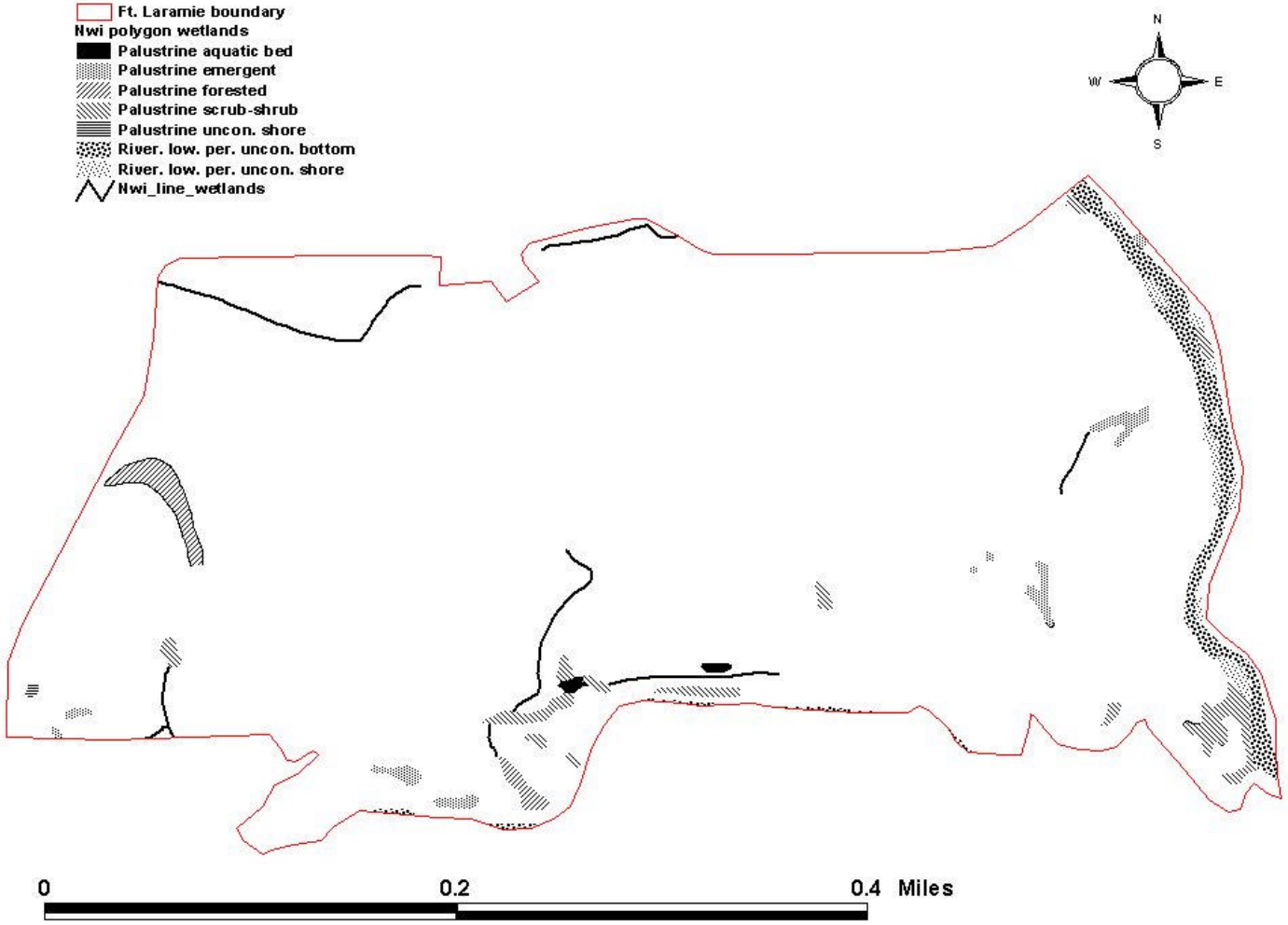
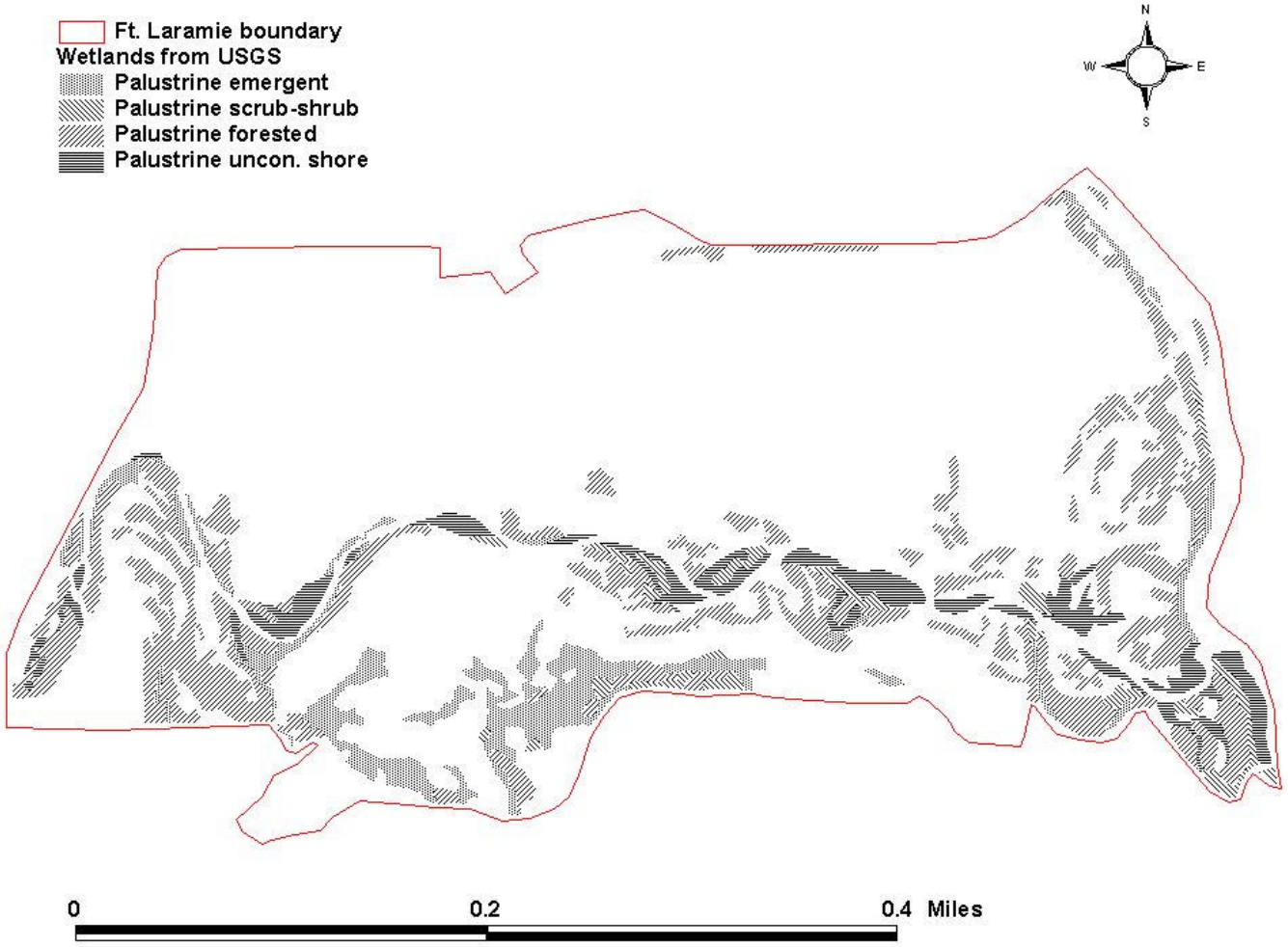


Figure 10. NWI wetland types as mapped by the USGS - NPS Mapping project on Fort Laramie NHS. See Table 6 for the relationship between NWI wetland classes and USGS - NPS community types.



APPENDIX 1. DESCRIPTIONS OF THE USGS - NPS MAPPING PROJECT'S COMMUNITY-TYPES ON FORT LARAMIE NATIONAL HISTORIC SITE.

The following descriptions, taken directly from the internet site of the mapping project (USDI Geological Survey 1998), are for those community-types mapped from the National Historic Site proper. The mapping project also described several additional community-types from the parcels of public lands in the area managed by the National Park Service, but they are not included here because this vegetation management plan does not cover those parcels.

Populus deltoides / Symphoricarpos occidentalis Woodland

COMMON NAME Eastern Cottonwood / Western Snowberry Woodland

SYNONYM Cottonwood / Wolfberry - Western Rose Floodplain Woodland

PHYSIOGNOMIC CLASS Woodland (II)

PHYSIOGNOMIC SUBCLASS Deciduous woodland (II.B)

PHYSIOGNOMIC GROUP Cold-deciduous woodland (II.B.2)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (II.B.2.N)

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

ALLIANCE *Populus deltoides* Temporarily Flooded Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Upland

RANGE
Globally This community is found in western North Dakota, western South Dakota, and Wyoming.

Fort Laramie National Historic Site This community occurs on the lower floodplain along the Platte and Laramie Rivers, with small isolated stands on the upper floodplain, along the highway north of the park, and north of the canal on the south edge of the park.

ENVIRONMENTAL DESCRIPTION
Globally This community is on medium to coarse textured alluvial soils on the floodplains of major rivers. The floodplains are both seasonally inundated and subirrigated (Thilenius *et al*. 1995). The meandering erosional and depositional pattern of rivers maintains and influences this community along rivers (Hanson 1990). It is rarely found at higher elevations in the mountains of eastern Wyoming and western South Dakota (Johnston 1987).

Fort Laramie National Historic Site This community occurs on the lower floodplain adjacent to rivers, and occasionally on the upper floodplain as isolated stands. It occurs on level ground on alluvial soils.

MOST ABUNDANT SPECIES

Globally

Statum	Species
Tree canopy	*Populus deltoides, Acer negundo, Fraxinus pennsylvanica*
Shrub	*Symphoricarpos occidentalis*
Herbaceous	*Elymus trachycaulus, Pascopyrum smithii*

Fort Laramie National Historic Site

Statum	Species
Tree canopy	*Populus deltoides, Salix amygdaloides*
Subcanopy	*Fraxinus pennsylvanica, Populus deltoides, Acer negundo*
Short shrub	*Symphoricarpos occidentalis*

DIAGNOSTIC SPECIES

Globally

Populus deltoides, Acer negundo, Fraxinus pennsylvanica, Symphoricarpos occidentalis, Pascopyrum smithii

Fort Laramie National Historic Site

Populus deltoides, Salix amygdaloides

VEGETATION DESCRIPTION

Globally This community is typically dominated by a single deciduous tree species, *Populus deltoides*. In some stands other species, such as *Acer negundo* and *Fraxinus pennsylvanica*, may contribute to the canopy. The tallest trees exceed 15 meters. *Populus deltoides* is a pioneer species that requires moist, sparsely vegetated alluvium to become established from seed, therefore stands of this community are seral. The shrub layer is typically 0.5-1 m tall. It is dominated by *Symphoricarpos occidentalis* and commonly includes *Juniperus scopulorum* and *Rosa* spp. In Wyoming, *Chrysothamnus nauseosus* is present and increases with heavy grazing (Thilenius *et al*. 1995). The herbaceous layer usually includes *Pascopyrum smithii* and *Elymus trachycaulus.* Weedy species such as *Cirsium arvense, Melilotus officinalis, Taraxacum officinale*, and *Poa secunda* are very common, especially in the presence of grazing (Jones and Walford 1995, Thilenius *et al*. 1995). *Maianthemum stellatum* is abundant only where grazing is absent.

Fort Laramie National Historic Site This community typically is dominated by *Populus deltoides* with trees to 20 m or more in height. Large individuals of *Salix amygdaloides* occasionally occur and *Populus angustifolia* and *P. x acuminata* occasionally occur in this community. Canopy coverage can be sparse (5%) or as much as 50%. The subcanopy often contributes substantial cover. In some cases, it is difficult to split canopy from subcanopy due to a continuous range in tree height. *Fraxinus pennsylvanica, Populus deltoides,* and *Acer negundo* are the most common subcanopy species. *Symphoricarpos occidentalis* dominates the shrub stratum in some areas, but is often absent or poorly developed. A few small stands of *Prunus virginiana* occur in this community on the east side of the Laramie River west of the Fort Site. Herbaceous stratum composition is quite variable. Most species found in the understory of this community are also typical of *Spartina*

pectinata, *Bromus inermis*, or *Pascopyrum smithii* Herbaceous Vegetation, or Upland Sand and Gravel Sparse Vegetation.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G2G3

RANK JUSTIFICATION

DATABASE CODE CEGL000660

COMMENTS
Globally In eastern Montana, Hanson *et al*. (1990) describe a *Populus deltoides/Symphoricarpos occidentalis* type as a grazing-induced stage of the *Populus deltoides/Cornus sericea* type. This contrasts with information from Wyoming, where Thilenius *et al*. (1995) found *that Symphoricarpos occidentalis* decreases with grazing and *Chrysothamnus nauseosus* increases.

Fort Laramie National Historic Site *Symphoricarpos occidentalis* is often absent or poorly developed in this community. Stands of *S. occidentalis* without tree cover are treated as extensions of the nearby stands of *Populus deltoides*. In some stands, *P. deltoides* is absent, and *Salix amygdaloides* dominates the canopy.

REFERENCES
Hansen, P., K. Boggs, R. Pfister, and J. Joy. 1990. Classification and management of riparian and wetland sites in central and eastern Montana. Draft version 2. Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula.

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Salix exigua Shrubland [Provisional]

COMMON NAME Narrow-Leaf Willow Shrubland [Provisional]

SYNONYM Sandbar Willow Shrubland

PHYSIOGNOMIC CLASS Shrubland (III)

PHYSIOGNOMIC SUBCLASS Deciduous shrubland (III.B)

PHYSIOGNOMIC GROUP Cold-deciduous shrubland (III.B.2)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (III.B.2.N)

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

ALLIANCE *Salix exigua* Temporarily Flooded Shrubland Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Palustrine

RANGE

Globally This community is found along rivers and streams in Oregon, Washington, Idaho, Montana, southern Manitoba, Wyoming, Colorado, Oklahoma, Nebraska, South Dakota. It probably extends into North Dakota.

Fort Laramie National Historic Site This community occurs along the Laramie and Platte Rivers and in seepage areas north of the canal.

ENVIRONMENTAL DESCRIPTION

Globally This community is found near lakes and streams on recently deposited or disturbed alluvial material. The parent material is alluvial sand, although silt, clay, or gravel may be present. Soil development is poor to absent (Steinauer 1989).

Fort Laramie National Historic Site This community occurs on level sites on alluvial soils along the Laramie and Platte Rivers and in seepage areas north of the canal.

MOST ABUNDANT SPECIES
Globally

Statum	Species
Shrub	*Salix exigua*
Herbaceous	*Carex pellita, Scirpus americanus*

Fort Laramie National Historic Site

Statum	Species
Shrub	*Salix exigua, Populus deltoides*

DIAGNOSTIC SPECIES
Globally
Salix exigua

Fort Laramie National Historic Site
Salix exigua, young *Populus deltoides* (less than 3 m tall)

VEGETATION DESCRIPTION
Globally The dominant vegetation in this community is short shrubs, usually not more than 4 meters tall. The most common of these is *Salix exigua*. *Salix irrorata* and saplings of *Populus deltoides* or *S. amygdaloides* are also frequently found in the shrub layer. This stratum can have moderate to high stem density in the community as a whole. The species in the shrub layer do not form a closed canopy, allowing significant light to reach the groundlayer. There are often patches where the shrub layer is absent. The herbaceous cover is sparse to moderate. Older stands and places with less competition from the shrubs have greater herbaceous cover. The composition of the herbaceous layer can vary greatly. Species that are often found in this community are *Cenchrus longispinus, Polygonatum lapathifolium, Scirpus americanus, Triglochin maritimum*, and *Xanthium strumarium*.

Fort Laramie National Historic Site This community is dominated by *Salix exigua* and/or young *Populus deltoides* (less than 3 m tall). Both species dominate the tall and short shrub strata, and combined cover is usually greater than 50%, sometimes approaching 100%. Herbaceous cover is sparse and quite variable in composition.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G5Q

RANK JUSTIFICATION

DATABASE CODE CEGL001197

COMMENTS
Globally This community is a primary or early secondary community and requires floods to create new areas on which it can develop. Once established, this community may not exist for

more than 10-20 years before it is replaced by a later seral stage (Wilson 1970, Bellah and Hulbert 1979).

Fort Laramie National Historic Site Some stands mapped as this type have very little *Salix exigua* and are dominated by young *Populus deltoides*. Succession to and from this community can be relatively rapid (several years), depending on flood events and rate of growth of the young cottonwoods.

REFERENCES

Bellah, R. G. and L. C. Hulbert. 1974. Forest succession on the Republican River floodplain in Clay County, Kansas. The Southwestern Naturalist 19(2):155-166.

Steinauer, G. 1989. Characterization of the natural communities of Nebraska. Pp. 103-141, *in* M. Clausen, M. Fritz, and G. Steinauer. The Nebraska Natural Heritage Program, Two Year Progress Report, Appendix D. Lincoln, NE.

Wilson, R. E. 1970. Succession in stands of *Populus deltoides* along the Missouri River in southeastern South Dakota. American Midland Naturalist 83(2):330-342.

Pascopyrum smithii Herbaceous Vegetation [Provisional]

COMMON NAME Western Wheatgrass Herbaceous Vegetation [Provisional]

SYNONYM Western Wheatgrass Mixedgrass Prairie

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)

PHYSIOGNOMIC GROUP Temperate or subpolar grassland (V.A.5)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (V.A.5.N)

FORMATION Medium-tall sod temperate or subpolar grassland (includes sod or mixed sod-bunch graminoids) (V.A.5.N.c.)

ALLIANCE *Pascopyrum smithii* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE

Globally This community is found in Montana, Wyoming, Colorado, Idaho, Utah, Nebraska, Saskatchewan, and possibly North Dakota.

Fort Laramie National Historic Site This community occurs on the floodplain. This type includes the seeded stands east of the Fort Site.

ENVIRONMENTAL DESCRIPTION

Globally This community occurs on flat to gently sloping topography. Soils are clay, clay loam, and silt loam. It is sometimes found on alluvial fans of small streams. The soils are deep (40-100 cm) and well developed (Godfread 1994).

Fort Laramie National Historic Site This community occurs on level sites on alluvial soils of the floodplain. Many of the sites were disturbed in the recent past (less than 40 years). This community is occasional in drainage bottoms on Bureau of Land Management land south of the NHS.

MOST ABUNDANT SPECIES
Globally

Statum	Species
Herbaceous	*Pascopyrum smithii*

Fort Laramie National Historic Site

Statum	Species
Herbaceous	*Pascopyrum smithii, Bouteloua gracilis, Sporobolus cryptandrus, Calamovilfa longifolia*

DIAGNOSTIC SPECIES
Globally
Pascopyrum smithii

Fort Laramie National Historic Site
Pascopyrum smithii (as dominant or codominant)

VEGETATION DESCRIPTION
Globally This is a midgrass community. Shrubs are rare. The dominant species grow to approximately 1 meter. *Pascopyrum smithii* is the only constant dominant species and may have 50% cover. Other species such as *Koeleria macrantha* and *Poa* spp. may be locally abundant. Many other species common in midgrass prairies are also found in this community. These include *Artemisia ludoviciana, Bouteloua gracilis, Nassella viridula,* and *Stipa comata* (Aldous 1924).

Fort Laramie National Historic Site This community is dominated by *Pascopyrum smithii*. In some areas, few other species occur. The codominant grass species for this community vary. *Bouteloua gracilis* is probably the most common. Other locally dominant species include *Poa pratensis, Distichlis spicata* (in seepage areas north of the canal), and *Sporobolus airoides,* as well as those mentioned above. *Bromus tectorum* can be locally abundant. Herbaceous cover typically is in the 25-50% range, and occasionally greater. Height is generally less than 0.5 m. This type includes seeded stands east of the Fort Site, which are composed of *P. smithii* with and without *Bouteloua gracilis*.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G3G5Q

RANK JUSTIFICATION

DATABASE CODE CEGL001577

COMMENTS
Globally This community is similar to several others that are dominated or co-dominated by *Pascopyrum smithii.* Further work needs to be done to refine the differences in composition and environmental characteristics.

Fort Laramie National Historic Site *P. smithii* also occurs as a minor component in other grassland types.

REFERENCES

Aldous, A. E. 1924. Types of vegetation in the semiarid portion of the United States and their economic significance. Journal of Agricultural Research 28(2):99-123.

Godfread, C. 1994. The vegetation of the Little Missouri Badlands of North Dakota. Pp. 17-24 *In* C. H. Schmidt (ed.) Proceedings of the Leafy Spurge Strategic Planning Workshop, Dickinson, ND.

Stipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation

COMMON NAME Needle-and-thread Grass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation

SYNONYM Needle-and-thread - Blue Grama Mixedgrass Prairie

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)

PHYSIOGNOMIC GROUP Temperate or subpolar grassland (V.A.5)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (V.A.5.N)

FORMATION Medium-tall sod temperate or subpolar grassland (includes sod or mixed sod-bunch graminoids) (V.A.5.N.c.)

ALLIANCE *Stipa comata - Bouteloua gracilis* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally This community is common in Montana, Wyoming, and is in Nebraska, North Dakota, South Dakota, southern Saskatchewan, and southern Manitoba.

Fort Laramie National Historic Site This community is most common on upland sites, especially on Bureau of Land Management lands south and northwest of the NHS. It also occurs in the northwest part of the NHS, and on the upper floodplain in the southwest part.

ENVIRONMENTAL DESCRIPTION

Globally This community is found on flat to gently sloping sites, predominantly with sandy loam or loam soil. The soil is typically 40-100 cm deep (Hanson and Whitman 1938, Hansen *et al*. 1984)..

Fort Laramie National Historic Site This community occurs on sandy soils on level and rolling sites, and on slopes to 15 degrees. There is no apparent correlation with aspect.

MOST ABUNDANT SPECIES
Globally

Statum	Species
Herbaceous	*Stipa comata, Bouteloua gracilis, Carex filifolia*

Fort Laramie National Historic Site

Statum	Species
Herbaceous	*Stipa comata, Bouteloua gracilis, Carex filifolia*

DIAGNOSTIC SPECIES
Globally
Stipa comata, Bouteloua gracilis, Carex filifolia

Fort Laramie National Historic Site
Stipa comata, Bouteloua gracilis

VEGETATION DESCRIPTION
Globally This midgrass prairie community is dominated by graminoids that are usually between 0.5 and 1 m tall. The vegetation cover is moderate. The dominant species are *Bouteloua gracilis, Carex filifolia,* and *Stipa comata. S. comata* usually has the most coverage of any single species. *Pascopyrum smithii* is constant in this community and can be locally abundant. *Carex duriuscula* is not always present but is also abundant at some sites. Forbs that are typical of this community are *Heterotheca villosa* var. *villosa, Guara coccinea, Liatris punctata,* and *Phlox hoodii*. Sandier areas often have *Calamovilfa longifolia* present. Shrubs rarely grow taller than the grasses, but *Artemisia frigida* is very common in this community. Other grasses that are likely to be present are *Aristida purpurea* var. *longiseta, Koeleria macrantha,* and *Sporobolus cryptandrus*. On 19 stands in west-central Montana the cover by the different strata was as follows: shrubs - 6%, graminoids - 67%, forbs - 11%, bryophytes - 14%, litter - 55%, rock 4%, bare soil - 9% (Mueggler and Stewart 1978). Thilenius *et al*. (1995) found that the average cover on 14 stands in eastern Wyoming was 42%. Tolstead (1942) described this community as the climax on the level lands of the northern part of Cherry County, Nebraska.

Fort Laramie National Historic Site This community typically is dominated by *Stipa comata* and *Bouteloua gracilis*. The latter is the more dominant species in some areas, as can be *Carex filifolia*. Low shrubs are often present but sparse, the most frequent being *Artemisia filifolia* and *A. frigida*. *Tradescantia occidentalis* and *Opuntia fragilis* frequently occur in this community. The latter is occasionally abundant. *Andropogon hallii* occurs occasionally in small patches. Small patches of *Calamovilfa longifolia* are common. At two sites, very small stands of *Schizachyrium scoparium* were observed on steeper slopes within this type. In some areas, such as old disturbed areas on Bureau of Land Management land northwest of the park (pipeline), large stands of *Calamovilfa longifolia* are present. Herbaceous cover typically ranges from 40 to 75%, with heights typically between 0.5 and 1 m.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G3G4

RANK JUSTIFICATION

DATABASE CODE CEGL002037

COMMENTS
Fort Laramie National Historic Site This community is very similar to the *Stipa comata - Yucca glauca* Herbaceous Vegetation type in composition. However, shrub cover is less than 10% or may be absent. At some sites, especially on the BLM land south of the NHS, *Bouteloua gracilis* is dominant, and *Stipa comata* is rare or absent, probably due to grazing (*S. comata* is known to be a decreaser and *B. gracilis* an increaser in these situations; USDA Forest Service 1937). *Carex filifolia*, also an increaser (Jones 1992), contributes substantial cover in some areas.

REFERENCES
Hansen, P. L., G. R. Hoffman, and A. J. Bjugstad. 1984. The vegetation of Theodore Roosevelt National Park, North Dakota: A habitat type classification. General Technical Report RM-113. USDA Forest Service, Rocky Mountains Forest and Range Experiment Station, Fort Collins, CO. 35 p.

Hanson, H. C. and W. Whitman. 1938. Characteristics of major grassland types in western North Dakota. Ecological Monographs 8(1):58-114.

Jones, G. 1992. Wyoming plant community classification. Wyoming Natural Diversity Database, The Nature Conservancy, Laramie, WY. 184 pp.

Mueggler, W. F. and W. L. Stewart. 1978. Grassland and shrubland habitat types of western Montana. USDA Forest Service General Technical Report INT-66. Intermountain Forest and Range Experiment Station, Ogden, UT. 154 pp.

Thilenius, J. F., G. R. Brown, and A. L. Medina. 1995. Vegetation on semi-arid rangelands, Cheyenne River basin, Wyoming. General Technical Report RM-263. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 60 p.

Tolstead, W. L. 1942. Vegetation of the northern part of Cherry County, Nebraska. Ecological Monographs 12(3):256-292.

USDA Forest Service. 1937. Range plant handbook.

Stipa comata - Yucca glauca Herbaceous Vegetation

COMMON NAME Needle-and-thread - Soapweed Yucca Herbaceous Vegetation

SYNONYM Needle-and-thread - Soapweed Mixedgrass Prairie

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)

PHYSIOGNOMIC GROUP Temperate or subpolar grassland (V.A.5)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (V.A.5.N)

FORMATION Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d.)

ALLIANCE *Stipa comata* Bunch Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally This community is found only in Wyoming.

Fort Laramie National Historic Site This community is most common on upland sites on Bureau of Land Management lands northwest and south of the NHS. *Artemisia filifolia* does occur in *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation within the NHS but, at these sites, shrub cover usually is less than 10%.

ENVIRONMENTAL DESCRIPTION

Globally Stands of the narrower *Stipa comata - Yucca glauca* Herbaceous Vegetation are found only along ridge tops and a short distance down the adjacent slopes (Thilenius *et al*. 1995). The broader *Yucca glauca* / *Calamovilfa longifolia* Shrub Herbaceous Vegetation, into which it is suggested *Stipa comata - Yucca glauca* Herbaceous Vegetation be placed, apparently occurs on a broader range of ridge tops and upper slopes.

Fort Laramie National Historic Site This community occurs on sandy soils on rolling terrain and on slopes to 18 degrees. There is no apparent correlation with aspect.

MOST ABUNDANT SPECIES

Globally

Statum	Species
Shrub	*Yucca glauca*
Herbaceous	*Calamovilfa longifolia, Stipa comata, Bouteloua gracilis*

Fort Laramie National Historic Site

Statum	Species
Shrub	*Artemisia filifolia, Yucca glauca*
Herbaceous	*Stipa comata, Bouteloua gracilis, Carex filifolia*

DIAGNOSTIC SPECIES
Globally
Yucca glauca, Calamovilfa longifolia, Stipa comata

Fort Laramie National Historic Site
Artemisia filifolia, Stipa comata, Bouteloua gracilis

VEGETATION DESCRIPTION
Globally Stands of the narrower *Stipa comata - Yucca glauca* Herbaceous Vegetation (Thilenius *et al*. 1995) contain an open to moderately-dense (at least 10% cover), low shrub layer above a species-rich herbaceous layer. Dominance of the shrub layer by *Yucca glauca* is characteristic (average cover in 6 stands was 9.8%). *Artemisia tridentata* ssp. *wyomingensis* and *Artemisia cana* ssp. *cana* may be present but are sparse and contribute little cover. In the herbaceous layer, *Stipa comata* and *Calamovilfa longifolia* co-dominate (16% cover and 8% cover respectively), and *Bouteloua gracilis* and *Carex filifolia* often are present but contribute much less cover than do *Stipa* or *Calamovilfa.* Forbs are common but contribute little cover; *Artemisia frigida* has the highest constancy, but no forb is characteristic of the association. Litter covers up to ca. half of the ground surface, and most of the rest of the ground surface is bare soil.

Fort Laramie National Historic Site This community typically is dominated by *Stipa comata* and *Bouteloua gracilis* in the herbaceous stratum, with greater than 10% low shrub cover dominated by *Artemisia filifolia*. *Yucca glauca* can be common as well. *B. gracilis* is the more dominant herbaceous species in some areas, as is *Carex filifolia. Tradescantia occidentalis* and *Opuntia fragilis* frequently occur in this community. The latter is occasionally abundant. .*Andropogon hallii* occurs occasionally in small patches. Small patches of *Calamovilfa longifolia* are common. In some areas, such as old disturbed areas on Bureau of Land Management land northwest of the park (pipeline), large stands of *Calamovilfa longifolia* occur.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G2?

RANK JUSTIFICATION

DATABASE CODE CEGL001706

COMMENTS
Globally This association is currently considered a temperate, mid-grass, bunchgrass grassland. But as described by Thilenius *et al*. (1995), the reference from which it was named, it is characterized by a low shrub layer of at least ca. 10% cover, and so should probably be considered a sparse shrub type in the *Yucca glauca* Shrub Herbaceous Alliance (V.A.7.N.h. in

TNC's national vegetation hierarchy) and renamed *Yucca glauca* / *Stipa comata* Shrub Herbaceous Vegetation.

Furthermore, it appears to be the same as the *Yucca glauca* / *Calamovilfa longifolia* Association (CEGL001456) from Montana, as suggested by the following evidence. First, the two types are markedly similar in species composition. Percent constancy and percent canopy cover of the major species in the *Yucca glauca* / *Calamovilfa longifolia* association are as follows (Prodgers 1978): *Yucca glauca* 100% (22.5%), *Stipa comata* 33% (0.2%), *Calamovilfa longifolia* 83% (15.6%), *Schizachyrium scoparium* 67% (11.3%), *Bouteloua gracilis* 67% (3.2%), *Carex filifolia* 50% (5.6%). In the *Yucca glauca* / *Stipa comata* shrub-steppe, percent constancy and percent canopy cover of the major species are quite similar (Thilenius *et al.* 1995): *Yucca glauca* 100% (9.8%), *Stipa comata* 100% (16.3%), *Calamovilfa longifolia* 100% (8.7%), *Schizachyrium scoparium* not listed; *Bouteloua gracilis* 83% (8.2%), *Carex filifolia* 83% (7.1%).

Second, stands of the two types occur on similar substrates. Stands of the *Yucca glauca* / *Calamovilfa longifolia* association occur on sandstone and scoria substrates (Prodgers 1978), and stands of the *Yucca glauca* / *Stipa comata* shrub-steppe occur on sandstone outcrops (Thilenius *et al*. 1995). Third, the authors of the *Yucca glauca* / *Stipa comata* shrub-steppe (Thilenius *et al*. 1995) originally identified a *Yucca glauca* / *Calamovilfa longifolia* type on sandstone outcrops and sandy soils, based on a reconnaissance of vegetation in the Cheyenne River Basin. They then sampled 6 stands and revised their original type to the *Yucca glauca* / *Stipa comata* shrub-steppe of sandstone outcrops. Surveys by George Jones in the Cheyenne River Basin suggest that the original concept of the *Yucca glauca* / *Calamovilfa longifolia* type on sandstone outcrops and sandy soils applies well to the vegetation.

Fort Laramie National Historic Site This community intergrades with *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation. At some sites, especially on the BLM land south of the NHS, *Bouteloua gracilis* is dominant, and *Stipa comata* is rare or absent, probably due to grazing (*S. comata* is known to be a decreaser and *B. gracilis* an increaser in these situations; USDA Forest Service 1937). *Carex filifolia*, also an increaser (Jones 1992), contributes substantial cover in some areas. Low shrubs occasionally contribute greater than 25% cover. However, these stands are included in this community rather than being segregated as a shrubland community.

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Prodgers, R. 1978. Circle West vegetation baseline study. Final report. Circle West technical report no. 1, Energy Division, Montana Department of Natural Resources and Conservation, Helena MT. 115 pp.

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USDA Forest Service. 1937. Range plant handbook.

Spartina pectinata - Scirpus pungens Herbaceous Vegetation

COMMON NAME Freshwater Cordgrass - Three-square Bulrush Herbaceous Vegetation

SYNONYM Prairie Cordgrass - Bulrush Wet Meadow

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)

PHYSIOGNOMIC GROUP Temperate or subpolar grassland (V.A.5)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (V.A.5.N)

FORMATION Temporarily flooded temperate or subpolar grassland (V.A.5.N.j.)

ALLIANCE *Spartina pectinata* Temporarily Flooded Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Palustrine

RANGE

Globally This community is found in eastern Wyoming and eastern Montana.

Fort Laramie National Historic Site This community occurs adjacent to the Laramie River.

ENVIRONMENTAL DESCRIPTION

Globally This community is usually found as narrow bands along the margins of low gradient or standing open water and in depressions where the soil is saturated or flooded for short periods during the growing season (Jones and Walford 1995). Soils are fine textured and often have a high organic content.

Fort Laramie National Historic Site This community occurs in narrow bands adjacent to the Laramie River on alluvial soils.

MOST ABUNDANT SPECIES

Globally

Statum	Species
Herbaceous	*Spartina pectinata, Scirpus pungens*

Fort Laramie National Historic Site

Statum	Species
Herbaceous	*Spartina pectinata*

DIAGNOSTIC SPECIES
Globally
Spartina pectinata, Scirpus pungens

Fort Laramie National Historic Site
Spartina pectinata

VEGETATION DESCRIPTION
Globally This community is dominated by tall graminoids approximately 1-2 meters tall. Vegetation cover is usually high. *Spartina pectinata* is dominant and can form near monocultures. *Scirpus pungens*, *Poa pratensis*, *Carex praegracilis*, and *Carex nebrascensis* are all common constituents of the herbaceous stratum (Jones 1992). Shrubs and trees are not abundant, but *Salix* spp. can be found in many stands.

Fort Laramie National Historic Site Herbaceous cover for this community is typically greater than 75%, with grasses and tall forbs 1-1.5 m in height. The community is heavily dominated by *Spartina pectinata.* Other species commonly found include *Asclepias speciosa* and *Verbena hastata*. *Bromus inermis* and *Cirsium arvense* are common on drier margins.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G3Q

RANK JUSTIFICATION

DATABASE CODE CEGL001478

COMMENTS
Globally This type is poorly described across its range. The stands at Fort Laramie NHS are similar to others described elsewhere in Wyoming (Jones and Walford 1995), but as the type is better described, these stands should be compared to the global range of variation to verify their placement.

Fort Laramie National Historic Site Stands of *Spartina pectinata* also occur under *Populus deltoides* along the east side of the Laramie River, west of the Fort Site. Some stands include scattered individuals of *Salix exigua* and/or *S. amygdaloides*.

REFERENCES
Jones, G. 1992. Wyoming plant community classification. Wyoming Natural Diversity Database, The Nature Conservancy, Laramie, WY. 184 pp.

Jones, G. and G. Walford. 1995. Major riparian vegetation types of eastern Wyoming. A report submitted to the Wyoming Department of Environmental Quality, Water Quality Division. 245 pp.

Carex nebrascensis Herbaceous Vegetation

COMMON NAME Nebraska Sedge Herbaceous Vegetation

SYNONYM Nebraska Sedge Wet Meadow

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)

PHYSIOGNOMIC GROUP Temperate or subpolar grassland (V.A.5)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (V.A.5.N)

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

ALLIANCE *Carex nebrascensis* Seasonally Flooded Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Palustrine

RANGE
Globally This community is found in Arizona, Utah, Nevada, California, Oregon, Idaho, Montana, Wyoming, Colorado, and possibly in Washington and New Mexico.

Fort Laramie National Historic Site This community occurs in intermittently wet areas on the upper floodplain north of the canal.

ENVIRONMENTAL DESCRIPTION
Globally This community is found in nearly level, poorly drained sites which are wet much of the year (Jones 1992). In eastern Wyoming, soils were gleyed sandy, silty loam, clay loam, or clays (Jones and Walford 1995).

Fort Laramie National Historic Site This community occurs on intermittently saturated alluvial soils on the upper floodplain north of the canal. This habitat is largely a product of seepage from the canal.

MOST ABUNDANT SPECIES
Globally

Statum	Species
Herbaceous	*Carex nebrascensis, Agrostis stolonifera, Juncus balticus*

Fort Laramie National Historic Site

Statum	Species
Herbaceous	*Carex nebrascensis*, *Carex* spp., *Juncus* spp., *Equisetum laevigatum*

DIAGNOSTIC SPECIES
Globally
Carex nebrascensis, Agrostis stolonifera, Juncus balticus

Fort Laramie National Historic Site
Carex nebrascensis, Carex spp., *Juncus* spp., *Equisetum laevigatum*

VEGETATION DESCRIPTION
Globally This community is occurs as bands parallel to streams and is dominated by herbaceous species typically less than 1 meter tall. Woody species are rare. Common species include *Carex nebrascensis*, *Agrostis stolonifera*, *Scirpus pungens*, *Juncus balticus*, *Triglochin* spp., and *Equisetum* spp.

Fort Laramie National Historic Site This community is locally dominated by several different species, especially *Carex nebrascensis* and *Juncus* spp. *Equisetum laevigatum* is dominant on drier margins and on drier sites.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G4

RANK JUSTIFICATION

DATABASE CODE CEGL001813

COMMENTS
Globally This type is poorly described across its range. As the type is better described, the placement of these Fort Laramie NHS stands into it should be re-examined.

REFERENCES
Jones, G. 1992. Wyoming plant community classification. Wyoming Natural Diversity Database, The Nature Conservancy, Laramie, WY. 184 pp.

Jones, G. and G. Walford. 1995. Major riparian vegetation types of eastern Wyoming. A report submitted to the Wyoming Department of Environmental Quality, Water Quality Division. 245 pp.

Typha latifolia Western Herbaceous Vegetation

COMMON NAME Broad-leaf Cattail Herbaceous Vegetation

SYNONYM Broad-leaved Cattail Marsh

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)

PHYSIOGNOMIC GROUP Temperate or subpolar grassland (V.A.5)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (V.A.5.N)

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

ALLIANCE *Typha* (*angustifolia*, *latifolia*) - (*Scirpus* spp.) Semipermanently Flooded Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Palustrine

RANGE

Globally This community occurs in Montana, Colorado, New Mexico, Wyoming, and western Nebraska.

Fort Laramie National Historic Site This community is occasional along the Platte and Laramie Rivers, and in seepage areas north of the canal.

ENVIRONMENTAL DESCRIPTION

Globally This community is found along streams, rivers, and the banks of ponds. The soil is saturated or flooded for much of the year (Ramaley 1939, Tolstead 1942). It usually has a high organic content.

Fort Laramie National Historic Site This community occurs on level sites near the river. The soils are saturated alluvium.

MOST ABUNDANT SPECIES
Globally

Statum	Species
Herbaceous	*Typha latifolia*

Fort Laramie National Historic Site

Statum	Species
Herbaceous	*Typha latifolia*

DIAGNOSTIC SPECIES
Globally
Typha latifolia

Fort Laramie National Historic Site
Typha latifolia

VEGETATION DESCRIPTION
Globally This community is dominated by hydrophytic macrophytes, especially *Typha latifolia*, which grow to approximately 2 meters. *T. latifolia* can form dense stands in places, almost to the exclusion of other species. Other species typical of wetlands are found in lesser amounts in this community. Among these are *Carex* spp. and *Scirpus* spp.

Fort Laramie National Historic Site This community consists of stands of *Typha latifolia*, typically 1-2 m tall. Coverage is typically 50-75%. Standing water may or may not be present, depending on the season.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G5

RANK JUSTIFICATION

DATABASE CODE CEGL002010

COMMENTS
Globally This community is a common element found in many wetland systems, but has received little attention. Consequently, the diagnostic features and species of this community are not well known.

Fort Laramie National Historic Site At least one stand contained plants that were suggestive of *Typha angustifolia*, and the study area is within the range of the species (Dorn 1992). In this species, the staminate and pistillate spikes are not contiguous, being separated by 1-8 cm of bare rachis. However, spikes in *T. latifolia* occasionally are not contiguous (to 4 cm of bare rachis), and intermediate hybrids between the two species are not uncommon (Great Plains Flora Assoc. 1986). In plants observed at Fort Laramie NHS, the bare rachis was quite short (less than 1 cm).

REFERENCES

Dorn, R. D. 1992. Vascular Plants of Wyoming. 2nd ed. Cheyenne, WY: Mountain West Publishers.

Great Plains Flora Association. 1986. Flora of the Great Plains. Lawrence, KS: University Press of KS.

Ramaley, F. 1939. Sand-hill vegetation of northeastern Colorado. Ecological Monographs 9(1):1-51.

Tolstead, W. L. 1942. Vegetation of the northern part of Cherry County, Nebraska. Ecological Monographs 12(3):256-292.

Bromus inermis Disturbed Herbaceous Vegetation

COMMON NAME Smooth Brome Disturbed Herbaceous Vegetation

SYNONYM

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)

PHYSIOGNOMIC GROUP Temperate or subpolar grassland (V.A.5)

PHYSIOGNOMIC SUBGROUP Planted/cultivated (V.A.5.C)

FORMATION Undefined

ALLIANCE Undefined

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE
Globally Information not available.

Fort Laramie National Historic Site This community type occurs on the floodplain.

ENVIRONMENTAL DESCRIPTION
Globally Information not available.

Fort Laramie National Historic Site This community type occurs on level sites on alluvial soils of the floodplain.

MOST ABUNDANT SPECIES
Globally
Information not available.

Fort Laramie National Historic Site

Statum	Species
Herbaceous	*Bromus inermis*

DIAGNOSTIC SPECIES
Globally
Information not available.

Fort Laramie National Historic Site
Bromus inermis

VEGETATION DESCRIPTION
Globally Information not available.

Fort Laramie National Historic Site This community is heavily dominated by *Bromus inermis*. At some sites, no other species occur. Herbaceous cover is typically 50 - 75%, with plants to 1 m in height when in bloom. Some areas mapped as this type include patches of other weedy species.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK

RANK JUSTIFICATION

DATABASE CODE Not applicable.

COMMENTS
Fort Laramie National Historic Site This community is a result of extensive disturbance with subsequent invasion by weedy exotic or native species. Thus, it is not placed within the National Vegetation Classification System. This community is included for possible future management considerations and represents a relatively insignificant entity within the flora.

REFERENCES

Sporobolus cryptandrus Disturbed Herbaceous Vegetation

COMMON NAME Sand Dropseed Disturbed Herbaceous Vegetation

SYNONYM

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)

PHYSIOGNOMIC GROUP Temperate or subpolar grassland (V.A.5)

PHYSIOGNOMIC SUBGROUP Planted/cultivated (V.A.5.C)

FORMATION Undefined

ALLIANCE Undefined

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE
Globally Information not available.

Fort Laramie National Historic Site This community occurs on sandy floodplain and is most common on the upper floodplain east of the Fort.

ENVIRONMENTAL DESCRIPTION
Globally Information not available.

Fort Laramie National Historic Site This community occurs on sandy soils on level sites on the floodplain. These sites were disturbed in the recent past (less than 40 years).

MOST ABUNDANT SPECIES
Globally
Information not available.

Fort Laramie National Historic Site

Statum	Species
Herbaceous	*Sporobolus cryptandrus, Bromus tectorum*

DIAGNOSTIC SPECIES
Globally
Information not available.

Fort Laramie National Historic Site
Sporobolus cryptandrus (as the dominant)

VEGETATION DESCRIPTION
Globally Information not available.

Fort Laramie National Historic Site This community is heavily dominated by *Sporobolus cryptandrus*. Early in the season, *Bromus tectorum* often is a codominant, but dries up and is overtopped by the *S. cryptandrus* later in the season. Patches of *Buchloe dactyloides* occasionally occur in stands of this community. Herbaceous cover is typically greater than 25%, and often in the 50-75% range. Height is typically between 0.5 and 1 m (late season).

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK

RANK JUSTIFICATION

DATABASE CODE Not applicable.

COMMENTS
Fort Laramie National Historic Site This community is a result of extensive disturbance with subsequent invasion by weedy exotic or native species. Thus, it is not placed within the National Vegetation Classification System. This community is included for possible future management considerations and represents a relatively insignificant entity within the flora.

Sporobolus cryptandrus occurs as a minor component in other vegetation types, such as Upland Weeds, Upland Sand and Gravel, and *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation.

REFERENCES

Upland Weedy Herbaceous Vegetation

COMMON NAME Upland Weedy Herbaceous Vegetation

SYNONYM

PHYSIOGNOMIC CLASS Herbaceous vegetation (V)

PHYSIOGNOMIC SUBCLASS Annual graminoid or forb vegetation (V.D)

PHYSIOGNOMIC GROUP Temperate or subpolar annual grassland or forb vegetation (V.D.2)

PHYSIOGNOMIC SUBGROUP Planted/cultivated (V.D.2.C)

FORMATION Undefined

ALLIANCE Undefined

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE
Globally Information not available.

Fort Laramie National Historic Site This community is occurs scattered throughout the study area, but is most common on the floodplain.

ENVIRONMENTAL DESCRIPTION
Globally Information not available.

Fort Laramie National Historic Site This community occurs on disturbed sites on both the floodplain and in upland areas.

MOST ABUNDANT SPECIES
Globally
Information not available.

Fort Laramie National Historic Site

Statum	Species
Herbaceous	*Bromus tectorum, Salsola* sp., *Kochia scoparia, Helianthus annuus*

DIAGNOSTIC SPECIES
Globally
Information not available.

Fort Laramie National Historic Site
Bromus tectorum, Salsola sp., *Kochia scoparia, Helianthus annuus, Iva xanthifolia*

VEGETATION DESCRIPTION
Globally Information not available.

Fort Laramie National Historic Site This community typically is dominated by annual grasses and large forbs. Herbaceous cover is usually high, from 50 - 100%, with plants to 1 m in height. Small patches of *Bromus inermis* occur in this community.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK

RANK JUSTIFICATION

DATABASE CODE Not applicable

COMMENTS
Fort Laramie National Historic Site *Bromus tectorum* contributes significantly more cover early in the season. The large forbs become more significant late season. *B. tectorum* also occurs as a significant component in some of the grassland communities, especially in the *Sporobolus cryptandrus* type.

This community is a result of extensive disturbance with subsequent invasion by weedy exotic or native species. Thus, it is not placed within the National Vegetation Classification System. This community is included for possible future management considerations and represents a relatively insignificant entity within the flora.

REFERENCES

Riverine Sand Flats - Bars Sparse Vegetation

COMMON NAME Riverine Sand Flats - Bars Sparse Vegetation

SYNONYM River Sand and Gravel Bars

PHYSIOGNOMIC CLASS Sparse vegetation (VII)

PHYSIOGNOMIC SUBCLASS Unconsolidated material sparse vegetation (VII.C)

PHYSIOGNOMIC GROUP Sparsely vegetated sand flats (VII.C.2)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (VII.C.2.N)

FORMATION Temporarily flooded sand flats (VII.C.2.N.c.)

ALLIANCE Sand Flats Temporarily Flooded Sparse Vegetation

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Palustrine

RANGE
Globally This community occurs in Illinois, Missouri, Minnesota, Nebraska, eastern Wyoming, southern Saskatchewan, southern Manitoba, southern Ontario, and possibly Indiana and North Dakota.

Fort Laramie National Historic Site This community occurs adjacent to the Laramie and Platte Rivers.

ENVIRONMENTAL DESCRIPTION
Globally This community is found on rivers and streams where frequent flooding changes the substrate. Soil is absent or sometimes poorly developed. Soil that is above the water table is prone to drought due to poor water retaining capability. Parent material is sand or gravel.

Fort Laramie National Historic Site This community occurs on sandy, gravelly and small-cobble soils adjacent to rivers. Soil type can change relatively rapidly (over several years?) with flood events.

MOST ABUNDANT SPECIES
Globally

Statum	Species
Herbaceous	*Cenchrus longispinus*, *Cyperus* spp., *Eragrostis trichodes*, *Polygonum lapathifolium*, *Sporobolus cryptandrus*

Fort Laramie National Historic Site

Statum	Species
Shrub	*Salix exigua, Populus deltoides*
Herbaceous	*Sporobolus cryptandrus, Melilotus* spp., *Artemisia campestris*

DIAGNOSTIC SPECIES
Globally
Information not available.

Fort Laramie National Historic Site
No species sufficiently constant to be diagnostic.

VEGETATION DESCRIPTION
Globally Vegetation cover is sparse to sometimes moderate in this community. Ground cover is in the range of 5-20%. The predominant vegetation is herbaceous although some young shrubs and trees may become established. Species composition is variable from site to site and on the same site due to frequent flooding and recolonization from nearby seed sources. Species commonly found in the herbaceous layer include *Cenchrus longispinus, Cyperus* spp., *Eragrsotis trichodes, Equisetum* spp., *Juncus* spp., *Polygonum lapathifolium,* and *Sporobolus cryptandrus*. Small *Populus deltoides* and *Salix* spp. are the most common woody species.

Fort Laramie National Historic Site This community is characterized by sparse herbaceous and shrub cover, typically 1-10%. The vegetation composition and structure can change rapidly as a result of flooding. *Salix exigua* and small *Populus deltoides* are the most abundant shrubs while *Sporobolus cryptandrus, Artemisia campestris,* and *Melilotus* spp. are typically found in the herbaceous layer. Small patches of *Spartina pectinata* sometime occurs in wet areas near the river.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK G?

RANK JUSTIFICATION

DATABASE CODE CEGL002049

COMMENTS
Globally This is a primary community that develops on recently deposited or disturbed alluvial sand and gravel. It is a short lived community. Either subsequent flooding destroys the plants or secondary communities develop on the site.

Fort Laramie National Historic Site Succession to and from *Salix exigua* Shrubland may occur rapidly (within a few years) depending on the extent of seasonal flooding.

REFERENCES

Upland Sand and Gravel Sparse Vegetation

COMMON NAME Upland Sand and Gravel Sparse Vegetation

SYNONYM Upland Flats

PHYSIOGNOMIC CLASS Sparse vegetation (VII)

PHYSIOGNOMIC SUBCLASS Unconsolidated material sparse vegetation (VII.C)

PHYSIOGNOMIC GROUP Sparsely vegetated sand flats (VII.C.2)

PHYSIOGNOMIC SUBGROUP Natural/semi-natural (VII.C.2.N)

FORMATION Sand flats (VII.C.2.N.a.)

ALLIANCE Undefined

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE
Globally This community has not been described other than at Fort Laramie NHS. It is likely to be found elsewhere in Wyoming and nearby states.

Fort Laramie National Historic Site This community occurs predominantly on the upper and lower floodplains, with occasional occurrences away from the river.

ENVIRONMENTAL DESCRIPTION
Globally Information not available.

Fort Laramie National Historic Site This community occurs on gravelly or sandy soils on the floodplain, and occasionally in drainage bottoms at upland sites.

MOST ABUNDANT SPECIES
Globally
Information not available.

Fort Laramie National Historic Site

Statum	Species
Shrub	*Artemisia frigida*
Herbaceous	*Artemisia campestris*, *Opuntia polyacantha*, *Sporobolus cryptandrus*

DIAGNOSTIC SPECIES
Globally

Information not available.

Fort Laramie National Historic Site
Artemisia campestris, *Opuntia polyacantha*

VEGETATION DESCRIPTION
Globally Information not available.

Fort Laramie National Historic Site This community typically consists of a low herbaceous stratum (less than 0.5 m in height) with 10-50% cover. Shrub cover is variable or absent, with *Artemisia frigida* occurring most frequently. Cryptogammic soil is often well developed.

OTHER NOTEWORTHY SPECIES Information not available.

CONSERVATION RANK

RANK JUSTIFICATION

DATABASE CODE Information not available.

COMMENTS
Globally This community has not been described other than at Fort Laramie NHS. It likely occurs elsewhere, but it needs further review for a complete rangewide description.

Fort Laramie National Historic Site Sites away from the river (washes and blowouts) are somewhat different than floodplain occurrences. *Opuntia polyacantha* can occur at these sites, but *Artemisia campestris* was not observed. *A. filifolia* is occasional; *Ambrosia psilostachya* and *Calamovilfa longifolia* also were locally common.

REFERENCES

APPENDIX 2. SELECTED SOURCES FOR NATIVE PLANT SEEDS

These company names and addresses were obtained from the world wide web on July 20, 2002. This should not be considered an exhaustive list of companies that might provide seeds of native plants suitable for planting at Fort Laramie. Nor should it be considered an endorsement of these companies.

1. Sharp Bros. Seed Co.
104 East 4th Street Road, Greeley, Colorado 80631
Tele 970-356-4710
Fax 970-356-1267
buffalo.gxy@sharpseed.com
http://www.sharpseed.com/

2. Wind River Seed
3075 Lane 51 ½, Manderson WY 82401
e-mail: wrstaff@windriverseed.com
Fax: (307) 568-3364
Phone: (307) 568-3361
http://www.windriverseed.com/index.htm

3. Western Native Seed
P.O. Box 188, Coaldale, CO 81222
Phone: (719) 942-3935 FAX: (719) 942-3605
Email: info@westernnativeseed.com
http://www.westernnativeseed.com/

4. Stock Seed Farms
28008 Mill Rd., Murdock, NE 68407-2350
Ph. 402.867.3771 (info)
Fax: 402.867.2442
Email: stockseed@alltel.net
Web: www.stockseed.com