



Vegetation Classification and Mapping Project Report, Grant-Kohrs Ranch National Historic Site

Natural Resource Report NPS/ROMN/NRR—2012/589



ON THE COVER

Ben Bobowski (former GRKO Resource Specialist) ponders the vegetation of Grant-Kohrs Ranch National Historic Site
Photograph by: B. Schweiger, NPS ROMN.

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List of Abbreviations and Acronyms

AA	Accuracy Assessment
BIA	Bureau of Indian Affairs
CBI	Center for Biological Informatics (of the USGS/BRD)
CEGL	Community Element Code
cm	Centimeter(s)
DEM	Digital Elevation Model
EPMT	Exotic Plant Management Team
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
Ft.	Foot/Ft
GIS	Geographic Information System
GPS	Global Positioning System
GRKO	Grant Kohrs Ranch National Historic Site
ha	Hectare(s)
in	Inch(es)
IPM	Integrated Pest Management
I&M	Inventory and Monitoring Program
ITIS	Integrated Taxonomic Information System
LIBI	Little Bighorn Battlefield National Monument
m	Meter(s)
MMU	Minimum mapping unit
NAD	North American Datum
NAIP	National Agricultural Imagery Program
NHS	National Historic Site
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NS	NatureServe
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
PI	Principal Investigator
ROMN	Rocky Mountain I&M Network
TNC	The Nature Conservancy
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USNVC	United States National Vegetation Classification
UTM	Universal Transverse Mercator
VMP	Vegetation Mapping Program
WRCC	Western Region Climate Center
WSAL	Wildlife Spatial Analysis Lab, University of Montana

Executive Summary

The vegetation mapping effort at Grant-Kohrs Ranch National Historic Site (GRKO) is part of the National Park Service Inventory and Monitoring program and provides core or ‘baseline’ information that park managers need to effectively manage and protect park resources. This vegetation inventory was conducted in accordance with specified protocols and quality assurance standards. Data obtained through this inventory are compatible with other efforts, allowing for synthesis and analysis at broader levels. These data comply with standards and protocols of the USGS-NPS Vegetation Mapping Program.

To effectively classify and map the wide range of vegetation within the mapping boundary required a multi-year approach and consisted of several linked phases: (1) vegetation classification using the U.S. National Vegetation Classification applied to field data collected by this project, (2) digital vegetation map production, (3) map accuracy assessment, and (4) revision of vegetation map and production of final products. The project was a cooperative effort between researchers from the University of Montana and National Park Service staff. Constant communication and coordinated efforts between these parties allowed for consistency in both accuracy and classification.

The Grant-Kohrs Ranch National Historic Site is a working ranch commemorating the western open-range cattle industry that peaked in the 1890’s. The Ranch is located in a broad Rocky Mountain valley in west central Montana. The terrain consists of dry upland benches and the floodplain of the Clark Fork River. There are corrals, barns, and other ranch operation structures, as well as the original ranch house. The Ranch administrative boundary includes approximately 1,618 acres. The Vegetation Mapping project focused on 1599 acres of ranch holdings.

A preliminary list of potential vegetation types was developed from previous descriptive vegetation inventory work in the area. Spectral analysis of aerial imagery from the National Agricultural Imagery Program was used in combination with soils data to delineate the boundaries of map unit polygons with apparently similar vegetation. Because of the small total area of the park and limited number of polygons it was decided to census every polygon as to community type rather than sample a subset of polygons and conduct a supervised classification. Map unit polygons were censused by field crews in 2006; crew members assigned each polygon to a vegetation or landcover type from the preliminary list. Accuracy assessment field work in 2007 collected data at 283 sample points which were used to assess the validity of the initial map assignments.

The initial vegetation mapping recognized 40 plant community types and an additional 4 landcover types, but was estimated to have an overall accuracy of less than 29%. This low initial rate was attributed to reduced repeatability from the fine scale of both the original community types as well as the very small map unit polygons enabled by the mapping methodology. Furthermore, the complexity and prevalence of cultural vegetation types at GRKO required that the revision of types consider park management requirements as more important in some cases than mapping program standards. Consequently, the original types were aggregated into 29 final map classes representing 22 USNVC plant associations, 3 park-specific vegetation types, and 4 landcover classes. This consolidation resulted in a 62.5% accuracy rate (90% confidence interval 57.6% to 67.5%), Map classes were also assigned to five Ecological Systems and one equivalent-

level group; this level of grouping represents the GRKO vegetation with an overall map accuracy of 84.1% (90% confidence interval 80.3% to 87.9%).

The uplands within GRKO are primarily vegetated by bunchgrass types in the blue bunch wheat grass (*Pseudoroegneria spicata*) Herbaceous Alliance, with needle and thread – blue grama – threadleaf sedge (*Hesperostipa comata* - *Bouteloua gracilis* - *Carex filifolia*) Herbaceous Vegetation in more exposed sites with rocky soil. Two semi-natural seeded grassland types are also present. Overall, the Grant-Kohrs uplands consist of relatively intact native bunchgrass vegetation, particularly in contrast to many areas of the West that have been under livestock grazing pressure for over a century. Internal GRKO records suggest that fall grazing in the uplands may have resulted in a more intact system.

Around 60% of the mapped acreage at GRKO consisted of introduced grass pastures and hayfields that are flood, sprinkler, or sub-irrigated. These hayfields are characterized by introduced pasture grasses including smooth brome (*Bromus inermis*), timothy (*Phleum pratense*), quackgrass (*Elymus repens*), Kentucky bluegrass (*Poa pratensis*), meadow fescue (*Festuca pratensis*), and redtop (*Agrostis stolonifera*). Many areas of these fields have been seeded with two or more of these grass species. Dominance of species is strongly influenced by annual variation in the amount, timing, and spatial distribution of irrigation and subsurface flow, with the result that the hayfield community composition is also variable from year to year.

The Clark Fork riparian floodplain and small east side creeks provide the most complex environment at the Ranch, and nineteen riparian vegetation types were utilized for the final classification. The floodplain has a long history of disturbance that forms part of the central historic narrative of the Ranch, however, stands of these types often retain a substantial component of native species even though they are altered from pre-settlement conditions.

Products developed for the Grant-Kohrs Ranch National Historic Site Vegetation Classification and Mapping Project described and presented in this report and stored on the accompanying DVD include:

- A Final Report that includes a vegetation key, and accuracy assessment information.
- A Geodatabase containing digital vegetation map, plots, and accuracy assessment layers.
- Field key for association identification and a list of associations present in the mapping area.
- Federal Geographic Data Committee-compliant metadata for all spatial database coverages and field data.

In addition, the NPS and the USGS Center for Biological Informatics (CBI) both received copies of:

- Digital data files and hard copy data sheets of the observation points, vegetation field plots, and accuracy assessment sites.

- Hardcopy, paper vegetation maps.

The DVD accompanying this report contains appendices, metadata files, keys, lists, field data, geospatial data, the vegetation map, graphics, and ground photos. The final products will be available on the USGS website: <http://biology.usgs.gov/npsveg/index.html>

Acknowledgments

A project of this size and complexity necessarily required the enthusiasm and energy of many people over several years. The dedication of all involved helped to produce a product that we, the authors, gratefully acknowledge. The combination of ecologists, geographers, botanists and natural resource professionals in all the cooperating agencies and organizations allowed for a successful work environment that enhanced the final set of products.

We would specifically like to thank the following people for their efforts: Ben Bobowski and Jason Smith, for their support, input and field contributions throughout the project and for their patience as we completed the final products. Karl Brown and Tammy Cook provided guidance and advice on vegetation mapping and the NPS Vegetation Inventory Program. Finally, T. Robison and M. Trujillo from the Tehabi Intern program from Utah State University assisted with the accuracy assessment.

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Introduction

Effective management of natural resources in our national parks depends on park managers having access to comprehensive, scientifically credible information on species and habitats found in their parks. Accurate and up-to-date vegetation maps can form the foundation for resource management activities in the national parks and are recognized by the National Park Service (NPS) Inventory & Monitoring Program as one of twelve basic data sets for every park with significant natural resources (Fancy et al. 2009). Activities as diverse as park planning, fire management, wildlife research, habitat conservation/restoration, and visitor interpretation all can be informed by current maps of vegetation distribution. Additionally, a vegetation map attributed to a standard, nationally used classification system provides a way to assess how an individual park's biodiversity fits into the context of the entire region. Finally, the associated information provide a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental processes across the landscape.

This report presents the final products from a five year effort to classify and map the vegetation at Grant-Kohrs Ranch National Historic Site (GRKO) in west-central Montana. Project methods, results, and products are documented in this report. This introductory section describes the USGS-NPS Vegetation Mapping Program, as well as the GRKO mapping project area. Later sections document the methods and results for each of the major steps in the project: scoping, vegetation classification and description, vegetation mapping, and map accuracy assessment.

The project was conducted by the NPS Rocky Mountain Network (ROMN), the University of Montana, GRKO park staff, and personnel from the USGS-NPS Vegetation Characterization Program. This report includes the final map (also available separately in a larger format). A project DVD that contains all products, including a geodatabase with the final data is included in select copies of this report. All materials will be available on the USGS-NPS Vegetation Characterization Program website (<http://biology.usgs.gov/npsveg/index.html>) and from the Rocky Mountain Network upon request.

The USGS-NPS Vegetation Mapping Program

Vegetation classification for National Park Service Vegetation Mapping Program (NPS-VMP) projects follows the National Vegetation Classification Standards, as maintained by the Federal Geographic Data Committee (FGDC). The FGDC maintains definitions of vegetation types to the hierarchical level of Formation. Units comprising the finer (floristic) levels, alliances and associations, are not currently recognized by FGDC. NatureServe (NatureServe 2007) maintains a provisional list of alliances and associations. The NPS-VMP uses this list for defining alliances and associations, to the extent practicable.

The National Vegetation Classification Standard

The USGS-NPS Vegetation Mapping Program adopted the U.S. National Vegetation Classification (USNVC or NVC, TNC and ESRI 1994a, Grossman et al. 1998) as a basis for the *a priori* definition of vegetation units to be inventoried. The use of standard national vegetation classification and mapping protocols (TNC and ESRI 1994b) facilitate effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies.

The USNVC has the following key attributes:

- It is based upon current vegetation;
- It uses a systematic approach to classify vegetation communities across environmental continuums;
- It emphasizes natural and existing vegetation;
- It uses a combined physiognomic-floristic hierarchy;
- It identifies vegetation units based on both qualitative and quantitative data;
- It is appropriate for mapping at multiple scales.

In 1997, the Federal Geographic Data Committee (FGDC) adopted a modified version of the upper (physiognomic) levels of the USNVC as a federal standard (FGDC-STD-005, FGDC 1997). This standard is hereafter termed the National Vegetation Classification Standard (NVCS)¹. The NVCS established a federal standard for a complete taxonomic treatment of vegetation in the United States at physiognomic levels (Table 1). It also established conceptual taxonomic levels for the floristic units of alliance and association, largely following the USNVC, but did not offer a taxonomic treatment for the floristic levels because of the immense scope of establishing robust floristic units for the entire United States. The FGDC standard requires that federally funded vegetation classification efforts collect data in a manner that enables crosswalking the data to the NVCS (i.e., the physiognomic levels) and sharing between agencies, but does not require use of that standard by agencies for internal mission needs. A 2008 NVCS revision (Version 2; FGDC 2008) was adopted by the FGDC in February 2008. However, the substantial revisions to the upper levels of the USNVC hierarchy accepted by the FGDC Vegetation Subcommittee (2008) are not used in this project. This has no practical impact on the content of the map or the classification of the vegetation in the park as presented in this report. It does mean that there may be some upper levels of a more current classification system that might not perfectly cross walk to those used in this report. Any future updates should include a more current USNVC hierarchy.

NatureServe maintains a treatment of floristic units (alliances and associations), which, though not a federal standard, are used as classification and mapping units by the VMP whenever feasible. This database is available online through NatureServe Explorer which provides public access to regularly updated versions of the USNVC plant community listings and descriptions. NatureServe's documentation of alliances and associations is the most accessible national listing currently available. However, the plant communities within the USNVC are not complete. Projects such as at GRKO constantly add to the documentation and listing of USNVC types. It is important to note that NatureServe follows Kartesz (1999) as its primary nomenclatural authority. As a result, nomenclature used in final map unit names also follows Kartesz (1999),

¹ The VMP program standards refer to the National Vegetation Classification System (also NVCS). Because of nomenclatural and acronym confusion with the federal (FGDC) National Vegetation Classification Standard, this term is no longer used by the VMP.

whereas species names in the text are those used by GRKO staff, generally according to Dorn (1984).

Table 1. The 1997 U.S. National Vegetation Classification physiognomic-floristic hierarchy for terrestrial vegetation (FGDC 1997; Grossman et al. 1998). Examples are taken from Grant-Kohrs Ranch National Historic Site.

Level	Primary Basis for Classification	Example
Class	Growth form and structure of vegetation	Herbaceous Vegetation
Subclass	Growth form characteristics, e.g., leaf phenology	Perennial graminoid vegetation
Group	Leaf types, corresponding to climate	Temperate or subpolar grassland with a sparse shrub layer
Formation	Additional physiognomic and environmental factors	Medium-tall bunch temperate or subpolar grassland
Alliance	Dominant/diagnostic species of the uppermost or dominant stratum	<i>Pseudoroegneria spicata</i> Herbaceous Alliance
Association (Plant Association)	Additional dominant/diagnostic species from any stratum	<i>Pseudoroegneria spicata</i> - <i>Pascopyrum smithii</i> Herbaceous Vegetation

For purposes of this document, the federal standard (FGDC 1997) is denoted as the National Vegetation Classification Standard (NVCS); the U.S. National Vegetation Classification (USNVC or NVC) will refer exclusively to NatureServe's treatment for vegetation floristic units (alliances and associations only). Alliances and associations are based on both the dominant (greatest canopy cover) species in the upper strata of a stand as well as on diagnostic species (those consistently found in some types but not others). Associations are the most specific classification unit and are hierarchically subsumed in the alliances. Each association is included in only one alliance, while each alliance typically includes many associations. Alliance names are generally based on the dominant/diagnostic species in the uppermost stratum of the vegetation, though up to four species may be used if necessary to define the type. Associations define a distinct plant composition which repeats across the landscape and are generally named using both the dominant species in the uppermost stratum of the vegetation and one or more dominant species in lower strata, or a diagnostic species in any stratum. The species nomenclature for all alliances and associations follows that of Kartesz (1999). Documentation from NatureServe (2007) describes the naming and syntax for all USNVC names:

- A hyphen ("-") separates names of species occurring in the same stratum.
- A slash ("/") separates names of species occurring in different strata.
- Species that occur in the uppermost stratum are listed first, followed successively by those in lower strata.
- Order of species names generally reflects decreasing levels of dominance, constancy, or indicator value.

- Parentheses around a species name indicates the species is less consistently found either in all associations of an alliance, or in all occurrences of an association.
- Association names include the dominant species of the significant strata, followed by the class in which they are classified (e.g., "Forest," "Woodland," or "Herbaceous Vegetation").
- Alliance names also include the class in which they are classified (e.g., "Forest," "Woodland," "Herbaceous"), but are followed by the word "Alliance" to distinguish them from associations.

In addition to the USNVC, NatureServe has created a standardized Terrestrial Ecological Systems Classification for describing sites based on both the vegetation and the ecological processes that drive them. Ecological systems are mid-scale biological communities that occur in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding (Comer et al. 2003). They are not conceptually a unit within the USNVC and do not have a place in the USNVC hierarchy, although they are similar in scale to the NVCS Version 2 Group Level. Because the ecological system concept has proved useful in work done by the ROMN across all network parks, we choose to include them at GRKO. Each ecological system is directly linked to USNVC by a list of core associations that occur within it. Unlike within the structure of the hierarchical USNVC where each association occurs in only one alliance, an association may occur in more than one ecological system, limited only by the range of ecological settings in which it is found. Ecological systems are much larger in scale than the map classes used at LIBI; they are broader in concept and include specific associations that might be found in a particular setting.

Standards

The NPS I&M Program established guidance and standards for all vegetation mapping projects in a series of documents. Specific projects may vary from these standards as noted. These documents are available on the USGS-NPS Vegetation Program web site (<http://biology.usgs.gov/npsveg/standards.html>):

Protocols

- National Vegetation Classification System (TNC and ESRI 1994a, NatureServe 2003)
- Field methods and mapping procedures (TNC and ESRI 1994b)
- Statistically rigorous and consistent accuracy assessment procedures (ESRI et al. 1994)
- Guidelines for using existing vegetation data (TNC 1996)

Standards

- National Vegetation Classification Standard (FGDC 1997)
- Spatial Data Transfer Standard (FGDC 1998b)
- Content Standard for Digital Geospatial Metadata (FGDC 1998a)
- United States National Map Accuracy Standards (USGS 1999)

- Integrated Taxonomic Information System (ITIS)
- Program-defined standards for map attribute accuracy and minimum mapping unit

In addition to vegetation classification, the FGDC sets standards for map spatial accuracy and for metadata employed in NPS vegetation mapping projects. Standards for map products stipulate map scales of 1:24,000 or finer, and minimum polygon size of 0.5 ha (1.24 acres). Positional accuracy for vegetation maps must meet National Map Accuracy Standards, which specify horizontal errors of less than 10.2 m (33.5 ft.) on the ground for 1:12,000-scale maps.

All digital vegetation products resulting from this project are accompanied by FGDC-compliant metadata. Metadata are “data about the data,” and describe the content, quality, condition, and other characteristics of the spatial dataset. Metadata are critical elements that expedite the interpretation and exchange of information among users.

Project Area Description

Setting and Location

The Grant-Kohrs Ranch National Historic Site is a working cattle ranch that commemorates the open range cattle king era from 1860 through 1890, and the subsequent evolution of the western cattle industry through the first half of the 20th century. Ongoing cattle operations, periodic demonstrations of cowboy life, and Ranger-guided and self-guided tours of the historic structures allow visitors to understand and appreciate this major aspect of the history of the American West.

Grant-Kohrs is on the immediate outskirts of the small rural town of Deer Lodge in west central Montana. Missoula (79 miles to the northwest) and Butte (37 miles to the southeast along Interstate 90) are the two nearest cities (Figure 1). GRKO encompasses 1,618 acres within its administrative boundary. The Ranch landscape is characterized by three major topographic vegetation settings: dry upland benches with native bunchgrasses; irrigated and sub-irrigated hayfields with improved forage grasses; and a shallow groundwater floodplain dominated by tall riparian shrubs in the well-drained areas and small wetland communities where the water table remains high throughout much of the year. The meandering Clark Fork River is a prominent feature of the floodplain portion of GRKO. The Clark Fork River generally divides GRKO in half, with all the domestic buildings and buildings associated with cattle ranching operations located to its east.

Settlement History and Land Use

GRKO illustrates the history of cattle ranching in western Montana beginning in the mid-1800s. The original ranch was founded in 1860 by pioneer stockgrower John Grant. In 1866, cattle baron Conrad Kohrs purchased the Grant home and 365 head of cattle. In partnership with his younger half-brother John Bielenberg he continued to graze cattle in this valley while expanding to other ranges in eastern Montana, Wyoming, Colorado, and Canada. After Bielenberg's death in 1922 the home ranch was managed as a component of the Kohrs Trust until Conrad Kohrs Warren purchased the ranch, the house, and its contents from the Trust in 1940. The ranch was designated a National Historic Landmark in 1960, and was acquired by the National Park Service on August 25, 1972. Congress authorized the establishment to:

"...provide an understanding of the frontier cattle era of the Nation's history, to preserve the Grant-Kohrs Ranch, and to interpret the nationally significant values thereof for the benefit and inspiration of present and future generations."

Current land-use activities in GRKO are related to ranching activities and visitation, which peaks in July and August, with an annual average of about 19,300 visitors during the past five years (NPS 2012). Over 80 historic ranching structures are maintained, including the primary ranch house with 19th century furnishing from American and European manufacturers, cowboy bunkhouses, horse barns, a dairy, workshops, and corrals. There is a vehicle bridge near the center of the Ranch that crosses the Clark Fork Rivers and various points where the irrigation canals can be crossed on foot. The principal landscape components are a shrub dominated riparian floodplain, irrigated pastures and hayfields with introduced grasses, and native bunchgrass terraces that rise above the floodplain and the intensively managed fields.

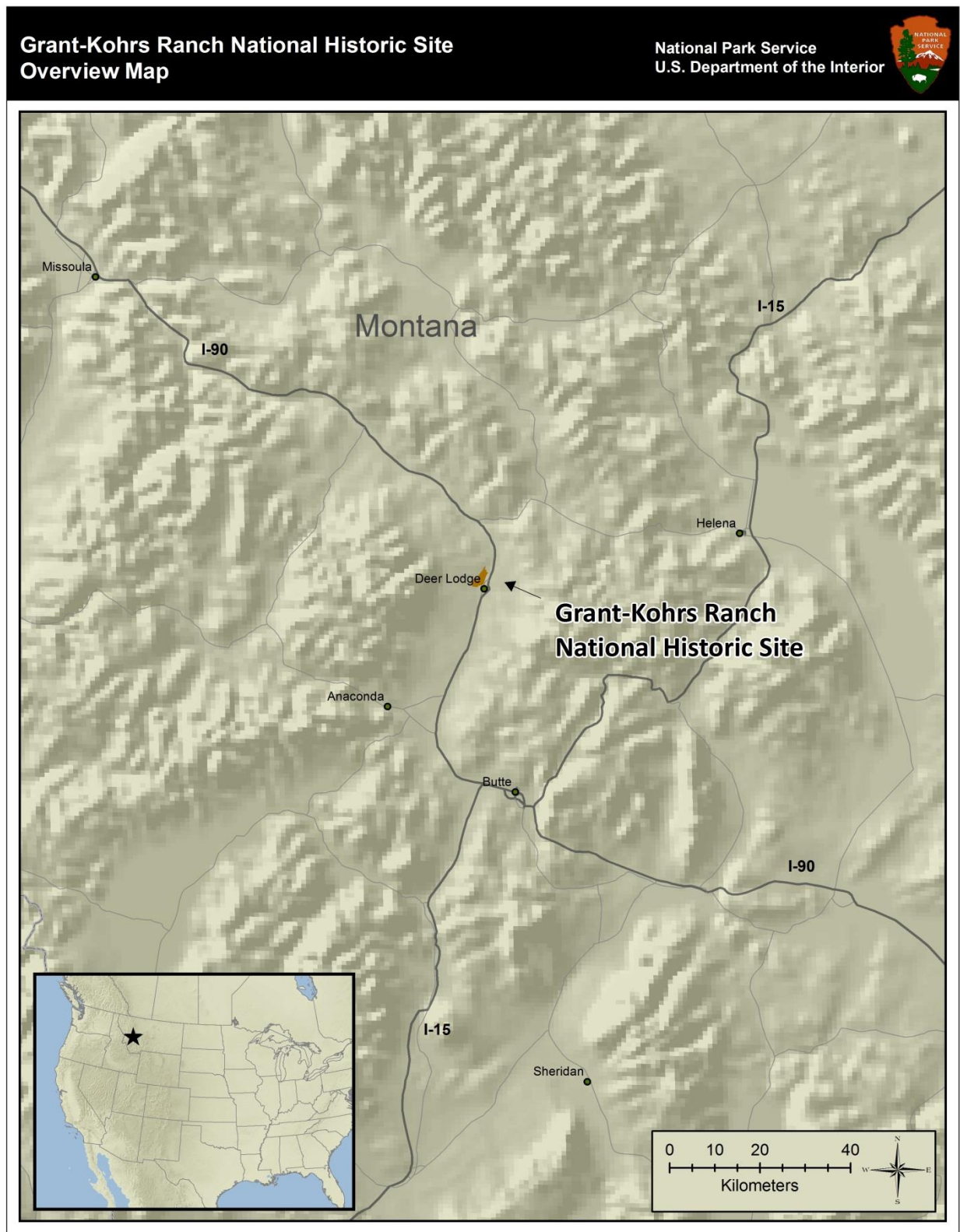


Figure 1. Location of Grant-Kohrs Ranch National Historic Site.



Figure 2. Grant-Kohrs Ranch National Historic Site viewshed (oblique, looking north). Scene is from Google Earth on early fall, 2010 imagery. Note the boundary shown is an unofficial ‘fence line’ boundary used for the Vegetation Mapping project.

GRKO obtains drinking water from several wells in the park. Wastewater is handled by the Deer Lodge wastewater treatment facility which is located just inside the northern park boundary. Since 2000, the ranch has used secondary treated sewage effluent from the wastewater treatment facility to irrigate some of its hayfields during summer months. For example, in June, July, and August of 2000 and 2001, 0.48 km² of park land were irrigated with 310 million and 650 million liters of effluent, respectively (Johnson 2002). This arrangement is part of the Clark Fork River Voluntary Nutrient Reduction Program, which was developed by stakeholders to reduce nutrient pollution in the upper and middle reaches of the Clark Fork River (Tri-state Water Quality Council 1998). In 2000, the NPS funded a study to determine the fate of sewage effluent nutrients (primarily nitrogen) applied to soils in GRKO by a sprinkler irrigation system (Johnson 2002). The study determined that most of the applied nitrogen was retained by plants and in the soil but that as much as 40 percent of the nitrogen might be leached to the shallow ground-water system that may drain into the Clark Fork.

Clark Fork Superfund Project

GRKO is within the Clark Fork River Superfund Site, which is contaminated with arsenic and heavy metals (copper, cadmium, lead, and zinc) related to historic mining, milling, and smelting activities in the headwaters of the Clark Fork River (Figure 3). Tailings from these operations were transported downstream and deposited along the floodplain of the Clark Fork River by at least six major floods in the late 1800s and early 1900s (Smith et al. 1998). Sedimentation ponds were later built to prevent movement of tailings from headwater areas; however, the river continues to be contaminated by erosion of previously deposited tailings and by direct leaching of metals from tailings into surface and ground water. Copper is the primary metal of concern because it is the most toxic to aquatic life and plants in the river floodplain.

In April of 2004, a Record of Decision was issued by the US EPA for the remediation of contaminated areas within Reach A of the Clark Fork River, which includes GRKO. The remediation will include removal of tailing deposits greater than 37 m² (400 ft²) in area and 60 cm (2 ft.) in depth, followed by revegetation of the excavated area. Smaller tailing deposits (generally what are found in GRKO) and impacted soil and vegetation will be remediated in situ using lime addition, soil mixing, and revegetation (U.S. EPA 2004). Additional details about this project are available at the Clark Fork River Operable Unit websites maintained by the [U.S. EPA](#) and the [Montana Department of Environmental Quality](#).

In 2010, the Montana Department of Justice through the Natural Resource Damage Program published a comprehensive long term monitoring plan for monitoring and reporting the environmental effectiveness of remedial actions implemented within the Clark Fork River Operable Unit of the Milltown Reservoir/Clark Fork River Superfund Site (PBS&J 2010). The monitoring plan describes the requirements for: 1) annual monitoring to ensure that remediation and restoration are meeting established performance standards, and 2) long-term monitoring to demonstrate that the remedies are achieving remedial goals over time, as set forth in the Clark Fork Operable Unit Record of Decision (U.S. EPA 2004) and in the Monitoring and Maintenance Plan for the Clark Fork Operable Unit (Montana Department of Environmental Quality 2008).

These metal contaminated sediments have significantly altered the community composition of the floodplain vegetation ((Rice 2002; Rice and Hardin 2002a). Surface-exposed tailings deposits lacking vegetation are called “slickens”. Bank erosion and point bar formation are periodically redistributing the contaminated sediments in the floodplain. The GRKO Vegetation Map likely provides useful data that may assist the park in its interaction with the restoration of the river corridor. However, the scale of the mapping is such that more detailed site level surveys should be used for specific locations of disturbance and/or restoration activities.



Figure 3. Clark Fork Operable Unit. Grant-Kohrs Ranch National Historic Site is located next to the town of Deer Lodge. Map from US EPA (2004).

Biogeography

GRKO lies in the heart of the Northern Rocky Mountain Biogeophysical Province, which extends northwestward from the Yellowstone Plateau to Canada, encompassing the western third of Montana as well as much of northern and central Idaho and the northeastern most part of Washington. Situated on the Clark Fork River, GRKO belongs to the Columbia River drainage; the continental divide 20 km to the southeast separates GRKO from the headwater tributaries of the Missouri River on the eastern side of the divide. The Northern Rocky Mountain province as a whole is characterized by high mountainous terrain shaped by glaciation and basins at lower elevations (Bailey 2001). In the vicinity of GRKO, broad valley floors at elevations of 4,500 to 6,000 ft. separate mountain ranges whose highest ridges extend to over 8,000 ft. Mountainous areas are dominated by forests of Lodgepole pine (*Pinus contorta*) and Engelmann spruce (*Picea engelmannii*) with small patches of western larch (*Larix occidentalis*), while grasslands comprised of bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), and rough fescue (*F. campestris*) are the primary native vegetation of basins and valley floors (Bailey 2001).

Topography, Geology and Soils

The high-elevation 300 square mile Clark Fork valley is broad and wide with a long south to north axis. GRKO is centered on the north flowing Clark Fork River. Topographic relief on the actual Ranch holdings encompasses about 165 feet. The Clark Fork River, which bisects the Ranch flowing south to north, is at 4,485 feet. Rising slightly above the floodplain, but still on the valley floor, about a half mile the east of the river the boundary elevation for the Ranch is at 4,520 feet. Upland benches are at an elevation of about 4,650 feet about a third of a mile to the west of the river. The Flint Creek Range on the west side of the north to south valley has peaks ranging from 8,000 to 10,400 feet. These often snow-capped mountains provide a spectacular backdrop from the valley floor.

The vicinity of GRKO contains metamorphic, sedimentary, and igneous rocks of Precambrian to Tertiary age as well as recent alluvial and glacial deposits (Thornberry-Ehrlich 2007; Figure 4). The valley floor at the Ranch consists of unconsolidated Tertiary fill. The upland benches on the west side of the Ranch are formed from Quaternary fill material. Precambrian rocks underlie the valley fill at the Ranch. Metal mining and smelting upriver of Grant-Kohrs Ranch resulted in large quantities of toxic tailings and wastes being dumped adjacent to and in the upper tributaries of the Clark Fork River.

The soils at Grant-Kohrs (Figure 5) are formed from alluvial or glacial outwash deposits typical of alluvial fans and stream terraces. Soil types adjacent to the Clark Fork River are mostly deep loams of the Anaconda series and are often coarse because of pebbles. The lower bench soils east of the river are of the Beaverell series. Beaverell loams have even higher pebble content. They are generally deep and well drained with a gravelly loam surface and a clay loam to sandy clay loam substratum. Most of the irrigated hayfield/bottomland and lower elevation land west of the Clark Fork are Tetonview series soils. These fine textured loams are formed from calcareous alluvium. They are deep but poorly drained, with a coarse pebble fraction found only at the lowest parts of the B horizon. The higher west side upland benches have shallow less developed soil.

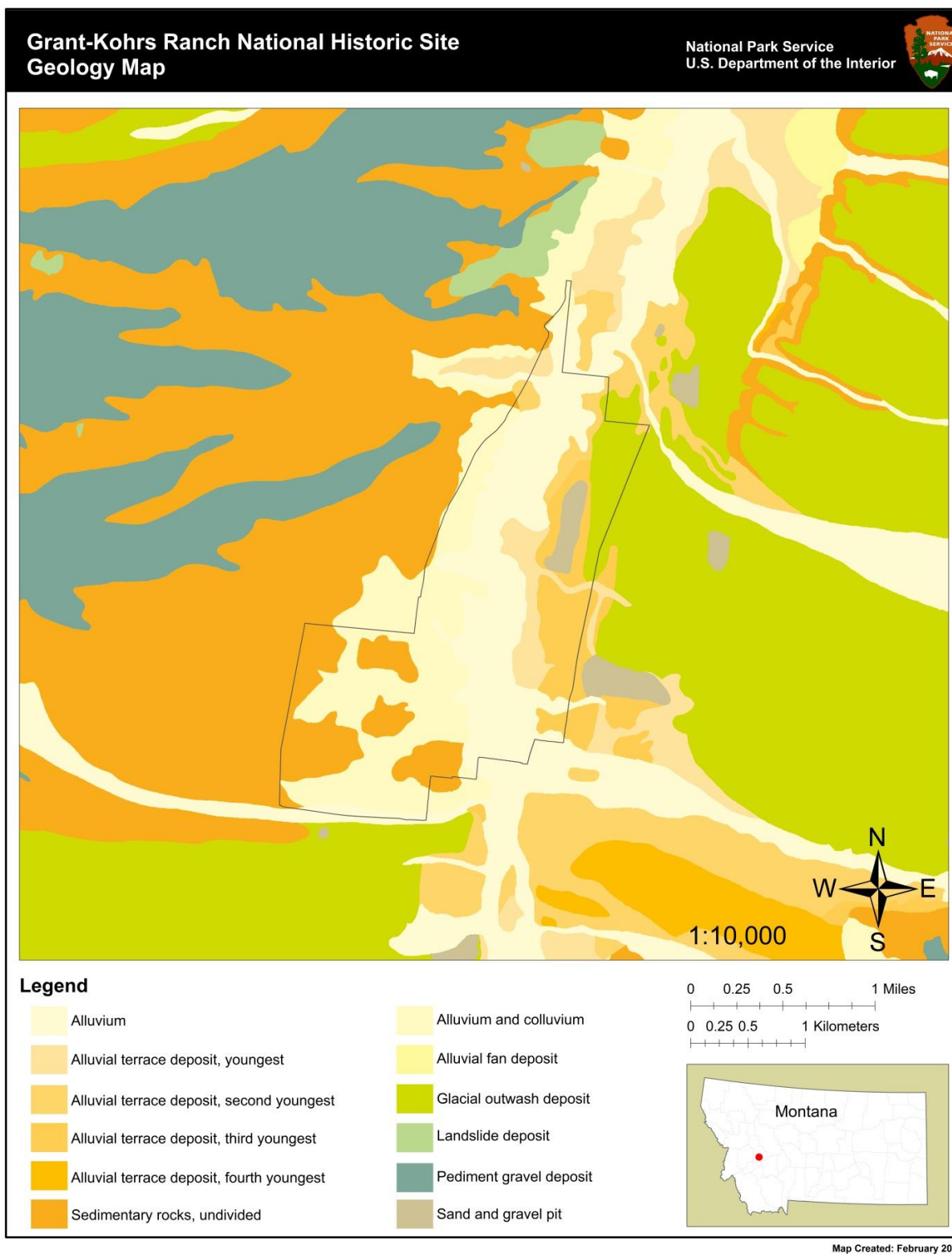


Figure 4. Surficial geology at Grant-Kohrs Ranch National Historic Site. Data are from Thornberry-Ehrlich (2007). Note the boundary shown is an unofficial 'fence line' boundary used for the Vegetation Mapping project.

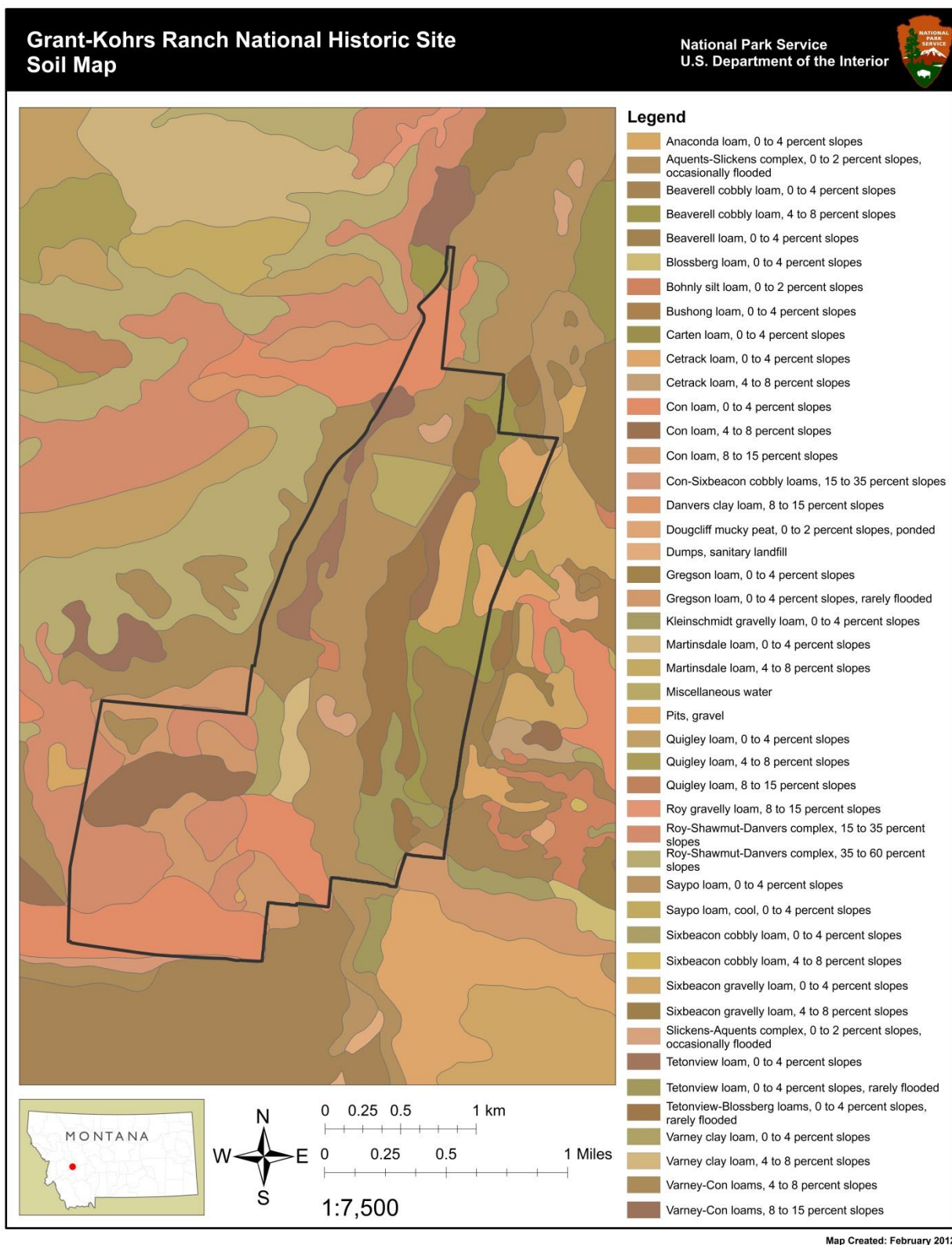


Figure 5. Soils at Grant-Kohrs Ranch National Historic Site. Data are from USDA-NRCS (2003). Note the boundary shown is an unofficial 'fence line' boundary used for the Vegetation Mapping project.

Climate

The location of Deer Lodge Valley close to the continental divide gives it a cold and dry continental climate (Figure 6). At an elevation of 4,530 feet the annual average high temperature is 55.9° F and the annual average low temperature is 28.1° F. The average July high is 82.0° F and the average January low is 10.1° F. Deer Lodge receives only 10.6 inches of precipitation a year. May and June are the wettest months but these two spring month of precipitation tally an average only 3.8 inches.

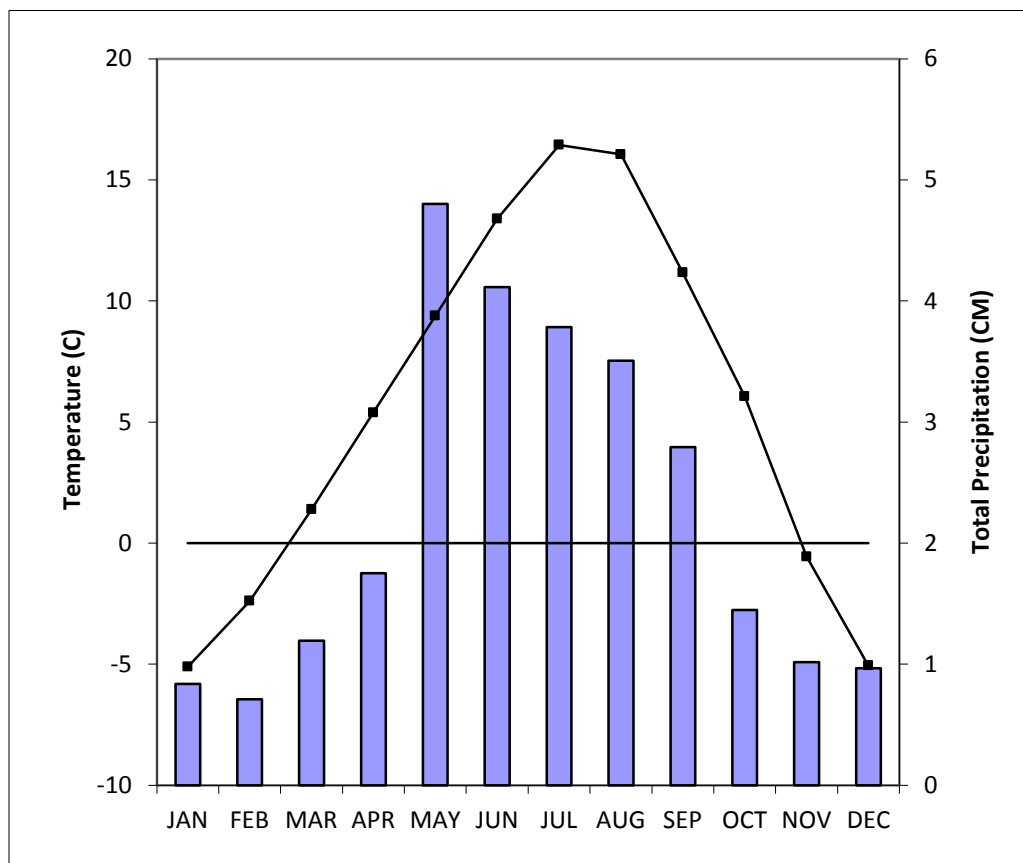


Figure 6. Monthly mean precipitation (bars) and temperature (line) over 1971-2000 at Deer Lodge. Data are from Deer Lodge (WRCC 2011).

Hydrology and Water Resources

GRKO is situated along a 5.5 km reach of the 7th order Clark Fork River, just downstream of the town of Deer Lodge between Cottonwood Creek and Fred Burr Creek (Figure 1 and Figure 2). The Clark Fork River begins at the confluence of Silver Bow Creek and Warm Springs Creek and flows northward through the broad and meandering floodplain of the Deer Lodge Valley with an average gradient of 3.8 m/km. From its headwaters, the Clark Fork flows north for approximately 43 river miles past the towns of Galen, Deer Lodge, and Garrison. The river then runs northwest for 77 river miles to the confluence with Blackfoot River near Bonner. The river has four west-side perennial tributaries which flow from the Flint Creek Range and several small east-side tributaries, which only flow during spring snowmelt. During the summer months, water in the Clark Fork River and its west-side tributary streams is diverted for irrigation (Smith 1998), some of which returns to the river channel as surface- or ground-water return flow. The Clark

Fork River generally divides GRKO in half, with all the domestic buildings and buildings associated with cattle ranching operations located to its east. The land on the west side of the river consists of pastures and hayfields; the bench land along the western edge of the ranch is very prominent in this area. Wetlands, ponds, marshes, sloughs and oxbows are common along the floodplain. The water table along the Clark Fork River is high and the continuous operation of the Kohrs-Manning Ditch has helped to maintain the wetlands. Despite the contamination that usually resides within the underlying soils, the wetlands have proven to be biologically robust (U.S. EPA 2004). GRKO's largest wetland is situated in the northern portion of the unit in a former Milwaukee Railroad gravel borrow excavation (NPS 1986; Rice and Hardin 2002a).

The Clark Fork River is a key lifeline of the Deer Lodge Valley. It is an important source of water for irrigation in the valley. It is also a key source of recreation, including fishing and rafting. The Clark Fork River played an important role in the western ranch lifestyle that the Grant-Kohrs National Historic Site commemorates as part of a living museum. There are six small tributary creeks and nine natural springs located on the Ranch that feed into the Clark Fork River. This natural abundance of fresh water, coupled with ideal topography and deep soils, provided the Grant, Kohrs, and Warren families the natural resources needed to support their domestic and ranching activities for over 150 years.

Vegetation

A History of Disturbance

The vegetation of the GRKO landscape presents a representative portrait of historical disturbances characteristic of the western U.S., both natural and anthropogenic. John Milner Associates, Inc. (2004) prepared an extensive analysis of the cultural landscape history at GRKO, which is briefly summarized below.

Prior to settlement, visitors to the bottomlands of the Clark Fork reported a valley vegetated with abundant native grasses and riparian trees and shrubs along drainages, supporting large numbers of deer, pronghorn, and elk. Early ranching gradually replaced native grazers with herds of cattle, still sustained by native grasses. However, the eventual conversion of bottomlands to irrigated agriculture began with the establishment of the Grant Ranch and a small cultivation of oats and garden vegetables. During the 1870s the expansion of grain cropping and especially haying in the bottomland meadows brought additional acreage into production and altered or removed native plant communities. Ranchers then, as now, are concerned with their ability to provide sufficient year-round forage for their herds. Although records are incomplete, it is likely that the introduction of European pasture grasses was a response to harsh winters and drought during the 1890s to late 1930s. By the late 1930s some 900 acres were under cultivation, while the remainder was kept as native range land. The requirements of ranch livestock led to the ever increasing production of irrigated hay (Figure 7).

Irrigation ditches were a necessary component of agricultural development from the early ranching days. Although beaver were largely exterminated prior to the commencement of ranching operations, their presence continued to conflict with irrigation operations, and their modifications of riparian ecosystems were eliminated as much as possible. Much of the bottomland was eventually plowed, graded, fertilized, and reworked over a period of decades, with the result that soils were redistributed, native meadow grasses eliminated, and original

hydrology highly modified. As pasture improvements, however, the efforts were generally quite successful, and the ranch prospered as a working cattle operation.

Flooding has brought both natural disturbance and a legacy of mining contamination to GRKO. Heavy metal waste discharge has left a legacy of contaminated, unvegetated areas within the floodplain. Occasional flooding disturbance continues to affect both NHS operations and the vegetation of the meadows.



Photo source: Grant Kohrs Ranch NHS Archives

Figure 7. Haying operations, circa 1937

Under drought conditions, disturbed areas were easily colonized by weed species. Early control efforts were limited to burning to clear irrigation ditches, and planting turf grass around the Ranch House. Beginning in the 1950s, periodic spraying of herbicide was done to treat ranch lands for problem species. In 1985, the NHS began to address the presence of knapweed and leafy spurge, especially along the riverine floodplain and the railroad rights of way.

Since its acquisition by the NPS, the GRKO landscape has undergone extensive stabilization and restoration to enhance and maintain the capacity of the NHS to function as a working cattle ranch, while protecting and restoring native vegetation wherever feasible. Native grasses and willows are used in restoration of riparian disturbances, and grazing patterns controlled by fencing. Most native plant species that were historically present are still represented on the NHS. However, overall species composition has been altered by cultivation, irrigation, and the introduction of alien species.

Current vegetation

Currently GRKO has three major vegetation types: dry upland benches with native bunchgrasses, irrigated and sub-irrigated hayfields with improved forage grasses, and a shallow groundwater floodplain dominated by tall riparian shrubs in the well-drained areas and small wetland communities where the water table remains high throughout much of the year. As with any ranching operation there are areas with disturbance or lacking vegetation such as corrals and the areas near buildings. A comprehensive vascular plant survey completed in 2002 identified 341 taxa within the Ranch boundaries (Rice and Hardin 2002b). Eighty-one (25%) of these plant species were exotic to North America. Of those exotic species, 11 are designated by law as noxious in the state of Montana, and a total of 57 species are considered noxious by various state and provincial governments in some portion of their North American distribution. The standard flora references for the area are (Dorn 1984) or (Hitchcock and Cronquist 1973). Also useful, but not including some prairie species found principally in central Montana and eastward, is (Lackschewitz 1991). The willow are difficult to identify to species: (Brunsfield and Johnson 1985) and (Heinze 1994) are helpful references. (Lesica and Husby 2001) provide a guide to the sedges and rushes found in the wetlands.



Photograph by: B. Schweiger, NPS ROMN

Figure 8. *Pseudoroegneria spicata* – *Pascopyrum smithii* Herbaceous Vegetation in the Grant-Kohrs Ranch National Historic Site uplands. The riparian floodplain is visible in the background with a mixture of the two *Populus balsamifera* ssp. *trichocarpa* types and *Betula occidentalis* Shrubland, *Salix exigua* Temporarily Flooded Shrubland, the two *Salix geyeriana* Shrubland types. A small patch of *Symphoricarpos occidentalis* Shrubland occurs about midway down the hill slope.

The elevated benches (Figure 8) on the west boundary have relatively intact native bunchgrass communities dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*) and needle-and-thread grass (*Hesperostipa comata*). There is also a native bunchgrass remnant that is a railroad in-holding in the northeast quadrant of GRKO.



Photograph by: D. Shorrock, NPS ROMN

Figure 9. (*Bromus inermis* – *Elymus repens* - *Phleum pratense* - *Poa pratensis* - *Schedonorus pratensis*) Irrigated Pasture Herbaceous Vegetation in the Grant-Kohrs Ranch National Historic Site irrigated pasture. The riparian floodplain is visible in the background. Image is from a ROMN vegetation monitoring plot taken in 2009.

Lower elevation areas (Figure 9) with more productive soils and topography suitable for flood irrigation have been converted to high-yield introduced grasses such as smooth brome (*Bromus inermis*) and timothy (*Phleum pratensis*). The flood-irrigated hayfields on the west side of the river run the full south-to-north length of the Ranch and extend up broad gullies between the upland benches. Sub-irrigated meadows in the southeast also provide high quality grass hay. Abandoned farm fields in the northeast sector have been under sprinkler irrigation with municipal sewage effluent for the past decade and are consequentially also dominated by pasture grasses such as smooth brome.



Photograph by: B. Schweiger, NPS ROMN

Figure 10. *Betula occidentalis* Shrubland in the Grant-Kohrs Ranch National Historic Site riparian floodplain interspersed with *Salix exigua* Temporarily Flooded Shrubland, and the two *Salix geyeriana* Shrubland types. A small patch of leafy spurge is on the banks of the Clark Fork River Shrubland occurs about midway down the hill slope.

The floodplain (Figure 10) supports a shrubland of 10-20 foot tall shrubs including water birch (*Betula occidentalis*) and some seven willow species of which Geyer willow (*Salix geyeriana*) and Booth willow (*Salix boothii*) are most common. Black cottonwoods (*Populus balsamifera* ssp. *trichocarpa*) are limited to the southeast corner on Cottonwood Creek and an east side artificial slough created by excavation to build a railroad bed. The low gradient and hydraulics in this reach of the Clark Fork River are not conducive to the formation of cottonwood stands. The riparian corridor also contains several patches of invasive plants such as leafy spurge (*Euphorbia esula*) and Canada thistle (*Cirsium arvense*). The floodplain also contains patches of disturbed ground (Figure 11), remnant from the toxic metal mine and smelter spoils distributed throughout the basin by the 1908 flood. The phytotoxicity and plant community level impacts of these deposits have been confirmed by various studies conducted as part of a natural resource damage assessment (Rice 2002; Kapustka 2002; Rice and Hardin 2002a). Tufted hairgrass (*Deschampsia caespitosa*) is known to be tolerant of heavy metals and low pH soils and has colonized parts of the “slickens” in the GRKO riparian corridor.



Photograph by: B. Schweiger, NPS ROMN

Figure 11. *Deschampsia caespitosa* Slickens Semi-natural Sparse Vegetation in the Grant-Kohrs Ranch National Historic Site riparian corridor. Patch is surrounded by a mixture of *Betula occidentalis* Shrubland and the three *Salix* sp. Types.

Exotic Plant Management

Invasive species are a critical concern at GRKO. Exotic invasive species, primarily spotted knapweed, leafy spurge and thistles, deteriorate the site's integrity and gradually decrease species diversity. The heaviest concentrations are along the two railroad rights-of-way, but they also thrive in other disturbed areas. From 1990-92 an aggressive contract spray operation has been carried out which has successfully reduced knapweed infestations.

In 2007, an effort began to develop an invasive plant management plan and associated environmental assessment for 10 small parks within the northern Rocky Mountains (including GRKO). Under this plan, resource managers identify high priority invasive species for treatment, determine what treatments are feasible to reduce the number of or population of plants, identify the most reasonable management strategy or strategies, and then select the most appropriate treatment option or combination of treatments to minimize potential impacts and maximize overall management success (NPS 2011).

Methods

The basic set of tasks for the GRKO Vegetation Classification and Mapping Project included planning and scoping, collecting and analyzing existing data, photo interpretation, development of a vegetation classification, development of a sample design, field work, data input, accuracy assessment and analyses, and final map interpretation and cartography. These tasks necessarily interacted with one another throughout the entire process.

Planning and Scoping

The Rocky Mountain Network (including park representatives) decided in early 2006 to fund and administer the two remaining Vegetation Mapping projects for the network (GRKO and Little Bighorn Battlefield National Monument, LIBI). This decision was supported by the national Vegetation Mapping Program and included an informal agreement that staff from the national program would assist on select items within the projects. The ROMN entered into a cooperative agreement with Peter Rice from the University of Montana and Will Gustafson from the University's Wildlife Spatial Analysis Lab (WSAL) in the spring of 2006. Peter Rice served as the lead principal investigator (PI) for the project, with a primary focus on the vegetation classification effort and running the field crews. Remote sensing and most initial GIS tasks within the project were assigned to WSAL. The ROMN assumed responsibility for administration of the project, select collaboration on vegetation classification, assistance in running the field crews, some field data collection and in organizing and completing the final products. Chris Lea from the national VMP assisted in the Accuracy Assessment design, implementation and analyses, and helped integrate these results into the final classification and map. Ben Bobowski from GRKO provided project guidance and on-site assistance to the field crew. The LIBI and GRKO mapping projects were done concurrently by the same PIs, approaches, field crews, and general methods.

Meetings

A project initiation and general planning meeting was held at GRKO in March of 2006 and included park staff, NPS staff, and the project Principal Investigators. Key decisions made during this meeting included adopt guidance for 'small parks' in use at the time (<http://biology.usgs.gov/npsveg/standards.html>). A common approach in large park units (greater than around 1000 acres) is to define the vegetation community of a park based on quantitative (relevé or similar) plot data. Vegetation types are defined through multivariate analyses that compare plots based on their similarity to g are then matched ("crosswalked") to the most similar USNVC units maintained by NatureServe (NatureServe 2007). In most cases, a suitable concept in the USNVC can be found. These vegetation groups are then attributed to the map units defined by imagery analysis (i.e., the segmentation discussed above). In many cases the scale of the map units differs from the scale of the vegetation groups and an additional crosswalk must be developed that nests vegetation groups within the map units. This approach to creating vegetation maps is well suited to large areas with high floristic diversity. It is, however, an expensive and time consuming effort.

The small park protocol includes the following key steps:

1. Apply existing classifications of vegetation at GRKO (versus developing a classification from novel or existing plot data),

2. Use largely automated remote sensing or mapping techniques (versus traditional photo interpretation or “heads up” digitizing) to create map unit polygons within the map,
3. Conduct a field census of all map unit polygons identified using these automated techniques to assign a type from the existing classifications,
4. Conduct an Accuracy Assessment of classified map unit polygons using a sample of sites in the park,
5. Restrict the final map extent to the “fence boundary” or an unofficial boundary defined by fence lines around the park (e.g., Figure 1 and Figure 2) recognized by all stakeholders. This created a total project area of 1599.6 acres. All areal percentages are based on this number.

Project participants met on several occasions (Figure 12) over the course of the project to discuss progress and develop the scope of activities that needed to be completed over the near-term. These usually informally structured meetings were held at least once per year, often more frequently. Most project communication occurred in small group phone calls, e-mails and in face-to-face meetings too numerous and informal to detail here.

Following completion of the vegetation sampling in 2007, the project focused on analyses and mapping. Important processing steps included the methodology for defining the appropriate number and distribution (spatial and thematic) of the AA plots, data to be collected at the plot locations, and logistics for sampling.



Photograph by: B. Schweiger, NPS ROMN

Figure 12. Peter Rice and Ben Bobowski discuss upland vegetation types at Grant-Kohrs Ranch National Historic Site during a group meeting in 2008.

A close-out meeting was held on May 14th, 2008 at GRKO. Staff and management were present from both GRKO and LIBI and we allocated equal time to each effort. We presented our draft final results, discussed the products and how they might meet the management needs of each park, gave examples of case studies and applications of the digital products and answered process and development questions.

Preliminary Data Collection and Review of Existing Information

To minimize duplication of previous work and to aid in the overall mapping project, existing data and reports were obtained from various sources. Background GIS data was obtained from the ROMN and GRKO. This included geology, soils, digital elevation models (DEM), structures, roads, and the park “fence boundary”. The WSAL was provided with these layers as well as 2004 True Color National Agriculture Imagery Program (NAIP) aerial photography with a 2 meter pixel size covering the park.

Development of an Initial Vegetation Classification

We used two well developed and accepted existing classifications of the expected vegetation in the park. (Mueggler and Stewart 1980) developed a classification of upland shrub and grassland

types of western Montana that we used for classifying the upland map unit polygons. Hansen et al. (1995) provides community and habitat types for riparian vegetation across the entire state of Montana. Careful review of these classifications by the project PIs allowed a subset of the most likely types to be found at GRKO to be identified and compiled into a key specific to the park. This was facilitated by the experience of the PIs and GRKO staff with the extant vegetation types in the park and by the relative small size and simplicity of the vegetation in the park. Topographic position determined which source to employ. In uplands we used (Mueggler and Stewart 1980) and on the river floodplain we used Hansen et al. (1995). We crosswalked each of these initial types to the best fit in the USNVC.

The initial classification (Table 2) recognized six Mueggler and Stewart (1980) bunchgrass habitat types in the uplands. Two additional upland types represent types that had been seeded with *Agropyron intermedium* (= *Thinopyrum intermedium*², intermediate wheatgrass) or *Agropyron cristatum* (crested wheatgrass). These two seeded grass types were recognized as NVCS Semi-natural Herbaceous Alliances. Twenty Hansen et al. (1995) riparian floodplain habitat types were initially identified, representing native or semi-natural vegetation. Two additional floodplain types were developed to represent vegetated and non-vegetated polygons of metal contaminated soils. Eleven irrigated hayfields were typed based on aspect and the dominance of one or two of the introduced grasses planted in these fields (as part of GRKO's working cattle ranch purpose). These eleven pasture types were developed specifically for GRKO but were typical of similar rangeland areas across south central Montana. Four landscape cover types representing non-vegetated areas were developed.

² We list nomenclature from Dorn (1984) followed by Kartesz (1999) where they are different.

Table 2. Initial, pre-accuracy assessment types (45, including land cover) at Grant-Kohrs Ranch National Historic Site using original source classification or project-specific (marked with an asterisk) names. Types are cross walked to an equivalent USNVC Association or Alliance when possible.

Type Name from Original Key	Crosswalk to USNVC Association, Alliance, or equivalent ^s
UPLANDS (8) Mueggler and Stewart 1980, or developed for project (*)	
<i>Agropyron spicatum</i> / <i>Agropyron smithii</i>	<i>Pseudoroegneria spicata</i> - <i>Pascopyrum smithii</i> Herbaceous Vegetation
<i>Agropyron spicatum</i> / <i>Agropyron smithii</i> / <i>Stipa viridula</i>	<i>Pseudoroegneria spicata</i> - <i>Pascopyrum smithii</i> Herbaceous Vegetation
<i>Agropyron spicatum</i> / <i>Bouteloua gracilis</i>	<i>Pseudoroegneria spicata</i> - <i>Bouteloua gracilis</i> Herbaceous Vegetation
<i>Agropyron spicatum</i> / <i>Poa secunda</i>	<i>Pseudoroegneria spicata</i> - <i>Poa secunda</i> Herbaceous Vegetation
<i>Agropyron spicatum</i>	<i>Pseudoroegneria spicata</i> Herbaceous Alliance
<i>Stipa comata</i> / <i>Bouteloua gracilis</i>	<i>Hesperostipa comata</i> - <i>Bouteloua gracilis</i> - <i>Carex filifolia</i> Herbaceous Vegetation
<i>Agropyron cristatum</i> semi-natural*	<i>Agropyron cristatum</i> Semi-natural Herbaceous Alliance
<i>A. intermedium</i> (<i>Thinopyrum intermedium</i>) semi-natural*	<i>Thinopyrum intermedium</i> Semi-natural Herbaceous Alliance
RIPARIAN FLOODPLAIN (22) Hansen et al. 1995, or developed for project (*)	
<i>Agrostis stolonifera</i>	<i>Agrostis stolonifera</i> Seasonally Flooded Herbaceous Alliance
<i>Betula occidentalis</i>	<i>Betula occidentalis</i> Shrubland
<i>Bromus inermis</i>	<i>Bromus inermis</i> Semi-natural Herbaceous Alliance
<i>Carex aquatilis</i>	<i>Carex aquatilis</i> Herbaceous Vegetation
<i>Carex lasiocarpa</i>	<i>Carex lasiocarpa</i> Herbaceous Vegetation
<i>Carex rostrata</i>	<i>Carex utriculata</i> Herbaceous Vegetation
<i>Eleocharis palustris</i>	<i>Eleocharis palustris</i> Herbaceous Vegetation
<i>Equisetum fluviatile</i>	<i>Equisetum fluviatile</i> Herbaceous Vegetation
<i>Juncus balticus</i>	<i>Juncus balticus</i> Herbaceous Vegetation
<i>Poa pratensis</i>	<i>Poa pratensis</i> Semi-natural Seasonally Flooded Herbaceous Alliance
<i>Populus trichocarpa</i> /herbaceous understory	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / Mixed Herbs Forest
<i>Populus trichocarpa</i> / <i>Symphoricarpos occidentalis</i>	<i>Populus balsamifera</i> (ssp. <i>trichocarpa</i> , ssp. <i>balsamifera</i> / <i>Symphoricarpos</i> (<i>albus</i> , <i>oreophilus</i> , <i>occidentalis</i>) Forest
<i>Rosa woodsii</i>	<i>Rosa woodsii</i> Shrubland
<i>Salix bebbiana</i>	<i>Salix bebbiana</i> Shrubland

USGS-NPS Vegetation Mapping Program
Grant-Kohrs Ranch National Historic Site

Type Name from Original Key	Crosswalk to USNVC Association, Alliance, or equivalent ^s
<i>Salix exigua</i>	<i>Salix exigua</i> Temporarily Flooded Shrubland
<i>Salix geyeriana</i>	<i>Salix geyeriana</i> / Mesic Graminoids Shrubland
<i>Salix geyeriana</i> /Carex rostrata	<i>Salix geyeriana</i> / <i>Carex utriculata</i> Shrubland
<i>Symphoricarpos occidentalis</i>	<i>Symphoricarpos occidentalis</i> Shrubland
<i>Typha latifolia</i>	<i>Typha</i> (<i>latifolia</i> , <i>angustifolia</i>) Western Herbaceous Vegetation
Unclassified Riparian	NA
<i>Deschampsia caespitosa</i> * / Metal contaminated soil. No vegetation*	<i>Deschampsia caespitosa</i> Slickens Semi-natural Sparse Vegetation
Slickens	NA
IRRIGATED HAYFIELDS (11) Developed for project	
<i>Agropyron repens</i> *	NA
<i>Agropyron repens</i> /Bromus inermis*	NA
<i>Agropyron repens</i> /Phleum pratense*	NA
<i>Agrostis stolonifera</i> *	NA
<i>Bromus inermis</i> /Phleum pratense*	NA
<i>Bromus inermis</i> *	NA
<i>Descurainia sophia</i> *	NA
<i>Festuca pratensis</i> *	NA
<i>Juncus balticus</i> *	NA
<i>Phleum pratense</i> *	NA
<i>Poa pratensis</i> *	NA
NON-VEGETATED OTHER LANDCOVER (4)	
Bare soil*	NA
Developed Area*	NA
Road*	NA
Water*	NA

^s Natural or semi-natural vegetation community name is for NVCS Association unless ending with Alliance

Photo Interpretation

Given cost considerations, the small project area, and the relative simplicity of the vegetation at GRKO, a largely automated process for defining map unit polygons in the 2005 NAIP imagery was chosen. Known as “segmentation”, the process uses a computer algorithm implemented in Definians (now Trimble) eCognition software to divide an image into regions defined by greater spectral homogeneity within each segment versus the spectral diversity found in the surrounding matrix (Figure 13). The process extracts information from images using a hierarchy of image objects (groups of pixels) examining pixels not in isolation, but in context based on color, shape, texture and size. We assumed that these map unit polygons reflected meaningful patterns in the vegetation community at GRKO. Moreover, as discussed below, we assumed that in most cases types from the existing classifications could be applied at the same spatial scale to the map unit polygons. In other words, the scale of the vegetation classification used was almost always the same as the map units.

Following guidance from park management we created four regions or zones within the project boundary to guide the detail at which eCognition performed the segmentation. These four zones were based on management and land use in the park and included high, medium, low and no sample areas. The no sample zones were roads, open water (i.e., the Clark Fork River), park infrastructure and the area around the water treatment lagoons on the north end of the park. The high intensity zone included the riparian corridor, with the medium and low zones split based on irrigation type (including no irrigation). Segmentation of the NAIP imagery was adjusted to create smaller map unit polygons for the six hundred acres of natural upland and riparian vegetation and larger polygons for the seven hundred acres of hayfields. Note that eCognition segmented imagery in all of these zones (“no sample” refers to whether crews could access these polygons to determine their type). Image segmentation using eCognition was an iterative process with some manual edits made between automated runs.

Minimum Mapping Unit

Although standards for VMP map products stipulate a minimum map unit (MMU) size of 0.5 ha (1.24 acres), we felt that our imagery analysis process, field methods that our one-to-one application of vegetation type to map unit polygon would allow finer resolution mapping at GRKO. We therefore set a target MMU of 0.1 ha (0.247 acres) for the final map unit polygons.

This MMU was only considered an approximate target. If the segmentation ‘found’ polygons smaller than this that were then confirmed in the field as a real vegetation type they would not be merged with adjacent map unit polygons. This method choice was developed in consultation with national VMP staff. A MMU on this order represents an attempt to map vegetation in great detail at GRKO. As a comparative example, our initial classification at GRKO (about 1,600 acres) had 45 map classes, whereas at Rocky Mountain National Park (~270,000 acres) there were only 46 map classes (Salas et al. 2005).

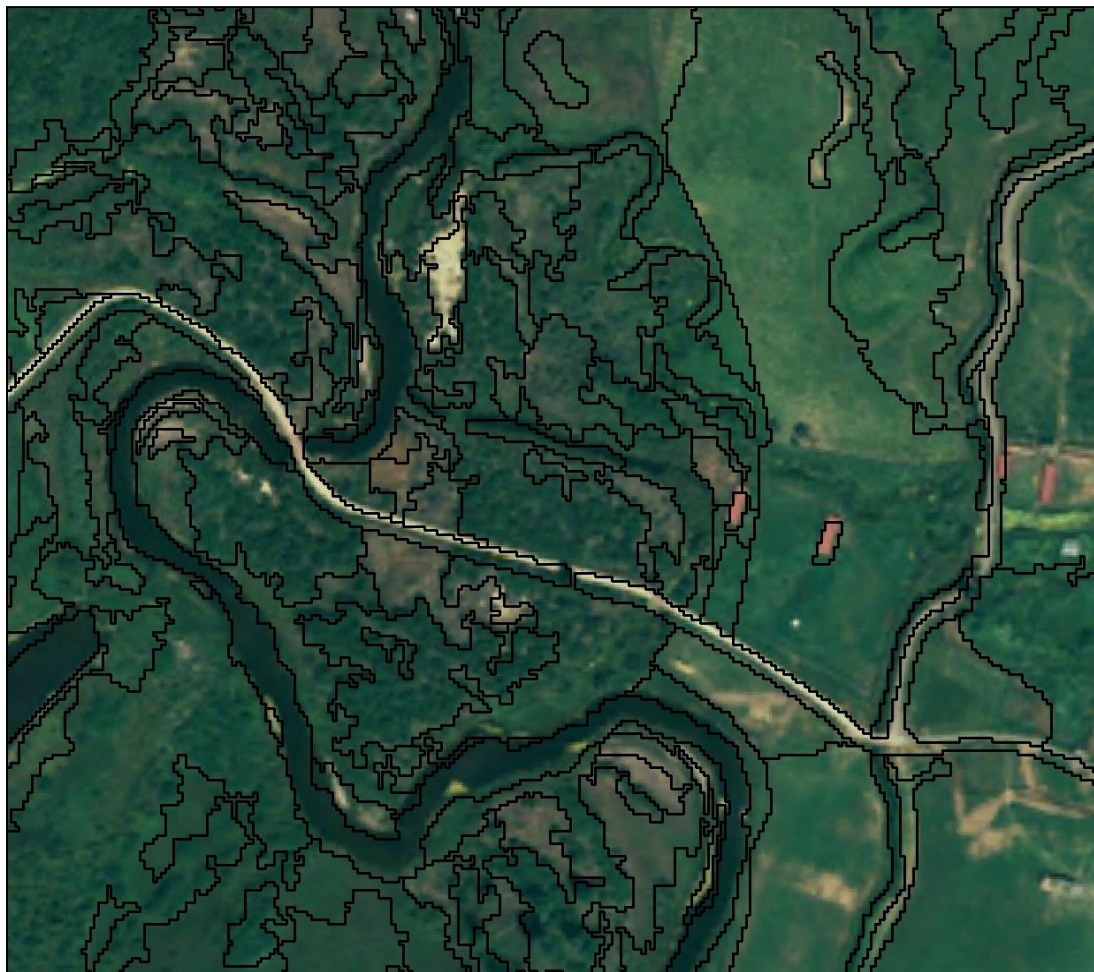


Figure 13. Example of 2005 NAIP imagery and initial segmentation by eCognition software at Grant-Kohrs Ranch National Historic Site. The left and center of the image is near the bridge over the Clark Fork River within the riparian corridor (high intensity zone). The right side of the image includes hayfields and the west edge of the main visitor facilities in the park (medium, low and no sample zones). Initial map unit polygons are shown with black linework.

Sample Design

Another common tool in large park units is to use replicated samples that represent a reasonably complete span of the floristic variability of each vegetation type across the park. Because of the relatively small size of GRKO, the use of an existing vegetation classification, and our approach to imagery analysis, we elected to census every polygon identified by the segmentation and assign each to existing community types (Table 2) developed from (Mueggler and Stewart 1980) and Hansen et al. (1995). Initial segmentations of the NAIP imagery indicated that approximately 850 polygons would be created and we felt that a census could be achieved with reasonable effort.

Field Mapping Protocol

The improved grass fields were mapped from June 28 through July 7, 2006 before the hay was cut. The natural vegetation areas were mapped from July 24 through August 1, 2006. Crew members assigned initial vegetation type to each map unit polygon. Crew members were

provided with the initial list of GRKO types, standard flora references for the area (Dorn 1984, Hitchcock and Cronquist 1973), GPS (Garmin 63c) and Polygon Data Forms referencing each map unit polygon number and the UTM coordinates for the approximate center of the polygon. They also had printed map sheets with the NAIP base images, polygon boundaries, map unit polygon numbers, and the approximate centroids for the polygons. Crew members navigated into the polygon using the GPS and reference to the printed map. The botanist first confirmed or adjusted the assigned zone (high, medium, low, no sample). After inspecting each vegetated polygon as a whole for dominants and indicator species the polygon was assigned a community type based on the original keys developed by Mueggler and Stewart (1980) for uplands, Hansen et al. (1995) for the floodplain, or a project specific key for the 11 hayfield types. *Importantly, crews were limited to the set of vegetation types available in these keys.* To facilitate later accuracy assessment, a reference waypoint was recorded within each polygon in a location representative of the polygon.

The cover class of up to three dominant indicator species was recorded at that representative, reference point. Cover classes for dominants were based on the traditional Braun-Blanquet cover scale: T=<1%, 1=1–5%, 2=6–25%, 3=26–50%, 4=51–75%, 5=76–95%, 6=96–100%. As a park request, the map unit location and cover class for any *Typha sp.* (cattail) observed were recorded. Data on dominants were collected to assist in later confirmation of assignment by crews of each map unit to one of the initial types.

In limited cases crews were allowed to adjust the topology of map unit polygons. This was done when it was clear that the segmentation split two or more distinct vegetation communities within the initial set of types or when a more homogeneous polygon could be created by dissolving boundaries. Crews added new boundary lines directly to the NAIP imagery field sheets for these polygon(s). A supplemental form (Appendix A) was completed for any adjusted polygon.

Data Input and Polygon Adjustment

After the field mapping crew finished the initial map unit polygon census, data was entered into a geodatabase (Appendix G). This data was quality checked and the final version was passed to WSAL. Polygons in the initial segmentation that were modified by crews as noted on the hardcopy maps supplied by the field crew were edited directly in the geodatabase. Any new map unit polygons created had a letter added to their original polygon-id field (i.e. 1241 became 1241a). A crosswalk table was created that linked the initial field key types to the USNVC series of hierarchical classifications and the field comments for each type. These classification attributes were then joined to the initial and final map units in the geodatabase.

Accuracy Assessment

An accuracy assessment (AA) is a statistical test of how well map unit polygon map class attributes represent vegetation on the ground. The AA compares field observations collected through a stratified random sampling design with the map class assignment of the sampled polygon. Errors occur when map classes assigned to the polygons do not agree with observations from the AA field sampling. Results are presented as “producer’s accuracy” (the probability that an AA point was mapped correctly) and “user’s accuracy” (the probability that the map represents what was found on the ground). High producer’s accuracy in combination with low user’s accuracy indicates that the type is under-mapped. Low producer’s accuracy combined with high user’s accuracy indicates that a type is over-mapped. Ideally, a map has both high

user's and producer's accuracy. Accuracy requirements for the VMP specify a 80% accuracy for both the collective map classes and for each individual map class.

In many other small park vegetation mapping projects that also employed a census an AA is not implemented (i.e., Saugus Iron Works National Historic Site (Largay and Sneddon, 2008), Buck Island Reef National Monument (Moser et al 2010), Knife River Indian Villages National Historic Site (Salas and Pucherelli, 2002). Rather, the assumption is that because every polygon created in the map is visited and attributed in the field, map accuracy will be within the NPS 80% standard. However, we felt that given the detail at which GRKO was segmented (using a 0.1 ha MMU) and the potential for misapplication of, or an imperfect fit with the *a priori* classifications in Mueggler and Stewart (1980) and Hansen et al. (1995), an AA was necessary.

Our aim in mapping the vegetation of GRKO was to provide accurate descriptions and locations of vegetation types as described by the USNVC. We sought to create a set of products that followed VMP standard and that were useful for the park and the ROMN. For the GRKO vegetation mapping project, the AA involved an analysis of data sets measuring the probability of map accuracy (absence of error) using a field based classification acquired at randomly selected sites for each map class (a thematic accuracy assessment). Positional accuracy (of polygon boundaries) was not considered in the AA since perceptions of transitions between type classes are only occasionally well-defined and variable seasonally and across years. Therefore, polygon boundaries represent approximate location within a gradient (ecotone) which was observed during these mapping years. Future work might use permanent fixtures (i.e., buildings) visible in the imagery to establish positional accuracy.

The objectives of collecting samples for accuracy assessment are somewhat different than those for classification. For AA the sampling is aimed at drawing inferences about the nature and magnitude of discrepancies between the true properties of a point or area and its representation on the map. Specifically, the primary purpose of collecting samples to assess the accuracy of the GRKO vegetation map is to obtain a measure of the probability with which a particular location has been assigned its correct vegetation class (thematic accuracy). According to the NPS Vegetation Mapping Program's Accuracy Assessment Procedures document (ESRI et al. 1994), the AA allows users of the data to assess the data's suitability for a particular application and enables the producers of the data to learn more about the data's errors and improve the mapping process and outcome.

Accuracy assessment field observations were conducted primarily from July 31 to August 2, 2007 by staff from GRKO, ROMN, the national VMP, and well-qualified volunteers. Analyses of these data were done in the fall of 2007 and winter of 2008 by Lea and Schweiger. All field and analytical methods followed the USGS-NPS Vegetation Characterization Program standards except as noted below.

Accuracy Assessment Sample Design

For a valid AA the randomness of site selection is crucial and the number of sites within map unit classes is heavily influenced by statistical constraints. In other words, the objectives require a sufficient number of samples to permit valid statistical inferences about the data as a whole.

We used the ESRI ArcView 3.2 geoprocessing wizard to prepare the sampling frame. We began by measuring the total area of each original map unit class (summing all individual map unit polygon areas). Individual polygons representing the same map class were dissolved to eliminate polygon boundaries between polygons of like map class. An 18 meter buffer inside the boundary of all dissolved polygons was then created. Polygons that were within the 18 meter buffer were selected and deleted from this union theme. The result of these geoprocessing steps was a polygon theme (sampling population) that was comprised of the interiors of all polygons (all areas more than 18 meters from a boundary with a different map class).

We allocated 30 AA sites to each map class that occupied more than 50 ha total area within GRKO. Map classes representing water, roads, and developed areas were omitted (these are assumed to be close to 100% accurate). For map classes with 50 ha or less of total area, we allocated AA plots equal to the total map class area (in hectares) divided by 1.67. This formula allocates points per class at the same ratio as the 30 points per 50 hectares requirement. The map class area was calculated prior to buffering for field positioning error, although the buffered areas of a map class were not considered for site placement. In the cases of very small map classes, the total size of the buffered area available, combined with the requirement of sampling without replacement (to allow observers to visit plots in sequence, but also to keep individual AA plot observations independent) limited the map class allocation to the total area available for multiple AA plots of minimum mapping unit size. We did not allocate additional points for map classes merely because they were more fragmented (e.g., less than 50 hectares total area, but more than 30 polygons). Our sample sizes per map unit class vary slightly from the guidance in Table 6 of Section 8.2.1.2 of ESRI et al. (1994).

To select individual AA sites from the sampling frame we used the Select Random Features function in the National Park Service Alaskapak tools package (NPS 2002). This uses simple random sampling within each map class, which is appropriate for the statistical analyses of the GRKO AA data (ESRI et al. 1994). When two or more AA plot sites were near enough to one another to produce overlapping observation areas (i.e., within 36 meters of one another, see below), one site at a time was selected randomly (using the random numbers function in Microsoft Excel) and deleted. A replacement site was generated for each site so deleted, using the “Select Random Features” function (as above). If the replacement site overlapped a previously determined site, it was rejected, and the process repeated, until either (1) the full complement of sites for the map class was assigned or (2) it was determined that the map class was saturated (could accommodate no more sites without observation area overlap between one or more AA plots). Figure 14 shows the 283 AA sample sites in GRKO.

Accuracy Assessment Field Methods

Three teams of one to two persons were employed to conduct the accuracy assessment. At least one person on each team was required to be familiar with all plant species mentioned in the field key and potential “look-alikes” species that might cause erroneous key decisions. The total number of plots to be visited for each map class was stratified by observation team (i.e., each team was assigned to visit an equal or near equal number of plots for each individual map class as the other teams) in order to minimize effects of observer bias. This type of methodological stratification is desirable, but precludes each site being visited sequentially by location, making it practical only in small projects such as GRKO where travel time is a minor consideration.

The site locations and unique identifiers were loaded into Garmin® 76CSXGPSunits. Teams navigated to each assigned site (plot center), usually in a sequence of proximity. The teams were not informed as to location of the map boundaries. Revealing map class boundaries creates a bias in the field calls that is especially problematic in small area projects, where compared to large area projects a larger proportion of each map class is likely to have map unit polygons populated with multiple sites and where adjoining polygons may also often have sites. It is unreasonable to expect a ground observer to make independent assessments of adjacent sites, when it has been revealed that the mapper has declared them to be the same or if the mapper has declared them to be different if two sites are separated by a single polygon/map class boundary. The bias can be especially problematic where field calls are not entirely clear cut, which is very often the case. There is also some inherent bias in using polygons where the lines have been determined based on spectral information that may or may not be visible on the ground.

A 0.1 hectare observation area (usually a circular plot, 18 meters in radius) was centered on each AA site. The area reduction from the 0.5 hectare observation area was necessary because of the small mean polygon area at GRKO (~ 0.75 hectares). Moreover, the vegetation at GRKO is primarily shrubland and herbaceous vegetation, in which smaller observation areas are expected to capture an adequate number of attributes to establish class (vegetation type).

A dichotomous field community classification key was prepared from the list of the initial types for the accuracy assessment teams (Appendix B). Field keys were designed to work in observation areas of relatively homogeneous (ecologically and floristically) stands of vegetation. While gradual transition zones within the observed area are acceptable (to test the key across the full gradient of described types), sharp boundaries with two or more very different vegetation types (e.g., wetlands and uplands) occurring in the observation area often will yield spurious key results and were avoided. However, it is possible for such sharp transitions to occur within an area mapped as a single class (an error of omission). To mitigate this situation, field crews were instructed to assess whether one of more such boundary occurred within the circular 18 meter radius (0.1 hectare) observation area. The general criteria for recognizing a boundary was a transition at the Formation level (i.e., shrubland versus woodland) of the USNVC (FGDC 1997); transitions between different alliances or associations within same Formation are generally too subtle for an observer to reliably and precisely locate on the ground; such boundaries are usually best ignored and the vegetation keyed in place. If a sharp (Formation or higher) vegetation boundary was detected in the observation area from the waypoint, the observer decided what vegetation type occupied the majority of the observation area (if two types are detected in the observation area) or plurality (if more than two types). The plot center was moved the minimal distance into the majority/plurality type along a path perpendicular to an imaginary line tangent to the ecological boundary between the majority/plurality type and all other types until only one association was detected within the plot. At this point, the observer stopped and evaluated a circular observation area of 18 meters radius from this new position.

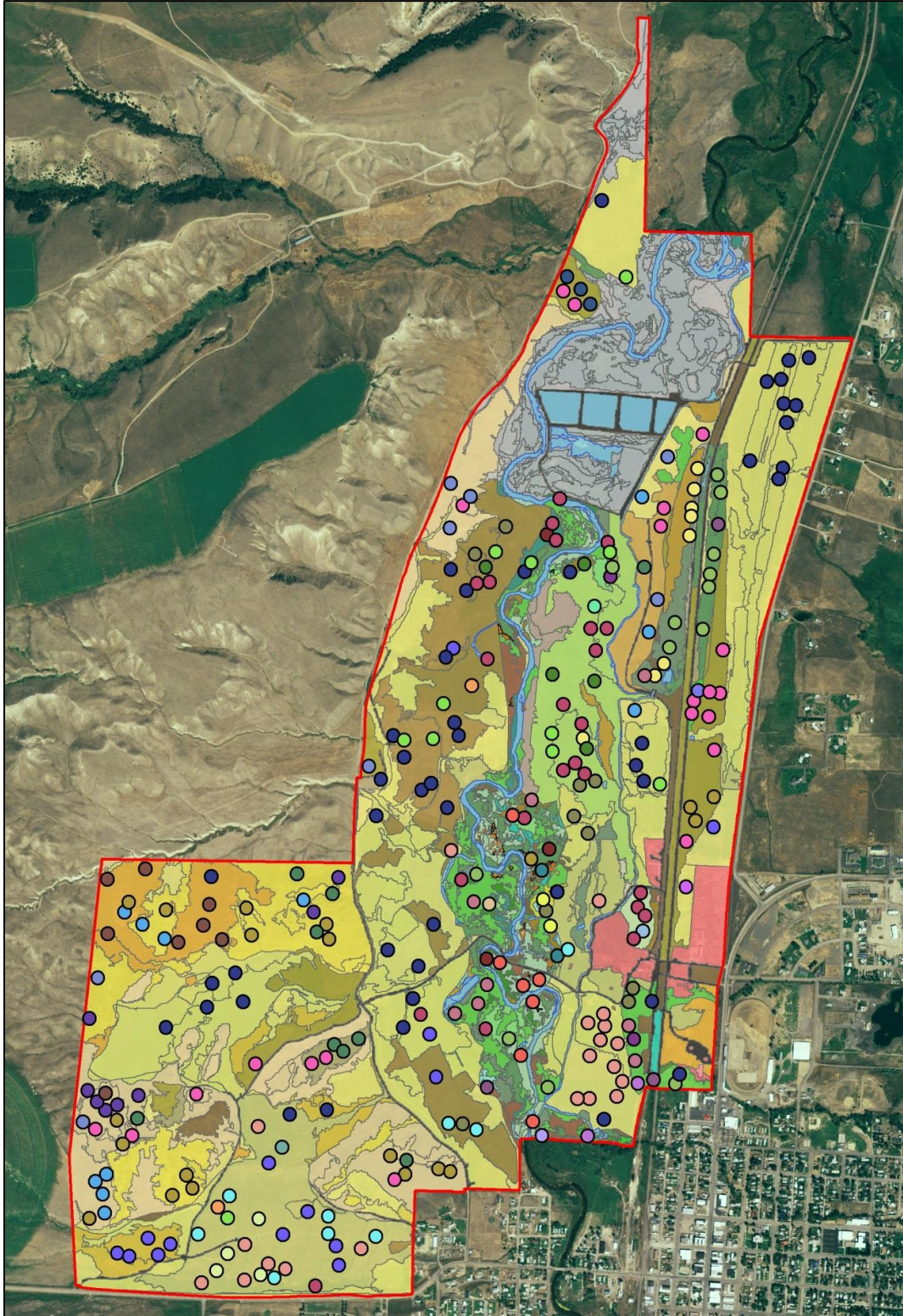


Figure 14. Accuracy assessment sample points at Grant-Kohrs Ranch National Historic Site. The initial, highly segmented map unit polygons and 2005 NAIP imagery are included as background. Point symbology is based on the field designation of the vegetation type at each site. Note the boundary shown is an unofficial 'fence line' boundary used for the Vegetation Mapping project.

If, while moving the plot center, a new ecological boundary appeared on another side of the circular plot, the observer stopped and attempted to implement a rectangular observation plot. To implement a rectangular plot, the observer located the point in the majority vegetation type along the path attempted above that is equidistant between the original boundary detected and the second boundary encountered when trying to move the circular plot. From this position, a 25 meter x 40 meter rectangular plot, with its short axis along the perpendicular path described above and centered on this point, was attempted. If the plot were more than 90% homogeneous as to vegetation type, the field call was made from this 25 meter x 40 meter plot. If a sharp vegetation boundary, as described above, existed in the rectangular plot, so that the area was less than 90% homogeneous to type, a 20 meter x 50 meter plot was attempted. If the 20 meter x 50 meter plot failed to produce 90% internal homogeneity, a 10 meter x 100 meter plot was attempted. If the 10 meter x 100 meter plot failed to produce 90% homogeneity, data from the site were not recorded.

Data collected within the final plot size and shape included location and plot type, the dominant vegetation type, secondary vegetation types, the proportional coverage of the plot of the dominant and secondary types (and any minor tertiary type). Crews also recorded the 1st to 5th most dominant species in the tree/shrub/ herbaceous layers (where these layers existed). An example AA form is given in Appendix A.

Accuracy Assessment Analytical Methods

All data was entered into a series of spreadsheets and quality checked. A misclassification matrix (contingency table) was created using the map unit assignment and the AA data. The field position (GPS) data were converted to a point theme and each point attributed with the vegetation type field call and the positioning (GPS) error recorded on the forms. Each field point was buffered by the field positioning (GPS) error recorded on the field forms to create a polygon theme of circular polygons with radius of each polygon equal to the recorded GPS error. The individual polygons represented the area where true position likely occurred. For rectangular observation areas, the dimensions of the observation area and the bearing of the long axis were taken from the field forms to create rectangular polygons. These polygons were spatially joined to the original GRKO vegetation type to determine whether any polygons had multiple original map class memberships (i.e., uncertainty about the map class that should be assigned to each point due to positioning error) and should therefore be discarded from the analysis.

The table derived from the spatially joined AA point data and original polygon map class layer was exported to Excel. A pivot table representing a misclassification matrix (contingency table) was created with the table columns representing the field calls, the table rows representing map classes (in the same order for rows and columns), and the cell totals representing the total number of plots for each possible combination of map class assignment and field class assignment.

User's accuracy (1 – commission error rate) was calculated as:

$$\frac{n_{ii}}{n_{i+}}$$

where i is the map class type, n_{ii} is the number of matches between map and reference data and n_{i+} is the total number of samples of i in the map. This formula is the number of “correct” observations divided by the sum of the column.

Producer’s accuracy ($1 - \text{omission error rate}$) was calculated as:

$$\frac{n_{ii}}{n_{+i}}$$

where n_{+i} = total number of sample of i in the reference data. This formula is the number of “correct” observations divided by the sum of the row.

Overall accuracy for the map was calculated as:

$$\frac{\sum_{i=1}^k n_{ii}}{n}$$

where k is the number of map class types and n is the total number of reference points. This formula is simply the sum of the diagonal entries divided by the total number of AA points.

A 90% confidence interval for a binomial distribution was obtained from the following equation:

$$\hat{p} \pm \left\{ z_{\alpha} \sqrt{\frac{\hat{p}(1 - \hat{p})}{n}} + \frac{1}{(2n)} \right\}$$

where $z_{\alpha} = 1.645$ (from a z -distribution at the significance level for a two-sided limit with a 90% confidence interval), $\hat{p}$ is the sample accuracy (0 to 1.0) and n is the number of sites sampled. The term $1/(2n)$ is the correction for continuity. The correction should be applied to account for the fact the binomial distribution describes discrete populations.

A kappa statistic was calculated for the overall accuracy. The Kappa statistic is a measure of agreement between model predictions and reality (Foody, 1992; Congalton 1991) that makes use of both the overall accuracy and the accuracies within each vegetation type category to correct for chance agreement between categories. Kappa can be used to determine if the values contained in an error matrix represent a result significantly better than random (Jensen 1996). Kappa is computed as:

$$\kappa = \frac{N \sum_{i=1}^r x_{ii} - \sum_{i=1}^r (x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^r (x_{i+} \times x_{+i})}$$

where N is the total number of sites in the matrix, r is the number of rows in the matrix, x_{ii} is the number in row i and column i , x_{+i} is the total for row i , and x_{i+} is the total for column i

(Jensen1996). An ArcView script made this process easy and repeatable (Jenness and Wynne 2005).

Final Data Interpretation and Map Production

Patterns in User's and Producer's error were used to guide possible changes in the map classes to be used in a final map. Collapsed map classes were also considered based on input from GRKO staff as to the utility of a particular class that while perhaps mapped with a lower accuracy, might still be desirable to retain given management applications.

The final map classes were summarized using standard queries in ArcGIS. A high quality map was generated following cartographic standards specified by the USGS-NPS Vegetation Characterization Program.

Results and Discussion

Image Segmentation

Processing of the NAIP imagery with eCognition produced 854 initial map unit polygons within the park boundary. We went through several iterations of the segmentation as we explored the balance of the settings for discriminating polygons based on color, shape, texture and size. The use of zones to guide the detail at which eCognition segmented imagery allowed us to create larger polygons in the upland areas than in the riparian corridor, reflecting the additional complexity of vegetation structure on the floodplain. However, in general, many polygons were below the target MMU of 0.1 ha. These were not dissolved in the GIS as the expectation was that there were mappable to a vegetation type.

Pre-AA Vegetation Map Classes

Map unit polygons were initially assigned to 40 vegetated and four land use types (Table 2) based on field observations. Four of the types (*Agrostis stolonifera*, *Bromus inermis*, *Juncus balticus*, and *Poa pratensis*) occurred both as individually distinguished types in the riparian floodplain, and as part of the irrigated hay meadow complex discussed below (Table 3).

The initial classification recognized six Mueggler and Stewart (1980) bunchgrass habitat types in the uplands. Some map unit polygons dominated by *Agropyron spicatum* (synonym *Pseudoroegneria spicata*, bluebunch wheatgrass) could not be classified at the finest scale to species habitat type or Association level because of the lack of strong indication of a second diagnostic species. These bluebunch wheatgrass polygons were classified at the higher NVCS *Pseudoroegneria spicata* Herbaceous Alliance level. Small areas of uplands had been seeded with *Agropyron intermedium* (synonym *Thinopyrum intermedium*, intermediate wheatgrass) or *Agropyron cristatum* (crested wheatgrass). These two grass types were recognized as NVCS Semi-natural Herbaceous Alliances.

Twenty Hansen et al (1995) riparian floodplain habitat types were initially recognized. Tall shrub types comprise roughly half of the riparian zone. The *Salix geyeriana* (Geyer willow) types were most abundant. The two Geyer willow types on the Ranch are indicated by the dominance of either *Salix geyeriana* and/or *Salix boothii* (Booth willow). Well drained *Salix geyeriana* map unit polygons were classified as *Salix geyeriana* community type having had an understory of primarily invasive introduced grasses and weedy exotic forbs such that they constitute the NVCS *Salix geyeriana*/Mesic Graminoids Shrubland Association. *Salix geyeriana* polygons with seasonal standing water or a very shallow groundwater table were *Salix geyeriana* /*Carex rostrata* (beaked sedge) habitat type in the Hansen et al.(1995) classification which is equivalent to *Salix geyeriana* / *Carex utriculata* Shrubland in the NVCS classification. The smaller statured early seral *Salix exigua* community type or *Salix exigua* Temporarily Flooded Shrubland Association was also common adjacent to the river. *Betula occidentalis* (water birch) community type or Shrubland Association accounted for only 33 acres but this very tall columnar shrub shares visual dominance with the *Salix geyeriana* types. Small clumps of two *Populus trichocarpa* (black cottonwood) types totaled less than 4 acres. On well drained riparian areas *Symphoricarpos occidentalis* (western snowberry) community type occupied 8 polygons for a total of 3.9 acres, and there was a single 0.1 acre map unit polygon designated as a *Rosa woodsii* (Woods rose) community type.

Early seral vegetation on new point bars and other exposed floodplain deposits was assigned to an Unclassified Riparian type, which accounted for 9.5 acres. The *Eleocharis palustris* (common spikeweed) type was also present immediately adjacent to the river. Metal contaminated deposits (slickens) comprised a total of 2.36 acres that were vegetated with monotypic *Deschampsia caespitosa* (tufted hairgrass), and an additional total 1 acre of bare slickens over 12 polygons. A finer resolution mapping in 2000 designated 7.9 acres of then bare slickens formed from 37 polygons (Rice and Hardin 2002a). A single 5.2 acre polygon was designated as a *Carex aquatilis* (water sedge) habitat type. Two minor sedge types were also mapped.

The initial eleven irrigated hayfield types as a group account for 48% of the mapped area at GRKO. The invasive rhizomatous grass *Bromus inermis* (smooth brome) community type, a Semi-natural Herbaceous Alliance, was the most extensive herbaceous association, covering 22 acres. Two other invasive rhizomatous grass but less prevalent community types were formed by *Agrostis stolonifera* (redtop) and *Poa pratensis* (Kentucky bluegrass). *Bromus inermis*/*Phleum pratense* (timothy) was the most prevalent type (346 acres). *Agropyron repens* (syn. *Elymus repens*) was the second most abundant introduced grass (83 acres). These two grasses are very productive in fields under flood irrigation or with high water tables. Although *Agrostis stolonifera* is most tolerant of conditions in low areas that retain surface water though longer parts of the growing season. A single 65 acre monotypic native *Juncus balticus* stand persisted in the North Meadow where there is a high water table. The common agricultural weed *Descurainia sophia* (flixweed) dominated one 1.1 acre polygon.

Table 3. Summary of extent and spatial characteristics of initial pre-Accuracy Assessment vegetation types at Grant-Kohrs Ranch National Historic Site. All units are acres.

Initial Type	Count	Smallest Polygon	Largest Polygon	Total	% of Total
IRRIGATED HAYFIELDS					
<i>Agropyron repens</i>	18	0.11	22.27	82.67	
<i>Agropyron repens/Bromus inermis</i>	12	0.09	20.54	54.67	
<i>Agropyron repens/Phleum pratense</i>	1	2.18	2.18	2.18	
<i>Agrostis stolonifera</i>	3	0.74	1.19	2.72	
<i>Bromus inermis</i>	3	2.68	5.29	11.93	
<i>Bromus inermis/Phleum pratense</i>	71	0.05	40.55	346.52	
<i>Descurainia sophia</i>	1	1.13	1.13	1.13	
<i>Festuca pratensis</i>	7	1.18	7.25	25.55	
<i>Juncus balticus</i>	4	1.61	36.62	66.66	
<i>Phleum pratense</i>	16	0.12	91.10	121.12	
<i>Poa pratensis</i>	4	0.26	54.14	60.79	
IRRIGATED HAYFIELDS TOTAL	140			775.92	48.51
RIPARIAN FLOODPLAIN					
<i>Agrostis stolonifera</i>	21	0.03	0.71	4.33	
<i>Betula occidentalis</i>	55	0.03	2.80	22.89	
<i>Bromus inermis</i>	16	0.06	4.07	9.87	
<i>Carex aquatilis</i>	1	5.23	5.23	5.23	
<i>Carex lasiocarpa</i>	3	0.35	0.70	1.41	
<i>Carex rostrata</i>	7	0.02	0.64	1.73	
<i>Deschampsia caespitosa</i>	6	0.11	1.42	2.37	
<i>Eleocharis palustris</i>	6	0.01	0.54	0.89	
<i>Equisetum fluviatile</i>	1	1.24	1.24	1.24	
<i>Juncus balticus</i>	9	0.04	0.33	1.55	
Metal contaminated soil. No vegetation	12	0.03	0.24	1.01	
<i>Poa pratensis</i>	7	0.02	1.35	2.98	
<i>Populus trichocarpa</i> /herbaceous understory	4	0.03	0.22	0.55	
<i>Populus trichocarpa/Symphoricarpos occidentalis</i>	18	0.00*	25.72	38.08	

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Initial Type	Count	Smallest Polygon	Largest Polygon	Total	% of Total
<i>Rosa woodsii</i>	8	0.05	3.76	7.55	
<i>Salix bebbiana</i>	46	0.02	8.80	33.76	
<i>Salix exigua</i>	59	0.04	7.33	53.82	
<i>Salix geyeriana</i>	14	0.07	11.74	19.86	
<i>Salix geyeriana/Carex rostrata</i>	9	0.47	47.89	83.42	
<i>Symphoricarpos occidentalis</i>	7	0.04	8.34	13.78	
<i>Typha latifolia</i>	19	0.04	2.68	9.55	
Unclassified Riparian	216	0.01	12.83	128.91	
RIPARIAN FLOODPLAIN TOTAL	544			444.77	27.81
UPLANDS					
<i>Agropyron cristatum semi-natural</i>	8	0.30	34.50	48.51	
<i>Agropyron intermedium (Thinopyrum intermedium) semi-natural</i>	1	1.65	1.65	1.65	
<i>Agropyron spicatum</i>	12	0.01	16.18	64.51	
<i>Agropyron spicatum/Agropyron smithii</i>	28	0.02	17.76	130.06	
<i>Agropyron spicatum/Agropyron smithii/Stipa viridula</i>	1	20.28	20.28	20.28	
<i>Agropyron spicatum/Bouteloua gracilis</i>	1	0.68	0.68	0.68	
<i>Agropyron spicatum/Poa secunda</i>	3	0.75	5.95	8.26	
<i>Stipa comata/Bouteloua gracilis</i>	34	0.00*	3.94	19.16	
UPLANDS TOTAL	88			293.11	18.32
NON-VEGETATED OTHER LANDCOVER					
Bare soil	8	0.24	1.21	3.88	
Developed Area	17	0.02	12.94	28.01	
Road	1	0.12	0.12	0.12	
Water	60	0.01	20.42	53.78	
NON-VEGETATED OTHER LANDCOVER TOTAL	86			85.80	5.36
GRAND TOTAL	858			1599.60	

*small polygons below the precision of this table

Dominant Species

Dominant taxa (Table 4) generally mirrored the patterns seen in the vegetation community types. The five most frequent dominants (*Bromus inermis*, *Agrostis stolonifera*, *Betula occidentalis*, *Elymus repens* and *Salix exigua*) account for almost 40% of the occurrences in the list. There were also several taxa with restricted distributions across the park, including *Carex pellita*, *C. praegracilis*, *Silene latifolia*, *C. lasiocarpa*, and *Medicago sativa* that were locally abundant. Many of these species are wetland plants or are otherwise specialized for specific habitat in which they can become locally quite dominant. Although the list of dominant species does not represent a complete species list for GRKO, given the comprehensive coverage GRKO vegetation mapping project census at over 850 locations in the park, the list is a useful characterization of patterns in characteristic species across GRKO and will be an important reference in a long-term monitoring context.

Table 4. Summary of dominant taxa as recorded in censused map unit polygons in Grant-Kohrs Ranch National Historic Site. Count is of the total number of times each species was recorded as one of the top three dominant species. Mean cover is across all occurrences of a taxa using the mid-point of the Braun-Blanquet cover class assigned to each observation. *The list is sorted by frequency with the most common taxa first.*

Species Name	Count	Mean cover	SD of cover
<i>Bromus inermis</i>	160	31.7	20.06
<i>Agrostis stolonifera</i>	121	15.4	12.29
<i>Betula occidentalis</i>	93	25.3	21.26
<i>Elymus repens</i>	88	19.0	13.75
<i>Salix exigua</i>	80	19.6	15.43
<i>Phleum pratense</i>	72	20.8	18.67
<i>Salix boothii</i>	71	17.0	12.37
<i>Juncus balticus</i>	56	22.3	13.71
<i>Salix geyeriana</i>	50	9.7	9.55
<i>Poa pratensis</i>	44	12.1	14.01
<i>Pseudoroegneria spicata</i>	44	14.1	9.55
<i>Cirsium arvense</i>	40	15.3	12.80
<i>Euphorbia esula</i>	38	22.5	14.13
<i>Salix bebbiana</i>	35	15.3	12.46
<i>Centaurea stoebe</i> ssp. <i>micranthos</i>	32	11.8	10.58
<i>Carex rostrata</i>	23	31.4	25.02
<i>Hesperostipa comata</i>	23	10.2	8.79
<i>Symphoricarpos occidentalis</i>	23	20.0	15.93
<i>Typha latifolia</i>	21	23.5	19.88
<i>Deschampsia caespitosa</i>	19	17.2	13.69
<i>Pascopyrum smithii</i>	18	6.5	7.26
<i>Koeleria pyramidata</i> (syn. <i>K. cristata</i>)	17	9.8	9.53
<i>Populus trichocarpa</i>	16	32.0	18.71
<i>Rosa woodsii</i>	15	10.1	9.71
<i>Artemisia frigida</i>	14	3.7	4.95
<i>Poa secunda</i>	14	4.0	4.77
<i>Glycyrrhiza lepidota</i>	13	22.4	10.38
<i>Agropyron cristatum</i>	12	24.8	17.28
<i>Bromus tectorum</i>	10	18.1	14.24
<i>Linaria vulgaris</i>	10	14.2	3.90
<i>Ericameria nauseosa</i> var. <i>nauseosa</i>	9	6.0	6.78

Species Name	Count	Mean cover	SD of cover
<i>Convolvulus arvensis</i>	8	7.1	6.58
<i>Eleocharis palustris</i>	8	34.2	20.64
<i>Festuca pratensis</i>	8	44.6	15.96
<i>Lepidium draba</i>	8	14.6	14.50
<i>Taraxacum officinale</i>	6	6.4	6.48
<i>Carex aquatilis</i>	5	6.7	7.22
<i>Ribes aureum</i>	4	8.4	7.17
<i>Sisymbrium altissimum</i>	4	12.3	5.63
<i>Thinopyrum intermedium</i>	4	14.0	15.04
<i>Bouteloua gracilis</i>	3	6.0	6.78
<i>Carex nebrascensis</i>	3	11.2	6.13
<i>Descurainia sophia</i>	3	6.8	6.13
<i>Equisetum fluviatile</i>	3	6.0	6.78
<i>Heterotheca villosa</i>	3	1.7	1.15
<i>Salix drummondiana</i>	3	1.7	1.15
<i>Achillea millefolium</i>	2	2.5	0.00
<i>Carex lasiocarpa</i>	2	26.8	11.25
<i>Equisetum arvense</i>	2	2.5	0.00
<i>Iris missouriensis</i>	2	15.5	0.00
<i>Medicago sativa</i>	2	20.3	17.75
<i>Nassella viridula</i>	2	15.5	0.00
<i>Phlox hoodii</i> ssp. <i>muscooides</i>	2	9.0	6.50
<i>Poa compressa</i>	2	9.0	6.50
<i>Alyssum alyssoides</i>	1	2.5	0.00
<i>Alopecurus pratensis</i>	1	0.1	0.00
<i>Artemisia ludoviciana</i>	1	0.1	0.00
<i>Carex filifolia</i>	1	2.5	0.00
<i>Carex pellita</i>	1	38.0	0.00
<i>Carex praegracilis</i>	1	38.0	0.00
<i>Cornus stolonifera</i>	1	2.5	0.00
<i>Lepidium latifolium</i>	1	2.5	0.00
<i>Phalaris arundinacea</i>	1	2.5	0.00
<i>Populus deltoides</i>	1	2.5	0.00
<i>Salix lutea</i>	1	2.5	0.00
<i>Silene latifolia</i> ssp. <i>alba</i>	1	38.0	0.00
<i>Tragopogon dubius</i>	1	0.1	0.00
<i>Verbascum thapsus</i>	1	15.5	0.00
Grand Mean		14.1	8.4

Cattail

Crews paid particular attention to *Typha* sp. (cattail). Cattail was a dominant species 21 times, with a mean cover of 23.5 (SD = 19.9). *Typha latifolia* was a pre- and post-AA vegetation type and was the characteristic vegetation in seven map unit polygons for a total of almost 14 acres. *Typha latifolia* was accurately mapped, with a User's accuracy of 100% (see below and Appendix C). Figure 15 shows the seven cattail polygons and the polygon centroid locations where it was one of the top three dominants (note that in some cases even though cattail was a dominant it did not lead to the map unit polygon being classified as a *Typha latifolia* type. Cattail can be a problematic species, often becoming invasive and forming monocultures. The GRKO vegetation map data provide a useful baseline for future monitoring of this species.

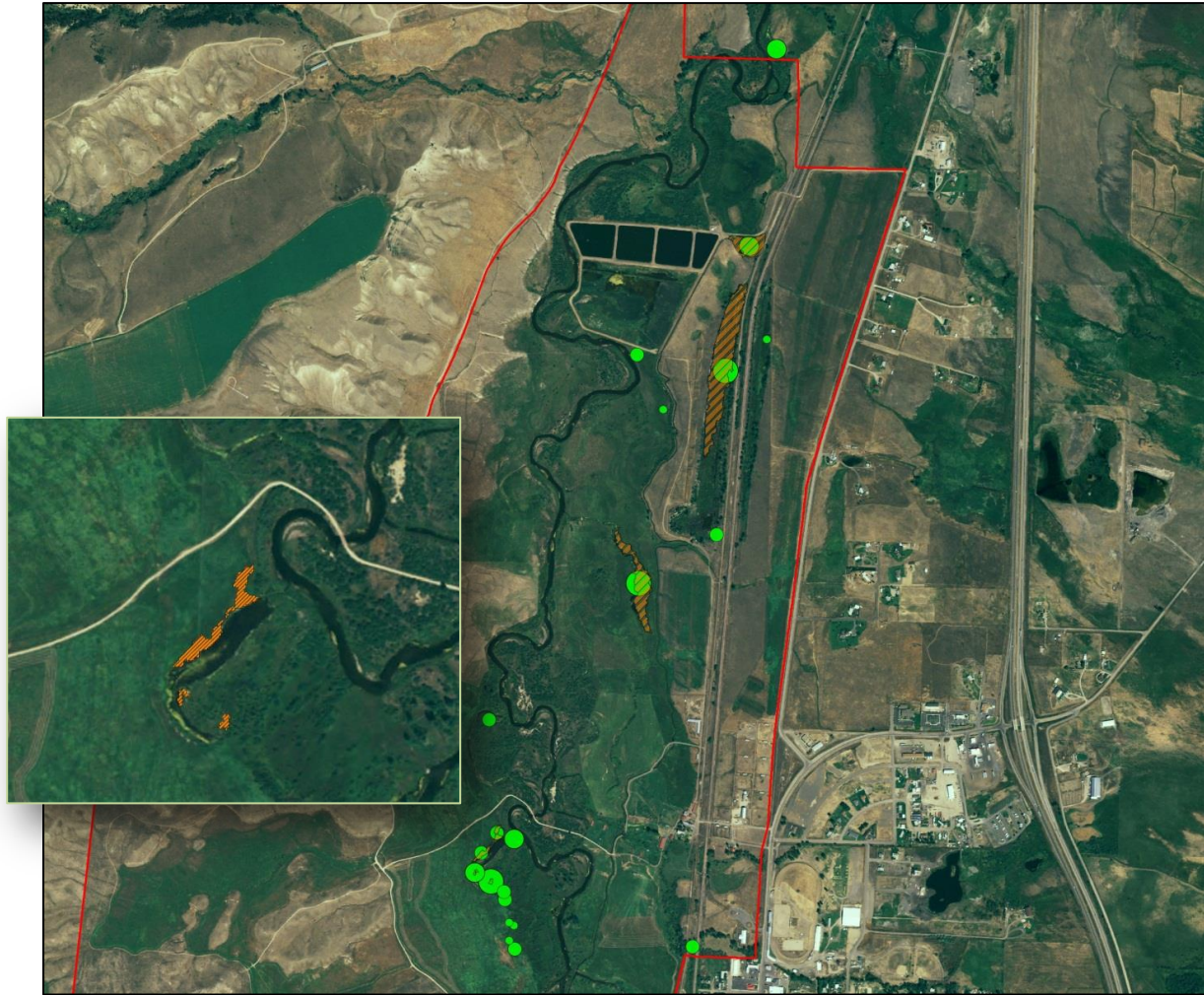


Figure 15. *Typha latifolia* (cattail) map unit polygons (orange hatched areas) and point locations where *T. latifolia* was a dominant (the point is polygon centroid for mapunits where cattail was a dominant species) at Grant-Kohrs Ranch National Historic Site in 2007. Point locations symbol size scales with the cover class value. Inset shows detail of cluster of polygons near the bridge that are obscured by point symbols. Note the boundary shown is an unofficial 'fence line' boundary used for the Vegetation Mapping project.

Accuracy Assessment

A total of 283AA plots were collected by four teams of observers. The overall map accuracies for the initial and final post AA vegetation classes and for the assignment of post-AA classes to Ecological Systems are given in Table 5. We include 90% confidence intervals and a Kappa statistic for the final post AA classifications. A set of full contingency tables are given in Appendix C.

Table 5. Overall map accuracies for pre and post accuracy assessment classifications at Grant-Kohrs Ranch National Historic Site.

Classification	Overall Accuracy	Lower 90% CI	Lower 90% CI	Kappa Index
Original Vegetation Types	29%	--	--	--
Post AA Vegetation Types	62.5	57.6	67.5	49.6
Post AA Ecological Systems	84.1	80.3	87.9	75.6

The original classification and mapping scheme was assessed to have a pooled (all sites totaled) accuracy rate of ~**29%**. This was very low, considering that all map unit polygons had been individually attributed on the ground. The inherent limitations of remote sensing methods in attributing vegetation stands is a usually a large potential error source in most mapping projects. However, because map unit polygons were all attributed on the ground by field crews at GRKO, this source was probably a relatively minor cause for error. As we crosswalked the original types to USNVC Associations recognized by NatureServe (2007) it became clear that the original vegetation types were sometimes at a finer scale than most corresponding USNVC Associations. As a result, the taxonomic (thematic) resolution of the initial classification was likely too specific, leading to one set of qualified field observers (the accuracy assessment team) not being able to consistently repeat the observations of the original team of qualified field observers (the original field crew). In a strict sense, this might be termed a lack of correspondence, rather than a deficit of accuracy, but this is not a meaningful distinction for the potential map user (such as staff from GRKO) who wishes to know the frequency of match or mismatch between the map class and what is found at a given site. The very small map unit polygons enabled by the mapping methodology may also have played a role in the resulting low accuracy rate. By constraining the observation areas used by the AA team, highly local patterns in vegetation composition may have been evaluated instead of the community level structure more typical of NPS vegetation maps (i.e., the polygon scale at which the map was delineated and attributed). Note that some types were rare and were never ‘found’ at an AA point. While this suggests that the accuracy on these types is not high, there may also be artifacts from the design (i.e., not enough points were allocated to the type) and so we describe these as ‘not evaluated’.

Final Grant-Kohrs Ranch National Historic Site Classification

Several patterns of type confusion (e.g. two types frequently reciprocally misidentified as the other) were evident in the accuracy assessment (Appendix C). These patterns suggested several new (or post-AA) combinations of types that would both retain ecological meaning and result in higher individual class and total map accuracy. In addition, several of the initial types were sparsely represented in the original map (by a few or even a single small polygon). While the aggregations represent a loss in detail of the map, we felt it would be difficult to recognize the some of the rare or inaccurate types in the field, or to use them in any meaningful management application. The following sections present brief summaries of the changes adopted given the accuracy assessment and a summary of the final vegetation classification at GRKO.

Changes to Create Final Vegetation Types

Based on the AA, the 44 original map types were collapsed into 29 (25 vegetation and 4 landcover) types (Table 6). These include two black cottonwood forest types, five shrubland types, five upland grassland types, ten wetland or riparian herbaceous vegetation types, two sparsely vegetated types, and one planted/cultivated pasture type. Detailed descriptions of each

(excluding landcover) are found in Appendix E, and a key to the final types is presented in Appendix D.

Key changes from the initial types include the following:

- All of the original eleven irrigated pasture types were merged to form a single introduced pasture grass type. This combined all map unit polygons that were originally *Descurainia sophia*, *Agrostis stolonifera*, *Agropyron repens*, *Agropyron repens* / *Bromus inermis*, *Agropyron repens* / *Phleum pratense*, *Bromus inermis*, *Bromus inermis*/ *Phleum pratense*, *Festuca pratensis*, *Phleum pratense*, *Juncus balticus*, or *Poa pratensis* types into a NPS (provisional) NVC Association equivalent of (*Bromus inermis* – *Elymus repens* - *Phleum pratense* - *Poa pratensis* - *Schedonorus pratensis*) Hayfield/Irrigated Pasture Herbaceous Vegetation. This final type has a user's accuracy of 94.0%.
 - As discussed below, following guidance from GRKO we retained the topology of the original 11 pasture types in the final map but symbolize all types consistently.
 - Some riparian floodplain polygons of *Agrostis stolonifera*, *Bromus inermis*, *Juncus balticus*, and *Poa pratensis* that were not accuracy assessed were reverted to their original designated type, rather than included in irrigated pasture.
- The drier upland types *Agropyron spicatum*, *Agropyron spicatum* / *Bouteloua gracilis*, *Agropyron spicatum* / *Agropyron smithii* / *Stipa viridula*, and *Agropyron spicatum* / *Poa secunda* were merged into a single *Pseudoroegneria spicata* – *Poa secunda* Herbaceous Vegetation type. This final type has a user's accuracy 95.2%.
- The *Salix bebbiana* and the *Salix geyeriana* types were merged into the *Salix geyeriana* / Mesic Graminoids Herbaceous Vegetation type. This final type has a user's accuracy of 31.3%.
- The *Populus trichocarpa* and the *Populus trichocarpa* / Herbaceous types were merged into the *Populus balsamifera* ssp. *trichocarpa* / Mixed Herbs Forest type. This type was not evaluated in the AA. Note that NatureServe uses *Populus balsamifera* ssp. *trichocarpa* for naming the black cottonwood types but ITIS does not accept that binomial and list *Populus trichocarpa* as the accepted name for black cottonwood. We use the NatureServe nomenclature as a final type name for consistency.
- The *Symphoricarpos occidentalis* Community Type and *Rosa woodsii* Community Type were merged to create the *Symphoricarpos occidentalis* Shrubland type. This type was not evaluated in the AA.

Actively Managed Landscapes and Vegetation Maps

One of the biggest challenges for a vegetation mapping project is to effectively capture and describe inherently dynamic vegetation composition across diverse landscapes. This is typically accomplished in three ways: 1) by using hierarchical vegetation community types within a nationally recognized system (the USNVC), 2) fairly coarse map unit boundaries, and 3) by

recognizing that a vegetation map is in fact a static product, not meant to replace more dynamic monitoring that can occur at smaller spatial and temporal scales.

At GRKO this is an important dilemma. Because the park is a working ranch, almost half the area of the park is actively managed through irrigation, haying, and livestock grazing. This management is appropriate for preserving and educating the public about these activities are the founding purposes of GRKO. In larger wilderness parks, vegetation mapping projects often effectively ignore non-natural vegetation types, lumping them into a “cultural vegetation class” and not treating them at the same level of detail as natural vegetation types (this is the case with the sister project for GRKO, LIBI for a few types). This was not a viable option at GRKO given the extent of “non-natural” vegetation in the park and its connection to the parks purpose.

We initially created eleven types within the pastures and hayfields of GRKO (see Figure 14 and Table 2). These were developed from the source classifications, from our experience with the vegetation in and around the park, and from conversations with GRKO staff as to how they “saw” these areas of the park. Our initial impressions were that these types were repeatable and “real”. They also met the approval of GRKO staff and reflected their sense that these pastures were not homogenous monocultures. The average size of these pasture map unit polygons generated by the segmentation was by design larger than in the floodplain and likely appropriately captured larger scale patterns of structure in the pastures.

When we applied the standard protocol for assessing the accuracy of these types, we saw variable monospecific and mixed dominance, probably due to historic management patterns, and it proved intractable to recognize pasture as individual types. Users Accuracy was very low for most types except the abundant *Bromus inermis* / *Phleum pretense*. The patterns in confusion suggested that they should all be considered one type.

However, there is not “one” vegetation type in the pastures and we believe to display it as such would do a disservice to the park. The fields are flood irrigated. The irrigator cuts a break in lateral ditches to distribute the water throughout the field. These breaks are in different places with different timing each year. In a hayfield/pasture with mixed introduced grasses the abundance of individual species is likely to vary year to year depending on the placement and timing of the breakouts.

We elected to deal with this issue by treating the eleven types as one in terms of how we include them in the final total accuracy of the map, in how we symbolize them in the final map product, and in how we describe the type in Appendix D. However, we have retained the topology generated by the initial types by not dissolving internal boundaries within the large pasture polygons. Known informally as “ghost lines” this is a somewhat commonly used solution to the issue (i.e., Rocky Mountain National Park, Salas et al 2005; Sleeping Bear Dunes National Lakeshore, K. Hop, pers. comm.; Mount Rushmore National Memorial, Salas and Pucherelli 1998; Jewel Cave National Monument, Salas and Pucherelli 1998). These types are included in the key to initial vegetation types (Appendix B). We suggest that this compromise appropriately accounts for the issues with the accuracy of these types yet provides the park tools to convey and understand the complexity of the vegetation in GRKO.

All other decisions to collapse or combine types were made by the lead ecologists on the project, with input from park management in cases where we felt that the park might want to accept lower accuracy to retain a useful designation. The final GRKO map is still a very "busy" treatment, with an impressive amount of detail remaining.

Final Accuracy

Even with the suite of combined types detailed above, the final map classes (treating the eleven pasture types as one) generated a total accuracy rate of only 62.5 (90% confidence interval 57.6% to 67.5%), with a kappa of 49.6% (Appendix C). The post-AA Kappa value suggests that final set of vegetation types at GRKO was marginally poorer than random (Jensen 1996).

When associations were aggregated to the thematically coarser classification scheme of Ecological Systems (Comer et al. 2003; NatureServe 2007), the overall map accuracy was 84.1% (90% confidence interval 80.3% to 87.9%) and a kappa of 75.6%. Detailed descriptions of each type are in Appendix F.

Table 6. Final post accuracy assessment vegetation and landcover types at Grant-Kohrs Ranch National Historic Site. Vegetation types not currently recognized within the USNVC are indicated by an asterisk.

Plant Association	Common name	User's Accuracy [†]
FORESTS/WOODLANDS (2)		
<i>Populus balsamifera</i> (ssp. <i>trichocarpa</i> , ssp. <i>balsamifera</i>) / <i>Symphoricarpos</i> (<i>albus</i> , <i>occidentalis</i> , <i>oreophilus</i>) Forest	Black Cottonwood / Western Snowberry Forest	20.0
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / Mixed Herbs Forest	Black Cottonwood / Mixed Herbs Forest	NA
SHRUBLANDS (5)		
<i>Betula occidentalis</i> Shrubland	Water Birch Shrubland	100
<i>Salix geyeriana</i> / <i>Carex utriculata</i> Shrubland	Geyer's Willow / Northwest Territory Sedge Shrubland	16.7
<i>Salix geyeriana</i> / Mesic Graminoids Shrubland	Geyer's Willow / Mesic Graminoids Shrubland	31.3
<i>Salix exigua</i> Temporarily Flooded Shrubland	Sandbar Willow Shrubland	12.5
<i>Symphoricarpos occidentalis</i> Shrubland	Western Snowberry Shrubland	0
UPLAND HERBACEOUS VEGETATION (5)		
<i>Agropyron cristatum</i> - (<i>Pascopyrum smithii</i> , <i>Hesperostipa comata</i>) Semi-natural Herbaceous Vegetation	Crested Wheatgrass Grassland	70.0
<i>Hesperostipa comata</i> – <i>Bouteloua gracilis</i> – <i>Carex filifolia</i> Herbaceous Vegetation	Needle-and-Thread Grass – Blue Grama Mixedgrass Prairie	18.8
<i>Pseudoroegneria spicata</i> – <i>Pascopyrum smithii</i> Herbaceous Vegetation	Bluebunch Wheatgrass – Western Wheatgrass Mixedgrass Prairie	14.3
<i>Pseudoroegneria spicata</i> – <i>Poa secunda</i> Herbaceous Vegetation	Bluebunch Wheatgrass – Curly Bluegrass Mixedgrass Prairie	95.2
<i>Thinopyrum intermedium</i> Semi-natural Herbaceous Vegetation	Intermediate Wheatgrass Semi-natural Herbaceous Vegetation	NA
WETLAND/RIPARIAN HERBACEOUS VEGETATION (10)		
<i>Agrostis (gigantea, stolonifera)</i> Semi-natural Herbaceous Vegetation	(Giant Bentgrass, Spreading Bentgrass) Semi-natural Herbaceous Vegetation	NA
<i>Bromus inermis</i> – (<i>Pascopyrum smithii</i>) Semi-natural Herbaceous Vegetation	Smooth Brome – (Western Wheatgrass) Semi-natural Herbaceous Vegetation	NA
<i>Carex aquatilis</i> Herbaceous Vegetation	Aquatic Sedge Wet Meadow	0
<i>Carex pellita</i> Herbaceous Vegetation	Woolly Sedge Wet Meadow	33.3
<i>Carex utriculata</i> Herbaceous Vegetation	Northwest Territory Sedge Wet Meadow	0
<i>Equisetum fluviatile</i> Herbaceous Vegetation	Water Horsetail Wet Meadow	NA
<i>Eleocharis palustris</i> Herbaceous Vegetation	Marsh Spikerush Wet Meadow	NA
<i>Juncus balticus</i> Herbaceous Vegetation	Baltic Rush Sedge Wet Meadow	NA

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Plant Association	Common name	User's Accuracy [†]
<i>Poa pratensis</i> Semi-natural Seasonally Flooded Herbaceous Vegetation	Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Vegetation	NA
<i>Typha</i> (<i>latifolia</i> , <i>angustifolia</i>) Western Herbaceous Vegetation	Broadleaf Cattail Marsh	100.0
SPARSE VEGETATION (2)		
<i>Deschampsia caespitosa</i> Slickens Semi-natural Sparse Vegetation[park-specific]	*Tufted Hairgrass Slickens	33.3
Rocky Mountain Riparian Bar Sparse Vegetation[park-specific]	*Riparian Bar	NA
PLANTED/CULTIVATED (CULTURAL) HERBACEOUS VEGETATION (1)		
(<i>Bromus inermis</i> – <i>Elymus repens</i> - <i>Phleum pratense</i> - <i>Poa pratensis</i> - <i>Schedonorus pratensis</i>)Irrigated Pasture Herbaceous Vegetation[park-specific]	*Hayfield/Pasture	94.0
LANDCOVER/NON-VEGETATED/OTHER (4)		
Bare soil*		NA
Developed Area*		NA
Road*		NA
Water*		NA

[†]User's accuracy was not calculated for landcover types or for more uncommon types.

Final Grant-Kohrs Ranch National Historic Site Map

Figure 16 presents the final Vegetation Map for GRKO. Table 6 presents summary statistics for the spatial extent of each type. Non-pasture map unit polygons with a common final type and shared contiguous boundaries with a neighbor(s) were spatially combined in the geodatabase. This reduced the total number of unique map unit polygons in the final map to 554. However, even after the type aggregations described above and the dissolves in the GIS across common type boundaries, many polygons were still below the target MMU of 0.1 ha (0.247 acres).

Overall, Grant-Kohrs Ranch National Historic Site has an interesting array of natural vegetation communities and an interesting and diverse suite of temporally dynamic semi-natural hayfield/pasture types that represent the land use history and interpretive mission of the park. At the Association scale, the 357 acres of uplands are primarily vegetated by bunchgrass types in the *Pseudoroegneria spicata* Herbaceous Alliance. On more exposed sites with stonier soil, *Hesperostipa comata* - *Bouteloua gracilis* - *Carex filifolia* Herbaceous Vegetation predominates, but the abundance of *Hesperostipa comata* may reflect past cumulative grazing pressure. About 48 upland acres had been inter-seeded in the past with *Agropyron cristatum*. These areas constitute *Agropyron cristatum* - (*Pascopyrum smithii*, *Hesperostipa comata*) Semi-natural Herbaceous Vegetation. Average *Agropyron cristatum* canopy cover was ~33% and these stands still retained some native component. A small strip on the east side was planted to *Thinopyrum intermedium* Semi-natural Herbaceous Vegetation. Overall the Grant-Kohrs uplands consist of relatively intact native bunchgrass vegetation, particularly in contrast to many areas of the West that have been under livestock grazing pressure for over a century. Historic records for the Ranch suggest that these uplands were primarily utilized for fall grazing rather than during the spring period of active plant growth. Fall grazing has much less impact on native bunchgrasses than grazing during the period of active spring growth.

Around 60% of the mapped acreage at GRKO consisted of introduced grass pastures and hayfields that are flood, sprinkler, or sub-irrigated. Smooth brome (*Bromus inermis*) and timothy (*Phleum pratense*) are the predominant species in these fields but the other introduced pasture grasses quackgrass (*Elymus repens*), Kentucky bluegrass (*Poa pratensis*), meadow fescue (*Festuca pratensis*), and redtop (*Agrostis stolonifera*) can obtain dominance over smaller patches. Many areas of these fields have been seeded with two or more of these introduced grass species. The amount, timing, and spatial distribution of irrigation and subsurface flow are highly variable from year to year. Dominance of species is strongly influenced by the irrigation practices, with the result that the hayfield community composition is also variable from year to year.

The Clark Fork riparian floodplain and small east side creeks provide the most complex environment at the Ranch. Twelve vegetation types were assigned within the 242 riparian acres within GRKO (note that the 128 acres we were unable to sample also largely occur within the riparian areas). Irrigation ditches and flowback add to the hydrologic complexity and resultant vegetation in this riparian zone. The *Salix geyeriana* / Mesic Graminoids Shrubland community is the predominant riparian type. It occupies better drained areas while *Salix geyeriana* / *Carex utriculata* Shrubland is maintained in areas that have prolonged seasonally high water tables. *Salix exigua* Temporarily Flooded Shrubland is the second most abundant type. Although many of these *Salix exigua* polygons are immediately adjacent to the Clark Fork River, there are *Salix exigua* stands that persist set back from the active channel. *Betula occidentalis* Shrubland is the

third most prevalent type, but the height of this columnar shrub creates an aspect dominance that rivals the more extensive *Salix geyeriana* types. Past livestock grazing in the riparian zone allowed the formation of *Bromus inermis*- (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation as the most prevalent herbaceous type. In areas with protracted standing water *Typha* (*latifolia*, *angustifolia*) Western Herbaceous Vegetation, *Agrostis gigantea*, *stolonifera* Semi-natural Herbaceous Vegetation, and *Carex aquatilis* Herbaceous Vegetation prevail. *Populus balsamifera* (black cottonwood *P. trichocarpa*) types are limited in extent not only on the Ranch but are generally absent along the entire Upper Clark Fork River. Presumably the low gradient, substrate, and moderate flood regime of the upper river does not create new depositional sites favorable for the establishment of cottonwood galleries.

The ecological integrity of riparian communities on the Ranch has been impacted by floodplain deposition of phytotoxic metal loaded waste material from mining and smelting upriver from Grant-Kohrs (Kapustka 2002; Rice 2002). Although nineteen riparian vegetation types were utilized for the final classification, many of the stands of these native types deviate in overall species composition and proportion from community types in Hansen et al. (1995) definitions (Rice and Hardin 2002a). The most salient example is for the *Deschampsia caespitosa* Slickens Semi-natural Sparse Vegetation which are monotypic *Deschampsia caespitosa* stands on or in a narrow band surrounding the edge of lenses of toxic metal, low pH, waste sediment deposits from the 1908 flood event. Stands of various types that occupy better drained contaminated soils are more deviant than contaminated soil stands of wet types, as anoxic conditions retard solubilization of the phytotoxic metals. For example, while Grant-Kohrs *Salix geyeriana* / Mesic Graminoids Shrubland stands were different from the type in Hansen et al. (1995), the GRKO wet *Typha* (*latifolia*, *angustifolia*) Western Herbaceous Vegetation and *Carex aquatilis* Herbaceous Vegetation types were very similar to the Hansen et al. compositional definitions

Although a woody overstory of native indicator species still dominates the riparian zone the native herbaceous layer on well drained areas has largely been displaced by invasive species. *Bromus inermis* is the predominant riparian graminoid. It forms the NVCS recognized semi-natural type *Bromus inermis* - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation over 22 acres and a *Bromus inermis* understory is prevalent in most of the woody types. In some areas with higher protracted water tables invasive *Agrostis stolonifera* forms stands classified by NVCS as *Agrostis gigantea*, *stolonifera* Semi-natural Herbaceous Vegetation are found. The noxious weeds yellow toadflax (*Linaria vulgaris*), Canada thistle (*Cirsium arvense*), and leafy spurge (*Euphorbia esula*) are wide spread in the riparian zone where they have largely replaced the characteristic native herbaceous species.

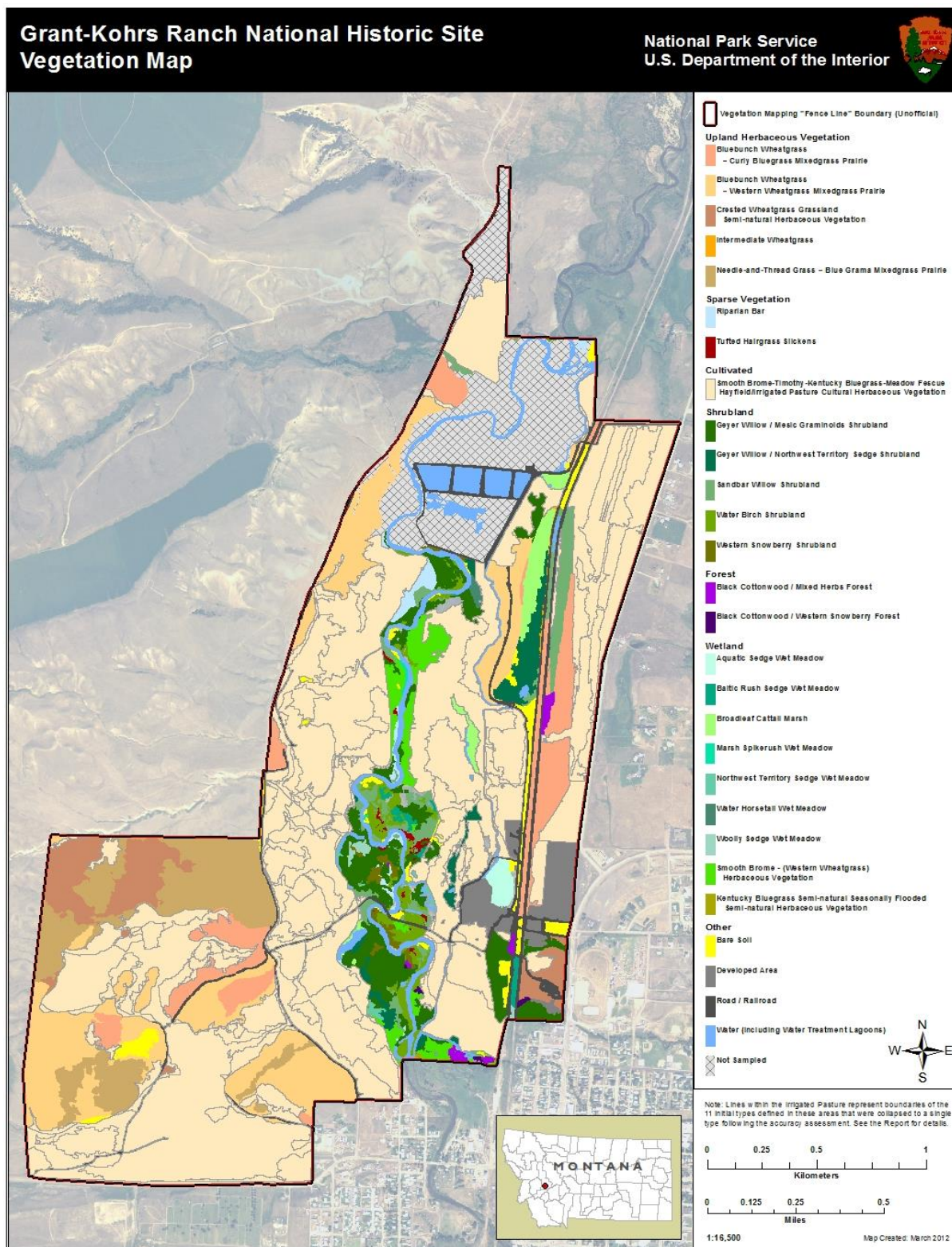


Figure 16. Final Vegetation Map for Grant-Kohrs Ranch National Historic Site. Faint gray lines within the large pasture polygons bound the 12 initial pasture types. Note the boundary shown is an unofficial 'fence line' boundary used for the Vegetation Mapping project.

Table 7. Summary of extent and spatial characteristics of final vegetation and landcover types at Grant-Kohrs Ranch National Historic Site. All sizes are acres.

Final Type	Count	Smallest Polygon	Largest Polygon	Total	% of Total
PLANTED/CULTIVATED (CULTURAL) HERBACEOUS VEGETATION					
<i>(Bromus inermis - Elymus repens - Phleum pratense - Poa pratensis - Schedonorus pratensis)</i> Irrigated Pasture Cultural Herbaceous Vegetation	23	0.09	175.90	759.41	
PLANTED/CULTIVATED (CULTURAL) HERBACEOUS VEGETATION TOTAL	23			759.41	47.48
RIPARIAN WETLAND/FORESTS/WOODLANDS/SHRUBLANDS					
<i>Agrostis (gigantea, stolonifera)</i> Semi-natural Herbaceous Vegetation	19	0.03	1.35	7.06	
<i>Betula occidentalis</i> Shrubland	30	0.03	4.62	22.89	
<i>Bromus inermis - (Pascopyrum smithii)</i> Semi-natural Herbaceous Vegetation	11	0.11	7.97	21.80	
<i>Carex aquatilis</i> Herbaceous Vegetation	1	5.23	5.23	5.23	
<i>Carex pellita</i> Herbaceous Vegetation	3	0.35	0.70	1.41	
<i>Carex utriculata</i> Herbaceous Vegetation	7	0.02	0.64	1.73	
<i>Deschampsia caespitosa</i> Slickens Semi-natural Sparse Vegetation	17	0.03	1.51	3.37	
<i>Eleocharis palustris</i> Herbaceous Vegetation	6	0.01	0.54	0.89	
<i>Equisetum fluviatile</i> Herbaceous Vegetation	1	1.24	1.24	1.24	
<i>Juncus balticus</i> Herbaceous Vegetation	9	0.04	1.61	3.16	
<i>Poa pratensis</i> Semi-natural Seasonally Flooded Herbaceous Vegetation	1	0.26	0.26	0.26	
<i>Populus balsamifera</i> (ssp. <i>trichocarpa</i> , ssp. <i>balsamifera</i>) / <i>Symphoricarpos</i> (<i>albus</i> , <i>occidentalis</i> , <i>oreophilus</i>) Forest	4	0.03	0.22	0.55	
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / Mixed Herbs Forest	6	0.02	1.35	2.98	
Rocky Mountain Riparian Bar Sparse Vegetation	11	0.04	4.43	9.55	
<i>Salix exigua</i> Temporarily Flooded Shrubland	32	0.03	10.57	33.76	
<i>Salix geyeriana</i> / <i>Carex utriculata</i> Shrubland	11	0.07	11.74	19.86	
<i>Salix geyeriana</i> / Mesic Graminoids Shrubland	37	0.04	13.50	61.37	
<i>Symphoricarpos occidentalis</i> Shrubland	8	0.12	1.21	4.00	
<i>Typha (latifolia, angustifolia)</i> Western Herbaceous Vegetation	7	0.04	8.34	13.78	
RIPARIAN WETLAND/FORESTS/WOODLANDS/SHRUBLANDS TOTAL	221			214.88	13.43
UPLAND HERBACEOUS VEGETATION					
<i>Agropyron cristatum - (Pascopyrum smithii, Hesperostipa comata)</i> Semi-natural Herbaceous Vegetation	7	0.30	37.86	48.51	
<i>Hesperostipa comata - Bouteloua gracilis - Carex filifolia</i> Herbaceous Vegetation	5	0.47	54.08	83.42	

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Final Type	Count	Smallest Polygon	Largest Polygon	Total	% of Total
<i>Pseudoroegneria spicata</i> - <i>Pascopyrum smithii</i> Herbaceous Vegetation	16	0.02	43.25	150.35	
<i>Pseudoroegneria spicata</i> - <i>Poa secunda</i> Herbaceous Vegetation	14	0.01	16.18	73.45	
<i>Thinopyrum intermedium</i> Semi-natural Herbaceous Vegetation	1	1.65	1.65	1.65	
UPLAND HERBACEOUS VEGETATION TOTAL	43			357.37	22.34
LANDCOVER/NON-VEGETATED/OTHER					
Bare soil	32	0.03	3.94	19.16	
Developed Area	15	0.02	12.94	28.01	
Road	13	0.07	28.13	38.07	
Unsampled	18	0.01	55.04	128.91	
Water	41	0.01	22.13	53.78	
LANDCOVER/NON-VEGETATED/OTHER TOTAL	119			267.94	16.75
GRAND TOTAL	406			1599.60	

Ecological Systems

Table 8 organizes the 25 final types at GRKO under six accepted NatureServe Ecological Systems (Comer et al. 2003) and two additional vegetation types characterized by highly altered or non-native vegetation that do not fall into a recognized ecological system. The Pasture type accounts for over half of the vegetated area of the Ranch. The five upland bunchgrass Associations belong to the Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland Ecological System and account for a quarter of the vegetated area. The riparian zone is split among five Ecological Systems with the largest portion being taller woody Associations belonging to the Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland. The Rocky Mountain Alpine-Montane Wet Meadow and North American Arid West Emergent Marsh Ecological Systems only account for less than 5% of the vegetated area but add a large increment of biological diversity to the Ranch. The 2.4 acres of *Deschampsia caespitosa* Slickens Semi-natural Sparse Vegetation was designated as Pollution Altered Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland. Descriptions of the six ecological systems recognized by NatureServe are found in Appendix F.

Table 8. Summary statistics for Grant-Kohrs Ranch National Historic Site final vegetation types within ecological system or vegetation type.

Ecological System and component Final Types	Total Area	% of total
Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland		
<i>Agropyron cristatum</i> - (<i>Pascopyrum smithii</i> , <i>Hesperostipa comata</i>) Semi-natural Herbaceous Vegetation	48.51	
<i>Hesperostipa comata</i> - <i>Bouteloua gracilis</i> - <i>Carex filifolia</i> Herbaceous Vegetation	83.42	
<i>Pseudoroegneria spicata</i> - <i>Pascopyrum smithii</i> Herbaceous Vegetation	150.35	
<i>Pseudoroegneria spicata</i> - <i>Poa secunda</i> Herbaceous Vegetation	73.45	
<i>Thinopyrum intermedium</i> Semi-natural Herbaceous Vegetation	1.65	
Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland Total	357.37	22.34%
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland		
<i>Betula occidentalis</i> Shrubland	22.89	
<i>Populus balsamifera</i> (ssp. <i>trichocarpa</i> , ssp. <i>balsamifera</i>) / <i>Symphoricarpos</i> (<i>albus</i> , <i>occidentalis</i> , <i>oreophilus</i>) Forest	0.55	
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / Mixed Herbs Forest	2.98	
<i>Salix exigua</i> Temporarily Flooded Shrubland	33.76	
<i>Salix geyeriana</i> / <i>Carex utriculata</i> Shrubland	19.86	
<i>Salix geyeriana</i> / Mesic Graminoids Shrubland	61.37	
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland Total	141.40	8.84%
Rocky Mountain Alpine-Montane Wet Meadow		
<i>Agrostis</i> (<i>gigantea</i> , <i>stolonifera</i>) Semi-natural Herbaceous Vegetation	7.06	
<i>Bromus inermis</i> - (<i>Pascopyrum smithii</i>) Semi-natural Herbaceous Vegetation	21.80	
<i>Carex aquatilis</i> Herbaceous Vegetation	5.23	
<i>Carex pellita</i> Herbaceous Vegetation	1.41	
<i>Carex utriculata</i> Herbaceous Vegetation	1.73	
<i>Eleocharis palustris</i> Herbaceous Vegetation	0.89	
<i>Equisetum fluviatile</i> Herbaceous Vegetation	1.24	
<i>Juncus balticus</i> Herbaceous Vegetation	3.16	

Ecological System and component Final Types	Total Area	% of total
<i>Poa pratensis</i> Semi-natural Seasonally Flooded Herbaceous Vegetation	0.26	
Rocky Mountain Alpine-Montane Wet Meadow Total	42.77	2.67%
North American Arid West Emergent Marsh		
<i>Typha</i> (<i>latifolia</i> , <i>angustifolia</i>) Western Herbaceous Vegetation	13.78	
North American Arid West Emergent Marsh Total	13.78	0.86%
Northwestern Great Plains Riparian		
Rocky Mountain Riparian Bar Sparse Vegetation	9.55	
Northwestern Great Plains Riparian Total	9.55	0.60%
Rocky Mountain Lower Montane-Foothill Shrubland		
<i>Symphoricarpos occidentalis</i> Shrubland	4.00	
Rocky Mountain Lower Montane-Foothill Shrubland Total	4.00	0.25%
Other vegetation type and component association(s) – No or unknown Ecological System		
(<i>Bromus inermis</i> - <i>Elymus repens</i> - <i>Phleum pratense</i> - <i>Poa pratensis</i> - <i>Schedonorus pratensis</i>) Irrigated Pasture Cultural Herbaceous Vegetation	759.41	
Bare soil	19.16	
Deschampsia caespitosa Slickens Semi-natural Sparse Vegetation	3.37	
Developed Area	28.01	
Road	38.07	
Water	53.78	
Unsampled	128.91	
Other vegetation type and component association(s) – No Ecological System Total	1030.72	64.44%
Grand Total	1599.60	

Verification Plots

Several types previously undocumented within the NVC, emerged as a result of the mapping effort at LIBI. Consequently, it was decided to establish verification plots in these new types. As of 2010, 14 verification plots had been sampled at LIBI in 12 types (two types had two plots). Methodology used followed the Vegetation Mapping Program protocol for classification plots in large parks. Verification data include a full floristic treatment (i.e. species level cover) and select environmental attributes. These data are available in the public domain (via the [NPS/USGS Vegetation Mapping Program](#) web site and/or VegBank) so that future development of the USNVC will include these types and enable LIBI and other users to see how types recorded as of 2010 are treated as the USNVC matures. The ROMN geospatial database developed for the LIBI project also includes the verification data. Note that some verification plots have a different final vegetation type name than the larger polygon they are nested within due to differences in how vegetation structure was interpreted across scale (e.g., the verification plot may be a small inclusion in a larger polygon).

Updating the Vegetation Map and Classification

Vegetation maps and classifications are (by design) static products. Imagery and field data are based on samples of conditions that existed over a span of only one to two years. However, vegetation community structure is dynamic across many scales, with changes due to both natural and anthropogenic causes. Even in the absence of any large scale disturbance event, map products will gradually become less accurate and useful as succession, erosion, sedimentation,

and other natural processes change the composition and distribution of vegetation across the Park. In the event of any large scale disturbances, the map will immediately become inaccurate for some or all areas of the park. At the more coarse levels in the GRKO classification the data presented in this report are likely correct for some time to come. However, at the patch scale the data presented here will not be accurate (to varying degrees) over time.

The National Vegetation Mapping Program has no official position on the process for updating maps and classifications but recognizes the importance of the issue. Until the program can complete all natural resource parks in the country (target date is 2018) there will not be funds allocated to updates. However, there are many opportunities for individual Parks and networks to do so. Taking the perspective that the map products are an integral part of the park infrastructure to be used and maintained will allow the Park to capitalize on the investment the NPS has made in creating the map and allow the map to function more dynamically than would otherwise be possible.

In response to changes that occur in vegetation, or any differences that are observed between the map and the landscape, it is important to transfer those changes to the map products using the same mapping and classification standards with which the map was created. This will allow the map to be the best possible representation of the real world conditions that exist now and through the future. A record of the changes made to the map should be maintained in a log that documents what the change was, the justification for making it, and the party making the change. Imagery products are produced on a fairly regular basis that might be used in this effort. These include Landsat satellite imagery as well as the more inexpensive NAIP imagery used in GRKO. A focused ground-based sampling effort may be the best means to understand the diverse changes due to disturbances and other, more subtle, changes. However, even simple efforts such as GRKO and ROMN recording GPS locations of unique vegetation not already on the map or where obvious change has occurred are useful.

The GRKO Vegetation Mapping database contains the point, map, AA and verification plot data collected during the project. The database structure (Appendix B) allows sample locations to be resampled and the data entered using the same plot code with a new date. Together these constitute an “event” and allow the database to track the vegetation sampled at the same location repeatedly through time. This will be valuable for various long-term monitoring efforts such as planned by the Rocky Mountain Network. To formalize the update process, the following steps could be followed by GRKO and the ROMN:

- Develop a protocol for updating data that includes the update cycle,
- Integrate this process with monitoring efforts, especially to detect more subtle change,
- Adhere to Vegetation Mapping Program standards,
- Define exhaustively the range of disturbance conditions to consider (especially fire and flooding).

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Available: <http://mac.usgs.gov/mac/isb/pubs/factsheets/fs17199.html>

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Available: <http://www.wrcc.dri.edu/summary/Climsmco.html>.

Appendix A: Field Data Collection Forms

This appendix presents examples of the forms used in collecting field data for the GRKO Vegetation Mapping Project.

Figure A-1. Field form for initial polygon attribution

Crew:			Year:							GPS Unit #:							See		
Poly ID	Super class	Owner	Date mm/dd	13 North - NAD83 UTM E	UTM N	WP #	# pts	err	New Super Class	New Owner	Association	D1	D1-CC	D2	D2-CC	D3	D3-CC	T-CC	Notes
0105	med	MIXED																	☐
0106	high	MIXED																	☐
0107	high	MIXED																	☐
0118	high	MIXED																	☐
0119	high	MIXED																	☐
0129	high	MIXED																	☐
0147	high	MIXED																	☐
0149	high	MIXED																	☐
0150	med	MIXED																	☐
0180	med	MIXED																	☐
0190	med	MIXED																	☐
0192	med	MIXED																	☐
0204	med	MIXED																	☐
0239	high	MIXED																	☐
0240	high	MIXED																	☐
0243	low	MIXED																	☐
0244	low	MIXED																	☐
0252	med	MIXED																	☐
0287	high	MIXED																	☐
0294	low	MIXED																	☐
0295	low	MIXED																	☐
0297	low	MIXED																	☐
0298	high	MIXED																	☐

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Figure A-2. Field form for polygon notes/changes

Polygon ID	Date	Dominant	Cover Class	Notes

Figure A-3. Example of a completed AA field form for GRKO AA

Revised January 2007

Accuracy Assessment Form
USGS-NPS Vegetation Mapping Program

Use one separate form for each waypoint collected. For each waypoint, fields marked in black capital letters are mandatory; those marked in orange italics are filled out only as are needed or applicable.

1. **PLOT (WAYPOINT) #:** 302 2. **DATE:** 07/31/2007

3. **OBSERVER (DETERMINING ASSOCIATION)** Daniel Robinson

4. *Other Staff (assisting)* Miguel Trejillo

5. **PLOT CONFIGURATION** (circle applicable shape and dimension used):
Circular, 18 meters radius (1st choice) Rectangular, 25 m x 40 m (2nd choice)
Rectangular, 20 m x 50 m (3rd choice) Rectangular, 10 m x 100 m (4th choice)

6. **PLOT CENTER UTM NORTHING** 5142551

7. **PLOT CENTER UTM EASTING** 0366013

8. **POSITION ACCURACY** (in meters) of above (from GPS) 4.3
Offset of above (if applicable; give reason in #22 "Comments"):

9. *Offset Distance (m):* _____ 10. *Offset Azimuth (degrees):* _____

11. *Plot end1 UTM Easting (if rectangular plot used)* _____

12. *Plot end1 UTM Northing (if rectangular plot used)* _____

13. *Position Accuracy (in meters) of above (from GPS) (if applicable)* _____

14. *Plot end2 UTM Easting (if rectangular plot used)* _____

15. *Plot end2 UTM Northing (if rectangular plot used)* _____

16. *Position Accuracy (in meters) of above (from GPS) (if applicable)* _____

17. **UTM Zone** 12 18. **Datum** NAD83

19. **DOMINANT VEGETATION ASSOCIATION** in plot (from key):
JUBA

20. *Other possibilities for dominant association in plot (if applicable):*

21. *If, even after reconfiguring, plot has multiple associations, list additional associations and percentage of plot covered by each (Pages for all should total 100%):*
Dominant Association (#19 or #20): _____ *Page:* _____
Association 2 (list): _____ *Page:* _____
Association 3 (list): _____ *Page:* _____

22. *Other possibilities for dominant association in plot (if applicable):*

19. **DOMINANT/CHARACTERISTIC SPECIES IN TREE LAYER** (~ 1 – 5 species, where layer is present)

20. **DOMINANT/CHARACTERISTIC SPECIES IN TREE LAYER** (~ 1 – 5 species, where layer is present):

21. **DOMINANT/CHARACTERISTIC SPECIES IN HERB LAYER** (~ 1 – 5 species, where layer is present):
JUBA, AGSM, CALA, CIAP

22. *Other comments / explanations (if needed)* _____

Appendix B: Key to Initial Vegetation Types at Grant-Kohrs Ranch National Historic Site

This dichotomous key is specific **to the initial vegetation types** delineated during the summer 2006 mapping of the vegetation at the Grant-Kohrs Ranch. A key to the final types is provided below.

Choices are made from paired couplets with the same number. After a choice is made from the couplet, the user either goes to the next higher numbered couplet, or if the selected choice is ended with a “go to #” statement the user skips to that even higher number. The key uses topographic position or land use and life form before considering specific indicator species.

The natural vegetation community type names used in this Grant-Kohrs specific key are the community names present in the original source documents that were used to classify the vegetation at the Grant-Kohrs Ranch. These natural community types are described in either Mueggler and Stewart 1980 or Hansen et al 1995. Three semi-natural grassland community type names (followed by Alliance) are taken directly from the National Vegetation Classification System as represented by the Nature Serve Explorer Ecological Communities & Systems website. Irrigated pasture or hayfield community names were established specifically for this project. The irrigated field types are mostly introduced grasses, but include one native grass (western wheatgrass), one introduced mustard weed (flixweed) and one native wetland species (Baltic rush). Two additional project specific types were used for toxic metal contaminated soils found in the riparian zone. These toxic metal associated “types” are for near monotypic tufted hairgrass stands that often form an edging band around bare soil metal contaminated areas, and for the essentially bare soil metal contaminated areas which are called slickens.

- Mueggler, W. F.; Stewart, W. L. 1980. Grassland and shrubland habitat types of western Montana. Ogden, UT: U.S.D.A. Forest Service, Intermountain Forest and Range Experiment Station. General Technical Report INT-66. 154 pp.
- Hansen, Paul L.; Pfister, Robert D.; Boggs, Keith; Cook, Bradley J.; Joy, John; Hinckley, Dan K. 1995. Classification and management of Montana's riparian and wetland sites. School of Forestry, University of Montana, Missoula, MT 59812: Montana Forest and Conservation Experiment Station: Miscellaneous Publication No. 54. xvi + 646 pp.
- National Vegetation Classification System Alliances
<http://www.natureserve.org/explorer/>
- Project specific types for irrigated pastures/hayfields and riparian areas with high concentration of toxic metal sediments.

The two published original source documents have detailed descriptions of their various natural community types. These source documents also contain ecological and management information, and the species plot data that was used to develop each classification system. If the key leads to a community type described in one the printed source documents the page number is given for that community description in its source document. If the semi-natural community name in the key ends with the word Alliance that community is a National Vegetation

Classification System type described in the Nature Serve Explorer Ecological Communities & Systems website.

To effectively use this key you should be able to identify the following 31 indicator species based on their growth form and vegetative characteristics. Nomenclature in the indicator species list follows that of the two original printed source documents.

Binomial in Regional Flora	Local Common Name
<i>Agropyron cristatum</i>	crested wheatgrass
<i>Agropyron intermedium</i>	intermediate wheatgrass
<i>Agropyron repens</i>	quackgrass
<i>Agropyron smithii</i>	western wheatgrass
<i>Agropyron spicatum</i>	bluebunch wheatgrass
<i>Agrostis gigantea</i>	redtop
<i>Betula occidentalis</i>	water birch
<i>Bouteloua gracilis</i>	blue grama
<i>Bromus inermis</i>	smooth brome
<i>Carex aquatilis</i>	water sedge
<i>Carex lasiocarpa</i> var. <i>latifolia</i>	Woolly sedge
<i>Carex rostrata</i> var. <i>utriculata</i>	Northwest Territory sedge
<i>Deschampsia caespitosa</i>	tufted hairgrass
<i>Descurainia sophia</i>	flixweed
<i>Eleocharis palustris</i>	common spikesedge
<i>Equisetum fluviatile</i>	water horsetail
<i>Festuca pratensis</i> ¹	meadow fescue
<i>Juncus balticus</i>	Baltic rush
<i>Phleum pratense</i>	timothy
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Poa sandbergii</i>	curly bluegrass
<i>Populus trichocarpa</i>	black cottonwood
<i>Rosa woodsii</i>	Woods rose
<i>Salix bebbiana</i>	Bebb willow
<i>Salix boothii</i>	Booth willow
<i>Salix exigua</i>	sandbar willow
<i>Salix geyeriana</i>	Geyer willow
<i>Stipa comata</i>	needle and thread grass
<i>Stipa viridula</i>	green needlegrass
<i>Symphoricarpos occidentalis</i>	western snowberry
<i>Typha latifolia</i>	common cattail

¹*Schedonorus pratensis* (syn: *Festuca pratensis*) (meadow fescue) cultivar on Grant-Kohrs Ranch is difficult to identify from most floral keys.

This indicator species nomenclature is also in concurrence with that used by the standard floras covering Montana:

- Dorn, Robert D. 1984. Vascular plants of Montana. Cheyenne, Wyoming: Mountain

West Publishing. 276pp.

- Hitchcock, C. L.; Cronquist, Arthur. 1973. Flora of the Pacific Northwest an illustrated manual. Seattle WA: University of Washington Press. 730pp.

Two useful references with illustrations for identifying willow species found on the Grant-Kohrs Ranch are:

- Brunsfeld, S. J.; Johnson F.D. 1985. Field guide to the willows of east-central Idaho. University of Idaho, College of Forestry, Wildlife and Range Sciences, Moscow, ID83843: Forest, Wildlife and Range Experiment Station; Bulletin Number 39. 95pp.
- Heinze, D.H. 1994. Willows of Montana. Riparian Technical Bulletin No. 2. Billings, MT: USDI Bureau of Land Management. 71pp.

A useful illustrated key for indicator species sedges on the Grant-Kohrs Ranch is:

- Lesica P, Husby P. 2001. Field guide to Montana's wetland vascular plants. Helena, MT: Montana Wetlands Trust. 92pp.

1. Dry upland grasslands

2. Introduced grasses *Agropyron cristatum* (crested wheatgrass) or *Agropyron intermedium* (intermediate wheatgrass) more abundant than just an occasional plant

3. *Agropyron cristatum* (crested wheatgrass) prevalent
***Agropyron cristatum* Semi-natural Herbaceous Alliance**
Crested Wheatgrass Semi-natural Herbaceous Alliance

3'. *Agropyron intermedium* (intermediate wheatgrass) prevalent
***Thinopyrum intermedium* Semi-natural Herbaceous Alliance**
Intermediate Wheatgrass Semi-natural Herbaceous Alliance

2'. Native grasses dominate and introduced grasses lacking (go to 4)

4. *Stipa comata* (needle and thread grass) dominant
Stipa comata/Bouteloua gracilis
Needle and thread grass/blue grama

4'. *Agropyron spicatum* (bluebunch wheatgrass) abundant

5. *Bouteloua gracilis* (blue grama) with more than 5% canopy cover
Agropyron spicatum/Bouteloua gracilis
Bluebunch wheatgrass/blue grama

5'. *Bouteloua gracilis* (blue grama) lacking

6. *Agropyron smithii* (western wheatgrass) present

7. *Stipa viridula* (green needle grass) absent
Agropyron spicatum/Agropyron smithii
Bluebunch wheatgrass/western wheatgrass

7'. *Stipa viridula* (green needle grass) present
Agropyron spicatum/Agropyron smithii/Stipa viridula
Bluebunch wheatgrass/western wheatgrass/ green needle grass

6'. *Agropyron smithii* (western wheatgrass) absent (go to 8)

8. *Poa sandbergii* (Sandberg bluegrass) evident
Agropyron spicatum/Poa sandbergii
Bluebunch wheatgrass/Sandberg bluegrass

8'. Other indicator grasses lacking and *Agropyron spicatum* (bluebunch wheatgrass) abundant

Pseudoroegneria spicata* Herbaceous Alliance

Bluebunch Wheatgrass Herbaceous Alliance

1'. Irrigated pasture/hayfields or riparian floodplain (go to 9)

9. Irrigated pasture/hayfields including irrigated gullies

10. The forb *Descurainia sophia* (flixweed) is dominant

***Descurainia sophia* Irrigated Pasture**

Flixweed Irrigated Pasture

10'. Grasses or *Juncus balticus* (Baltic rush) dominate

11. *Juncus balticus* (Baltic rush) dominates

***Juncus balticus* Irrigated Pasture**

Baltic rush Irrigated Pasture

11'. Grasses dominate

12. Native grass *Agropyron spicatum* is dominant

Pseudoroegneria spicata* Herbaceous Alliance

Bluebunch Wheatgrass Herbaceous Alliance

12'. Introduced perennial grasses dominant

13. *Agropyron repens* (quackgrass) dominant or co-dominant

14. *Agropyron repens* (quackgrass) forms most of the grass component

***Agropyron repens* Irrigated Pasture**

Quackgrass Irrigated Pasture

14'. *Agropyron repens* (quackgrass) approximately co-dominant with other grasses

15. *Agropyron repens* (quackgrass) and *Bromus inermis* (smooth brome) nearly co-dominant

***Agropyron repens* /*Bromus inermis* Irrigated Pasture**

Quackgrass/smooth brome Irrigated Pasture

15'. *Agropyron repens* (quackgrass) and *Phleum pratense* (timothy) nearly co-dominant

***Agropyron repens* /*Phleum pratense* Irrigated Pasture**

Quackgrass/timothy Irrigated Pasture

*Most are along RR tracks, only one on west side upland, a few in irrigated pastures.

13'. *Agropyron repens* (quackgrass) lacking (go to 16)

16. *Bromus inermis* (smooth brome) either dominant or approximately co-dominant

17. *Bromus inermis* (smooth brome) forms most of the grass component

***Bromus inermis* Irrigated Pasture**

Smooth brome Irrigated Pasture

17'. *Bromus inermis* (smooth brome) approximately co-dominant with *Phleum pratense* (timothy)

***Bromus inermis*/*Phleum pratense* Irrigated Pasture**

Smooth brome/timothy Irrigated Pasture

16'. *Bromus inermis* (smooth brome) neither dominant nor approximately co-dominant (go to 18)

18. *Phleum pratense* (timothy) forms most of the grass component

***Phleum pratense* Irrigated Pasture**

Timothy Irrigated Pasture

18'. *Phleum pratense* (timothy) lacking

19. *Festuca pratensis*[‡] (meadow fescue) forms most of the grass component

***Festuca pratensis* Irrigated Pasture**

Meadow fescue Irrigated Pasture

19'. *Festuca pratensis* (meadow fescue) lacking, *Agrostis stolonifera* (redtop) or *Poa pratensis* (Kentucky bluegrass) the dominant grass

20. *Agrostis stolonifera* (redtop) forms most of the grass component, usually on poorly drained soils

***Agrostis stolonifera* Irrigated Pasture**

Redtop Irrigated Pasture

20'. *Poa pratensis* (Kentucky bluegrass) the dominant grass

***Poa pratensis* Irrigated Pasture**

Kentucky bluegrass Irrigated Pasture

[‡]*Festuca pratensis* (meadow fescue) cultivar on Grant-Kohrs Ranch difficult to identify from most flora keys

9'. Riparian floodplain (go to 21)

21. Bare soil polygon, often with blue-green salts on surface and surface objects
Slickens

21'. Vegetated polygon

22. Herbaceous aspect, trees and tall shrubs absent, may have an occasional short shrub but shrubs not distributed throughout the polygon

23. Sedges with a combined canopy cover of at least 25%

24. *Carex rostrata* (beaked sedge) with at least 25% canopy cover
Carex rostrata
Beaked sedge

24'. *Carex rostrata* (beaked sedge) with less than 25% canopy cover

25. *Carex aquatilis* (water sedge) with at least 25% canopy cover
Carex aquatilis
Water sedge

25. *Carex lasiocarpa* (slender sedge) with at least 25% canopy cover
cover
Carex lasiocarpa
Slender sedge

23'. Sedges with a combined canopy cover of less than 25% (go to 26)

26. *Typha latifolia* (common cattail) with at least 25% canopy cover
Typha latifolia
Common cattail

26'. *Typha latifolia* (common cattail) with less than 25% canopy cover

27. *Equisetum fluviatile* (water horsetail) with at least 25% canopy cover
Equisetum fluviatile
Water horsetail

27'. *Equisetum fluviatile* (water horsetail) with less than 25% canopy cover

28. *Eleocharis palustris* (common spikesedge) with at least 25% canopy cover
cover
Eleocharis palustris
Common spikesedge

28.' *Eleocharis palustris* (common spikesedge) with less than 25% canopy cover

29. *Juncus balticus* (Baltic rush) with more canopy cover than any other species

Juncus balticus
Baltic rush

29'. One individual grass species with more canopy cover than any other herbaceous life form

30. *Agrostis stolonifera* (redtop) with more canopy cover than any other individual herbaceous species

Agrostis stolonifera
Redtop

30'. Other individual herbaceous species with more canopy cover than *Agrostis stolonifera* (redtop)

31. *Bromus inermis* (smooth brome) with more canopy cover than any other herbaceous species

Bromus inermis
Smooth brome

31'. Other individual herbaceous species with more canopy cover than *Bromus inermis* (smooth brome)

32. *Deschampsia caespitosa* (tufted hairgrass) dominant

Deschampsia caespitosa
Tufted hairgrass slickens

32'. Other individual herbaceous species with more canopy cover than *Deschampsia caespitosa* (tufted hairgrass)

33. *Poa pratensis* (Kentucky bluegrass) with more canopy cover than any other herbaceous species

Poa pratensis
Kentucky bluegrass

33'. Does not fit with any type above, often early seral vegetation on new bar or otherwise disturbed area

Unclassified riparian

22.' Woody species present and distributed throughout the polygon (go to 34)

34. Large trees (when mature) with canopy cover greater than 25%; these are all *Populus trichocarpa* (black cottonwood)

35. *Populus trichocarpa* (black cottonwood) with an understory short shrub layer of 10% canopy cover dominated by *Symphoricarpos occidentalis* (western snowberry) or *Rosa woodsii* (Woods rose)

Populus trichocarpa*/ *Symphoricarpos occidentalis
Black cottonwood/western snowberry

35.' *Populus trichocarpa* (black cottonwood) with an understory short shrub layer of less than 10% canopy cover

***Populus trichocarpa*/Herbaceous understory**
Black cottonwood/herbaceous understory

34.' Large tree species lacking, shrubs distributed throughout the polygon (go to 36)

36. Short shrubs (less than 6 ft. tall when mature) prevalent, tall shrubs or *Salix exigua* (sandbar willow) lacking.

37. *Rosa woodsii* (Woods rose) with at least 15% canopy cover and with the greatest canopy cover in the tallest layer

Rosa woodsii
Woods rose

37. *Symphoricarpos occidentalis* (western snowberry) with at least 15% canopy cover and with the greatest canopy cover in the tallest layer

Symphoricarpos occidentalis
Western snowberry

36.' Tall shrubs (six ft. or taller when mature) or *Salix exigua* (sandbar willow) prevalent (go to 38)

38. Willows with less than 10% canopy cover, *Betula occidentalis* (water birch) with at least 15% canopy cover and with the greatest canopy cover in the tallest layer

Betula occidentalis
Water birch p. 355

38.' Willows with at least 10% canopy cover

39. *Salix geyeriana* (Geyer willow) and/or *Salix boothii* (Booth willow) alone or in combination with more canopy cover than other individual willow species

40. *Carex* spp. (sedge species) individually or in combination with at least 10% canopy cover

Salix geyeriana*/*Carex rostrata

Geyer willow/beaked sedge

40.' *Carex* spp. (sedge species) individually or in combination with less than 10% canopy cover

Salix geyeriana

Geyer willow

39.' *Salix bebbiana* (Bebb willow) or *Salix exigua* (sandbar willow) with greater canopy cover than other individual willows (go to 41)

41. *Salix bebbiana* (Bebb willow) with greater canopy cover than other individual willows

Salix bebbiana

Bebb willow

41'. *Salix exigua* (sandbar willow) with greater canopy cover than other individual willows

Salix exigua

Sandbar willow

Appendix C: Accuracy Assessment Results

This appendix presents the final contingency tables for the map classes used at GRKO, and for ecological systems represented at the monument. Tables C-1 and C-2 show the data metrics for each map class, a mean value for each type of error, and a mean value for the confidence interval for each type of error for pre- and post-AA types. As expected, the overall accuracy of the map and individual accuracies increase as requirements are relaxed. Table C-2 evaluates the final ecological systems to which map classes were assigned.

Contingency tables are read as follows. The rows represent the assigned map class value for each of the polygons (the map) and the columns represent the reference or accuracy assessment point observed in the field. Shaded cells on the principal diagonal represent map values confirmed as correct. The sum of the principal diagonal divided by the total number of sample points provides the overall map accuracy. Additionally, each map class has two accuracy results, the “producers accuracy” showing errors of omission, and the “users” map accuracy reflecting errors of commission. The total number of samples (n) and a confidence interval with a 90% two-sided limit for each class are also shown. Refer to Environmental Systems Research Institute et al. (1994) for guidance on interpretation.

Table C-1. GRKO final vegetation types contingency table

This table presents the 25 vegetated map classes retained following the accuracy assessment and revision process. Map Classes listed in rows; field calls listed in columns. Not all types were evaluated. Cells representing "correct" sites (absolute agreement between map class and field call) are shaded gray on the diagonal.

	<i>Symphoricarpos occidentalis</i>	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Symphoricarpos occidentalis</i>	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / Mixed Herbs	<i>Betula occidentalis</i>	<i>Salix exigua</i>	<i>Salix geyeriana</i> / Mesic Graminoids	<i>Salix geyeriana</i> / <i>Carex utriculata</i>	<i>Typha latifolia</i>	Rocky Mountain Riparian Bar Sparse Vegetation	<i>Deschampsia cespitosa</i> Slickens	<i>Equisetum fluviatile</i>	<i>Eleocharis palustris</i>	<i>Carex aquatilis</i>	<i>Carex pallida</i>	<i>Carex utriculata</i>	<i>Pseudoroegneria spicata</i> – <i>Pascopyrum smithii</i>	<i>Pseudoroegneria spicata</i> – <i>Poa secunda</i>	<i>Hesperostipa comata</i> – <i>Bouteloua gracilis</i> – <i>Carex filifolia</i>	<i>Juncus balticus</i>	<i>Agrostis stolonifera</i>	<i>Eriophorum inermis</i>	<i>Poa pratensis</i>	Irrigated Pasture	<i>Agropyron cristatum</i>	<i>Thinopyrum intermedium</i>	open water	GRAND TOTALS	POINT ESTIMATE OF MAP CLASS USER'S ACCURACY	90% LOWER LIMIT, CONFIDENCE INTERVAL (two-sided)	90% UPPER LIMIT, CONFIDENCE INTERVAL (two-sided)**
<i>Symphoricarpos occidentalis</i>					1					1																	3	0.0%	0%	17%
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Symphoricarpos occidentalis</i>		1	1														1							2			5	20.0%	0%	59%
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / Mixed Herbs				5																							0	not evaluated	N/A	N/A
<i>Betula occidentalis</i>					1	6							1														5	100.0%	90%	100%
<i>Salix exigua</i>																											8	12.5%	0%	38%
<i>Salix geyeriana</i> / Mesic Graminoids			1			5	6																	4			16	31.3%	9%	53%
<i>Salix geyeriana</i> / <i>Carex utriculata</i>						2	1	3																			6	16.7%	0%	50%
<i>Typha latifolia</i>								4																			4	100.0%	88%	100%
Rocky Mountain Riparian Bar Sparse Vegetation					1																			4			5	not evaluated	N/A	N/A
<i>Deschampsia cespitosa</i> Slickens				1						1							1										3	33.3%	0%	95%
<i>Equisetum fluviatile</i>						1													1				1				3	not evaluated	N/A	N/A
<i>Eleocharis palustris</i>																											0	not evaluated	N/A	N/A
<i>Carex aquatilis</i>																			5								5	0.0%	0%	10%
<i>Carex pallida</i>						1							1														3	33.3%	0%	95%
<i>Carex utriculata</i>														1					1								1	0.0%	0%	50%
<i>Pseudoroegneria spicata</i> – <i>Pascopyrum smithii</i>																4	15	5							1	3	28	14.3%	2%	27%
<i>Pseudoroegneria spicata</i> – <i>Poa secunda</i>																1	20										21	95.2%	85%	100%
<i>Hesperostipa comata</i> – <i>Bouteloua gracilis</i> – <i>Carex filifolia</i>																	11	3							2		16	18.8%	0%	38%
<i>Juncus balticus</i>																											0	not evaluated	N/A	N/A
<i>Agrostis stolonifera</i>							1			1														3			5	not evaluated	N/A	N/A
<i>Eriophorum inermis</i>													1														1	not evaluated	N/A	N/A
<i>Poa pratensis</i>		1																									1	not evaluated	N/A	N/A
Irrigated Pasture								1	1					1	1	1	1	2						125			133	94.0%	90%	96%
<i>Agropyron cristatum</i>																1		1			1				7		10	70.0%	41%	99%
<i>Thinopyrum intermedium</i>																											0	not evaluated	N/A	N/A
open water				1																							1	not evaluated	N/A	N/A
GRAND TOTALS	1	1	2	7	3	15	8	8	1	3	0	0	3	2	1	7	49	11	7	0	1	0	140	10	3	0	283	OVERALL ACCURACY:		
POINT ESTIMATE OF MAP CLASS PRODUCER'S ACCURACY	0%	100%	NA	71.4%	33.3%	33.3%	12.5%	50.0%	NA	33.3%	NA	NA	0%	0%	0%	57.1%	40.8%	27.3%	NA	NA	NA	NA	89.3%	70.0%	NA	NA	283	62.5%	57.6%	67.5%
LOWER LIMIT, 90% CONFIDENCE INTERVAL (two-sided)	0%	50%		36.2%	0.0%	10.0%	0.0%	14.7%		0%			0%	0%	0%	19.2%	28.2%	0.6%					84.6%	41.2%				KAPPA INDEX:		49.6%
UPPER LIMIT, 90% CONFIDENCE INTERVAL (two-sided)**	0%	100%	100%	94.8%	56.7%	38.0%	85.3%		94.8%		0%	0%	0%	0%	0%	95.1%	53.4%	53.9%					93.9%	98.8%						

** - reported as 100%, if calculated value > 100%, or as 0%, if calculated value < 0%

Table C-2. GRKO final ecological system contingency table.

This table represents the final five ecological systems and one equivalent group to which map classes were assigned. Assigned Map Classes listed in rows; field calls listed in columns. Cells representing "correct" sites (absolute agreement between map class and field call) are shaded gray on the diagonal.

	Rocky Mountain Lower Montane-Foothill Shrubland	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland	North American Arid West Emergent Marsh	Rocky Mountain Alpine-Montane Wet Meadow	Irrigated Pasture	Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland	Northwestern Great Plains Riparian	GRAND TOTALS	POINT ESTIMATE OF MAP CLASS USER'S ACCURACY (two-sided) ^{***}	LOWER LIMIT, 90% CONFIDENCE INTERVAL (two-sided) ^{***}	UPPER LIMIT, 90% CONFIDENCE INTERVAL (two-sided) ^{***}
Rocky Mountain Lower Montane-Foothill Shrubland		1			2			3	0.0%	0.0%	16.7%
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland		29	3	1	5	2		40	72.5%	59.6%	85.4%
North American Arid West Emergent Marsh			4					4	100.0%	87.5%	100.0%
Rocky Mountain Alpine-Montane Wet Meadow	1	3		4	11			19	21.1%	3.0%	39.1%
Irrigated Pasture, other		2	1	2	127	5		137	92.7%	88.7%	96.7%
Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland					1	74		75	98.7%	95.8%	100.0%
Northwestern Great Plains Riparian		1				4		5	not evaluated		
GRAND TOTALS	1	36	8	7	146	85	0	283			
POINT ESTIMATE OF MAP CLASS PRODUCER'S ACCURACY	0.0%	80.6%	50.0%	57.1%	87.0%	87.1%	NA	OVERALL ACCURACY:	84.1%	80.3%	87.9%
LOWER LIMIT, 90% CONFIDENCE INTERVAL (two-sided) ^{***}	0.0%	68.3%	14.7%	19.2%	82.1%	80.5%		KAPPA INDEX:	75.6%		
UPPER LIMIT, 90% CONFIDENCE INTERVAL (two-sided) ^{***}	50.0%	100%	100%	95.1%	91.9%	93.6%					

^{***} - reported as 100% or 0%, if calculated value > 100% or <0%, respectively

Appendix D: Key to Final Vegetation Types at Grant-Kohrs Ranch National Historic Site

This dichotomous key is specific to the **final vegetation types** at Grant-Kohrs Ranch. The key is “dichotomous”, which means the user follows the order of the ‘couplets’ and makes a choice between the 2 options represented in the couplet. The ordering of the couplets does matter, and the user should choose the option in each couplet that best fits the data or field situation. A choice leads the user to the next couplet to be utilized in the keying process, via a number at the far right, or else leads to the appropriate vegetation type.

If the choices the user makes leads to a “result”, then a vegetation type is named and represents a NVC association, alliance or group of alliances, or a landcover type. These NVC-based map classes are recognizable because “alliance” or “association” is in the name, although some of the landcover types may be described using NVC alliances. Keys are generally based on dominance within vegetation strata, with tree cover generally considered first, then shrubs, and finally the herbaceous component. Co-dominant species within a given strata may be important as well, in some cases an association or alliances will have 2 or more codominant species, which may or may not be present in all stands..

To effectively use this key you should be able to identify the following 31 indicator species based on their growth form and vegetative characteristics. Nomenclature in the indicator species list follows USDA PLANTS, except for *Juncus balticus*.

Binomial in Regional Flora	Binomial in Plants DB	Local Common Name
<i>Agropyron cristatum</i>	<i>Pascopyrum smithii</i>	crested wheatgrass
<i>Agropyron intermedium</i>	<i>Thinopyrum intermedium</i>	intermediate wheatgrass
<i>Agropyron repens</i>	<i>Elymus repens</i>	quackgrass
<i>Agropyron smithii</i>	<i>Pascopyrum smithii</i>	western wheatgrass
<i>Agropyron spicatum</i>	<i>Pseudoroegneria spicata</i>	bluebunch wheatgrass
<i>Agrostis gigantea</i>	<i>Agrostis stolonifera</i> ssp. <i>gigantea</i>	redtop
<i>Betula occidentalis</i>	<i>Betula occidentalis</i>	water birch
<i>Bouteloua gracilis</i>	<i>Bouteloua gracilis</i>	blue grama
<i>Bromus inermis</i>	<i>Bromus inermis</i>	smooth brome
<i>Carex aquatilis</i>	<i>Carex aquatilis</i>	water sedge
<i>Carex lasiocarpa</i> var. <i>latifolia</i>	<i>Carex pellita</i>	Woolly sedge
<i>Carex rostrata</i> var. <i>utriculata</i>	<i>Carex utriculata</i>	Northwest Territory sedge
<i>Deschampsia caespitosa</i>	<i>Deschampsia caespitosa</i>	tufted hairgrass
<i>Descurainia sophia</i>	<i>Descurainia sophia</i>	flixweed
<i>Eleocharis palustris</i>	<i>Eleocharis palustris</i>	common spikesedge
<i>Equisetum fluviatile</i>	<i>Equisetum fluviatile</i>	water horsetail
<i>Festuca pratensis</i> ¹	<i>Schedonoruspratensis</i> ¹	meadow fescue
<i>Juncus balticus</i>	<i>Juncus arcticus</i> ssp. <i>littoralis</i>	Baltic rush
<i>Phleum pratense</i>	<i>Phleum pratense</i>	timothy
<i>Poa pratensis</i>	<i>Poa pratensis</i>	Kentucky bluegrass

Binomial in Regional Flora	Binomial in Plants DB	Local Common Name
<i>Poa sandbergii</i>	<i>Poa secunda</i>	curly bluegrass
<i>Populus trichocarpa</i>	<i>Populus balsamifera</i> spp. <i>trichocarpa</i>	black cottonwood
<i>Rosa woodsii</i>	<i>Rosa woodsii</i>	Woods rose
<i>Salix bebbiana</i>	<i>Salix bebbiana</i>	Bebb willow
<i>Salix boothii</i>	<i>Salix boothii</i>	Booth willow
<i>Salix exigua</i>	<i>Salix exigua</i>	sandbar willow
<i>Salix geyeriana</i>	<i>Salix geyeriana</i>	Geyer willow
<i>Stipa comata</i>	<i>Hesperostipa comata</i>	needle and thread grass
<i>Stipa viridula</i>	<i>Nasella viridula</i>	green needlegrass
<i>Symphoricarpos occidentalis</i>	<i>Symphoricarpos occidentalis</i>	western snowberry
<i>Typha latifolia</i>	<i>Typha latifolia</i>	common cattail

¹*Schedonorus pratensis* (syn: *Festuca pratensis*) (meadow fescue) cultivar on Grant-Kohrs Ranch is difficult to identify from most floral keys.

This indicator species nomenclature, at least the synonyms, is also in concurrence with that used by the two standard floras covering Montana:

- Dorn, Robert D. 1984. Vascular plants of Montana. Cheyenne, Wyoming: Mountain West Publishing. 276pp.
- Hitchcock, C. L.; Cronquist, Arthur. 1973. Flora of the Pacific Northwest an illustrated manual. SeattleWA: University of Washington Press. 730pp.

Two useful references with illustrations for identifying willow species found on the Grant-Kohrs Ranch are:

- Brunsfeld, S. J.; Johnson F.D. 1985. Field guide to the willows of east-central Idaho. University of Idaho, College of Forestry, Wildlife and Range Sciences, Moscow, ID83843: Forest, Wildlife and Range Experiment Station; Bulletin Number 39. 95pp.
- Heinze, D.H. 1994. Willows of Montana. Riparian Technical Bulletin No. 2. Billings, MT: USDI Bureau of Land Management. 71pp.

A useful illustrated key for indicator species sedges on the Grant-Kohrs Ranch is:

- Lesica P, Husby P. 2001. Field guide to Montana's wetland vascular plants. Helena, MT: Montana Wetlands Trust. 92pp.

Key to Final Plant Communities at Grant-Kohrs Ranch

- 1a Dry upland grasslands (2)
- 1b Irrigated pasture/hayfields or riparian floodplain (8)
- 2a Introduced grasses *Agropyron cristatum* (crested wheatgrass) or *Thinopyrum* (*Agropyron*) *intermedium* (intermediate wheatgrass) more abundant than just an occasional plant (3)
- 2b Native grasses dominate and introduced grasses lacking (4)
- 3a *Agropyron cristatum* (crested wheatgrass) prevalent: ***Agropyron cristatum* - (*Pascopyrum smithii*, *Hesperostipa comata*) Semi-natural Herbaceous Vegetation**
- 3b *Thinopyrum intermedium* (intermediate wheatgrass) prevalent: ***Thinopyrum intermedium* Semi-natural Herbaceous Vegetation**
- 4a *Hesperostipa comata* (needle and thread grass) dominant. ***Hesperostipa comata* - *Bouteloua gracilis* – *Carex filifolia* Herbaceous Vegetation**
- 4b *Pseudoroegneria spicata* (bluebunch wheatgrass) abundant (5)
- 5a *Bouteloua gracilis* (blue grama) with more than 5% canopy cover: ***Pseudoroegneria spicata* – *Poa secunda* Herbaceous Vegetation**
- 5b *Bouteloua gracilis* (blue grama) lacking (6)
- 6a *Pascopyrum smithii* (western wheatgrass) present (7)
- 6b *Pascopyrum smithii* (western wheatgrass) absent. ***Pseudoroegneria spicata* – *Poa secunda* Herbaceous Vegetation**
- 7a *Nassella viridula* (green needle grass) absent: ***Pseudoroegneria spicata* – *Pascopyrum smithii* Herbaceous Vegetation**
- 7b *Nassella viridula* (green needle grass) present: ***Pseudoroegneria spicata* – *Poa secunda* Herbaceous Vegetation**
- 8a Irrigated pasture/hayfields including irrigated gullies (9)
- 8b Riparian floodplain (12)
- 9a The forb *Descurainia sophia* (flixweed) is dominant: **(*Bromus inermis* – *Elymus repens* - *Phleum pratense* - *Poa pratensis* – *Schedonorus pratensis*) Irrigated Pasture Herbaceous Vegetation**
- 9b Grasses and/or *Juncus balticus* (Baltic rush) dominate (10)
- 10a *Juncus balticus* (Baltic rush) dominates with significant presence of introduced grasses: **(*Bromus inermis* – *Elymus repens* - *Phleum pratense* - *Poa pratensis* – *Schedonorus pratensis*) Irrigated Pasture Herbaceous Vegetation**
- 10b Grasses dominate (11)

- 11a** Native grass *Pseudoroegneria spicata* is dominant (usually pasture areas that are not receiving supplemental water): ***Pseudoroegneria spicata* – *Pascopyrum smithii* Herbaceous Vegetation**
- 11b** Introduced perennial grasses (*Agrostis gigantea*, *Bromus inermis*, *Elymus repens*, *Phleum pratense*, *Poa pratensis*, and/or *Schedonorus pratensis*) dominant: **(*Bromus inermis* – *Elymus repens* - *Phleum pratense* - *Poa pratensis* – *Schedonorus pratensis*) Irrigated Pasture Herbaceous Vegetation**
- 12a** Bare soil polygon, often with blue-green salts on surface and surface objects: **Slicken**
- 12b** Vegetated polygon **(13)**
- 13a** Woody species present and distributed throughout the polygon **(14)**
- 13b** Herbaceous aspect, trees and tall shrubs absent, may have an occasional short shrub but shrubs not distributed throughout the polygon **(20)**
- 14a** Large trees (when mature) with canopy cover greater than 25%; these are all *Populus trichocarpa* (black cottonwood) **(15)**
- 14b** Large tree species lacking, shrubs distributed throughout the polygon **(16)**
- 15a** Understory consist of herbaceous species, shrubs lacking: ***Populus balsamifera* ssp. *trichocarpa* / Mixed Herbs Forest**
- 15b** *Symphoricarpos occidentalis* (western snowberry) present in understory: ***Populus balsamifera* (ssp. *trichocarpa*, ssp. *balsamifera*)/ *Symphoricarpos* (*albus*, *occidentalis*, *oreophilus*) Forest**
- 16a** Short shrubs (less than 6 ft tall when mature, usually *Symphoricarpos occidentalis* (western snowberry) or *Rosa woodsii* (Woods' rose), prevalent, tall shrubs or *Salix exigua* (sandbar willow) lacking: ***Symphoricarpos occidentalis* Shrubland**
- 16b** Tall shrubs (six ft or taller when mature) or *Salix exigua* sandbar willow prevalent **(17)**
- 17a** Willows with less than 10% canopy cover, *Betula occidentalis* (water birch) with at least 15% canopy cover and with the greatest canopy cover in the tallest layer: ***Betula occidentalis* Shrubland**
- 17b** Willows with at least 10% canopy cover **(18)**
- 18a** *Salix exigua* (sandbar willow) with greater canopy cover than other individual willows: ***Salix exigua* Temporarily flooded Shrubland**
- 18b** Taller willows (mostly *Salix geyeriana*, *S. boothii*, *S. bebbiana* (Geyer, Booth, Bebb willows) dominate shrub layer **(19)**
- 19a** Taller *Salix* species with a *Carex utriculata* (Northwest Territory sedge) understory component: ***Salix geyeriana* / *Carex utriculata* Shrubland**
- 19b** Taller *Salix* species where wet site sedges are lacking in understory: ***Salix geyeriana* / Mesic Graminoids Shrubland**

- 20a** Sedges with a combined canopy cover of at least 25% **(21)**
20b Sedges with a combined canopy cover of less than 25% **(23)**
- 21a** *Carex utriculata* (Northwest Territory sedge) with at least 25% canopy cover: ***Carex utriculata* Herbaceous Vegetation**
21b *Carex utriculata* (Northwest Territory sedge) with less than 25% canopy cover **(22)**
- 22a** *Carex aquatilis* (aquatic sedge) with at least 25% canopy cover: ***Carex aquatilis* Herbaceous Vegetation**
22b *Carex pellita* (woolly sedge) with at least 25% canopy cover: ***Carex pellita* Herbaceous Vegetation**
- 23a** *Typha latifolia* (common cattail) with at least 25% canopy cover: ***Typha latifolia* Herbaceous Vegetation**
23b *Typha latifolia* (common cattail) with less than 25% canopy cover **(24)**
- 24a** *Equisetum fluviatile* (water horsetail) with at least 25% canopy cover: ***Equisetum fluviatile* Herbaceous Vegetation**
24b *Equisetum fluviatile* (water horsetail) with less than 25% canopy cover **(25)**
- 25a** *Eleocharis palustris* (common spikeweed) with at least 25% canopy cover: ***Eleocharis palustris* Herbaceous Vegetation**
25b *Eleocharis palustris* (common spikeweed) with less than 25% canopy cover **(26)**
- 26a** *Juncus balticus* (Baltic rush) with more canopy cover than any other species: ***Juncus balticus* Herbaceous Vegetation**
26b One individual grass species with more canopy cover than any other herbaceous life form **(27)**
- 27a** *Agrostis gigantea* (redtop) with more canopy cover than any other individual herbaceous species: ***Agrostis (gigantea, stolonifera)* Semi-natural Herbaceous Vegetation**
27b Other individual herbaceous species with more canopy cover than *Agrostis gigantea* (redtop) **(28)**
- 28a** *Bromus inermis* (smooth brome) with more canopy cover than any other herbaceous species: ***Bromus inermis* – (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation**
28b Other individual herbaceous species with more canopy cover than *Bromus inermis* (smooth brome) **(29)**
- 29a** *Deschampsia caespitosa* (tufted hairgrass) dominant: ***Deschampsia caespitosa* Slickens Semi-natural Sparse Vegetation Tufted Hairgrass Slickens Semi-natural Sparse Vegetation**
29b Other individual herbaceous species with more canopy cover than *Deschampsia caespitosa* (tufted hairgrass) **(30)**

- 30a** *Poa pratensis* (Kentucky bluegrass) with more canopy cover than any other herbaceous species: ***Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation**
- 30b** Does not fit with any type above, often early seral vegetation on new bar or otherwise disturbed area: **Rocky Mountain Riparian Bar Sparse Vegetation**

Appendix E: Final Vegetation Type Descriptions

The GRKO vegetation mapping project identified 22 vegetation types, and three Park-specific types described from this project. The detailed vegetation descriptions in this appendix are essential for recognizing vegetation types in the field. In this appendix, vegetation types are arranged by physiognomic class (e.g. Shrubland, Herbaceous, etc.). An explanation of the field names used in the following descriptions is presented below (Table D-1). A bibliography of sources used in these descriptions is included in this appendix.

Table D-1. Explanation of field names used in vegetation association descriptions

FIELD	DESCRIPTION
MAP NAME	The name used to describe the vegetation type. At LIBI this was usually at the Association level. When this is the case we use Latin names of nominal taxa as conferred by NatureServe (2007).
COMMON NAME	The map name in common usage. When the map name is an association we use common (English) names of nominal taxa as conferred by NatureServe (2007).
LOCAL NAME	Additional descriptive name for the association is listed, if available.
CLASS	1997 National Vegetation Classification Standard (NVCS) Class assignment of association.
SUBCLASS	1997 NVCS Subclass assignment of association.
GROUP	1997 NVCS Group assignment of association.
SUBGROUP	1997 NVCS Subgroup assignment of association.
FORMATION	1997 NVCS Formation assignment of association.
ALLIANCE	The alliance assignment of the association, as conferred by NatureServe (2007).
ASSOCIATION IDENTIFIER	The unique alphanumeric identifier of the association, as conferred by NatureServe (2007)
USFWS WETLAND SYSTEM	The Cowardin et al. assignment of the association, including National Wetlands Inventory (NWI) mapping code, if applicable.
NS ECOLOGICAL SYSTEM	Most likely NatureServe Ecological System assignment for association at Little Bighorn Battlefield National Monument (Comer et al. 2003) (NatureServe 2007).
RANGE	The geographic range of the association, both at Little Bighorn Battlefield National Monument (as defined by this study) and global (NatureServe 2007).
ENVIRONMENTAL DESCRIPTION	The environmental setting of the association, both at Little Bighorn Battlefield National Monument, as defined by this study, including National Park Service (2006a, 2006b) and global, as defined by NatureServe (2007).
MOST ABUNDANT SPECIES	The most abundant species in each vegetation stratum for the association at Little Bighorn Battlefield National Monument (as defined by this study).
CHARACTERISTIC SPECIES	Characteristic species for the association at Little Bighorn Battlefield National Monument (as defined by this study).

FIELD	DESCRIPTION
VEGETATION DESCRIPTION	A qualitative description of the vegetation (floristic) composition of the association, both at Little Bighorn Battlefield National Monument (as defined by this study) and global (NatureServe 2007)
GLOBAL CLASSIFICATION CONFIDENCE	A relative ranking of the confidence in the robustness of the association concept on a global scale (1="Strong"; 2="Moderate"; 3="Weak" (NatureServe 2007).
CONSERVATION RANK	A ranking of the global abundance of the association (see Grossman et al. 1998 for symbol explanations) (NatureServe 2007).
SIMILAR ASSOCIATIONS	Distinguishing characters between the association and similar and/or intergrading associations that also occur at Little Bighorn Battlefield National Monument (if applicable).
CLASSIFICATION COMMENTS	Discussion of association assignments as derived at Little Bighorn Battlefield National Monument (if applicable). Also, discussion of distinguishing characters between the association and similar and/or intergrading associations that also occur at Little Bighorn Battlefield National Monument (if applicable).

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Forest

***Populus balsamifera* (ssp. *trichocarpa*, ssp. *balsamifera*) / *Symphoricarpos* (*albus*, *occidentalis*, *oreophilus*) Forest**

COMMON NAME	(Black Cottonwood, Balsam Poplar) / (Common Snowberry, Western Snowberry, Mountain Snowberry) Forest
LOCAL NAME	Black Cottonwood / Western Snowberry Forest
CLASS	Forest (I)
SUBCLASS	Deciduous forest (I.B)
GROUP	Cold-deciduous forest (I.B.2)
SUBGROUP	Natural/Semi-natural cold-deciduous forest (I.B.2.N)
FORMATION	Temporarily flooded cold-deciduous forest (I.B.2.N.d)
ALLIANCE	<i>POPULUS BALSAMIFERA</i> SSP. <i>TRICHOCARPA</i> TEMPORARILY FLOODED FOREST ALLIANCE
ASSOCIATION IDENTIFIER	CEGL000677
USFWS WETLAND SYSTEM	Palustrine Forested broad-leaved deciduous, temporarily flooded (PFO1A)
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804)

RANGE

Grant-Kohrs Ranch National Historic Site

One stand is on the south side of Cottonwood Creek, a second stand on Johnson Creek, and the other two stands are on the Clark Fork River floodplain but set back from the current river channel.

Global

This association is known from low-elevation, large rivers in Oregon, Washington, Idaho, western Wyoming, and British Columbia. It has been reported from Montana as part of another community [see Hansen et al. (1995)].

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Cottonwood and Johnson Creeks have a steeper gradient than the Clark Fork River at the Ranch and may have been relatively isolated from intense grazing pressure.

Global

This late-seral association typically occurs at low elevations from 579 to 2040 m (1900-6693 feet) in broad mountain valleys and canyons of low- to moderate-gradient streams and rivers. The association occupies alluvial terraces and elevated streambanks with deep silty loam soils (over cobble and gravel) on infrequently flooded sites well above the average high-water line and summer water table.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Tree	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>
Shrub	<i>Salix geyeriana</i> , <i>Salix boothii</i> , <i>Symphoricarpos occidentalis</i> , <i>Ribes</i> sp.
Herbaceous	<i>Agrostis gigantea</i>

CHARACTERISTIC SPECIES

Populus balsamifera ssp. *trichocarpa*

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 2 accuracy assessment observations)

Populus balsamifera ssp. *trichocarpa* (= *P. trichocarpa*) was dominant in the tree layer. *Salix geyeriana* and *Salix boothii* were present in the shrub layer in both stands observed. *Ribes* sp. was present in one stand. The herbaceous layer was variable, with one stand apparently drier and dominated by alien weedy species (*Bromus inermis*, *Agrostis gigantea*, *Cirsium* sp., and several species of *Brassicaceae*), and the other apparently wetter and dominated by *Carex aquatilis* and *Agrostis gigantea*, with *Phleum pratense* and *Alopecurus aequalis* also present.

Global

Tall and mature *Populus balsamifera* ssp. *trichocarpa* form the open to closed overstory canopy, with occasional understory asexual reproduction and conifers present. Conifer species, especially *Pinus ponderosa* and *Pseudotsuga menziesii*, may indicate the potential successional pathway on these relatively dry terrace sites. The shrub layer is clearly dominated by one species of *Symphoricarpos*, either *Symphoricarpos albus*, *Symphoricarpos oreophilus*, or *Symphoricarpos occidentalis* (usually with at least 20% cover), although a variety of other tall and medium shrubs (all with cover less than *Symphoricarpos* sp.) are usually present. The most consistently prominent shrubs are *Acer glabrum*, *Amelanchier alnifolia*, *Crataegus douglasii*, *Philadelphus lewisii*, *Prunus virginiana*, *Rosa* spp., and *Rubus parviflorus*, the presence of which may reflect successional relationships with other alluvial terrace associations. The herbaceous layer is diverse, but has only moderate cover, and often includes exotic species indicative of past disturbance. Perennial grasses, especially *Elymus glaucus*, *Phalaris arundinacea*, and *Poa pratensis*, often codominate with various tall forbs and *Equisetum* spp. The most important forbs include *Clematis ligusticifolia*, *Heracleum maximum*, *Maianthemum* spp., *Wyethia amplexicaulis*, *Thalictrum occidentale*, *Urtica dioica*, *Geranium viscosissimum*, and *Helianthella uniflora*.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G2

CLASSIFICATION COMMENTS

Association level assignment of stands dominated by *Populus balsamifera* ssp. *trichocarpa* at Grant-Kohrs Ranch National Historic Site is difficult because of the small amount of vegetation, history of disturbance, and the apparent lack of *Populus balsamifera* ssp. *trichocarpa* types that are dominated by obligate or facultative wetland species for Montana in the current floristic content of the NVCS (NatureServe 2007).

***Populus balsamifera* ssp. *trichocarpa* / Mixed Herbs Forest**

COMMON NAME	Black Cottonwood / Mixed Herbs Forest
LOCAL NAME	Black Cottonwood / Mixed Herbs Forest
CLASS	Forest (I)
SUBCLASS	Deciduous forest (I.B)
GROUP	Cold-deciduous forest (I.B.2)
SUBGROUP	Natural/Semi-natural cold-deciduous forest (I.B.2.N)
FORMATION	Temporarily flooded cold-deciduous forest (I.B.2.N.d)
ALLIANCE	<i>POPULUS BALSAMIFERA</i> SSP. <i>TRICHOCARPA</i> TEMPORARILY FLOODED FOREST ALLIANCE
ASSOCIATION IDENTIFIER	CEGL000675
USFWS WETLAND SYSTEM	Palustrine Forested broad-leaved deciduous, temporarily flooded (PF01A)
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804)

RANGE

Grant-Kohrs Ranch National Historic Site

The largest “natural” stands of *Populus balsamifera* ssp. *trichocarpa* are along Cottonwood Creek in the southeast corner of the Ranch. A large anthropogenic stand along the railroad track was formed as a result excavation of fill to build the elevated railroad bed along the northeast side of the Ranch.

Global

This association is reported from Montana, Nevada, and Wyoming.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

The native herbaceous component of these *Populus balsamifera* ssp. *trichocarpa* stands was depleted by historic livestock grazing. The excavation pit created by building the elevated railroad bed is filled by groundwater and perhaps irrigation excess.

Global

This cold-deciduous riparian forest is common in low mountains and foothills. It occurs from 610 to 2013 m (2000-6591 feet) elevation on alluvial terraces and floodplains of major and minor rivers and streams. Soils are poorly developed, loamy to cobbly Entisols. It is thought to be a grazing-induced type; the trees are mature and the herbaceous layer predominantly dominated by non-native graminoid species.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Tree	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>
Herbaceous	<i>Agrostis gigantea</i> , <i>Bromus inermis</i>

CHARACTERISTIC SPECIES

Populus balsamifera ssp. *trichocarpa*

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 2 accuracy assessment observations)

Populus balsamifera ssp. *trichocarpa* (= *P. trichocarpa*) was dominant in the tree layer. The herbaceous layer was dominated by alien weedy species (*Bromus inermis*, *Agrostis gigantea*, *Cirsium* sp., and several species of *Brassicaceae*).

Global

This association is thought to be a grazing-induced type. The trees are mature and the herbaceous layer is predominantly dominated by non-native graminoid species. The canopy cover is *Populus balsamifera* ssp. *trichocarpa* (= *Populus trichocarpa*) with 30-60% cover. *Populus angustifolia* and *Pinus ponderosa* may also be present in low amounts. There are very few shrubs and, if present, do not form a stratum layer. Scattered shrub species include *Ribes inerme*, *Lonicera involucrata*, *Cornus sericea*, *Rosa woodsii*, and *Rubus idaeus*. The herbaceous layer is dominated by either non-native graminoids or increaser species such as *Phleum pratense*, *Poa pratensis*, *Bromus vulgaris*, and *Elymus glaucus*. Forbs present include *Tanacetum vulgare*, *Centaurea biebersteinii* (= *Centaurea maculosa*), *Urtica dioica*, *Thalictrum*, *Aconitum columbianum*, *Angelica arguta*, *Fragaria virginiana*, *Galium boreale*, *Geranium viscosissimum*, *Rudbeckia occidentalis*, and *Achillea millefolium*.

GLOBAL CLASSIFICATION CONFIDENCE 2

CONSERVATION RANK G3?

CLASSIFICATION COMMENTS

Association level assignment of stands dominated by *Populus balsamifera* ssp. *trichocarpa* at Grant-Kohrs Ranch National Historic Site is difficult because of the small amount of vegetation, history of disturbance, and the apparent lack of *Populus balsamifera* ssp. *trichocarpa* types that are dominated by obligate or facultative wetland species for Montana in the current floristic content of the NVCS (NatureServe 2007). The constant presence of *Salix* in the understory of both stands observed in the accuracy assessment and prevalence of wetland species in one stand seem to justify attribution of this poorly understood concept as the best fit available.

Shrubland

Betula occidentalis Shrubland

COMMON NAME	Water Birch Shrubland
LOCAL NAME	Water Birch Shrubland
CLASS	Shrubland (III)
SUBCLASS	Deciduous shrubland (III.B)
GROUP	Cold-deciduous shrubland (III.B.2)
SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N)
FORMATION	Seasonally flooded cold-deciduous shrubland (III.B.2.N.e)
ALLIANCE	<i>BETULA OCCIDENTALIS</i> SEASONALLY FLOODED SHRUBLAND ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001080
USFWS WETLAND SYSTEM	Palustrine Scrub-Shrub broad-leaved deciduous, seasonally flooded (PSS1C)
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804)

RANGE

Grant-Kohrs Ranch National Historic Site

Betula occidentalis Shrubland is a common type along much of the upper Clark Fork. It is the major component in the Clark Fork floodplain in the south half of the Ranch. It is present but less extensive in the north half of the Ranch.

Global

This association is known from mountainous regions of Washington, Idaho, Montana, Wyoming, north into Alberta, and may extend south into Colorado and Nevada.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Thin soils overlay river cobbles and gravel and the close proximity to the river allows the roots to reach the water table although the upper soil profile is well drained.

Global

This shrubland occupies moderately wide stream benches and floodplains in narrow to moderately wide valleys and hillside seeps in mountains and foothills, as well as on stream banks and canyon bottoms in the Colorado Plateau. It is found primarily along fast-moving, moderate- to high-gradient mountain and foothill streams, although in the Colorado Plateau it occurs more frequently on low-gradient perennial or intermittent streams. Elevation ranges from 910 to 2700 m (2975-6630 feet). Stands also occur along small floodplains of steep-gradient, narrow streams where the valley sideslope meets the stream edge. In high-gradient situations, the community often occurs as narrow, linear stringers where *Betula occidentalis* forms a closed canopy crowding the streambank. Broader stands occur around seeps adjacent to the stream channel, or along isolated springs on hillslopes away from the valley bottom, and on the floodplains of low-gradient streams. Surface water is present for extended periods during the growing season. After flooding ceases, the water table is variable and ranges from nearly saturated to well below the ground surface.

Soils are fairly shallow, ranging from 30 cm to greater than 60 cm, often overlying river cobbles. Most soils have a surface layer of 50-90% organic matter. Subsurface layers range from loam to sand with abundant gravel throughout the profile (Hansen et al. 1995). Skeletal layers, derived from alluvium, occur at a greater depth. In the northern range of Yellowstone National Park, soils typically have a large ash component. Stands along narrow, steep stream channels occur between large alluvial and colluvial boulders and have almost no soil development.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
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Shrub *Betula occidentalis*
Herbaceous Variable

CHARACTERISTIC SPECIES

Betula occidentalis

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 7 accuracy assessment observations)

Betula occidentalis was dominant or co-dominant in the shrub layer in all stands. *Salix geyeriana* (co-dominant in one stand), *Salix exigua*, and *Alnus incana* ssp. *tenuifolia* were present in at least two stands, and *Symphoricarpos occidentalis* (co-dominant), *Salix boothii*, *Prunus virginiana*, and *Ribes* sp. were seen in one stand each. The herbaceous layer composition was variable, with *Poa* but generally dominated by weedy alien and native facultative or upland species, including *Agrostis gigantea*, *Elymus repens*, *Poa pratensis*, *Cirsium arvense*, *Juncus balticus* (= *J. arcticus* ssp. *littoralis*), *Phleum pretense*, and *Euphorbia esula* most frequently reported. *Solidago* sp., *Bromus inermis*, *Carex pellita*, and *Deschampsia caespitosa* were also reported.

Global

Betula occidentalis forms a nearly continuous tall-shrub to small-tree canopy with 10-90% cover. Other shrub species include *Alnus incana*, *Cornus sericea*, *Dasiphora fruticosa* ssp. *floribunda* (= *Pentaphylloides floribunda*), *Salix exigua*, *Shepherdia argentea*, *Jamesia americana*, *Amelanchier utahensis*, *Juniperus scopulorum*, *Prunus virginiana*, *Rhus trilobata*, *Salix boothii*, and *Salix monticola*. Along narrow valleys at higher elevations, conifers may overhang the stream edge. At lower elevations, *Populus balsamifera* ssp. *trichocarpa*, *Populus tremuloides*, and other *Populus* species may be present. Conifer species present include *Pseudotsuga menziesii*, *Abies lasiocarpa*, and *Picea pungens*. If the shrub canopy is dense, herbaceous undergrowth will be limited; if open, the herbaceous layer can be abundant. Herbaceous species are typically weedy or adapted to frequent disturbance. Herbaceous-rich stands generally have equal amounts of forb and graminoid cover. Forb species can include *Maianthemum stellatum*, *Heracleum sphondylium*, *Thalictrum fendleri*, *Equisetum arvense*, *Mentha arvensis*, *Solidago gigantea*, and *Rudbeckia laciniata*. Graminoid species include *Calamagrostis canadensis*, *Poa palustris*, *Carex utriculata*, *Carex pellita* (= *Carex lanuginosa*), *Carex microptera*, *Carex nebrascensis*, *Glyceria* spp., and *Juncus balticus*. Introduced species typically present include *Cirsium arvense*, *Taraxacum officinale*, *Agrostis stolonifera*, and *Poa pratensis*.

GLOBAL CLASSIFICATION CONFIDENCE 2

CONSERVATION RANK G3

***Salix exigua* Temporarily Flooded Shrubland**

COMMON NAME	Coyote Willow Temporarily Flooded Shrubland
LOCAL NAME	Coyote Willow Shrubland
CLASS	Shrubland (III)
SUBCLASS	Deciduous shrubland (III.B)
GROUP	Cold-deciduous shrubland (III.B.2)
SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d)
ALLIANCE	<i>SALIX (EXIGUA, INTERIOR)</i> TEMPORARILY FLOODED SHRUBLAND ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001197
USFWS WETLAND SYSTEM	Palustrine Scrub-Shrub broad-leaved deciduous, temporarily flooded (PSS1A)
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804)

RANGE

Grant-Kohrs Ranch National Historic Site

There are numerous large stands of *Salix exigua* immediately adjacent to the river and two stands along Cottonwood Creek. Additional smaller stands are scattered throughout the floodplain. Several long narrow stands parallel the railroad bed in the northeast sector of the Ranch

Global

This willow shrubland association is found along rivers and streams at lower elevations throughout the western United States and Great Plains, ranging sporadically from Oklahoma northwest to the Dakotas and Manitoba, west to Washington, and south to the Rio Grande, San Juan and Canadian River watersheds in northern New Mexico. In California, this association has been sampled along the Sacramento River, in the Central Coast Ranges, northern and central Sierra Nevada foothills, and Cascade Range foothills. Part of this type's former range in the Great Plains and eastward is actually occupied, at least in part, by *Salix interior* [see *Salix interior* Temporarily Flooded Shrubland (CEGL008562)].

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

The local common name for *Salix exigua* is sandbar willow. Although *Salix exigua* is a primary colonizer of new river deposits, at the Ranch there are areas not abutting the current river channel where irrigation flowback still provides favorable habitat for *Salix exigua*. Excavation for the railroad bed and standing water in a portion of this borrow pit promoted the development of *Salix exigua* thickets.

Global

This association is found on recently deposited or disturbed alluvial material. The parent material is alluvial sand, although silt, clay, or gravel may be present. Soil development is poor to absent. In New Mexico, this association occurs along wide, low-gradient streams and rivers in foothill regions and in lowland valleys and canyons at low to mid elevations of 1430 to 1910 m (4700-6250 feet). The type is common on low alluvial bars that are subject to repeated flooding (1- to 5-year recurrence intervals). Soils are poorly stratified and generally consist of a thin layer of sandy loam at the surface overlying deep deposits of sand, gravel, or cobble. Rock fragments comprise upwards of 80% of the soil profile. These well-drained soils provide good aeration and rapid movement of water through the profile. Sites composed mostly of riverwash are moist at the surface for much of the season, while high bars may be dry on the surface, but tend to be moist at depths of 15 to 30 cm (6-12 inches) during most years.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Shrub	<i>Salix exigua</i> , <i>Betula occidentalis</i>

Herbaceous *Cirsium arvense*

CHARACTERISTIC SPECIES

Salix exigua

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 3 accuracy assessment observations)

Salix exigua was dominant in the shrub layer. Other shrubs present were *Betula occidentalis* (2 stands), *Salix geyeriana*, and *Ribes* sp. (1 stand each). The herbaceous layer was variable, but generally dominated by weedy alien and native facultative or upland species, including *Cirsium arvense* (2 stands), *Juncus balticus* (= *J. arcticus* ssp. *littoralis*), *Poa pratensis*, *Agrostis gigantea*, and *Euphorbia esula* (1 stand each). *Elymus repens*, *Iris missouriensis*, and *Phleum pratense* were each present in one stand at low cover.

Global

This association is dominated by shrubs, generally between 2 and 4 m tall. The most common of these is *Salix exigua* (*Salix interior* or intermediates of the two willow species may be present in the eastern part of the range). *Salix irrorata*, *Salix lutea*, and saplings of *Populus deltoides* or *Salix amygdaloides* are also frequently found in the shrub layer in lower elevation stands. *Populus balsamifera* seedlings become more common in northern and western stands. This stratum can have moderate to high stem density in the association as a whole. The species in the shrub layer do not form a closed canopy, allowing significant light to reach the ground layer. There are often patches where the shrub layer is absent. The herbaceous cover is sparse to moderate but rarely exceeds 30%. Older stands and places with less competition from the shrubs have greater herbaceous cover. The composition of the herbaceous layer can vary greatly. Species that are often found in this association are *Cenchrus longispinus*, *Polygonum lapathifolium*, *Schoenoplectus americanus* (= *Scirpus americanus*), *Triglochin maritima*, *Xanthium strumarium*, *Juncus balticus*, *Eleocharis palustris*, *Elymus repens* (= *Elytrigia repens*), *Poa pratensis*, *Phleum pratense*, *Agrostis scabra*, *Bromus inermis*, *Heracleum maximum*, *Achillea millefolium*, *Solidago* sp., *Equisetum arvense*, and *Linaria vulgaris*.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G5

CLASSIFICATION COMMENTS

Without plot data with more floristic and environmental detail, the treatment and NVCS assignment of riparian shrubland stands at Grant-Kohrs Ranch National Historic Site is difficult because of mixed dominance of various *Salix* species together and with *Betula occidentalis*. Because *Salix exigua* is usually more distinct in its environmental preference from the other *Salix* present at this site (preferring active stream channels versus floodplains and less hydrologically active wetlands for other *Salix* and *B. occidentalis*), it was decided to retain this type as distinct. However, the association of *S. exigua* with upland species and other riparian shrubs at Grant-Kohrs Ranch National Historic Site may support treating these stands as a mixed willow type with patchy *S. exigua* present at high cover.

***Salix geyeriana* / *Carex utriculata* Shrubland**

COMMON NAME	Geyer's Willow / Northwest Territory Sedge Shrubland
LOCAL NAME	Geyer Willow / Northwest Territory Sedge Shrubland
CLASS	Shrubland (III)
SUBCLASS	Deciduous shrubland (III.B)
GROUP	Cold-deciduous shrubland (III.B.2)
SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N)
FORMATION	Seasonally flooded cold-deciduous shrubland (III.B.2.N.e)
ALLIANCE	<i>SALIX GEYERIANA</i> SEASONALLY FLOODED SHRUBLAND ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001207
USFWS WETLAND SYSTEM	Palustrine Scrub-Shrub broad-leaved deciduous, seasonally flooded (PSS1C)
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804)

RANGE

Grant-Kohrs Ranch National Historic Site

Salix geyeriana / *Carex utriculata* Shrubland polygons are present on the floodplains of the Clark Fork River, Cottonwood Creek, along Spring Slough on the east side of the Ranch, and the railroad bed borrow pit area to the northeast.

Global

This association has been documented in Colorado, Idaho, Montana, Nevada, Oregon, Utah and Wyoming.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

These are less well drained portions of the floodplain, often receiving flowback water from irrigation, canals, and active sloughs.

Global

Throughout its distribution, this association occurs in mountains and high valleys at elevations ranging from 1310 to 2740 m (4300-9000 feet). This is the wettest of the *Salix geyeriana*-dominated willow shrublands. It is most common on broad, level floodplains but does occur in narrow bands along smaller streams in open U-shaped valleys. Valley bottom gradients are usually low. Surface microtopography is often hummocky as a result of the irregular buildup of organic material. Hydrology of these sites is usually maintained through subirrigation, and soil moisture is maintained at or near the surface in most cases. These sites may or may not be annually flooded during high water in the spring and early summer. This association occurs on a range of soil types that are typically wet, cold, and organic or have organic surface horizons. They are generally classified as Mollisols and Histisols. Organic surface horizons, often extending to a depth of 45 cm (18 inches) or more, are riddled with fibrous roots and plant material. Soil textures are categorized as fine, generally silts and clays. Deeper alluvial mineral deposits are comprised of coarse and fine sands and gravels. The soils are usually mottled, indicating seasonal flooding and water table recession.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Shrub	<i>Salix geyeriana</i>
Herbaceous	<i>Carex utriculata</i> , <i>Typha latifolia</i>

CHARACTERISTIC SPECIES

Salix geyeriana, *Carex utriculata*

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 8 accuracy assessment observations)

Salix geyeriana was the leading dominant shrub. Other shrubs that may occur, usually at low cover, if present, include *Alnus incana* ssp. *tenuifolia*, *Betula occidentalis*, *Salix exigua*, and/or *Cornus sericea*. *Carex utriculata* was dominant or co-dominant in the herbaceous layer, with *Typha latifolia* occasionally dominant or co-dominant. Other frequent herbaceous species were *Carex aquatilis*, *Juncus balticus* (= *J. arcticus* ssp. *littoralis*) and *Agrostis gigantea*.

Global

Salix geyeriana dominates the overstory and can have large, often widely spaced clumps. *Salix geyeriana* can be as much as 3 m tall. A diversity of other shrubs may be present but usually in low amounts. Some of these subordinate shrubs are present in the upper canopy along with *Salix geyeriana*, such as *Salix boothii*, *Salix drummondiana*, *Salix monticola*, and *Alnus incana*. Often there are shorter shrubs present but usually with not more than 20% cover. Shorter shrub species include *Salix planifolia*, *Salix wolfii*, *Betula nana* (= *Betula glandulosa*), *Ribes inerme*, *Lonicera involucrata*, and *Dasiphora fruticosa* ssp. *floribunda* (= *Potentilla fruticosa*). *Carex utriculata* clearly dominates the understory. Other sedges and grasses, such as *Carex aquatilis*, *Carex interior*, *Carex scopulorum*, *Carex simulata*, *Carex praegracilis*, or *Calamagrostis canadensis*, may be present, but they have low cover. Forb species are sparse, but *Geum macrophyllum* appears to be the most constant species across the range of this type.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G5

CLASSIFICATION COMMENTS

Classification of willow stands at Grant-Kohrs Ranch National Historic Site into types with monospecific shrub layer dominance was problematic without plot data and with the accuracy assessment showing poor success as distinguishing them. Similar problems were encountered in attempting to classify based on the herbaceous layer. Until more data from the site are available, it seems best to recognize willow types with dominance other than *Salix exigua* as one mesic and one wet type, with mixed dominance at the site scale (or variable dominance at the stand scale). *S. geyeriana* is clearly the most frequent shrub dominant, although frequent dominance to co-dominance by *S. boothii* suggests a mixed association may be warranted, rather than a strictly *S. geyeriana*-dominated type. Hansen et al 1995 are explicit that the western Montana *S. geyeriana* types often have codominant *S. boothii* or even are dominated by *S. boothii* and they consider these two as “ecologically equivalent” hence they did not classify separate *S. boothii* types. This duality is discussed in the NatureServe description for this drier *S. geyeriana* type and *S. boothii* is at least mentioned by NatureServe for the wetter *Salix geyeriana*/ *Carex utriculata* Shrubland type. This willow duality is incorporated in the current NatureServe classification system and was not an artifact of our assessment methods. *Salix bebbiana* achieves co-dominance in a minority of stands, but its usual occurrence with *S. geyeriana* suggests that this situation is best treated as patch dominance within a *Salix geyeriana* type.

This type represents the wetter (hydric) stands with *Salix geyeriana* dominance or co-dominance.

Salix geyeriana / Mesic Graminoids Shrubland

COMMON NAME	Geyer's Willow / Mesic Graminoids Shrubland
LOCAL NAME	Geyer's Willow / Mesic Graminoids Shrubland
CLASS	Shrubland (III)
SUBCLASS	Deciduous shrubland (III.B)
GROUP	Cold-deciduous shrubland (III.B.2)
SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d)
ALLIANCE	<i>SALIX GEYERIANA</i> TEMPORARILY FLOODED SHRUBLAND ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001210
USFWS WETLAND SYSTEM	Palustrine Scrub-Shrub broad-leaved deciduous, temporarily flooded (PSS1A)
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804)

RANGE

Grant-Kohrs Ranch National Historic Site

Salix geyeriana / Mesic Graminoids Shrubland is one of the most abundant types on the Clark Fork River floodplain. There are also large stands along Johnson Creek.

Global

This association is widely distributed in the West at mid to high elevations, ranging from Idaho, Wyoming, Utah, Nevada, Colorado, and possibly California, Montana and Oregon. This may be the first documentation from Montana.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

The *Salix geyeriana* / Mesic Graminoids Shrubland develops and persists on the better drained portions of the floodplain.

Global

This riparian shrubland association is found in Idaho, Oregon, Montana, Utah, Colorado, and northwestern Wyoming. Stands of this association are often found in wide mountain valleys, cirques, and troughs, at elevations from about 1525 to 3000 m (5000-9900 feet), with narrow, meandering streams or braided rivers. The association mainly occurs on seasonally saturated or flooded sites, such as streambanks, terraces, floodplains, abandoned meanders, spring-fed meadows, lake or reservoir shores, and occasionally alluvial gravel bars. Soils vary but are mostly moderately well-drained to poorly drained, silt to clay loams with organic/sedge peat horizons. Ground surface has high cover of litter and duff.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Shrub	<i>Salix geyeriana</i> , <i>Salix boothii</i>
Herbaceous	<i>Carex aquatilis</i> , <i>Juncus balticus</i> (= <i>J. arcticus</i> ssp. <i>littoralis</i>), <i>Agrostis gigantea</i>

CHARACTERISTIC SPECIES

Salix geyeriana, *Salix boothii*, *Salix bebbiana*, *Carex aquatilis*

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 14 accuracy assessment observations)

Salix geyeriana was the leading dominant or a co-dominant shrub, with *Salix boothii* usually present and often co-dominant. *Salix bebbiana* was dominant or co-dominant in a small number of stands. Other shrubs that

may occur, usually at low cover, if present, include *Alnus incana* ssp. *tenuifolia*, *Betula occidentalis*, *Salix exigua*, *Cornus sericea*, and *Symphoricarpos occidentalis*. *Carex aquatilis* was usually present and important to dominant in the herbaceous layer, with *Juncus balticus* (= *J. arcticus* ssp. *littoralis*) and *Agrostis gigantea* often present to co-dominant.

Global

This plant association is a tall (2-5m), deciduous shrubland with an open to nearly closed canopy of clumped willows and a thick layer of sedges and grasses in the undergrowth. Dominance of *Salix geyeriana* (20-70% cover), occasionally intermixed with *Salix boothii* (with <20% cover), characterizes this association. Other shrubs, including *Alnus incana* ssp. *tenuifolia*, *Dasiphora fruticosa* ssp. *floribunda*, *Ribes inerme*, *Ribes lacustre*, *Rosa woodsii*, and other *Salix* spp. such as *Salix drummondiana*, *Salix lemmonii*, *Salix lucida* ssp. *lasiandra* (= *Salix lasiandra*), *Salix monticola*, *Salix planifolia*, or *Salix wolfii*, are scattered around the bases of taller *Salix* clumps. The herbaceous understory is dominated by a diverse mix of mesic graminoid species that always has greater total cover than the total cover of mesic forbs. In good-condition, mid- to late-seral stands, the most common graminoids are *Carex microptera*, *Carex pellita*, *Deschampsia caespitosa*, and occasionally *Carex nebrascensis*, but no single species consistently has high cover. Other graminoids with low to moderate cover and constancy include *Bromus porteri*, *Calamagrostis canadensis*, *Carex aquatilis*, *Carex athrostachya*, *Carex pellita* (= *Carex lanuginosa*), *Carex praegracilis*, *Carex rostrata*, *Carex simulata*, *Carex subnigricans*, *Carex utriculata*, *Elymus glaucus*, *Festuca thurberi*, *Hordeum jubatum*, *Glyceria* spp., *Juncus balticus*, *Juncus orthophyllus*, and *Muhlenbergia richardsonis*. Introduced grasses *Phalaris arundinacea*, *Phleum pratense*, and *Poa pratensis* are frequently present, but their cover varies depending on the amount of grazing disturbance and site desiccation. Stands in poor condition need to be codominated by a mixture of native graminoids (not a single species such as *Deschampsia caespitosa*) with the introduced graminoids and forbs. The most common forb species are sometimes indicative of grazing disturbance. Associated species include *Achillea millefolium*, *Antennaria* spp., *Caltha leptosepala*, *Cirsium* sp., *Geum macrophyllum*, *Iris missouriensis*, *Maianthemum stellatum*, *Pedicularis groenlandica*, *Penstemon* spp., *Polygonum bistortoides*, *Potentilla gracilis*, *Thalictrum* spp., *Taraxacum officinale*, *Trifolium* spp., *Urtica dioica*, *Veronica* sp., and *Vicia americana*.

GLOBAL CLASSIFICATION CONFIDENCE 2

CONSERVATION RANK G3?

CLASSIFICATION COMMENTS

Classification of willow stands at Grant-Kohrs Ranch National Historic Site into types with monospecific shrub layer dominance was problematic without plot data and with the accuracy assessment showing poor success at distinguishing them. Similar problems were encountered in attempting to classify based on the herbaceous layer. Until more data from the site are available, it seems best to recognize willow types with dominance other than *Salix exigua* as one mesic and one wet type, with mixed dominance at the site scale (or variable dominance at the stand scale). *S. geyeriana* is clearly the most frequent shrub dominant, although frequent dominance to co-dominance by *S. boothii* suggests a mixed association may be warranted, rather than a strictly *S. geyeriana*-dominated type. Hansen et al 1995 are explicit that the western Montana *S. geyeriana* types often have codominant *S. boothii* or even are dominated by *S. boothii* and they consider these two as “ecologically equivalent” hence they did not classify separate *S. boothii* types. This duality is discussed in the NatureServe description for this drier *S. geyeriana* type, and *S. boothii* is at least mentioned by NatureServe for the wetter *Salix geyeriana*/ *Carex utriculata* Shrubland type. This willow duality is incorporated in the current NatureServe classification system and was not an artifact of our assessment methods. *Salix bebbiana* achieves co-dominance in a minority of stands, but its usual occurrence with *S. geyeriana* suggests that this situation is best treated as patch dominance within a *Salix geyeriana* type.

This type represents the drier (mesic) stands dominated by some combination of *Salix geyeriana*, *Salix bebbiana*, and/or *Salix boothii*. *Salix geyeriana*, *Salix bebbiana*, and/or *Salix boothii*. [Salix \(boothii, geyeriana\) / Carex aquatilis Shrubland](#)(CEGL001176), [Salix boothii - Salix geyeriana Shrubland](#)(CEGL001184) might also be reasonable treatments for this vegetation.

Symphoricarpos occidentalis Shrubland

COMMON NAME	Western Snowberry Shrubland
LOCAL NAME	Western Snowberry Shrubland
CLASS	Shrubland (III)
SUBCLASS	Deciduous shrubland (III.B)
GROUP	Cold-deciduous shrubland (III.B.2)
SUBGROUP	Natural/Semi-natural cold-deciduous shrubland (III.B.2.N)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d)
ALLIANCE	<i>SYMPHORICARPOS OCCIDENTALIS</i> TEMPORARILY FLOODED SHRUBLAND
ASSOCIATION IDENTIFIER	CEGL001131
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	Rocky Mountain Lower Montane-Foothill Shrubland (CES306.822)

RANGE

Grant-Kohrs Ranch National Historic Site

This minor type is found at the Ranch immediately adjacent or proximal to the Clark Fork River.

Global

This western snowberry shrubland is found in the western tallgrass, the northern Great Plains, and in the foothills of the northern Rocky Mountains of the United States and Canada.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

These *Symphoricarpos occidentalis* Shrubland polygons may flood during high water years but the sites are well drained.

Global

This association is found in mesic swales, depressions, ravines and floodplains. Some examples of this association experience intermittent and brief flooding. In Glacier National Park, it occurs at 1022-1092 m (3350-3580 feet) elevation. 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

STRATUM	SPECIES
Shrub	<i>Symphoricarpos occidentalis</i> , <i>Rosa woodsii</i>
Herbaceous	Variable

CHARACTERISTIC SPECIES

Symphoricarpos occidentalis

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 2 accuracy assessment observations)

Symphoricarpos occidentalis was dominant in the shrub layer. *Rosa woodsii* was present in both stands and *Salix geyeriana*, *Salix boothii*, and *Salix exigua* were present in one stand each. In the herbaceous layer, *Poa pratensis* was dominant in one stand. Other species present included *Juncus balticus* (= *J. arcticus* ssp. *littoralis*), *Deschampsia caespitosa*, *Equisetum fluviatile*, *Bromus inermis*, *Pascopyrum smithii*, *Thapsus* sp. and *Descurainia* sp.

Global

Throughout its range this association 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 trilobata* and *Prunus virginiana* can be locally abundant and can grow to 2-3 m in places. *Toxicodendron rydbergii*, *Amelanchier alnifolia*, *Rubus idaeus*, and *Rosa acicularis* may also be present. Herbaceous species and smaller shrubs are most abundant at the edges of this association 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*, *Calamagrostis canadensis*, *Calamagrostis rubescens*, *Achnatherum nelsonii*, and *Poa pratensis*. *Achillea millefolium*, *Artemisia ludoviciana*, *Galium boreale*, and *Solidago* spp. are common forbs of this association. Woody vines sometimes occur, including *Parthenocissus vitacea*.

GLOBAL CLASSIFICATION CONFIDENCE 3

CONSERVATION RANK G4G5

Upland 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
LOCAL NAME	Crested Wheatgrass Grassland
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d)
ALLIANCE	AGROPYRON CRISTATUM SEMI-NATURAL HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL005266
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland (CES306.040)

RANGE

Grant-Kohrs Ranch National Historic Site

The seminatural type was sown primarily into the upland Upper Northwest Range on the west side of the Ranch and planted adjacent to the visitor center in the southeast corner of the Ranch.

Global

This association occurs in the northern Great Plains of the United States and Canada (Von Loh et al. 2000).

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

The area adjacent to the visitor center had been highly disturbed before it was rehabilitated but the Upper Northwest Range still retains much of its original native components.

Global

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 (Von Loh et al. 2000).

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Shrub (Dwarf)	<i>Artemisia frigida</i>
Herbaceous	<i>Agropyron cristatum</i>

CHARACTERISTIC SPECIES

Agropyron cristatum

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 8 accuracy assessment observations)

Agropyron cristatum is strongly dominant in the herbaceous layer. *Thinopyrum intermedium*, *Sisymbrium altissimum*, and *Poa secunda* (= *Poa sandbergii*) are the most frequent associates. *Artemisia frigida* is often present at low cover as a dwarf shrub.

Global

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 (Von Loh et al. 2000).

GLOBAL CLASSIFICATION CONFIDENCE 3

CONSERVATION RANK GW

CLASSIFICATION COMMENTS

The global information for this type was derived from Von Loh et al. (2000).

***Hesperostipa comata* – *Bouteloua gracilis* – *Carex filifolia* Herbaceous Vegetation**

COMMON NAME	Needle-and-Thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation
LOCAL NAME	Needle-and-Thread - Blue Grama Mixedgrass Prairie
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c)
ALLIANCE	<i>HESPEROSTIPA COMATA</i> – <i>BOUTELOUA GRACILIS</i> HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL002037
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland (CES306.040)

RANGE

Grant-Kohrs Ranch National Historic Site

This *Hesperostipa comata* community is limited to the uplands in the southwest quadrant of the Ranch where it is prevalent in the Upper Northwest and Taylor Ridge Ranges, and along the crest of the Gravel Pit Range.

Global

This needlegrass - grama grass prairie community is common in the northern and central Great Plains of the United States and Canada, ranging from Manitoba west to Alberta, south to Kansas and possibly Colorado.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

These are harsh xeric sites on coarse poorly developed soil. In some areas the surface is armored with pebbles indicating the wind swept nature of these west side uplands.

Global

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 600 to 1700 m (2000-5500 feet); average annual precipitation associated with these elevation parameters ranges from slightly less than 25 cm to over 50 cm (10 to 20 inches).

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Shrub (Dwarf)	<i>Artemisia frigida</i>
Herbaceous	<i>Hesperostipa comata</i>

CHARACTERISTIC SPECIES

Hesperostipa comata

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 11 accuracy assessment observations)

Hesperostipa comata is dominant in the herbaceous layer. *Pascopyrum smithii*, *Bouteloua gracilis*, and *Poa secunda* (= *Poa sandbergii*) are the most frequent associates. The invasive alien *Bromus tectorum* occurs at high cover in

some stands. A sparse dwarf shrub layer may be present, with *Artemisia frigida*, *Krascheninnikovia lanata*, and *Gutierrezia sarothrae* most frequent.

Global

The vegetation is dominated by moderately dense graminoids that are usually between 0.5 and 1 m tall. For example, on 19 stands in west-central Montana the cover by the different strata was as follows: shrubs 6%, graminoids 67%, forbs 11%, bryophytes 14%, litter 55%, rock 4%, bare soil 9% (Mueggler and Stewart 1980). Thilenius et al. (1995) found that the average cover on 14 stands in eastern Wyoming was 42%. *Hesperostipa comata* (= *Stipa comata*) is the tallest of the dominant species, sending seed heads to a maximum height of approximately 1 m. The rhizomatous graminoids *Bouteloua gracilis* and *Carex filifolia*, the other two dominant/codominant species, do not usually exceed 0.5 m. *Calamovilfa longifolia* is often found with high cover values on sandier soils and *Koeleria macrantha* (*K. cristata*) cover increases on degraded sites. There are regionalized expressions of variability with *Carex inops ssp. heliophila* surpassing *Carex filifolia* in Colorado and *Calamagrostis montanensis* being at least as important as the diagnostic species in north-central Montana. *Pascopyrum smithii* is consistently present. For woody species, subshrub forms (*Artemisia frigida*, *Gutierrezia sarothrae*, *Rosa arkansana*) have the highest cover and constancy but their total cover does not exceed more than 5%, except on overgrazed sites. Cover values for forbs are low throughout the range of the type (the exception being *Selaginella densa*). Geographic setting does influence forb composition to some degree. *Sphaeralcea coccinea*, *Phlox hoodii*, *Heterotheca villosa*, *Gaura coccinea*, and *Liatris punctata*, have high constancy values in northern areas, whereas in the eastern and southern portions of the range *Lygodesmia juncea*, *Opuntia polyacantha*, *Artemisia dracunculus* and *Ratibida columnifera* seems to be more constant.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G5

CLASSIFICATION COMMENTS

The taxonomic disposition of this vegetation at Grant-Kohrs Ranch National Historic Site is enigmatic. *Carex filifolia* was not recorded in accuracy assessment and *Bouteloua gracilis* was inconstant and generally at low cover, when present. Mueggler and Stewart 1980 split their *Stipa comata* (*Hesperostipa comata*) series into two phases, a simple *Stipa comata/Bouteloua gracilis* type for 7 stands where they never observed *Carex filifolia* and the constancy of *Bouteloua gracilis* was 86%; then 19 stands of an *Stipa comata/Bouteloua gracilis Agropyron* (*Pascopyrum*) *smithii* phase where *Carex filifolia* did have a constancy of 84%. The vegetation has elements of the *Krascheninnikovia lanata* / *Hesperostipa comata* Dwarf-shrubland (CEGL001327), but *Krascheninnikovia lanata* is inconstant and at low cover, when it does occur. Mueggler and Stewart recognized a *Stipa comata* phase of the *Pseudoroegneria spicata* – *Poa secunda* Habitat Type (= *Pseudoroegneria spicata* – *Poa secunda* Herbaceous Vegetation), which has elements of this vegetation; thus, the *Hesperostipa comata* dominated vegetation at vegetation Grant-Kohrs Ranch National Historic Site might be regarded as a grazing-induced variant of that type.

***Pseudoroegneria spicata* - *Pascopyrum smithii* Herbaceous Vegetation**

COMMON NAME	Bluebunch Wheatgrass - Western Wheatgrass Herbaceous Vegetation
LOCAL NAME	Bluebunch Wheatgrass - Western Wheatgrass Mixedgrass Prairie
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d)
ALLIANCE	<i>PSEUDOROEGNERIA SPICATA</i> HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001675
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland (CES306.040)

RANGE

Grant-Kohrs Ranch National Historic Site

The *Pseudoroegneria spicata* - *Pascopyrum smithii* Herbaceous Vegetation is important in the Taylor Ridge, No Name, and Gravel Pit Ranges in the upland southwest quadrant of the Ranch. This type also dominates most of the thin steep strip of uplands owned by the Ranch along the west side of its northwest quadrant.

Global

This association has been described from western and central Montana (Jorgensen 1979, Mueggler and Stewart 1980, Cooper et al. 1995), northeastern Montana (DeVelice et al. 1995), southeastern Montana (Hansen and Hoffman 1988), northwestern and west-central Wyoming (Tweit and Houston 1980), and apparently from northeastern Wyoming (Terwilliger et al. 1979).

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

These are harsh xeric sites on coarse poorly developed soil. In some areas the surface is armored with pebbles indicating the wind swept nature of these west side uplands.

Global

Stands of this grassland association grow over a broad elevation range, from 2600 feet in Great Plains to 7500 feet in the foothills of the Rocky Mountains. They occur on slopes, from gentle alluvial fans to slopes as steep as 40%, facing all aspects. Substrates are glacial deposits, alluvium, limestone, and calcareous sandstones. Soils usually are shallow, may contain a substantial volume of coarse fragments, and belong to sandy clay loam, loam, or clay loam textural classes. The sites often are exposed to strong, persistent winds.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Pascopyrum smithii</i> , <i>Pseudoroegneria spicata</i>

CHARACTERISTIC SPECIES

Pascopyrum smithii

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 8 accuracy assessment observations)

Agropyron smithii is dominant in the herbaceous layer. *Pseudoroegneria spicata* is usually present and sometimes co-dominant. *Bromus tectorum* and *Descurainia sophia* may occur at high cover.

Global

Grasses contribute most of the cover and production. *Pseudoroegneria spicata* dominates (usually strongly). The rhizomatous wheatgrasses *Pascopyrum smithii* or *Elymus lanceolatus* (or both) are secondary species, but the rhizomatous wheatgrasses may codominate with *Pseudoroegneria spicata*. *Hesperostipa comata* (= *Stipa comata*), *Koeleria macrantha* (*K. cristata*), and *Poa secunda* usually are present in smaller amounts, but *Hesperostipa comata* often codominates in west-central Montana (Jorgensen 1979). *Bouteloua gracilis* is absent or is a minor species. *Nassella viridula* (= *Stipa viridula*) contributes substantial cover in some stands, especially in the Great Plains but also in some foothills stands (Mueggler and Stewart's (1980) *Stipa viridula* phase). Stands in the foothills often contain *Poa cusickii*, *Leucopoa kingii*, and *Calamagrostis montanensis*. In southeastern Montana (Hansen and Hoffman 1988) and northeastern Wyoming (Terwilliger et al. 1979), *Bouteloua curtipendula* may also occur in the vegetation. Forbs contribute little cover or production, but a number of species may be present, including *Ambrosia psilostachya* (in Great Plains stands), *Draba oligosperma*, *Erigeron compositus*, *Stenotus acaulis* (= *Haplopappus acaulis*), *Heterotheca villosa*, *Sphaeralcea coccinea*, *Phlox hoodii*, *Tragopogon dubius*, and *Vicia americana*. The subshrubs *Artemisia frigida* and *Gutierrezia sarothrae* usually are present in small amounts. Shrubs generally are absent or are present only as scattered individuals, but Tweit and Houston (1980) note that *Tetradymia canescens* may be common and *Chrysothamnus* spp. may form a distinct shrub layer in disturbed stands.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G4

CLASSIFICATION COMMENTS

The taxonomic disposition of this type as it occurs at Grant-Kohrs Ranch National Historic Site is uncertain, as *Pascopyrum smithii* is more constant, more diagnostic of this type and usually occurs at higher cover than *Pseudoroegneria spicata*. *Pascopyrum smithii* Herbaceous Vegetation (CEGL001577) may be more appropriate. However Mueggler and Stewart 1980 did not assign a pure *Pascopyrum smithii* type to western or southcentral Montana, but as one progresses eastward *Pascopyrum smithii* is increasingly abundant. As to the assigned association NatureServe does comment that "but the rhizomatous wheatgrasses may codominate with *Pseudoroegneria spicata*." The original mapping team did record *Pascopyrum smithii* in 13 of the 27 of the *Pseudoroegneria spicata*/*Pascopyrum smithii* polygons they mapped

***Pseudoroegneria spicata* – *Poa secunda* Herbaceous Vegetation**

COMMON NAME	Bluebunch Wheatgrass – Curly Bluegrass Herbaceous Vegetation
LOCAL NAME	Bluebunch Wheatgrass – Curly Bluegrass Grassland
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d)
ALLIANCE	<i>PSEUDOROEGNERIA SPICATA</i> HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001677
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland (CES306.040)

RANGE

Grant-Kohrs Ranch National Historic Site

This native bunchgrass Association is present in the upland ranges in the southwest quadrant of the ranch. The east side railroad inholding in the northeast quadrant is mostly of this natural community type. These railroad owned polygons are a classic example of remnant native vegetation in an otherwise human developed area.

Global

This association has been described from British Columbia, Washington, Oregon, Idaho, Utah, Colorado, Wyoming, and Montana.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

The west side upland range soils are coarse and poorly developed. In some areas the surface is armored with pebbles indicating the wind swept nature of these west side uplands. The east side railroad remnant is flat terrain.

Global

Stands of this association grow on well-drained, often shallow, and frequently gravelly or rocky soils generally of loam, clay loam, silt loam, or sandy loam textural classes. Sites usually are ridges and slopes, sometimes alluvial fans, scree slopes, sloped rocky cliff faces, and bedrock outcrops of any aspect, although southerly and westerly aspects are most common in the northwestern (British Columbia, Washington, Idaho) and northern (Montana) parts of the geographic range. In Wyoming and Colorado, many of the sites supporting this association are windswept slopes and ridges. This association grows over a very broad elevation range, from 213 to 854 m (700-2800 feet) in the northwestern part of the range, 915 to 2288 m (3000-7500 feet) in the north-central part, and 2867 to 3050 m (9400-10,000 feet) in central Colorado.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Pseudoroegneria spicata</i> , <i>Koeleria macrantha</i> , <i>Nassella viridula</i> , <i>Poa secunda</i>

CHARACTERISTIC SPECIES

Pseudoroegneria spicata, *Koeleria macrantha*, *Nassella viridula*, *Poa secunda*

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 61 accuracy assessment observations)

Pseudoroegneria spicata is dominant in the herbaceous layer, with *Koeleria macrantha*, *Nassella viridula*, *Poa secunda* (= *Poa sandbergii*) frequent and often co-dominant. The non-native rhizomatous grass *Thinopyrum intermedium* is occasionally the leading dominant. *Poa pratensis* and *Pascopyrum smithii* are occasional. The non-native *Bromus tectorum* and *Centaurea stoebe* ssp. *micranthos* may be frequent. *Gutierrezia sarothrae* and *Artemisia frigida* are occasional dwarf shrubs.

Global

As would be expected for an association whose geographic range includes such a broad range of climates and prehistoric grazing regimes, the composition of the vegetation varies, but a number of traits are constant. Throughout, this is a bunch grassland with minor cover of forbs and, often, sparse shrubs. *Pseudoroegneria spicata* dominates or codominates the vegetation; *Poa secunda* and *Koeleria macrantha* usually are present in substantial amounts, and *Festuca idahoensis* is absent or present in very small amounts. *Hesperostipa comata* (= *Stipa comata*) often is present in substantial amounts and may codominate, due (at least in part of the range) to prolonged grazing. *Bromus tectorum*, *Tragopogon* spp., and *Alyssum* spp. also are common members of the vegetation, due at least in part to disturbance. The common shrubs are *Ericameria nauseosa* (= *Chrysothamnus nauseosus*), *Chrysothamnus viscidiflorus*, and *Artemisia tridentata* (subspecies unknown). In southern British Columbia (Tisdale 1947), eastern Washington (Daubenmire 1988), and northeastern Oregon (Poulton 1955, Anderson 1956), the undisturbed vegetation of this type consists of *Pseudoroegneria spicata* and *Poa secunda*, with few other vascular plants (*Lomatium macrocarpum*, *Draba verna*, *Artemisia frigida*, *Gutierrezia sarothrae*, and a number of annuals), and substantial cover of epigeous cryptogams. *Hesperostipa comata* is present in most stands and may codominate with *Pseudoroegneria spicata*, as a result of heavy grazing. In western Idaho (Tisdale 1986), xeric sites support open vegetation with little *Poa secunda* and with *Opuntia polyacantha*, *Phacelia heterophylla*, and *Scutellaria angustifolia*. Stands on mesic sites are denser and usually contain *Balsamorhiza sagittata*, *Lomatium triternatum*, and *Lupinus sericeus*. In Utah (Christensen 1963, Christensen and Welsh 1963), *Gutierrezia sarothrae* is a common but minor species; *Hesperostipa comata* and *Achnatherum hymenoides* (= *Oryzopsis hymenoides*) are now common and often contribute substantial cover, apparently in stands disturbed by prolonged grazing. Montana stands (Mueggler and Stewart 1980, Cooper et al. 1995) often contain *Artemisia frigida*, *Gutierrezia sarothrae*, *Heuchera cylindrica*, *Achillea millefolium*, *Phlox hoodii*, *Eriogonum flavum*, *Stenotus acaulis* (= *Haplopappus acaulis*), and a number of other forbs as well as the fern *Cryptogramma acrostichoides*; *Hesperostipa comata* or *Hesperostipa spartea* (= *Stipa spartea*) often codominate with *Pseudoroegneria spicata*, apparently even in stands that have not been markedly disturbed. *Calamagrostis purpurascens* and *Festuca occidentalis* may also be present. In northwestern Wyoming (Tweit and Houston 1980), the vegetation is much like that in Montana (but without *Hesperostipa spartea*), while in central Wyoming (Williams 1961, Fisser 1964) and northeastern Wyoming (Terwilliger et al. 1979), nearer to the eastern edge of the geographic range, *Bouteloua gracilis*, *Rhus trilobata*, *Pascopyrum smithii*, and *Carex filifolia* may be present as minor species. In Colorado (Hess and Wasser 1982), species present in greater than trace amounts are *Achillea millefolium*, *Arenaria fendleri*, *Oxytropis lambertii*, *Potentilla gracilis*, and *Taraxacum officinale*. GLOBAL CLASSIFICATION CONFIDENCE 2

CONSERVATION RANK

G4?

CLASSIFICATION COMMENTS

This association has variable composition at Grant-Kohrs Ranch National Historic Site, possibly due to grazing and other land management practices. Plot data would be necessary to determine whether several types are actually represented.

***Thinopyrum intermedium* Semi-natural Herbaceous Vegetation**

COMMON NAME	Intermediate Wheatgrass Semi-natural Herbaceous Vegetation
LOCAL NAME	Intermediate Wheatgrass Grassland
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c)
ALLIANCE	THINOPYRUM INTERMEDIUMSEMI-NATURAL HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL002935
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland (CES306.040)

RANGE

Grant-Kohrs Ranch National Historic Site

This single polygon is a thin long strip planted along the railroad in the northeast quadrant of the Ranch

Global

This *Thinopyrum intermedium* type occurs widely throughout the northern Great Plains of the United States, at montane elevations in the Intermountain West, and perhaps more widely in the West, Midwest and Canada. It has been specifically reported for South Dakota, Utah, and Colorado (S. Menard, NatureServe, January 2009).

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

This area along the railroad tracks had been heavily disturbed.

Global

Stands can occur in a wide variety of human-disturbed habitats, and *Thinopyrum intermedium* (= *Agropyron intermedium*) is widely planted as pasture and hayland along road ditches, for CRP, and in dense-nesting-cover mixes (D. Ode pers. comm.). It is commonly found on reseeded cultivated lands planted with legumes such as sweet clover and alfalfa and may also have escaped into surrounding habitats (D. Ode pers. comm.). It is most abundant on dry, medium-textured soils, but has adapted to a broad range of soil textures and moisture conditions.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Thinopyrum intermedium</i>

CHARACTERISTIC SPECIES

Thinopyrum intermedium

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Along this single narrow strip polygon the canopy cover of *Thinopyrum intermedium* range from 26 to 50%. *Bromus tectorum* was the most common second component but averaged less than 5% canopy cover.

Global

Vegetation is primarily medium-tall (0.5-1 m) graminoids and dominated by *Thinopyrum intermedium*, a naturalized, cool-season grass species from eastern Europe. Other weedy species such as *Bromus inermis* may occur as well, but native species are generally less than 20% cover.

GLOBAL CLASSIFICATION CONFIDENCE ?

CONSERVATION RANK ?

CLASSIFICATION COMMENTS

The global information for this type was derived from S. Menard, NatureServe, January 2009

Wetland/Riparian Herbaceous Vegetation

Agrostis (gigantea, stolonifera) Semi-natural Herbaceous Vegetation

COMMON NAME	(Giant Bentgrass, Spreading Bentgrass) Semi-natural Herbaceous Vegetation
LOCAL NAME	Redtop Community Type
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	AGROSTIS STOLONIFERA Seasonally Flooded Herbaceous Alliance
ASSOCIATION IDENTIFIER	CEGL001558
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, seasonally flooded (PEM1C)
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

This *Agrostis stolonifera* semi-natural type is established immediately adjacent to or proximal to the Clark Fork River as stands scattered along the entire length of the floodplain. It is also present along the eastern side of the developed area of the Ranch and Cottonwood Creek.

Global

This vegetation includes grasslands dominated by an introduced perennial sod grass native to Europe. Stands have been described from Montana, but the alliances is likely more widespread. It has also been reported in Idaho, Nevada and Colorado. *Agrostis stolonifera* has been widely planted for forage in North America and has invaded native communities from hay fields, especially more mesic areas such as riparian floodplains and seasonally flooded wetlands in the semi-arid western U.S. References for this alliance include Hansen et al. 1995.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

This grass type is present in riparian areas that have prolonged standing water in part due to irrigation flowback.

Global

This vegetation is typically found in more mesic areas such as riparian floodplains and seasonally flooded wetlands in the semi-arid western U.S. where it has escaped from cultivation.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Agrostis stolonifera</i>

CHARACTERISTIC SPECIES

Agrostis stolonifera

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Phleum pratense, also tolerant of prolonged standing water or a high water table was the typically second most abundant species in these polygons. *Agropyron repens* was also often found at significant cover values. The invasive forbs *Cirsium arvense* and *Euphorbia esula* were also present in many polygons. A few polygons had scattered *Salix exigua* or *Betula occidentalis*.

Global

This alliance is characterized by a moderate to dense perennial graminoid layer dominated by *Agrostis stolonifera*. Other native species may occur as well, but they are generally less than 10% cover.

GLOBAL CLASSIFICATION CONFIDENCE ?

CONSERVATION RANK ?

CLASSIFICATION COMMENTS

The global information for this type was derived from M.S. Reid, mod. K. Schulz, NatureServe, January 2009

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

COMMON NAME	Smooth Brome – (Western Wheatgrass) Semi-natural Herbaceous Vegetation
LOCAL NAME	Smooth Brome Community Type
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Medium-tall bunch temperate or subpolar grassland (V.A.5.N.d)
ALLIANCE	<i>BROMUS INERMIS</i> SEMI-NATURAL HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL005264
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

These small areas dominated by invasive *Bromus inermis* are in the riparian floodplain of the Clark Fork River.

Global

This semi-natural grassland occurs widely throughout the northern Great Plains of the United States, and perhaps more widely in the Midwest and Canada. It likely occurs throughout much of the Rocky Mountains and Intermountain West. It has been specifically reported from Utah, Wyoming, Montana, Colorado, and North and South Dakota.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Periodic flooding or seasonally high water tables create mesic enough conditions to allow *Bromus inermis* to act as an invasive even with the low annual precipitation rate. A prior history of grazing cattle in the riparian zone likely facilitated the displacement of native graminoids by *Bromus inermis*.

Global

In semi-arid environments, it is restricted to relatively mesic conditions such as in riparian areas or forest openings at montane elevations. Stands can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. *Bromus inermis* is also widely planted for cover, pasture, and hay, and has escaped into a variety of habitats.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Bromus inermis</i>

CHARACTERISTIC SPECIES

Bromus inermis

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Additional riparian invaders are often present including *Agropyron repens*, *Phleum pratense*, *Cirsium arvense*, and *Euphorbia esula*. Remnant native include *Juncus balticus*. An occasional riparian shrub was sometimes incorporated into these *Bromus inermis* dominated polygons.

Global

This alliance is characterized by a moderately dense to dense layer of medium-tall (0.5-1 m) perennial graminoids. The dominant grass is *Bromus inermis*, a naturalized species from Eurasia. Other weedy species

may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie grasses, such as *Pascopyrum smithii* and *Hesperostipa comata* (= *Stipa comata*), as well as others.

GLOBAL CLASSIFICATION CONFIDENCE ?

CONSERVATION RANK ?

CLASSIFICATION COMMENTS

The global information for this type was derived from D. Faber-Langendoen, mod. K. Schulz, NatureServe, January 2009

***Carex aquatilis* Herbaceous Vegetation**

COMMON NAME	Aquatic Sedge Herbaceous Vegetation
LOCAL NAME	Aquatic Sedge Wet Meadow
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	<i>CAREX AQUATILIS</i> SEASONALLY FLOODED HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001802
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, seasonally flooded (PEM1C)
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

This seasonal wetland type is clearly represented by a single large (5.2 ac) polygon, the Ox Barn Pasture, immediately north of the main complex of corrals and barns.

Global

This association is common and located in mountainous areas throughout the western U.S. and Canada.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

This pasture has standing water to a very shallow water table because of a number of springs that surface in the pasture and adjoining area.

Global

This plant association occurs in a variety of valley types, but the largest expanses occur in broad, low-gradient valleys where large snowmelt-fed swales and slopes dominate the landscape. It can also grow in fine sediments at the margins of lakes and beaver ponds. These palustrine wetlands have a range of hydrologic regimes, though all stands are saturated for a significant enough period during the growing season to cause a build up of organic material in the soil. Soils are organic mucks and peats and are poorly to very poorly drained.

MOST ABUNDANT SPECIES

Grant-Kohrs Ranch National Historic Site

STRATUM	SPECIES
Herbaceous	<i>Carex aquatilis</i>

CHARACTERISTIC SPECIES

Carex aquatilis

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 3 accuracy assessment observations)

Carex aquatilis is dominant in the herbaceous layer, *Juncus balticus* (= *J. arcticus* ssp. *littoralis*), *Typha latifolia*, and *Alopecurus aequalis* were co-dominant in one accuracy assessment plot each. *Phleum pratense* was present at low cover in 2 accuracy assessment plots.

Global

This plant association is characterized by a dense rhizomatous meadow of *Carex aquatilis* (10-80% cover), usually accompanied by a few other graminoids species such as *Calamagrostis canadensis* (1-40%) or *Deschampsia caespitosa* (1-16%), *Juncus balticus*, and *Poa palustris*. *Eleocharis quinqueflora* can be abundant on organic

substrates (1-49% cover) at high elevations. *Carex utriculata* (1-20% cover) may be present. When present, *Carex utriculata* is usually not more than one-third the cover of *Carex aquatilis* cover. If it is more than that, the stand may be classified as *Carex aquatilis* - *Carex utriculata* Herbaceous Vegetation (CEGL001803) or *Carex utriculata* Herbaceous Vegetation (CEGL001562). Forbs are often present, although sometimes inconspicuous (generally <10%, but can be as high as 40%). Species include *Epilobium* spp., *Pedicularis groenlandica*, *Caltha leptosepala*, *Menyanthes trifoliata*, *Cardamine cordifolia*, and *Mertensia ciliata*. Shrubs and trees have been observed invading the wetland from surrounding areas, including *Betula nana*, *Salix maccalliana*, and *Picea engelmannii*.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G5

***Carex pellita* Herbaceous Vegetation**

COMMON NAME	Woolly Sedge Herbaceous Vegetation
LOCAL NAME	Woolly Sedge Wet Meadow
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	CAREX PELLITA SEASONALLY FLOODED HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001809
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, seasonally flooded (PEM1C)
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

Carex pellita Herbaceous Vegetation is present in the floodplain in the northwest quadrant of the Ranch between a major slough and the current river channel and as a polygon between the two parallel railroad beds where Johnson Creek enters the Ranch.

Global

This plant association is a minor wetland type in Colorado, Utah, Idaho, Montana, Washington, Oregon, and British Columbia, Canada. *Carex pellita* is a common sedge that occurs throughout the northern and western United States. It is likely that this or a closely related association occurs in Wyoming, California, and New Mexico.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Shallow groundwater and seasonally high water tables provide suitable habitat for *Carex pellita* Herbaceous Vegetation on the Clark Fork River floodplain and along Johnson Creek where the railroad beds altered the original topography and hydrology.

Global

This groundwater-supported plant association occurs in small patches along stream channels and in seasonally wet depressions and swales at low to moderate elevations in the western U.S. from Washington to Montana south to Oregon, Utah, Wyoming and Colorado. It has also been reported from British Columbia, Canada. These wetlands form small to medium-sized meadows on valley bottoms. Soils are alluvial and remain saturated through at least part of the growing season.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Carex pellita</i> , <i>Juncus balticus</i>

CHARACTERISTIC SPECIES

Carex pellita

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 1 accuracy assessment observation)

Carex pellita and *Juncus balticus* (= *J. arcticus* ssp. *littoralis*) were co-dominant in the herbaceous layer, with *Schedenorus pratensis* (= *Festuca pratensis*) frequent..

Global

Carex pellita, a distinctive wetland-indicator species, clearly dominates stands of this association with 30-80% cover. Low species diversity is characteristic. *Deschampsia caespitosa*, *Carex microptera*, *Carex nebrascensis*, *Carex simulata*, *Carex praegracilis*, *Carex utriculata*, *Elymus glaucus*, *Juncus balticus*, *Schoenoplectus pungens* (= *Scirpus pungens*), *Equisetum arvense*, and *Equisetum hyemale* are sometimes present with low cover. Stands that have been degraded by grazing may have high cover by the exotic species *Agrostis stolonifera* or *Poa pratensis* or the native rush *Juncus balticus* (Jankovsky-Jones et al. 2001). Scattered shrubs and small trees may be present, including *Salix exigua*, *Chrysothamnus linifolius*, *Salix amygdaloides*, *Populus deltoides*, and exotic *Tamarix* spp.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G3

***Carex utriculata* Herbaceous Vegetation**

COMMON NAME	Northwest Territory Sedge Herbaceous Vegetation
LOCAL NAME	Northwest Territory Sedge Wet Meadow
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	<i>CAREX (ROSTRATA, UTRICULATA)</i> SEASONALLY FLOODED HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001562
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, seasonally flooded (PEM1C)
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

Carex utriculata Herbaceous Vegetation polygons are found on both sides of the floodplain in the south half of the Ranch.

Global

This wetland association is found at montane and subalpine elevations throughout much of the western U.S.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Sloughs and flowback from irrigation maintain the high water table that creates the habitat for *Carex utriculata* Herbaceous Vegetation in these set backs from the current river channel.

Global

This herbaceous wetland association is found throughout much of the western U.S. Elevation ranges from 1060 to 3230 m (3500-10,600 feet). Stands occur in montane and subalpine areas around the edges of lakes and beaver ponds, along the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains (Kittel et al. 1999). Sites are flat to undulating, often with a hummocky microtopography (Kovalchik 1993). The water table is usually near the surface for most of the growing season. There are a wide variety of soil types for this association ranging from saturated organics or fine silty clays to clays over cobbles and alluvium to fine-loamy and sandy-skeletal, with an organic surface layer. Many stands occur on organic muck or peat soils. Mottling and gleying often occur near the surface because of the high water table.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Carex utriculata</i>

CHARACTERISTIC SPECIES

Carex utriculata

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 2 accuracy assessment observations)

Carex utriculata (= *Carex rostrata* var. *utriculata*) was dominant in the herbaceous layer, with *Juncus balticus* (= *J. arcticus* ssp. *littoralis*) and *Bromus inermis* co-dominant in one of the stands. *Typha latifolia*, *Alopecurus aequalis*, and *Agrostis gigantea* were recorded in one stand each. Various species of *Salix* may occur in a sparse shrub layer.

Global

This plant association is characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex utriculata* (20-99% cover). Stands often appear to be nearly pure *Carex utriculata*, but a variety of other graminoid species may be present as well. Other *Carex* species present include *Carex aquatilis*, *Carex canescens*, *Carex lenticularis*, *Carex microptera*, *Carex nebrascensis*, and *Carex scopulorum*, but usually with low cover. Other graminoid species that may be present include *Calamagrostis canadensis*, *Deschampsia caespitosa*, *Eriophorum angustifolium*, *Glyceria striata*, and *Juncus balticus*. Sparse forb cover may include *Epilobium* spp., *Geum macrophyllum*, *Fragaria virginiana*, *Mentha arvensis*, *Mimulus guttatus*, and *Polemonium occidentale*. Scattered *Salix* spp. shrubs may be present because these riparian shrublands are often adjacent. *Salix* species vary depending on elevation and geography. *Salix monticola*, *Salix drummondiana*, *Salix geyeriana*, *Salix planifolia*, *Salix wolfii*, and *Salix exigua* are common species.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G5

***Equisetum fluviatile* Herbaceous Vegetation**

COMMON NAME	Water Horsetail Herbaceous Vegetation
LOCAL NAME	Water Horsetail Marsh
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Semipermanently flooded temperate or subpolar grassland (V.A.5.N.1)
ALLIANCE	<i>EQUISETUM FLUVIATILE</i> SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL002746
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, semipermanently flooded (PEM1F)
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

One polygon proximal to the north boundary of the Ranch and the Deer Lodge sewage ponds was designated as a *Equisetum fluviatile* type.

Global

This emergent wetland herbaceous vegetation is known from the Columbia River tidal surge plain in western Washington, and non-tidal locations in eastern Washington, as well as in Oregon, Idaho, Montana and possibly British Columbia.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

This polygon is just west of the Kohrs-Manning Ditch and abuts the east bank of Clark Fork River so it has a high water table.

Global

This is an emergent wetland community occurring on seasonally to permanently flooded edges of lakes and ponds, along tidally influenced plains of larger rivers, calm backwater areas of rivers and streams, and in watered abandoned channels. It occurs from sea level to 1340 m (0-4390 feet) in elevation. Water depths range from below the soil surface to 0.5 m (1.5 feet) deep. Soils are fine-textured silts, clays and muck. Mineral soils often have layers of organic accumulation. Along the Columbia River Gorge, stands occur on river and slough channels on sand and silt and are flooded by freshwater during most high tides. Inland, stands occur at the edges of slow-moving meander curves in rivers and in shallow water and wet ground on the margins of lakes and ponds, stock ponds and reservoirs.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Equisetum fluviatile</i>

CHARACTERISTIC SPECIES

Equisetum fluviatile

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

No stands visited during accuracy assessment. The original mapping team reported that after the dominant *Equisetum fluviatile* with up to 25% canopy cover, *Poa pratensis* was the second most abundant species followed by *Agrostis stolonifera*.

Global

Stands are characterized by *Equisetum fluviatile* with 30-100% cover. Stands tend to be species-poor. Other species present can include *Glyceria grandis*, *Alopecurus aequalis*, *Carex* spp., *Eleocharis palustris*, *Typha* spp., and *Scirpus* and/or *Schoenoplectus* spp. Stands at lower elevations (Columbia River Surge Plain) had higher species diversity (n=18 for all sampled stands combined) than those at higher elevations (n=3 eastern Washington and Montana). In Alberta, it often forms open monotypic stands in the deepest zone of emergent vegetation, developing a denser cover moving in shore. Typically there then follows a transition zone of mixed *Equisetum fluviatile* and *Carex* spp. that leads to a zone of shoreline sedges, usually *Carex aquatilis*, *Carex rostrata*, and/or *Carex utriculata*.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G4

CLASSIFICATION COMMENTS

The presence of this type at Grant-Kohrs Ranch National Historic Site may be in question. Stands of *Equisetum fluviatile* might better be treated as wet meadows invaded by clones of *E. fluviatile*, as the mapped stand\ was found to be mixed with other vegetation and not distinguishable. The concept of *Equisetum fluviatile* Herbaceous Vegetation (CEGL002746) appears to be a deeper water marsh type than the one stand mapped at Grant-Kohrs Ranch National Historic Site.

***Eleocharis palustris* Herbaceous Vegetation**

COMMON NAME	Marsh Spikerush Herbaceous Vegetation
LOCAL NAME	Marsh Spikerush Wet Meadow
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	<i>ELEOCHARIS (PALUSTRIS, MACROSTACHYA)</i> SEASONALLY FLOODED HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001833
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, seasonally flooded (PEM1C)
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

Small linear polygons of *Eleocharis palustris* Herbaceous Vegetation are found along the active river channel.

Global

This association is found in the central Great Plains of the United States and Canada and throughout the western United States including the desert Southwest..

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Recent bank side fine textured alluvial deposits that are seasonally inundated by the Clark Fork River provide the substrate susceptible to dominance by *Eleocharis palustris*.

Global

This wetland occurs across the central and northwestern Great Plains and western United States. Elevations range from near sea level to 3050 m (0-10,000 feet). In the western mountains, it occurs in valleys and canyon bottoms on the banks and in the overflow channels of low-gradient streams, as well as along the margins of ponds and lakes. On the Great Plains, this community occurs in small depressions in intermittent streambeds, depression ponds that flood early in the season and dry out by summer, and small prairie potholes. It can also occur in the bottom of ephemeral ponds or playas on floodplain terraces of large rivers, and around semipermanently flooded beaver ponds and stock tanks. In wet years, stands may remain ponded throughout the growing season. Soils range from organic to silty clay to fine loam formed from weathered siltstone and shale or eolian loess. Soils are reported as slightly alkaline

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Eleocharis palustris</i>

CHARACTERISTIC SPECIES

Eleocharis palustris

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Eleocharis palustris was dominant in the herbaceous layer.

Global

This wetland association is dominated by submersed and emergent rooted vegetation under 1 m tall. The species composition can be quite variable, but this community is easy to recognize by the bright green, nearly pure stands of *Eleocharis palustris*. Vegetation cover can be sparse to dense (10-90%), but *Eleocharis palustris* is the dominant

species, and the only species with 100% constancy. Other species, when present, can contribute as much as 40% cover, but never exceed that of the *Eleocharis palustris* cover. Some of this variation is described from Colorado (Baker and Kennedy 1985, Kittel et al. 1999b). Co-occurring species in low-elevation stands on the western slope can include *Phalaris arundinacea* (= *Phalaroides arundinacea*), *Juncus balticus*, *Hordeum jubatum*, *Equisetum* spp., *Pascopyrum smithii*, *Schoenoplectus americanus* (= *Scirpus americanus*), *Sparganium angustifolium*, species of *Lemna* and *Potamogeton*, as well as the introduced *Melilotus officinalis* and *Bromus inermis*. On the eastern plains of Colorado co-occurring species can include *Leersia oryzoides*, *Schoenoplectus pungens* (= *Scirpus pungens*), *Panicum virgatum*, *Carex pellita* (= *Carex lanuginosa*), and *Spartina pectinata*. At montane elevations, other graminoids, such as *Carex aquatilis*, *Carex utriculata*, and *Deschampsia caespitosa*, are present. Forb cover is typically low but can be occasionally abundant (30%) in some stands. Forb species include *Pedicularis groenlandica*, *Rhodiola integrifolia*, and *Caltha leptosepala*.

In stands from eastern Washington, associates include *Carex utriculata*, *Cicuta douglasii*, and species of *Glyceria* and *Potamogeton*. In northwestern Nebraska, stands are dominated by *Eleocharis acicularis* and *Eleocharis palustris* which commonly cover the bottoms of the pools and emerge above the water as the pools dry out. Ephemeral submersed aquatics, such as *Callitriche palustris* (= *Callitriche verna*), *Potamogeton diversifolius*, and *Marsilea vestita*, may be present. As the pools dry out in mid-summer, ephemeral annual forbs, such as *Limosella aquatica* and *Plagiobothrys scouleri*, may appear. By late summer *Amaranthus californicus* and *Gnaphalium palustre* may dominate in the lowest parts of the depression (Steinauer and Rolfmeier 2000). In southwestern South Dakota, vegetation is composed of nearly homogeneous stands of *Eleocharis palustris*. Other emergents, such as *Polygonum amphibium*, *Marsilea vestita*, and *Eleocharis ovata*, are occasionally found. Herbaceous cover is greater than 75% except in areas of deeper open water where floating and submerged aquatic plants occur, including *Bacopa rotundifolia* and *Heteranthera limosa* (H. Marriott pers. comm. 1999). In lower elevation Utah stands, *Glaux maritima*, *Distichlis spicata*, and *Juncus balticus* are important associates (Brotherson and Barnes 1984).

Few stand data are available for Colorado examples. Generally, it appears that this community is dominated by *Eleocharis palustris*, forming a scattered to dense overstory, often with few associated species. Commonly associated graminoids include *Hordeum jubatum* and *Pascopyrum smithii*. Forbs present may include *Atriplex argentea*, *Polygonum aviculare*, and *Rorippa sinuata* (Baker and Kennedy 1985). The higher elevation stands may include a slightly different suite of species, but no stand data are available. Ramaley (1942) described a *Distichlis spicata*-dominated salt meadow on a lakeshore in the San Luis Valley which was ringed by *Eleocharis palustris*. Communities in Utah include *Eleocharis acicularis* and *Alopecurus aequalis* as likely associates (Padgett et al. 1989).

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G5

***Juncus balticus* Herbaceous Vegetation**

COMMON NAME	Baltic Rush Herbaceous Vegetation
LOCAL NAME	Baltic Rush Wet Meadow
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	<i>JUNCUS BALTICUS</i> SEASONALLY FLOODED HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL001838
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, seasonally flooded (PEM1C)
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

There are a number of smaller *Juncus balticus* stands in the vicinity of the southwest portions of the North Meadows. A disjunct stand of *Juncus balticus* developed between the two parallel railroad beds from the south fork to the north fork of Johnson Creek. A large (38 acres) polygon in the North Meadow was originally attributed to *Juncus balticus* Herbaceous Vegetation but subsequent to the accuracy assessment was reassigned to the provisional (*Bromus inermis* - *Elymus repens* - *Phleum pratense* - *Poa pratensis* - *Schedonorus pratensis*) Irrigated Pasture Herbaceous Vegetation because of the significant presence of introduced grasses.

Global

This Baltic rush wet meadow community is found widely throughout the western United States, ranging from South Dakota and Nebraska west to Washington, south to California, and east to New Mexico. It also occurs in western Canada.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Standing water and prolonged high seasonal water tables promote dominance by *Juncus balticus* in these wet meadows. Spring Slough and adjacent springs provide sufficient water to the North Meadows.

Global

This broadly defined and widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 138 to 3500 m (454-11,475 feet). Far northern stands in the Boreal Plains are at about 800 m (2625 feet). 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 from deeply entrenched to very sinuous (Kittel et al. 1999). In the boreal regions, this community occurs more commonly on gradual sandy shorelines. Soils are also variable and range from sandy and well-drained to poorly drained silty clay loam or silty clay alluvium to organic muck; however, soils tend to be finer-textured, alkaline and may be saline (Brotherson and Barnes 1984, Padgett et al. 1989, Kittel et al. 1999). Sites with sandy soils are usually saturated for part of the growing season or have high water tables. 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

STRATUM	SPECIES
Herbaceous	<i>Juncus balticus</i> , <i>Schedonorus pratensis</i>

CHARACTERISTIC SPECIES

Juncus balticus

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 22 accuracy assessment observations)

Juncus balticus (= *J. arcticus* ssp. *littoralis*) is dominant in the herbaceous layer, with other species mentioned here occasionally co-dominant – most often *Schedonorus pratensis* (= *Festuca pratensis*). Other species present may include *Carex utriculata*, *Alopecurus aequalis*, *Pascopyrum smithii*, *Agrostis gigantea*, *Carex pellita*, *Poa pratensis*, *Cirsium arvense*, *Elymus repens*, *Iris missouriensis*, and *Carex aquatilis*. Various species of *Salix* or *Symphoricarpos occidentalis* may occur in a sparse shrub layer.

Global

This broadly defined association is characterized by a low (<50 cm), open to typically dense graminoid layer dominated by the rhizomatous perennial *Juncus balticus*. In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis*, *Carex praegracilis*, *Carex microptera*, *Carex nebrascensis*, or *Carex utriculata*, is often present. Other common graminoids include *Deschampsia caespitosa*, *Distichlis spicata*, *Glyceria striata*, *Hordeum brachyantherum*, *Hordeum jubatum*, *Muhlenbergia andina*, *Muhlenbergia asperifolia*, *Pascopyrum smithii*, *Poa nemoralis* ssp. *interior*, *Phleum alpinum*, and *Sporobolus airoides*. Forb cover is generally low but may include *Achillea millefolium*, *Artemisia ludoviciana*, *Caltha leptosepala*, *Cirsium scariosum* (= *Cirsium tioganum*), *Dodecatheon pulchellum*, *Glaux maritima*, *Iris missouriensis*, *Maianthemum stellatum*, *Rumex aquaticus*, *Polygonum bistortoides*, *Potentilla plattensis*, and *Solidago canadensis*. Shrubs and dwarf-shrubs are not common; however, *Artemisia frigida* cover may be significant in some stands, and occasional *Artemisia cana*, *Artemisia tridentata* ssp. *tridentata*, *Dasiphora fruticosa* ssp. *floribunda*, *Ericameria nauseosa*, *Populus* spp., *Rosa woodsii*, *Salix* spp., or *Sarcobatus vermiculatus* shrubs may occur. Some stands may be codominated by the introduced perennial sod grasses *Poa pratensis*, *Bromus inermis*, or *Agrostis stolonifera*. Other introduced species, such as *Cirsium arvense*, *Cirsium vulgare*, *Erodium cicutarium*, *Iva axillaris*, *Lactuca serriola*, *Phleum pratense*, *Taraxacum officinale*, *Thinopyrum intermedium*, *Trifolium* spp., *Tragopogon dubius*, and *Xanthium strumarium*, may occur in disturbed stands.

GLOBAL CLASSIFICATION CONFIDENCE 1

CONSERVATION RANK G5

CLASSIFICATION COMMENTS

This vegetation may intergrade with and be difficult to separate from other wetland types or from irrigated pastures that have been disturbed and invaded by *Juncus balticus*.

Poa pratensisSemi-natural Seasonally Flooded Herbaceous Vegetation

COMMON NAME	Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Vegetation
LOCAL NAME	Kentucky Bluegrass Community Type
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	<i>POA PRATENSIS</i> SEASONALLY FLOODED HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL003081
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, seasonally flooded (PEM1C)
NS ECOLOGICAL SYSTEM	Rocky Mountain Alpine-Montane Wet Meadow (CES306.812)

RANGE

Grant-Kohrs Ranch National Historic Site

This single small quarter acre polygon is the southeast corner of the Ranch on the historic floodplain but now on the east side of the Kohrs-Manning Ditch south of the confluence of Cottonwood Creek with the Clark Fork River.

Global

This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural meadows and riparian areas. It is reported from Washington, Oregon, Montana, Wyoming, Idaho, Utah, and California, but is likely widespread in the western U.S. and northern Great Plains.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

This invasive grass type is present in the riparian area but only forms a semi-natural stand in this one floodplain location.

Global

This alliance has invaded natural prairies, meadows and riparian areas. Elevation ranges from 1100-2625 m (3600-8600 feet). Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid regions it is restricted to relatively mesic sites. Soils are variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content (Hansen et al. 1995). It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate mildly alkaline and saline soils, and some drought (Hansen et al. 1995, Hall and Hansen 1997, Kovalchik 1987, Manning and Padgett 1995, Padgett et al. 1989).

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Poa pratensis</i>

CHARACTERISTIC SPECIES

Poa pratensis

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Although *Poa pratensis* is frequently found in the riparian zone of the Ranch it only had contiguous cover in one polygon. This polygon also had an abundance of *Agropyron repens* and *Equisetum arvense*.

***Typha (latifolia, angustifolia)* Western Herbaceous Vegetation**

COMMON NAME	(Broadleaf Cattail, Narrowleaf Cattail) Western Herbaceous Vegetation
LOCAL NAME	Broadleaf Cattail Marsh
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N)
FORMATION	Semipermanently flooded temperate or subpolar grassland (V.A.5.N.1)
ALLIANCE	<i>TYPHA (ANGUSTIFOLIA, LATIFOLIA)</i> - (<i>SCHOENOPLECTUS</i> SPP.) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE
ASSOCIATION IDENTIFIER	CEGL002010
USFWS WETLAND SYSTEM	Palustrine Emergent persistent, semipermanently flooded (PEM1F)
NS ECOLOGICAL SYSTEM	North American Arid West Emergent Marsh (CES300.729)

RANGE

Grant-Kohrs Ranch National Historic Site

The largest *Typha latifolia* stand is adjacent to the railroad beds in the northeast corner of the Ranch. The second largest stand is along Spring Slough in the North Meadows. Several smaller stands are on the west side floodplain.

Global

This association is widely distributed, occurring across the western United States and western Great Plains.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

There are numerous (21) occurrences of *Typha latifolia* at the Ranch because of irrigation ditches and flowback as well as the natural sloughs and a man made depression but only 7 polygons were designated as *Typha latifolia* Herbaceous Vegetation type. The largest stand is in a standing water excavation pit dug to provide material for the elevated railroad beds. A large natural stand follows the Spring Slough. Several smaller stands about a natural slough on the west side of the river in the south half of the Ranch. This west side slough receives irrigation flowback from Lower Meadow #1.

Global

This widespread community is found along streams, rivers, canals, and the banks of ponds and lakes. Elevations range from near sea level to 2000 m. Sites are nearly level. The soil is saturated or flooded for much of the year from freshwater sources such as springs or streams. The alluvial soils have variable textures ranging from sand to clay and usually with a high organic content.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Typha latifolia</i>

CHARACTERISTIC SPECIES

Typha latifolia

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 7 accuracy assessment observations)

Typha latifolia is dominant in the herbaceous layer, with *Carex aquatilis* sometimes important or codominant. Few other species are present, with *Juncus balticus* (= *J. arcticus* ssp. *littoralis*) most often recorded. Various species of *Salix* may occur in a sparse shrub layer.

Global

This community is dominated by hydrophytic macrophytes, especially *Typha latifolia* or *Typha angustifolia*, which grow from approximately 2-3 m tall. *Typha latifolia* and *Typha angustifolia* often form dense, near-monotypic stands (70-98% cover), almost to the exclusion of other species. In some stands the two *Typha* species are codominant. Other species typical of wetlands may be found in lesser amounts in this community; among these are shallower water emergents such as *Carex* spp., *Eleocharis macrostachya*, *Eleocharis palustris*, *Glyceria* spp., *Juncus balticus*, *Juncus torreyi*, *Mentha arvensis*, *Schoenoplectus acutus*, and *Veronica* spp. In deeper water, *Lemna minor*, *Potamogeton* spp., *Sagittaria* spp., *Azolla filiculoides*, and other aquatics may be present in trace amounts. Trace amounts of grasses like *Agrostis stolonifera*, *Beckmannia syzigachne*, *Hordeum jubatum*, *Muhlenbergia asperifolia*, and *Phalaris arundinacea* may also be present.

GLOBAL CLASSIFICATION CONFIDENCE 2

CONSERVATION RANK G5

Sparse Vegetation

***Deschampsia caespitosa* Slickens Semi-natural Sparse Vegetation [NPS Special]**

COMMON NAME	Tufted Hairgrass Slickens Semi-natural Sparse Vegetation
LOCAL NAME	Tufted hairgrass Slickens
CLASS	Sparse Vegetation (VII)
SUBCLASS	Unconsolidated material sparse vegetation (VII.C)
GROUP	Sparsely vegetated soil slopes (VII.C.3)
SUBGROUP	Natural/Semi-natural (VII.C.3.N)
FORMATION	Moist slopes (VII.C.3.N.a)
ALLIANCE	Undefined
ASSOCIATION IDENTIFIER	NPSGRK0002(described from this project)
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	Pollution Altered Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland

RANGE

Grant-Kohrs Ranch National Historic Site

These semi-natural polygons are located on the Clark Fork River floodplain.

Global

This vegetation is known only from Grant-Kohrs Ranch National Historic Site in western Montana.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

A major flood in 1908 deposited toxic metal mine and smelter spoils on top of the historic floodplain of the upper Clark Fork River. These spoils were generated by copper mining and smelting upriver at Anaconda and Butte. The pre 1908 flood floodplain at the Ranch was elevated about one foot by these deposits and many sloughs and other depressions were filled in. The phytotoxicity and plant community level impacts of these deposits have been confirmed by various studies conducted as part of a natural resource damage assessment (Rice 2002; Kapustka 2002; Rice and Hardin 2002a). *Deschampsia caespitosa* is known to be tolerant of heavy metals and low pH soils and has colonized smelter and mine deposits around the globe.

Global

Same as for Grant-Kohrs Ranch National Historic Site.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Deschampsia caespitosa</i>

CHARACTERISTIC SPECIES

Deschampsia caespitosa

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

This type is virtually unvegetated to sparsely vegetated with clumps of *Deschampsia caespitosa* which may form a thin ring around an unvegetated center area, or consists of more or less continuous cover of monotypic *Deschampsia caespitosa*.

Global

Same as for Grant-Kohrs Ranch National Historic Site.

GLOBAL CLASSIFICATION CONFIDENCE Not Ranked

GLOBAL CONSERVATION RANK Probably GW.

CLASSIFICATION COMMENTS

Classification of ruderal, semi-natural vegetation at alliance and association levels is very under-developed in the NVCS. This vegetation was mapped as unclassifiable from any existing floristic descriptions. It was determined to the lowest determinable level of the NVCS (the Formation, as defined by the 1997 standard) and given a provisional (project-specific description) as a “placeholder” to classify mapped stands for the Grant-Kohrs National Historic Site project and as an occurrence record for future work.

Rocky Mountain Riparian Bar Sparse Vegetation [NPS Special]

COMMON NAME	Rocky Mountain Riparian Bar Sparse Vegetation
LOCAL NAME	Riparian Bar
CLASS	Sparse Vegetation (VII)
SUBCLASS	Unconsolidated material sparse vegetation (VII.C)
GROUP	Sparsely vegetated sand flats (VII.C.2)
SUBGROUP	Natural/Semi-natural sparsely vegetated sand flats (VII.C.2.N)
FORMATION	Temporarily flooded sand flats (VII.C.2.N.c)
ALLIANCE	Rocky Mountain Riparian Bar Sparsely Vegetated Alliance (NPS Special)
ASSOCIATION IDENTIFIER	NPSGRK0003(described from this project)
USFWS WETLAND SYSTEM	Riverine Upper Perennial Unconsolidated Shore Cobble-Gravel, temporarily flooded (R3US1A)
NS ECOLOGICAL SYSTEM	Northwestern Great Plains Riparian

RANGE

Grant-Kohrs Ranch National Historic Site

Some of these polygons are immediately adjacent to the Clark Fork River channel although others are on portions of the floodplain set back from the current channel.

Global

Unknown.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

These polygons are recent deposits along the river channel or older deposits of coarse material that precluded succession to recognized climax communities.

Global

Unknown.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	Unknown

CHARACTERISTIC SPECIES

Unknown

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

Introduced invasive grasses are a principal component of these early succession polygons. They include *Bromus inermis*, *Agrostis stolonifera*, and *Phleum pratense*. Invasive forbs including *Centaurea maculosa*, and *Euphorbia esula* are found in these polygons. Native components at low constancy included *Juncus balticus* and a few riparian shrubs. No stands were visited during accuracy assessment.

Global

Unknown.

GLOBAL CLASSIFICATION CONFIDENCE N/A

CONSERVATION RANK N/A

CLASSIFICATION COMMENTS

This type is a placeholder to represent sparsely vegetated riparian bars at Grant-Kohrs Ranch National Historic Site. It is a Rocky Mountain analogue to the generalized Riverine Sand Flats - Bars Sparse Vegetation (CEGL002049).

Planted/Cultivated (Cultural) Herbaceous Vegetation

(*Bromus inermis* - *Elymus repens* - *Phleum pratense* - *Poa pratensis* - *Schedonorus pratensis*) Hayfield/Irrigated Pasture Herbaceous Vegetation [NPS Special]

COMMON NAME	(Smooth Brome – Timothy – Kentucky Bluegrass – Meadow Fescue) Hayfield/Irrigated Pasture Cultural Herbaceous Vegetation
LOCAL NAME	Hayfield/Pasture
CLASS	Herbaceous Vegetation (V)
SUBCLASS	Perennial graminoid vegetation (V.A)
GROUP	Temperate or subpolar grassland (V.A.5)
SUBGROUP	Planted/Cultivated (V.A.5.C)
FORMATION	Perennial grass crops (hayland, pastureland) (V.A.5.C.a)
ALLIANCE	None defined
ASSOCIATION IDENTIFIER	NPSGRK0001 (described from this project)
USFWS WETLAND SYSTEM	Upland
NS ECOLOGICAL SYSTEM	N/A

RANGE

Grant-Kohrs Ranch National Historic Site

These improved grass pastures occupy over half (753 acres) of the Ranch. On the west side and proximal to the Clark Fork River floodplain they are designated as Lower Meadows 1 through 4. In the southwest quadrant of the Ranch 3 broad gulches (Big Gulch, Little Gulch, and Taylor Field) lie between the dry bunchgrass upland ranges. Stuart Field is the major hayfield in the southeast quadrant. In the northeast quadrant there are large improved pastures east of the railroad tracks.

Global

Unknown. This vegetation is likely to be widespread as it is typical of irrigated improved grass pastures in the northwest states.

ENVIRONMENTAL DESCRIPTION

Grant-Kohrs Ranch National Historic Site

The west side pastures and hayfields are flood irrigated. Stuart Field and the smaller Johnson Creek Field in the southeast quadrant are subirrigated by adjoining Johnson and Cottonwood Creeks. The fields east of the railroad tracks in the northeast quadrant were sprinkler irrigated using effluent from the Deer Lodge sewage plant.

Global

Unknown. Environmental setting is likely to be similar to that at Grant-Kohrs Ranch National Historic Site.

MOST ABUNDANT SPECIES

STRATUM	SPECIES
Herbaceous	<i>Bromus inermis</i> , <i>Elymus repens</i> , <i>Phleum pratense</i> , <i>Poa pratensis</i> , <i>Juncus balticus</i> , <i>Schedonorus pratensis</i>

CHARACTERISTIC SPECIES

Bromus inermis, *Elymus repens*, *Phleum pratense*, *Poa pratensis*, *Schedonorus pratensis*

VEGETATION DESCRIPTION

Grant-Kohrs Ranch National Historic Site

(from 122 accuracy assessment observations)

This type is characterized by either monospecific or various patterns of mixed dominance by non-native, rhizomatous pasture grasses, primarily *Bromus inermis*, *Elymus repens*, *Phleum pratense*, *Poa pratensis*, and/or *Schedenorus pratensis* (= *Festuca pratensis*). *Juncus balticus* (= *Juncus arcticus* ssp. *littoralis*) may be co-dominant with the grasses, especially in heavily grazed pastures. Other grasses that may be present and occasionally contribute significant cover are *Agrostis gigantea*, *Pascopyrum smithii*, *Alopecurus aequalis*, *Agropyron cristatum*, *Hesperostipa comata*, and/or *Dactylis glomerata*. Annual weeds, mostly in the family *Brassicaceae*, are often present and may occasionally be seasonally co-dominant: these include *Descurainia sophia*, *Alyssum* spp., *Lepidium latifolium*, *Thlaspi arvense*, and *Medicago sativa*. Other frequent weeds present at low cover are *Cirsium* spp., *Taraxacum* spp., and *Trifolium* spp.. In wetter settings, *Iris missouriensis*, *Carex* spp. and/or *Equisetum fluviatile* may be present at low cover. Shrubs are generally absent, but may be present at low cover (usually *Salix* spp.), especially where the type intergrades with natural vegetation.

Global

Unknown. Composition may depend on how the variable dominance seen at Grant-Kohrs Ranch National Historic Site is treated.

GLOBAL CLASSIFICATION CONFIDENCE Not defined

CONSERVATION RANK None (Planted/Cultivated vegetation)

CLASSIFICATION COMMENTS

Because of variable monospecific and mixed dominance patterns in similar settings, probably due to historic management patterns, it proved intractable to recognize this type as individual monospecific types. Without plot data and more detailed analysis a single and variable irrigated pasture/hayfield type seems warranted. This vegetation is treated as Planted/Cultivated Vegetation in the sense of the 1997 FGDC standard for the NVCS (to be defined as Cultural Vegetation in the [2008] revision of the FGDC standard).

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Appendix F: Ecological System Descriptions

This appendix contains summary descriptions of ecological system units (NatureServe 2003b, Comer et al. 2003) occurring at GRKO. The accuracy assessment indicated eight vegetation groups at the level of the Ecological System would provide a map accuracy of 85.0%. Two groups are altered vegetation types described for environmental situations and plant assemblages found at Grant-Kohrs Ranch. Each ecological system represents one or more National Vegetation Classification (NVC) plant associations. Map classes were also crosswalked to ecological system units. The ecological systems classification was developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. One purpose of ecological systems is to provide a coarse-scale mapping unit that can be applied across management boundaries.

Table G-1. Final (post accuracy assessment) Ecological System assignments for associations at the Grant-Kohrs Ranch (Comer et al. 2003, NatureServe 2007).

Post Accuracy Assessment Ecological Systems
North American Arid West Emergent Marsh
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland
Northwestern Great Plains Riparian
Rocky Mountain Alpine-Montane Wet Meadow
Rocky Mountain Lower Montane-Foothill Shrubland
Other vegetation types
Pollution Altered Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
Irrigated Pasture

The following six Ecological Systems descriptions were obtained from NatureServe Explorer <http://www.natureserve.org/explorer/> on January 7, 2010.

Scientific Name: North American Arid West Emergent Marsh

Unique Identifier: CES300.729

Classification Confidence: 1 – Strong

This widespread ecological system occurs throughout much of the arid and semi-arid regions of western North America, typically surrounded by savanna, shrub steppe, steppe, or desert vegetation. Natural marshes may occur in depressions in the landscape (ponds, kettle ponds), as fringes around lakes, and along slow-flowing streams and rivers (such riparian marshes are also referred to as sloughs). Marshes are frequently or continually inundated, with water depths up to 2 m. Water levels may be stable, or may fluctuate 1 m or more over the course of the growing season. Water chemistry may include some alkaline or semi-alkaline situations, but the alkalinity is highly variable even within the same complex of wetlands. Marshes have distinctive soils that are typically mineral, but can also accumulate organic material. Soils have characteristics that result from long periods of anaerobic conditions in the soils (e.g., gleyed soils, high organic content, redoximorphic features). The vegetation is characterized by herbaceous plants that are adapted to saturated soil conditions. Common emergent and floating vegetation includes species of *Scirpus* and/or *Schoenoplectus*, *Typha*, *Juncus*, *Potamogeton*, *Polygonum*, *Nuphar*, and *Phalaris*. This system may also include areas of relatively deep water with floating-leaved plants (*Lemna*, *Potamogeton*, and *Brasenia*) and submergent and floating plants (*Myriophyllum*, *Ceratophyllum*, and *Elodea*).

Classification Comments: This ecological system occurs in the arid and semi-arid regions of western North America, where semipermanently flooded habitats are found as small patches in the matrix of a relatively dry landscape. Except for stands in the semi-arid portions of the western Great Plains, emergent marsh found in the Great Plains should be classified into one of the Western Great Plains depressional wetland systems.

Scientific Name: Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland

Unique Identifier: CES306.804

Classification Confidence: 2 - Moderate

This ecological system of the northern Rocky Mountains and the east slopes of the Cascades consists of deciduous, coniferous, and mixed conifer-deciduous forests that occur on streambanks and river floodplains of the lower montane and foothill zones. Riparian forest stands are maintained by annual flooding and hydric soils throughout the growing season. Riparian forests are often accompanied by riparian shrublands or open areas dominated by wet meadows. *Populus balsamifera* is the key indicator species. Several other tree species can be mixed in the canopy, including *Populus tremuloides*, *Betula papyrifera*, *Betula occidentalis*, *Picea mariana*, and *Picea glauca*. *Abies grandis*, *Thuja plicata*, and *Tsuga heterophylla* are commonly dominant canopy species in western Montana and northern Idaho occurrences, in lower montane riparian zones. Shrub understory components include *Cornus sericea*, *Acer glabrum*, *Alnus incana*, *Betula papyrifera*, *Oplopanax horridus*, and *Symphoricarpos albus*. Ferns and forbs of mesic sites are commonly present in many occurrences, including such species as *Athyrium filix-femina*, *Gymnocarpium dryopteris*, and *Senecio triangularis*.

Classification Comments: This system is from the Canadian Rockies ecoregion project and represents lower montane riparian in Montana north into Canada. In the Okanagan, this is defined as all the cottonwood-dominated or -codominated riparian systems below subalpine and above the Ponderosa pine zone. This system occurs in fire-dominated landscapes, which distinguishes it from North Pacific and subalpine/alpine landscapes that have significantly different fire regimes. This system is distinguished from the similar Rocky Mountain Subalpine-Montane Riparian Woodland (CES306.833) by the floristic component of northern Rocky Mountain species, both in the woody layers and in the herbaceous taxa. This system may occur in northwestern Wyoming where *Populus balsamifera* dominates or codominates some woodlands, but those woodlands may be better placed into Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821), which lists *Populus balsamifera* as a possible dominant.

Scientific Name: Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland

Unique Identifier: CES306.040

Classification Confidence: 3 - Weak

This ecological system of the northern Rocky Mountains is found at lower montane to foothill elevations in the mountains and large valleys of northeastern Wyoming and western Montana, west through Idaho into the Blue Mountains of Oregon, and north into the Okanagan and Fraser plateaus of British Columbia and the Canadian Rockies. They also occur to the east in the central Montana mountain "islands," foothills, as well as the Rocky Mountain Front and Big and Little Belt ranges. These grasslands are floristically similar to Inter-Mountain Basins Big Sagebrush Steppe (CES304.778), Columbia Basin Foothill and Canyon Dry Grassland (CES304.993), and Columbia Basin Palouse Prairie (CES304.792), but are defined by shorter summers, colder winters, and young soils derived from recent glacial and alluvial material. These northern lower montane and valley grasslands represent a shift in the precipitation regime from summer monsoons and cold snowy winters found in the southern Rockies to predominantly dry summers and winter precipitation. In the eastern portion of its range in Montana, winter precipitation is replaced by a huge spring peak in precipitation. They are found at elevations from 300 to 1650 m, ranging from small meadows to large open parks surrounded by conifers in the lower montane, to extensive foothill and valley grasslands below the lower treeline. Many of these valleys may have been primarily sage-steppe with patches of grassland in the past, but because of land-use history post-settlement (herbicide, grazing, fire suppression, pasturing, etc.), they have been converted to grassland-dominated areas. Soils are relatively deep, fine-textured, often with coarse fragments, and non-saline, often with a microphytic crust. The most important species are cool-season perennial bunch grasses and forbs (>25% cover), sometimes with a sparse (<10% cover) shrub layer. *Pseudoroegneria spicata*, *Festuca campestris*, *Festuca idahoensis*, or *Hesperostipa comata* commonly dominate sites on all aspects of level to moderate slopes and on certain steep slopes with a variety of other grasses, such as *Achnatherum hymenoides*, *Achnatherum richardsonii*, *Hesperostipa curtisetia*, *Koeleria macrantha*, *Leymus cinereus*, *Elymus trachycaulus*, *Bromus inermis* ssp. *pumpellianus* (= *Bromus pumpellianus*), *Achnatherum occidentale* (= *Stipa occidentalis*), *Pascopyrum smithii*, and other graminoids such as *Carex filifolia* and *Danthonia intermedia*. Other grassland species include *Opuntia fragilis*,

Artemisia frigida, *Carex petasata*, *Antennaria* spp., and *Selaginella densa*. Important exotic grasses include *Phleum pratense*, *Bromus inermis*, and *Poa pratensis*. Shrub species may be scattered, including *Amelanchier alnifolia*, *Rosa* spp., *Symphoricarpos* spp., *Juniperus communis*, *Artemisia tridentata*, and in Wyoming *Artemisia tripartita* ssp. *rupicola*. Common associated forbs include *Geum triflorum*, *Galium boreale*, *Campanula rotundifolia*, *Antennaria microphylla*, *Geranium viscosissimum*, and *Potentilla gracilis*. A soil crust of lichen covers almost all open soil between clumps of grasses; *Cladonia* and *Peltigera* are the most common lichens. Unvegetated mineral soil is commonly found between clumps of grass and the lichen cover. The fire regime of this ecological system maintains a grassland due to rapid fire return that retards shrub invasion or landscape isolation and fragmentation that limits seed dispersal of native shrub species. Fire frequency is presumed to be less than 20 years. These are extensive grasslands, not grass-dominated patches within the sagebrush shrub steppe ecological system. *Festuca campestris* is easily eliminated by grazing and does not occur in all areas of this system.

Classification Comments: This is the same as the Interior Plateau Grassland also called "Northern Plateau Grassland" of the Okanagan Ecoregional Plan. In Wyoming, this is distinguished from Northwestern Great Plains Mixedgrass Prairie (CES303.674) by the presence of *Festuca idahoensis* or *Carex rossii*, the lack of *Bouteloua gracilis* (which is common in CES303.674), or the presence of *Artemisia nova* or *Artemisia tripartita* ssp. *rupicola*, neither of which occur in CES303.674.

Scientific Name: Northwestern Great Plains Riparian

Unique Identifier: CES303.677

Classification Confidence: 3 - Weak

This system is found in the riparian areas of medium and small rivers and streams throughout the northwestern Great Plains. It is likely most common in the Northern Great Plains Steppe. This system occurs in the Upper Missouri and tributaries starting at the Niobrara, White, Cheyenne, Belle Fourche, Moreau, Grand, Heart, Little Missouri, Yellowstone, Powder, Tongue, Bighorn, Wind, Milk, Musselshell, Marias, and Teton rivers; and in Canada, the Southern Saskatchewan, Red Deer and Old Man rivers to where they extend into Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821) or Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.804). These are found on alluvial soils in highly variable landscape settings, from deep cut ravines to wide, braided streambeds.

Hydrologically, these tend to be more flashy with less developed floodplain than on larger rivers, and typically dry down completely for some portion of the year. Dominant vegetation shares much with generally drier portions of larger floodplain systems downstream, but overall abundance of vegetation is generally lower. Communities within this system range from riparian forests and shrublands to gravel/sand flats. Dominant species include *Populus deltoides*, *Populus balsamifera* ssp. *trichocarpa*, *Salix* spp., *Artemisia cana* ssp. *cana*, and *Pascopyrum smithii*. These areas are often subjected to heavy grazing and/or agriculture and can be heavily degraded. Another factor is that groundwater depletion and lack of fire have created additional species changes.

Classification Comments: This system needs to be more clearly delineated from Northwestern Great Plains Floodplain (CES303.676). The component plant association list is incomplete. All the riparian/floodplain/alluvial systems of the Great Plains region need to be revisited for naming conventions, along with better definitions of conceptual boundaries. There is much apparent overlap in their concepts and distribution, and the names add to the confusion. In particular, the difference between "riparian" and "floodplain" usage in the names needs revisiting and possible changing. These systems include Northwestern Great Plains Floodplain (CES303.676), Northwestern Great Plains Riparian (CES303.677), Western Great Plains Floodplain (CES303.678), and Western Great Plains Riparian (CES303.956).

Scientific Name: Rocky Mountain Alpine-Montane Wet Meadow

Unique Identifier: CES306.812

Classification Confidence: 2 - Moderate

These are high-elevation communities found throughout the Rocky Mountains and Intermountain regions, dominated by herbaceous species found on wetter sites with very low-velocity surface and subsurface flows. They range in elevation from montane to alpine (1000-3600 m). These types occur as large meadows in montane or subalpine valleys, as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on sub-irrigated sites with slopes up to 10%. In alpine regions, sites typically are small depressions located below late-melting snow patches or on snowbeds. Soils of this system may be mineral or organic. In either case, soils show typical hydric soil characteristics, including high organic content and/or low chroma and redoximorphic features. This system often occurs as a mosaic of several plant associations, often dominated by graminoids, including *Calamagrostis stricta*, *Caltha leptosepala*, *Cardamine cordifolia*, *Carex illota*, *Carex microptera*, *Carex nigricans*, *Carex scopulorum*, *Carex utriculata*, *Carex vernacula*, *Deschampsia caespitosa*, *Eleocharis quinqueflora*, *Juncus drummondii*, *Phippsia algida*, *Rorippa alpina*, *Senecio triangularis*, *Trifolium parryi*, and *Trollius laxus*. Often alpine dwarf-shrublands, especially those dominated by *Salix*, are immediately adjacent to the wet meadows. Wet meadows are tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.

Classification Comments: Similar systems to this one include Temperate Pacific Subalpine-Montane Wet Meadow (CES200.998) and Boreal Wet Meadow (CES103.873). Rocky Mountain Alpine-Montane Wet Meadow (CES306.812) occurs to the east of the coastal and Sierran mountains, in the semi-arid interior regions of western North America. Boreal wet meadow systems occur farther north and east in boreal regions where the climatic regime is generally colder than that of the Rockies or Pacific Northwest regions. Floristics of these three systems are somewhat similar, but there are differences related to biogeographic affinities of the species composing the vegetation.

Scientific Name: Rocky Mountain Lower Montane-Foothill Shrubland

Unique Identifier: CES306.822

Classification Confidence: 2 - Moderate

This ecological system is found in the foothills, canyon slopes and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico, extending north into Wyoming, and west into the Intermountain West region. These shrublands occur between 1500 and 2900 m elevation and are usually associated with exposed sites, rocky substrates, and dry conditions, which limit tree growth. It is common where *Quercus gambelii* is absent, such as the northern Colorado Front Range and in drier foothills and prairie hills. This system is generally drier than Rocky Mountain Gambel Oak-Mixed Montane Shrubland (CES306.818) but may include mesic montane shrublands where *Quercus gambelii* does not occur. *Cercocarpus montanus* dominates pure stands in parts of Wyoming and Colorado. Scattered trees or inclusions of grassland patches or steppe may be present, but the vegetation is typically dominated by a variety of shrubs, including *Amelanchier utahensis*, *Cercocarpus montanus*, *Purshia tridentata*, *Rhus trilobata*, *Ribes cereum*, *Symphoricarpos oreophilus*, or *Yucca glauca*. Grasses are represented as species of *Muhlenbergia*, *Bouteloua*, *Hesperostipa*, and *Pseudoroegneria spicata*. Fires play an important role in this system as the dominant shrubs usually have a severe die-back, although some plants will stump sprout. *Cercocarpus montanus* requires a disturbance such as fire to reproduce, either by seed sprout or root-crown sprouting. Fire suppression may have allowed an invasion of trees into some of these shrublands, but in many cases sites are too xeric for tree growth. In Wyoming, stands where *Cercocarpus montanus* is a component of mixed shrublands are placed in Northern Rocky Mountain Montane-Foothill Deciduous Shrubland (CES306.994).

Classification Comments: Some reviewers have requested that this system be renamed in such a way as to more strongly indicate that it is dominated primarily by *Cercocarpus montanus*. However, while *Cercocarpus montanus* is an important shrub in this system, it is not the only dominant, and in many occurrences is not found at all.

Appendix G: Geodatabase Documentation

Introduction

This document describes the relationships and entities of the relational geodatabase model used to house the GRKO vegetation map data. This model was developed for ArcGIS 9.3 using the personal geodatabase Microsoft Access JET engine.

The structure of this database differs from many of the other NPS Vegetation Maps. Because intensive field sampling was not involved, this vegetation map did not use the NatureServe Plots database. Thus, only a limited set of information was collected in the field. Records of dominant species composition are preserved in this geodatabase as a feature class, and in tables; these tables and data are identified with “Field” and “AA” (Accuracy Assessment) in their headings.

Entity Relationships

Figure G-1 provides a diagram showing the relationships among the primary entities, both spatial and tabular. In total, there are six feature classes that contain geographic information, three main tables, and four lookup tables used for reference.

Referential integrity is enforced among the main tables (tbl) through MS Access. Due to the limitations of the geodatabase model, referential integrity is not enforced among the look-up (tlu) tables and the related feature classes (fcl).

This structure reflects a compromise between normalization and functionality. In general, all spatial information (especially polygons) was represented in the feature classes while all tabular information was housed in relational tables. However, there is sometimes redundancy between the two. For instance, the map names are located in both the feature classes and the lookup tables. This simultaneously ensures that one can work in ArcGIS without having to plot x-y points while another can work in Access without the risk of corrupting the feature classes.

Table and Attribute Descriptions

Details for each table and data field are provided in Figure G-1.

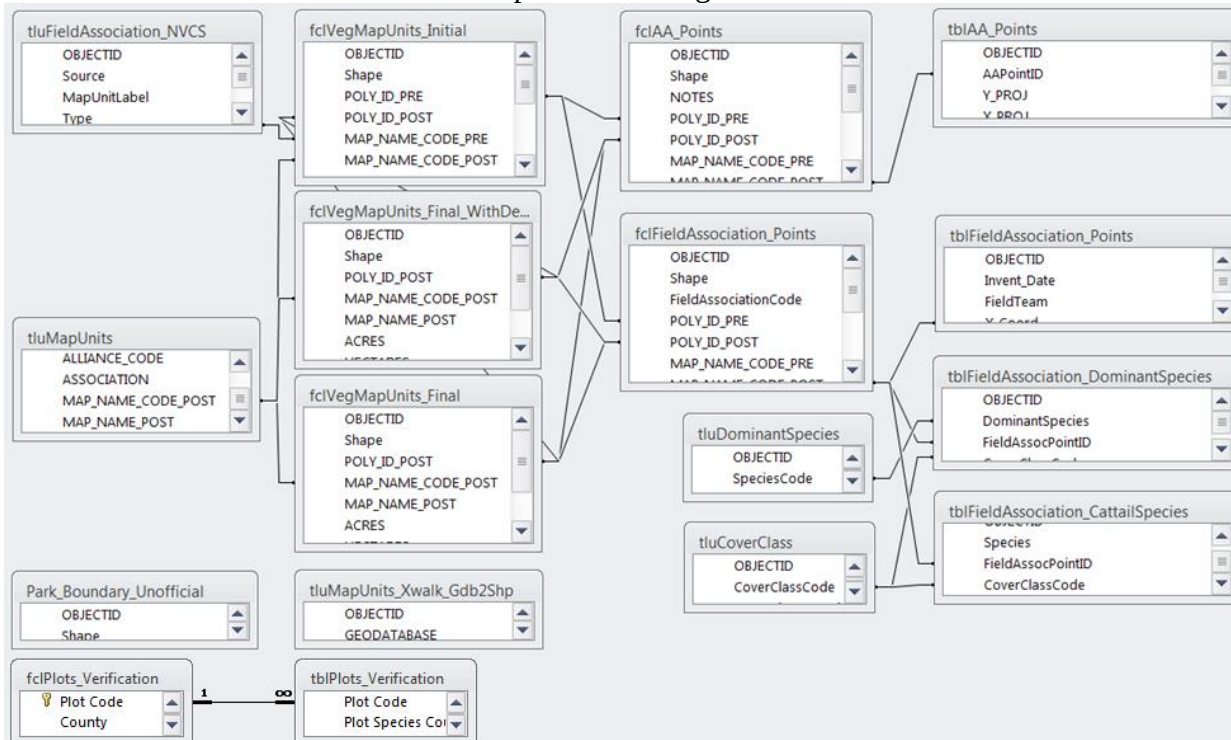


Figure G-1. Diagram of Relationships Among Core Tables in the Geodatabase Model

fclAA_Points

This feature class contains the geographic locations of all accuracy assessment points. This feature class is a spatial representation of 'tblAA_Points'.

Attribute	Description	Type
OBJECTID	Autonumber. Internal to ESRI	Long
Shape	Shape. Internal to ESRI	Blob
AAPointID	Unique point ID for each AA point	Text 50
NOTES	Comments about the pre-post transition	Text 200
POLY_ID_PRE	Original (segmented polys) unique polygon identifier	Integer
POLY_ID_POST	Final (collapsed polys) polygon identifier	Integer
MAP_NAME_CODE_PRE	Original (segmented polys) Map Unit Association code	Text 50
MAP_NAME_CODE_POST	Final (collapsed polys) Map Unit Association code	Text 50
MAP_NAME_PRE	Original (segmented polys) Map Unit Label	Text 255
MAP_NAME_POST	Final (collapsed polys) Map Unit Label	Text 255
FieldCallAssociation	Final Association given to the point	Text 50
FieldCallAssociation_Original	Original Association given to the point	Text 50

FieldCallAssociation_Original2	Working amendments to the Association given to the point	Text 50
DominantSpecies_Tree	Species code for all dominant species in the tree canopy	Text 200
DominantSpecies_Shrub	Species code for all dominant species in the shrub canopy	Text 200
DominantSpecies_Herbaceous	Species code for all dominant species in the herbaceous canopy	Text 200
DominantSpecies_Notes	Notes about dominant species in all canopy layers	Text 200

fclFieldAssociation_Points

This feature class contains the point locations used as reference to assign the polygons an association. Additional details of the original “field call” related to these point features are included in ‘tblFieldAssociation_Points’.

Attribute	Description	Type
OBJECTID	Autonumber. Internal to ESRI	Long
Shape	Shape. Internal to ESRI	Blob
FieldAssocPointID	Field code from field census	Text 50
FieldAssociationCode	Final Association given to the point	Text 50
FieldAssociationCode_Original	Original Association given to the point	Text 50
FieldAssociationCode_Original2	Working amendments to the Association given to the point	Text 50
POLY_ID_PRE	Original (segmented polys) unique polygon identifier	Integer
POLY_ID_POST	Final (collapsed polys) polygon identifier	Integer
MAP_NAME_CODE_PRE	Original (segmented polys) Map Unit Association code	Text 50
MAP_NAME_CODE_POST	Final (collapsed polys) Map Unit Association code	Text 50
MAP_NAME_PRE	Original (segmented polys) Map Unit Label	Text 255
MAP_NAME_POST	Final (collapsed polys) Map Unit Label	Text 255
NOTES	Comments about the pre-post transition	Text 200

fclPlots_Verification

This feature class contains the centroid point location of each vegetation classification plot. Additional details of the species found at these point features are included in ‘tblPlots_Verification’.

Attribute	Description	Type
OBJECTID	Autonumber. Internal to ESRI	Long
Plot_Code	Unique identifier for this vegetation plot	Text 255
County	County the point is within	Text 255
Provisional_Community_Name	Vegetation community name assigned in field prior to classification	Text 255
Classified_Community_Name	Vegetation community name assigned in field after classification	Text 255
NVC_ELCODE	National Vegetation Classification Code for the Classified Community Name for this plot	Text 255
Location_Code	NPS Park code	Text 255
Sublocation	Area within the park	Text 255

Quad_Name	1:24k Quad	Text 255
Coord_System	Coordinate system of the XY data, 1 if UTM, 2 if Lat/Long	Double
GPS_File	Path and filename of waypoints downloaded from GPS unit	Text 255
GPS_Techniques	Description of equipment/techniques used to collect spatial information	Text 255
Field_UTM_X	X (east-west) coordinate recorded in the field for this plot	Double
Field_UTM_Y	Y (north-south) coordinate recorded in the field for this plot	Double
UTM_Zone	UTM Zone	Double
Survey_Date	Date plot was visited	Text 255
Surveyors	Names of people doing the fieldwork for this plot	Text 255
Plot_Directions	Narrative description of how to get to plot	Text 255
X_Dimension	If rectangular plots used, give plot width (x dimension)	Double
Y_Dimension	If rectangular plots used, give plot length (y dimension)	Double
Plot_Shape	Shape of vegetation plots (rectangular, circular, etc)	Text 255
Representativeness	How similar to the plot is the 1 hectare area surrounding the plot?	Text 255
Elevation	Elevation of plot	Double
Elevation_Units	Units of elevation measure, 1=meters, 2=feet	Text 255
GPS_Datum	Datum used in conjunction with the coordinate system	Text 255
GPS_Accuracy	Measurement error as recorded on the GPS unit used	Text 255
Slope	Slope measured in classes	Text 255
Precise_Slope	Slope measured to precise degrees or percent	Text 255
Aspect	Aspect measured in classes	Text 255
Precise_Aspect	Aspect measured in precise degrees	Text 255
Topo_Position	Topographic position of plot	Text 255
Landform	Major landform description of plot and surrounding area	Text 255
Surficial_Geology	Description of substrate	Text 255
Cowardin_System	General wetland classification of plot (Upland, Palustrine, Estuarine, Riverine, Lacustrine)	Text 255
Hydro_Regime	Hydrological regime to further define wetlands, or if Upland: dry, dry-mesic or mesic	Text 255
Hydrology_Evidence	Narrative description of hydrological influence	Text 255
Environmental_Comments	Narrative description of the habitat, including animal use and disturbance	Text 255
Soil_Texture	General soil texture of plot area	Text 255
Soil_Drainage	General soil drainage of plot area	Text 255
Prcnt_Bedrock	% of unvegetated ground surface covered by bedrock	Double
Prcnt_Large_Rocks	% of unvegetated ground surface covered by large rocks (> gravel)	Double
Prcnt_Small_Rocks	% of unvegetated ground surface covered by small rocks (gravel or smaller)	Double
Prcnt_Sand	% of unvegetated ground surface covered by sand	Double
Prcnt_Litter_Duff	% of unvegetated ground surface covered by litter or duff	Double
Prcnt_Wood	% of unvegetated ground surface covered by dead wood	Double
Prcnt_Water	% of unvegetated ground surface covered by water	Double

Prcnt_Bare_Soil	% of unvegetated ground surface covered by bare soil (clay, silt, or loam)	Double
Prcnt_Other	% of unvegetated ground surface covered by anything else	Double
Prcnt_Other_Description	Describe what that "anything else" really is	Text 255
Leaf_Phenology	Leaf phenology of dominant stratum	Text 255
Leaf_Type	Leaf type of dominant stratum	Text 255
Physio_Class	Physiognomic class of dominant stratum	Text 255
T1_Hgt	Maximum height of Emergent Tree Stratum (meters)	Text 255
T1_Cover	% cover of Emergent trees	Text 255
T2_Hgt	Maximum height of Canopy Stratum (meters)	Text 255
T2_Cover	% cover of Tree canopy	Text 255
T3_Hgt	Maximum height of Subcanopy Stratum (meters)	Text 255
T3_Cover	% cover of Subcanopy	Text 255
S1_Hgt	Maximum height of Tall Shrub Stratum (meters)	Text 255
S1_Cover	% cover of Tall shrubs	Double
S2_Hgt	Maximum height of Medium Shrub Stratum (meters)	Text 255
S2_Cover	% cover of Medium shrubs	Double
S3_Hgt	Maximum height of Low Shrub Stratum (meters)	Text 255
S3_Cover	% cover of Low shrubs	Text 255
H_Hgt	Maximum height of Herbaceous Stratum (meters)	Text 255
H_Cover	% cover of Herbaceous plants	Double
N_Hgt	Maximum height of Nonvascular Stratum (meters)	Text 255
N_Cover	% cover of Nonvascular plants	Double
V_Hgt	Maximum height of Vine/liana Stratum (meters)	Text 255
V_Cover	% cover of Vines/lianas	Text 255
E_Hgt	Maximum height of Epiphyte Stratum (meters)	Text 255
E_Cover	% cover of Epiphytes	Text 255
Disturbance_Comments	A place to put any other comments	Text 255
Update_	Date of most recent change to data	Date
User	Data entry person to last update record	Text 255
Species_Counter	Plot-specific counter for Plot-Species record keys	Double

fclVegMapUnits_Final

This feature class contains the geographic location of all vegetation map polygons, their associated classifications, and labels. The Map Unit Association code field ('MAP_NAME_CODE_POST') is a four letter code derived from the standard scientific name (i.e. the first two letters of the Genus and specific epitaph; some of the entries recognize two dominant species (separated by '/'). Most of these codes match the NVC standards (i.e. may be based on former nomenclature, as in the case of *Pseudoroegneria spicata* which is coded 'AGSP'); a few of the codes are custom names for this map (e.g. those other than natural vegetation types). Map Unit Label includes the common names for the dominant species (same species identified in 'MAP_NAME_CODE_POST'.

Attribute	Description	Type
OBJECTID	Autonumber. Internal to ESRI	Long
Shape	Shape. Internal to ESRI	Blob
PLOY_ID_POST	Final (collapsed polys) polygon identifier	Integer
MAP_NAME_CODE_POST	Final (collapsed polys) Map Unit Association code	Text 50
MAP_NAME_POST	Final (collapsed polys) Map Unit Label	Text 255
ACRES	Area in acres. Calculated in ArcMap	Double
HECTARES	Area in hectares. Calculated in ArcMap	Double
Shape_Length	Length in meters. Internal to ESRI	Double
Shape_Area	Area in square meters. Internal to ESRI	Double

fclVegMapUnits_Final_WithDetailedPasture

This feature class contains the geographic location of all vegetation map polygons, their associated classifications, and labels. When adjacent polygons had the same final classification ('MAP_NAME_CODE_POST'), the polygons were merged together to create a larger polygon ('PLOY_ID_POST'). However, the initial polygons with a final classification of 'Pasture' have been retained in this feature class even when the polygons share a border.

Attribute	Description	Type
OBJECTID	Autonumber. Internal to ESRI	Long
Shape	Shape. Internal to ESRI	Blob
PLOY_ID_POST	Final (collapsed polys) polygon identifier	Integer
MAP_NAME_CODE_POST	Final (collapsed polys) Map Unit Association code	Text 50
MAP_NAME_POST	Final (collapsed polys) Map Unit Label	Text 255
ACRES	Area in acres. Calculated in ArcMap	Double
HECTARES	Area in hectares. Calculated in ArcMap	Double
Shape_Length	Length in meters. Internal to ESRI	Double
Shape_Area	Area in square meters. Internal to ESRI	Double

fclVegMapUnits_Initial

This feature class contains the geographic location of original vegetation map polygons, their associated classifications, and labels. The original Map Unit Association code and the code after polygons were collapsed are both maintained in this feature class. The unique identifiers for each original polygon and the final unique identifier for the polygon are also maintained. The spatial extent has been clipped to the park border.

Attribute	Description	Type
OBJECTID	Autonumber. Internal to ESRI	Long
Shape	Shape. Internal to ESRI	Blob
POLY_ID_PRE	Original (segmented polys) unique polygon identifier	Integer
POLY_ID_POST	Final (collapsed polys) polygon identifier	Integer
MAP_NAME_CODE_PRE	Original (segmented polys) Map Unit Association code	Text 50

MAP_NAME_CODE_POST	Final (collapsed polys) Map Unit Association code	Text 15
MAP_NAME_PRE	Original (segmented polys) Map Unit Label	Text 255
MAP_NAME_POST	Final (collapsed polys) Map Unit Label	Text 255
NOTES	Comments about the pre-post transition	Double
ACRES	Area in acres. Calculated in ArcMap	Double
HECTARES	Area in hectares. Calculated in ArcMap	Double
SuperClass	Zone guiding detail of eCognition segmentation	Text 50
Shape_Length	Length in meters. Internal to ESRI	Double
Shape_Area	Area in square meters. Internal to ESRI	Double

Park_Boundary_Unofficial

This feature class represents the extent of the spatial data delivered by the Vegetation Classification and Mapping Project. It is the result of a digitizing effort utilizing a mix of the legal park boundary and the fence surrounding the park.

Attribute	Description	Type
Notes	Comments about the derived polygon	Text 255
Shape_Length	Length in meters. Internal to ESRI	Double
Shape_Area	Area in square meters. Internal to ESRI	Double
Shape	Shape. Internal to ESRI	Blob
OBJECTID	Autonumber. Internal to ESRI	Long

tblAA_Points

This table contains the locations and field identification call made by the accuracy assessment team; these data were used to assess correlation between original field calls, assigned polygon associations and user accuracy.

Attribute	Description	Type
AAPointID	Unique AA point ID	Text 255
Y_PROJ	UTM NAD 83, 13 North	Long Integer
X_PROJ	UTM NAD 83, 13 North	Long Integer
GPS_ErrorMeters	Estimated GPS positional error in meters	Double
Surveyor	Name of the surveyor making the field call	Text 255
Invent_Date	Date the point was visited	Date
Altitude	Elevation from GPS	Double
GPS_Model	Make of the GPS	Text 50

tblFieldAssociation_CattailSpecies

This table contains the species of cattail found for each point based on a survey around the point of reference. These are the original field calls recorded by botanists during the polygon census.

Attribute	Description	Type
FieldAssocPointID	Unique code identifying each field call	Text 50
Species	Species code for one of the cattail species in a polygon	Text 10
CoverClassCode	Percent cover for the particular species	Text 10
OBJECTID	Autonumber. Internal to ESRI	Long

tblFieldAssociation_DominantSpecies

This table contains the dominant species found for each point based on a survey around the point of reference. These are the original field calls recorded by botanists during the polygon census.

Attribute	Description	Type
FieldAssocPointID	Unique code identifying each field call	Text 50
DominantSpecies	Species code for one of the dominant species in a polygon	Text 10
CoverClassCode	Percent cover for the particular species	Text 10
OBJECTID	Autonumber. Internal to ESRI	Long

tblFieldAssociation_Points

This table contains the data collected in the field to determine the association for each polygon.

Attribute	Description	Type
FieldAssocPointID	Unique ID for each field call	Text 50
Invent_Date	Date the polygon was visited	Date
FieldTeam	Identifier initials from the field team	Text 2
X_Coord	UTM Easting, 13 North, NAD 83	Double
Y_Coord	UTM Northing, 13 North, NAD 83	Double
TotalPointsAvged	The number of points collected in recording the waypoint	Long
GPS_ErrorMeters	The estimated accuracy of the GPS unit when point was visited (meters)	Text 50
FieldAssociationCode	Community type assigned to the polygon during the fieldwork	Text 50
SourceFile	Name of the waypoint file used to assign the point	Text 50
Notes	Notes from the field sheet	Memo
OBJECTID	Autonumber. Internal to ESRI	Long

tblPlots_Verification

This table contains the taxonomic data collected in the field at each vegetation classification plot.

Attribute	Description	Type
OBJECTID	Autonumber. Internal to ESRI	Long
Plot_Code	Unique identifier for this vegetation plot	Text 255
Plot_Species_Counter	Unique sequence for species within this plot	Text 255
Plant_Symbol	USDA PLANTS accepted symbol for this species	Double

Scientific_Name	Scientific Name only (without Authors)	Text 255
Common_Name	National Common Name	Text 255
Family	Taxonomic Family	Text 255
Specimen_Number	Number given to the specimen taken	Text 255
Used_PLANTS	Yes if name came from the PLANTS database	Short Integer
Source	From Plant List table: SS or NS	Text 255
Within_Plot	Species is present within the Plot boundaries	Short Integer
Stratum_Sort	Major sort order of stratum type	Double
Stratum	Stratum code	Text 255
Diagnostic	Species is a known diagnostic for the community	Short Integer
Range_Cover	Category per scale classification scheme	Text 255
Real_Cover	Percent cover for this species	Text 255
Other_Measure1	Other measure of species presence	Text 255
Other_Measure2	Other measure of species presence	Text 255
Update_	Date of most recent change to data	Date
User	Data entry person to last update record	Text 255

tluCoverClass

This reference table contains cover classes used to identify dominant species within each polygon.

Attribute	Description	Type
CoverClassCode	Shorthand code	Text 50
CoverClassDescription	Description of each cover class (% range)	Text 200
CoverClassMidpoint	Numeric midpoint of the cover class range	Double
ObjectID	Autonumber. Internal to ESRI	Long

tluDominantSpecies

This reference table connects 4-letter species codes to the proper scientific name. Note that a species code can represent more than a single species.

Attribute	Description	Type
SpeciesCode	Shorthand 4 letter code	Text 10
SpeciesName	Scientific nomenclature	Text 200
TSN	PLANTS TSN code	Long
SpeciesCode_Updated	Revised Shorthand 4 letter code to be current as of 03/2012	Text 10
SpeciesName_Updated	Revised Scientific nomenclature to be current as of 03/2012	Text 200
TSN_Updated	Revised PLANTS TSN code to be current as of 03/2012	Long
ObjectID	Autonumber. Internal to ESRI	Long

tluFieldAssociation_NVCS

This table preserves the original Association assigned by botanists mapping in the field; these are connected to the appropriate NVC hierarchical classes. Note that some codes change between the original field call and the final classification, which is why this information is preserved.

Attribute	Description	Type
MAP_NAME_CODE_PRE	Original (segmented polys) Map Unit Association code	Text 50
MAP_NAME_PRE	Original (segmented polys) Map Unit Label	Text 255
Source	Field key or other source for field level classification	Text 255
MapUnitLabel	Common Name Association Label	Text 100
Type	Hierarchy Level, e.g. habitat, community, alliance, etc.	Text 50
NVCS_Association	Association from NatureServe Explorer Web site (Oct 2006)	Text 255
NPS_VegMapAssociation	Association from NatureServe Explorer web site (Oct 2006). NA = field typed only to alliance level, or Association does not exist	Text 100
NVCS_CEGLCODE	CEGL (NVCS/NatureServe) Association Code (CEGL#####) or NPS Code (NPS####)	Text 50
NVCS_Alliance	Alliance from NatureServe Explorer Web site (Oct 2006)	Text 100
NVCS_AllianceCode	Alliance Code (A.####)	Text 50
NVCS_EcologicalSystem	Ecological System from NatureServe Explorer (Oct 2006)	Text 100
NVCS_Formation	Formation from NatureServe Explorer (Oct 2006)	Text 255
Zone_Pre	Generalized vegetation grouping	Text 100
Comments	Details on the citation and/or record information	Text 255
OBJECTID	Unique ID. Internal to ESRI	Long

tluMapUnits

This table of classes represents the final crosswalk for the NVCS associations; it includes codes, scientific nomenclature and class hierarchy assignments.

Attribute	Description	Type
OBJECTID	Autonumber. Internal to ESRI	Long Integer
MAP_NAME_CODE_POST	Final (collapsed polys) Map Unit Association code	Text 255
MAP_NAME_POST	Final (collapsed polys) Map Unit Label	Text 255
COMMON_NAME	Classification name used for the map symbology	Text 255
ASSOCIATION_IDENTIFIER	Unique NVCS alpha-numeric from NVCS (NatureServe): Association Code (CEGL#####), or project specific NPS code (NPS.GRKO#) for non-natural types (Manier per Chris Lea recs.)	Text 255
ASSOCIATION	NVCS (NatureServe) Association description	Text 255
CLASS	Class from NVCS hierarchy	Text 255
SUBCLASS	Subclass from NVCS hierarchy	Text 255

GROUP	Group from NVCS hierarchy	Text 255
SUBGROUP	Subgroup from NVCS hierarchy	Text 255
FORMATION	Formation from NVCS hierarchy	Text 255
ALLIANCE	Alliance associated with the final map name code	Text 255
ALLIANCE_CODE	Alliance Code (A.####)	Text 50
USFWS_WETLAND_SYSTEM	Wetland type from USFWS	Text 255
NS_ECOLOGICAL_SYSTEM_1	NVCS/NatureServe Ecological System	Text 255
NS_ECOLOGICAL_SYSTEM_2	NVCS/NatureServe Ecological System	Text 255
NS_ECOLOGICAL_SYSTEM_3	NVCS/NatureServe Ecological System	Text 255
NS_ECOLOGICAL_SYSTEM_4	NVCS/NatureServe Ecological System	Text 255
NS_ECO_SYSTEM_1_CODE	Code associated with NVCS/NatureServe Ecological System 1	Text 255
NS_ECO_SYSTEM_2_CODE	Code associated with NVCS/NatureServe Ecological System 2	Text 255
NS_ECO_SYSTEM_3_CODE	Code associated with NVCS/NatureServe Ecological System 3	Text 255
NS_ECO_SYSTEM_4_CODE	Code associated with NVCS/NatureServe Ecological System 4	Text 255
Zone_Post	Generalized vegetation grouping	Text 100
Comments	Notes about the classification	Text 255

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



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