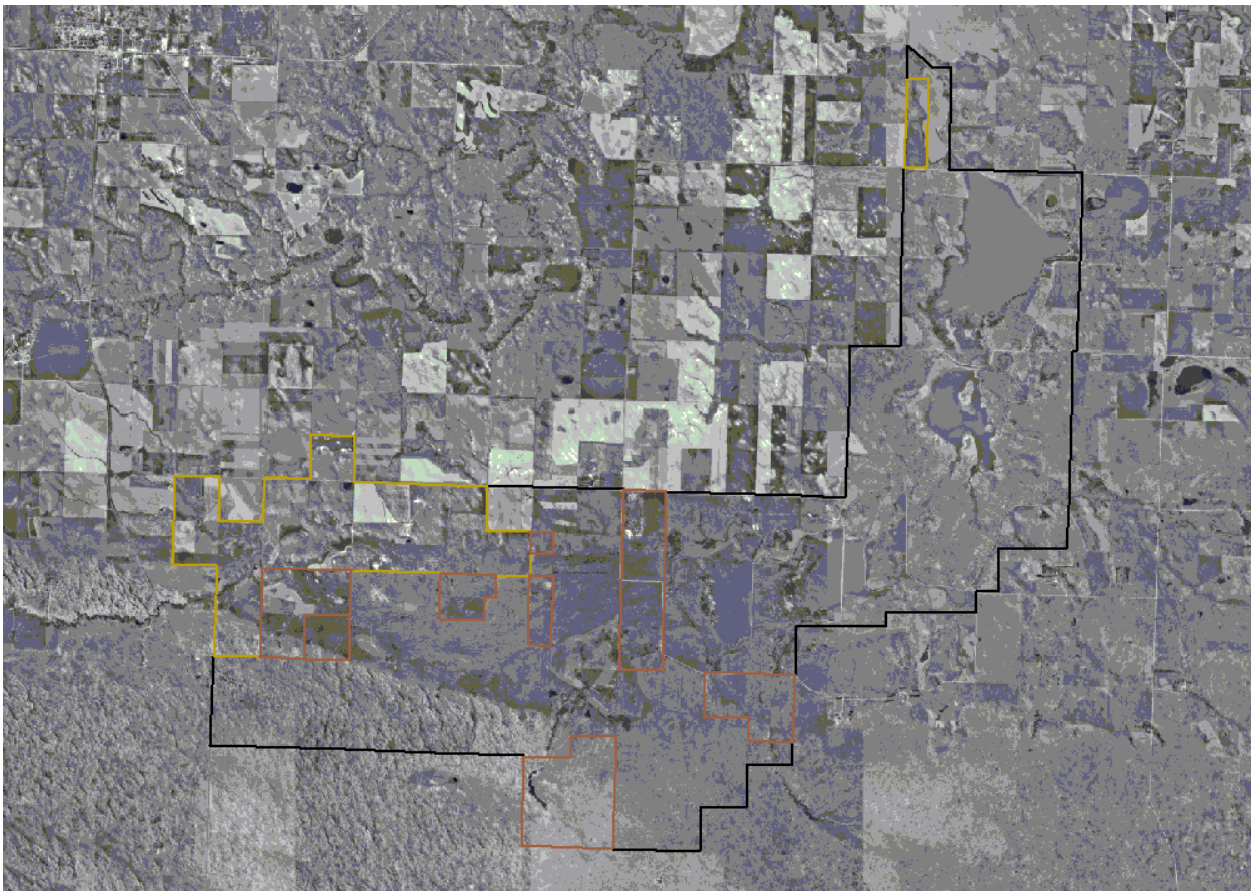
Lacreek National Wildlife Refuge, South Dakota
2000-2001 VEGETATION MAPPING PROJECT



FINAL REPORT Feburary 28, 2002

Technical Memorandum 8260-02-02
Remote Sensing and GIS Group
Technical Service Center
Bureau of Reclamation
Denver, CO

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The Remote Sensing and Geographic Information Group, organized in 1975, provides assistance and advice regarding the application of remote sensing and geographic information systems (GIS) technologies to meet the spatial information needs of the Bureau of Reclamation and other governmental clients.

This report was prepared for the U.S. Fish and Wildlife Service's Mountain-Prairie Region (Region 6) and the U.S. Geological Survey's Center for Biological Informatics by the Remote Sensing and GIS Group of the Bureau of Reclamation's Technical Service Center, Denver, CO as Technical Memorandum No. 8260-02-02.

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Adapting the USGS-NPS Vegetation Mapping Standards to the needs of National Wildlife Refuges required the dedicated and ingenious efforts of many individuals. The staff at Lacreek National Wildlife Refuge (LNWR) contributed in many ways to the completion of the project, including help with the initial organization and review of draft vegetation maps and vegetation classification. NatureServe helped complete the vegetation descriptions, while the USGS Center for Biological Informatics and the Region 6 office of USFWS provided overall program coordination. Last but hardly least, two individuals put in untold hours of fieldwork to collect data for the classification and for accuracy assessment, without their commitment this project would not have been possible.

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- The entire staff of BOR RSGIS (both past and present) for so many things.

LIST OF ABBREVIATIONS AND ACRONYMS

AA	Accuracy Assessment
ABI	Association for Biodiversity Information (now NatureServe a TNC Affiliate)
AML	Arc Macro Language
BOR	Bureau of Reclamation (Also USBR)
BRD	Biological Resource Division (of the USGS)
CBI	Center for Biological Informatics (of the USGS/BRD)
CIR	Color Infra-Red Photography
DEM	Digital Elevation Model
DLG	Digital Line Graph
DRG	Digital Raster Graphic
DOQQ	Digital Orthophoto Quarter Quadrangles
FGDC	Federal Geographic Data Committee
FWS	Fish and Wildlife Service
LNWR	Lacreek National Wildlife Refuge
GIS	Geographic Information System(s)
GPS	Global Positioning System
MMU	Minimum Mapping Unit
NPS	National Park Service
NS	NatureServe (formally ABI)
NAD	North American Datum (Cartography)
NBII	National Biological Information Infrastructure
NRCS	Natural Resources Conservation Service (formerly Soil Conservation Service)
NVCS	National Vegetation Classification System
PLGR	Precision Light-weight GPS Receiver
RSGIG	Remote Sensing and Geographic Information Group (Bureau of Reclamation)
TNC	The Nature Conservancy
USBR	United States Bureau of Reclamation (Also BOR)
USFS	United States Forest Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator (Cartography)

EXECUTIVE SUMMARY

The Lacreek National Wildlife Refuge (LNWR) was established in 1935 as a waterfowl production area and sanctuary for migratory birds. In accordance with the 1997 National Wildlife Refuge Improvement Act, LNWR's management emphasis shifted toward ecosystem-based management of all resident and migratory species. Refuge and Regional staff asked that a detailed and accurate vegetation map be developed for planning and for managing the Refuge effectively. The Bureau of Reclamation's Remote Sensing and Geographic Information Group (RSGIS) was contracted by US Fish and Wildlife Service to map vegetation and land-use classes at LNWR using remote sensing and GIS technologies originally developed for the National Park Service's Vegetation Mapping Program.

The diverse vegetation and complicated land-use history of Lacreek National Wildlife Refuge presented an unique challenge to mapping vegetation at the plant association level of the US National Vegetation Classification. To meet this challenge, the project consisted of two linked phases: (1) vegetation classification and (2) digital vegetation map production. To classify the vegetation, we sampled representative plots located throughout the 21,950-acre (8884 hectares) project area. Analysis of the plot data using ordination and clustering techniques yielded 27 distinct plant associations. To produce the digital map, we used a combination of new color-infrared aerial photography and fieldwork to interpret the complex patterns of vegetation and land-use at LNWR. Sixty-one land cover units were developed and the 44 vegetation map units matched to the corresponding plant associations. The interpreted map data were converted to a GIS database using ArcInfo©. Draft maps created from the vegetation classification were field-tested and revised before an independent ecologist conducted map accuracy assessment.

Two thousand and sixty-one polygons were delineated, split between the following ecological groups: Nebraska Sandhills, Northern Mixed Grass Prairie, and Great Plains Wetlands. The greatest number of hectares (h) mapped was open water (Pools) with 2150 acres and the largest frequency of polygons mapped belonged to the Peachleaf Willow (*Salix amygdaloides*) Woodland with 164. 386 field data points were used to test the thematic accuracy of the map. Overall thematic map accuracy was 77%.

Products developed for the LNWR Vegetation Mapping Project include

- the final report, vegetation key, map accuracy assessment results and contingency table, and photo interpretation key;
- spatial database coverages of the vegetation map, vegetation plots, accuracy assessment sites, and flight line index;
- digital photos (scanned from 35mm slides) of each vegetation type;
- graphics of all spatial database coverages;
- Federal Geographic Data Committee-compliant metadata for all spatial database coverages and field data.

In addition, the Refuge and USFWS copies of this report contain

- original aerial photographs of the project area;
- digital data files and hard copy data sheets of the observation points, vegetation field plots, and accuracy assessment sites;
- original slides of each vegetation type.

A CD-ROM attached to this report contains text and metadata files, keys, lists, field data, spatial data, the vegetation map, graphics, and ground photos. The USGS will post this project on its website: http://biology.usgs.gov/cbi/bio-char/fws_veg.html. For information on other projects completed by the RSGIS, visit http://www.rsgis.do.usbr.gov/.

1. INTRODUCTION

This report describes the creation of a vegetation classification and a spatial vegetation database for Lacreek National Wildlife Refuge (LNWR) by the Remote Sensing and GIS Group of the Bureau of Reclamation (RSGIS). The objectives of this project were to:

- collect and analyze vegetation data;
- create vegetation and map unit classifications based on the National Vegetation Classification System (NVCS) and Refuge-specific requirements;
- develop a spatial database of LNWR's vegetation, using remote sensing and Geographic Information System (GIS) techniques;
- produce digital and hard copy vegetation maps with a minimum 80% accuracy

1.1 Background

The Prairie-Mountain Region of the USFWS has made a priority of obtaining accurate vegetation data in order to improve Refuge capacity for inventory, planning and management. The USGS-NPS Vegetation Mapping Program (URL: http://biology.usgs.gov/npsveg) was selected as the operating model and LNWR was one of two Refuges chosen to test the applicability of the model. The USGS-NPS Vegetation Mapping Program uses standard methods and protocols to classify, describe, and map vegetation, but they were developed for use at relatively pristine National Parks. At the beginning of this project no one knew how well USGS-NPS methods would work on the modified and manipulated vegetation of a National Wildlife Refuge.

In March 2000, the U. S. Fish and Wildlife Service (USFWS) asked the U.S Bureau of Reclamation's Remote Sensing and Geographic Information Group (RSGIS) to undertake the classification and mapping of vegetation at Lacreek National Wildlife Refuge. The USFWS requested that the U.S. Geological Survey's Biological Resources Division, Center for Biological Informatics (CBI) be responsible for overall project coordination and ensuring that the mapping was performed following standard procedures outlined in the USGS-NPS Vegetation Mapping Program (**Appendix A**). The RSGIS submitted a work proposal (**Appendix B**) to CBI and in June 2000, an Inter-Agency Agreement was established between USFWS, CBI, and RSGIS for this project.

1.2 Scope of Work

The goal of this project was to describe the vegetation of 21,950 acres of the Lacreek National Wildlife Refuge, including adjacent lands owned by other entities. Project goals centered around the following products: digital files of the vegetation map and field data, descriptions of and keys to the plant associations, metadata, map accuracy summaries, and aerial photographs. The RSGIS created most of the products and provided day-to-day project coordination. CBI was responsible for general oversight and adherence to the standards and protocols of the USGS-NPS Vegetation Mapping Program. NatureServe was responsible for producing a preliminary vegetation classification and providing global descriptions for the final plant associations.

1.3 Lacreek National Wildlife Refuge

Lacreek National Wildlife Refuge is located in southwestern South Dakota. To access the Refuge, travel south approximately three miles from Martin, SD (Bennett County) then turn east and go nine miles (**Figure 1**). The Refuge consists of approximately 16,410 acres owned by the USFWS. In addition, portions of this project included state-owned lands managed by the State of South Dakota Department of Game, Fish and Parks and private inholdings (**Figure 2**.).

Climate: The climate of the area is described as semi-arid and is characterized by cold winters and hot summers (USDA 1971). The 42-year average annual precipitation is 17 inches with about 63% of it as rainfall between April and July (URL: http://www.ncdc.noaa.gov/oa/ncdc.html). Annual average temperature is about 60 degrees Fahrenheit and the growing season is generally from mid-May to late September (135 frost-free days). Temperatures range from an average low of 10° F in January to an average high of 89° F in August.

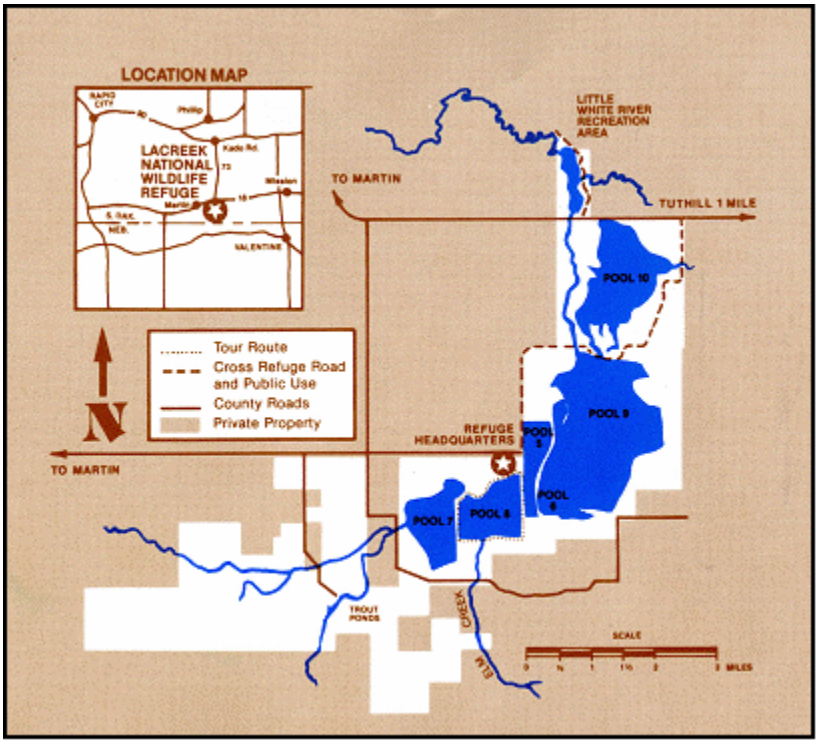


Figure 1. Lacreek National Wildlife Refuge map and location relative to Martin, South Dakota.

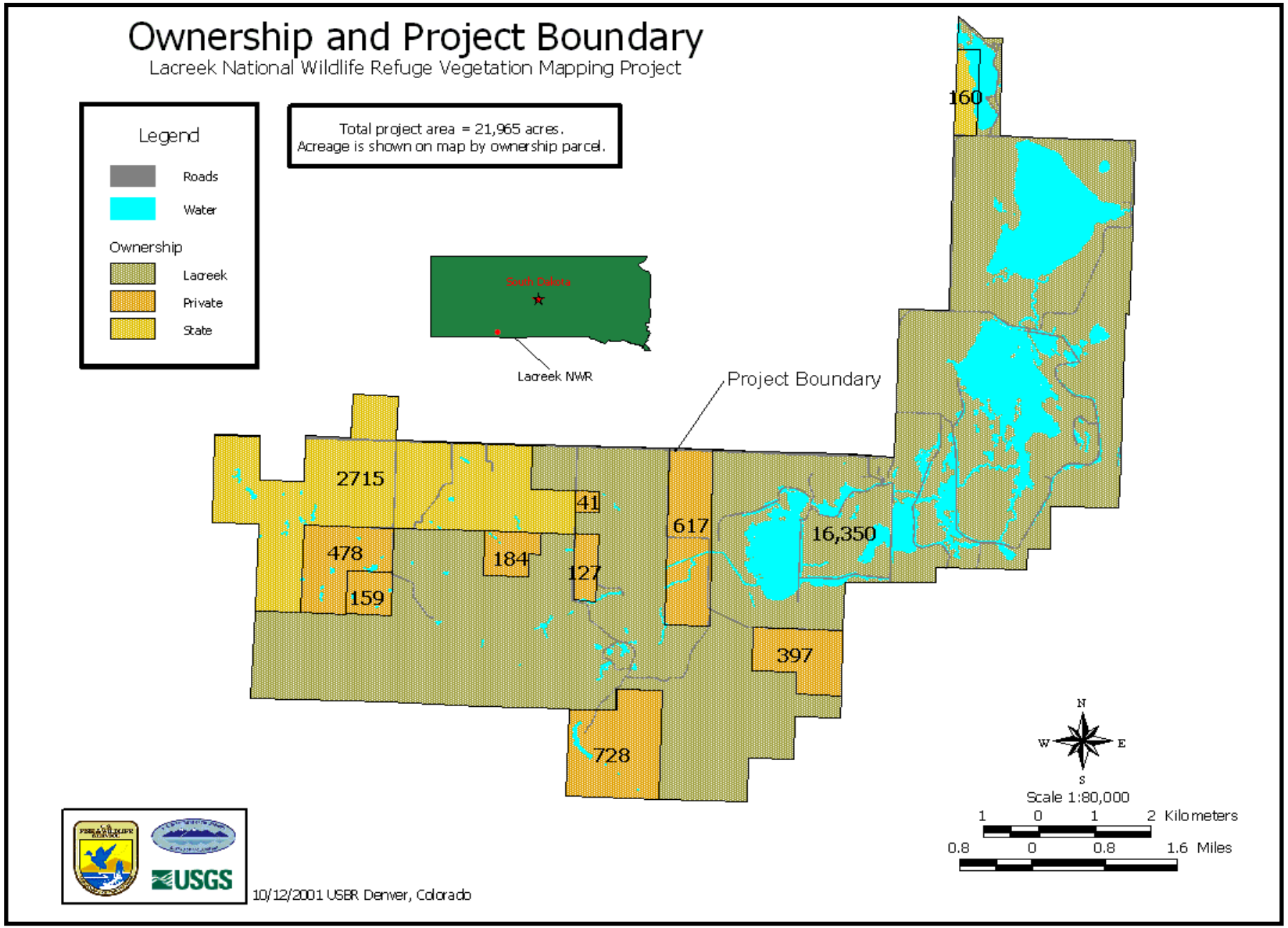


Figure 2. Land ownership and project boundary map for Lacreek National Wildlife Refuge and environs.

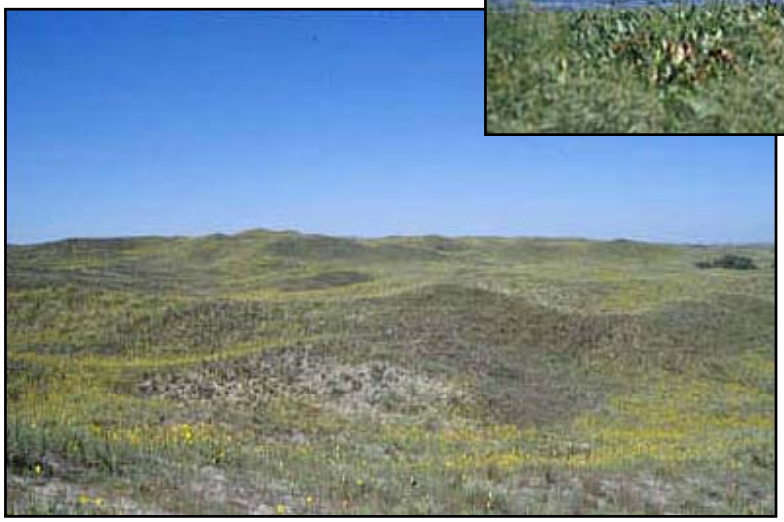
Topology: Most of LNWR is located within Lake Creek valley, a broad drainage cut into Valentine and Harrison Formations (Gries 1996). Topography in the valley ranges from nearly level to gently rolling. Soils located near Lake Creek are typically deep, loamy in texture, poorly drained, and occupy sites that have a fluctuating water table. The gently rolling uplands above the valley are characterized by silty loam soils that are well drained. In the southern portion of the Refuge, the topography changes abruptly into rolling dunes that are the northernmost edge of the Nebraska Sandhills. Sandy, well drained to excessively drained soils characterize this portion of the Refuge. Although slopes range from 3 to 35 percent, the original moving dunes are now well stabilized by a cover of grasses and shrubs (USDA 1971).

Wildlife: LNWR supports an array of wildlife species including large numbers of migrating waterfowl and shorebirds. More than 281 species of birds have been recorded since 1959 (URL: http://mountain-prairie.fws.gov/Lacreek/wildlife.htm). Also present on the Refuge are white-tailed and mule deer, burrowing owls, prairie dogs and other animals common to the Central Great Plains region. Fish are present in most of the pools and streams at LNWR. Common species include northern pike, saugeye, large-mouth bass, black crappie, perch, bluegill, pumpkinseed, bullhead, carp and a variety of minnows including the endangered plains topminnow, pearl dace and red-belly dace. Some pools are specifically stocked with rainbow trout (URL: http://mountain-prairie.fws.gov/Lacreek/wildlife.htm).

Vegetation: LNWR is composed of many species common to the northern mixed grass prairie and the sandhill regions of the Great Plains. Western wheatgrass (*Pascopyrum smithii*), green needle grass (*Nassella viridula*), and needle-and-thread grass (*Heterostipa comata*) are typical components of the moderately deep, to deep silty and loamy soils of the gently rolling uplands above Lake Creek. Western wheatgrass is also a common species on the nearly level soils relatively close to the marshes and pools of the Refuge. Almost pure stands of Inland saltgrass (*Distichlis spicata*) are frequently found on saline-alkaline soils that occupy flats and valleys with a fluctuating water table. Several sites have an almost even mixture of both western wheatgrass and inland saltgrass. Prairie cordgrass (*Spartina pectinata*) stands are often found between stands of inland saltgrass/western wheatgrass and cattail (*Typha* spp.). Woodland and shrub communities occur as small, infrequent stands throughout this portion of the Refuge. The most common dominants include peachleaf willow (*Salix amygdaloides*), sandbar willow (*Salix exigua*), and American plum (*Prunus americana*).

The vegetation of the sandhills portion of the Refuge is most diverse and contains the fewest non-native plant species. Prairie sandreed (*Calamovilfa longifolia*), needle-and-thread, sand dropseed (*Sporobolus cryptandrus*), and soapweed (*Yucca glauca*) are the usual dominants. The density of soapweed increases on steeper, north facing slopes. Well-developed stands of needle-and-thread occur on gently rolling to nearly level sites. Stands of switchgrass (*Panicum virgatum*) often occur in relatively small, isolated patches in the concave, lowland areas of the sandhills.

Several non-native/invasive plant species are found within the Refuge. Kentucky bluegrass (*Poa pratensis*), crested wheatgrass (*Agropyron cristatum*) and smooth brome (*Bromus inermis*) are probably the most common species having been planted extensively. Canada thistle (*Cirsium arvense*) is another troublesome exotic species that is being actively controlled in the Refuge by mowing.



Lacreek NWR Scenes: From upper right, Grasslands of the Northern Mixed Grass Prairie, Pelican standing in open water among Central Plains Wetland vegetation, and Rolling grasslands and shrublands of the Nebraska Sandhills Region.

2. MATERIALS AND METHODS

Based on the overall scope and the assigned responsibilities (see 2.1 below), the project was divided into six major steps following the USGS flowchart (**Appendix A**):

1. plan, gather data, and coordinate tasks
2. conduct a field survey of LNWR to understand and sample the vegetation
3. classify the vegetation using field data to USNCV standards and crosswalk it to recognizable map units
4. acquire aerial photography and interpret the photographs using the classification scheme and crosswalk
5. transfer the interpreted data to a digital form
6. ground-truth and assess the accuracy of the final map product.

All protocols for this project as outlined in the following sections can be found in documents produced by The Nature Conservancy (1994a, 1994b, and 1994c) for the USGS-NPS Vegetation Mapping Program and found at its website URL: http://biology.usgs.gov/npsveg.

2.1 Planning, Data Gathering and Coordination

A scoping meeting was held in July 2000 and attended by RSGIS, USFWS (Region 6 and LNWR), NatureServe, and CBI staff. The goals of this meeting were to (1) determine the project boundary, (2) assess the availability of aerial photography, base maps and other data, (3) plan the logistics of doing fieldwork at LNWR, and (4) assign specific tasks to the organizations involved.

The meeting resulted in two guiding decisions:

1. The project extent was defined as the 'executive' boundary of the Refuge plus adjacent state owned land (approximately 21,951 acres).

2. New aerial photography would be required and existing USGS DOQQs (digital orthophoto quarter quadrangles) would be used as basemaps.

Work responsibilities were assigned to the participants:

USBR Responsibilities

- Provide overall project facilitation and coordination.
- Acquire new 1:12,000 scale color infrared aerial photography and obtain necessary USGS DOQQs.
- Verify vegetation and land use/land cover signatures on the aerial photographs.
- Collect data for the vegetation classification and local NVCS descriptions.
- Develop map units linked to the NVCS.
- Provide NatureServe with information regarding the distribution and characteristics of vegetation types within LNWR.
- Interpret and delineate vegetation and land use types using aerial photographs.

- Transfer and automate interpreted photographs to produce a digital spatial database and hard copy vegetation maps.
- Produce spatial coverages of plot and accuracy assessment site locations.
- Provide an analysis of the accuracy assessment.
- Provide a final report describing all aspects of the project.
- Provide a visual guide to the photo signatures of each map unit.
- Document FGDC-compliant metadata for all vegetation data.
- Create a CD-ROM containing the reports, metadata, guides, vegetation classification, plot data, spatial data, vegetation database (map), graphics, and ground photos.

USFWS Responsibilities

- Provide program oversight in conjunction with CBI.
- Supply RSGIS with the LNWR boundary in digital format.

NatureServe Responsibilities

- Develop preliminary list of potential plant associations and provide feedback on the vegetation classification for the study area based on the NVCS, using field data provided by RSGIS.
- Provide guidance to the photo interpreters regarding the ecology and floristic composition of each vegetation type.
- Provide global vegetation descriptions and assist with keys to the vegetation.

RSGIS obtained copies of maps, soil surveys, reports, and other documents describing the Refuge and its environmental setting. LNWR provided species lists, annual reports, and their draft comprehensive conservation plan. The Region 6 office of the USFWS provided a digital copy of the project area boundary

2.2 Field Survey

RSGIS conducted a field survey in September 2000 and August 2001, during which both observation point data and plot data were collected. Observation points allowed the field person to become generally familiar with the vegetation while field checking NatureServe's list of potential plant associations. Data collected at each observation point included a general description of the vegetation, UTM coordinates, estimates of foliar cover for the dominant species, and a brief description of the environmental characteristics (**Appendix C**). We collected data at 167 observation points during the September field survey (**Figure 3**).

We also sampled 65 vegetation plots during the August 2000 field survey (**Figure 4**). These plots differed from the observation points in two important ways. First, plot boundaries were formally defined, and second, the data we collected were quantitative and much more detailed. The plots were placed subjectively in vegetation that was judged to be "representative" and relatively homogeneous over at least 0.5 ha (the size of the minimum mapping unit). Ecotones were not sampled, and smaller areas were

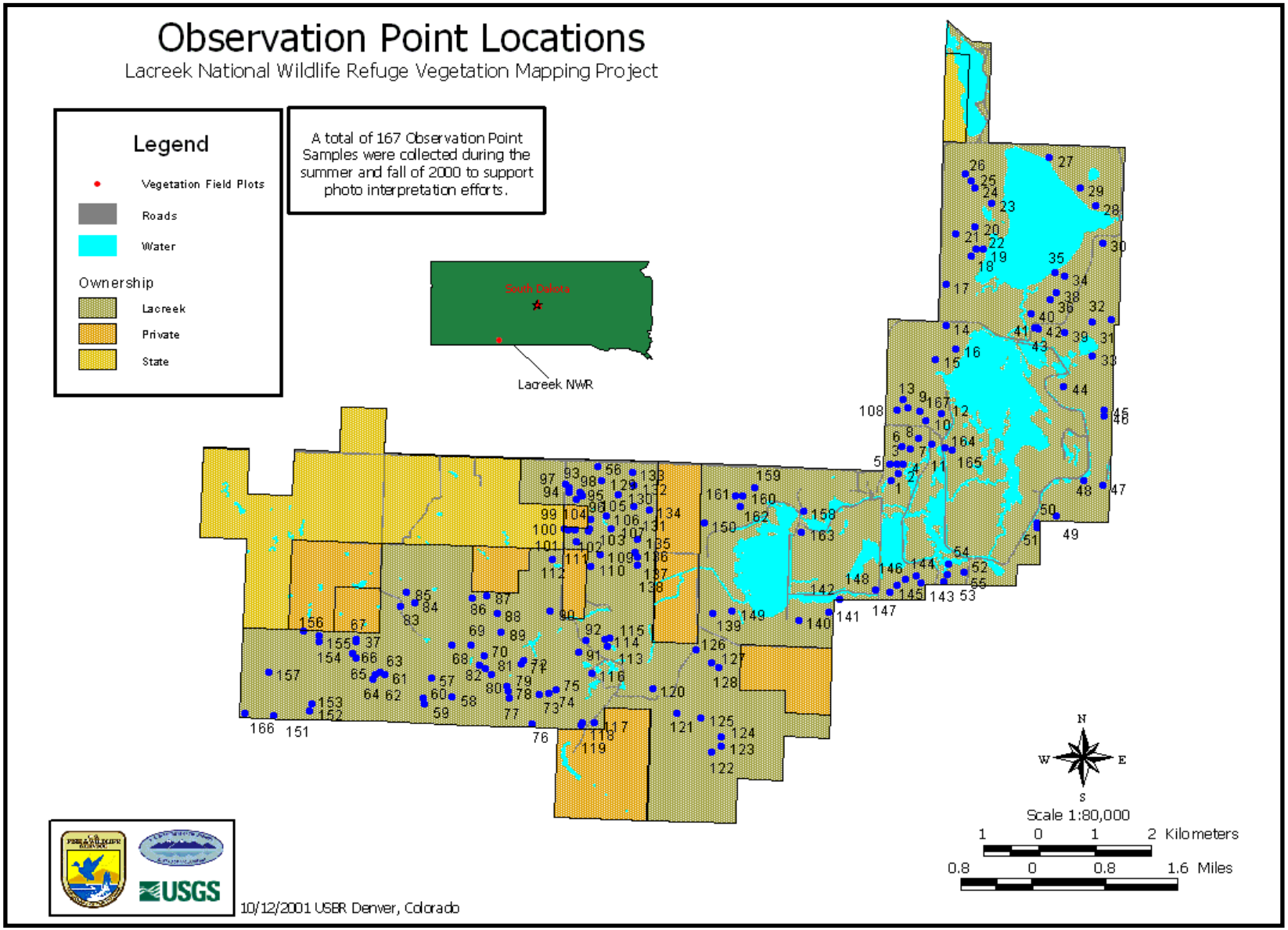


Figure 3. Location of observation points at Lacreek National Wildlife Refuge.

only sampled if they represented unique or distinctive vegetation types. We used 20 x 20 m square plots to sample forest and woodland communities, while shrubland and herbaceous communities were sampled using 10 x 10 m plots. We made an effort to sample three plots per vegetation type with more plots in types not previously documented by the NVCS. The plots were spread across the Refuge to capture the full range of variation.

The descriptive information we collected in each plot included slope, aspect, elevation, soil characteristics, and evidence of wildlife and human disturbance (**Appendix C**). To characterize the vegetation in a plot, we estimated the cover of all vascular plant species (Daubenmire 1959) by layer (herb, shrub, tall shrub, subcanopy, canopy, etc.). The UTM coordinates and elevation of all plots were logged using a Garmin™ 12XL GPS receiver. We took photographs (35 mm format) of each plot and scanned them as digital images. Scanned representative slides for all plots are included in **Appendix G** and all scanned images can be found on the CD_ROM attached to this report. Data collected for each plot was entered into a MS Acess© database and analyzed by NatureServe ecologists using the procedures described in **Section 2.3**.

2.3 NVCS Classification at Lacreek NWR

The National Vegetation Classification System (NVCS) for the United States was selected as the vegetation classification standard for this project for several reasons. First, the NVCS is the system mandated by the USGS-NPS Vegetation Mapping Program. Second, the Federal Geographic Data Committee (FGDC) (FGDC, 1997) has adopted the NVCS to the formation level as a standard for federal agencies. Finally, a national (as opposed to regional, state, or local) vegetation classification system facilitates resource stewardship by ensuring that the same plant associations get the same names throughout the National Refuge System. In short, the strengths of the NVCS include:

- it is vegetation based
- uses a systematic approach to classify a continuum
- emphasizes natural and existing vegetation
- uses a combined physiognomic-floristic hierarchy
- identifies vegetation units based on both qualitative and quantitative data
- is appropriate for mapping at multiple scales

The NVCS was established primarily by The Nature Conservancy (TNC) and is being implemented and updated by NatureServe in support of the network of Natural Heritage Programs (Grossman *et al.* 1998). Development and refinement of the classification is an ongoing process, and proposed revisions are reviewed both locally and nationally. TNC published two volumes describing the classification of U.S. vegetation as of April 1997 (Grossman *et al.* 1998). This publication can be found on the Internet (URL: http://www.natureserve.org/publications/library.jsp#nspubs) NatureServe also posts regular updates to the list of plant associations in the United States and Canada on their online database server: http://www.natureserve.org/explorer).

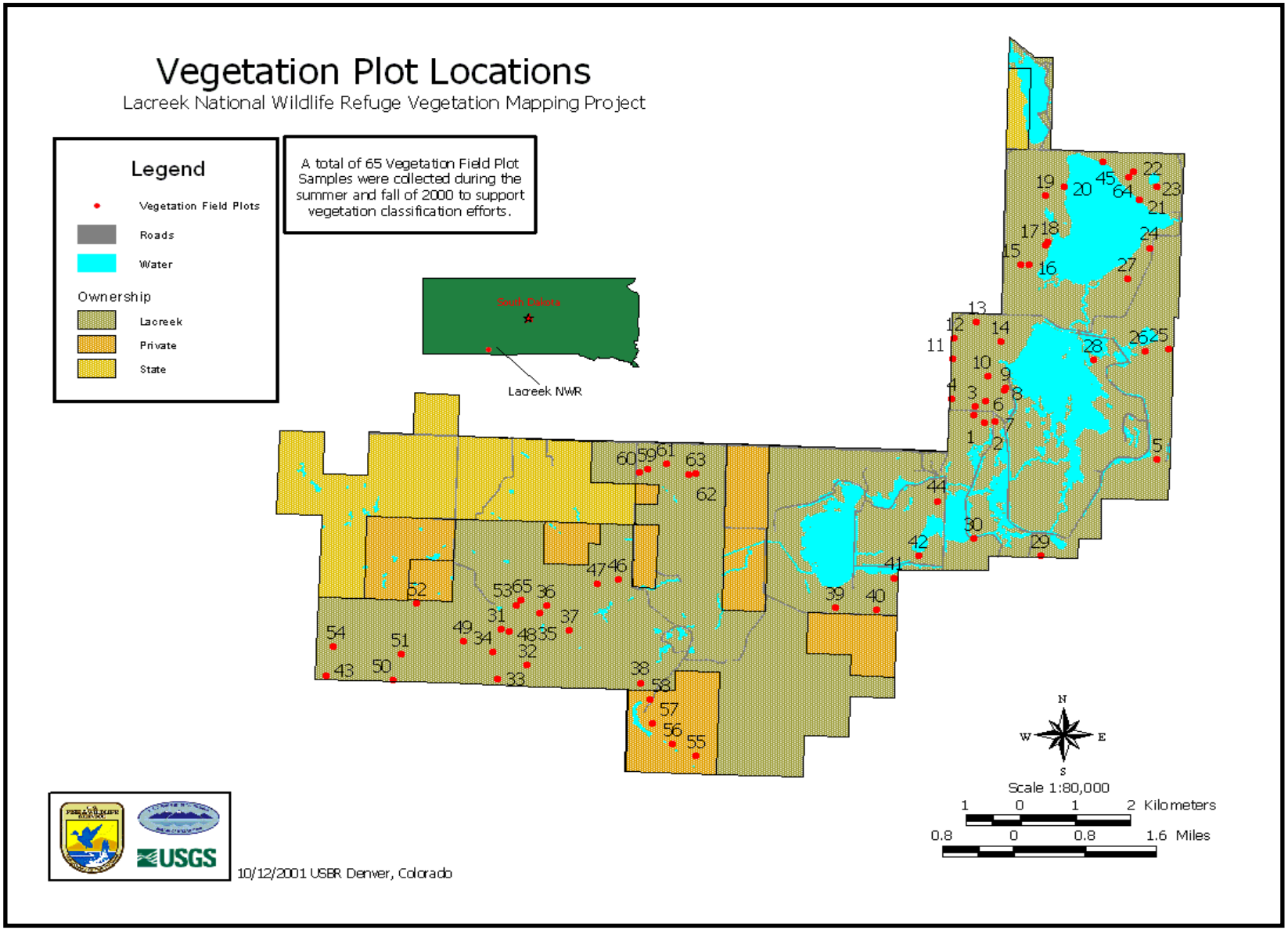


Figure 4. Location of vegetation plots at Lacreek National Wildlife Refuge.

The procedure for classifying vegetation followed guidelines described in the Vegetation Classification Standard (FGDC 1997), which was derived from the NVCS. The NVCS is a species-based, hierarchical system with seven levels (Grossman *et al.* 1998). The highest (*i.e.* course) levels of the hierarchy have a broad geographic perspective and use physiognomic features to distinguish among groups of plant communities. The lower levels *(i.e.* finest) have a local and site-specific perspective and are based on floristics (**Table 1**). The two lowest levels (alliance and association) were used in the LNWR project.

Table 1. An example of the NVCS physiognomic-floristic classification hierarchy.

Level	Primary Basis For Classification	Example
Class	Growth form and structure of vegetation	Woodland
Subclass	Growth form characteristics, e.g., leaf phenology	Deciduous Woodland
Group	Leaf types, corresponding to climate	Cold-deciduous Woodland
Subgroup	Relative human impact (natural/semi-natural or cultural)	Natural/Semi-natural
Formation	Additional physiognomic and environmental factors, including hydrology	Temporarily Flooded Cold-deciduous Woodland
Alliance	Dominant/diagnostic species of uppermost or dominant stratum	*Salix amygdaloides* Temporarily Flooded Woodland Alliance
Association	Additional dominant/diagnostic species from any stratum	*Salix amygdaloides/Salix exigua* Woodland

The association is defined as "a plant community of definite floristic composition, uniform habitat conditions, and uniform physiognomy" (see Flahault and Schroter 1910 in Moravec 1993). Associations are separated from alliances through the use of total floristic composition and are named by the most dominant and/or indicator species. If two or more dominant species occur in the same stratum a dash symbol is used between the names. If the species occur in different strata then a slash is used. Parentheses indicate that a diagnostic species is not always present. Alliances are physiognomically uniform groups of plant associations that share dominant or diagnostic species, usually found in the uppermost stratum of the vegetation. For forested types, the alliance is roughly equivalent to the "cover type" of the Society of American Foresters. Alliances also include non-forested types.

Unlike classifications based on habitat types or potential vegetation, the NVCS strives to describe existing vegetation, whether natural or cultural vegetation. However, due in part to the conservation focus of TNC and NatureServe, the classification of natural vegetation types is often better developed than that of cultural or modified types. The NVCS is also unique in that the association is the basic unit, with the higher levels of the hierarchy representing aggregations of units in the lower levels. This differs from other types that work from the top down.

Preparing the Data for Analysis

The vegetation classification for LNWR began with RSGIS and NatureServe ecologists manually sorting observation point and plot data into groups based on vegetation structure and composition. Most of the plots could be evaluated qualitatively and assigned to an existing NVCS alliance or association. In a few instances, new NVCS units were defined from quantitative analysis of the plot data using ordination techniques described below. The results of the numerical analyses were compared to the subjective classification so that discrepancies between the two could be reconciled.

Data from the 65 vegetation plots sampled at LNWR were entered into a MS Acess© database using TNC's PLOTS interface and following procedures outlined by the NVCS (Grossman *et al.* 1998). The cover values for the species in each plot were used to create a plots-by-species data matrix. Prior to analysis, all species with total cover values (summed over all plots) of 1% or less were removed from the data matrix. This prevented minor species from controlling the classification. The resulting matrix was then run through a number of computer analyses designed to organize and summarize the compositional and structural characteristics of the vegetation and assess patterns related to environmental gradients.

Data Analysis

Following procedures described by Grossman *et al.* (1998) and McCune and Mefford (1999), the plots were analyzed using TWINSPAN (a classification program) and DECORANA (an ordination program). The TWINSPAN grouping analyses were conducted using relative cover values, while raw cover values were used in the DECORANA ordination procedures. TWINSPAN recognizes distinct ecological groups of plots such as wetlands, riparian woodlands, shrublands, and grasslands. DECORANA clarifies the patterns revealed by the classification and places the plots along a two-dimensional environmental gradient.

In most cases, there were only a few sample plots per vegetation type; so the numerical analyses (as described above) were compared to the subjective classification so that any discrepancies between the two could be detected. Almost all of the numerical classes matched existing NVCS types described for the Midwest portion of the U.S. (Faber-Langendoen, D. *et al.* 1996). Those that didn't were sent to NatureServe for consideration as new NVCS plant associations.

A preliminary classification of the LNWR was the end product of this process. RSGIS ecologists, photo interpreters, and Refuge staff field-reviewed the classification. RSGIS and NatureServe prepared a dichotomous map unit key for LNWR (**Appendix D**). The key was tested during the accuracy assessment process. An illustrated guide to the map units **(Appendix G)** was also developed to assist managers and field researchers in identifying plant associations in the field.

2.4 Aerial Photograph Acquisition and Photo-interpretation

Horizons, Inc. (Rapid City, SD) flew color-infrared (CIR) aerial photography for LNWR at 1:12,000-scale on July 27, 2000. We chose CIR film because of its ability to highlight subtle differences in vegetation, especially among wetland types. Frame overlap on the 1:12,000-scale photographs was between 50% and 60% along the flight lines and 20% to 30% between the flight lines (**Figure 5**). RSGIS photo interpreters used 9" X 9" prints of the 1:12,000-scale photography (**Figure 6**) to map the Refuge's vegetation A total of nine digital orthophoto quarter quadrangle basemaps were obtained from the USGS and mosaiced to produce the project's basemap (**Title Page)**

RSGIS interpreted the aerial photographs twice. The first interpretation identified patches of homogenous vegetation (areas on the photos with similar tone, texture, color and landscape position) to identify the best sites to place sample plots. The final interpretation was further refined using NVCS-derived map units, field notes, observation point and vegetation plot data to prepare the GIS vegetation database.

Stereoscopic photo interpretation

For both levels of interpretation, we covered each 9"x 9" aerial photograph with sheets of translucent (semi-frosted) Mylar. The aerial photos and their overlays were backlit on a light table and a stereoscope was used to help recognize photo signatures and three-dimensional features. Corner and side tics, photograph and flight line numbers were marked on each Mylar sheet. Polygons were delineated using a 0.5 mm lead pencil. Only the center portion of each aerial photograph was interpreted to minimize the effects of edge distortion. In order to insure completeness and accuracy, digital transfer specialists reviewed all of the interpreted photos for consistency and recommended changes where necessary.

The map units delineated on the photos were derived from the NVCS classification as constrained by the limitations of the photography. Photo interpreters applied the preliminary NVCS classification to aerial photo signatures to see how many plant associations could be recognized on the photos. In most instances, one NVCS association corresponded to one map unit. However, sometimes a plant association could not be recognized consistently on the photos or the photo interpreter could see more detail than was recognized by the vegetation classification. These problems were overcome by using two separate but related classifications: (1) a NVCS classification for the plot data and (2) a map unit classification for the GIS database. The two were related or "crosswalked" by noting where plant associations were lumped into single map units and where other associations were split into multiple map units.

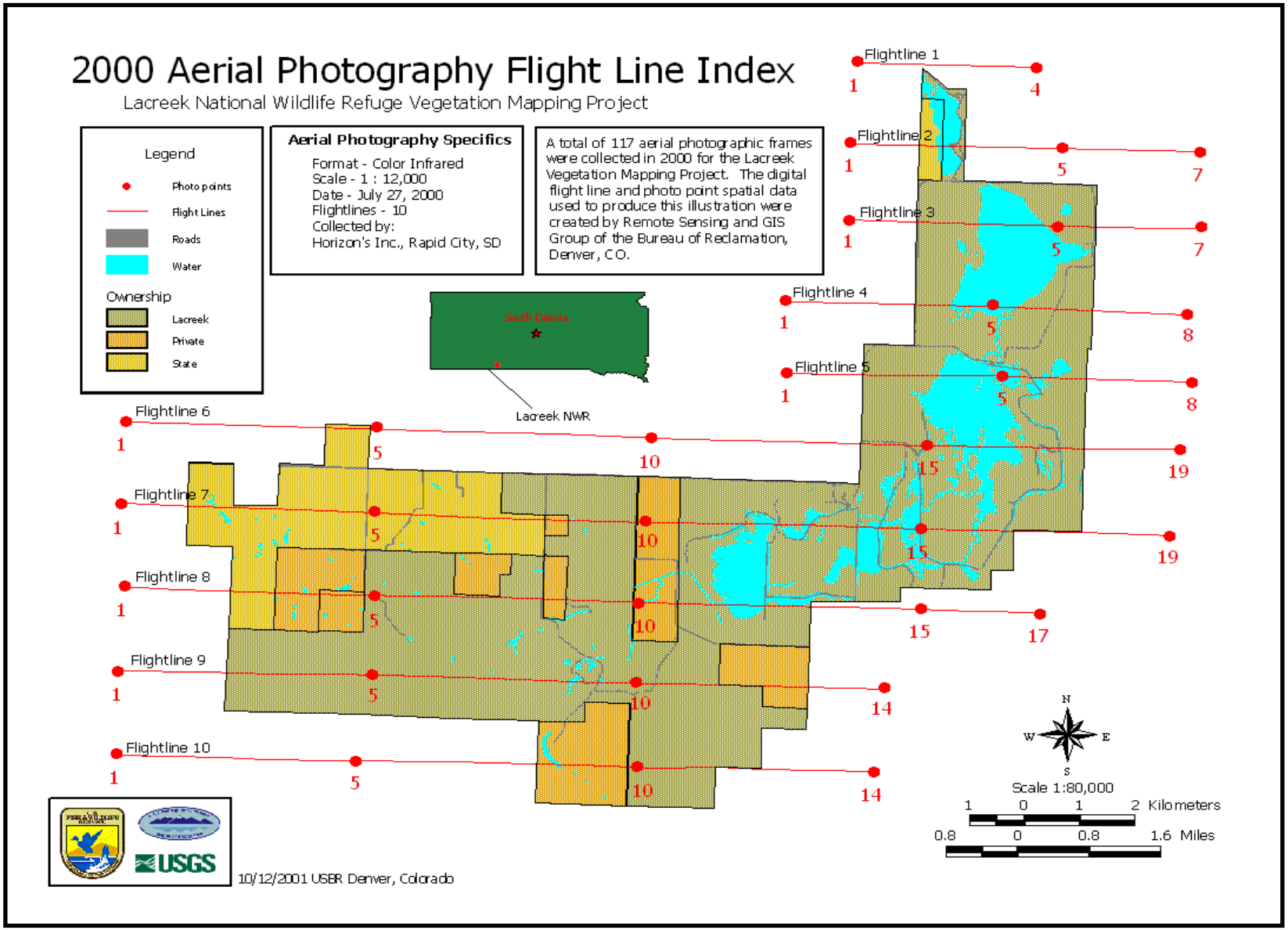


Figure 5. 2000 aerial photo flight line index map for Lacreek National Wildlife Refuge.

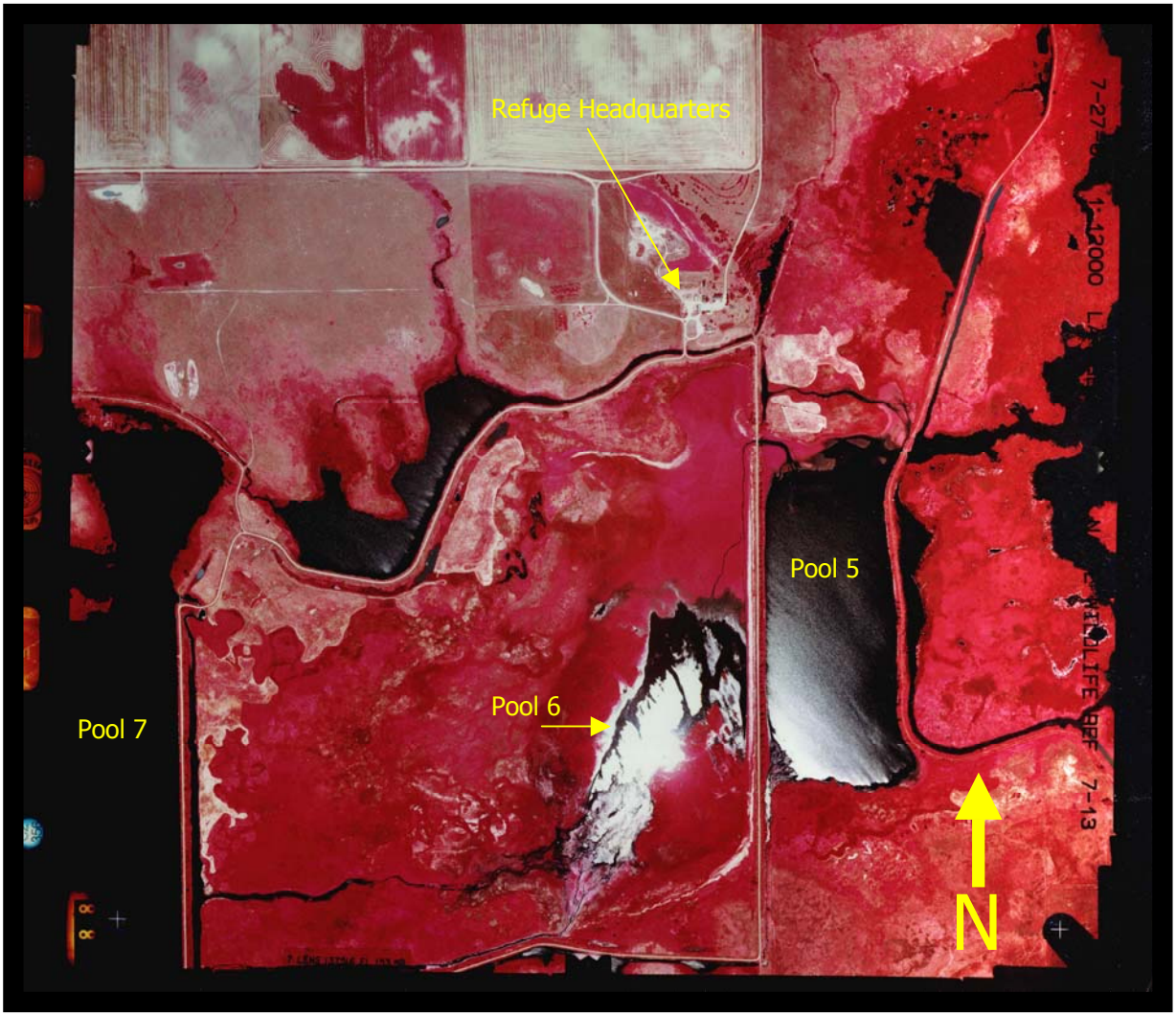


Figure 6. Example of an aerial photograph for the Lacreek National Wildlife Refuge Vegetation Mapping Project (example is not to scale).

We created map units for land-use types based on the system developed by Anderson (1976) to classify remotely sensed cover types. This includes unvegetated lands not included in the NVCS, such as roads, facilities, and agricultural fields. A third class of map units was defined especially for LNWR to cover vegetation types that were easily mapped but were not included in either the NVCS or Anderson, such as priaire dog towns. In addition to refuge special types, LNWR staff also specified other mapping criteria based on management needs. These were addressed by creating a set of modifiers (*i.e.* new polygon attribute items) that provided information on the physiognomic structure of the vegetation.

A list of the final map units appears in **Table 3**.

2.5 Digital Transfer of Photo Interpreted Data

The transfer process removes much of an aerial photograph's inherent distortion and ties the interpreted data to real-world coordinates so it can be digitally automated. To accomplish this for LNWR, an ArcInfo© GIS database was created using in-house protocols. The protocols consist of a shell (*i.e.* master file) of Arc Macro Language (AML) scripts and menus (nearly 100 files) that automate the transfer process, thus insuring that all spatial and attribute data are consistent and stored properly (**Figure 7**). The actual transfer of information from the interpreted aerial photographs to a digital, geo-referenced format involves two basic techniques: (1) scanning the interpreted line work and (2) on-screen digitizing. Both techniques require a background image or basemap. For LNWR, we used nine black/white digital orthophoto quarter quadrangles (**Figure 8**).

The scanning technique used for LNWR involved a multi-step process whereby the Mylar overlay sheets produced by the photo interpreters were scanned into a digital form. The digital image file (tagged image format =.tif) created from the scanned sheet was then converted from a raster image to a vector file using RSGIS-developed AMLs in ArcInfo©. The vector file or 'line coverage' was then geo-referenced to the orthophoto base map. The essential principle of geo-referencing is to match the scale and position of features on the photographs with the scale and position of the same features on the orthophotos. Technicians accomplished this by adjusting the scale of the scanned Mylar between known control points using computer program routines until the adjustment was considered a good fit.

Large Format Scanning

Any remaining land use classes not already scanned (such as roads) were transferred by means of on-screen digitizing. This process entered data into GIS format by manually tracing digital lines (using a mouse) on a computer monitor screen with a DOQQ as a background image. The completed line work for each photo was then edge matched. Finally, polygon topology was built and attribute information added to produce digital vector or polygon coverages (one per photo) that were combined into a final coverage for the entire Refuge.

On-screen Digitizing

We attributed, or labeled, each vegetation polygon for LNWR with necessary information pertaining to map units, NVCS units, Anderson land-use classes, Refuge-special units, and other relevant data. The attribute items are listed in **Table 2** and are referenced in the LNWR vegetation look-up table included on the accompanying CD-ROM. Attribute items include standard GIS categories (area, perimeter), NVCS types mandated by the program (Association, Alliance), and USFWS specific modifiers (mod and eco).

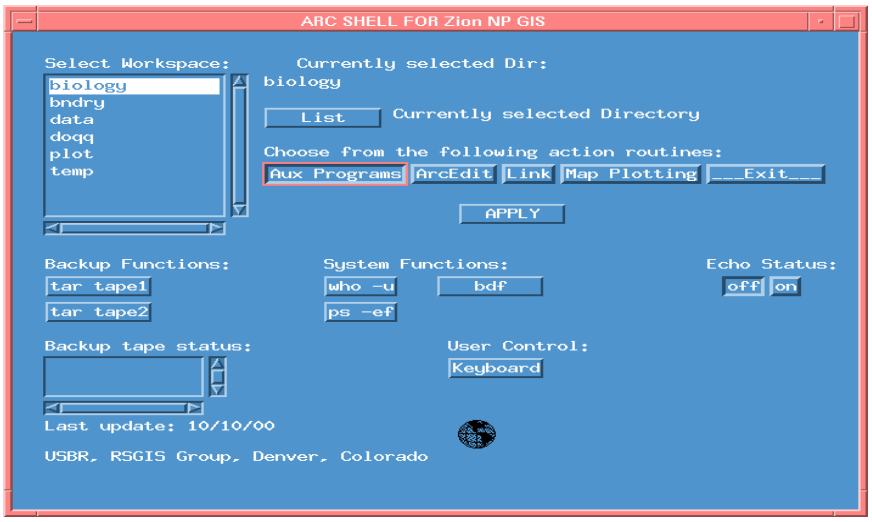


Figure 7. Example of UNIX ArcInfo© Shell Menu Interface.

Table 2. Lacreek Vegetation Spatial Database (GIS Coverage) polygon attribute items and descriptions.

AREA* Surface area of the polygon in meters squared
PERIMETER* Perimeter of the polygon in meters
LNWREEK_VEG#* Unique internal polygon coding
LNWREEK_VEG-ID* Unique internal polygon coding
VEG_CODE Map unit code -project derived, project specific
VEG_NAME Map unit description name - project derived, project specific
ECO Ecological description
PHYS Physiographic description
MOD "R" Modifier indicating the polygon contains an additional USFWS_NAME
FWS_NAME Management unit name – USFWS derived, project specific, not NVCS
FWS_CODE Management unit code – USFWS derived, project specific, not NVCS
ASSN_NAME Project global community name - NVCS association
ASSN_CNAME Project global common community name -
SYNONYM Other common name of association
ASSN_CEGL Community element global code - TNC elcode link to NVCS association
ALL_NAME NVCS alliance name
ALL_CNAME Common alliance name - translated common name of NVCS alliance
NVCS_CODE NVCS code - to NVCS formation level
CLASS NVCS formation class - class name (code)
SUBCLASS NVCS formation subclass - subclass name (code)
GROUP NVCS formation group - group name (code)
SUBGROUP NVCS formation subgroup - subgroup name (code)
FORMATION NVCS formation - formation name
LUC_II Land use and land cover classification system (USGS, Anderson et al. 1976)
COMMENT1 General description of the map unit
COMMENT2 General comment of how the map unit relates to other map units.
LOCATION Location of the polygon, either on LNWR ("Refuge") or on State of South Dakota Lands ("State")
PDOG Evidence of prairie dog activity in the polygon
(*ArcInfo default items)
ACRES Surface Area of Polygon in Acres (calculated: 0.000247 x **Area**)

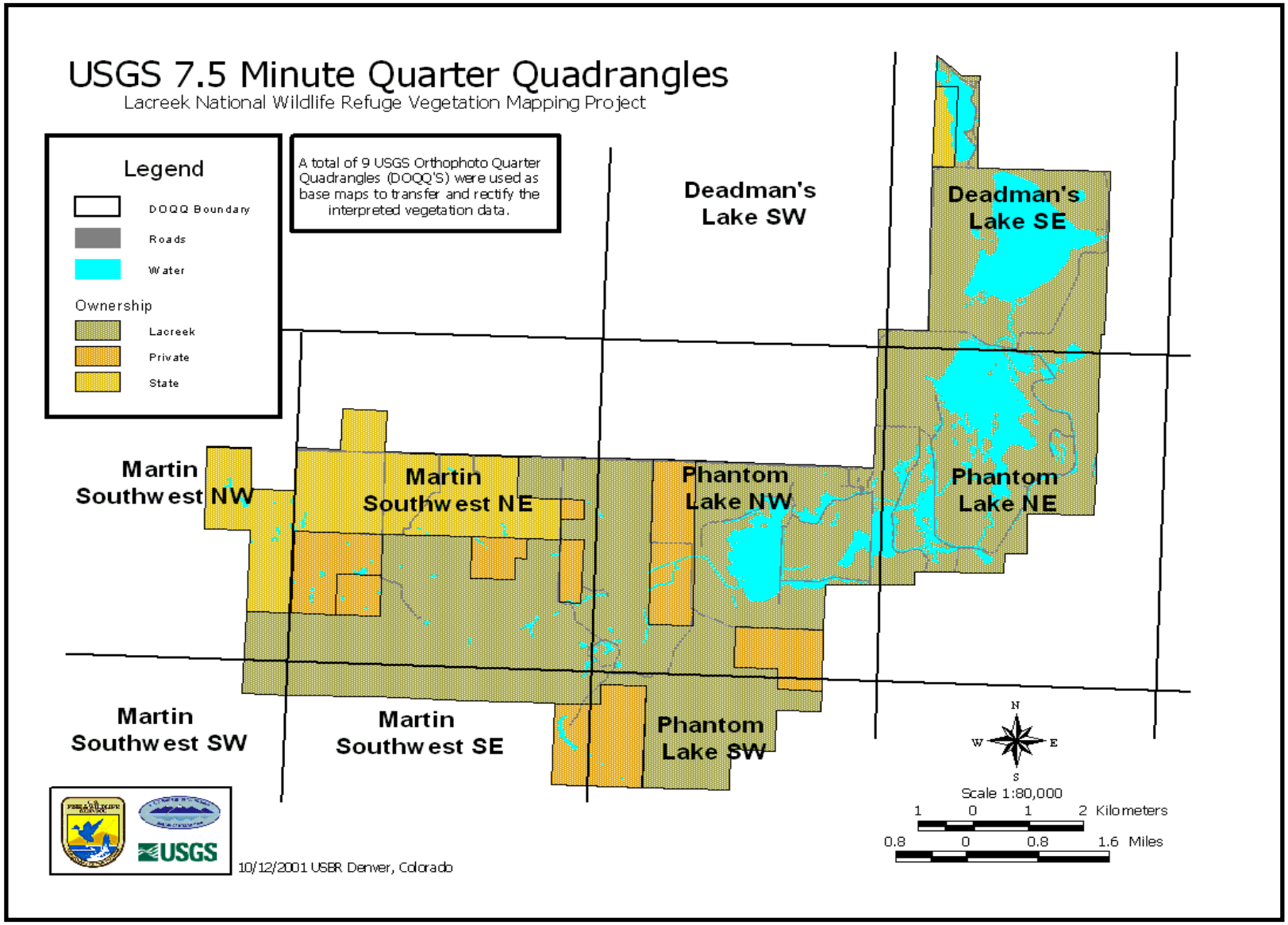


Figure 8. 7.5 minute digital orthophoto quarter quadrangle (DOQQ) index map for Lacreek National Wildlife Refuge.

2.6 Field Verification and Accuracy Assessment

Once the aerial photo interpretation transfer and digitization was complete, we printed draft 1:12,000-scale hard copy vegetation maps. Photo interpreters checked the map against the interpreted aerial photographs to ensure that the polygons were labeled properly and to locate any extra or missing lines. They also compared the map labels to the observation and plot data. Copies of the revised draft map were then sent to the Refuge for review and taken into field by the photo interpreters for ground-truthing. During the ground-truthing process, we collected additional plot data, observation points, and verified aerial photograph signatures using landmarks and GPS waypoints. The map and map units were then modified to correct any mistakes.

RSGIS conducted an assessment of the vegetation map's thematic accuracy in the summer of 2001. Accuracy assessment (AA) sample sites were selected by following the protocols defined by the USGS-NPS Vegetation Mapping Program (TNC 1994a). AA points were selected using a 100-meter grid overlain on the LNWR vegetation coverage in ArcInfo©. The origin of the grid was selected using a random number table and the intersections of the gridlines became the pool of potential sample points. Sample points were removed from the pool if they fell within 10 meters of a vegetation polygon line, fell on a non-vegetated site, or fell on a less than 0.5 ha polygon (mmu). The remaining points were attributed by vegetation type. Between five and 30 points were randomly selected for each vegetation type using a random number generator in ArcInfo©. More AA sample points were selected for common map units and fewer selected for rare map units. Some extremely rare map units had fewer than five AA sample points due to their small size and limited distribution. A total 386 points were selected for accuracy assessment purposes (**Figure 9**).

AA logistics involved plotting AA points and polygon boundaries on hard copy 1:12,000-scale topographic quadrangle maps. Each point's UTM coordinates were uploaded into a Garmin GPS unit to help find the field location of the AA points. Armed with the vegetation key, the digital AA point coordinates, and the map, an RSGIS ecologist (who had no involvement with the project otherwise) collected AA data at LNWR. The ecologist walked to each AA point and used the vegetation key (**Appendix D**) to identify the plant association within a 40m radius. Data recorded for each point included the community name(s), dominant species, environmental conditions, and rationale for the identification (**Appendix C**).

Upon completion of the fieldwork, AA data were entered into a MS Acess© database and reviewed for entry errors. Incomplete data on the field sheets, including missing GPS coordinates, were corrected if possible. Final AA points were viewed in ArcView in relation to the vegetation map coverage. Actual assessment consisted of comparing the determination made in the field for each AA point to the polygon map label. These comparisons were made at an AA meeting held in September 2001 by a panel of USFWS and BOR staff. Each point was reviewed for accuracy and for errors made by the AA ecologist. In this manner, "false" errors or mismatches between a polygon and

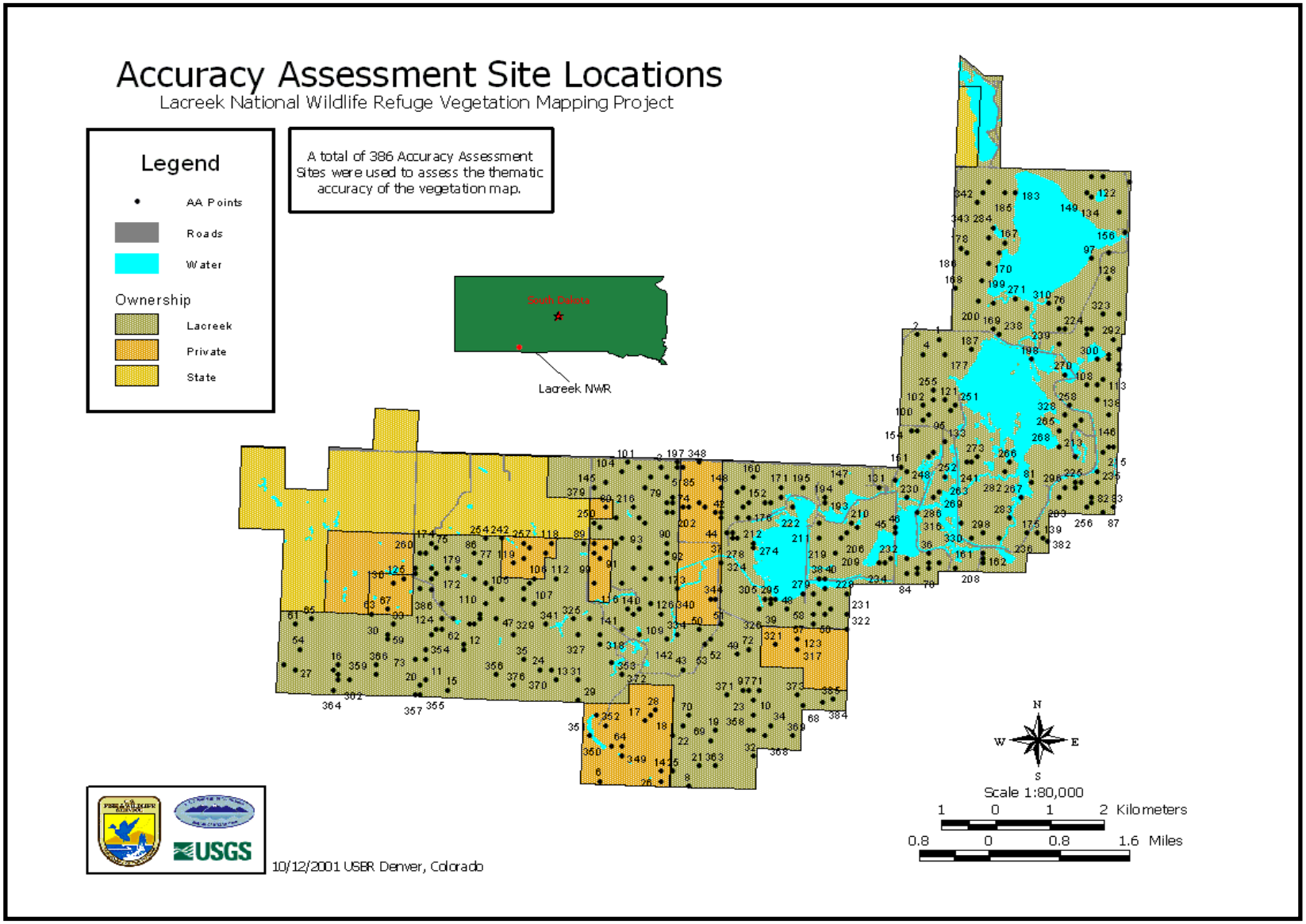


Figure 9. Locations of accuracy assessment points at Lacreek National Wildlife Refuge.

an accuracy assessment were separated from true errors. False errors were generally recognized as resulting from one of three problems:

- **GPS errors:** The point was located incorrectly (wrong polygon) due to GPS limitations (+/- error). Usually the point was too close to a polygon boundary. (10 meter buffer was not sufficient)
- **Ecotone errors:** A point occurred in a zone of transition between two types.
- **Intuitive errors:** A point was classified differently than the polygon label but was overruled by USFWS staff. These errors probably resulted either from assessing areas too small to map (*i.e.* inclusion) or assessing too small an area around the point while on the ground. Also, seasonality changes in species composition (*e.g.* warm season and cool season grasses) from the time of the photography to the time of the AA were addressed.

An assessment for each point was recorded in error matrix (*i.e.* contingency table) upon final approval by the LNWR staff.

Landuse contrast at Lacreek National Wildlife Refuge highlighting the differences in herbaceous cover on grazed (left) and ungrazed (right) in Soapweed Yucca Shrubland.

3. RESULTS AND DISCUSSION

3.1 NVCS Classification at Lacreek NWR

Visual inspection, classification and ordination of the 65 plots sampled at LNWR resulted in 23 plant associations (see **Table 3**). We determined the classification using species foliar cover values following procedures described by Grossman *et al.* (1988) and McCune and Mefford (1999). The plot data was analyzed several times using TWINSPAN (classification technique) and DECORANA (ordination technique) (**Figures 10-11**). We edited the plot data prior to analysis by first removing all species that had total cover values (summed over all 65 plots) of $\leq$ 1%. Further, all TWINSPAN grouping analyses were conducted using relative foliar cover values, while raw foliar cover scores were used in the DECORANA ordination procedures. The data was then subjectively evaluated for plots that demonstrated exceptionally low similarity to the remaining plots, *i.e*. outliers (Gauch 1982).

Prairie dog town plots were the first outlier group to be identified and removed from the data set due to their extremely heterogeneous composition. We then combined the remaining plots that demonstrated considerable similarity into composite plots. By using DECORANA ordination again we identified the composite class of *Polygonum amphibum* Herbaceous Vegetation and the *Juncus balticus* Herbaceous Vegetation as a second outlier and removed it prior to the final ordination. Removing the outliers from the analysis spread the remaining plots across a larger two-dimensional space helping to emphasize environmental gradients and highlighting distinct communities.

The results of the classification process produced several large and predictable groups such as wetlands, mesic grasslands, sandhills grasslands and shrublands, and "Restoration Areas". Segregation of these types appeared to be based on a complex environmental gradient related to soil type/texture, land-use history, and soil moisture levels. Sandhills communities dominated by *Hesperostipa comata and Yucca glauca* were ordinated at one end of the resulting gradient while wetland associations dominated by *Salix* sp. and *Typha* sp. were found at the opposite end. The middle had an intricate mixture of natural grasslands, introduced grasslands, and restoration areas.

Based on the resulting classification, we separated the vegetation of LNWR into three broad physiognomic categories. These categories are similar to ecological groups in that they share similar ecological processes. The use of ecological groups is a way of emphasizing some of the ecological, rather than floristic or physiognomic, similarities among the types. The three types found at LNWR include the Nebraska Sandhills, Northern Mixed Grass Prairie, and Great Plains Wetlands. Most of the plant associations matched the preliminary classification and were similar for other classified sites in the Great Plains and described in the Midwest Classification (Faber-Langendoen *et al.* 1996 (**Table 3**). The final NVCS classification summary and detailed NVCS descriptions are included in **(Appendix E)**.

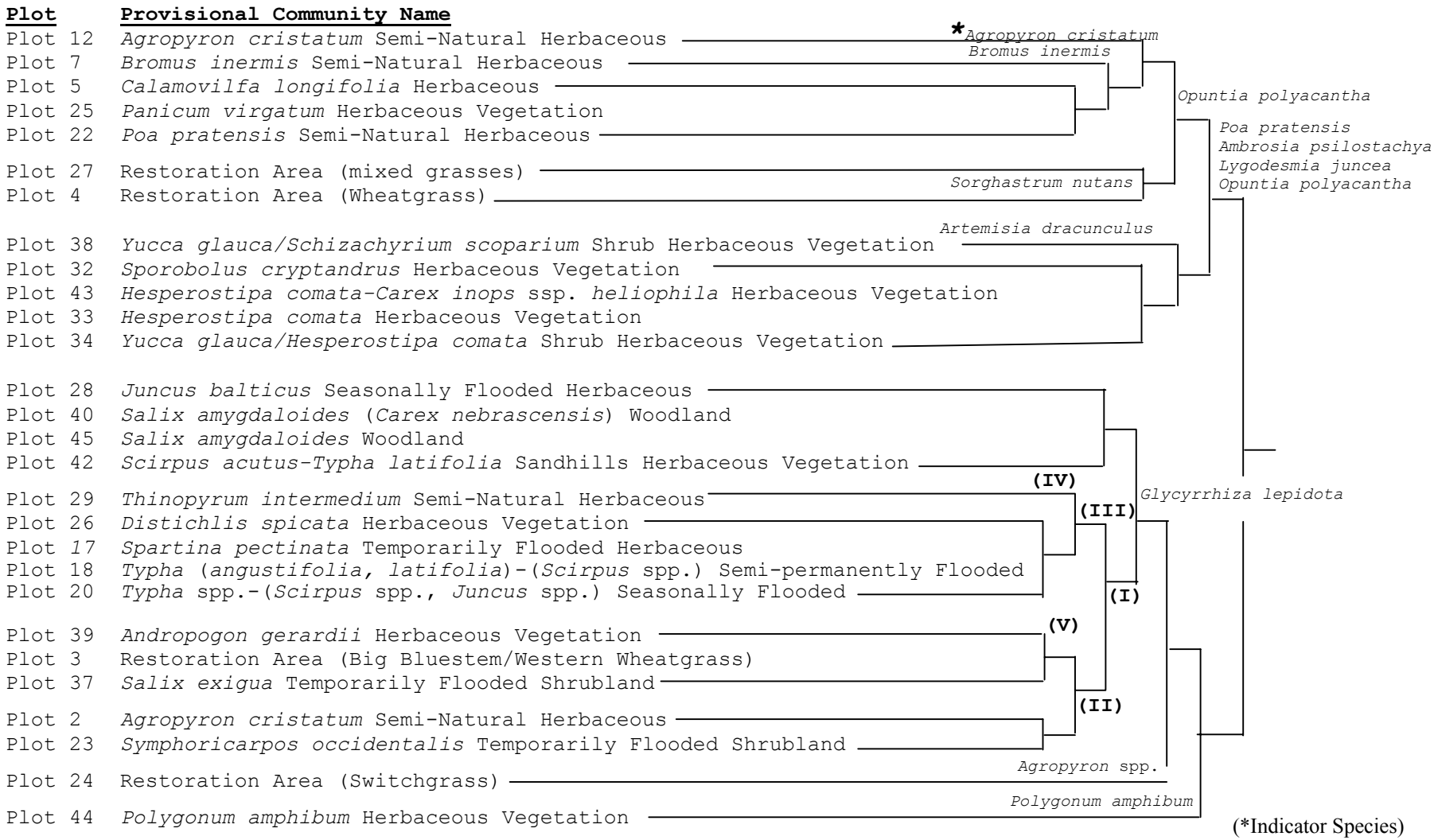


Figure 10. Final twinspan dendrogram of 28 plots (composite plots and individual plots) collected at Lacreek National Wildlife Refuge.

- Indicator species: (I) = *Cirsium arvense*, *Aster ericoides*, and *Sonchus arvensis*, (II) = *Bromus inermis*, (III) = *Sonchus arvensis*, (IV) = *Thinopyrum intermedium*, and (V) = *Andropogon gerardii*.

Figure 11. Detrended correspondence analysis ordination of 24 vegetation plots (composite plots and individual plots) recorded during the 2000 field season from Lacreek National Wildlife Refuge, Martin, South Dakota.

-please see Figure 10 for provisional community names for each plot.

Table 3. Vegetation communities (plant associations) recognized at Lacreek NWR and environs based on the NVCS.

Community Name (Association)	Common Name (Synonym)	Elcode*
Northern Mixed Grass Prairie: Animal Units		
Blacktailed Prairie Dog Town Grassland Complex	Blacktailed Prairie Dog Town Grassland Complex,	CECX002003
Sandhills Vegetation		
Calamovilfa longifolia - Carex inops ssp. heliophila Herbaceous Vegetation.	Prairie Sandreed - Sun Sedge Herbaceous Vegetation	CEGL001471
Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation	Prairie Sandreed - Needle-and-Thread Herbaceous Vegetation	CEGL001473
Schizachyrium scoparium - Bouteloua (curtipendula, gracilis) - Carex filifolia Herbaceous Vegetation	Little Bluestem - (Sideoats Grama, Blue Grama) - Threadleaf Sedge Herbaceous Vegetation	CEGL001681
Yucca glauca / Calamovilfa longifolia Shrub Herbaceous Vegetation	Soapweed Yucca / Prairie Sandreed Shrub Herbaceous Vegetation	CEGL002675
Northern Mixed Grass Prairie: Upland Grasslands		
Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata) Semi-natural Herbaceous Vegetation	Crested Wheatgrass - (Western Wheatgrass, Needle-and-Thread) Semi-natural Herbaceous Vegetation	CEGL005266
Andropogon gerardii - Panicum virgatum - Helianthus grosseserratus Herbaceous Vegetation	Big Bluestem - Switchgrass - Sawtooth Sunflower Herbaceous Vegetation	CEGL002024
Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation	CEGL005264
Hesperostipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation	Needle-and-thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation	CEGL002037
Pascopyrum smithii - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation	Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation	CEGL001579
Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	Kentucky Bluegrass - (Western Wheatgrass) Semi-natural Herbaceous Vegetation	CEGL005265
Thinopyrum intermedium Semi-natural Herbaceous Vegetation	Intermediate Wheatgrass Semi-natural Herbaceous Vegetation	CEGL002935
Northern Mixed Grass Prairie: Forblands		
Polygonum spp. - Mixed Forbs Herbaceous Vegetation	Smartweed Species - Mixed Forbs Herbaceous Vegetation	CEGL002430
Northern Mixed Grass Prairie: Mesic Grasslands		
Distichlis spicata - Hordeum jubatum - Puccinellia nuttalliana - Suaeda calceoliformis Herbaceous Vegetation	Saltgrass - Foxtail Barley - Nuttail's Alkali Grass - Seablite Herbaceous Vegetation	CEGL002273
Panicum virgatum - (*Pascopyrum smithii*) Herbaceous Vegetation	Switchgrass - (Western Wheatgrass) Herbaceous Vegetation	CEGL001484
Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation	Common Reed Western North America Temperate Semi-natural Herbaceous Vegetation	CEGL001475
Spartina pectinata - Carex spp. Herbaceous Vegetation	Prairie Cordgrass - Sedge species Herbaceous Vegetation	CEGL001477

Great Plains Wetland: Herbaceous Vegetation		
Carex nebrascensis Herbaceous Vegetation	Nebraska Sedge Herbaceous Vegetation	CEGL001813
Juncus balticus Herbaceous Vegetation	Baltic Rush Herbaceous Vegetation	CEGL001838
Schoenoplectus acutus - Typha latifolia - (Schoenoplectus tabernaemontani) Sandhills Herbaceous Vegetation	Hardstem Bulrush - Broadleaf Cattail - (Softstem Bulrush) Sandhills Herbaceous Vegetation	CEGL002030
Schoenoplectus pungens Herbaceous Vegetation	Threesquare Bulrush Herbaceous Vegetation	CEGL001587
Typha spp. Great Plains Herbaceous Vegetation	Cattail species Great Plains Herbaceous Vegetation	CEGL002389
Northern Mixed Grass Prairie: Upland Shrublands		
Symphoricarpos occidentalis Shrubland	Western Snowberry Shrubland	CEGL001131
Northern Mixed Grass Prairie: Mesic Shrublands		
Salix exigua / Mesic Graminoids Shrubland	Sandbar Willow / Mesic Graminoids Shrubland	CEGL001203
Northern Mixed Grass Prairie: Mesic Woodlands		
Salix amygdaloides Woodland	Peachleaf Willow Woodland	CEGL000947

*ELCODE represents NatureServe/TNC's internal NVCS database code (CEGL) for each vegetation association.

3.2 Photo-interpretation and Map Units

We recognized and delineated 60 map units on the color infrared aerial photographs for LNWR. This included 43 vegetation land-cover units and 17 Anderson (1976) Level II and 'Sub-level' II (more detailed units than Level II) land-use units (**Table 4**). The map units were developed from a combination of an initial NVCS vegetation classification provided by NatureServe with input from Refuge biologists and BOR ecologists, fieldwork, and preliminary photo-interpretation.

Included below are brief descriptions of the vegetation map units for LNWR as viewed in the field and from an overhead perspective. Please reference **Appendix G.** for photo-signature descriptions and representative photos for all vegetation map units.

Northern Mixed Grass Prairie: Animal Unit

1.0 Prairie Dog Town Complex
Prairie dog towns are found on deep, well-drained soils. The vegetation found on the prairie dog towns is somewhat variable depending primarily on the types of plant associations and agricultural activities that are in close proximity. Usually, the prairie dog towns are a mixture of areas of long-term established burrows, areas where the town is expanding, and areas of abandoned burrows. Collectively, this produces a fairly complex and patchy mosaic of vegetation. The result is usually a mix of introduced perennial graminoids that include smooth brome, Kentucky bluegrass, and crested wheatgrass (*Agropyron cristatum*) as well as a few species of native grasses such as western wheatgrass. The burrowing and grazing activities of the prairie dogs also provide bare soil for weedy plants that include dog fennel (*Dyssodia papposa*), Russian thistle (*Salsola iberica*) Canada thistle (*Cirsium arvense*), annual sunflower (*Helianthus annuus*), and white sweet clover (*Melilotus officinalis*).

Nebraska Sandhills Vegetation
The Sandhills region of northwestern Nebraska extends about a mile into the southern portion of the Refuge, covering approximately 28% (4500 acres) of LNWRs total area. This area is characterized by rolling terrain and stable sand deposits supporting a variety of common graminoids and shrubs, primarily prairie sandreed (*Calamovilfa longifolia*), sand bluestem (*Andropogon hallii*), needle-and-thread (*Hesperostipa comata*), and Soapweed yucca (*Yucca glauca*). Other species include sun sedge (*Carex inops* ssp. *Heliophila*), prairie junegrass (*Koeleria macrantha*), little bluestem (*Schizachyrium scoparium*), hairy grama (*Bouteloua hirsuta*), blue grama (*B.* gracilis), and sand dropseed (*Sporobolus cryptandrus*). There are six map units in this group.

2.1 Soapweed Yucca (Sparse Understory) Shrub Herbaceous Vegetation,
2.2 Soapweed Yucca / Prairie Sandreed Shrub Herbaceous Vegetation,
3.1 Needle-and-Thread / Soapweed Herbaceous Vegetation
Cover values for soapweed yucca shrubs ranges between 5-30% in these types. Cover and density of soapweed yucca tends to be highest on north facing slopes. While species composition may vary, overall foliar cover of the herbaceous vegetation is usually consistent. The most common grasses include prairie sandreed, sand bluestem, and needle-and-thread. Using the relatively consistent signature that soapweed densities provided, an attempt was made to separate it into three map classes based on shrub density and associated species.

Table 4. Map units and related levels within the NVCS or Land-use classification for Lacreek NWR. (Map units are organized by Ecological Groups.)

Map Class	Map Unit Name	Map Unit Common Name	Level
Northern Mixed Grass Prairie: Animal Units			
1.0	Blacktailed Prairie Dog Town Grassland Complex	Blacktailed Prairie Dog Town Grassland Complex	Association
Sandhills Vegetation			
2.1	*Yucca glauca* (Sparse Understory) Shrub Herbaceous Vegetation	Soapweed Yucca (Sparse Understory) Shrub Herbaceous Vegetation	Floristic Sub-Association
2.2	*Yucca glauca / Hesperostipa comata* Shrub Herbaceous Vegetation	Soapweed Yucca / Needle-and-thread Shrub Herbaceous Vegetation	Floristic Sub-Association
3.1	*Hesperostipa comata / Yucca glauca* Herbaceous Vegetation	Needle-and-thread / Soapweed Yucca Herbaceous Vegetation	Floristic Sub-Association
3.2	*Calamovilfa longifolia - Hesperostipa comata* Herbaceous Vegetation	Prairie Sandreed - Needle-and-thread Herbaceous Vegetation	Floristic Sub-Association
3.3	*Calamovilfa longifolia - Carex inops ssp. heliophila* Herbaceous Vegetation.	Prairie Sandreed - Sun Sedge Herbaceous Vegetation	Association
4.0	*Schizachyrium scoparium - Bouteloua (curtipendula, gracilis) - Carex filifolia* Herbaceous Vegetation	Little Bluestem - (Sideoats Grama, Blue Grama) - Threadleaf Sedge Herbaceous Vegetation	Association
Northern Mixed Grass Prairie: Upland Grasslands			
5.0	*Hesperostipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation	Needle-and-thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation	Association
6.0	*Andropogon gerardii - Panicum virgatum - Helianthus grosseserratus* Herbaceous Vegetation	Big Bluestem - Switchgrass - Sawtooth Sunflower Herbaceous Vegetation	Association
7.0	*Pascopyrum smithii - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation	Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation	Association
8.0	*Poa pratensis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation	Kentucky Bluegrass - (Western Wheatgrass) Semi-natural Herbaceous Vegetation	Association
9.0	*Bromus inermis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation	Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation	Association
10.0	*Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata)* Semi-natural Herbaceous Vegetation	Crested Wheatgrass - (Western Wheatgrass, Needle-and-Thread) Semi-natural Herbaceous Vegetation	Association
11.0	*Thinopyrum intermedium* Semi-Natural Herbaceous Vegetation	Intermediate Wheatgrass Semi-Natural Herbaceous Vegetation	Association
12.1	Mixed Grasslands	Mixed Grassland	*Complex/Association
12.2	Mixed Grassland (Warm Season Natives)	Mixed Grassland (Warm Season Natives)	Complex/Association
12.3	Mixed Grassland (Cool Season Natives)	Mixed Grassland (Cool Season Natives)	Complex/Association

Northern Mixed Grass Prairie: Forblands			
13.0	Mixed Forblands	Mixed Forblands	Complex/Association
14.0	*Cirsium arvense* Patches	Canada Thistle Patches	Association
15.0	*Glycyrrhiza lepidota* Stands	Wild Licorice Stands	Sub-Association
16.0	*Polygonum amphibum* Herbaceous Vegetation	Water Smartweed Herbaceous Vegetation	Association
Northern Mixed Grass Prairie: Mesic Grasslands			
17.0	*Panicum virgatum - (Pascopyrum smithii)* Herbaceous Vegetation	Switchgrass - (Western Wheatgrass) Herbaceous Vegetation	Association
18.1	*Hordeum jubatum* Herbaceous Vegetation	Foxtail Barley Herbaceous Vegetation	Floristic Sub-Association
18.2	*Distichlis spicata* Herbaceous Vegetation	Saltgrass Herbaceous Vegetation	Floristic Sub-Association
19.0	*Spartina pectinata - Carex spp.* Herbaceous Vegetation	Prairie Cordgrass - Sedge species Herbaceous Vegetation	Association
20.0	*Phragmites australis* Herbaceous Vegetation	Common Reed Herbaceous Vegetation	Association
Great Plains Wetland: Herbaceous Vegetation			
21.0	*Juncus balticus* Herbaceous Vegetation	Baltic Rush Herbaceous Vegetation	Association
22.0	*Carex nebrascensis* Herbaceous Vegetation	Nebraska Sedge Herbaceous Vegetation	Association
23.0	Emergent Sandhills Wetland	Emergent Sandhills Wetland	Alliance
24.0	*Schoenoplectus pungens* Herbaceous Vegetation	Threesquare Bulrush Herbaceous Vegetation	Association
25.0	*Schoenoplectus acutus - Typha latifolia - (Schoenoplectus tabernaemontani)* Sandhills Herbaceous Vegetation	Hardstem Bulrush - Broadleaf Cattail - (Softstem Bulrush) Sandhills Herbaceous Vegetation	Association
26.1	*Typha spp.* Great Plains Herbaceous Vegetation (Semipermanently Flooded)	Cattail species Great Plains Herbaceous Vegetation (Semipermanently Flooded)	Hydrology Sub-Association
26.2	*Typha spp.* Great Plains Herbaceous Vegetation (Seasonally Flooded)	Cattail species Great Plains Herbaceous Vegetation (Seasonally Flooded)	Hydrology Sub-Association
Northern Mixed Grass Prairie: Upland Shrublands			
27.0	*Symphoricarpos occidentalis* Shrubland	Western Snowberry Shrubland	Association

Northern Mixed Grass Prairie: Mesic Shrublands			
28.0	*Prunus americana* Stands	American Plum Stands	Association
29.0	*Amorpha fruticosa* Stands	False Indigobush Stands	Association
30.0	*Salix exigua / Mesic Graminoids* Shrubland	Sandbar Willow / Mesic Graminoids Shrubland	Association
Northern Mixed Grass Prairie: Mesic Woodlands			
31.0	*Celtis occidentalis* Stands	American Hackberry Stands	Association
32.0	*Salix amygdaloides* Woodland	Peachleaf Willow Woodland	Association
33.0	*Populus deltoides* Stands	Plains Cottonwood Stands	Association
34.0	*Fraxinus pennsylvanica* Stands	Green Ash Stands	Association
Northern Mixed Grass Prairie: Upland Grasslands (Planted)			
35.1	Native Species Plantings (*Bouteloua curtipendula*)	Native Species Plantings (Sideoats Grama)	Floristic Sub-Association
35.2	Native Species Plantings (*Mixed Grasses*)	Native Species Plantings (Mixed Grasses)	Complex/Association
35.3	Native Species Plantings (*Panicum virgatum*)	Native Species Plantings (Switchgrass)	Floristic Sub-Association
Agriculture			
40.0	Agricultural Lands	Agricultural Lands	Level I
41.0	Shelterbelt	Shelterbelt	Level II
Barren Lands			
42.0	Beach	Beach	Level II
43.0	Sandhills Blowout	Sandhills Blowout	Sub-Level II
Land-use and Transportation			
44.0	Bennett County Roads	Bennett County Roads	Sub-Level II
45.0	Refuge Management Roads	Refuge Management Roads	Sub-Level II
46.0	Levees (Flood Control)	Levees (Flood Control)	Sub-Level II
47.0	Dikes (Separate Impoundments)	Dikes (Separate Impoundments)	Sub-Level II

48.0	Cemetery	Cemetery	Level II
Ponds			
49.0	Ponds, impoundments	Ponds, impoundments	Sub-Level II
50.0	Ponds, Trout	Ponds, Trout	Sub-Level II
51.0	Ponds, potholes/dugout/stock	Ponds, potholes/dugout/stock	Sub-Level II
52.0	Pools	Pools	Sub-Level II
Streams and Rivers			
53.0	Lake Creek Channel	Lake Creek Channel	Sub-Level II
Built-up Lands			
54.0	Clay Pits	Clay Pits	Level II
55.0	Refuge Facilities	Refuge Facilities	Level II
56.0	Residential	Residential	Level II

***COMPLEX:** Individual associations are not recognizable on the aerial photographs but repeatedly occur together in the landscape**.** Complexes typically are composed of communities with similar physiognomies; thus are more difficult to tell apart on the photo.

3.2 Prairie sandreed – Needle-and-Thread Herbaceous Vegetation
Small stands are common throughout the sandhills; however, many are smaller than the minimum mapping unit of 0.5 ha. The most extensive stands of prairie sandreed occur primarily in the northeast corner of the sandhills (southeast corner of the Refuge) and often appear to serve as a transition between the sandhills and the mixed prairie on finer textured soils and wetlands to the north. Foliar cover for this association ranges from 20-40%. The dominant species is prairie sandreed, with sand bluestem, needle-and-thread, and Kentucky bluegrass (*Poa pratensis*) as common secondary species. Soapweed is often present but usually at low densities.

3.3 Prairie Sandreed – Sun Sedge Herbaceous Vegetation
These grasslands are intricately intermixed with the Prairie Sandreed – Needle-and-Thread Herbaceous Vegetation and the Soapweed yucca units. Cover of soapweed yucca shrubs is typically less than 5%. Prairie sandreed is the most common graminoid but sand bluestem appears to vary considerably and may be locally dominant. Common secondary species include needle-and-thread, sun sedge, sand dropseed, hairy grama, and prairie Junegrass. Forb cover and composition is highly variable. Sunflower (*Helianthus annuus*) was especially prominent during the 2001 field season.

4.0 Little Bluestem - Grama Grass (Sideoats, Blue) - Threadleaf Herbaceous Vegetation
This community type is restricted to moderately steep, north and east facing slopes in the sandhills. Vegetation cover is typically between 75 and 85% and is dominated by little bluestem. Cover by soapweed yucca varies, but is usually 10 to 20%. Although species richness can be relatively high, overall cover and frequency of associated species is exceptionally low. Needle-and-thread, prairie june grass (*Koeleria macrantha*), dotted gayfeather (*Liatris punctata*), and prairie sandreed are common associates.

Northern Mixed Grass Prairie: Upland Grasslands
The herbaceous vegetation units recorded on the Refuge are probably typical of managed mixed grass prairie types found throughout the northern Great Plains region. Introduced grass species, native prairie restoration, and mowing to control Canada thistle have modified many of the natural grasslands of the Refuge. Western wheatgrass (*Pascopyrum smithii*) is probably the most common native grass species on the Refuge. Stands of switchgrass (*Panicum virgatum*) and big bluestem (*Andropogon gerardii*) are widely scattered throughout. Ten map units make-up this group.

5.0 Needle-and-Thread - Blue Grama Grass - Threadleaf Sedge Herbaceous Vegetation
This unit is found only on a few localized areas on the Refuge. Stands occur on hill summits and on gentle slopes with loamy soils. Needle-and-thread, blue grama, and threadleaf sedge (*Carex filifolia*) are the major species, while sand dropseed and western wheatgrass are common secondary species. Total cover ranges from 40-70% depending primarily on the abundance of threadleaf sedge and blue grama. Japanese brome is a common invader on these sites.

6.0 Big Bluestem - Switchgrass - Sawtooth Sunflower Herbaceous Vegetation
This unit is widely scattered on mesic sites throughout the Refuge, except in the Sandhills portion. It is often closely associated with prairie cordgrass (*Spartina pectinata*) and switchgrass (*Panicum virgatum*) map units. Big bluestem also appears to be a common constituent of many prairie restoration efforts on the Refuge. Typical stands of this association have moderate to dense herbaceous cover with typical foliar cover values ranging from 50 to 100%. Big bluestem is the dominant species, becoming more prominent later in the growing season. Distribution of the species is often patchy within a stand, with associated species such as sawtooth sunflower (*Helianthus grosseserratus),* prairie cordgrass*,* smooth brome, and switchgrass occupying the interstitial spaces.

7.0 Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation
Extensive stands of western wheatgrass are found on silty loam soils throughout the Refuge. Overall species richness in this community type is low. However, inland saltgrass (*Distichlis spicata*), blue grama, and Kentucky bluegrass are frequent associates.

Introduced, exotic grasslands occur throughout the Refuge and are sometimes associated with disturbances such as roadsides, abandoned farm fields, and areas that were interseeded with exotic grasses. However, exotic grasses can and do invade intact native communities. Exotic grasses often dominate areas that have been disturbed as a result of construction or agriculture. Exotic grasses, such as smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis),* crested wheatgrass (*Agropyron cristatum*) have invaded native grassland types, often becoming the dominant species. In some areas, the mixed grass prairie types form an intricate and intermixed transition zone between the sandhills vegetation types and the wetland types.

8.0 Kentucky Bluegrass - (Western Wheatgrass) Semi-natural Herbaceous Vegetation
The Kentucky bluegrass semi-natural association also occurs in a wide variety of habitats, including the Sandhills. Although stands can be monotypic, overall species richness is usually higher in this association than in other introduced grasslands. Litter accumulation is often very high in many stands.

9.0 Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation
The smooth brome semi-natural map unit is probably the most common and widely distributed plant species on the Refuge. Stands occur in an exceptionally wide variety of habitats, with the exception of the Sandhills. The species was widely planted for soil stabilization and as part of the Conservation Reserve Program. It is a very aggressive exotic that has expanded into disturbed and undisturbed areas. These grasslands usually consist of a nearly monotypic stand of *Bromus inermis* that is usually less than 1 m in height. Well-developed stands have few, if any, associated species.

10.0 Crested Wheatgrass - (Western Wheatgrass, Needle-and-Thread) Semi-natural Herbaceous Vegetation
The crested wheatgrass semi-natural type is probably best represented on the upland grassland areas north and west of the Refuge headquarters. These grasslands are usually found on relatively level to gently rolling sites. Typically the soils are silt or clay loams that probably supported western wheatgrass grasslands in the past. Stands of crested wheatgrass typically have moderate herbaceous cover that ranges from 30 to 60%. Litter cover on the soil surface is often dense. The sites are dominated by crested wheatgrass with a host of invasive species such as Kentucky bluegrass and/or smooth brome. The forb component is usually very sparse.

11.0 Intermediate wheatgrass Semi-Natural Herbaceous Vegetation
The intermediate wheatgrass semi-natural type is only represented on a few sites in the Refuge. Stands of intermediate wheatgrass typically have moderate herbaceous cover that ranges from 30 to 60%. Litter cover on the soil surface is often dense. The sites are dominated by intermediate wheatgrass with other invasive species such as Kentucky bluegrass and/or smooth brome. The forb component is usually very sparse.

12.1, 12.2, 12.3 Mixed Native Species
35.1, 35.2, 35.2 Native Species Plantings
Historic land management practices resulted in different native species complexes scattered throughout the Refuge. In addition, restoration efforts have occurred throughout the Refuge at various times and produced several types. Some types have clear dominants such as side oats grama (*Bouteloua curtipendula*) and switchgrass. However, other sites have experienced secondary succession producing more complex vegetation types characterized by a mixture of species.

Northern Mixed Grass Prairie: Forbland

13.0 Mixed Forblands
This unit represents areas in and around the Refuge pools that support mixed weedy or annual forbs with little graminoid species. Areas are usually heavily disturbed from flooding.

14.0 Canada Thistle Patches
This unit is common throughout the Refuge in mesic grassland sites. Canada thistle usually contributes heavily to the cover, upwards of 100%, and may displace the native species. Mowing to control the spread of this type is evident in large patches.

15.0 Wild Licorice Stands
This map unit is rare on the Refuge and restricted to only a few sites around the Refuge Pools. Wild licorice (*Glycyrrhiza lepidota*) is clearly the dominant in these sites with very little associated species.

16.0 Smartweed Species - Mixed Forbs Herbaceous Vegetation
This association is common to drawdown and mudflat areas around the Refuge. The soils are usually saturated and support mixed weedy or annual forbs with little graminoid species. Diversity is usually low and association composition likely varies from season to season and year to year.

Northern Mixed Grass Prairie: Mesic Grasslands

17.0 Switchgrass – (Western Wheatgrass) Herbaceous Vegetation
This association occurs on upland sites throughout the Refuge, including isolated patches in sandhill swales and depressions. Well-developed examples also occur on sites adjacent to wetland community types. The switchgrass herbaceous vegetation type provides ground cover values of between 50 and 80%. Switchgrass and big bluestem are the dominant species, especially in mesic areas, while western wheatgrass is more abundant on drier sites. Common associated species include wild licorice and Kentucky bluegrass. Where the type occurs in the sandhills, the distribution becomes patchy and bordered by prairie sandreed, needle-and-thread, and soapweed yucca shrubs. Smooth brome is a major invader in sites adjacent to the Sandhills, resulting in complex mosaics of switchgrass and smooth brome.

18.1 Foxtail Barely Herbaceous Vegetation
18.2 Saltgrass Herbaceous Vegetation
These units occupy flat, alkaline, silt loam soils near the Refuge pools on sites that are poorly to moderately well-drained. The fluctuating water table is probably within the rooting zone of the vegetation for most of the growing season. In many cases, this association is fairly monotypic and dominated by inland saltgrass (*Distichlis spicata*). Total foliar cover is usually less than 50% and vegetation height is often less than 15 cm. The most common secondary species is Kentucky bluegrass. Small depressions often contain nearly pure stands of foxtail barley (*Hordeum jubatum*).

19.0 Prairie Cordgrass – Sedge Species Grassland
The prairie cordgrass (*Spartina pectinata*) vegetation type occurs throughout the Refuge where the soil is wet for at least part of the growing season, including the sandhills portion. Large stands grow between the cattail and inland saltgrass *a*ssociations Refuge pools. Smaller stands, most less than 0.5 ha in size, are found in isolated depressions in the sandhills. Foliar cover is typically high (75-100%) in most stands and dominated by prairie cordgrass between 0.5 m to 1 m tall. Associated vegetation varies with location of the stand. Typically, cattail species are common constituents in mesic areas near Refuge pools, while big bluestem and switchgrass frequently grow on drier upland sites and in the sandhills.

20.0 Common Reed Western North America Temperate Semi-natural Herbaceous Vegetation
This is a rare association at LNWR that only occurs in a few small stands. The association is characterized by having dense cover of common reed and little overall species diversity.

Great Plains Wetlands: Herbaceous Vegetation

21.0 Baltic Rush Herbaceous Vegetation
Baltic rush (*Juncus balticus*) stands are rare and patchy within the Refuge. Stands are usually less than 0.5 ha in size and occur in poorly drained sites where the soil is saturated for most of the growing season. The stands are characterized by a dense cover of Baltic rush with cattail species and prairie cordgrass as minor components of the association.

22.0 Nebraska Sedge Herbaceous Vegetation
The distribution of this type on the Refuge is extremely patchy. Most stands are smaller the minimum mapping unit of 0.5 ha. Stands usually occur in poorly drained sites adjacent to wetlands and near small drainages with few, if any, associated species. Soils are saturated and intermittently flooded for most of the growing season. A few scattered peachleaf willow trees occur in one stand adjacent to Elm Creek.

24.0 Three-square Bulrush Herbaceous Vegetation
This rare unit is comprised of stands that are less than 0.5 ha in size. Stands of this community type occur in small, isolated depressions where the water table intersects the surface. Hydrologic conditions are very similar to those of the Hardstem bulrush type (map unit 25.0). The vegetation is typically 0.5 to 2 m in height with foliar cover approaching 100%.

25.0 Hardstem Bulrush – Broadleaf Cattail – (Softstem Bulrush) Sandhills Herbaceous Vegetation
The vast majority of the stands that characterize this map unit are less than 0.5 ha in size. Stands of this community type occur in small, isolated depressions where the water table intersects the surface. The soils are intermittently saturated; however, the amount of moisture probably fluctuates considerably from one year to the next. The vegetation is typically 1 to 2 m in height with foliar cover approaching 100%. Because this community is restricted to very small, isolated depressions, the size of the stands probably fluctuates seasonally as well as from one year to the next. Cattail (*Typha latifolia*) is the most common secondary species.

26.1 Cattail Species Great Plains Herbaceous Vegetation (Semipermanently Flooded)
26.1 Cattail Species Great Plains Herbaceous Vegetation (Seasonally Flooded)
Cattail stands are found throughout intermittently flooded areas adjacent to Refuge pools, ponds, dugouts, and drainages. Foliar cover typically approaches 100% and plants are usually 2 to 2.5 m in height. Bulrush, Canada thistle (*Cirsium arvense*), and sow thistle (*Sonchus arvensis*) are frequent constituents.

Northern Mixed Grass Prairie: Upland Shrublands

27.0 Western Snowberry Shrubland
Western snowberry shrublands are rare within the Refuge. Only a few small stands (less than 0.5 ha in size) were recorded in the northernmost portion of the Refuge. Western snowberry is generally found on sites that receive some form of supplemental moisture. Consequently, they are usually associated with small depressions in the uplands. At the Refuge, the stands are often intermixed with, a wide variety of vegetation types such as western wheatgrass and other upland grasses.

Northern Mixed Grass Prairie: Mesic Shrublands

Naturally occurring, well-developed shrublands and woodlands are relatively rare at LNWR making them important for monitoring and management concerns. For this reason, all sites regardless of size were sampled, classified, and mapped with varying success. Stands were usually considerably smaller than the minimum mapping unit of 0.5 ha and were extremely difficult to identify on the aerial photographs. Due to their small size and limited distributions most shrub and tree map units were primarily mapped during on-ground surveys resulting in map units that resemble, but are not true plant associations.

28.0 American Plum Stands

Stands of American plum occupy many sites throughout the more mesic portions of the Refuge. In many cases, stands are closely associated with shelterbelts along county roads. American plum also occurs as isolated patches in grassland types and as linear stands along dikes and levees. Stands usually occur as dense, almost impenetrable thickets with foliar cover approaching 100%. Common understory includes weedy species such as catnip (*Nepeta cataria*), Canada thistle (*Cirsium arvense*), and Japanese brome (*Bromus japonicus*). Wild licorice (*Glycyrrhiza lepidota*) is also a frequent constituent.

29.0 Indigo Bush Stands

These shrublands often form dense stands that border Lake Creek. Height of the shrubs is usually about 2 m and foliar cover ranges from 60 to 80%. The understory vegetation is typically dominated by smooth brome and prairie cordgrass.

30.0 Sandbar Willow / Mesic Graminoids Shrubland

The sandbar willow / mesic graminoids shrubland occurs as scattered stands near the edges of ponds, and along dike, levee, and roadway edges throughout the Refuge, except for the sandhills portion. Typical stands of sandbar willow are 1-3 m tall with dense interlocking canopies that approach 100% foliar cover. Stands are usually devoid of understory vegetation; however, prairie cordgrass and cattail (*Typha)* are sometimes found in close association. An occasional individual peachleaf willow (*Salix amygdaloides)* tree sometimes occurs adjacent to the stands and is recorded as an overstory species.

Northern Mixed Grass Prairie: Mesic Woodlands

31.0 American Hackberry Stands
32.0 Peachleaf Willow Woodland
33.0 Plains Cottonwood Stands
34.0 Green Ash Stands

These map units represent rare wooded areas within the Refuge. In most cases, all units are smaller than the minimum mapping unit. Peachleaf willow is the most abundant and represents a true woodland association. This type is widely scattered in small stands throughout the Refuge, except for the sandhills portion. Many of the stands are less than 0.5 ha in size and occupy a range of mesic sites in close association with wetland communities dominated by prairie cordgrass, cattail, and Nebraska sedge (*Carex nebrascensis*). The peachleaf willow association typically occurs as three to six trees clustered together to form a dense canopy. These clusters sometimes appear to have coalesced to form a larger stand. Total foliar cover values range from 60 to 100%. The lower values occur where canopies between the stands do not overlap. Individual trees were generally large (10-15 m tall) and mature. Understory shrubs were not common.

3.3 Relationship Between Lacreek NWR Map Units and NVCS

The LNWR map units represent a compromise among the detail of the NVCS classification, the needs of the Refuge and the limitations of the photography. As a result, the LNWR mapping scheme does not exactly match the NVCS. The vegetation map units are linked ("crosswalked") to the NVCS plant associations (**Appendix E**). When a plant association had a unique photo signature, the map unit and the plant association are the same. When plant associations occurred in complexes of stands too small to map or when related plant associations shared the same signature, several plant associations might be lumped into a single map unit. When more than one phase of a single plant association could be recognized on the photos, a plant association would be split among several map classes. Finally, non-vegetated areas and vegetation types not recognized by the NVCS received special map unit designations.

Map Units Representing Associations (one to one)

The following map units were created from the NVCS associations and represent single types that could be discerned and delineated on the aerial photography. The cross-walking of these map units is on a one map unit to one NVCS association basis.

Map Class Map Unit
NVCS Association

1.0 Blacktailed Prairie Dog Town Grassland Complex
Blacktailed Prairie Dog Town Grassland Complex

3.3 Prairie Sandreed - Sun Sedge Herbaceous Vegetation
Calamovilfa longifolia - Carex inops ssp. heliophila Herbaceous Vegetation.

4.0 Little Bluestem - (Sideoats Grama, Blue Grama) - Threadleaf Sedge Herbaceous Vegetation
Schizachyrium scoparium - Bouteloua (curtipendula, gracilis) - Carex filifolia Herbaceous Vegetation

5.0 Needle-and-thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation
Hesperostipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation

6.0 Big Bluestem - Switchgrass - Sawtooth Sunflower Herbaceous Vegetation
Andropogon gerardii - Panicum virgatum - Helianthus grosseserratus Herbaceous Vegetation

7.0 Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation
Pascopyrum smithii - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation

8.0 Kentucky Bluegrass - (Western Wheatgrass) Semi-natural Herbaceous Vegetation
Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation

9.0 Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation
Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation

10.0 Crested Wheatgrass - (Western Wheatgrass, Needle-and-Thread) Semi-natural Herbaceous Veg.
Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata) Semi-natural Herbaceous Vegetation

11.0 Intermediate Wheatgrass Semi-Natural Herbaceous Vegetation
Thinopyrum intermedium Semi-natural Herbaceous Vegetation

16.0 Water Smartweed Herbaceous Vegetation
Polygonum spp. - Mixed Forbs Herbaceous Vegetation

17.0 Switchgrass - (Western Wheatgrass) Herbaceous Vegetation
Panicum virgatum - (Pascopyrum smithii) Herbaceous Vegetation

19.0 Prairie Cordgrass - Sedge species Herbaceous Vegetation
Spartina pectinata - Carex spp. Herbaceous Vegetation

20.0 Common Reed Herbaceous Vegetation
Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation

21.0 Baltic Rush Herbaceous Vegetation
Juncus balticus Herbaceous Vegetation

22.0 Nebraska Sedge Herbaceous Vegetation
Carex nebrascensis Herbaceous Vegetation

24.0 Threesquare Bulrush Herbaceous Vegetation
Schoenoplectus pungens Herbaceous Vegetation

25.0 Hardstem Bulrush - Broadleaf Cattail - (Softstem Bulrush) Sandhills Herbaceous Vegetation
Schoenoplectus acutus - Typha latifolia - (Schoenoplectus tabernaemontani) Sandhills Herbaceous Vegetation

27.0 Western Snowberry Shrubland
Symphoricarpos occidentalis Shrubland

30.0 Sandbar Willow / Mesic Graminoids Shrubland
Salix exigua / Mesic Graminoids Shrubland

32.0 Peachleaf Willow Woodland
Salix amygdaloides Woodland

Map Units Representing Floristic or Physiographic Change (many to one)

The following map units have been separated from a single plant association due to either floristic (*i.e.* one species is clearly dominate over another in the association) or physiographic (*i.e.* differences can be detected in the substrate or hydrology that influences the association) differences. For floristic splits the dominant species in the NVCS association varies across the Refuge and this shift is clearly recognizable both in the field and on the photography. This change in dominance likely results from a combination of management, substrate, or moisture differences. Map units used to delineate these types can be considered a sub-set of the association representing only one plant species (indicated in the NVCS association below with an underline).

Map units split from one NVCS association based on physiographic changes are based on the ability to discern and delineate subtle changes in the association caused by differences in the hydrologic regime. This change is represented as separate map units with only a different modifier indicating the physiographic condition (*e.g.* seasonally flooded). The cross-walking of these map units to the NVCS is on a multiple map unit to one NVCS association basis.

Map Class Map Unit
NVCS Association

Floristic

2.1 Soapweed Yucca (Sparse Understory) Shrub Herbaceous Vegetation
Yucca glauca / Calamovilfa longifolia Shrub Herbaceous Vegetation

2.2 Soapweed Yucca / Needle-and-thread Shrub Herbaceous Vegetation
Yucca glauca / Calamovilfa longifolia Shrub Herbaceous Vegetation

3.1 Needle-and-thread / Soapweed Yucca Herbaceous Vegetation
Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation

3.2 Prairie Sandreed - Needle-and-thread Herbaceous Vegetation
Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation

18.1 Foxtail Barley Herbaceous Vegetation
Distichlis spicata - Hordeum jubatum - Puccinellia nuttalliana - Suaeda calceoliformis Herbaceous Vegetation

18.2 Saltgrass Herbaceous Vegetation
Distichlis spicata - Hordeum jubatum - Puccinellia nuttalliana - Suaeda calceoliformis Herbaceous Vegetation

Physiographic

26.1 Cattail species Great Plains Herbaceous Vegetation (Semipermanently Flooded)
Typha spp. Great Plains Herbaceous Vegetation

26.2 Cattail species Great Plains Herbaceous Vegetation (Seasonally Flooded)
Typha spp. Great Plains Herbaceous Vegetation

Map Units Representing No Association (refuge specials)

The management needs at LNWR were of great concern to Refuge staff, especially land-use history and vegetation management records. For example, a clearly defined polygon was classified as Western wheatgrass - blue grama - threadleaf sedge Herbaceous Vegetation type according to the fieldwork and the NVCS. Part of this polygon was then reassessed by LNWR as a mix of cool season native grasses due to restoration or seeding efforts. Technically, labels are correct and important to their respective contexts. To address these differences in classification, two solutions were implemented at LNWR: "Refuge Specials" and, U.S. Fish and Wildlife Service (FWS) modifiers.

Refuge Special types were created for LNWR for one of the following reasons:

- To represent important wildlife habitat types not known outside the Refuge;
- To represent important wildlife habitat types occurring in patches smaller than the minimum mapping unit of 0.5 ha;
- To represent vegetation that was manipulated in the recent past. This includes native species plantings and truly mixed grasslands that could not be classified to an NVCS association.

Map Class	Map Unit Explanation
12.1 Mixed Grassland	This type has either been planted or manipulated and has no clear dominant species.
12.2 Mixed Grassland (Warm Season Natives)	This type has either been planted or manipulated and has no clear dominant species.
12.3 Mixed Grassland (Cool Season Natives)	This type has either been planted or manipulated and has no clear dominant species.
13.0 Mixed Forbland	This type contains many different forb species with no clear dominants to be classified.
14.0 Canada Thistle Patches*	Only occurs on the Refuge in limited areas, always in conjunction with an association and can't be classified due to its spreading throughout multiple vegetation types.
15.0 Wild Licorice Stands*	Only occurs on the Refuge in limited areas, too small to classify as an association.
23.0 Emergent Sandhills Wetland	Only occurs on the Refuge in limited areas, no clear dominant or associated species to classify.
28.0 American Plum Stands*	Only occurs on the Refuge in limited areas, too small to classify as an association.

29.0 False Indigobush Stands*
Only occurs on the Refuge in limited areas, too small to classify as an association.

31.0 American Hackberry Stands*
Only occurs on the Refuge in limited areas, too small to classify as an association.

33.0 Plains Cottonwood Stands*
Only occurs on the Refuge in limited areas, no clear associated species and too small to classify as an association.

34.0 Green Ash Stands*
Only occurs on the Refuge in one area, too small to classify as an association.

35.1 Native Species Plantings (Sideoats Grama)
This type is a planted monoculture with few other species present.

35.2 Native Species Plantings (Mixed Grasses)
This type has been planted and has no clear dominant species.

35.3 Native Species Plantings (Switchgrass)
This type is a planted monoculture with few other species present.

(*Patches and Stands indicate likely NVCS associations that did not occur in sufficient size or frequency to be considered a valid community (association).

FWS Modifiers are additional vegetation attributes recorded on the photography and incorporated into the GIS spatial data layer. These attributes acknowledged LNWR vegetation names for a polygon as well as maintaining the NVCS association name. In this manner both types can be queried for analysis and an overlay pattern can be used for presentation purposes. The following were FWS modifier names used to indicate differences in classification:

- Blue Grama (*Bouteloua gracilis*) Grazed Grassland
  (This type was used to indicate areas that were grazed by cattle causing blue grama to become the dominant species in the NVCS association).

- Canada Bluegrass (*Poa compressa*) Introduced Grassland
  (This type was used to indicate areas that were planted by the Refuge to Canada bluegrass but was either not the dominant or was not apparent in the field.)

- Mixed Brome - Mixed Native Grassland
  (This type was used to indicate areas that had a large component of smooth brome (*Bromus inermis*), cheatgrass (*B. tectorum*) and/or Japanese brome (*B. japonicus*). These areas were classified in the field to an NVCS association based on the native grass component.)

- Mixed Cool Season - Native Grassland
  (This type was used to indicate areas that had a large component of mixed cool season natives, both native and non-native. These areas were classified in the field to an NVCS association based on the native grass component.)

3.4 Vegetation Map

A total area of 21,950 acres (8883 ha) comprising LNWR was mapped, including acreage owned or leased by the State of South Dakota and private individuals. Of this total, NVCS-related vegetation map units covered about 16,633 acres. The remaining acreage was mapped using land cover and Refuge special map units. Of all the map units, the most frequent was Peachleaf willow Woodland (164 polygons). However these were typically quite small (0.7 acres). The most abundant map unit in terms of area was Refuge Pools, (map unit 52.0) covering 2,152 acres. Frequencies of map units (*i.e.* number of polygons) along with acreage per map unit are listed in **Table 5**.

Deer at Lacreek National Wildlife Refuge

Table 5. Acreage and frequency of map units for Lacreek National Wildlife Refuge summarized by ownership.

Map Class	Map Unit Common Name	Refuge* Polygons	State Polygons	Total Polygons	Refuge* Acres	State Acres	Total Acres	Ave Total (a)	Total Hectares	Ave Total (h)
1.0	Blacktailed Prairie Dog Town Grassland Complex	9	4	13	159.6	44.7	204.3	15.7	82.7	6.4
2.1	Soapweed Yucca (Sparse Understory) Shrub Herbaceous Vegetation	107	13	120	992.4	49.5	1041.9	8.7	421.7	3.5
2.2	Soapweed Yucca / Needle-and-thread Shrub Herbaceous Vegetation	36	0	36	243.1	0	243.1	6.8	98.4	2.7
3.1	Needle-and-thread / Soapweed Yucca Herbaceous Vegetation	79	1	80	974.0	1.0	975.0	12.2	394.6	4.9
3.2	Prairie Sandreed - Needle-and-thread Herbaceous Vegetation	38	2	40	618.2	0.8	619.0	6.5	250.5	6.3
3.3	Prairie Sandreed – Sun Sedge Herbaceous Vegetation	25	4	29	1679.8	142.3	1822.1	62.8	737.4	25.4
4.0	Little Bluestem - (Sideoats Grama, Blue Grama) - Threadleaf Sedge Herbaceous Vegetation	6	1	7	2.4	0.3	2.7	0.4	1.1	0.2
5.0	Needle-and-thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation	3	0	3	9.1	0	9.1	3.0	3.7	1.2
6.0	Big Bluestem - Switchgrass - Sawtooth Sunflower Herbaceous Vegetation	6	0	6	214.3	0	214.3	35.7	86.7	14.5
7.0	Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation	25	15	40	445.4	408.9	854.3	21.4	345.7	8.6
8.0	Kentucky Bluegrass - (Western Wheatgrass) Semi-natural Herbaceous Vegetation	70	2	72	971.2	36.8	1008.0	14.0	407.9	5.7
9.0	Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation	122	38	160	1530.7	333.5	1864.2	11.7	754.4	4.7
10.0	Crested Wheatgrass - (Western Wheatgrass, Needle-and-Thread) Semi-natural Herbaceous Vegetation	31	2	33	931.0	6.1	937.1	28.4	379.2	11.5
11.0	Intermediate Wheatgrass Semi-Natural Herbaceous Vegetation	5	1	6	14.8	42.2	57.0	9.5	23.1	3.8
12.1	Mixed Grassland	2	7	9	20.8	56.3	77.1	8.6	31.2	3.5
12.2	Mixed Grassland (Warm Season Natives)	9	0	9	556.3	0	556.3	61.8	225.1	25.0
12.3	Mixed Grassland (Cool Season Natives)	2	0	2	168.7	0	168.7	84.4	68.3	34.1
13.0	Mixed Forbland	90	15	105	1302.8	218.7	1521.5	14.5	615.8	5.9
14.0	Canada Thistle - Weedy Forb Great Plains Herbaceous Vegetation (Provisional)	6	0	6	5.0	0	5.0	0.8	2.0	0.3
15.0	Wild Licorice Stands	28	5	33	63.5	6.2	69.7	2.1	28.2	0.9
16.0	Water Smartweed Herbaceous Vegetation	21	5	26	126.3	17.1	143.4	5.5	58.0	2.2

Map Class	Map Unit Common Name	Refuge* Polygons	State Polygons	Total Polygons	Refuge* Acres	State Acres	Total Acres	Ave Total (a)	Total Hectares	Ave Total (h)
17.0	Switchgrass - (Western Wheatgrass) Herbaceous Vegetation	49	0	49	67.1	0	67.1	1.4	27.2	0.6
18.1	Foxtail Barley Herbaceous Vegetation	8	1	9	17.1	2.3	19.4	2.2	7.9	0.9
18.2		67	11	78	483.3	78.8	562.1	7.2	227.5	2.9
19.0	Prairie Cordgrass - Sedge species Herbaceous Vegetation	122	48	170	732.0	154.8	886.8	5.2	358.9	2.1
20.0	Common Reed Herbaceous Vegetation	12	0	12	21.5	0	21.5	1.8	8.7	0.7
21.0	Baltic Rush Herbaceous Vegetation	6	0	6	28.2	0		4.7	11.4	1.9
22.0	Nebraska Sedge Herbaceous Vegetation	6	1	7	7.3	0.1	7.4	1.1	3.0	0.4
23.0	Marsh Spikerush Herbaceous Vegetation	8	0	8	12.9	0	12.9	1.6	5.2	0.7
24.0	Threesquare Bulrush Herbaceous Vegetation	2	0	2	14.6	0	14.6	7.3	5.9	3.0
25.0	Hardstem Bulrush - Broadleaf Cattail - (Softstem Bulrush) Sandhills Herbaceous Vegetation	15	0	15	39.8	0	39.8	2.7	16.1	1.1
26.1	Cattail species Great Plains Herbaceous Vegetation (Semipermanently Flooded)	123	6	129	1612.6	16.7	1629.3	12.6	659.4	5.1
26.2	Cattail species Great Plains Herbaceous Vegetation (Seasonally Flooded)	130	16	146	681.3	76.6	757.9	5.2	306.7	2.1
27.0	Western Snowberry Shrubland	3	0	3	0.4	0	0.4	0.1	0.2	0.1
28.0	American Plum Stands	27	0	27	7.6	0	7.6	0.3	3.1	0.1
29.0	False Indigobush Stands	6	0	6	34.5	0	34.5	5.8	14.0	2.3
30.0	Sandbar Willow / Mesic Graminoids Shrubland	36	3	39	26.3	0.7	27.0	0.7	10.9	0.3
31.0	American Hackberry Stands	2	0	2	0.5	0.0	0.5	0.3	0.2	0.1
32.0	Peachleaf Willow Woodland	164	14	178	104.0	14.2	118.2	0.7	47.8	0.3
33.0	Plains Cottonwood Woodland	4	0	4	2.3	0	2.3	0.6	0.9	0.2
34.0	Green Ash Stand	1	0	1	2.2	0	2.2	2.2	0.9	0.9
35.1	Native Species Plantings (Sideoats Grama)	1	0	1	19.1	0	19.1	19.1	7.7	7.7
35.2	Native Species Plantings (Mixed Grasses)	12	1	13	530.0	0.1	530.1	40.8	214.5	16.5

Map Class	Map Unit Common Name	Refuge* Polygons	State Polygons	Total Polygons	Refuge* Acres	State Acres	Total Acres	Ave Total (a)	Total Hectares	Ave Total (h)
35.3	Native Species Plantings (Switchgrass)	19	3	22	156.3	1.5	157.8	7.2	63.9	2.9
40.0	Agricultural Lands	8	22	30	306.7	1457.0	1763.7	58.8	713.8	23.8
41.0	Shelterbelt	26	11	37	83.7	40.2	123.9	3.3	50.1	1.4
42.0	Beach	4	0	4	4.1	0	4.1	1.0	1.7	0.4
43.0	Sandhills Blowout	16	4	20	16.6	0.8	17.4	0.9	7.0	0.4
44.0	Bennett County Roads	4	4	8	136.9	22.0	158.9	19.9	64.3	8.0
45.0	Refuge Management Roads	4	0	4	17.7	0	17.7	4.4	7.2	1.8
46.0	Levees (Flood Control)	1	0	1	3.1	0	3.1	3.1	1.3	1.3
47.0	Dikes (Separate Impoundments)	4	0	4	6.0	0	6.0	1.5	2.4	0.6
48.0	Cemetery	1	0	1	2.3	0	2.3	2.3	0.9	0.9
49.0	Ponds, impoundments	13	1	14	10.1	0.6	10.7	0.8	4.3	0.3
50.0	Ponds, Trout	10	0	10	10.9	0	10.9	1.1	4.4	0.4
51.0	Ponds, potholes/dugout/stock	26	27	53	141.0	54.2	195.2	3.7	79.0	1.5
52.0	Pools	74	0	74	2152.3	0	2152.3	29.1	871.0	11.8
53.0	Lake Creek Channel	9	0	9	9.5	0	9.5	1.1	3.8	0.4
54.0	Clay Pits	8	3	11	8.8	1.0	9.8	0.9	4.0	0.4
55.0	Refuge Facilities	5	0	5	13.9	0	13.9	2.8	5.6	1.1
56.0	Residential	5	9	14	45.7	63.9	109.6	7.8	44.4	3.2
Totals										
	All Map Units	1,761	300	2,061	18,599.6	3,349.9	21,949.5	687.6	8,883.0	278.3
	Natural/Semi-natural Vegetation Map Units (1.0 – 34.0)	1,511	215	1,726	14,924.9	1,708.6	16,633.5	478.2	6,731.6	193.5
	Planted/Cultivated and Land Use/Land Cover Map Units (34.1 - 56.0)	250	85	335	3,674.7	1,641.3	5,316.0	209.4	2,151.4	84.8

*Refuge acres are based on LNWR Administrative boundary and include about 2190 acres of privately-owned inholdings (See Section **3.1**).

3.5 Accuracy Assessment

Of the 386 sampling points generated for the accuracy assessment, 39 were taken out of the analysis either because they were inaccessible in the field or had data inconsistencies (*i.e.* gps recording errors, missing species data, etc…). The remainders were evaluated for accuracy in September 2001. By comparing these points back to the vegetation map we were able to calculate an overall thematic accuracy of 77% for 38 vegetation map units. **Table 6** presents the accuracy assessment scores and confidence intervals for each map unit assessed along with the overall values.

Eleven map units were not assessed for accuracy due to their limited distribution and small size (usually below the minimum mapping unit) (see **Table 5**), these included:

4.0 Little Bluestem - (Sideoats Grama, Blue Grama) - Threadleaf Sedge Herbaceous Vegetation
11.0 Intermediate Wheatgrass Semi-Natural Herbaceous Vegetation
14.0 Canada Thistle - Weedy Forb Great Plains Herbaceous Vegetation (Provisional)
27.0 Western Snowberry Shrubland
28.0 American Plum Stands
30.0 Sandbar Willow / Mesic Graminoids Shrubland
31.0 American Hackberry Stands
32.0 Peachleaf Willow Woodland
33.0 Plains Cottonwood Woodland
34.0 Green Ash Stand
35.3 Native Species Plantings (Switchgrass)

In most cases these units represented very rare types that were already documented in their entirety by plot or observation data. Further, the small nature of these types made it impossible to place and buffer AA points within their polygons.

Using the Accuracy Assessment Contingency Table (**Table 6**)*:* The contingency table or error matrix is an array of numbers set out in rows and columns corresponding to a particular vegetation map unit relative to the actual vegetation type as verified on the ground. The column headings represent the vegetation associations as determined in the field and the row headings represent the map unit classes (codes) taken from the vegetation map (see **Table 5**). The highlighted diagonal indicates the number of points assessed in the field that agree with the map label. Conversely, the inaccuracies of each map unit are described as both errors of inclusion (user's or commission errors) and errors of exclusion (producer's or omission errors). By reading across this table (*i.e.* rows) one can calculate the percent error of commission, or how many polygons for each map unit were incorrectly labeled according to the field ecologist. By reading down the table (*i.e.* columns) one can calculate the percent error of omission, or how many polygons for that type were left off the map. Numbers "on the diagonal" tell the user how well the map unit was interpreted and how confident they can be in using it. Numbers "off the diagonal" yield important information about the deficiencies of the map including which types were often confused and which types were under or over represented.

Table 6. Contingency table (error matrix) for vegetation mapping at Lacreek National Wildlife Refuge.

		Reference Data (Accuracy Assessment Field Classification)																																								
	Map Class	1.0	2.1, 2.2	3.1	3.2	3.3	5.0	6.0	7.0	8.0	9.0	10.0	12.1-12.3	13.0	15.0	16.0	17.0	18.1	18.2	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.1	26.2	29.0	30.0	32.0	35.1	35.2	n/a*	Total Samples (N)	Commission Error % Correct	90% Confidence Interval -	90% Confidence Interval +
S	1.0	5																																	5	100%	62%	100%
a	2.1, 2.2		18		1												1																	1	21	86%	69%	95%
m	3.1			27	1																														28	96%	86%	100%
p	3.2				6																														6	100%	66%	100%
l	3.3					16											2																		18	89%	72%	98%
e	5.0						2		1																										3	67%	20%	97%
	6.0							7			1																								8	88%	58%	99%
D	7.0								8	1									1																10	80%	50%	95%
a	8.0								1	24	1								1	1												1			29	83%	70%	91%
t	9.0										30									6												1			37	81%	67%	91%
a	10.0									1		15																						1	17	88%	71%	97%
	12.1-12.3												7																					1	8	88%	68%	99%
(M	13.0													8						1	1							1		1	1		1		14	57%	36%	78%
a	15.0											3			4																				7	57%	28%	83%
p	16.0															2												1							3	67%	20%	97%
	17.0																5																		5	100%	62%	100%
U	18.1								2									1																1	4	25%	3%	68%
n	18.2								5	5									7	2								1							20	35%	20%	58%
i	19.0									1	1				2					15								2							21	71%	54%	87%
t)	20.0																				3														3	100%	46%	100%
	21.0																					0					1	3							4	0%	0%	50%
	22.0																						1												1	100%	10%	100%
	23.0																							3											3	100%	46%	100%
	24.0																			2					0										2	0%	0%	68%
	25.0																									4		1							5	80%	38%	98%
	26.1																										15	7							22	68%	50%	82%
	26.2																											19							19	100%	87%	100%
	29.0																											1	1						2	50%	5%	95%
	30.0																													1	1			2	4	25%	3%	68%
	32.0									1						1															3				5	60%	25%	89%
	35.1										1																					7			8	88%	58%	99%
	35.2				1																												2		3	67%	20%	97%
	n/a*				1																											1		n/a	2	n/a		
	Total Samples	5	18	27	10	16	2	7	17	33	34	18	7	8	6	3	8	1	9	27	4	0	1	3	0	4	16	36	1	2	5	10	3	6	Total Correct:		266	
Omission Error		100%	100%	100%	60%	100%	100%	100%	47%	73%	88%	83%	100%	100%	67%	67%	63%	100%	78%	56%	75%	0%	100%	100%	0%	100%	94%	53%	100%	50%	60%	70%	67%	n/a	Total Samples:		347	
90% Confidence -		62%	87%	91%	34%	87%	28%	68%	28%	59%	75%	65%	68%	75%	33%	20%	26%	10%	49%	37%	32%	0%	10%	46%	0%	50%	77%	38%	10%	5%	25%	35%	20%					
90% Confidence +		100%	100%	100%	81%	100%	100%	100%	71%	87%	96%	94%	100%	100%	91%	97%	85%	100%	94%	71%	97%	0%	100%	100%	0%	100%	99%	68%	100%	95%	89%	88%	97%					

OVERALL TOTAL ACCURACY = 77 % **OVERALL KAPPA INDEX = 76 %** [Pchance = 0.0551] **OVERALL TOTAL ACCURACY 90% UPPER AND LOWER CONFIDENCE INTERVAL: 81%** and **73%**

Map units 2.1 and 2.2 and 12.1, 12.2, and 12.3 were combined for the AA. The total sample size (N) is used to calculate Overall Total Accuracy. (Omission and Commission errors were calculated using total accuracy)

***n/a** category represents land-use, semi-natural (i.e. disturbed, agricultural lands), or other types not included in the accuracy assessment.

For the purpose of the accuracy assessment, we combined map units 2.1 and 2.2 due to their complex intermixing and difficulty in distinguishing them apart on the ground. We also combined map units 12.1, 12.2, and 12.3 into one accuracy assessment class. These three units were mapped in the field by LNWR staff, not from aerial photography.

Of the assessed map units, some had lower then expected levels of accuracy. By carefully examining these discrepancies, we found four common issues that seem to explain most of the error. These include:

1. Many of the errors occurred when a polygon was mapped as an association that was very similar (*i.e.* same physiognomic class, same species, etc…), but different to the one identified by the field ecologist. This can happen because the photo interpreter and the field ecologist see the vegetation differently. For example, the photo interpreter may map large areas that have small inclusions of other types below the minimum mapping unit. However, a field biologist without an overhead perspective may deem them large enough to record as a separate type.

   - *Example:* Recording of inclusions likely explains the high omission error for Prairie Cordgrass – Sedge species Herbaceous Vegetation (Map Class 19.0). Prairie cordgrass is relatively easy to recognize in the field and typically occurs in mesic pockets such as shallow drainages and potholes. Some random AA points likely fell in these highly visible sites and were recorded as such even if they though were below the mmu.

2. Discrepancies with some map units likely arose from the NVCS classification system, which depends on an arbitrary cutoff of the dominant plant cover to separate associations with similar species. Further, some associations are recognized by the mere presence of diagnostic native species regardless of cover.

   - *Example:* Typically, the NVCS doesn't recognize an introduced or exotic plant community (semi-natural) until the cover of exotics reaches a high threshold (usually around 80%). At Lacreek, associations dominated by the exotics smooth brome, Kentucky bluegrass, or crested wheatgrass can, and will be recognized at a lower cover value even when associated with native species. We feel that the commission errors between native and semi-natural grassland associations as reported in Table 6 are likely a result of this high cut-off for classification.

3. The vegetation map was based on the photo interpretation of CIR aerial photography flown in 2000, while the accuracy assessment took place in 2001. Some map errors can be ascribed to changes in plant expression and phenology caused by differences in hydrologic and meteorological variation such as

moisture levels (wet vs. dry years) and land use and flooding regimes within the Refuge. Areas bordering Refuge pools are most likely to reflect this change since they are directly influenced by the timing, height, and duration of flooding or lack thereof. Vegetation in these areas are the most likely to exhibit variation from year to year and season to season.

- *Example:* Commission and omission errors for wetland associations such as Baltic Rush (21.0), Cattail types (26.1, 26.2) and others can likely be explained by hydrologic variation from year to year. Areas that dried out in 2001 would likely not be recorded as the same wetland type leading to errors of commission. We feel this explains the high commission error separating semipermanently flooded (26.1) from seasonally flooded cattails (26.2). (Conversely, areas that were wet in 2001 but not in 2000 would lead to errors of omission.)

4. Subtle differences in grassland types were extremely hard to distinguish from the aerial photography. This was further compounded by the Refuges need to have seeding history included for sites that were reclaimed or planted with native species.

- *Example:* Commission errors for Saltgrass and Foxtail Herbaceous Vegetation types (18.1 and 18.2) were primarily confused with other grassland types including Western wheatgrass (7.0), Kentucky bluegrass (8.0), and Prairie cordgrass (19.0). Although they appear to be different types, we found that most of the diagnostic species tended to occur across all types. This species overlap likely led to difficult AA determinations in the field and commission error.

3.6 Recommendations for Future Projects

Several ideas for improving the mapping process have surfaced as a result of the Lacreek project. Improving the mapping process in ways suggested herein would increase quality and efficiency, and provide for more accurate and useful products.

Vegetation Classification and Characterization

Lacreek National Wildlife Refuge lies within the Northwestern Great Plains ecoregion and includes biological elements typical of the Keya Paya Tablelands and Nebraska Sandhills sections. In addition, the Refuge is intensively managed for wildlife through control of exotics such as Canada thistle, water storage and release for fish and birds, and seeding areas for forage. This variation due to changes in geology, topography, and land management creates a mosaic of plant species in numerous and sometimes atypical assemblages. Identifying these associations and placing them in the NVCS for LNWR was extremely challenging, time-consuming and in most cases not overly beneficial to management needs. Instead, alternative classifications such as land-cover or land-history types for manipulated and actively managed sites and NVCS for pristine areas may have made more sense.

Regardless of the classification used, we highly recommend that a complete (or nearly completed) classification be in place before the actual interpretation begins. Plot sampling should begin early in the project, followed by analysis of the vegetation data to the NVCS before the ground-truthing and interpretation of the aerial photographs. It is important to have written descriptions of the associations, approval of the types by the Refuge, and a vegetation key during ground-truthing so that vegetation types can be related to the photo signatures. Also critical is deciding how to characterize and describe vegetation that has been manipulated in the past. This includes dealing with areas inherent to Refuges that have been reclaimed or reseeded and are not necessarily covered by the NVCS.

Vegetation Mapping

During the drier-than-normal 2000 field season when the aerial photographs were taken and when most of the fieldwork was conducted, cool season grassland species were the principal species expressed. In contrast, during the 2001 field season, when the accuracy assessment was conducted, relatively large amounts of summer precipitation shifted the vegetative expression to warm season species. The difference in vegetative expression between 2000 and 2001 was a factor during the accuracy assessment, but was not during the photo interpretation process. This inconsistency was realized in lower than expected map class accuracies and should probably be addressed in future grassland projects. Possible solutions include multiple aerial photo missions in both cool (dry) and warm (wet) seasons, or recognition of this shift by the accuracy assessment team.

Central to the mapping process is the ability to produce a clearly defined set of map units. Ideally, these will be based entirely from the NVCS on a strict one-to-one correspondence, but typically they involve the use of detailed links or crosswalks. Normally, crosswalks help clarify the differences between vegetation characteristics that can be seen on aerial photography and those evident on the ground. However, crosswalks between the map units and NVCS associations at LNWR were relatively confusing and lengthy. This was due in part to the difficult task of describing the manipulated and semi-natural vegetation inherit, not only to Lacreek, but all refuges. In order to avoid having to describe and map both NVCS and local management types, standard-mapping units should be created for managed USFWS lands in addition to the NVCS. These would include such things as reseeded and reclaimed fields, highly manipulated wetlands, weedy mudflats, etc. Having a standard list of management vegetation types would eliminate the need for elaborate crosswalks and would greatly promote increased sharing, exchanging, and comparing of vegetation-related data across all refuges. At LNWR, having these map units decided beforehand would have saved untold time spent re-interpreting, revising, re-mapping, and creating crosswalks for managed areas.

Summary

Recognizing the logistical and technical issues inherent to the vegetation mapping process, there are a number of factors that are critical to the success of any vegetation-mapping project. The timing associated with collecting aerial photography and conducting fieldwork are essential first steps. The photography for LNWR was taken at the end of July while the initial fieldwork was conducted in mid-September. Simultaneously completing this portion of the process in late June or early July would have greatly enhanced both photo interpretation and vegetation classification.

The amount of time needed to develop map units, create mapping conventions, make photo interpretation decisions, and produce the final digital map is inversely proportional to the degree that the parties involved communicate. Consensus building and good communication among the ecologists, photo interpreters, and Refuge staff greatly increases the quality and efficiency of the project. Future projects should strive to involve USFWS staff (both at the region and local levels), NatureServe ecologists, and BOR ecologists/photo-interpreters at all stages of the project. Prompt and constructive feedback from Refuge personnel throughout, but especially during the initial interpretation and classification can substantially reduce many of the problems that might otherwise surface late in the process.

It was also noted by USFWS staff that 80% accuracy for every map unit might not be realistic or desirable for vegetation mapping projects in refuges. Having less than 80% accuracy for some classes is likely a result of either land manipulation and/or seasonal/annual variations in precipitation, flooding, draw down timing etc. Instead of grouping similar types together to increase the overall accuracy it was deemed more

important to retain the detail for future studies. This detail will allow the refuge staff to focus their validation/ground-truthing efforts along with their long-term monitoring and inventory studies on types that are subject to anthropogenic or natural environmental change.

Pelicans at Lacreek National Wildlife Refuge

4. BIBLIOGRAPHY

Anderson, J.R., E.E. Hardy, J.T. Roach, R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. *Geological Survey Professional Paper 964*. Washington, DC: U.S. Government Printing Office.

Daubenmire R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 23: 69-82.

Faber-Langendoen, D. and Midwest State Natural Heritage Program Ecologists. 1996. *Terrestrial vegetation of the Midwestern United States*. from International Classification of Ecological Communities: Terrestrial Vegetation of the United States, The Nature Conservancy, Arlington, VA.

Federal Geographic Data Committee. 1997. *FGDC Vegetation Classification and Information Standards*. Reston, VA.

Gauch, H.G. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press, London, UK

Gries, J.P. 1996. *Roadside Geology of South Dakota.* Mountain Press Publishing Company. Missoula, MT. 358 pp.

Grossman, D.H., D. Faber-Langendoen, A.W. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International Classification of Ecological Communities: *Terrestrial Vegetation of the United States. Volume I: The National Vegetation Classification Standard.* (Draft June 1997.) The Nature Conservancy, Arlington, VA.

McCune, B. and M.J.Mefford. 1997. PC-ORD*. Multivariate Analysis of Ecological Data, Version 3.0*. Gleneden Beach, OR: MjM Software Design

Moravec, J. 1993. Syntaxonomic and nomenclatural treatment of Scandanavian-type associations and sociations. Journal of Vegetation Science 4:833-838.

The Nature Conservancy and Environmental Research Systems Institute. 1994. *NBS/NPS Vegetation Mapping Program: Accuracy Assessment Procedures.* Arlington, VA.

_____. 1994. *NBS/NPS Vegetation Mapping Program: Field Methods for Vegetation Mapping*. Arlington, VA.

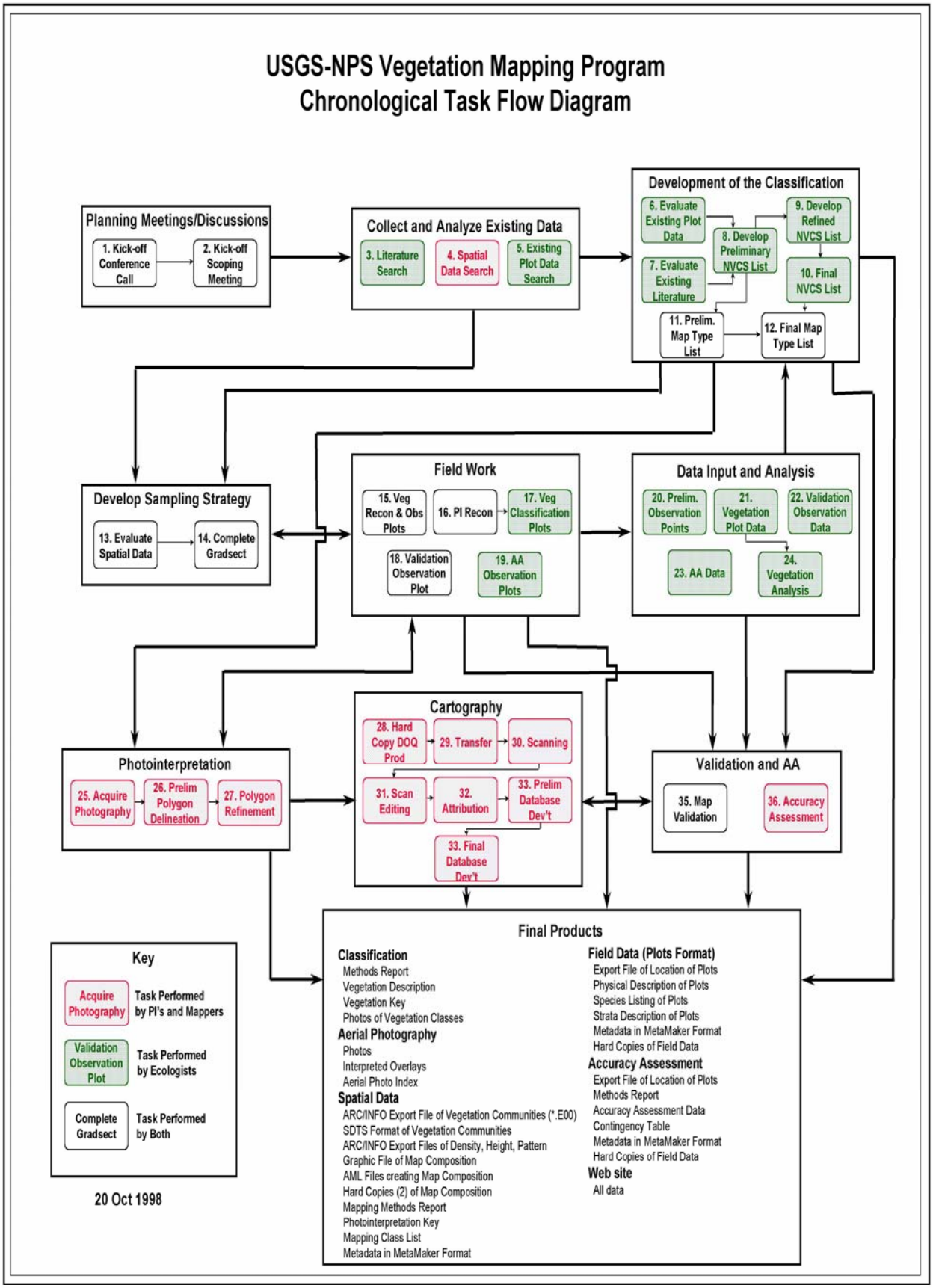
_____. 1994. *NBS/NPS Vegetation Mapping Program: Standardized National Vegetation Classification System*. Arlington, VA.

U.S. Department of Agriculture, Soil Conservation Service. 1971. *Bennett County, South Dakota*. *Soil Survey,*

APPENDIX A: Flowchart for the USGS-NPS Vegetation Mapping Program

(Tom Owens, USGS-BRD)

(The following diagram is included to illustrate the different stages and how they are interconnected in the NPS vegetation mapping program. Mapping vegetation on National Wildlife Refuges may not include all the steps listed below or additional stages specific to USFWS concerns may not be included. Please see the material and methods section of this report for more information.)


USGS-NPS Vegetation Mapping Program
Chronological Task Flow Diagram
Planning Meetings/Discussions
1. Kick-off Conference Call
2. Kick-off Scoping Meeting
Collect and Analyze Existing Data
3. Literature Search
4. Spatial Data Search
5. Existing Plot Data Search
Development of the Classification
6. Evaluate Existing Plot Data
7. Evaluate Existing Literature
8. Develop Preliminary NVCS List
9. Develop Refined NVCS List
10. Final NVCS List
11. Prelim. Map Type List
12. Final Map Type List
Develop Sampling Strategy
13. Evaluate Spatial Data
14. Complete Gradsect
Field Work
15. Veg Recon & Obs Plots
16. PI Recon
17. Veg Classification Plots
18. Validation Observation Plot
19. AA Observation Plots
Data Input and Analysis
20. Prelim. Observation Points
21. Vegetation Plot Data
22. Validation Observation Data
23. AA Data
24. Vegetation Analysis
Photointerpretation
25. Acquire Photography
26. Prelim Polygon Delineation
27. Polygon Refinement
Cartography
28. Hard Copy DOQ Prod
29. Transfer
30. Scanning
31. Scan Editing
32. Attribution
33. Prelim Database Dev't
33. Final Database Dev't
Validation and AA
35. Map Validation
36. Accuracy Assessment
Key
Acquire Photography
Task Performed by PI's and Mappers
Validation Observation Plot
Task Performed by Ecologists
Complete Gradsect
Task Performed by Both
20 Oct 1998
Final Products
Classification
Methods Report
Vegetation Description
Vegetation Key
Photos of Vegetation Classes
Aerial Photography
Photos
Interpreted Overlays
Aerial Photo Index
Spatial Data
ARC/INFO Export File of Vegetation Communities (*.E00)
SDTS Format of Vegetation Communities
ARC/INFO Export Files of Density, Height, Pattern
Graphic File of Map Composition
AML Files creating Map Composition
Hard Copies (2) of Map Composition
Mapping Methods Report
Photointerpretation Key
Mapping Class List
Metadata in MetaMaker Format
Field Data (Plots Format)
Export File of Location of Plots
Physical Description of Plots
Species Listing of Plots
Strata Description of Plots
Metadata in MetaMaker Format
Hard Copies of Field Data
Accuracy Assessment
Export File of Location of Plots
Methods Report
Accuracy Assessment Data
Contingency Table
Metadata in MetaMaker Format
Hard Copies of Field Data
Web site
All data

APPENDIX B: Work Proposal (USBR-RSGIS)

Proposal for Classifying and Mapping Vegetation Communities Lacreek National Wildlife Refuge - South Dakota

April 27, 2000

U.S. Bureau of Reclamation, Remote Sensing and Geographic Information Group
Technical Service Center, Denver, Colorado

1. Overview

This document presents our revised proposed methods and estimated costs associated with classifying and mapping vegetation communities at Lacreek National Wildlife Refuge (LNWR), SD to the standards developed under the USGS-NPS Vegetation Mapping Program. This discussion is based on our previous proposal and from discussions during our meeting with the FWS the morning of April 27th. The area to be mapped will be approximately 18,400 acres inside the LNWR including some adjacent or interior private lands. If access to the non-LNWR areas cannot be arranged, we would anticipate not doing any field work in these areas, therefore, the accuracy assessment would only apply to LNWR lands. According to the FWS, the Refuge consists of 16,136 acres with 2300 acres of open water.

(Note, refer to Section 5. below for abbreviations used in this proposal.)

2. Aerial Photograph Acquisition and Basemap.

The FWS will acquire the necessary CIR photography for this project. Also, B/W DOQQ's of this area are available and will also be acquired by the FWS. The date of the DOQQ's is 1991, which means that there will be a 9-year difference between sets of photography. Depending on the amount of changes occurring at the Refuge during this time period, this may result in some difficulty during the GIS transfer stage (3.5 below). The FWS should contact the Refuge to find out if this time difference might be a problem. Also, this process will not result in a digital version of the CIR photography. If a digital version is desired, the CIR photos would have to be scanned. However, our proposal does not include costs for scanning the CIR photos.

3. Project Tasks.

3.1 Scoping / Kick-off Meeting.

A preliminary meeting would be required with Refuge and Regional FWS personnel to discuss the project, present examples of similar projects the BOR has performed, and acquire available information from the FWS (ex: Refuge boundary, roads, hydrology, NWI, etc). This meeting would allow FWS to address any special mapping needs and vegetation classification. Our proposal is based on this meeting taking place in Denver, therefore, no field time or travel expenses are anticipated for this task.

3.2. Field Data Collection.

Vegetation field data will be collected at two levels of intensity: 1) Approximately 75 observation points will be visited and data collected to determine the range of aerial photograph signatures to guide interpretation for potential map classes or units, collect preliminary vegetation data relative to species dominance and habitat structure, and to determine the distribution of plant associations within LNWR; and 2) More detailed plot data (vegetation, soils, hydrology, environmental, etc.) will be collected for each plant association present to determine the NVCS classification. A set of representative color slides or digital photographs for each plant association and a comprehensive species list will be produced.

Detailed vegetation data and photo-documentation will be collected from 1-3 plots per association (approximately 50-75 vegetation plots), depending on stand dominance and variability within the landscape. Likely plant associations will include stand dominants such as eastern cottonwood, green ash, willow (peachleaf and sandbar/coyote), western snowberry/ buckbrush, chokecherry, soapweed yucca, silver and sand sagebrush, silver buffaloberry, little bluestem, western wheatgrass, prairie sand-reed, blue grama, prairie cordgrass, cattail, bulrush, spikerush, sedge, reed canarygrass, common reed, smooth brome, Kentucky bluegrass, and intermediate wheatgrass, among others. Other classes may include blowouts and prairie dog colonies. Plots will be established in representative vegetation stands that meet or exceed the minimum mapping unit (mmu) of 0.5 hectares. If determined to be important to Refuge staff, some smaller units of vegetation or land use may be considered as "Refuge Specials", to be determined during scoping meetings. Unless otherwise directed by FWS-LNWR ecologists/staff, the plots will be 10m x 10m for herbaceous and shrub associations and 20m x 20m for woodlands. During the Observation data collection field trip, a PI reconnaissance will also take place (see item 3.4 below).

Observation Point/Photo Signature Data Collection

- 2 Researchers/2 Travel days/5 data collection/recon days = 14 field days (Summer 2000).

Plot/NVCS Classification Data Collection

- 2 Researchers/2 Travel Days/10 data collection days = 20 field days (Summer 2000).

1 Researcher/1 day per trip planning = 2 office days (ASAP)

3.3. Vegetation Classification.

Plot data collected in LNWR will be evaluated using the NVCS (Standardized National Vegetation Classification System); this system contains seven classification levels with the two finest being the alliance and association (community) levels. These data are quantitatively analyzed using ordination techniques (Detrended Correspondence Analysis and Non-Metric Multidimensional Scales), a clustering algorithm, Unweighted Pair-Group Method Using Arithmetic Means, and Two-Way Indicator Species Analysis.

Following analysis, plant associations are described as they occur in LNWR (local description), and nationally or world-wide (global descriptions, by others). Further, a dichotomous key to the

plant associations is prepared and illustrated with photos taken during the vegetation data gathering phase of the study. This key is valuable both to researchers conducting the accuracy assessment for this project, but also as an educational guide for other researchers or visitors to LNWR. Another product of this analysis is a comprehensive species list.

Vegetation Data Analysis/Descriptions/Species List: 1 Researcher/20 office days

3.4. Photo-interpretation.

A reconnaissance trip to establish photo-signatures and take ground photographs will be conducted prior to photo-interpretation. This trip will be combined with the Field Data Collection trip (see 3.2 above) and will add one day to that trip. Interpretation of the aerial photos will be performed using a combination of stereo pairs and on-screen digitizing. Data will be interpreted on drafting film (Mylar) overlays on the hardcopy orthophoto prints.

Photo-interpretation: 1 Researcher / 16 days = 16 office days

3.5. GIS Database.

Mylar overlays from the photo-interpretation will be scanned, rectified, and converted to ArcInfo coverages. The transfer technique will involve finding common control points between the DOQQ's and the CIR prints and then transforming and adjusting the scanned linework using ArcInfo software. This is a timely process, may prove to be difficult due to the 9-year time difference in photography, and will not result in a truly ortho-rectified database (as opposed to using ortho-rectified CIR photos). Coverages will be edited, attributed according to the markings on the mylar overlays, and combined into one final coverage. One overall hard-copy map will be produced. An FGDC-compliant metadata file will be produced for the coverage and the field data points.

Transfer data into GIS database: 1 Technician / 20 days = 20 office days

Produce Map Product: 1 Technician / 2 days = 2 office days

Metadata: 1 Technician / 2 days = 2 office days

3.6. Accuracy Assessment.

An accuracy assessment (AA) of the vegetation map will be performed during the second field season, Summer 2001. Eighty to 100 points will be randomly selected and field ecologists will navigate to their coordinates using a hand-held GPS receiver and determine the vegetation type present. The vegetation type will be determined by using an *Illustrated Field Key to the NVCS Vegetation Associations at LNWR*, prepared for this purpose. Also recorded will be other vegetation types occurring within 50m of the selected point. This data will be entered into a digital overlay (also export file for AA plot locations) for the vegetation map and each point will be evaluated for accuracy or error of omission or commission; an AA matrix or contingency table will be prepared to summarize results.

Typical guidelines for the AA procedure include:

1. Observations of vegetation types are ground-based,
2. Ground sampling techniques are similar to the Observation Points collected during initial classification,
3. The number of samples per vegetation mapping unit will vary depending on abundance of the class upon the landscape,
4. Logistical planning for the AA will revolve around access to work areas within LNWR and will be based on completed vegetation maps, and
5. AA points will be randomly selected.

Following the AA, a decision analysis will be undertaken which examines the accuracy of each vegetation-mapping unit. The analysis will determine if the vegetation mapping unit, with its inherent variability: 1) meets the minimum standard of 80% accurate at the 90% confidence interval and is considered acceptable, or 2) two or more vegetation mapping units must be combined into an alliance, complex, or mosaic in order to meet the minimum accuracy standard.

- 2 Researchers/2 Travel days/3 data collection days = 10 field days (Summer 2001).
- 2 Researchers/3 Office days/ = 6 office days (Summer 2001).

3.7. Final Report

All study methods, results, and appendices will be presented in a comprehensive final report. At a minimum, the final report will contain: list of contacts and contributors, list of tables and figures, executive summary and introduction, project area description, materials and methods, results, discussion, bibliography, appendices, CD-ROM (containing report and digital point and vegetation coverages in Arc export format), and a vegetation map. Along with the final report, all original observation point/plot/accuracy assessment data will become the property of FWS as will any plant materials collected and preserved for identification purposes.

- Final Report: 2 Researchers/10 office days = 20 days (Late Summer 2001).

4. Cost Estimates. - (Please contact BOR RSGIG for information on the cost estimate).

5. Abbreviations and Acronyms:

B/W Black and White; CIR Color-Infrared ;
DOQQ Digital Orthophoto Quarter Quadrangle (USGS product);
FGDC Federal Geographic Data Committee;
FWS U.S. Fish and Wildlife Service;
Metadata Describes the content, quality, condition, and other characteristics of data;
NAPP National Aerial Photography Program;
NPS National Park Service;
LNWR Lacreek National Wildlife Refuge;

APPENDIX C: Observation, Plot, and AA Field Forms

NATIONAL WILDLIFE REFUGE VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM (1997)

IDENTIFIERS/LOCATORS

Plot Code_____ Polygon Code_____

Provisional Community Name_____

State ___ Refuge Name _____ Refuge Site Name _____

Quad Name_____ Quad Code_____

GPS file name_____ Field UTM X___ ___ ___ ___ ___ ___ m E Field UTM Y___ ___ ___ ___ ___ ___ ___ m N

please do not complete the following information when in the field
Corrected UTM X___ ___ ___ ___ ___ ___ m E Corrected UTM Y___ ___ ___ ___ ___ ___ ___ m N UTM Zone_____

Survey Date_____ Surveyors_____

ENVIRONMENTAL DESCRIPTION

Elevation _____ Slope _____ Aspect_____

Topographic Position

Landform

Cowardian System	Hydrologic Regime		Salinity Modifiers
___Upland	Non-Tidal		___Saltwater
___Riverine	___Permanently Flooded	___Saturated	___Brackish
___Palustrine	___Semipermanetly Flooded	___Temporarily Flooded/Saturated	___Freshwater
___Lacustrine	___Seasonally Flooded	___Intermittently Flooded	

Environmental Comments:	Unvegetated Surface: (please use the cover scale below)
	___ Bedrock ___ Litter, duff ___ Wood (> 1 cm)
	___ Large rocks (cobbles, boulders > 10 cm)
	___ Small rocks (gravel, 0.2-10 cm)
	___ Sand (0.1-2 mm) ___ Bare soil
	___ Other:_____

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface		Height Scale for Strata	
Trees and Shrubs		___Forest				
___Evergreen	___Broad-leaved	___Woodland	01	5%	01	<0.5 m
___Cold-deciduous	___Needle-leaved	___Shrubland	02	10%	02	0.5-1m
___Drought-deciduous	___Mixed broad-leaved/Needle leaved	___Dwarf Shrubland	03	20%	03	1-2 m
___Mixed evergreen - cold-deciduous	___Microphyllous	___Herbaceous	04	30%	04	2-5 m
___Mixed evergreen - drought-deciduous	___Graminoid	___Nonvascular	05	40%	05	5-10 m
	___Forb	___Sparsely Vegetated	06	50%	06	10-15 m
Herbs	___Pteridophyte		07	60%	07	15-20 m
___Annual			08	70%	08	20-35 m
___Perennial			09	80%	09	35 - 50 m
			10	90%	10	>50 m
			11	100%		

Strata	Height	Cover Class	Dominant species (mark any known diagnostic species with a *)	Cover Class
T1 Emergent	_____	_____		
T2 Canopy	_____	_____		
T3 Sub-canopy	_____	_____		
S1 Tall shrub	_____	_____		
S2 Short Shrub	_____	_____		
S3 Dwarf-shrub H Herbaceous	_____	_____		
N Non-vascular	_____	_____		
V Vine/liana	_____	_____		
E Epiphyte	_____	_____		

please see the table on the previous page for height and cover scales for strata

Other Comments

Cover Scale for Species
01 <1%
02 1-5%
03 5-25%
04 25-50%
05 50-75%
06 75-100%

NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM

IDENTIFIERS/LOCATORS

Plot Code____LACREEK_____ Habitat/BPU Code_____

Provisional Community Name_____

State _SD__ Park Name__Lacreek NWR_____ Refuge Site Name_____

Quad Name_____ Quad Code_____

GPS file name_____ Field UTM X___ ___ ___ ___ ___ ___ m E Field UTM Y___ ___ ___ ___ ___ ___ ___ m N

Comments: _____ Error +/- ___ ____ m

Please do not complete the following information when in the field

Corrected UTM X___ ___ ___ ___ ___ ___ m E Corrected UTM Y___ ___ ___ ___ ___ ___ ___ m N UTM Zone _____

Survey Date_____ Surveyors_____

Directions to Plot

Plot length(m)_____ Azimuth _____ Plot width(m)_____ If circle (diam)_____ Plot Photos (y/n) __ Roll # _____ Frame # _____

Plot Permanent (y/n) ____ Comments on photos or marker

Plot representativeness (discuss decisions for placement and/or reasons for non-representativeness)

a. Representativeness of association (if known):

b. Representativeness of plot in stand:

ENVIRONMENTAL DESCRIPTION

Elevation _____ Slope _____ Aspect_____

Topographic Position (see cheat sheet)

Landform (see cheat sheet)

Surficial Geology (see cheat sheet)

Cowardian System

___ Upland ____ Palustrine

___ Riverine ____ Lacustrine

Hydrology

___Permanently Flooded ___Seasonally Flooded ___Temporarily Flooded

___Semipermanetly Flooded ___Saturated ___Intermittently Flooded

___Unknown

Environmental Comments (dynamic stage, fire history, insect damage, etc):

Ground Cover: *(please estimate to the nearest percentage. Sum = 100%)*

___ Bare soil ___ Litter / duff ___ Wood (> 1 cm)

___ Bedrock ___Large rocks (cobbles, boulders > 10 cm)

___ Small rocks (gravel, 0.2-10 cm) ___ Sand (0.1-2 mm) dune /alluvium

___ Moss ___ Lichen ___ Cryptogam ___ Water ___ Other (name):

Soil Texture:

___ sand ___ loamy sand ___ sandy loam ___ loam

___ silt loam ___ silt ___ clay loam ___ silty clay

___ sandy clay ___ clay ___ peat ___ muck

Soil Drainage

___ Rapidly drained ___ Well drained

___ Moderately well drained ___ Somewhat poorly drained

___ Poorly drained ___ Very poorly drained

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata	Height Scale for Strata
<u>Trees and Shrubs</u> __Evergreen __Cold-deciduous __Mixed evergreen-cold-deciduous <u>Herbs</u> ___Annual ___Perennial	___Broad-leaved ___Needle-leaved ___Microphyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ___Shrubland ___Dwarf Shrubland ___Herbaceous ___Nonvascular ___Sparsely Vegetated	T 0-1% P >1-5% 1 >5-15% 2 >15-25% 3 >25-35% 4 >35-45% 5 >45-55% 6 >55-65% 7 >65-75% 8 >75-85% 9 >85-95% 10 > 95%	01 <0.5 m 02 0.5-1m 03 1-2 m 04 2-5 m 05 5-10 m 06 10-15 m 07 15-20 m 08 20-35 m 09 35 – 50 m 10 >50 m

	Height/Strata Class	Cover Class	Dominant Species (mark Diagnostics with *)
T1 Emergent	_____	_____	_____
T2 Canopy	_____	_____	_____
T3 Sub-canopy	_____	_____	_____
S1 Tall shrub	_____	_____	_____
S2 Short Shrub	_____	_____	_____
S3 Dwarf-shrub	_____	_____	_____
Ht Herbaceous	_____	_____	_____
H1 Graminoids	_____	_____	_____
H2 Forbs	_____	_____	_____
H3 Ferns	_____	_____	_____
H4 Tree seedlings	_____	_____	_____
N Non-vascular	_____	_____	_____
V Vine/liana	_____	_____	_____
E Epiphyte	_____	_____	_____

Animal Use Evidence (including scat, browse, graze, burrows, bedding sites, etc)

Natural and Anthropogenic Disturbance Comments (please see cheat sheet for impact codes, list intensity as High, Med, or Low)

Other Comments (locations of photos and permanent plot marker)

Lacreek National Wildlife Refuge Vegetation Mapping Project

Plot Code__Lacreek._____

Species/percent cover: Starting with the uppermost stratum, list all species with % cover for each species in the stratum. For each tree species estimate seedling, sapling, mature and total cover indicating stratum . Also for forests and woodlands, on a separate page **or** line below each tree species, list the DBH of all trees above 5 cm diameter. Separate measurements with a comma (note if measurements are from multi-stemmed tree). Put an asterisk next to any species that are known diagnostics for a particular community in the classification. **Also list species outside the plot at the end of the table or designate with a 0 in Cover Class column.**

Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class

Cover Class Scale

T = >0-1%	5 = >45-55%
P = >1-5%	6 = >55-65%
1 = >5-15%	7 = >65-75%
2 = >15-25%	8 = >75-85%
3 = >25-35%	9 = >85-95%
4 = >35-45%	10 = >95%

Tree D.B.H Form

Plot Code: Lacreek Units in cm or inches (circle one)

Record tree diameter over 5 cm at 4.5 feet (1.37 m) height for species that contribute to tree canopy.

Separate measurements of multi-stemmed trees with commas. Can estimate by 5 cm dia. classes

Species	D.B.H.(s) for multi-stems trees

Accuracy assessment Form (1998)
USGS-USFWS Vegetation Mapping Program

1. Plot Number _____ 2. Refuge Code _____ 3. Date _____

4. Observer(s)_____5. Datum _____ 6. Accuracy _____

7. UTM Coordinates: Easting __ __ __, __ __ __ Northing __, __ __ __, __ __ __

8. UTM Zone _____ 9. Offset from Point: Easting _____m Northing _____m

10. Topographic Description _____

11. Elevation _____m 12. Aspect _____

13. Veg Assoc. at Site _____

14. Veg Assoc 2 within 50m of Site _____

15. Veg Assoc 3 within 50m of Site _____

16. Major Species Present (by strata)_____

_____

_____

17. Canopy Closure of Top Layer _____

18. Rationale for Classification_____

_____

_____

_____

19. Comments _____

_____

_____

APPENDIX D: Dichotomous Field Key to Mapping Units at Lacreek NWR.

How to use the Key – On the following pages, plant associations and alliances are arranged in dichotomous couplets with corresponding field descriptions. Starting with the number "1", read through the groups of statements and select the one that is most appropriate. If necessary, follow the numbers in parentheses until a "best match" is found. Read the description to verify the match. It may be necessary to compare descriptions for similar associations by backtracking. The map code for each association is given in parentheses after each association name. Note that not all associations were mapped directly (1:1) on the map; consequently, some types may appear within alliances.

There will be some stands that do not match any of the descriptions exactly. Many plant associations are variable in composition and, while the descriptions attempt to address that variability, there will always be exceptions. Stands can represent transition zones between two vegetation types. Furthermore, there can be small inclusions of one type in larger stands of another. It is important to survey sufficiently large stands (≈ 0.5 ha or least 50 m diameter area around a point, or at least 100 m length in riparian areas) when classifying, and to base decisions on representative areas within stands.

1. Site supports > 10% tree and/or shrub cover **(14)**.

1. Site mostly herbaceous; grasses and forbs. Shrubs and trees, if present, provide less than 10% aerial cover **(2)**.

1. Site mostly herbaceous cover with evidence of recent prairie dog activity (runs, mounds, holes, etc.). **Blacktailed Prairie Dog Grassland Complex** (Map Unit 1.0)

2. Sites located within sandhills portion of the Refuge. Site consists of deep, loose, sandy soils on undulating to rolling uplands in the southern portion of the Refuge. *Yucca glauca, Hesperostipa comata,* and *Calamovilfa longifolia* are common on slopes, shoulders, and summits. *Panicum virgatum* may be locally abundant in low lying areas **(3)**.

2. Sites not within the sandhills portion of the Refuge. Site consists of moderately deep and deep, silty and loamy soils on nearly level to gently rolling uplands. Species composition can vary from wetlands to upland northern mixed grass prairie. *Yucca glauca* is not a prominent component of the community **(7)**.

3. Foliar cover of *Yucca glauca* 10-25%. Herbaceous foliar cover consists primarily of *Hesperosti pa comata* (=*Stipa* comata) and/or *Calamovilfa longifolia*.

3. Foliar cover of *Yucca glauca* < 10%. Dominant graminoids may include *Hesperostipa comata*, *Calamovilfa longifolia, Schizachyrium scoparium,* or *Panicum virgatum* **(4)**.

3a. Associated herbaceous species cover (graminoid) is <10%. (**3a)**
***Yucca glauca* / (Sparse Understory) Shrub Herbaceous Vegetation** (Map Unit 2.1)

3b. Associated herbaceous species cover (graminoid) is >10%. **(3b)**
***Yucca glauca / Hesperostipa comata* Shrub Herbaceous Vegetation** (Map Unit 2.2)

4. *Yucca glauca* plants visually prominent and herbaceous cover dominated by *Hesperostipa comata* (>10%).
***Hesperostipa comata - Yucca glauca* Herbaceous Vegetation** (Map Class 3.1)

4. *Yucca glauca* plants may be absent or, if present, density is relatively low. Dominant graminoids include *Hesperostipa comata*, *Calamovilfa longifolia, Schizachyrium scoparium,* or *Panicum virgatum*. **(5).**

5. Site located in swale or depression and dominated by *Panicum virgatum*.
***Panicum virgatum - (Pascopyrum smithii)* Herbaceous Vegetation** (Map Class 17.0)

5. Site located on nearly level to gently rolling uplands, moderately steep to steep slopes, or shoulders. If located in swale or depression, then not dominated by *Panicum virgatum*. **(6)**.

6. Site located on nearly level to gently rolling uplands dominated by *Calamovilfa longifolia* with *Hesperostipa comata* as the dominant secondary species.
***Calamovilfa longifolia - Hesperostipa comata* Herbaceous Vegetation** (Map Unit 3.2)

6. Site located on nearly level to gently rolling uplands dominated by *Calamovilfa longifolia* with *Carex inops* ssp. *heliophila* or *Andropogon hallii* as the dominant secondary species.
***Calamovilfa longifolia - Carex inops* ssp. *heliophila* Herbaceous Vegetation** (Map Unit 3.3)

6. Site located on moderately steep to steep (usually north facing) slopes and shoulders, and dominated by *Schizachyrium scoparium*.
***Schizachyrium scoparium - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation Herbaceous Vegetation** (Map Unit 4.0)

7. Site predominantly native species. Exotic species, if present, are minor components of the stand **(8).**

7. Site predominantly (>50% cover) introduced/exotic species, which include *Cirsium arvense* (**7a**), *Poa pratensis* (**7b**), *Bromus inermis* (**7c**), *Agropyron cristatum* (**7d**), or *Thinopyrum intermedium* (**7e**).

7a. Dominant species is *Cirsium arvense* (Canada Thistle).
***Cirsium arvense* Patches** (Map Unit 14.0)

7b. Dominant species is *Poa pratensis* (Kentucky bluegrass).
***Poa pratensis-Bouteloua gracilis-Carex filifolia* Semi-Natural Herbaceous Vegetation** (Map Unit 8.0).

7c. Dominant species is *Bromus inermis* (Smooth brome).
***Bromus inermis-(Pascopyrum smithii)* Semi-Natural Herbaceous Vegetation** (Map Unit 9.0.)

7d. Dominant species is *Agropyron cristatum* (Crested wheatgrass).
***Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata)* Semi-Natural Herbaceous Alliance** (Map Unit 10.0)

7e. Dominant species is *Thinopyron intermedium* (Intermediate wheatgrass)
***Thinopyron intermedium* Semi-Natural Herbaceous Alliance** (Map Unit 11.0)

8. Sites with moist to saturated soils dominated by *Schoenoplectus acutus* (**8a**), *Juncus* (**8b**), *Spartina* (**8c**), *Phragmites* (**8d**), mixed forb species (usually dominated by *Helianthus* spp.) (**8e**), *Carex* (**8f**), *Schoenoplectus pungens* (**8g**), a mix of emergent sprcies (**8h**), *Glycyrrhiza lepidota* (**8i**), *Polygonum amphibium* (**8j**) or *Typha* (**9**),

8. Sites with silty and loamy soils that support predominantly native species characteristic of northern mixed grass prairie. Some sites may have been seeded. **(9)**

8a. Dominant species is *Scirpus acutus* and site is located in the sandhills region
***Schoenoplectus acutus – Typha latifolia* (*Schoenoplectus tabernaemont*) Sandhills Herbaceous Vegetation** (Map Class 25.0).

8b. Dominant species is *Juncus balticus*.
***Juncus balticus* Seasonally Flooded Herbaceous Alliance** (Map Class 21.0)

8c. Dominant species is *Spartina pectinata*.
***Spartina pectinata - Carex* spp. Herbaceous Vegetation** (Map Class 19.0)

8d. Dominant species is *Phragmites australis*.
***Phragmites australis* Herbaceous Vegetation** (Map Class 20.0)

8e. Dominated by a mix of forbs that may vary across the Refuge. *Helianthus* spp. are usually present.
Mixed Forb Herbaceous Vegetation (Map Class 13.0)

8f. Site is covered with a monotypic stand of *Carex nebrascensis*.
***Carex nebrascensis* Herbaceous Vegetation** (Map Class 22.0)

8g. Small site dominated by *Schoenoplectus pungens.*
***Schoenoplectus pungens* Herbaceous Vegetation** (Map Class 24.0)

8h. Mesic sites located in the sandhills region, mainly on private land, containing a mix of emergent wetland species. Site is associated with a stock pond or drainage.
Emergent Sandhills Wetland (Map Class 23.0)

8i. Small site dominated by *Glycyrrhiza lepidota.*
***Glyccyrrhiza lepidota* Herbaceous Vegetation** (Map Class 15.0)

8j. Rather large site dominated by monotypic stand of *Polygonum amphibium.*
***Polygonum amphibium* Herbaceous Vegetation** (Map Class 16.0)

9. Site is dominated by thick stands of *Typha* spp. (cattails).

9. Site is not dominated by *Typha* spp (**10)**

9a. *Typha* occurs on regularly flooded sites that are associated with pools, ponds, or reservoirs.
***Typha* spp.–Great Plains Herbaceous Veg. (Semi-permanently Flooded)** (Map Class 26.1)

9b. *Typha* occurs on sites that have only been flooded during seasonal flooding events.
***Typha* spp. – Great Plains Herbaceous Vegetation (Seasonally Flooded)** (Map Class 26.2)

10. Sites do not appear to have been seeded with native species and appear more typical of northern mixed grass prairie. Topography ranges from nearly level to gently rolling. **(11)**.

10. Sites appear to have been seeded with native species such as *Panicum virgatum* (**10a**), *Bouteloua curtipendula* (**10b**), or a mixture of native species (**10c**). Most sites appear as relatively uniform in composition and cover, and are usually found on nearly level sites. **Restoration Areas**

10a. Restoration site is dominated by *Panicum virgatum*.
Native Species Plantings (*Panicum virgatum*) (Map Class 35.3)

10b. Restoration site is dominated by *Bouteloua curtipendula*.
Native Species Plantings (*Bouteloua curtipendula*) (Map Class 35.1)

10c. Restoration site is dominated by mix of planted native graminoid species.
Native Species Plantings (Mixed Grasses) (Map Class 35.2)

11. Sites do not appear to have been manipulated or grazed and appear more typical of natural, undisturbed prairie. Topography ranges from nearly level to gently rolling. **(12)**.

11. Sites appear to have been grazed or manipulated (other than seeded) with some non-native speices and no clear dominant graminoid species. **Mixed Grasslands**

11a. Site is dominated by a complex mix of warm season natives such as *Sporobolus spp., Bouteloua spp.,* and *Panicum virgatum*.
Mixed Grassland (Warm Season Natives) (Map Class 12.2)

11b. Site is dominated by a complex mix of cool season native such as *Pascopyrum smithii* and *Koeleria macrantha*. **Mixed Grassland (Cool Season Natives)** (Map Class 12.3)

11c. Site is dominated by a complex mix of both warm and cool season natives.
Mixed Grassland (Map Class 12.1)

12. Sites on fine textured soils, sometimes saline or alkaline, usually fairly level and appear to have a monoculture of either *Pascopyrum smithii* or *Distchilis spicata* **(13)**.

12. Sites on gently rolling, loamy soils usually on toe or foot slopes dominated by *Andropogon gerardii*.
***Andropogon gerardii* Herbaceous Vegetation** (Map Unit 6.0)

12. Sites on high terraces or slopes (shoulder or mid-slope), usually loamy or silty soils, dominant species is *Hesperostipa comata*.
***Hesperostipa comata – Bouteloua gracilis – Carex filifolia* Herbaceous Vegetation** (Map Unit 5.0)

13. Site not associated with saline or alkaline soil. Stand appears as a monotypic stand of *Pascopyrum smithii*. ***Pascopyrum smithii- Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation** (Map Unit 7.0).

13. Sites with saline or alkaline soils located near ponds or streams, sometimes associated with a fluctuating water table. Species composition is usually a monotypic stand of *Distchilis spicata* (**13b**) or *Hordeum jubatum* (**13a**), often closely associated with stands of *Spartina pectinata*. The site may contain inclusions of *Poa pratensis, Hordeum jubatum,* or *Pascopyrum smithii*.

13a. Site site is completely dominated by *Hordeum jubatum*.
***Hordeum jubatum* Herbaceous Vegetation** (Map Class 18.1)

13b. Site is completely dominated by *Distichlis spicata.*
***Distichlis spicata* Herbaceous Vegetation** (Map Unit 18.2)

14. Site primarily vegetated by shrub species (**15**).

14. Site primarily vegetated by trees > 4 m in height with foliar cover > 10%, and typically greater than 25%.

14a. Site dominated by *Salix amygdaloides* trees growing along riparian and floodplain corridors.
***Salix amygdaloides* Woodland** (Map Class 32.0)

14b. Site is dominated by a small stand of *Populus deltoides* trees.
Populus deltoides Woodland (Map Class 33.0)

14c. Site is dominated by a small stand of *Celtis occidentalis* trees in the Sandhills region.
***Celtis occidentalis* Woodland** (Map Class 31.0)

14d. Site is contains a small stand of *Fraxinus pennsylvanica* trees
***Fraxinus Pennsylvanica* Woodland** (Map Class 34.0)

15. Sites are dominated by *Symphoricarpos occidentalis* occurring in upland prairie locations; usually swales or dry drainages.
***Symphoricarpos occidentalis* Temporarily Flooded Shrubland Alliance** (Map Class 27.0)

15. Sites are dominated by *Prunus americana* (**15a**)*, Salix exigua* (**15b**), or *Amorpha fruiticosa* (**15c**), mostly < 4 m in height; however, heights for *Prunus americana* and *Salix exigua* can approach 5 m in height. Stands occur in mesic sites. Shrub cover > 10% and usually > 25%.

15a. Site is dominated by thick stands of *Salix exigua*.
***Salix exigua* / Mesic Graminoids Shrubland** (Map Class 30.0)

15b. Site is dominated by small pockets of *Prunus americana*.
***Prunus americana* Shrubland** (Map Class 28.0)

15c. Site is dominated by *Amorpha fruiticosa*.
***Amorpha fruticosa* Shrubland** (Map Class 29.0)

APPENDIX E: NVCS Association Descriptions for Lacreek NWR.

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Blacktailed Prairie Dog Town Grassland Complex

COMMON NAME	Blacktailed Prairie Dog Town Grassland Complex
SYNONYM	Blacktailed Prairie Dog Town Grassland Complex
PHYSIOGNOMIC CLASS	(n/a)
PHYSIOGNOMIC SUBCLASS	(n/a)
PHYSIOGNOMIC GROUP	(n/a)
PHYSIOGNOMIC SUBGROUP	(n/a)
FORMATION	(n/a)
ALLIANCE	
CLASSIFICATION CONFIDENCE LEVEL	3
USFWS WETLAND SYSTEM	Terrestrial

RANGE

Lacreek National Wildlife Refuge

Black-tailed prairie dog (*Cynomys ludovicianus*) towns are widespread within Lacreek and its environs, where soils are deep enough and have sufficient structure to support burrowing activity. Towns may range in size from less than one hectare to several hundred hectares; the largest occur adjacent to and contiguous with the Conata Basin. A black-footed ferret (*Mustela nigripes*) reintroduction program is underway within Lacreek, to help return this predator of prairie dogs to portions of its former range.

Globally

The blacktailed prairie dogs (*Cynomys ludovicianus ludovicianus*) occur on the Great Plains and the whitetailed prairie dogs (*Cynomus leucurus*) occur in the Great Basin (Knight 1994). Prairie dog towns historically covered millions of hectares in the Great Plains; currently their towns range in size from tens to hundreds of hectares, with an average density of 10 to 55 animals/ha (Whicker and Detling 1988). Blacktailed prairie dog towns occur widely throughout the short and mixed-grass regions of the Great Plains of the United States and Canada, and this complex ranges from Saskatchewan in Canada south to the southern Great Plains states, including Colorado and Kansas

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Prairie dog towns are located on clay, clay loam, silty loam and some sandy loam soils deposited following erosion from adjacent uplands, including badlands formations. The soils are primarily derived from the Brule, Chadron, and Pierre Shale formations. Soils are deep, structured and not easily eroded. This type is found on level sites along drainages, in broad valleys, on gentle to moderately sloping hillslopes, and flats on tables and buttes.

Globally

Prairie dog towns are located on a wide variety of soils, including clay, clay loam, silty loam and some sandy loam soils deposited following erosion from adjacent uplands, including badlands formations. Soils are deep, structured and not easily eroded. This type is found on level sites along drainages, in broad valleys, on gentle to moderately sloping hillslopes, and flats on tables and buttes (Von Loh *et al.* 1999). Prairie dogs create extensive burrows in their towns. Large volumes of soil are moved, improving filtration, hastening the incorporation of organic matter,

facilitating nutrient cycling, and increasing the spatial heterogeneity of vegetation, soils, and other ecosystem components (Knight 1994).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Verbena bracteata, Conyza ramosissima, Hedeoma hispida, Dyssodia papposa, Aristida purpurea, Buchloe dactyloides, Pascopyrum smithii*

Globally

Stratum	Species
Short Shrub	*Artemisia frigida*
Forb	*Dyssodia papposa*
Graminoid	*Aristida purpurea, Bouteloua gracilis, Buchloe dactyloides, Pascopyrum smithii*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Pascopyrum smithii, Aristida purpurea, Dyssodia papposa, Hedeoma hispida, Conyza ramosissima, Verbena bracteata

Globally

Aristida purpurea, Artemisia frigida, Bouteloua gracilis, Conyza ramosissima, Dyssodia papposa, Hedeoma hispida, Pascopyrum smithii, Verbena bracteata

OTHER NOTABLE SPECIES

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

The prairie dog towns are extremely variable in their vegetation characteristics, which are dependent largely on age of town, soil type, and population density (as it relates to grazing frequency). Vegetation cover averages between 30-80% with frequent patches of 100% cover. The vegetation sometimes occurs in relatively concentric zones, relating to outward expansion of town boundaries over time. Abandoned towns, towns with sparse prairie dog populations, and the outer edges of most towns are typically dominated by western wheatgrass (*Pascopyrum smithii*), blue grama (*Bouteloua gracilis*), and/or buffalograss (*Buchloe dactyloides*). Vegetation is typically patchy in distribution, and towns may encompass other plant associations as they expand, including emergent wetlands and badlands complex vegetation (no burrows are dug in these types, they merely become surrounded). The more common patches of vegetation within towns include purple three-awn (*Aristida purpurea*), fetid dogweed (*Dyssodia papposa*), dwarf conyza (*Conyza ramosissima*), field bindweed (*Convolvulus arvensis*), and large-bract verbena (*Verbena bracteata*).

Globally

Blacktailed prairie dog towns are located in open mixedgrass or shortgrass prairie habitat, and their activity has both direct and indirect effects on the vegetation. The blacktailed prairie dogs keep the surrounding vegetation clipped close to the ground, presumably to improve their ability to detect stalking predators. This clipping gives the impression of a mowed lawn, or overgrazed

rangeland. Cover averages between 30 and 80%, but some patches may be 100%. Prairie dogs repeatedly clip and graze plants, rarely allowing shoots to reach full size. Thus, canopy height within the colony is about 5-10 cm, compared to 20-50 cm in nearby, uncolonized grassland (Whicker and Detling 1988). Changes in plant species composition may begin as early as 2 or more years after colonization. Shortgrass species, such as *Bouteloua gracilis* and *Buchloe dactyloides*, and annual forbs become abundant and replace mid-height or tall grasses, such as *Pascopyrum smithii*. Continued heavy grazing may eventually result in complete dominance by a few species of forbs or dwarf shrubs, such as *Artemisia frigida*, *Dyssodia papposa*, and *Aristida purpurea* (Whicker and Detling 1988). Grazing may even cause genetic shifts within species. The shorter, more prostrate, growth forms of *Pascopyrum smithii* on prairie dog towns have been shown to be more abundant than those away from towns, suggesting that some genotypes within the species may tolerate grazing better than others (Jaramillo and Detling 1988, Whicker and Detling 1988).

Bison may be attracted to the prairie dog towns, and a series of studies found that bison preferentially graze them (Coppock et al. 1983, Coppock and Detling 1986, Day and Detling 1990). The forage on the colonies is more nutritious than off, with higher nitrogen content and younger shoots, apparently because the animal waste products are deposited there. In turn, the presence of bison waste products further increases the soil fertility and forage quality (Knight 1994). Pronghorns may also prefer the prairie dog towns (Knight 1994). Plant species diversity is increased by the small-scale disturbances caused by the digging of prairie dogs, and animal species diversity may also increase because of the habitat provided for the badger, rattlesnake, burrowing owl, black-footed ferret, and cottontail, in addition to the bison and pronghorn (Knight 1994).

Prairie dog towns also move over time, expanding and contracting, and, as larger towns can cover thousands of hectares at a time, the effect on the prairie landscape is substantial.
The plant community types on a prairie dog colony are roughly indicative of the extent of herbivore disturbance and reflect the cumulative impact of grazing intensity, grazing duration, activities of other animals, soil characteristics, and weather (Whicker and Detling 1988). Early stages of the town may have a typical mixed grass or shortgrass prairie type. With continued grazing and age of the town, the composition may shift to a mix of annual species and dwarf-shrubs. These latter stages have not been classified, but are treated here as a complex. Species richness appears to be highest under moderate levels of disturbance, because grass species have not yet begun to disappear, but forb species have begun to increase.

CONSERVATION RANK G4. This rank has been assigned based on the G4 rank that is currently assigned to the Blacktailed prairie dog itself. However, more careful review of the rank from a community perspective is needed.

DATABASE CODE CECX002003

SIMILAR ASSOCIATIONS
Pascopyrum smithii - *Bouteloua gracilis* - *Carex filifolia* Herbaceous Vegetation
Pascopyrum smithii - *Nassella viridula* Herbaceous Vegetation

COMMENTS

Lacreek National Wildlife Refuge

The disturbance-related vegetation occurs on the naturally-disturbed soils of prairie dog towns. Prairie dog town disturbed vegetation is quite patchy in distribution, and variable in terms of species distribution, with dominance varying locally within a stand. This is typical of early successional species on disturbed sites. The Prairie Dog Town Complex was well-surveyed during the preparation of the vegetation map.

REFERENCES

Coppock, D.L. and J.K. Detling. 1986. Alteration of bison and black-tailed prairie dog grazing interaction by prescribed burning. J. Wildl. Mgmt. 50(3):452-455.

Coppock, D.L. et al. 1983. Plant-herbivore interactions ina North American mixed-grass prairie. Oecologia (Berlin) 56:1-9.

Day, T. A. and J. K. Detling. Grassland patch dynamics and herbivore grazing preference following urine deposition. Ecology. 71(1):180-188.

Jaramillo, V. J. and J. K. Detling. 1988. Grazing history, defoliation, and competition: Effects on shortgrass production and nitrogen accumulation. Ecology. 69(5):1599-1608.

Von Loh, J., D. Cogan, D. Faber-Langendoen, D. Crawford, and M. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program, Badlands National Park, South Dakota (Final Report). Technical Memorandum No. 8260-00-02. U.S. Bureau of Reclamation Technical Service Center. Denver Colorado.

Whicker, A. D., and J. K. Detling. 1988. Ecological consequences of prairie dog disturbances. BioScience. 38(11):778-784.

Calamovilfa longifolia - Carex inops ssp. heliophila Herbaceous Vegetation

COMMON NAME Prairie Sandreed - Long-stolon Sedge Herbaceous Vegetation
SYNONYM Prairie Sandreed - Sedge 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 Tall sod temperate grassland (V.A.5.N.a)
ALLIANCE CALAMOVILFA LONGIFOLIA HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

The prairie sandreed type is found primarily in the sandhills portion of the Refuge, although small stands sometimes occur in coarse textered soils along the northern margin of pool #10.

Globally

This community is found in 3 ecoregional sections in Wyoming, Montana, North Dakota, South Dakota, and Saskatchewan.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

The more developed stands of prairie sandreed grassland are found on sandy deposits along the northern border of the sandhills. Extensive stands occur primarily in the northeast corner of the sandhills. These species are also common components of many of the sandhill communities.

Globally

Stands are found on gently rolling uplands with little to moderate slopes (typically between 0 and 20%, but occasionally as high as 39%, Hirsch 1985, Hansen and Hoffman 1988). The soils are sand, sandy loam, or loamy sand and there is rarely substantial soil horizon development (Hanson and Whitman 1938). The parent material is sandstone (USFS 1992). Moisture levels may be high deep in the profile.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Shrub	*Yucca glauca*
Herbaceous	*Calamovilfa longifolia, Carex inops ssp heliophila, Hesperostipa comata, Poa pratensis*

Globally

Stratum	Species
Graminoid	*Calamovilfa longifolia, Carex filifolia, Carex inops ssp heliophila*

CHARACTERISTIC SPECIES
Lacreek National Wildlife Refuge
Calamovilfa longifolia, *Hesperostipa comata*

Globally
Calamovilfa longifolia, Carex filifolia, Carex inops ssp *heliophila*

OTHER NOTABLE SPECIES
Globally

Stratum	Species
Graminoid	*Koeleria macrantha, Schizachyrium scoparium, Hesperostipa comata*

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
Small stands of prairie sandreed grasslands are farily common throughout the sandhills. Many are below the minimum mapping unit of 0.5 hectares. Foliar cover is usually sparse, ranging from 20-40%. The dominant grass is prairie sandreed (*Calamovilfa longifolia*), with needle-and-thread (*Hesperostipa comata*) and Kentucky bluegrass (*Poa pratensis*) as common secondary species.

Globally
The vegetation structure is somewhat open, with cover averaging 65 percent in parts of its range (USFS 1992). The vegetation is dominated by graminoids, with two strata, one of mid- to tall-grasses, the other of dense short sedges. In the taller grass layer, the most abundant species is *Calamovilfa longifolia*. Other species found in this layer include *Koeleria macrantha, Schizachyrium scoparium*, and *Hesperostipa comata*. *Pascopyrum smithii* may be present on some stands with finer soil textures. The short graminoid layer is composed chiefly of *Carex filifolia* and *Carex inops* ssp. *heliophila*, which may have high cover values. Other upland Carices, such as *Carex duriuscula (=Carex eleocharis)*, as well as *Bouteloua gracilis* and *Muhlenbergia pungens*, may also be present. Forb species diversity is moderate, but they do not contribute greatly to the cover (Hanson and Whitman 1938, USFS 1992). The forbs that are typical of this community include *Artemisia dracunculus, Artemisia frigida* (a shrub to some), *Artemisia ludoviciana, Chenopodium album, Chenopodium leptophyllum, Lathyrus* spp., *Liatris punctata, Lygodesmia juncea, Phlox hoodii*, and *Psoralidium lanceolatum*. Shrubs are uncommon. When shrubs are present they are short shrubs such as *Yucca glauca, Rosa spp*., and *Artemisia frigida* (a forb to some).

CONSERVATION RANK G3. No occurrences have been documented, but the community is reported in 3 ecoregional subsections in Wyoming, Montana, North Dakota, South Dakota, and Saskatchewan. It is a very uncommon community in Badlands National Park, South Dakota.

DATABASE CODE CEGL001471

SIMILAR ASSOCIATIONS
Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation

COMMENTS

Lacreek National Wildlife Refuge

Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation (CEGL001473) may be an equally good fit.

REFERENCES

Bruner, W. E. 1931. The vegetation of Oklahoma. Ecological Monographs 1:99-188.

Burgess, R. L. 1965. A study of plant succession in the sandhills of southeastern North Dakota. Proceedings of the North Dakota Academy of Science 19:62-80.

Hansen, P.L. 1985. An ecological study of the vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest. Unpublished dissertation, South Dakota State University. 257 pp.

Hirsch, K. J. 1985. Habitat type classification of grasslands and shrublands of southwestern North Dakota. Ph.D. thesis. North Dakota State University, Fargo.

Hoagland, B. W. 1998a. Classification of Oklahoma vegetation types. Working draft. University of Oklahoma, Oklahoma Natural Heritage Inventory, Norman. 43 pp.

Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.

Lauver, C. L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44:421-443.

Looman, J. 1980. The vegetation of the Canadian prairie provinces. II. The grasslands, Part 1. Phytocoenologia 8(2):153-190.

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

Soil Conservation Service. 1978. Range site descriptions for Colorado. Technical Guide, Section II-E. USDA Soil Conservation Service, Colorado State Office, Denver.

Steinauer, G. 1989. Characterization of the natural communities of Nebraska. Appendix D, pages 103-114 in: M. Clausen, M. Fritz, and G. Steinauer. The Nebraska Natural Heritage Program, two year progress report. Unpublished document. Nebraska Game and Parks Commission, Natural Heritage Program, Lincoln, NE.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Tolstead, W. L. 1941. Plant communities and secondary succession in south-central South Dakota. Ecology 22(3):322-328.

Tolstead, W. L. 1942. Vegetation of the northern part of Cherry County, Nebraska. Ecological Monographs 12(3):257-292.

Calamovilfa longifolia - Hesperostipa comata Herbaceous Vegetation

COMMON NAME Prairie Sandreed - Needle-and-thread Herbaceous Vegetation
SYNONYM Prairie Sandreed - Needle-and-thread Prairie
NE Sandhills Dry Valley Prairie; Eastern Sandhills Needlegrass 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 Tall sod temperate grassland (V.A.5.N.a)
ALLIANCE CALAMOVILFA LONGIFOLIA HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

The prairie sandreed type is found primarily in the sandhills portion of the Refuge, although small stands sometimes occur in coarse textered soils along the northern margin of pool #10.

Globally

This prairie sandreed grassland community type occurs in the central and northern Great Plains region of the United States, ranging from Colorado and Nebraska, north to Wyoming and South Dakota.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

The more developed stands of prairie sandreed grassland are found on sandy deposits along the northern border of the sandhills. Extensive stands occur primarily in the northeast corner of the sandhills. These species are also common components of many of the sandhill communities.

Globally

Stands occur on stabilized sand dunes, as well as in interdunal valleys or draws, colluvial sands, and, less commonly, silty terraces of intermittent streams. Soils are medium to fine sands formed either from eolian or colluvial processes. For example, in Nebraska stands occur below sandstone outcrops and escarpments. More rarely, stands occur on floodplain terraces of intermittent streams, where soils are moderately deep, poorly drained, silty loams and loams (Heerwagen 1958, USDI 1979, Barnes et al. 1984, Steinauer and Rolfsmeier 2000). Blowouts caused by drought and wind may occur in this type. The type probably represents a later successional stage. Earlier stages may be dominated by *Andropogon hallii* (e.g. CEGL001467). Heavy grazing may increase the likelihood of blowouts.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Shrub	*Yucca glauca*
Herbaceous	*Calamovilfa longifolia, Carex inops ssp heliophila, Hesperostipa comata, Poa pratensis*

Globally

Stratum	Species
Graminoid	*Calamovilfa longifolia, Carex filifolia, Carex inops ssp heliophila*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Calamovilfa longifolia, *Hesperostipa comata*

Globally

Calamovilfa longifolia, Carex filifolia, Carex inops ssp *heliophila*

OTHER NOTABLE SPECIES

Globally

Stratum	Species
Graminoid	*Koeleria macrantha, Schizachyrium scoparium, Hesperostipa comata*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

Small stands of prairie sandreed grasslands are farily common throughout the sandhills. Many are below the minimum mapping unit of 0.5 hectares. Foliar cover is usually sparse, ranging from 20-40%. The dominant grass is prairie sandreed (*Calamovilfa longifolia*), with needle-and-thread (*Hesperostipa comata*) and Kentucky bluegrass (*Poa pratensis*) as common secondary species.

Globally

The vegetation has an open canopy, dominated by mid to tall grasses. *Calamovilfa longifolia* is the most conspicuous grass. Other common grasses include *Bouteloua gracilis, Bouteloua gracilis, Koeleria macrantha, Achnatherum hymenoides (= Oryzopsis hymenoides), Sporobolus cryptandru*s, and *Hesperostipa comata Pascopyrum smithii* and *Nassella viridula* may occur on more level sites at the base of slopes (Barnes et al. 1984, Steinauer and Rolfsmeier 2000). *Andropogon hallii* may also be present. Sedges are rare but could include *Carex inops ssp. heliophil*a. Forb diversity ranges from low to moderate, depending on the site. Dry valley sand prairies may be particularly forb-rich. Silty terraces of intermittent streams may contain *Artemisia frigida, Artemisia ludoviciana, Gutierrezia sarothrae, Psoralidium tenuiflor*um, and *Yucca glauca* (Steinauer and Rolfsmeier 2000). Shrubs are scattered and infrequent to absent, with *Rhus trilobata* the most common species. These areas are highly susceptible to invasion by exotic brome grasses *(Bromus japonicus, Bromus squarrosus, Bromus tectoru*m) and may be quite weedy (Heerwagen 1958, USDI 1979, Steinauer and Rolfsmeier 2000).

CONSERVATION RANK G3. No occurrences have been documented, but the community is reported in 2 ecoregionalsections in Wyoming, Colorado, and Nebraska. It is restricted primarily to stabilized sand dunes, as well as in interdunal valleys or draws, colluvial sands, and intermittent streams, but it has a moderately wide distribution in the central to northern Great Plains. Stands are typically less than a few hectares in size, but larger stands are found in interdunal valleys in Nebraska, some reaching 100 acres or more (G. Steinauer pers. comm.

1999). In Nebraska, this community can be heavily grazed and subsequently invaded by exotic species (Steinauer and Rolfsmeier 2000).

DATABASE CODE CEGL001473

SIMILAR ASSOCIATIONS
Calamovilfa longifolia - Carex inops ssp. heliophila Herbaceous Vegetation

COMMENTS
Lacreek National Wildlife Refuge

Globally
This type may perhaps be differentiated from other types, such as *Calamovilfa longifolia –Carex inops ssp. heliophila* Herbaceous Vegetation (CEGL001471), by the absence or low abundance of *Carex filifolia* and *Carex inops ssp. heliophil*a, though why those species are not abundant in this type is not clear. Further floristic comparisons need to be made to help make the distinction clear between that type and this type. Some floristic variability is to be expected in this type, based on successional patterns following dune blowouts. Steve Kettler (pers. comm. 1998) says they don't have this type in Colorado. It sounds like a version of a locally described *Andropogon hallii - Stipa comata* type, of which Colorado is also not very confident. Kettler suspects that a lot of the variation in grass dominance is from different management (grazing) over the years. The silty terrace stands arereported from the White River drainage in northwestern Nebraska and Badlands National Park, South Dakota (Von Loh et al. 1999, Steinauer and Rolfsmeier 2000).

REFERENCES
Barnes, P. W., A. T. Harrison, and S. P. Heinisch. 1984. Vegetation patterns in relation to topography and edaphic variation in Nebraska Sandhills prairie. Prairie Naturalist 16(4):145-158.
Bureau of Land Management. 1974. Final environmental impact statement, eastern Powder River coal basin of Wyoming.
CDM Consultants. No date. Dave Johnston Mine Application No. 291-T2, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.
Heerwagen, A. 1958. Management as related to range site in the central plains of eastern Colorado. Journal of Range Management 11:5-9.
Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.
Mine Reclamation Consultants. 1977. Buckskin Mine Application No. 500-T2, on file at Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne.
Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.
Von Loh, J., D. Cogan, D. Faber-Langendoen, D. Crawford, and M. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program, Badlands National Park, South Dakota. USDI Bureau of Reclamation. Technical Memorandum No. 8260-99-02. Denver, CO.

Note:

This association is found in two different map classes:

1) Needle-and-Thread / Soapweed Yucca Herbaceous Vegetation
2) Prairie Sandreed - Needle-and-Thread Herbaceous Vegetation

Schizachyrium scoparium - Bouteloua (curtipendula, gracilis) - Carex filifolia Herbaceous Vegetation

COMMON NAME Little Bluestem - (Sideoats Grama, Blue Grama) - Threadleaf Sedge Herbaceous Vegetation
SYNONYM Northern Great Plains Little Bluestem 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 (V.A.5.N.c)
ALLIANCE SCHIZACHYRIUM SCOPARIUM - BOUTELOUA CURTIPENDULA HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

Little bluestem grasslands in the Refuge are generally restricted to small patches on the slopes and shoulders of the sandhills.

Globally

This community is found in western North Dakota, western South Dakota, eastern and northern Wyoming, central and eastern Montana, southern Saskatchewan, and southern Manitoba.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Little bluestem stands typically occur on slopes and shoulders of variable steepness and aspect. The sites appear to be more stable (less susceptible to blowouts, but appear more prone soil creep) compared to some of the surrounding sandhills types.

Globally

This community is usually found on gentle to steep slopes with variable aspects (Hansen *et al.* 1984, Johnston 1987, Hansen and Hoffman 1988). The soil may be loamy sand, sandy loam, loam, or clay loam. There may be a substantial component of gravel. Hansen *et al.* (1984) found 7-36% gravel by weight in 16 stands in western North Dakota. The soils are typically shallow and occur over sandstone or limestone (Johnston 1987, Thilenius *et al.* 1995).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Schizachyrium scoparium, Andropogon hallii, Calamovilfa longifolia*

Globally

Stratum	Species
Graminoid	*Bouteloua curtipendula, Bouteloua gracilis, Schizachyrium scoparium*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Schizachyrium scoparium, *Calamovilfa longifolia*, *Yucca glauca*

Globally

Bouteloua curtipendula, Bouteloua gracilis, Carex filifolia, Schizachyrium scoparium

OTHER NOTABLE SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Graminoid	*Poa pratensis*

Globally

Stratum	Species
Graminoid	*Bromus inermis, Bromus tectorum, Poa pratensis*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

Little bluestem grasslands typically have moderate to dense cover that ranges between from 40 to 70%, with much of the soil surface covered by litter. Little bluestem (*Schizachyrium scoparium*) is strongly dominant with prairie sandreed (*Calamovilfa longifolia*) as a common associate. Few forbs are usually present. A few soapweed plants (*Yucca* glauca) are sometimes scattered within the stand.

Globally

This community is predominantly composed of graminoid species less than 1 m tall. Occasional *Pinus ponderosa* are scattered throughout the type. The vegetation cover is moderate to high. Thilenius *et al.* (1995) found that vegetation cover was 44 percent in Wyoming, and Hansen and Hoffman (1988) found 75 percent cover in North Dakota. The dominant species is *Schizachyrium scoparium,* with *Bouteloua curtipendula, Bouteloua gracilis*, and *Carex filifolia* as associates or codominants. *Andropogon gerardii, Carex inops* ssp. *heliophila, Carex duriuscula (= Carex eleocharis), Koeleria macrantha* and *Calamovilfa longifolia* are often present. *Calamovilfa longifolia* may be abundant on sandier soils. *Muhlenbergia cuspidata, Hesperostipa comata, Pascopyrum smithii*, and *Nassella viridula* may also be present. *Pseudoroegneria spicata* may be found in the western portions of this community (Jones 1992). In Manitoba, the graminoids *Festuca ovina* and *Elymus trachycaulus* and the lichen *Selaginella densa* are more abundant (Greenall 1995). Forbs do not contribute greatly to the canopy, but many species may be found in this community (Hanson and Whitman 1938). Among the forbs that may be found are *Echinacea angustifolia, Aster oblongifolius, Aster ericoides, Gaura coccinea, Lygodesmia juncea, Helianthus pauciflorus* ssp. *pauciflorus, Rosa arkansana, Liatris punctata, Pediomelum argophyllum (=Psoralea argophyllum), Dalea purpurea, Phlox hoodii*, and *Campanula rotundifolia*. There are very few woody species; those that are present are usually short shrubs such as *Artemisia frigida, Juniperus horizontalis*, and *Yucca glauca*. Litter often accumulates and may cover more than 50 percent of the ground (Hirsch 1985).

CONSERVATION RANK G3G4.

DATABASE CODE CEGL001681

SIMILAR ASSOCIATIONS (n/a)

COMMENTS

Lacreek National Wildlife Refuge

Little bluestem vegetation is relatively uncommon in the Refuge.

Globally

This type occurs on variable aspects throughout its range. Hansen *et al.* (1984) and McAdams *et al.* (1998) report this type on southerly aspects for western South Dakota and southwestern North Dakota. In southeast Montana and the Cheyenne River Basin, Butler *et al.* (1986) found that, in a ravine in western North Dakota, the most abundant species on a south-facing footslope were *Bouteloua curtipendula* and *Carex filifolia*. Other species that were abundant were *Schizachyrium scoparium, Calamovilfa longifolia, Hesperostipa comata*, and *Artemisia frigida*. *Pascopyrum smithii, Bouteloua gracilis*, and *Koeleria macrantha* were also present. Fire probably played a major role in this type, whereby periodic fires would increase graminoid production and deter tree growth.

REFERENCES

Butler, J. , J. Richardson, and H. Goetz. 1986. Vegetation and soil-landscape relationships in the North Dakota Badlands. Am. Midl. Nat. 116(2):278-386.

Greenall, J. A. 1995. Draft element descriptions for natural communities of southern Manitoba (prairie and parkland regions). Manitoba Conservation Data Centre, Winnipeg. 17p.

Hansen, P. L., G. R. Hoffman, and A. J. Bjugstad. 1984. The vegetation of Theodore Roosevelt National Park, North Dakota: A habitat type classification. U. S. Dep. Agric., For. Serv., Rocky Mt. For. and Range Exp. Sta., Gen. Tech. Rep. RM-113. Fort Collins, Colo. 35p.

Hansen, P.L. 1985. An ecological study of the vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest. Unpublished dissertation, South Dakota State University. 257 pp.

Hansen, P.L. and G.R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: a habitat type classification. USDA Forest Service General Technical Report RM-157, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Hansen, P.L. and G.R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: a habitat type classification. USDA Forest Service General Technical Report RM-157, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Hanson, H. C., and W. Whitman. 1938. Characteristics of major grassland types in western North Dakota. Ecol. Monogr. 8(1):57-114.

Hirsch, K.J. 1985. Habitat type classification of grasslands and shrublands of southwestern North Dakota. Ph.D. Thesis. NDSU, Fargo, ND.

Johnston, B. C. 1987. Plant associations of region two: potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. Edition 4. USDA Forest

Service, Rocky Mountain Region. R2-Ecol-87-2. 429 pp.

Jones, G. 1992. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, WY. 183 pp.

McAdams, A.G., D.A. Stutzman, and D. Faber-Langendoen. 1998. Black Hills Community Inventory, unpublished data. The Nature Conservancy, Midwest Regional Office, Minneapolis, MN.

Montana Natural Heritage Program (MT NHP). 1988. Draft Guide to the natural vegetation of Montana. Montana Natural Heritage Program, Helena. 389 p.

Thilenius, J. F. 1972. Classification of deer habitat in the ponderosa pine forest of the Black Hills, South Dakota. RM-91. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 28p.

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

Yucca glauca / Calamovilfa longifolia Shrub Herbaceous Vegetation

COMMON NAME Soapweed Yucca / Prairie Sandreed Shrub Herbaceous Vegetation
SYNONYM Soapweed / Prairie Sandreed Shrub Prairie
PHYSIOGNOMIC CLASS Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP Temperate or subpolar grassland with a sparse shrub layer (V.A.7)
PHYSIOGNOMIC SUBGROUP Natural/Semi-natural (V.A.7.N)
FORMATION Medium-tall temperate grassland with a sparse xeromorphic (often thorny) shrub layer (V.A.7.N.h)
ALLIANCE YUCCA GLAUCA SHRUB HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

Yucca shrub grasslands occupy sandy ridges and undulating sand dunes within the sandhills region of the Refuge.

Globally

This type is found in the northwestern Great Plains, including eastern Wyoming and Montana, and western South Dakota.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Yucca shrub grasslands occur most commonly as sparse shrulands in the sandhills region. These shrublands are also associated with sand hill complexes, where they occupy the lower sandy ridges as the dominant shrub, but also intergrade with other soapweed yucca types on sandy slopes and hills.

Globally

Stands dominated by *Hesperostipa comata* are more typically found only along sandstone outcrop ridge tops and a short distance down the adjacent slopes (the *Yucca glauca / Hesperostipa comata* association of Thilenius *et al.* 1995). Soils are relatively deep (> 1 m), pure sands, with medium to coarse-textured lower horizons. The substrate is well-drained, but not xeric. Stands with *Calamovilfa longifolia* occur on a broader range of ridge tops and upper slopes (*Yucca glauca / Calamovilfa longifolia* association of Thilenius *et al.* 1995).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Shrub	*Yucca glauca*
Herbaceous	*Bromus tectorum*, *Carex filifolia*, *Sporobolus cryptandrus*, *Bouteloua gracilis*

Globally

Stratum	Species
Short Shrub	*Yucca glauca*
Graminoid	*Bouteloua gracilis, Calamovilfa longifolia, Carex filifolia, Hesperostipa comata*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Yucca glauca, *Bouteloua gracilis*, *Sporobolus cryptandrus*, *Calamovilfa longifolia*, *Carex filifolia*

Globally

Bouteloua gracilis, Calamovilfa longifolia, Hesperostipa comata, Yucca glauca

OTHER NOTABLE SPECIES

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

Yucca shrub grasslands have a sparse cover of yucca (*Yucca glauca*) shrubs, typically between 15-25%, but they usually have good cover in the herbaceous stratum. This plant association rarely has other shrubs present; rather, the understory species change relative to soil types. On silty clay to clay soils, threadleaf sedge (*Carex filifolia*) dominates, while on sandy-clay soils needle-and-thread (*Hesperostipa comata*) provides dense understory cover. Sandy ridges dominated by yucca also support prairie sand-reed grass (Calamovilfa longifolia), sand dropseed (*Sporobolus cryptandrus*), sand bluestem (*Andropogon hallii*), and purple three-awn (*Aristida purpurea*) in abundance.

Globally

Stands 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, *Hesperostipa comata* and *Calamovilfa longifolia* codominate (16% cover and 8% cover, respectively), and *Bouteloua gracilis* and *Carex filifolia* often are present but contribute much less cover than do *Hesperostipa* or *Calamovilfa*. Forbs are common but contribute little cover; *Artemisia frigida* (dwarf shrub-like) has the highest constancy, but no forb is characteristic of the association. Litter covers up to about half of the ground surface, and most of the rest of the ground surface is bare soil.

CONSERVATION RANK G4.

DATABASE CODE CEGL002675

SIMILAR ASSOCIATIONS

Calamovilfa longifolia – Hesperpstipa comata Herbaceous Vegetation

COMMENTS

Lacreek National Wildlife Refuge

Soapwed yucca is common in the sandhills region of the Refuge and forms discrete map units based on density and associated species.

Globally

In Badlands Naitional Park, South Dakota vegetation cover varies with soil conditions. Sandy soils have characteristic dominants, but on more silty clay soils, *Carex filifolia* and *Pascopyrum smithii* may dominate.

REFERENCES

Barnes, P. W., A. T. Harrison, and S. P. Heinisch. 1984. Vegetation patterns in relation to topography and edaphic variation in Nebraska Sandhills prairie. Prairie Naturalist 16(4):145-158.

Faber-Langendoen, D., J. Drake, G. Jones, D. Lenz, P. Lesica, S. Rolfsmeier. 1997. Rare plant communities of the northern Great Plains. Report to Nebraska National Forest. The Nature Conservancy. 155pp.

Johnston, B. C. 1987. Plant associations of region two: potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. Edition 4. USDA Forest Service, Rocky Mountain Region. R2-Ecol-87-2. 429 pp.

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. 115 pp.

Ross, R.L., and H.E. Hunter. 1976. Climax vegetation of Montana, based on soils and climate. USDA-SCS. Bozeman, Mont.

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

Thilenius, J.F., and G.R. Brown. 1990. Vegetation on semi-arid rangelands, Cheyenne River Basin, Wyoming. Unpublished report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Laramie, WY. 147 pp.

USDA Soil Conservation Service. 1986. Technical guide to range sites, section II. Wyoming State Office, Casper, WY.

Note:

This association is found in two different map classes:

1) Soapweed Yucca (Sparse Understory) Shrub Herbaceous Vegetation
2) Soapweed yucca / Needle-and-Thread Shrub Herbaceous Vegetation

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

COMMON NAME Crested Wheatgrass - (Western Wheatgrass, Needle-and-Thread Grass) Semi-natural Herbaceous Vegetation
SYNONYM Crested Wheatgrass Semi-natural Grassland
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 AGROPYRON CRISTATUM SEMI-NATURAL HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 3
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

Introduced, exotic grasslands occur throughout the Refuge and are sometimes associated with disturbances such as roadsides, abandoned farm fields, and areas that were interseeded with exotic grasses. However, these exotic grasslands can and do invade intact native communities.

Globally

This type occurs most commonly in the northern Great Plains of the United States and Canada.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Crested wheatgrass grasslands are usually found on relatively level to gently rolling sites accessible to farming equipment. Typically the soils are silt and/or clay loams, which probably supported western wheatgrass (*Pascopyrum smithii*) grasslands in the past.

Globally

This type can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. It is also widely planted to revegetate pastures and rangelands.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Agropyron cristatum, Poa pratensis, Bromus inermis*

Globally

Stratum	Species
Graminoid	*Agropyron cristatum*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Agropyron cristatum, *Poa pratensis, Bromus inermis*

Globally
Agropyron cristatum, Pascopyrum smithii

OTHER NOTABLE SPECIES

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
Stands typically have moderate herbaceous cover that ranges from 30-60%. Litter cover on the soil surface is often fairly dense.. The sites are dominated by crested wheatgrass (*Agropyron cristatum*), often with a host of invasive species such as Kentucky bluegrass (*Poa pratensis)* or smooth broom (*Bromus inermis*). The forb component is usually sparse.

Globally
The vegetation is dominated by medium-tall (0.5 - 1 m) graminoids. The dominant grass is *Agropyron cristatum*, a naturalized species from Europe. Other weedy species may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata*, as well as others.

CONSERVATION RANK GW. This is a naturalized type from Europe, widely planted to revegetate roadsides and pastures.

DATABASE CODE CEGL005266

SIMILAR ASSOCIATIONS (n/a)

COMMENTS
Lacreek National Wildlife Refuge.
The introduced grassland group occupies previously disturbed sites that include roadsides, abandoned agricultural fields, and interseeded rangeland.

Globally
Hansen and Hoffman (1988, p 6, Fig. 6) show a seral stand of *Agropyron cristatum*, with signs of succession leading to the *Hesperostipa comata* / *Carex filifolia* habitat type.

REFERENCES
Hansen, P.L. and G.R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: a habitat type classification. USDA Forest Service General Technical Report RM-157, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Andropogon gerardii - Panicum virgatum - Helianthus grosseserratus Herbaceous Vegetation

COMMON NAME Big Bluestem - Switchgrass - Sawtooth Sunflower Herbaceous Vegetation
SYNONYM Central Wet-mesic Tallgrass 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 Tall sod temperate grassland (V.A.5.N.a)
ALLIANCE ANDROPOGON GERARDII - (CALAMAGROSTIS CANADENSIS, PANICUM VIRGATUM) HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Terrestrial

RANGE
Lacreek National Wildlife Refuge
This unit is widely scattered on mesic sites throughout the Refuge.

Globally
This big bluestem sandhills community type occurs in the central Great Plains of the United States, particularly in the Sandhills region of Nebraska and adjacent South Dakota.

ENVIRONMENTAL DESCRIPTION
Lacreek National Wildlife Refuge
Distribution is of this type is throughout the Refuge in mesic sites such as swales, and shallow bottoms. The dominant species are often patchy within a stand, with associated species such as sawtooth sunflower (*Helianthus grosseserratus),* prairie cordgrass*,* smooth brome, and switchgrass occupying the interstitial spaces.

Globally
This community occurs mostly in interdunal valleys and floodplains of streams and rivers, and on level ground where drainage is poor. Soils are poorly drained sandy loams and sands with considerable organic matter (but no peat accumulation) and are formed in eolian sand or alluvium. These sites are rarely, if ever, flooded but are constantly supplied by high groundwater levels (about 1 m below the surface) (Steinauer and Rolfsmeier 2000).

MOST ABUNDANT SPECIES
Lacreek National Wildlife Refuge

Stratum	Species
Shrub	*Yucca glauca*
Herbaceous	*Andropogon gerardi, Panicum virgatum*

Globally

Stratum	Species
Graminoid	*Andropogon gerardi, Panicum virgatum, Sorghastrum nutans, Calamagrostis canadensis, Spartina pectinata, Agrostis stolonifera, Phleum pratens*e, *Poa*

pratensis

CHARACTERISTIC SPECIES
Lacreek National Wildlife Refuge
Andropogon gerardi, Panicum virgatum

Globally
Andropogon gerardi, Panicum virgatum, Sorghastrum nutans

OTHER NOTABLE SPECIES
Globally

Stratum	Species
Herbaceous	*Euthamia gymnospermoides, Helianthus nuttallii, Rudbeckia hirta, Solidago canadensi*s, and *Solidago gigante*a

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
It is often closely associated with prairie cordgrass (*Spartina pectinata*) and switchgrass (*Panicum virgatum*) map units. Big bluestem also appears to be a common constituent of many prairie restoration efforts on the Refuge. Typical stands of this association have moderate to dense herbaceous cover with typical foliar cover values ranging from 50 to 100%. Big bluestem is the dominant species, becoming more prominent later in the growing season.

Globally
This community is dominated by a dense layer of mesophytic tall grasses 1-2 m tall, with *Andropogon gerardii* and *Sorghastrum nutans* most abundant in undisturbed sites. In moist swales and wetter areas along the margin of this community, *Calamagrostis canadensis* and *Spartina pectinata* may be abundant. Cool-season Eurasian grasses such as *Agrostis stolonifera, Phleum pratens*e, and *Poa pratensis* are commonly seeded in these sites and may dominate. Forbs are usually common, but are seldom mentioned in the literature. Conspicuous forbsspecies include *Euthamia gymnospermoides, Helianthus nuttallii, Rudbeckia hirta, Solidago canadensi*s, and *Solidago gigante*a. Woody plants are uncommon, though scattered thickets of *Salix exigua* may be present. In the eastern portion of its range, this community often contains forbs typical of tall-grass prairie to the east, such as *Sisyrinchium campestre* and *Viola pedatifid*a. Species diversity is relatively high in undisturbed sites, and often much lower in sites seeded to exotic cool-season grasses (Steinauer and Rolfsmeier 2000).

CONSERVATION RANK G3? Many sites in the eastern portion of the range of this community have been converted to cropland. Excessive center-pivot irrigation may lower the water table enough to convert some remaining sites to dry dry prairie communities. Most remaining sites have been seeded to exotic grasses and legumes.

DATABASE CODE CEGL002023

SIMILAR ASSOCIATIONS
Andropogon hallii - Calamovilfa longifolia Herbaceous Vegetation

COMMENTS

Lacreek National Wildlife Refuge

(n/a)

Globally

This type is geographically defined to include areas of the Nebraska (and adjacent South Dakota) Sandhills region.

REFERENCES

Allard, D. J. 1990. Southeastern United States ecological community classification. Interim report, Version 1.2. The Nature Conservancy, Southeast Regional Office, Chapel Hill, NC. 96 pp.

Evans, M. 1991. Kentucky ecological communities. Draft report to the Kentucky Nature Preserves Commission. 19 pp.

Foti, T., compiler. 1994. Natural vegetation classification system of Arkansas, draft five. Unpublished document. Arkansas Natural Heritage Commission, Little Rock. 8 pp.

Foti, T., M. Blaney, X. Li, and K. G. Smith. 1994. A classification system for the natural vegetation of Arkansas. Proceedings of the Arkansas Academy of Science 48:50-53.

Hladek, K. L., G. K. Hulett, and G. W. Tomanek. 1972. The vegetation of remnant shale-limestone prairies in western Kansas. Southwestern Naturalist 17(1):1-10.

Hoagland, B. W. 1997. Preliminary plant community classification for Oklahoma. Unpublished draft document, version 35629. University of Oklahoma, Oklahoma Natural Heritage Inventory, Norman. 47 pp.

Lauver, C. L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44:421-443.

Minnesota Natural Heritage Program. 1993. Minnesota's native vegetation: A key to natural communities. Version 1.5. Minnesota Department of Natural Resources, Natural Heritage Program, St. Paul, MN. 110 pp.

Nelson, P. W. 1985. The terrestrial natural communities of Missouri. Missouri Natural Areas Committee, Jefferson City. 197 pp. Revised edition, 1987.

Smith, D. D. 1981. Iowa prairie--An endangered ecosystem. Proceedings of the Iowa Academy of Science 88(1):7-10.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Weakley, A. S., K. D. Patterson, S. Landaal, M. Pyne, and others, compilers. 1998. International classification of ecological communities: Terrestrial vegetation of the Southeastern United States. Working draft of March 1998. The Nature Conservancy, Southeast Regional Office, Southern Conservation Science Department, Community Ecology Group. Chapel Hill, NC. 689 pp.

Weaver, J. E. 1958. Native grassland of southwestern Iowa. Ecology 39(4):733-750.

White, J., and M. Madany. 1978. Classification of natural communities in Illinois. Pages 311-405 in: Natural Areas Inventory technical report: Volume I, survey methods and results. Illinois Natural Areas Inventory, Urbana, IL.

Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation

COMMON NAME Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation
SYNONYM Smooth Brome Semi-natural GrasslandPHYSIOGNOMIC 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 BROMUS INERMIS SEMI-NATURAL HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 3
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

Introduced, exotic grasslands occur throughout the Refuge and are associated with disturbances such as roadsides, abandoned farm fields, and areas that were interseeded with exotic grasses to "improve" the range for grazing. Areas especially noted are adjacent to the Refuge roads and facilities and abandoned or reclaimed agricultural fields.

Globally

This type occurs widely throughout the northern Great Plains, and perhaps more widely in the Midwest, depending on how the type is defined.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Introduced grasslands are on relatively level sites accessible to farming equipment. Typically the soils are silt and/or clay loams, which historically supported western wheatgrass (*Pascopyrum smithii*) alliance grasslands.

Globally

This type can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. It is also widely planted for cover, pasture, and hay, and has escaped into a variety of habitats.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Bromus inermis*

Globally

Stratum	Species
Graminoid	*Bromus inermis*

CHARACTERISTIC SPECIES
Lacreek National Wildlife Refuge
Bromus inermis, *Pascopyrum smithii*, *Bromus japonicus*, *Psoralidium tenuiflorum*

Globally
Bromus inermis, Pascopyrum smithii

OTHER NOTABLE SPECIES
(n/a)

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
Stands of introduced grasses typically have moderate herbaceous cover, ranging from 40-90%, and very dense litter over the ground surface. Along roadsides, smooth brome (*Bromus inermis*) is strongly dominant, with alfalfa (*Medicago sativa*) and yellow sweetclover (*Melilotus officianalis*) included in the plantings along some highways. Many species of forbs and occasional shrubs are also found in the type.

Globally
The vegetation is dominated by medium-tall (0.5 - 1 m) graminoids. The dominant grass is *Bromus inermis*, a naturalized species from Europe and Asia. Other weedy species may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata*, as well as others.

CONSERVATION RANK GW. This is a naturalized type from Europe and Asia, widely planted for cover, pasture, and hay, and has escaped into a variety of habitats.

DATABASE CODE CEGL005264

SIMILAR ASSOCIATIONS

COMMENTS
Lacreek National Wildlife Refuge
The introduced grassland group occupies previously disturbed sites, including roadsides, abandoned agricultural fields, and interseeded rangeland. Stands of bromegrass tend to be monotypic. They tend to have dense litter layers.

Globally
This type could be defined very broadly to include almost any *Bromus inermis* dominated stand, in which case the variability of the minor species associated with the type may be very high.

REFERENCES
(n/a)

Hesperostipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation

COMMON NAME Needle-and-Thread - 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 (V.A.5.N.c)
ALLIANCE STIPA COMATA - BOUTELOUA GRACILIS HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 1
USFWS WETLAND SYSTEM

RANGE
Lacreek National Wildlife Refuge
This type was limited to a few sites in the northern portion of the Refuge.

Globally
This community is common in Montana, Wyoming, and is in Nebraska, North Dakota, South Dakota, southern Saskatchewan, and southern Manitoba. In Nebraska it is apparently absent from extreme northwestern and east-central regions (Steinauer and Rolfsmeier 1997).

ENVIRONMENTAL DESCRIPTION
Lacreek National Wildlife Refuge
Stands occurred on flat terraces and moderate sloping foot and toe slopes.

Globally
Stands occur on flat to rolling topography with deep (40- 100 cm) sandy loam to loam soils. They are typically associated with uplands, though they may also occur lower in the landscape, such as coulee and draw bottoms, if soils are sufficiently coarse (usually sandstone derived). Even though it is a major association in the Northern Plains, it does not occur in areas dominated exclusively by shale and mudstone parent materials, from which heavy soils are derived. This type is found at elevations ranging from 2000 to 5500 feet; average annual precipitation associated with these elevation parameters ranges from slightly less than 10 to slightly more than 20 inches. This association and the *Pascopyrum smithii - Bouteloua gracilis - Carex filifolia* association could be considered the most common plant associations in the Northern Great Plains (Martin et al. 1998). These two associations, cited by many authors as the climatic climax communities for this region, are manifested by matrix or large patch occurrences frequently found dominating whole landscapes. The *Hesperostipa comata* defined community is more associated with uplands and the *Pascopyrum smithii* defined type characterizes sites with higher moisture status, generally occurring at lower positions in the landscape.

MOST ABUNDANT SPECIES
Globally

Stratum	Species
Graminoid	*Bouteloua gracilis, Carex filifolia, Hesperostipa comata*

CHARACTERISTIC SPECIES
Globally
Bouteloua gracilis, Carex filifolia, Hesperostipa comata

OTHER SPECIES
Globally

Stratum	Species
Graminoid	*Calamovilfa longifolia, Koeleria macrantha*

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
Needle-and-thread, blue grama, and threadleaf sedge (*Carex filifolia*) are the major species, while sand dropseed and western wheatgrass are common secondary species. Total cover ranges from 40-70% depending primarily on the abundance of threadleaf sedge and blue grama. Japanese brome is a common invader on these sites.

Globally
The vegetation is dominated by graminoids that are usually between 0.5 and 1 m tall. Total cover is moderate. On 19 stands in west-central Montana the cover by the different strata was as follows: shrubs 6 percent, graminoids 67 percent, forbs 11 percent, bryophytes 14 percent, litter 55 percent, rock 4 percent, bare soil 9 percent (Mueggler and Stewart 1978). Thilenius et al. (1995) found that the average cover on 14 stands in eastern Wyoming was 42 percent. Tolstead (1942) described this community as the climax on the level lands of the northern part of Cherry County, Nebraska. *Hesperostipa comata* is the tallest of the dominant species, sending seed heads to a maximum height of approximately 1 m. The rhizomatous graminoids, *Bouteloua gracilis* and *Carex filifolia*, the other two dominant/codominant species, do not usually exceed 0.5 meter. *Calamovilfa longifolia* is often found with high cover values on sandier soils and *Koeleria macrantha* cover increases on degraded sites. There are regionalized expressions of variability with *Carex inops var. heliophila* surpassing *Carex filifolia* in Colorado and *Calamagrostis montanensis* being at least as important as the diagnostic species in north-central Montana. *Pascopyrum smithii* is consistently present and reaches the same height as *Hesperostipa comata*. For woody species, subshrub forms (*Artemisia frigida, Gutierrezia sarothrae, Rosa arkansana*) have the highest cover and constancy but their total cover does exceed more than 5 percent, except on overgrazed sites. Regardless of the geographic region of this broadly distributed type, cover values for forbs are low (the exception being *Selaginella densa*), though geographic setting does influence forb composition to some degree. *Sphaeralcea coccinea, Phlox hoodii, Heterotheca villosa, Gaura coccinea*, and *Liatris punctata*, at least in the northern distribution of this type, have high constancy values; the constancy of *Lygodesmia juncea*, *Opuntia polyacantha*, *Artemisia dracunculus* and *Ratibida columnifera* seems to increase to the eastern and southern portions of the type's distribution.

ENVIRONMENTAL CONDITION

Lacreek National Wildlife Refuge

Stands occur primarily on loam soils of terraces and moderate slopes.

Globally

Stands occur on flat to rolling topography with deep (40- 100 cm) sandy loam to loam soils. They are typically associated with uplands, though they may also occur lower in the landscape, such as coulee and draw bottoms, if soils are sufficiently coarse (usually sandstone derived). Even though it is a major association in the Northern Plains, it does not occur in areas dominated exclusively by shale and mudstone parent materials, from which heavy soils are derived. This type is found at elevations ranging from 2000 to 5500 feet; average annual precipitation associated with these elevation parameters ranges from slightly less than 10 to slightly more than 20 inches. This association and the *Pascopyrum smithii* - *Bouteloua gracilis* - *Carex filifolia* association could be considered the most common plant associations in the Northern Great Plains (Martin et al. 1998). These two associations, cited by many authors as the climatic climax communities for this region, are manifested by matrix or large patch occurrences frequently found dominating whole landscapes. The *Hesperostipa comata* defined community is more associated with uplands and the *Pascopyrum smithii* defined type characterizes sites with higher moisture status, generally occurring at lower positions in the landscape.

CONSERVATION RANK G5. This is an exceedingly common type, manifesting any number of permutations, some of which are related to disturbance and some of which appear to be related to the expected geographic distinctions in such a broadly distributed type. The only reason to consider it a G4 is that it has received, and continues to receive, significant grazing pressure which, combined with the surge in alien weed populations, pose a significant threat to its quality.

DATABASE CODE CEGL002037

SIMILAR ASSOCIATIONS

Bouteloua gracilis - *Buchloe dactyloides* Xeric Soil Herbaceous Vegetation (On degraded sites, or on intermediate habitats, this type can be confused with CEGL002037.)

Pascopyrum smithii - *Hesperostipa comata* Central Mixedgrass Herbaceous Vegetation

COMMENTS

Lacreek National Wildlife Refuge

This type was probably more prevalent before agricultural and management disturbance.

Globally

Vast (singly and in the aggregate) prairie dog (*Cynomys ludovicianus, C. leucurus*) "towns" once developed on the favorable substrates of this type and exploited its vegetation. Prairie dog populations have undergone a precipitous decline since settlement, so much of this type could be in various states of secondary succession, returning from a somewhat denuded state and altered composition created by the prairie dogs (and attendant bison that found nutritious forage here). Fire, both aboriginal- and lightening-caused, was a regular part of this landscape. Fire-return intervals have been considerably lengthened since settlement by European-Americans.

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. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-113. Fort Collins, CO. 35 pp.

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

Hubbard, W. A. 1950. The climate, soils, and soil-plant relationships of an area in southwestern Saskatchewan. Sci. Agric. 30(8):327-342.

Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.

Looman, J. 1980. The vegetation of the Canadian prairie provinces. II. The grasslands, Part 1. Phytocoenologia 8(2):153-190.

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

Mueggler, W. F., and W. L. Stewart. 1980. 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.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

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

Tolstead, W. L. 1941. Plant communities and secondary succession in south-central South Dakota. Ecology 22(3):322-328.

Tolstead, W. L. 1942. Vegetation of the northern part of Cherry County, Nebraska. Ecological Monographs 12(3):257-292.

Weaver, J. E., and F. W. Albertson. 1956. Grasslands of the Great Plains: Their nature and use. Johnsen Publishing Co., Lincoln, NE. 395 pp.

Pascopyrum smithii - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation

COMMON NAME Western Wheatgrass - Blue Grama - Threadleaf Sedge Herbaceous Vegetation
SYNONYM Western Wheatgrass - Blue Grama - Threadleaf Sedge 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 (V.A.5.N.c)
ALLIANCE PASCOPYRUM SMITHII HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

Areas of western wheatgrass - blue grama vegetation are found throughout the Refuge and the project environs on mesic sites. Associations of this type occupy clay, silt, loam, and sandy soils of flats, swales, drainages, hills, and slopes. The type adjoins little bluestem stands in drainages and on steeper slopes. In some areas stands of western wheatgrass has been converted to exotic perennial grasses, including smooth brome, Kentucky bluegrass, and crested wheatgrass.

Globally

This community is found in Colorado, Wyoming, Montana, North Dakota, South Dakota, and Saskatchewan.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Sites are found on flat to moderately steep slopes and occur on all aspects. Blue grama and threadleaf sedge may appear on drier soils, and Kentucky bluegrass on more mesic sites.

Globally

This community is found on flat or gently sloping terrain. Many stands are on floodplains or gentle valley slopes, others are on uplands. Surface layers of soils are usually clay loams, although stands of this type may also be found on loams, silt loams, silty clays and clays (Hanson and Whitman 1938, Hansen and Hoffman 1988). In Alberta and Saskatchewan this association grows on solonetzic soils (with an elluvial horizon above a dense clay horizon high in sodium salts) developed on thin glacial till over Cretaceous shale (Coupland 1961). This community does not appear to be found in mountain valleys (Hanson and Dahl 1956, Jones 1992).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Bromus japonicus*, *Poa pratensis*, *Nassella viridula*, *Bouteloua gracilis*, *Pascopyrum smithii*

Globally

Stratum	Species
Graminoid	*Bouteloua gracilis, Carex filifolia, Elymus lanceolatus, Pascopyrum smithii*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Pascopyrum smithii, *Bouteloua gracilis*, *Nassella viridula*, *Bromus japonicus*

Globally

Bouteloua gracilis, Buchloe dactyloides, Carex filifolia, Elymus lanceolatus, Pascopyrum smithii

OTHER NOTABLE SPECIES

Globally

Stratum	Species
Graminoid	*Bromus inermis, Bromus tectorum, Poa pratensis*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

Stands of the western wheatgrass - grama type range from moderate to complete herbaceous cover, between 40-100%. Western wheatgrass (*Pascopyrum smithii*) is strongly dominant in ungrazed stands, less so in stands subjected to annual grazing by livestock. Species dominance can vary locally within a stand, dependent on soils and land use factors. Dominant graminoids are western wheatgrass, blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*), and Japanese brome (*Bromus japonicus*). Other common herbaceous species include green needlegrass (*Nassella viridula*), wild alfalfa (*Psoralidium tenuiflorum*), poverty cactus (*Opuntia polyacantha*), and white sagebrush (*Artemisia ludoviciana*). In western wheatgrass - grama stands within Lacreek, species dominance varies within the stand. Western wheatgrass, blue grama, and buffalograss all can be locally dominant, often to the exclusion of other species. For this reason, multiple sample points were taken to characterize this vegetation type.

Globally

This community is dominated by medium and short graminoids. Total vegetation cover is usually high (Hanson and Dahl 1956, Hansen *et al.* 1984). *Pascopyrum smithii* or *Elymus lanceolatus* or both (the two species are similar both morphologically and ecologically) and *Bouteloua gracilis* usually contribute the most cover; however, *Bouteloua gracilis* may contribute little cover and it may be absent locally. *Carex filifolia, Carex duriuscula (=Carex eleocharis), and Carex pensylvanica* often are secondary species, but in many stands they contribute little cover and they may be absent locally. *Hesperostipa comata* usually is present as a secondary species, but it often codominates on sandy loam soils.. In Alberta and Saskatchewan, *Hesperostipa spartea* var. *curtiseta* may be as common as *Hesperostipa comata. Koeleria macrantha* is present in most stands and may contribute substantial cover. The forbs most likely to be found in this association are *Phlox hoodii, Sphaeralcea coccinea, Polygonum ramosissimum, Plantago patagonica, Opuntia polyacantha, Artemisia frigida, Antennaria microphylla*, and *Hedeoma hispida*. In southeastern Montana, western North Dakota, and northeastern Wyoming, stands of this association often contain *Artemisia tridentata ssp.*

wyomingensis. Exotic brome grasses, especially *Bromus commutatus* and *B. tectorum*, are present in many stands of this association and they commonly contribute substantial cover (Hanson and Dahl 1956, Coupland 1961, Hansen *et al.* 1984, Hansen and Hoffman 1988).
CONSERVATION RANK G4. The G4 rank is based on the broad geographic range of this type, and its status as a common vegetation type within that geographic range.

DATABASE CODE CEGL001579

SIMILAR ASSOCIATIONS
Pascopyrum smithii - Bouteloua gracilis Herbaceous Vegetation (is similar to this type but occurs in the southern portion of the Great Plains (where *Carex filifolia* is not as prevalent.)
Pascopyrum smithii - Nassella viridula Herbaceous Vegetation (Drier graminoids, such as *Bouteloua gracilis* or *Carex filifolia* are rare or absent in this type.)
Pascopyrum smithii - Hesperostipa comata Central Mixedgrass Herbaceous Vegetation
Hesperostipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation (*Hesperostipa comata* contributes more cover than do *Pascopyrum smithii* or *Elymus lanceolatus*, and the association grows on soils of loam or coarser textural classes.)

COMMENTS
Lacreek National Wildlife Refuge
The western wheatgrass - blue grama type ranges from very low diversity on clay flats to high diversity on clay-loam and sandy-loam soils. Where this type intergrades with little bluestem and Kentucky bluegrass it can become very difficult to classify. Difficulty in classification can also occur on sites grazed, because the cool-season western wheatgrass is grazed initially, resulting in warm-season grasses like blue grama appearing to be the stand dominant. During some years, this type will be covered with very tall yellow sweetclover (*Melilotus officianalis*) plants.

Globally
The coverage of *Pascopyrum smithii* varies more with use than geographic range. *Bouteloua gracilis* and *Buchloe dactyloides* have been observed to increase with grazing as *Pascopyrum smithii* decreases. This type, as currently understood by MRO, is equivalent to the *Pascopyrum smithii / Carex filifolia* Herbaceous Vegetation in the Western Region's 1994 classification (Bourgeron and Engelking 1994). Fire was likely a common event in this type historically.

REFERENCES
Bourgeron, P. S., and L. D. Engelking, eds. 1994. A preliminary vegetation classification of the western United States. Unpubl. rep. The Nature Conservancy, West. Heritage Task Force. Boulder, Colo. 175 p. plus app.
Hansen, P. L., G. R. Hoffman, and A. J. Bjugstad. 1984. The vegetation of Theodore Roosevelt National Park, North Dakota: A habitat type classification. U. S. Dep. Agric., For. Serv., Rocky Mt. For. and Range Exp. Sta., Gen. Tech. Rep. RM-113. Fort Collins, Colo. 35 p.
Hansen, P.L. 1985. An ecological study of the vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest. Unpublished dissertation, South Dakota State University. 257 pp.
Hansen, P.L. and G.R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux,

and Ashland Districts of the Custer National Forest: a habitat type classification. USDA Forest Service General Technical Report RM-157, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Hanson, H. C, and E. Dahl. 1956. Some grassland communities in the mountain-front zone in northern Colorado. Vegetatio 7:249-270.

Hanson, H. C., and W. Whitman. 1938. Characteristics of major grassland types in western North Dakota. Ecol. Monogr. 8(1):57-114.

Johnston, B. C. 1987. Plant associations of region two: potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. Edition 4. USDA Forest Service, Rocky Mountain Region. R2-Ecol-87-2. 429 pp.

Jones, G. 1992. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, WY. 183 pp.

Ode, D. 1997. Personal communication. South Dakota Natural Heritage Program, Pierre, South Dakota. March 17,1998.

Steinauer, G. and S. Rolfsmeier. 1997. Terrestrial natural communities of Nebraska. Draft – October 28, 1997. Nebraska Game and Parks Commission, Lincoln, NE. 117 p.

Weaver, J. E. and F. W. Albertson. 1956. Grasslands of the Great Plains: their nature and use. J Johnsen Publishing Company, Lincoln, Nebraska. 395 pp.

Poa pratensis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation

COMMON NAME Kentucky Bluegrass - (Western Wheatgrass) Semi-natural Herbaceous Vegetation
SYNONYM Kentucky Bluegrass Semi-natural Grassland
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 POA PRATENSIS SEMI-NATURAL HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 3
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

Introduced, exotic grasslands occur throughout the northern portion of the Refuge and are associated with disturbances such as roadsides, abandoned farm fields, and areas that were interseeded with exotic grasses to "improve" the range for grazing.

Globally

This type is potentially widespread throughout the Great Plains and into the Midwest, depending on how the type is defined.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Introduced grasslands are on relatively level sites accessible to farming equipment. Typically the soils are silt and/or clay loams, which historically supported western wheatgrass (*Pascopyrum smithii*) alliance grasslands.

Globally

This type can occur in a wide variety of human-disturbed and native habitats.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Poa pratensis*

Globally

Stratum	Species
Graminoid	*Poa pratensis*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Poa pratensis, *Pascopyrum smithii*, *Bromus japonicus*, *Psoralidium tenuiflorum*

Globally
Pascopyrum smithii, Poa pratensis

OTHER NOTABLE SPECIES (n/a)

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
Stands of introduced grasses typically have moderate herbaceous cover, ranging from 40-90%, and very dense litter over the ground surface. Many abandoned agricultural fields and selected range interseeding sites are strongly dominated by Kentucky bluegrass (*Poa pratensis*). In some cases, a few plants of western wheatgrass (*Pascopyrum smithii*) and fairly large stands of ragweed (*Ambrosia psilostachya*) may also be present. Many species of forbs and occasional shrubs are also found in the type.

Globally
The vegetation is dominated by medium-tall (0.5 - 1 m) graminoids. The dominant grass is *Poa pratensis*, considered to be both a native and naturalized species from Eurasia (Great Plains Flora Association 1986, Gleason and Cronquist 1991). Other native species may occur as well, but they are generally less than 10% cover. Native species may include mixed-grass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata*, as well as others.

CONSERVATION RANK GW. This is primarily a naturalized type from Europe and Asia, widely planted for lawns and pasture, and it has escaped into a variety of habitats (Great Plains Flora Association 1986, Gleason and Cronquist 1991). Although native populations do exist,and may be integral parts of some prairie and other native habitats, most stands that are thoroughly dominated by *Poa pratensis* are a result of human modifications to the habitat.

DATABASE CODE CEGL005265

SIMILAR ASSOCIATIONS

COMMENTS
Lacreek National Wildlife Refuge
The introduced grassland group occupies previously disturbed sites, including roadsides, abandoned agricultural fields, and interseeded rangeland. Stands of Kentucky bluegrass tend to be monotypic. They tend to have dense litter layers that impede other species establishment and also serves to store moisture following precipitation events.

Globally
(n/a)

REFERENCES
Gleason, H.A., and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. New York Botanical Garden, Bronx, NY. 910 pp.
Great Plains Flora Association. 1986. Flora of the Great Plains. University of Kansas Press, Lawrence. 1392 pp.

Thinopyrum intermedium Semi-natural Herbaceous Vegetation

COMMON NAME Intermediate Wheatgrass Semi-natural 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 Natural/Semi-natural (V.A.5.N)
FORMATION Medium-tall sod temperate or subpolar grassland (V.A.5.N.c)
ALLIANCE THINOPYRUM INTERMEDIUM SEMI-NATURAL HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 3
USFWS WETLAND SYSTEM TERRESTRIAL

RANGE
Lacreek National Wildlife Refuge
The intermediate wheatgrass semi-natural type is only represented on a few sites in the Refuge.

Globally

ENVIRONMENTAL DESCRIPTION
Lacreek National Wildlife Refuge
Stands of intermediate wheatgrass typically have moderate herbaceous cover that ranges from 30 to 60%. Litter cover on the soil surface is often dense.

Globally
This community is most common on dry, medium-textured soils, but has adapted to a broad range of soil textures and moisture conditions.

MOST ABUNDANT SPECIES
Lacreek National Wildlife Refuge

Stratum	Species
GRAMINOID	*Thinopyrum intermedium*

Globally

Stratum	Species
GRAMINOID	*Thinopyrum intermedium*

CHARACTERISTIC SPECIES
Lacreek National Wildlife Refuge

Stratum	Species
GRAMINOID	*Thinopyrum intermedium*

Globally

Stratum	Species
GRAMINOID	*Thinopyrum intermedium*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

The sites are dominated by intermediate wheatgrass with other invasive species such as Kentucky bluegrass and/or smooth brome. The forb component is usually very sparse.

Globally

Thinopyrum intermedium (= Agropyron intermedium) often contributes 90% of the cover for this community; however, other exotics such as *Bromus inermis* can invade into these areas. Native species almost never reestablish in areas dominated by *Thinopyrum intermedium* and contribute less than 20% cover.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK GW.

DATABASE CODE CEGL002935

COMMENTS

Lacreek National Wildlife Refuge

(n/a)

Globally

(n/a)

REFERENCES

Ode, Dave. Personal communication. South Dakota Natural Heritage Program, Pierre, SD.

Polygonum spp. (amphibium) – Mixed Forbs Permanently Flooded Herbaceous Alliance

COMMON NAME Water Smartweed Permanently Flooded Herbaceous Alliance
SYNONYM Water Smartweed Wetland
PHYSIOGNOMIC CLASS Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS Hydromorphic rooted vegetation (V.C)
PHYSIOGNOMIC GROUP Temperate or subpolar hydromorphic rooted vegetation (V.C.2)
PHYSIOGNOMIC SUBGROUP Natural/Semi-natural (V.C.2.N)
FORMATION Permanently flooded temperate or subpolar hydromorphic rooted vegetation (V.C.2.N.a)
ALLIANCE POLYGONUM AMPHIBIUM PERMANENTLY FLOODED HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 1
USFWS WETLAND SYSTEM PALUSTRINE

RANGE
Lacreek National Wildlife Refuge
This association is common to drawdown and mudflat areas around the Refuge.

Globally
This alliance is found primarily in the western United States, Great Plains, and Canada, but may extend further east.

ENVIRONMENTAL DESCRIPTION
Lacreek National Wildlife Refuge
The soils are usually saturated and support mixed weedy or annual forbs with little graminoid species.

Globally
This wetland occurs in shallow water around the edges of ponds and lakes in western North America. Elevation varies depending on geographical location. Stands reported along the Columbia River and in the Great Plains are located just above sea level, in Montana between 640-1080 m, in northeastern Utah at 1420 m, and in Colorado from 2050-2700 m. Sites include oxbow lakes and backwater areas of the Columbia floodplains, seasonally flooded basins in the floodplains of the Green River, in glacial ponds or prairie potholes in northern Montana, in shallow lakes in the mountains of Colorado, and in flooded basins in South Dakota and possibly the Sandhills of Nebraska. Stands are located in standing water that is permanent or present at least during the growing season. The pond bottoms are composed of finer sediments, organic muck, clay, or silt.

MOST ABUNDANT SPECIES
Lacreek National Wildlife Refuge

Stratum	Species
FORB	*Polygonum amphibium*

Globally

Stratum	Species
FORB	*Polygonum amphibium*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
FORB	*Polygonum amphibium*

Globally

Stratum	Species
FORB	*Polygonum amphibium*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

Overall diversity is low with only few annual forb or weedy species.

Globally

This wetland vegetation type occurs in shallow water along the edges of ponds and lakes. Floating-leaved aquatic forbs cover at least 30% of the water's surface (Kunze 1994). *Polygonum amphibium* often forms dense, nearly monotypic stands. *Lemna minor, Potamogeton natans, Sagittaria* spp., *Spirodela polyrrhiza*, and *Wolffia* spp. are occasionally present.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5.

DATABASE CODE CEGL2430 (CEGL002002)

MAP UNITS

COMMENTS

Lacreek National Wildlife Refuge

This type likely occurs as a result of pool management and fluctuating water levels.

Globally

This vegetation type is only classified to the alliance level. More work is needed to describe associations. In South Dakota, the species dominating this vegetation type is *Polygonum amphibium var. emersum* (denoted *as Polygonum coccineum* in South Dakota). In contrast to *Polygonum amphibium var. amphibium*, an obligate wetland plant, this species is a facultative wetland plant. It is very well adapted to fluctuating water levels and even able to climb out into the upland margins of prairie wetlands (D. Ode, personal communication). Almost pure stands of *Polygonum amphibium var. emersum* can occur in areas originally dominated by a mixture of *Eleocharis palustris* and *P. amphibium var. emersum* and sometimes *Hordeum jubatum* (D. Ode, personal communication). This occurs with a flooding of these basins during *which Eleocharis palustris* would decompose, leaving the basin with 50% coverage by *Polygonum*. In the first

year of drawdown following the flooding, the *Polygonum* community would persist; however, by the second year, the *Eleocharis* would reestablish and cause a shift back to the original mixed species community type (D. Ode, personal communiciation). Further review is needed to determine if those stands dominated by *Polygonum amphibium var. emersum* need to be separate types from those dominated by *Polygonum amphibium var. amphibium* and/or a *Eleocharis palustris* - *Polygonum amphibium* type.

REFERENCES

Bourgeron, P. S., and L. D. Engelking, editors. 1994. A preliminary vegetation classification of the western United States. Unpublished report. The Nature Conservancy, Western Heritage Task Force, Boulder, CO. 175 pp. plus appendix.

Christy, J. A., and J. A. Putera. 1993. Lower Columbia River Natural Area Inventory, 1992. Oregon Natural Heritage Program, Portland. 75 pp.

Driscoll, R. S., D. L. Merkel, D. L. Radloff, D. E. Snyder, and J. S. Hagihara. 1984. An ecological land classification framework for the United States. USDA Forest Service. Miscellaneous Publication No. 1439. Washington, DC. 56 pp.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Johnson, K. R. 1932. Ecology of a glacial lake in central Colorado. Unpublished thesis. University of Colorado, Boulder. 30 pp.

Johnson, K. R. 1932a. Plant ecology of a glacial lake. Journal of the Colorado-Wyoming Academy of Science 1(4):13. [Abstract]

Johnson, K. R. 1936. Ecology of a glacial lake in central Colorado. University of Colorado Studies 23(3):235-243.

Johnson, K. R. 1939. Plant ecology of northwestern Colorado lakes and surrounding areas. Unpublished dissertation. University of Colorado, Boulder. 138 pp.

Johnson, K. R. 1941. Vegetation of some mountain lakes and shores in northwestern Colorado. Ecology 22:306-316.

Kunze, L. M. 1994. Preliminary classification of native, low elevation, freshwater wetland vegetation in western Washington. Washington State Department of Natural Resources, Natural Heritage Program. 120 pp.

Ramaley, F. 1930. Zonation at the San Luis Lakes, near Alamosa, Colorado. Journal of the Colorado-Wyoming Academy of Science 1(2):19-20. (Abstract)

Ramaley, F. 1942. Vegetation of the San Luis Valley in southern Colorado. University of Colorado Studies, Series D, 1:231-277.

Von Loh, J. 2000. Draft local descriptions of the vegetation associations of Ouray National Wildlife Refuge. USGS Bureau of Reclamation, Remote Sensing and GIS Group, Denver Federal Center, Denver.

Distichlis spicata - Hordeum jubatum - Puccinellia nuttalliana - Suaeda calceoliformis Herbaceous Vegetation

COMMON NAME Saltgrass - Foxtail Barley - Nuttall's Alkali Grass - Sea-blite Herbaceous Vegetation
SYNONYM Northern Great Plains Saltgrass Saline 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 DISTICHLIS SPICATA - (HORDEUM JUBATUM) TEMPORARILY FLOODED HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 3
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

These units occupy flat, alkaline, silt loam soils near the Refuge pools on sites that are poorly to moderately well-drained.

Globally

This inland saltgrass wet meadow is found in the northeastern and north-central Great Plains and tallgrass prairie regions of the United States and adjacent Canada, ranging from Minnesota and the Dakotas to Manitoba.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

These units occupy flat, alkaline, silt loam soils near the Refuge pools on sites that are poorly to moderately well-drained. The fluctuating water table is probably within the rooting zone of the vegetation for most of the growing season.

Globally

This community is found on terraces, floodplains, swales and other low sites where drainage is poor. The soils are moderately to strongly saline, fine-textured, and moderately deep to deep (Redmann 1972, USFS 1992). Hirsch (1985) found this community on a variety of soil textures, including sandy clays, clay loam, sandy loams, and sandy clay loams. Periodic flooding is common, and this may result in soil deposition and consequent poor soil development (Hanson and Whitman 1938). The water table is often high, and salt encrustations may be present on the surface (Hirsch 1985).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Distichlis spicata, Hordeum jubatum, Puccinellia nuttalliana, Suaeda calceoliformis*

Globally

Stratum	Species
Herbaceous	*Distichlis spicata, Hordeum jubatum, Puccinellia nuttalliana, Suaeda calceoliformis*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Distichlis spicata, Hordeum jubatum

Globally

Distichlis spicata, Hordeum jubatum

OTHER NOTABLE SPECIES

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

In many cases, this association is fairly monotypic and dominated by inland saltgrass (*Distichlis spicata*). Total foliar cover is usually less than 50% and vegetation height is often less than 15 cm. The most common secondary species is Kentucky bluegrass. Small depressions often contain nearly pure stands of foxtail barley (*Hordeum jubatum*).

Globally

This community has low species diversity and is dominated by salt-tolerant graminoids. Total vegetation cover is sparse to moderate, and bare ground is common (Hanson and Whitman 1938, Redmann 1972). Graminoids dominate the stand. The dominant species are *Distichlis spicata* and *Hordeum jubatu*m. Other common species include *Muhlenbergia asperifolia, Muhlenbergia richardsonis, Puccinellia nuttalliana, Suaeda calceoliformi*s, and *Spartina gracili*s. *Pascopyrum smithii* and *Bouteloua gracilis* can be common on relatively dry inclusions within this community (Hirsch 1985), and *Elymus lanceolatus* may be found on the upland border (Hanson and Whitman 1938). *Carex hallii, Carex praegracili*s, and *Sporobolus compositus (= Sporobolus asper)* can also be found. *Andropogon gerardii, Schizachyrium scoparium, Panicum virgatu*m, and other tall grasses can be a component of these wet meadows. Common forbs include *Ambrosia psilostachya (= Ambrosia coronopifolia), Symphyotrichum ericoides (= Aster ericoides), Chenopodium leptophyllum, Grindelia squarrosa, Melilotus officinalis, Plantago elongata, Plantago eriopoda* (western Minnesota), *Plantago patagonic*a, and *Salicornia rubr*a. Shrubs are very rare. *Artemisia frigida, Atriplex nuttalli*i, and *Sarcobatus vermiculatus* are the only shrubs that have been noted from the western part of the type's range (Hirsch 1985, USFS 1992, R. Dana pers. comm. 1999).

CONSERVATION RANK *G2G3.* This type is fairly restricted in distribution and occurs in relatively localized salinedepressions. Many sites have been heavily grazed (R. Dana pers. comm. 1999).

DATABASE CODE CEGL002273

SIMILAR ASSOCIATIONS
Hordeum jubatum Herbaceous Vegetation

COMMENTS
Lacreek National Wildlife Refuge
Extensive areas naturally dominated by switchgrass are rare in the Great Plains and this type is unique in that regard. The swales and drainages which the type dominates are sometimes saturated throughout much of the growing season, or in the case of the sandhills, the stands are subirrigated.

Globally
The relationship between this community and *Hordeum jubatum* Herbaceous Vegetation (CEGL001798) is unclear. Both communities usually contain *Distichlis spicata* and *Hordeum jubatu*m. *Hordeum* may be more common on heavily grazed sites (R. Dana pers. comm. 1999). The presence of *Puccinellia nuttalliana* or *Suaeda calceoliformis* may be distinguishing factors. They appear to be more characteristic of strongly saline areas while *Hordeum jubatum* can dominate on less saline sites (Redmann 1972). Classification problems may arise on intermediate sites when *Hordeum jubatum* is the dominant species and *Distichlis spicata, Puccinellia nuttallian*a, and *Suaeda calceoliformis* are present in minor amounts. Compare type with *Sporobolus airoides* Northern Plains Herbaceous Vegetation (CEGL002274), found in western North Dakota.

REFERENCES
Greenall, J. A. 1995. Draft element descriptions for natural communities of southern Manitoba (prairie and parkland regions). Manitoba Conservation Data Centre, Winnipeg. 17 pp.
Hanson, H. C., and W. Whitman. 1938. Characteristics of major grassland types in western North Dakota. Ecological Monographs 8:58-114.
Hirsch, K. J. 1985. Habitat type classification of grasslands and shrublands of southwestern North Dakota. Ph.D. thesis. North Dakota State University, Fargo.
Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.
Redmann, R. E. 1972. Plant communities and soils of an eastern North Dakota prairie. Bulletin of the Torrey Botanical Club 99(2):65-76.
U.S. Forest Service. 1992. Draft habitat types of the Little Missouri National Grasslands. Medora and McKenzie ranger districts, Custer National Forest. Dickinson, ND.

Note:
This association is found in two different map classes:
1) Foxtail Barley Herbaceous Vegetation
2) Saltgrass Herbaceous Vegetation Alliance

Panicum virgatum – (Pascopyrum smithii) Herbaceous Vegetation

COMMON NAME Switchgrass – (Western wheatgrass) Herbaceous Vegetation
SYNONYM Switchgrass Wet-mesic Tallgrass 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 Tall sod temperate grassland (V.A.5.N.a)
ALLIANCE ANDROPOGON GERARDII - (CALAMAGROSTIS CANADENSIS, PANICUM VIRGATUM) HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 3
USFWS WETLAND SYSTEM Terrestrial

RANGE

Lacreek National Wildlife Refuge

The switchgrass type is found as relatively small, sometimes pure stands throughout the Refuge. The most naturally occuring communities are found as isolated patches in some of the swales and depressions in the sandhills portion of the Refuge. Stands found in the upland grassland areas and adjacent to the wetland communities appear to be the result of seeding efforts.

Globally

This type has been reported from eastern Wyoming and western South Dakota, but its range is not well understood.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Switchgrass is an infrequent but common component of many of the more mesic; however it rarely forms large continues stands..

Globally

Switchgrass is a common component of many wetlands and mesic sites, but becomes dominant in wetter parts of drainages and wetland basins (Von Loh et al. 1999)

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Glycyrrhiza lepidota*, *Pascopyrum smithii*, *Panicum virgatum, Andropogon gerardii, Poa pratensis, Bromus inermis*

Globally

Stratum	Species
Herbaceous	*Aster ericoides*, *Glycyrrhiza lepidota*, *Sporobolus heterolepis*, *Schizachyrium scoparium*, *Pascopyrum smithii*, *Panicum virgatum*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Panicum virgatum, *Andropogon gerardii*, *Glycyrrhiza lepidota*

Globally
Panicum virgatum, *Pascopyrum smithii*, *Schizachyrium scoparium*, *Glycyrrhiza lepidota*
OTHER NOTABLE SPECIES
VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
The switchgrass herbaceous vegetation type often provides farily dense ground cover of between 50 to 80%. Switchgrass (*Panicum virgatum*) and big bluestem (*Andropogon* gerardii) are the dominant species in more mesic areas while western wheatgrass (*Pascopyrum smithii*) is more abundant on somewhat drier elevated sites. Common associated species include wild licorice (*Glycyrrhiza lepidota*), Kentucky bluegrass (*Poa* pratensis), and smooth brome (*Bromus* inermis). Where the switchgrass type occurs in the sandhills, the distribution often becomes "patchy" with most stands bordered by prairie sandreed (*Calamovilfa longifolia*), neelde-and-thread (*Hesperostipa comata*), and soapweed (*Yucca glauca*).

Globally
In Badland National Park, South Dakota, the switchgrass grassland type provides dense ground cover, typically between 50-80%. *Panicum virgatum* is the dominant species in more mesic areas, *Pascopyrum smithii* is more abundant on elevated sites within the drainages and basins, and *Schizachyrium scoparium* is the dominant species along the upper margin of the type. Where this type is found in drainages, the distribution often becomes "patchy" and *Calamovilfa longifolia* replaces *Schizachyrium scoparium* on the upper type margin. Commonly associated species include *Glycyrrhiza lepidota*, *Aster ericoides*, and stems of *Populus deltoides*.

CONSERVATION RANK G2Q.
DATABASE CODE CEGL001484
SIMILAR ASSOCIATIONS
COMMENTS
Lacreek National Wildlife Refuge
Extensive areas naturally dominated by switchgrass are rare in the Great Plains and this type is unique in that regard. The swales and drainages which the type dominates are sometimes saturated throughout much of the growing season, or in the case of the sandhills, the stands are subirrigated.

Globally
The concept of this type is still under review, as well as its alliance placement. Other candidate alliances *include Panicum virgatum* Temporarily Flooded Herbaceous Alliance (A.1343), which is currently reported only from the southern United States, and the *Pascopyrum smithii* Temporarily Flooded Herbaceous Alliance (A.1354), which has many floristic affinities with stands in this type.

REFERENCES
Montana Natural Heritage Program. No Date. Unpublished data on file. Helena, Montana.
Von Loh, J., D. Cogan, D. Faber-Langendoen, D. Crawford, and M. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program, Badlands National Park, South Dakota (Final Report). Technical Memorandum No. 8260-00-02. U.S. Bureau of Reclamation Technical Service Center. Denver Colorado.

Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation

COMMON NAME	Common Reed Western North America Temperate Semi-natural Herbaceous Vegetation
SYNONYM	Western Reed 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	PHRAGMITES AUSTRALIS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL	3
USFWS WETLAND SYSTEM	Terrestrial

RANGE

Lacreek National Wildlife Refuge

This is a rare association at LNWR that only occurs in a few small stands.

Globally

This reed marsh type is found across the west-temperate regions of the United States and Canada, ranging from western North Dakota and Saskatchewan to Oregon, south to California and Texas. Its distribution is somewhat incomplete as not all states have listed semi-natural types in their state.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

The association is characterized by having dense cover of common reed and little overall species diversity.

Globally

This association is widespread in the western U.S. and Canada. Elevation ranges from 640-1980 m. Stands occur in temporarily to semipermanently flooded marshes, ditches, impoundments, pond and lake margins, swales, and wet meadows that often have been disturbed by human activity. Sites are usually flooded during the growing season, but the soil surface may dry out in late summer. Soils are often fine-textured silts and clays. In Colorado and Utah, this reed marsh often occurs in small wet patches in seeps and backwater areas of large floodplains, around the fringes of irrigation ponds, ditches, and along railroad embankments that have poor drainage.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
HERBACEOUS	*Phragmites australis, Typha latifolia*

Globally

Stratum	Species
GRAMINOID	*Phragmites australis*

CHARACTERISTIC SPECIES
Lacreek National Wildlife Refuge
Phragmites australis, Typha latifolia

Globally
Phragmites australis

OTHER NOTABLE SPECIES (n/a)

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
Small stands of this type typically have very little associated species.

Globally
The vegetation is often variable, as *Phragmites australis* will often invade into existing natural or semi-natural communities present on the site. Once firmly established, this community is usually strongly dominated by *Phragmites australis*, with few or no other vascular plants present. Stands have a dense, 1- to 3-m tall herbaceous layer dominated by the perennial graminoid *Phragmites australis* usually with over 80% cover. Associates include *Agrostis stolonifera, Carex* spp., *Conyza canadensis, Glycyrrhiza lepidota, Iva axillaris, Mentha arvensis, Schoenoplectus acutus (= Scirpus acutus)*, and *Typha latifolia*. Introduced species such as *Lepidium latifolium* and *Cirsium arvense* may be present and compete well against *Phragmites australis* in disturbed sites.

CONSERVATION RANK G2Q.

DATABASE CODE CEGL001484

SIMILAR ASSOCIATIONS
Phragmites australis Eastern North America Temperate Semi-natural Herbaceous Vegetation (CEGL004141)

COMMENTS
Lacreek National Wildlife Refuge
(n/a)

Globally
This vegetation has variable hydrology and is often treated as part of other marshes and meadows. The geographic distribution of the type is arbitrarily limited to Bailey's Dry and Humid Temperate Domain in western North America (Bailey 1997, 1998). Compare with *Phragmites australis* Eastern North America Temperate Semi-natural Herbaceous Vegetation

(CEGL004141). The two types need to be better distinguished, both conceptually and nomenclaturally.

REFERENCES

Bailey, R. G., P. E. Avers, T. King, and W. H. McNab, editors. 1994. Ecoregions and subregions of the United States (map). Washington, DC: U.S. Geological Survey. Scale 1:7,500,000 colored. Accompanied by a supplementary table of map unit descriptions compiled and edited by W. H. McNab and R. G. Bailey. Prepared for the USDA Forest Service.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River basins, Colorado. Final report submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Colorado Natural Heritage Program, Boulder. 166 pp.

Spartina pectinata - Carex spp. Herbaceous Vegetation

COMMON NAME Prairie Cordgrass - Sedge species Herbaceous Vegetation
SYNONYM Prairie Cordgrass - 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 Temporarily flooded temperate or subpolar grassland (V.A.5.N.j)
ALLIANCE SPARTINA PECTINATA TEMPORARILY FLOODED HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM Palustrine

RANGE

Lacreek National Wildlife Refuge

The prairie cordgrass wetland is restricted to the margins of linear wetlands with a perennial hydrologic regime.

Globally

This type is found in the northwestern Great Plains in eastern Montana and western North and South Dakota.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Prairie cordgrass wetland stands occur in drainage bottoms, along perennial stream courses, forming a patchy mosaic with other wetland species.

Globally

At Wind Cave NP in South Dakota, stands occur in drainage bottoms where the soil is wet for at least part of the growing season. At Theodore Roosevelt and Badlands National Parks, stands occur in poorly drained depressions within floodplains of major rivers.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Scirpus americanus*, *Carex* spp., *Spartina pectinata*

Globally

Stratum	Species
Graminoid	*Spartina pectinata*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Spartina pectinata, *Carex* spp., *Scirpus americanus*, *Eleocharis palustris*

Globally
Spartina pectinata

OTHER NOTABLE SPECIES
Globally

Stratum	Species
Graminoid	*Carex nebrascensis, Hordeum jubatum*

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
Prairie cordgrass stands within Lacreek are small, but dense. Aerial cover of the entire herbaceous layer is typically estimated at 75-100%. Prairie cordgrass (*Spartina pectinata*) is the dominant species. The stands occupy moist soils and occur adjacent to spikerush (*Eleocharis palustris*), water smartweed (*Polygonum amphibium*), cattails (*Typha angustifolia*, *Typha latifolia*), and bulrush (*Scirpus americanus* (= *Scirpus pungens*)) stands, these latter stands occupying saturated to inundated soils. Adjacent uplands are typically vegetated by western wheatgrass (*Pascopyrum smithii*) grasslands.

Globally
At Wind Cave NP in South Dakota, this type has dense herbaceous cover, greater than 75 percent. Species dominance is patchy within stands, with various graminoids locally abundant, often to the exclusion of other species. In the single sampled stand, *Spartina pectinata, Carex nebrascensis*, and *Eleocharis palustris* were locally dominant. *Epilobium ciliatum* was common in shallow water (H. Marriott pers. comm. 1999). At Theodore Roosevelt National Park in North Dakota *Spartina pectinata* is the dominant species. Species richness is generally low. *Hordeum jubatum* and *Pascopyrum smithii* are the most prominent secondary species (J. Butler personal communication 1999). At Badlands National Park in South Dakota, Prairie cordgrass stands are small, but dense. Aerial cover of the entire herbaceous layer is typically estimated at 75-100%. *Spartina pectinata* is the dominant species. The stands occupy moist soils and occur adjacent to spikerush *Eleocharis palustris*, *Polygonum amphibium*, *Typha angustifolia*, *Typha latifolia,* and *Scirpus americanus* (= *Scirpus pungens*) stands, these latter stands occupying saturated to inundated soils. Adjacent uplands are typically vegetated by *Pascopyrum smithii*.

CONSERVATION RANK G3?. This type has a relatively restricted distribution, and occurs in somewhat specialized wetland habitats in an arid climate. In addition, many such wetland sites are subject to heavy grazing pressure by cattle, who favor these moist locations. No element occurrences have been documented for this type, but at least several stands occur within three National Parks in the western Dakotas.

DATABASE CODE CEGL001477

SIMILAR ASSOCIATIONS
Spartina pectinata - *Calamagrostis stricta* - *Carex* spp. Herbaceous Vegetation (This is the northern tallgrass region equivalent of 1477.)
Spartina pectinata - *Scirpus pungens* Herbaceous Vegetation (This association may simply need to be split between a *Scirpus pungens* association and a *Spartina pectinata* association.)

COMMENTS

Lacreek National Wildlife Refuge

Prairie cordgrass stands or patches only occur along perennial flowing waters of slow-moving and along irrigation and water collection ditches.

Globally

Sites may occasionally flood from rivers or ponding up of depressions.

REFERENCES

Culwell, L.D. and K.L. Scow. 1982. Terrestrial vegetation inventory: Dominy Project Area, Custer County, Montana 1979-1980. Unpublished technical report for Western Energy Company by Westech, Helena, Montana. 144 pp. + 15 pp. Appendix.

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 (V.A.5.N.k)
ALLIANCE CAREX NEBRASCENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM

RANGE

Lacreek National Wildlife Refuge

Cattail wetlands occur throughout the Refuge, occupying depressions, drainages, seeps, springs, and ponds where saturated soils or shallow standing water is present on a more-or-less permanent basis. This type is especially prevalent around the Refuge pools.

Globally

This sedge meadow type is widely distributed from the western Great Plains into the western mountains of the United States, ranging from South Dakota and Montana to possibly as far west as Washington, south to California and east to New Mexico.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Cattail wetlands occupy flats, slow-flowing drainages, sidehill and toeslope seeps and springs, and the edges of ponds, pools, and reservoirs.

Globally

In Nebraska and Colorado, this community occurs as bands parallel to streams and is dominated by medium-tall (<1 m) herbaceous species. This community is also found in nearly level, poorly drained sites that are wet or saturated for much of the year (Jones 1992). In eastern Wyoming and the panhandle of western Nebraska, soils were gleyed sandy, silty loam, clay loam, or clays (Jones and Walford 1995, Steinauer and Rolfsmeier 2000). In Colorado, these wetlands form open meadows that occur along the margins of stream banks, lakes and seeps on the plains. The soils are generally saturated for much of the growing season and are subject to compaction by livestock.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Hordeum vulgare*, *Juncus* spp., *Scirpus americanus*, *Scirpus validus*, *Typha angustifolia*, *Typha latifolia*

Globally

Stratum	Species
Herbaceous	*Scirpus acutus, Scirpus tabernaemontani, Typha angustifolia, Typha latifolia*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Typha angustifolia*, *Scirpus americanus*

Globally

Stratum	Species
Herbaceous	*Scirpus acutus, Scirpus tabernaemontani, Typha angustifolia*

OTHER NOTABLE SPECIES

Globally

Stratum	Species
Graminoid	*Eleocharis palustris, Leersia oryzoides*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

Naturally occurring, emergent wetlands growing along slow-moving creeks are dominated by prairie cordgrass (*Spartina pectinata*), spikerush, three-square bulrush (*Scirpus americanus* or *Scirpus pungens*), and softstem bulrush (*Scirpus validus*). Vegetative cover for emergent wetlands established along streams is dense, between 75-100% in most cases. Emergent wetlands that have formed around and in constructed pools and reservoirs are dominated by species of cat-tail (*Typha angustifolia* and *Typha latifolia*) and bulrush (*Scirpus validus* and *Scirpus americanus*). These sites may also support some wetland shrubs such as sandbar willow (*Salix exigua*). Typically, vegetative cover in emergent wetlands of disturbed sites ranges from approximately 50-90%.

Globally

Woody species are rare. Stands are dominated by the perennial graminoid *Carex nebrascensi*s, a widespread species that generally forms small to medium-sized meadows. In Nebraska, common species include *Agrostis stolonifera, Carex hystericina, Carex pellita (= Carex lanuginosa), Eleocharis erythropoda, Equisetum* spp., *Juncus balticus, Schoenoplectus pungens (= Scirpus pungens*), and *Triglochin* spp. (Steinauer and Rolfsmeier 2000).

CONSERVATION RANK G4. This type is widely distributed, but many examples have been heavily grazed by cattle, lowering their floristic quality.

DATABASE CODE CEGL001813

SIMILAR ASSOCIATIONS

Scirpus acutus - Typha latifolia - (Scirpus tabernaemontani) Sandhills Herbaceous Vegetation
Typha latifolia Southern Herbaceous Vegetation (southeastern states)
Typha latifolia Western Herbaceous Vegetation (western states)

Typha spp. - Scirpus spp. - Mixed Herbs Great Plains Herbaceous Vegetation (A more species diverse association.)

COMMENTS

Lacreek National Wildlife Refuge

An effort was made to split this type into two map units based on hydrologic patterns, semipermenately and seasonally flooded.

Globally

In the Black Hills, classification of stands was problematic due to identification problems with *Carex nebrascensis* and *Carex aquatic*a. The two are difficult to distinguish based on available keys and written descriptions (Marriott and Faber-Langendoen 2000).

REFERENCES

Baker, W. L. 1982. Natural vegetation of the Piceance Basin, Colorado. Appendix D, pages 1-113 in: J. S. Peterson and W. L. Baker, editors. Inventory of the Piceance Basin, Colorado. Unpublished report for the Bureau Land Management, Craig, CO.

Cooper, D. J., and T. R. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Unpublished report prepared for The Nature Conservancy, Colorado Field Office, Boulder. 115 pp.

Hall, F. C. 1973. Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington. USDA Forest Service, Pacific Northwest Region. R6 Area Guide 3-1. 62 pp.

Hansen, P. L., S. W. Chadde, and R. D. Pfister. 1988. Riparian dominance types of Montana. University of Montana Miscellaneous Publication 49. Montana Forest and Conservation Experiment Station, Missoula. 411 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Jones, G. 1992. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, WY. 183 pp.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, WY. 245 pp.

Kittel, G., R. Rondeau, and A. McMullen. 1996. A classification of the riparian vegetation of the Lower South Platte and parts of the Upper Arkansas River basins, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Prepared by Colorado Natural Heritage Program, Fort Collins. 243 pp.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River basins, Colorado. Final report submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Colorado Natural Heritage Program, Boulder. 166 pp.

Kovalchik, B. L. 1987. Riparian zone associations - Deschutes, Ochoco, Fremont, and Winema national forests. USDA Forest Service Technical Paper 279-87. Pacific Northwest Region, Portland, OR. 171 pp.

Marriott, H. J., and D. Faber-Langendoen. 2000. The Black Hills community inventory. Volume 2: Plant community descriptions. The Nature Conservancy, Midwestern Resource Office, Minneapolis, MN. 326 pp.

Mutz, K. M., and J. Queiroz. 1983. Riparian community classification for the Centennial Mountains and South Fork Salmon River, Idaho. Unpublished report prepared for USDA Forest Service Intermountain Region under contract 53-84M8-2-0048 by Meiiji Resource Consultants, Layton, UT. 168 pp.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1988b. Riparian community type classification of Utah. USDA Forest Service, Intermountain Region Publication R4-ECOL-88-01. Ogden, UT.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1989. Riparian community type classification of Utah and southeastern Idaho. USDA Forest Service, Intermountain Region. Report R4-ECOL-89-01. Ogden, UT. 191 pp.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985a. Riparian community type classification of eastern Idaho-western Wyoming. USDA Forest Service, Intermountain Region. R4-Ecol-85-01. Ogden, UT. 78 pp.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985b. Riparian community type classification of northern Utah and adjacent Idaho. Unpublished report prepared for USDA Forest Service, Intermountain Region, Ogden, UT. 104 pp.

Juncus balticus Herbaceous Vegetation

COMMON NAME Baltic Rush Herbaceous Vegetation
SYNONYM Baltic Rush 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 JUNCUS BALTICUS SEASONALLY FLOODED HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 1
USFWS WETLAND SYSTEM PALUSTRINE

RANGE

Lacreek National Wildlife Refuge

Baltic rush (*Juncus balticus*) stands are rare and patchy within the Refuge.

Globally

This Baltic rush wet meadow community is found widely throughout the western United States, ranging from South Dakota and Montana west to Washington, south to possibly California, and east to New Mexico.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Stands are usually less than 0.5 ha in size and occur in poorly drained sites where the soil is saturated for most of the growing season.

Globally

This widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 1420-3500 m. Stands usually occur as small, dense patches on flat to gently sloping sites near seeps and streams. Stream channels are highly variable in size and type ranging from narrow to moderately wide, and deeply entrenched to very sinuous (Kittel et al. 1999). Soils are also variable and range from alluvial sandy and well-drained, to poorly drained silty clay loam, to organic; however, soils tend to be finer-textured, alkaline and may be saline (Brotherson and Barnes, Kittel et al. 1999, Padgett et al. 1989). Cobbles and gravel are common on many sites, and gleyed and mottled horizons are often present because of flooding or high water tables (Kittel et al. 1999).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
GRAMINOID	*Carex nebrascensis*

Globally

Stratum	Species
GRAMINOID	*Carex nebrascensis, Carex praegracilis, Juncus balticus*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
GRAMINOID	*Carex nebrascensis*

Globally

Stratum	Species
GRAMINOID	*Carex nebrascensis, Carex praegracilis, Juncus balticus*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

The stands are characterized by a dense cover of Baltic rush with cattail species and prairie cordgrass as minor components of the association.

Globally

This association is characterized by a low (<50 cm), dense graminoid layer dominated by the rhizomatous perennial *Juncus balticus*. Minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex nebrascensis* or *Carex utriculata*, is often present. Other common graminoids include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum jubatum, Muhlenbergia asperifolia, Phleum alpinum*, and *Sporobolus airoides*. Forb cover is generally low but may include *Caltha leptosepala, Glaux maritima, Maianthemum stellatum*, and *Dodecatheon pulchellum*. Shrubs are not common, but occasional *Salix* spp. may occur. Some stands may be codominated by the introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera*. Other introduced species, such as *Taraxacum officinale, Trifolium* spp., *Cirsium arvense, Lactuca serriola, Phleum pratense*, and *Thinopyrum intermedium*, may occur in disturbed stands.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5.

DATABASE CODE CEGL001838

COMMENTS

Lacreek National Wildlife Refuge

(n/a)

Globally

(n./a)

REFERENCES

Brotherson, J. D., and S. J. Barnes. 1984. Habitat relationships of *Glaux maritima* in central Utah. Great Basin Naturalist 44(2):299-309.

Bunin, J. E. 1985. Vegetation of the City of Boulder, Colorado open space lands. Report prepared for the City of Boulder, Real Estate/Open Space, Boulder, CO. 114 pp.

Flowers, S. 1962. Vegetation of Morrow Point and Blue Mesa Reservoir basins of the upper Gunnison River, Colorado. Pages 47-102 in: A. M. Woodbury, editor. Ecological studies of the flora and fauna of the Curecanti Reservoir Basins, western Colorado. University of Utah, Anthropological Papers No. 59 (Upper Colo. Series No. 8).

Hansen, P. L., S. W. Chadde, and R. D. Pfister. 1988. Riparian dominance types of Montana. University of Montana Miscellaneous Publication 49. Montana Forest and Conservation Experiment Station, Missoula. 411 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Hess, K. 1981. Phyto-edaphic study of habitat types of the Arapaho-Roosevelt National Forest, Colorado. Unpublished dissertation. Colorado State University, Fort Collins. 558 pp.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, WY. 245 pp.

Kittel, G. M., and N. D. Lederer. 1993. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores river basins. Unpublished report prepared for Colorado Department of Health and the Environmental Protection Agency by The Nature Conservancy, Colorado Field Office, Boulder.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River basins, Colorado. Final report submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Colorado Natural Heritage Program, Boulder. 166 pp.

Komarkova, V. 1986. Habitat types on selected parts of the Gunnison and Uncompahgre national forests. Unpublished final report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 270 pp. plus appendices.

Manning, M. 1988. Ecology and rooting characteristics of four intermountain meadow community types. Unpublished thesis. University of Nevada, Reno.

Mutel, C. F. 1973. An ecological study of the plant communities of certain montane meadows in the Front Range of Colorado. Unpublished thesis. University of Colorado, Boulder. 77 pp.

Mutz, K. M., and R. Graham. 1982. Riparian community type classification-Big Piney Range District, Wyoming. Unpublished report prepared for USDA Forest Service, Intermountain Region under contract 53-84M8-1-974, by Meiiji Resource Consultants, Layton, UT. 88 pp.

Olson, R. A., and W. A. Gerhart. 1982. A physical and biological characterization of riparian habitat and its importance to wildlife in Wyoming. Unpublished report prepared for Wyoming Fish and Game Department, Cheyenne, WY. 188 pp.

Padgett, W. G. 1982. Ecology of riparian plant communities in southern Malheur National

Forest. Unpublished thesis. Oregon State University, Corvallis. 143 pp.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1989. Riparian community type classification of Utah and southeastern Idaho. USDA Forest Service, Intermountain Region. Report R4-ECOL-89-01. Ogden, UT. 191 pp.

Rector, C. D. 1979. Lower Gunnison River Basin wetland inventory and evaluation. Unpublished thesis. University of Colorado, Boulder. 71 pp.

Richard, C., G. Kittel, and S. Kettler. 1996. A Classification of the Riparian Vegetation of the San Juan National Forest. Draft 1 report. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Shupe, J. B., J. D. Brotherson, and S. R. Rushforth. 1986. Patterns of vegetation surrounding springs in Goshen Bay, Utah County, Utah, U.S.A. Hydrobiologia 139:97-107.

Stewart, B. K. 1940. Plant ecology and paleoecology of the Creede Valley, Colorado. Unpublished dissertation. University of Colorado, Boulder. 154 pp.

Tuhy, J. S., and S. Jensen. 1982. Riparian classification for the Upper Salmon and Middle Fork Salmon River drainages, Idaho. Unpublished report prepared for the USDA Forest Service, Intermountain Region by White Horse Associates, Smithfield, UT. 183 pp.

Wasser, C. H., and K. Hess. 1982. The habitat types of Region II. USDA Forest Service: A synthesis. Final report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 140 pp.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985a. Riparian community type classification of eastern Idaho-western Wyoming. USDA Forest Service, Intermountain Region. R4-Ecol-85-01. Ogden, UT. 78 pp.

Schoenoplectus acutus - Typha latifolia - (Schoenoplectus tabernaemontani) Sandhills Herbaceous Vegetation

COMMON NAME	Hardstem Bulrush - Broadleaf Cattail - (Softstem Bulrush) Sandhills Herbaceous Vegetation
SYNONYM	Sandhills Bulrush 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) – (SCHOENOPLECTUS SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL	2
USFWS WETLAND SYSTEM	PALUSTRINE

RANGE

Lacreek National Wildlife Refuge

The vast majority of the stands that characterize this type at LNWR are less than 0.5 ha in size.

Globally

This community is found in floodplains and interdunal valleys of the sandhills regions of the central Great Plains in the United States.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Stands of this community type occur in small, isolated depressions where the water table intersects the surface. The soils are intermittently saturated; however, the amount of moisture probably fluctuates considerably from one year to the next. Because this community is restricted to very small, isolated depressions, the size of the stands probably fluctuates seasonally as well as from one year to the next.

Globally

This community occurs where the regionally high water table of the Sandhills intersects the land surface in interdunal valleys, and is commonly associated with lakes, though it may occur in smaller depressions as well. Soils are deep, very poorly drained, and contain much organic matter (peat or muck) and are formed in eolian sand or alluvium. Soils are flooded or waterlogged through much of the season. The water is usually slightly alkaline, and surface water levels fluctuate seasonally with groundwater levels (Steinauer and Rolfsmeier 2000).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
GRAMINOID	*Schoenoplectus acutus, Schoenoplectus pungens*

Globally

Stratum	Species
GRAMINOID	*Carex lacustris, Eleocharis erythropoda, Phragmites australis, Schoenoplectus acutus, Schoenoplectus pungens, Sparganium eurycarpum, Typha latifolia*
FORB	*Polygonum amphibium var emersum, Sagittaria latifolia*
SUBMERSED	*Ceratophyllum demersum, Lemna trisulca, Zannichellia palustris*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
GRAMINOID	*Schoenoplectus acutus*

Globally

Stratum	Species
GRAMINOID	*Phragmites australis, Schoenoplectus acutus, Typha latifolia*
FORB	*Sagittaria latifolia*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

The vegetation is typically 1 to 2 m in height with foliar cover approaching 100%. Cattail (*Typha latifolia*) is the most common secondary species.

Globally

The vegetational composition of this community varies in response to water depth and other factors. This community is dominated by tall, emergent, hydrophytic graminoids. In areas flooded most of the season *Schoenoplectus acutus (= Scirpus acutus)* is usually dominant, with *Typha latifolia* increasingly common in areas of deeper water. Scattered patches of *Phragmites australis* may be present, but are seldom common. *Sagittaria latifolia* frequently forms a sparse understory layer, but is often dense in openings in the overstory and in deeper water with *Typha latifolia* at the margin of the permanent water line. Other species found in openings include *Carex lacustris, Polygonum amphibium var. emersum (= Polygonum coccineum)*, and *Sparganium eurycarpum*. In areas which experience a more frequent fluctuation in the water level, *Phragmites australis* dominates, and may spread extensively during extended periods of low water. Scattered *Carex lacustris, Polygonum amphibium var. emersum (= Polygonum coccineum)*, and *Schoenoplectus acutus* are found with *Phragmites australis* in these sites. Species diversity is low (Steinauer and Rolfsmeier 2000).

The vegetation may form two intergrading zones, a bulrush/cattail zone where areas are flooded most of the season and dominated by a mixture of species, and a reed zone where areas are seasonally flooded and dominated by *Phragmites australis*. *Phragmites* may spread extensively during periods when the water table is low. Understory vegetation is usually sparse in the denser stands, though scattered *Typha* and *Schoenoplectus* may be present along with other plants of the bulrush/cattail zone.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4. Many unmodified marshes remain, though many more have been drained, particularly in the eastern portion of the range of this community. These sites are vulnerable to invasion by *Lythrum salicaria*.

DATABASE CODE CEGL002030

COMMENTS
Lacreek National Wildlife Refuge
(n/a)

Globally
(n/a)

REFERENCES
Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Pool, R. J. 1914. A study of the vegetation of the sandhills of Nebraska. Minnesota Botanical Studies 4:189-312.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Tolstead, W. L. 1942. Vegetation of the northern part of Cherry County, Nebraska. Ecological Monographs 12(3):257-292.

Schoenoplectus pungens Herbaceous Vegetation

COMMON NAME Threesquare Herbaceous Vegetation
SYNONYM 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 Semipermanently flooded temperate or subpolar grassland (V.A.5.N.l)
ALLIANCE SCHOENOPLECTUS PUNGENS SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 2
USFWS WETLAND SYSTEM PALUSTRINE

RANGE

Lacreek National Wildlife Refuge

This rare unit is comprised of stands that are less than 0.5 ha in size.

Globally

This community is found in the western United States in the intermountain basins, as well as in western parts of the Great Plains, from Montana south to Colorado, and west into Nevada, Utah, and Wyoming.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Stands of this community type occur in small, isolated depressions where the water table intersects the surface. Hydrologic conditions are very similar to those of the Hardstem bulrush type.

Globally

Stands of this widespread association are found throughout much of the western U.S. in appropriate wetland habitat. Elevations range from 1000-2400 m. Stands occur along low-gradient, meandering, usually perennial streams, around the margins of ponds and marshes, in low-lying swales, and abandoned or overflow channels where the soils remain saturated. (Hansen et al. 1995, Kittel et al. 1999, Jones and Walford 1995, Walford 1996). It also occurs on silt and sand bars within the active channel. Soils are generally derived from alluvium and are fine-textured, black, alkaline, organic anoxic with gleying. Soils range from normal to saline with pH ranging from 7.4-9.1.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
GRAMINOID	*Schoenoplectus pungens*

Globally

Stratum	Species

GRAMINOID *Schoenoplectus pungens*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
GRAMINOID	*Schoenoplectus pungens*

Globally

Stratum	Species
GRAMINOID	*Schoenoplectus pungens*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

The vegetation is typically 0.5 to 2 m in height with foliar cover approaching 100%. Other wetland species common to LNWR are usually present in low abundance.

Globally

This widespread wetland association is characterized by a dense, 0.3- to 0.6-m tall herbaceous vegetation layer that is dominated by *Schoenoplectus pungens (= Scirpus pungens)*. Associated species include *Schoenoplectus maritimus (= Scirpus maritimus), Spartina gracilis, Hordeum jubatum, Pascopyrum smithii, Juncus balticus, Eleocharis palustris, Lemna minor, Sagittaria latifolia*, and *Typha* spp. Stands of this association contain no tree or shrub layer, but a few scattered trees and shrubs may be present, most commonly *Populus deltoides, Salix amygdaloides, Salix exigua, Symphoricarpos occidentalis*, or *Sarcobatus vermiculatus*.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3G4.

DATABASE CODE CEGL001587

COMMENTS

Lacreek National Wildlife Refuge

(n/a)

Globally

(n/a)

REFERENCES

Brotherson, J. D., and S. J. Barnes. 1984. Habitat relationships of *Glaux maritima* in central Utah. Great Basin Naturalist 44(2):299-309.

Gleason, H. A., and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. New York Botanical Garden, Bronx, NY. 910 pp.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence. 1402 pp.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995.

Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, WY. 245 pp.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, WY. 245 pp.

Kittel, G. M., and N. D. Lederer. 1993. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores river basins. Unpublished report prepared for Colorado Department of Health and the Environmental Protection Agency by The Nature Conservancy, Colorado Field Office, Boulder.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River basins, Colorado. Final report submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Colorado Natural Heritage Program, Boulder. 166 pp.

Larson, G. E. 1993. Aquatic and wetland vascular plants of the northern Great Plains. USDA Forest Service General Technical Report RM-238. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 681 pp.

Lauver, C. L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44:421-443.

Montana Natural Heritage Program. 1988. Draft guide to the natural vegetation of Montana. Montana Natural Heritage Program, Helena. 389 pp.

Walford, G. M. 1996. Statewide classification of riparian and wetland dominance types and plant communities - Bighorn Basin segment. Report submitted to the Wyoming Department of Environmental Quality, Land Quality Division by the Wyoming Natural Diversity Database. 185 pp.

Walford, G. M. 1996. Statewide classification of riparian and wetland dominance types and plant communities - Bighorn Basin segment. Report submitted to the Wyoming Department of Environmental Quality, Land Quality Division by the Wyoming Natural Diversity Database. 185 pp.

Typha spp. Great Plains Herbaceous Vegetation

COMMON NAME Cattail species Great Plains Herbaceous Vegetation
SYNONYM Northern Great Plains 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

RANGE

Lacreek National Wildlife Refuge

Cattail wetlands occur throughout the Refuge, occupying depressions, drainages, seeps, springs, and ponds where saturated soils or shallow standing water is present on a more-or-less permanent basis. This type is especially prevalent around the Refuge pools.

Globally

This community ranges broadly over the northern Great Plains of the United States.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Cattail wetlands occupy flats, slow-flowing drainages, sidehill and toeslope seeps and springs, and the edges of ponds, pools, and reservoirs.

Globally

Stands occur in basin-like depressions, backwater areas of floodplains and shallow margins of lakes or ponds. Hydrology varies from seasonally flooded to semipermanently flooded.

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Herbaceous	*Hordeum vulgare*, *Juncus* spp., *Scirpus americanus*, *Scirpus validus*, *Typha angustifolia*, *Typha latifolia*

Globally

Stratum	Species
Graminoid	*Scirpus acutus, Scirpus tabernaemontani, Typha angustifolia, Typha latifolia*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Typha angustifolia, *Scirpus americanus*

Globally
Scirpus acutus, Scirpus tabernaemontani, Typha angustifolia

OTHER NOTABLE SPECIES
Lacreek National Wildlife Refuge

Globally

Stratum	Species
Graminoid	*Eleocharis palustris, Leersia oryzoides*

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
Naturally occurring, emergent wetlands growing along slow-moving creeks are dominated by prairie cordgrass (*Spartina pectinata*), spikerush, three-square bulrush (*Scirpus americanus* or *Scirpus pungens*), and softstem bulrush (*Scirpus validus*). Vegetative cover for emergent wetlands established along streams is dense, between 75-100% in most cases. Emergent wetlands that have formed around and in constructed pools and reservoirs are dominated by species of cat-tail (*Typha angustifolia* and *Typha latifolia*) and bulrush (*Scirpus validus* and *Scirpus americanus*). These sites may also support some wetland shrubs such as sandbar willow (*Salix exigua*). Typically, vegetative cover in emergent wetlands of disturbed sites ranges from approximately 50-90%.

Globally
The vegetation is dominated by relatively pure stands of *Typha* spp., either *Typha latifolia* or *Typha angustifolia* or both. Many associates could occur. This type may simply be a less diverse variation of *Typha spp - Scirpus spp* Mixed Herbs Great Plains Herbaceous Vegetation (CEGL002228).

CONSERVATION RANK G4G5. Type is widespread throughout the plains, but most examples show evidence of disturbance. It is possible that the type originates primarily from human-related disturbances, and perhaps the rank should be GW.

DATABASE CODE CEGL002389

SIMILAR ASSOCIATIONS
Scirpus acutus - Typha latifolia - (Scirpus tabernaemontani) Sandhills Herbaceous Vegetation
Typha latifolia Southern Herbaceous Vegetation (southeastern states)
Typha latifolia Western Herbaceous Vegetation (western states)
Typha spp. - Scirpus spp. - Mixed Herbs Great Plains Herbaceous Vegetation (A more species diverse association.)

COMMENTS
Lacreek National Wildlife Refuge
An effort was made to split this type into two map units based on hydrologic patterns, semipermenately and seasonally flooded.

Globally

Cattail - bulrush wetlands represent a regulated resource and are a valuable wildlife habitat. The presence of wetlands and ponded water controls the movement of livestock and many wildlife species, particularly bison, the largest grazing mammal on the park.

REFERENCES

Steinauer, G. and S. Rolfsmeier. 1997. Terrestrial natural communities of Nebraska. Draft – October 28, 1997. Nebraska Game and Parks Commission, Lincoln, NE. 117 p.

Note:

This association is found in two different map classes:

1) Cattail spp. Great Plains Herbaceous Vegetation (Semipermently Flooded)
2) Cattail spp. Great Plains Herbaceous Vegetation (Seasonally Flooded)

Symphoricarpos occidentalis Shrubland

COMMON NAME Western Snowberry Shrubland
SYNONYM Western Snowberry 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 SYMPHORICARPOS OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 3
USFWS WETLAND SYSTEM PALUSTRINE

RANGE

Lacreek National Wildlife Refuge

Western snowberry shrublands are rare within the Refuge. Only a few small stands (less than 0.5 ha in size) were recorded in the northernmost portion of the Refuge.

Globally

This western snowberry shrubland is found in the western tallgrass and northern Great Plains of the United States and Canada.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Western snowberry is generally found on sites that receive some form of supplemental moisture. Consequently, they are usually associated with small depressions in the uplands.

Globally

This community is found in mesic swales, depressions, ravines and floodplains. Some examples of this community experience intermittent and brief flooding. The soils are fertile and well-drained to imperfectly drained silts and loams. The upper soil horizon is usually deep, although a thin layer of sand may be present if the site has been recently flooded (Jones and Walford 1995).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
SHORT SHRUB	*Symphoricarpos occidentalis*

Globally

Stratum	Species
SHORT SHRUB	*Symphoricarpos occidentalis*

CHARACTERISTIC SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
SHORT SHRUB	*Symphoricarpos occidentalis*

Globally

Stratum	Species
SHORT SHRUB	*Symphoricarpos occidentalis*

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

At the Refuge, the stands are often intermixed with, a wide variety of vegetation types such as western wheatgrass and other upland grasses.

Globally

Throughout its range this community is dominated by shrubs approximately 1 m tall. Shrub cover is typically greater than 50%, and in places it can approach 100%. These shrubs form dense clumps that exclude most other species. *Symphoricarpos occidentalis* is the most common shrub, but *Rhus aromatica* (or *Rhus trilobata*) and *Prunus virginiana* can be locally abundant and can grow to 2-3 m in places. *Toxicodendron rydbergii* may also be present. Herbaceous species and smaller shrubs are most abundant at the edges of this community and in gaps between the clumps of taller shrubs where the shading is less complete. *Rosa woodsii* is a typical smaller shrub. Common graminoids include *Pascopyrum smithii* and *Poa pratensis*. *Achillea millefolium, Artemisia ludoviciana, Galium boreale*, and *Solidago* spp. are common forbs of this community. Woody vines sometimes occur, including *Parthenocissus vitacea*.

This shrubland type occurs throughout its range as thickets surrounded by grasslands or occasionally by tall shrublands (e.g., *Prunus virginana*).

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4G5. This type is common throughout the northern Great Plains. Historically, it may never have been very extensive. It has been observed to grow out from forest or woodland edges and shade out the grasses. It is tolerant of both grazing and fire (Hansen and Hoffman 1988), and is under no threat from human activities. In some cases, heavily grazed pastures may favor this types. Many examples are somewhat weedy; thus the type is not demonstrably secure.

DATABASE CODE CEGL001131

COMMENTS

Lacreek National Wildlife Refuge

(n/a)

Globally

(n/a)

REFERENCES

Christy, S. 1973. An analysis of the woody vegetation on the South Platte River flood plain in northeastern Colorado. Unpublished thesis. University of Northern Colorado, Greeley. 82 pp.

Clark, S. J. V. 1977b. The vegetation of Rocky Flats, Colorado. Unpublished thesis. University of Colorado, Boulder.

Clark, S. V., P. J. Webber, V. Komarkova, and W. A. Weber. 1980. Map of mixed prairie

grassland vegetation-Rocky Flats, Colorado. University of Colorado, Institute of Arctic and Alpine Research Occasional Paper 35. 66 pp.

Hansen, P. L., and G. R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland districts of the Custer National Forest: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-157. Fort Collins, CO. 68 pp.

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

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

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.

Jones, G. 1992. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, WY. 183 pp.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, WY. 245 pp.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River basins, Colorado. Final report submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Colorado Natural Heritage Program, Boulder. 166 pp.

McAdams, A. G., D. A. Stutzman, and D. Faber-Langendoen. 1998. Black Hills Community Inventory, unpublished data. The Nature Conservancy, Midwest Regional Office, Minneapolis, MN.

Meyer, M. I. 1985. Classification of native vegetation at the Woodworth Station, North Dakota. Prairie Naturalist 17(3):167-175.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Salix exigua / Mesic Graminoids Shrubland

COMMON NAME Sandbar Willow / Mesic Graminoids Shrubland
SYNONYM Coyote Willow / Mesic Graminoids 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, INTERIOR) TEMPORARILY FLOODED SHRUBLAND ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 1
USFWS WETLAND SYSTEM PALUSTRINE

RANGE

Lacreek National Wildlife Refuge

Sandbar willow shrubland stands are usually quite small and widely scattered within the Refuge. They are usually found associated with dikes and levees.

Globally

This association is found primarily in the central Great Plains, but also parts of the Rocky Mountains and Intermountain Semi-desert regions, ranging from Wyoming west to possibly Idaho, south to Utah, and east to Oklahoma.

ENVIRONMENTAL DESCRIPTION

Lacreek National Wildlife Refuge

Sandbar willow shrubland stands occur as patches adjacent to several wetland communities. These sites are nearly level and well-supplied with near-to-surface ground water.

Globally

In Nebraska, this community is found on sandbars, islands and shorelines of stream channels and braided rivers. Soils are poorly developed and composed of sand with lesser amounts of clay, silt and gravel formed in alluvium. Drainage varies with texture and height above the river surface (Steinauer and Rolfsmeier 2000).

MOST ABUNDANT SPECIES

Lacreek National Wildlife Refuge

Stratum	Species
Shrub	*Salix exigua*
Herbaceous	*Spartina pectinata, Phragmites australis, Typha* sp.

Globally

Stratum	Species
Shrub	*Salix exigua*

CHARACTERISTIC SPECIES
Lacreek National Wildlife Refuge
Salix exigua, *Spartina pectinata*

Globally
Salix exigua

OTHER NOTABLE SPECIES
(n/a)

VEGETATION DESCRIPTION
Lacreek National Wildlife Refuge
The majority of the mature sandbar willow shrublands typically have dense cover of between 60-90%. The understory is usually relatively sparse with composition similar to the adjacent communities.

Globally
The vegetation is dominated by shrubs with a fairly dense ground layer (at least 30% cover) of mesic graminoids and forbs. In Nebraska, the vegetation is quite variable and is dominated by perennial shrubs and grasses about 1 m tall. *Salix exigua* is the common shrub. Others include saplings of *Populus deltoides* or *Salix amygdaloides, Salix eriocephala, Salix lutea*, and *Amorpha fruticosa*. Tall perennial grasses can appear to codominate the stand, with *Spartina pectinata* the dominant. Other herbaceous species include *Bidens* spp., *Eleocharis* spp., *Juncus* spp., *Lobelia siphilitica, Lycopus americanus, Lythrum alatum, Polygonum* spp., *Schoenoplectus pungens (= Scirpus pungens), Sphenopholis obtusata*, and *Xanthium strumarium* (Steinauer and Rolfsmeier 2000). Lauver et al. (1999) note that *Andropogon gerardii* can be present.

CONSERVATION RANK G5. This type is widespread and common throughout its range.

DATABASE CODE CEGL001203

SIMILAR ASSOCIATIONS
Salix exigua / Mesic Graminoids Shrubland (These two types may be essentially the same.)

COMMENTS
Lacreek National Wildlife Refuge
Sandbar willow shrubland stands are small and nearly insignificant in cover value for the park. Only a few stands were visited during the course of the study, particularly along Sage Creek and the White River near the Visitor's Center.

Globally
In Nebraska, Steinauer and Rolfsmeier (1997) report that *Amorpha fruticosa, Cornus sericea*, and *Salix lutea* are also present in the shrub layer. In the herbaceous layer they report the following species: *Ambrosia artemisiifolia* and *Aster lanceolatus.*

REFERENCES

Christy, S. 1973. An analysis of the woody vegetation on the South Platte River flood plain in northeastern Colorado. Unpublished thesis. University of Northern Colorado, Greeley. 82 pp.

Cooper, D. J., and T. R. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Unpublished report prepared for The Nature Conservancy, Colorado Field Office, Boulder. 115 pp.

Kittel, G. M. 1994. Montane vegetation in relation to elevation and geomorphology along the Cache la Poudre River, Colorado. Unpublished thesis. University of Wyoming, Laramie.

Kittel, G. M., and N. D. Lederer. 1993. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores river basins. Unpublished report prepared for Colorado Department of Health and the Environmental Protection Agency by The Nature Conservancy, Colorado Field Office, Boulder.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., R. Rondeau, and A. McMullen. 1996. A classification of the riparian vegetation of the Lower South Platte and parts of the Upper Arkansas River basins, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Prepared by Colorado Natural Heritage Program, Fort Collins. 243 pp.

Lauver, C. L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44:421-443.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1988b. Riparian community type classification of Utah. USDA Forest Service, Intermountain Region Publication R4-ECOL-88-01. Ogden, UT.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1989. Riparian community type classification of Utah and southeastern Idaho. USDA Forest Service, Intermountain Region. Report R4-ECOL-89-01. Ogden, UT. 191 pp.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska (January 2000 version). Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Salix amygdaloides Woodland

COMMON NAME Peachleaf Willow Woodland
SYNONYM Peachleaf Willow 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 SALIX AMYGDALOIDES TEMPORARILY FLOODED WOODLAND ALLIANCE
CLASSIFICATION CONFIDENCE LEVEL 1
USFWS WETLAND SYSTEM PALUSTRINE

RANGE
Lacreek National Wildlife Refuge
Wooded areas are rare and widely scattered in small stands throughout the Refuge, except for the sandhills portion.

Globally
The peachleaf willow woodland type is found in the Northern Rocky Mountains, ranging from Idaho to Montana and possibly into parts of the western Great Plains.

ENVIRONMENTAL DESCRIPTION
Lacreek National Wildlife Refuge
Many of the stands are less than 0.5 ha in size and occupy a range of mesic sites. The peachleaf willow association typically occurs as three to six trees clustered together to form a dense canopy. These clusters sometimes appear to have coalesced to form a larger stand.

Globally

MOST ABUNDANT SPECIES
Lacreek National Wildlife Refuge

Stratum	Species
CANOPY	*Salix amygdaloides*

Globally

Stratum	Species
CANOPY	*Salix amygdaloides*

CHARACTERISTIC SPECIES
Lacreek National Wildlife Refuge
Salix amygdaloides

Globally
Salix amygdaloides

VEGETATION DESCRIPTION

Lacreek National Wildlife Refuge

in close association with wetland communities dominated by prairie cordgrass, cattail, and Nebraska sedge (*Carex nebrascensis*). Total foliar cover values range from 60 to 100%. The lower values occur where canopies between the stands do not overlap. Individual trees were generally large (10-15 m tall) and mature. Understory shrubs were not common.

Globally

(n/a)

OTHER NOTEWORTHY SPECIES

(n/a)

CONSERVATION RANK G3.

DATABASE CODE CEGL000947

COMMENTS

Lacreek National Wildlife Refuge

(n/a)

Globally

(n/a)

REFERENCES

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Marriott, H. J., and D. Faber-Langendoen. 2000. The Black Hills community inventory. Volume 2: Plant community descriptions. The Nature Conservancy, Midwestern Resource Office, Minneapolis, MN. 326 pp.

Moseley, R. K., M. Manusco, and J. Hiltly. 1992. Rare plant and riparian vegetation inventory of the Boise foothills, Ada County, Idaho. Unpublished report on file IdCDC Department of Fish & Game, Boise, ID. 20 pp.

APPENDIX F: A List of Species found at Lacreek National Wildlife Refuge

Summarized by Plant Family
Nomenclature follows the PLANTS database

The following list of species includes those found during the Vegetation Mapping Project for Lacreek National Wildlife Refuge. It is not intended to be a comprehensive list of every species that occurs at LNWR. Species are presented alphabetically by family.

Family	Scientific Name	Common Name
Agavaceae	*Yucca glauca Nutt.*	small soapweed yucca
Alismataceae	*Sagittaria latifolia Willd.*	broadleaf arrowhead
Apocynaceae	*Apocynum cannabinum L.*	Indianhemp
Asclepiadaceae	*Asclepias pumila (Gray) Vail*	plains milkweed
	Asclepias speciosa Torr.	showy milkweed
Asteraceae	*Ambrosia psilostachya DC.*	Cuman ragweed
	Artemisia dracunculus L.	green sagewort
	Artemisia ludoviciana Nutt.	Louisiana sagewort
	Aster ericoides L.	heath aster
	Bidens cernua L.	nodding beggartick
	Carduus nutans L.	nodding plumeless thistle
	Cirsium arvense (L.) Scop.	Canada thistle
	Cirsium undulatum (Nutt.) Spreng.	wavyleaf thistle
	Dyssodia papposa (Vent.) A.S. Hitchc.	fetid marigold
	Eupatorium maculatum L.	spotted joepyeweed
	Helianthus annuus L.	common sunflower
	Helianthus grosseserratus Martens	sawtooth sunflower
	Heterotheca villosa (Pursh) Nutt. ex DC.	golden aster
	Lactuca serriola L.	prickly lettuce
	Liatris punctata Hook.	dotted gayfeather
	Lygodesmia juncea (Pursh) D. Don ex Hook.	rush skeletonplant
	Oligoneuron rigidum (L.) Small	rigid goldenrod
	Senecio L.	groundsel
	Solidago canadensis L.	Canada goldenrod
	Solidago gigantea Ait.	giant goldenrod
	Solidago missouriensis Nutt.	Missouri goldenrod
	Solidago mollis Bartl.	velvety goldenrod

	Sonchus arvensis L.	field sowthistle
	Tragopogon dubius Scop.	yellow salsify
Boraginaceae	*Lappula occidentalis (S.Wats) Greene*	beggar's tick
Cactaceae	*Opuntia polyacantha Haw.*	plains pricklypear
Caprifoliaceae	*Symphoricarpos occidentalis Hook.*	western snowberry
Chenopodiaceae	*Chenopodium L.*	
	Chenopodium album L.	lambsquarters
	Kochia scoparia (L.) Schrad.	common kochia
Convolvulaceae	*Convolvulus arvensis L.*	field bindweed
	Ipomoea leptophylla Torr.	bush morningglory
Cyperaceae	*Carex L.*	sedge
	Carex filifolia Nutt.	threadleaf sedge
	Carex inops Bailey	longstolon sedge
	Carex inops ssp. heliophila (Mackenzie) Crins	sun sedge
	Carex nebrascensis Dewey	Nebraska sedge
	Carex pensylvanica Lam.	Pennsylvania sedge
	Cyperus L.	flatsedge
	Eleocharis R. Br.	spikerush
	Schoenoplectus pungens (Vahl) Palla	threesquare bulrush
	Schoenoplectus acutus (Muhl. Ex Bigelow)	hardstem bulrush
Elaeagnaceae	*Elaeagnus angustifolia L.*	Russian olive
Euphorbiaceae	*Croton L.*	croton
	Chamaesyce serpyllifolia (pers.) Small	thyme-leaved Spurge
Fabaceae	*Amorpha canescens Pursh*	leadplant
	Astragalus L.	milkvetch
	Glycyrrhiza lepidota Pursh	American licorice
	Medicago sativa L.	alfalfa

	Melilotus alba Medikus	white sweetclover
	Melilotus officinalis (L.) Lam.	yellow sweetclover
	Petalostemon albidus (Torr. & Gray) Small	white prairieclover
	Petalostemon purpureus (Vent.) Rydb.	purple prairie clover
	Psoralea argophylla Pursh	silverleaf scurfpea
	Psoralea tenuiflora Pursh	wild alfalfa or scurfpea
Juncaceae	*Juncus balticus Willd.*	Baltic rush
	Juncus dudleyi Wieg.	Dudley's rush
Lamiaceae	*Lycopus americanus Muhl. ex W. Bart.*	American waterhorehound
Lamiaceae	*Mentha arvensis L.*	wild mint
Linaceae	*Linum L.*	flax
Onagraceae	*Gaura coccinea Nutt. ex Pursh*	scarlet beeblossom
	Oenothera serrulata Nutt.	yellow sundrop
Poaceae	*Agropyron Gaertn.*	wheatgrass
	Agropyron cristatum (L.) Gaertn.	crested wheatgrass
	Thinopyrum intermedium (Host) Beauv.	intermediate wheatgrass
	Andropogon gerardii Vitman	big bluestem
	Andropogon hallii Hack.	sand bluestem
	Aristida purpurea Nutt.	purple threeawn
	Bouteloua curtipendula (Michx.) Torr.	sideoats grama
	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	blue grama
	Bouteloua hirsuta Lag.	hairy grama
	Bromus inermis Leyss.	smooth brome
	Bromus japonicus Thunb. ex Murr.	Japanese brome
	Bromus tectorum L.	cheatgrass
	Calamagrostis inexpansa Gray	reed bent-grass
	Calamovilfa longifolia (Hook.) Scribn.	prairie sandreed
	Dichanthelium wilcoxianum (Vasey) Freckmann	fall panicum

	Distichlis spicata (L.) Greene	inland saltgrass
	Echinochloa crus-galli (L.) Beauv.	barnyardgrass
	Hordeum jubatum L.	foxtail barley
	Koeleria macrantha (Ledeb.) J.A. Schultes	prairie Junegrass
	Muhlenbergia Schreb.	
	Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi	alkali muhly
	Nassella viridula (Trin.) Barkworth	green needlegrass
	Panicum L.	panicum
	Panicum capillare L.	witchgrass
	Panicum virgatum L.	switchgrass
	Panicum virgatum var. cubense Griseb.	switchgrass
	Pascopyrum smithii (Rydb.) A. Love	western wheatgrass
	Phleum pratense L.	timothy
	Phragmites australis (Cav.) Trin. ex Steud.	common reed
	Poa compressa L.	Canada bluegrass
	Poa pratensis L.	Kentucky bluegrass
	Schizachyrium scoparium (Michx.) Nash	little bluestem
	Setaria viridis (L.) Beauv.	green bristlegrass
	Sorghastrum nutans (L.) Nash	yellow Indiangrass
	Sorghum halepense (L.) Pers.	Johnsongrass
	Spartina pectinata Link	prairie cordgrass
	Sporobolus airoides (Torr.) Torr.	alkali sacaton
	Sporobolus cryptandrus (Torr.) Gray	sand dropseed
	Hesperostipa comata (Trin&Rupr)Barkwirth	needle-and-thread
Polygonaceae	*Polygonum amphibium L.*	water knotweed
	Rumex crispus L.	curly dock
Rosaceae	*Prunus pumila L.*	sand cherry
	Rosa arkansana Porter	prairie rose

Salicaceae	*Populus deltoides Bartr. ex Marsh.*	eastern cottonwood
Salicaceae	*Salix amygdaloides Anderss.*	peachleaf willow
Salicaceae	*Salix exigua Nutt.*	sandbar willow
Solanaceae	*Solanum L.*	nightshade
Typhaceae	*Typha L.*	cattail
Verbenaceae	*Verbena hastata L.*	swamp verbena
	Unknown Fern	