USGS-NPS Vegetation Mapping Program

Wind Cave National Park, South Dakota

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EXECUTIVE SUMMARY

The USGS Biological Resources Division (USGS/BRD) under contract with the Inventory and Monitoring (I&M) Program of the National Park Service has initiated a multi-year project to produce vegetation maps for 235 national parks. As a contractor under this program, the Bureau of Reclamation's Remote Sensing and Geographic Information Group (RSGIG) with assistance from The Nature Conservancy (TNC) has mapped the vegetation occurring in and around Wind Cave National Park (near Hot Springs, South Dakota). Thirty-two vegetation map classes representing 28 plant community types and six Anderson Level II land-use classes were used for interpretation for approximately 139 square miles encompassing the Park and surrounding environs.

Vegetation map classes were determined through extensive field reconnaissance, data collection, and analysis in accordance with the National Vegetation Classification System (NVCS). The vegetation map was created initially by interpretation of 1997, 1:12,000 scale color infrared aerial photography (0.5 hectare minimum mapping unit). All vegetation and land-use information was then transferred to USGS digital orthophoto quarter-quads (DOQQ's) using a combination of on-screen digitizing and scanning techniques. Arc/Info™ (ESRI, Inc.) software was used throughout the project for digitizing, scanning, transforming, registering, and plotting the interpreted data. Overall map accuracy for the entire mapping effort was assessed initially at 73%. Final map products complied with national map accuracy standards, are described in this report, and occur on the accompanying compact disk (CD-ROM). They include the following:

- Vegetation Classification Descriptions and Key
- Land Use Classification System
- Representative Photos from Field Studies
- Vegetation Key
- Field Data (Digital Database)
- Digital and Hard Copy Vegetation Maps
- Accuracy Assessment
- Metadata
- Final Report

Wind Cave and other similar national park vegetation mapping databases can be accessed at the USGS/BRD website: http://biology.usgs.gov/npsveg.

INTRODUCTION

The Inventory and Monitoring (I&M) Program of the National Park Service (NPS) was created in 1991 to provide park managers with critical information on natural resources. A long-term goal of this program is to provide baseline inventories of the biological and geophysical resources for all natural resource parks. To address this need, the NPS entered a multi-year partnership with the United States Geological Survey's (USGS) Biological Resources Division (BRD) to map the vegetation resources of 235 national parks, monuments, and historic sites. Goals of the USGS-NPS Vegetation Mapping Program include the following:

- Provide support for NPS Resources Management
- Promote vegetation-related research for both NPS and USGS/BRD
- Provide support for NPS Planning and Compliance
- Add to the information base for NPS Interpretation
- Assist in NPS Operations

Efforts to make this program a reality have lead to various work contracts with other government and private agencies. Among those contracted was the United States Bureau of Reclamation's (BOR) Remote Sensing and Geographic Information Group (RSGIG) based at the Federal Center Denver, Colorado. The task of the RSGIG was to create a digital, spatial database representative of the vegetation occurring at Wind Cave National Park (WICA), South Dakota during 1997. The primary subcontractor for vegetation classification and characterization is The Nature Conservancy (TNC) (Minneapolis Satellite Offices Minneapolis, MN) and its affiliate the Wyoming Nature Conservancy (Lander, WY).

The specific objectives of this study included:

- Creation of vegetation and mapping classifications based on the National Vegetation Classification System (NVCS).

- Development of a spatial database for the vegetation of WICA using remote sensing and GIS techniques.

Production of digital and hard copy vegetation maps, assessed to be at least 80% accurate.

Vegetation mapping for WICA falls under the USGS-NPS Vegetation Mapping Program's general task of completing all the national parks within the Great Plains Ecosystem. Other parks in this region that have been mapped or are currently in progress include: Theodore Roosevelt National Park, Badlands National Park, Mt. Rushmore National Memorial, Agate Fossil Beds National Monument, Jewel Cave National Monument, Devil's Tower National Monument, Scott's Bluff National Monument, and Fort Laramie National Historic Site. Any available data pertaining to these and other USGS-NPS Vegetation Mapping projects can be accessed at the USGS/BRD's website: http://biology.usgs.gov/npsveg.

photo by D. Cogan

Figure 1. Bison on a western wheatgrass - Kentucky bluegrass grassland at Wind Cave National Park.

PROJECT AREA

Founded in 1903 as the seventh national park in the United States, Wind Cave National Park is best known for its extensive cave system and abundant wildlife. WICA personnel presently manage 81.76 miles of known passages in the Wind Cave complex along with 28,295 surface acres, predominately mixed-grass prairie and ponderosa pine forest. Two lightly used gravel roads and several trails cross the central and eastern parts of the Park.

Location and Regional Setting

WICA is situated on the southeastern edge of the Black Hills Region of South Dakota (Figure 2), about 7 miles north of Hot Springs, SD. The Park lies in Custer County between Custer State Park to the north and Black Hills National Forest to the west. U.S. Highway 385 and South Dakota Highway 87 are the Park's major roads; secondary roads within WICA include NPS 5 and 6 (Figure 3).

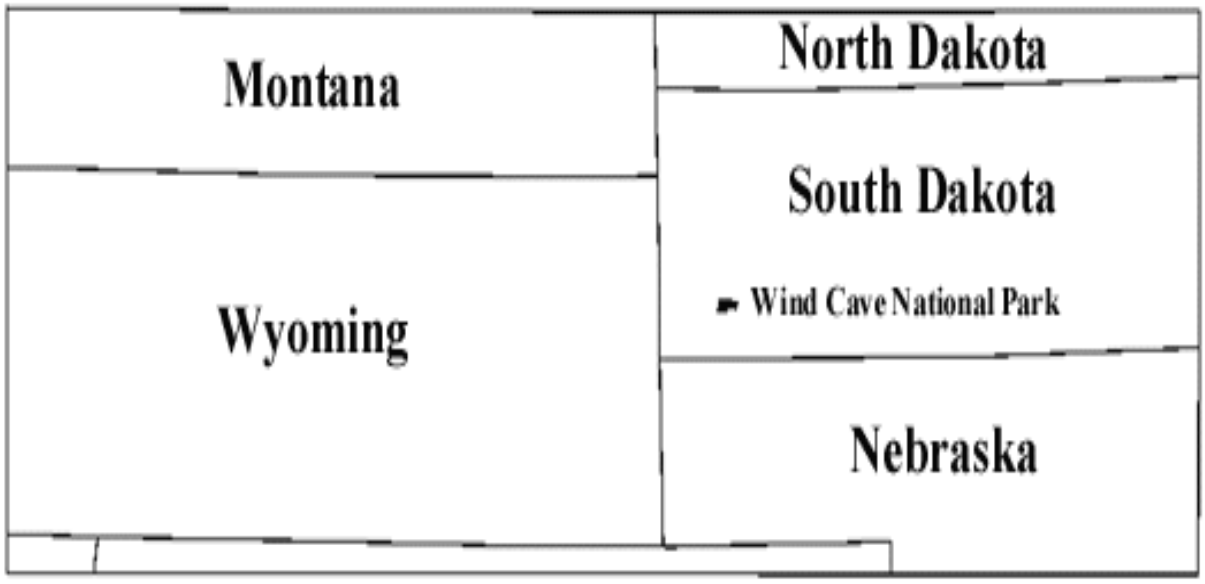


Figure 2. Location Map for Wind Cave National Park.

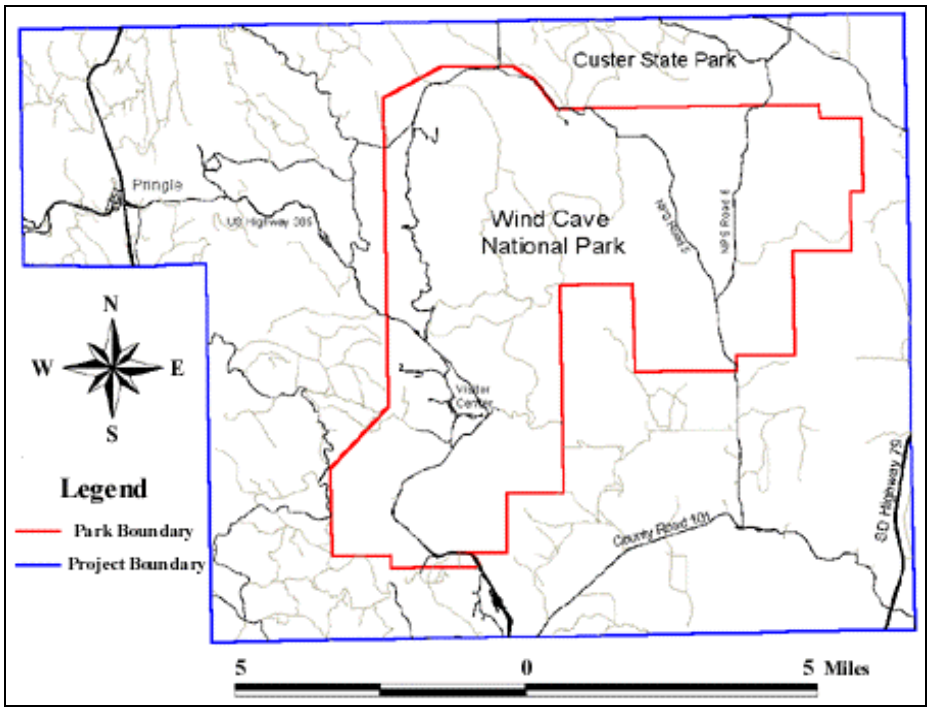


Figure 3. Wind Cave National Park and project mapping area.

Climate

Wind Cave National Park lies in the southern Black Hills, which typically records warm summers and relatively mild winters. Average temperatures recorded for Custer, SD (about 11 miles northwest of the Park) range from 23o F in the winter to 62o F in the summer (Ensz 1990). Temperatures in the spring and fall seasons can vary dramatically and change abruptly within short time periods. Throughout the year, humidity averages around 50% during mid-afternoons and winds are usually less than 13 mph. The Park usually experiences about 115 frost-free days a year (Smith 1978).

Precipitation for the southern Black Hills is usually heaviest in late spring and early summer. Local observations by WICA personnel report the last ten years as wetter than normal, largely based on the rise of the water table within the cave complex during this time period. Monthly precipitation records from Hot Springs and Custer show an increase in 1997 monthly averages compared to the last 50-year averages (1997-1947) (Appendices 1-2). Precipitation values

recorded at WICA are limited to the last 8 years, and show no real increase from year to year (Appendix 3). Average seasonal accumulation of snowfall for Custer is about 45 inches (Ensz 1990).

Geology and Topography

The basic geology of the Black Hills can be traced to various uplifting events that resulted in an approximate 125-mile by 60-mile elliptical dome reaching up to 7,242 feet above sea level. Over time, sedimentary rock cover has been weathered by erosion, leaving more resistant crystalline rocks as caps, ridges, pinnacles and outcrops. As seen from an aerial perspective, the Black Hills consist of concentric rings of progressively younger rocks moving out from central high elevations. This concentric pattern can be separated into five major geomorphic regions: 1) the Central Crystalline Area (CCA), 2) the Limestone Plateau, 3) Minnelusa Foothills, 4) the Red Valley, and 5) the Cretaceous or "Dakota" Hogback (Froiland 1990). Interspersed within these formations are deposits of sediment (alluvium) left by various depositional events (Figure 4). Directly to the east of the Park, the Black Hills blend into the rolling prairie lands of the Central Great Plains Region.

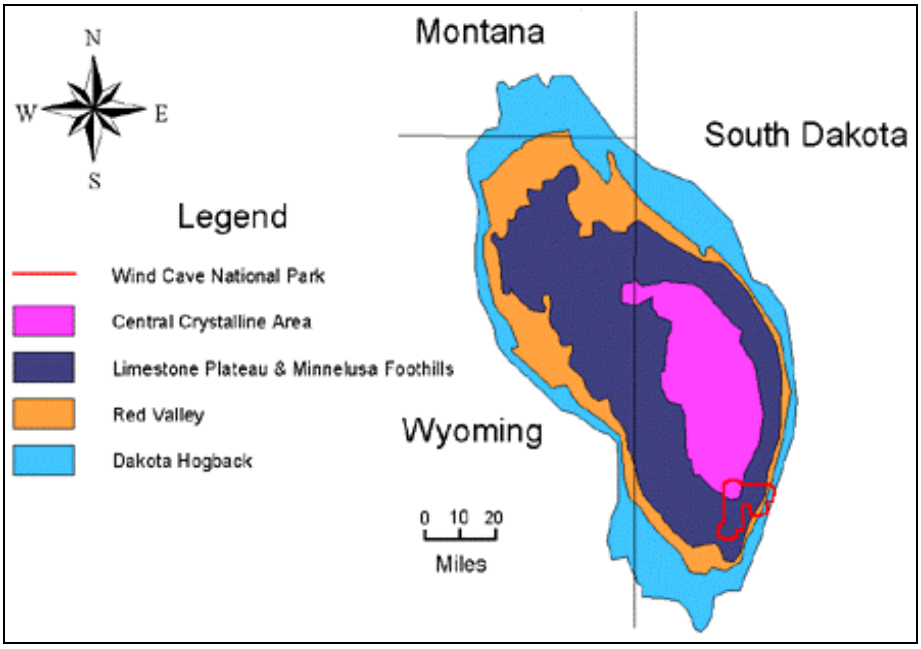


Figure 4. An overview map of the Black Hills showing general geomorphic regions.

All of the major geomorphic subdivisions of the Black Hills are represented at WICA and its immediate surroundings (Froiland 1990). The Central Crystalline Area, made up of granitic and metamorphic rocks, occurs in the highest, westernmost part of the Park (4,525 - 5,000 feet elevation). Dramatic topographic relief and rugged slopes characterize this area. East of this zone is an area underlain by limestones and sandstones, corresponding to the Limestone Plateau and Minnelusa Foothills regions (4,500 feet elevation). In the project area, the Limestone Plateau is not well developed due to steep dips of the rock strata (Pahasapa limestone). The Minnelusa Foothills zone is more extensive including outcrops and narrow limestone-rimmed drainages such as Limestone and Curley Canyons (Figure 5). Elevations drop through the Minnelusa Foothills to the Red Valley in the eastern part of the Park. Here, the underlying red, iron-rich Spearfish formation is intermittently exposed as red badlands or "redbeds" intermingled with gypsum outcrops (3,610 to 3,770 feet elevation) (Figures 7 and 8). The outermost geomorphic subdivision is the Dakota Hogback, or Hogback Rim, which is represented in the project area by Boland Ridge near the east Park boundary (Figure 8). Boland Ridge stands up to 400 ft. above the Red Valley (4,101feet elevation) and is underlain by steeply tilted sandstones. The eastern side of the Dakota Hogback is gently sloping, while the western slope is generally steeper and more rugged. The Dakota Hogback represents an interface between the Black Hills and the Central Great Plains. Finally, broad flat benches capped with old alluvial deposits occur in the northern and central parts of the study area. Good examples of these benches are located in northeast WICA between NPS Roads 5 and 6.

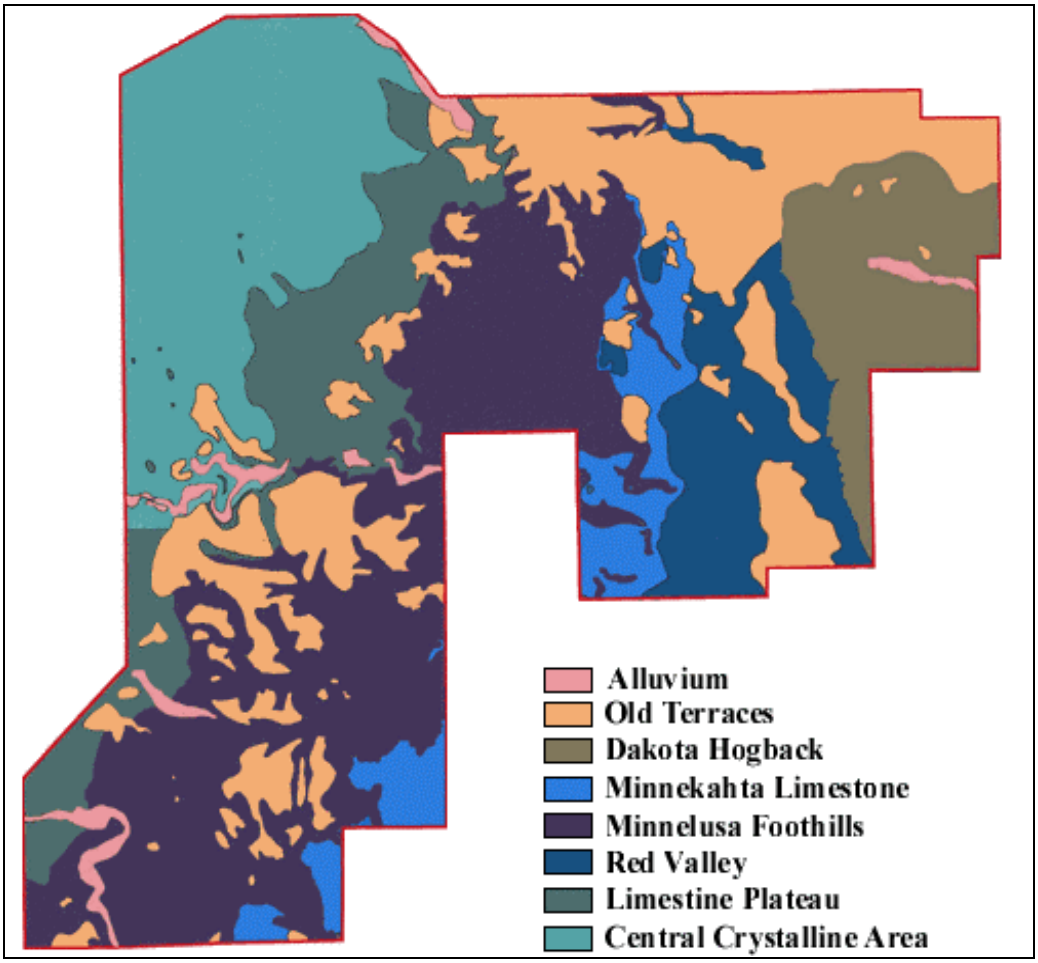


Figure 5. Map of Wind Cave National Park showing general geomorphic regions.

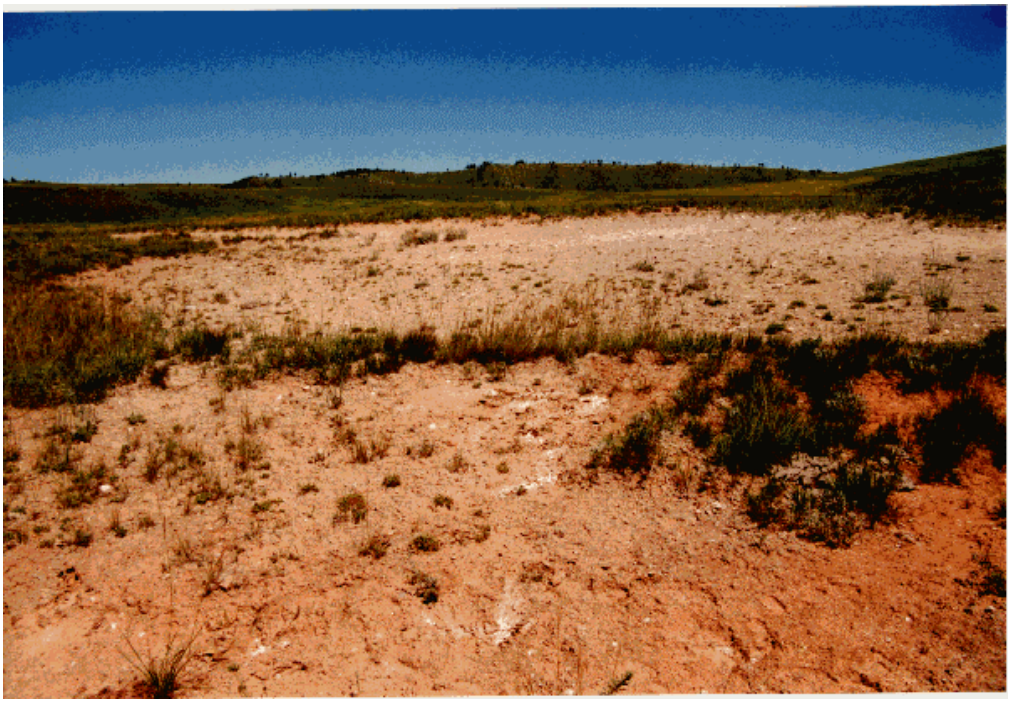


photo by D. Cogan

Figure 6. A sparsely vegetated redbed in the Red Valley region of WICA.

photo by D. Cogan

Figure 7. The Red Valley region of Wind Cave National Park with the Dakota Hogback (Boland Ridge) in the background.

Major drainages in WICA generally trend east and southeast. The more important are Beaver, Spring and Highland Creeks, sections of which flow all or most of the year. Many of the smaller drainages are dry, flowing only during precipitation events. Active springs are occasional and found at scattered locations. Other standing water is rare. In most years, an ephemeral pond forms on Bison Flats in the south portion of the Park, drying out through the summer. A few other very small ponds with limited aquatic vegetation are found at scattered locations.

Soils

Major soil associations occurring at WICA are either derived directly from the underlying parent material or were deposited as alluvium by erosion events. These soils relate to specific geologic landforms, topographic relief, climate, and the corresponding natural vegetation (Ensz 1990). Table 1 contains the major soil associations present, separated by their corresponding geologic formations. Each soil association consists of a variety of major and minor soil units that are sometimes combined to form complexes. Appendix 4 contains all the soil units and their descriptions found at WICA.

photo by D. Cogan

Figure 8. Limestone rock outcrops at Wind Cave National Park

Table 1. Major geomorphic region, soil association, soil names, and descriptions for the WICA mapping project (summarized from Ensz 1990 and Neilsen 1996).

Geomorphic Region	Soil Asscociation	Soil Name	Description	Location	Dominant Species
Central Crystalline Area	Buska-Mocmont-Rock Outcrop				
		Buska	Gray loam	Broad ridges and slopes	Ponderosa pine
		Mocmont	Gray/brown gravelly loam	Ridges & Mt. slopes	Ponderosa pine
		Rock Outcrop	Granite and schist	Peaks and dikes	Thin ponderosa pine
	Pactola-Rock Outcrop-Virkula				
		Pactola	Gray channery loam	Upper side slopes	Ponderosa pine
		Rock Outcrop	Hard metamorphic rock	Peaks, ledges, and dikes	Thin ponderosa pine
		Virkula soils	Gray/brown loam	Mid and low slopes	Ponderosa pine
	Heely-Cordeston				
		Heely	Gray/brown channery loam	High areas	Various native grasses
		Cordeston	Gray loam	Toe slopes and swales	Shrubs and deciduous trees
Limestone Plateau & Minnelusa Foothills	Vanocker-Sawdust-Paunsaugunt				
		Vanocker	Brown channery loam	N and E facing slopes	Ponderosa pine
		Sawdust	Gray/brown calcareous channery loam	S and W facing slopes	Ponderosa pine
		Paunsaugunt	Brown calcareous gravelly loam	Ridges	Ponderosa pine
		Rock Outcrop	Limestone and sandstone	Ridges and ledges	Thin ponderosa pine

Table 1. Continued

Geomorphic Region	Soil Asscociation	Soil Name	Description	Location	Dominant Species
Red Valley	Nevee-Gypnevee-Rekop				
		Nevee	Red/yellow calcareous silt loam	Mid and low regions	Various native grasses
		Gypnevee	Red/brown calcareous silt loam	Mid and low regions	Various native grasses & thin ponderosa pine
		Rekop	Red/brown calcareous loam	High regions	Various native grasses
		Rock Outcrops	Red/white gypsum and gypsiferous siltstone	High regions	Sparsley vegetated
Dakota Hogback	Canyon-Rockoa-Rock Outcrop				
		Canyon	Brown calcareous loam	S and W facing slopes	Various native grasses
		Rockoa	Gray/brown cobbly fine sandy loam	N and E facing slopes	Ponderosa pine
		Rock-Outcrop	Sandstone, limestone, or shale	Ledges and high regions	Sparsely vegetated
Prairie	Samsil-Pierre Association				
		Samsil	Brown clay	Shoulder and upper back slopes (shallow)	Western wheatgrass and juniper
		Pierre	Gray/brown clay	Back slopes (deep)	Western wheatgrass

Wildlife

WICA supports numerous species including many of the historical animals native to the Black Hills. Some of the larger mammals are actively managed (or have been managed historically) by Park personnel to ensure the overall health of the Park. These include bison (Bison bison), elk (Cervus canadensis), pronghorn antelope (Antilocapra americana), mule deer (Odocoileus hemionus) and black-tailed prairie dog (Cynomys ludovicianus) (Figure 9). Domesticated cattle and sheep have not been present at WICA since 1946 (Coppock et al. 1983).

photo by D. Cogan

Figure 9. A typical black-tailed prairie dog burrow.

Vegetation

WICA's vegetation can be divided into two major types, ponderosa pine forest and mixed grass prairie. Ponderosa pine forest comprises almost 30% of the Park and typically grows in the higher elevations; it is the dominant tree and is occasionally observed with birch, aspen, and white spruce. Fire suppression, timber management, and increased precipitation have likely led to an expansion of ponderosa pine cover in parts of the Black Hills. In some areas, this has resulted in dense stands of even-aged pines and rapid encroachment of young trees into grassland areas.

Other major vegetation types at WICA and its surrounding area include hardwood drainages dominated by boxelder, green ash and elm with occasional stands of other hardwoods, mountain mahogany shrublands, several shrubby draw types, riparian/wet meadow vegetation, and prairie dog towns. The higher western part of the study area generally has more tree cover. Much of the eastern part is prairie, with stands of pine woodland on Boland Ridge along the eastern boundary. Mountain mahogany shrubland is well developed in the Minnelusa Foothills zone in the central part of WICA.

Fire History

Throughout the history of WICA, the vegetation has been altered by fire events of various sizes and intensities. This has resulted in large prairie and forested tracts being in different stages of re-growth. Prairie grasses recover relatively quickly from fire making burned prairie sites more difficult to distinguish from non-burned prairie. Forest fires are typically more dramatic, leaving behind charred ponderosa pine trees (both standing and fallen) and blackened soil and rocks for many years (Figure 10). Recent and intense forest fires usually show greater effects; an example is the controlled fire set along Beaver and Cold Spring Creeks in May 1997.

photo by D. Cogan

Figure 10. Evidence of a historic forest fire that occurred just north of Wind Cave National Park, showing charred ponderosa pine stumps and fallen debris.

MATERIALS AND METHODS

The organization of this project followed the protocols outlined in Field Methods for Vegetation Mapping, Standardized National Vegetation Classification System (NVCS), and Accuracy Assessment Procedures (The Nature Conservancy 1994). The basic steps included:

1. Planning and Scoping

2. Preliminary Data Collection and Review of Existing Information

3. Aerial Photography Acquisition

4. Gradsect Design

5. Field Survey

6. Vegetation Classification and Characterization

7. Vegetation Map Preparation

8. Accuracy Assessment

1. Planning and Scoping

This project incorporated the combined expertise and oversight of several organizations. Oversight and programmatic considerations were managed by the Center for Biological Informatics (CBI) of the USGS/BRD. NPS and WICA personnel provided additional guidance on specific Park needs. The technical mapping portion was contracted to the BOR RSGIG in Denver, CO. TNC was sub-contracted to collect, analyze, and write-up the requisite plant association data and conduct fieldwork to support the accuracy assessment (AA). The specific technical responsibilities and deliverables for the mapping portion included the following:

BOR Responsibilities and Deliverables:

- Interpret aerial photographs;
- Transfer interpreted information to a digital spatial database and produce hard copy (paper) vegetation maps;

- Create digital vegetation coverages including relevant attribute information;
- Produce Arc/Info export file of vegetation plot, observation point, and accuracy assessment locations;
- Provide an annotated list of representative field site photographs/slides;
- Create a spreadsheet and contingency table comparing the mapped classes with the AA classes in order to determine map accuracy;
- Provide any ancillary digital files developed during the mapping process;
- Document and record digital FGDC compliant metadata files (*.html) for all created spatial data;
- Final report and CD-ROM describing procedures used in preparing all products;

TNC Responsibilities and Deliverables:

- Develop a preliminary vegetation classification for the study area from secondary sources;
- Design a sampling strategy;
- Collect observation points to refine the preliminary classification and familiarize investigators with community characteristics and their range of variation;
- Select and sample representative stands for all community types;
- Prepare final classification, community descriptions, and key to community types;
- Field test final classification, descriptions, and key during accuracy assessment;
- Collect accuracy assessment points;

Scoping Meeting:

A scoping meeting was held at the WICA visitor center with all interested parties during Spring 1997. The purpose of this meeting was to determine the project mapping extent, discuss logistics, and develop a sampling approach. At this time, various project boundaries around the Park were presented. It was decided that the mapping environs would include the town of Pringle, SD in the northwest corner and extend to the intersection of SD Highway 79 and County Road 101 in the southeast (Figure 2). This mapping boundary effectively covered two large expanses of Beaver Creek, an important riparian corridor and waterway through the Park. In order to sample in the environs, WICA personnel agreed to contact, and try to obtain permission from, all private landowners south and east of the Park. Following the data sampling protocols

for large parks outlined in the Field Methods for Vegetation Mapping (TNC 1994), it was decided that a gradient-oriented transect or gradsect sampling approach (Austin and Heyligers 1989, Gillison & Brewer 1985) would be used at WICA.

2. Preliminary Data Collection and Review of Existing Information

To minimize duplication of previous work and to aid in the overall mapping project, existing maps and reports were obtained from various sources. The staff at WICA provided digital and hard copy background material for geology, fire history, prairie dog town locations, Canada thistle locations, elk exclosure locations, and rare tree and shrub locations (Smith 1978) for WICA. Soil surveys were obtained for Custer and Pennington Counties. Digital elevation models (DEM's), digital line graphics (DLG's), and digital raster graphics (DRG's) were obtained from the USGS. The DEM's were further manipulated to create slope and aspect maps.

A preliminary list of community types thought to have a high likelihood of being in the mapping area was used to develop the preliminary vegetation classification. This preliminary list contained vegetation associations and alliances generated for the Park in May of 1996 from the Midwest portion of the NVCS (Faber-Langendoen *et al*. 1996). Modifications were made to the list through a literature review of WICA and Black Hills vegetation and by contacting knowledgeable experts.

3. Aerial Photography Acquisition

Horizons, Incorporated of Rapid City, South Dakota acquired the aerial photography for WICA; thirteen flight lines were used to cover the entire project area (Figure 11). Flight lines 1-4 were flown on June 22, 5-8 flown on June 27, and 9-13 flown on June 26, 1997. A total of 220 color-infrared (CIR) photographs were taken at 1:12,000 (1"=1,000') scale and printed on 9"x9" stock. Overlap for these photos were approximately 50-60% and sidelap between flight lines was approximately 20-30%.

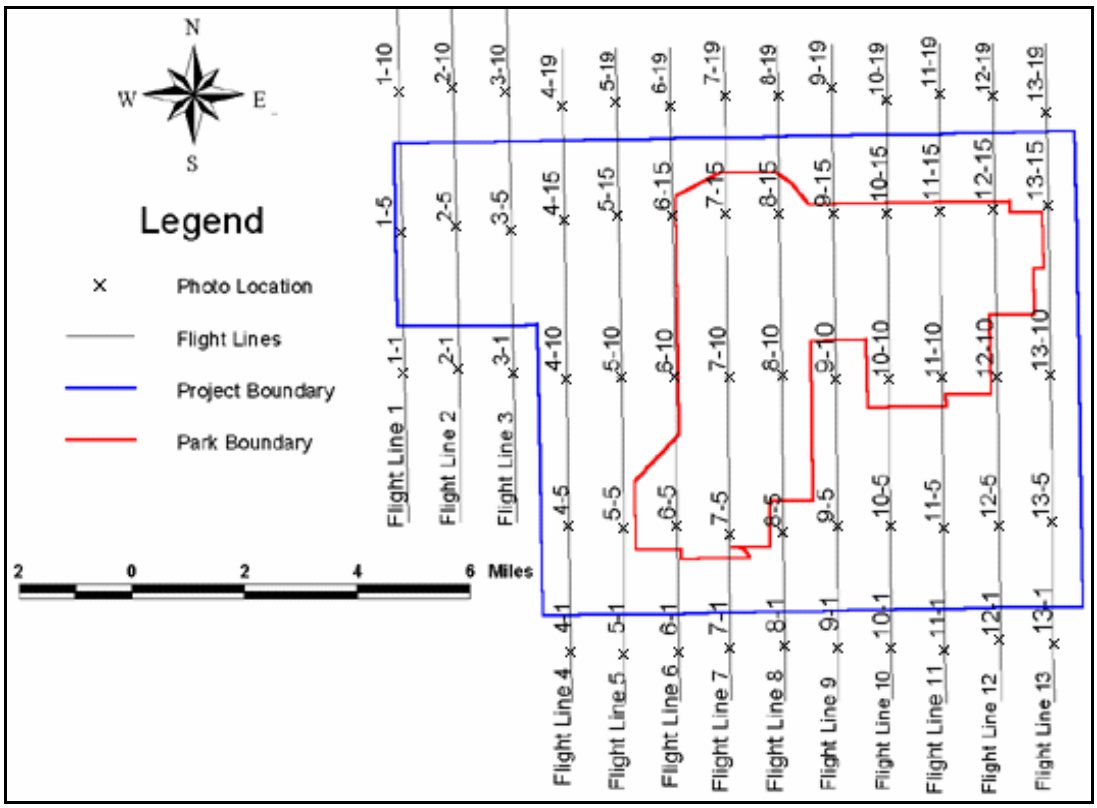


Figure 11. Flight line map for the Wind Cave National Park vegetation mapping program flown in June 1997.

4. Gradsect Design

The WICA study area was sufficiently large to require a gradsect approach to vegetation sampling. Gradsects were used to concentrate the sampling effort into smaller areas representing the full range of vegetation variability. This was achieved using the following assumptions: 1) certain site characteristics or combination of characteristics dictate the presence and growth of plant communities, 2) these characteristics tend to repeat themselves across a landscape, and 3) the concentration of sampling efforts across small heterogeneous areas provides an accurate representation of the vegetation diversity for a much larger region (Austin & Heyligers 1989).

Gradsects for WICA were designed at a meeting of BOR and TNC staff held in the RSGIG offices in Denver prior to the 1997 field season. Aerial photography was manually overlaid and compared with soils, geologic, and topographic maps. Composite maps were also used showing the relative variability of different environmental factors. Gradsects were placed on a majority of the stratigraphic units, elevations, major soil types, and several major drainages within the study area. Accessibility and land ownership influenced placement of the gradsects. Locations and design were also slightly modified based on prior knowledge of WICA's vegetation. The resulting gradsects included roughly 20% of the overall study area, and were considered highly likely to include the full range of plant communities found in the area (Figure 12).

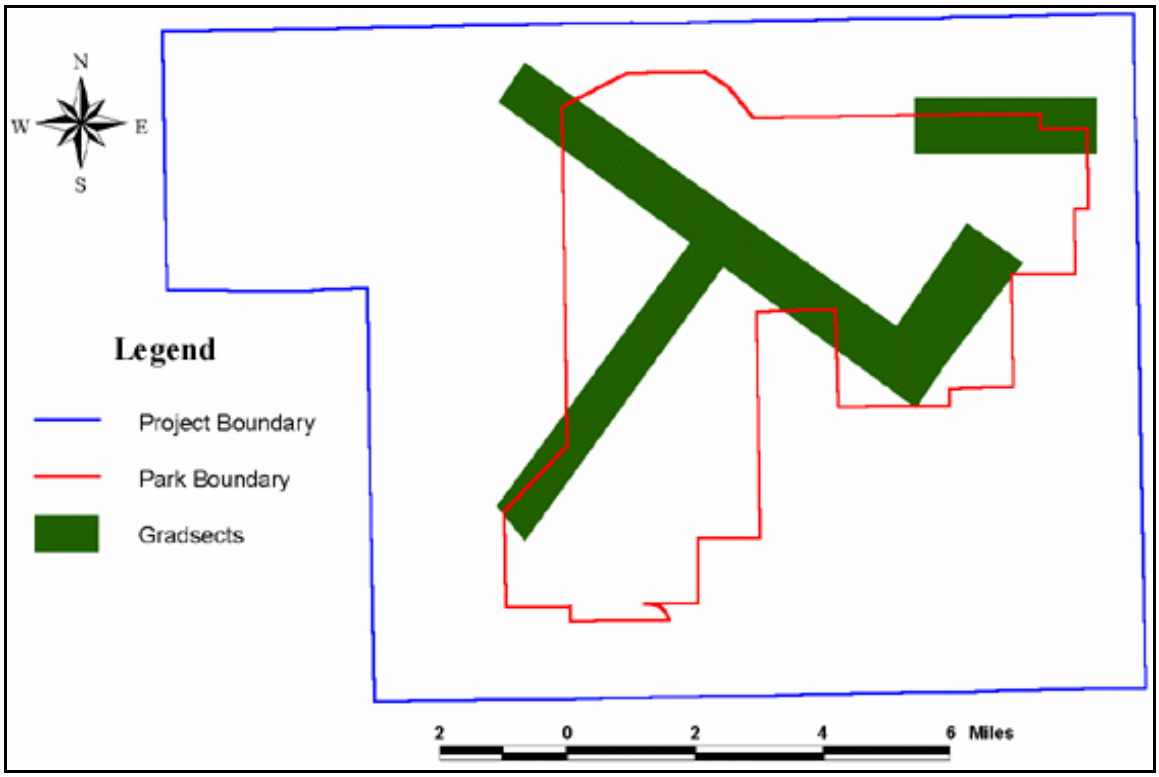


Figure 12. Map of the gradsect locations for Wind Cave National Park.

5. Field Survey

Field surveys began in the first week of July 1997 after aerial photography was acquired. The first step was reconnaissance using observation points, which allowed investigators to visit many areas. Observation points were used to become quickly familiar with community characteristics, community ranges of variation, and to field check the preliminary classification. Observation point sampling included basic information on habitat and vegetation structure and composition. Specific information recorded included UTM X-Y coordinates, dominant species cover data, and brief environmental characteristics (Appendix 5). Limitations of observation point data included no measurement or delineation of the sampling area and cover was only estimated for the common species in each stratum.

Data from 134 observation points were collected from the beginning of field survey through the second week of September 1997. Points were recorded mainly within gradsects, and were chosen to sample the range of habitat and vegetation variability observed on aerial photography, on preliminary maps, and in the field (Figure 13).

After completion of observation point survey, investigators chose representative stands of plant communities for more intensive sampling. Sample sites were identified in the field within gradsects using standard Relevè methodology (Mueller-Dombois 1974). Detailed sampling plots were subjectively placed in vegetation that was representative of an area, relatively homogeneous, and which covered more than 1/2 ha (the minimum mapping unit). Thus, ecotones and small patches of vegetation were avoided. Forest and woodland communities were sampled with 20 x 20 meter plots while shrubland and herbaceous communities were sampled with 10 x 10 meter plots. Collected data included habitat characteristics (e.g. slope, aspect, elevation, and soil characteristics), vegetation composition and structure, and other site features such as wildlife or human disturbance (Appendix 6).

To characterize vegetation structure, all species found within a plot were noted and foliar cover for each species by strata was estimated using a modified Daubenmire (1959) classification. Since cover was estimated independently for both species and strata, total coverage for some of the plots was greater than 100%. In forests and woodlands, dbh (diameter at breast height) was

measured for all trees greater than 10 cm dbh. Various environmental data were also collected for each plot to characterize the abiotic conditions under which the sampled vegetation occurred. The UTM coordinates and elevation of all plots where logged using a hand-held Precision Light-weight Global Positioning System (GPS) Receiver (PLGR) unit. 35mm slides were taken for each plot and representatives are included in this report (Appendix 16).

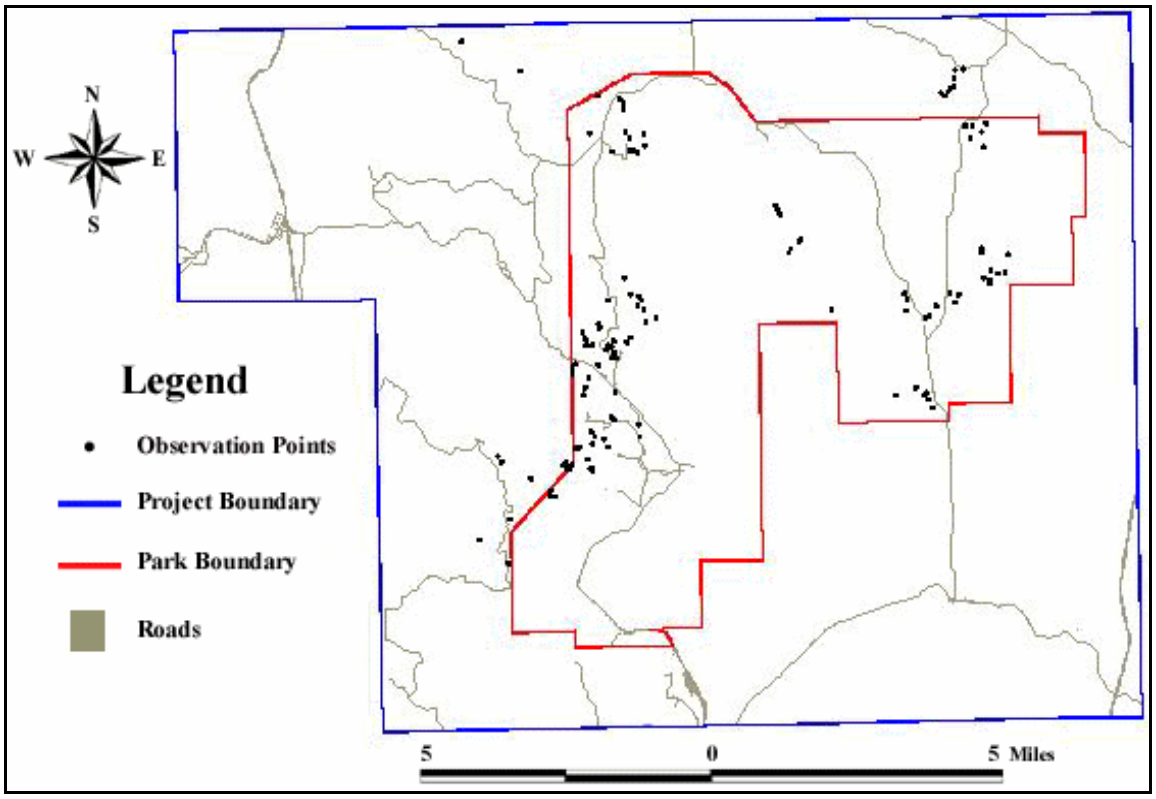


Figure 13. Map of the observation points collected during summer 1997.

Data were collected on 65 plots during the 1997 field season extending into early September and four additional plots were sampled in 1998 (Figure 14). Three plots were sampled for each plant community found in the study area, as long as three stands were available. For several uncommon plant communities, only one or two plots were sampled. All sampled data were eventually entered into TNC's "PLOTS" database program.

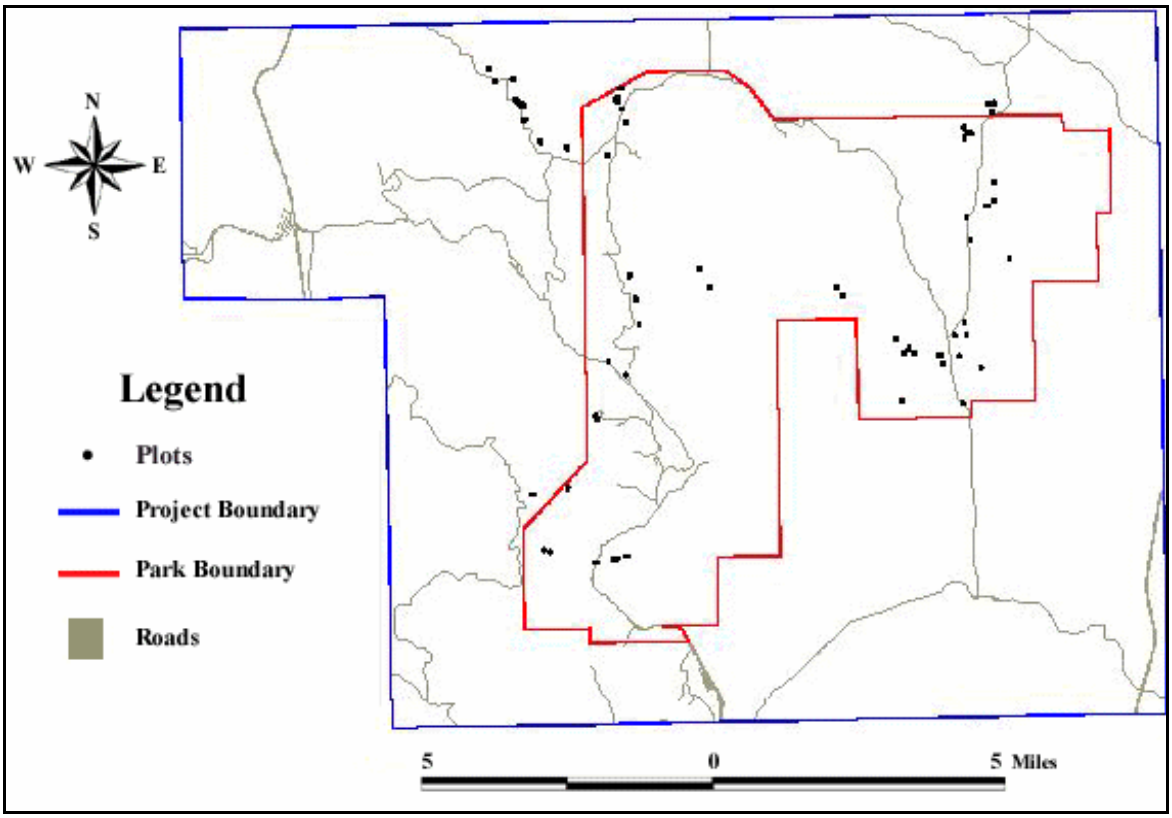


Figure 14. Map of the plot locations sampled during summer 1997.

6. Vegetation Classification and Characterization

The procedure for classifying vegetation followed guidelines set forth in the Vegetation Classification Standard (FGDC 1997) which was developed from the Standardized National Vegetation Classification System (NVCS) (TNC 1994). This national system contains seven classification levels with the two finest (lowest) being the alliance and association (community) levels. Associations are separated from alliances through the use of floristic composition and are named by the most dominant and/or indicator species. If two or more dominant species occur in the same stratum a dash symbol is used. If the species occur in different strata then a slash is used. Parentheses are used in instances when the diagnostic species are not consistently present in the vegetation unit.

Classification for the WICA study area involved placing all observation point data and plot data into groups based on vegetation structure and composition. From here, extensive floristic knowledge of the field team allowed most of the sampled community types to be qualitatively evaluated and subjectively assigned to an existing NVCS class. In a few instances, new NVCS classes were discerned and prepared from evaluations of the floristic data. Additional analyses were performed using the plot data combined with other similar Black Hills data (including other local National Parks) to provide a better regional perspective on vegetation types. These were quantitatively analyzed using ordination techniques (Detrended Correspondence Analysis "DCA"and Non-Metric Multidimensional Scales "NMS"), a clustering algorithm, Unweighted Pair-Group Method Using Arithmetic Means (UPGMA), and Two-Way Indicator Species Analysis (TWINSPAN). Since, in a number of cases, there were only a few sample plots per vegetation type, the above analyses could not be solely relied upon for classification. However, the results of the numerical analyses were compared to the subjective classification in order to detect any discrepancies between the two. All analyses were completed using PC-ORD (McCune and Mefford 1997).

A synoptic vegetation key for WICA was prepared during the 1998 field season (Appendix 8). The key was tested during the Accuracy Assessment process, resulting in only minor modifications. A synoptic key leading to community type descriptions was chosen rather than a

dichotomous key based on previous keys developed for other NPS sites in the Black Hills. It was felt that these dichotomous keys did not fully address the natural range of variability occurring in each of the plant communities. This was due in part, to the very brief descriptions required at branch points in dichotomous keys, potentially leading the user to the incorrect type. The WICA synoptic key allows the user to quickly browse relevant vegetation types within each major vegetation group and make an accurate decision based on comprehensive descriptions.

7. Vegetation Map Preparation

Map Units

Final WICA map units used for photo-interpretation were based on the NVCS, Anderson (1976) Level II classification system, and special requests by WICA personnel. The preliminary NVCS classification was used to determine relationships between signatures on aerial photos and vegetation associations on the ground. In most instances, one NVCS association corresponded to one map unit. However, due to various limitations in the aerial photography, certain individual NVCS had to be merged into a larger map unit (i.e. complex). Anderson Level II classes were used to classify land-use types including semi-natural and cultural types (i.e. roads, facilities, and agricultural fields). Finally, some small vegetation types recognized by the Park but not included in the NVCS were mapped. In these situations, the vegetation had an unique photo signature and could be easily interpreted from the aerial photography.

Aerial Photograph Interpretation

All aerial photographs for WICA were covered with translucent mylar overlays. Fiducial points (corner and side marks), flight line, and photograph numbers were transferred from each photo onto its corresponding overlay. The center portion of each aerial photograph was systematically delineated to minimize the effects of edge distortion. Aerial photos and their overlays were then back-lit on a light table and visually scanned for photographic signatures using magnification and stereo. The actual interpretation of the photographs involved three basic steps. First, all of the photos were initially interpreted into broad classes based solely on standard photo-interpretation signature characteristics. These included: tone, texture, color, pattern, topographic position, size, and shadow. Second, field note overlays and plot and observation

point locations were used to refine the preliminary delineation into the appropriate map units. Finally, in order to ensure completeness and accuracy, another independent researcher reviewed all of the interpreted photos for consistency and recommended changes where necessary.

Additional references aided in aerial photo interpretation. These included: the Soil Surveys of Custer and Pennington Counties, Black Hills and Prairie Parts, SD (Ensz 1990 and Nielsen 1996), USGS geology maps, and prairie dog town maps (provided by WICA). Specific guidelines written for prairie dog colony mapping were used in this study to improve the interpretation of prairie dog town edges at WICA (Appendix 11).

Map Validation

Before the accuracy assessment, a verification or map validation trip was taken in August 1998 to refine and assess the initial mapping effort. This trip included collecting additional observation points and ground-truthing aerial photographs using landmarks and GPS waypoints. Map classes were modified to reflect any inadequacies in the initial photointerpretation.

Digital Transfer

An ArcInfo(tm) (ESRI) GIS database was designed for WICA using the National Park GIS Database Design, Layout, and Procedures created by the BOR (Appendix 12). This was created through Arc Macro Language (AML) scripts that helped automate the transfer process and ensure that all spatial and attribute data was consistent and stored properly. Actual transfer of information from the interpreted aerial photographs to a digital, geo-referenced format involved two techniques, scanning (for the vegetation classes) and on-screen digitizing (for the land-use classes). Both techniques required the use of 14 digital black-and-white orthophoto quarter quadrangles (DOQQ's) covering the study area (Appendix 13); supplied by the USGS.

The scanning technique used for WICA involved a multi-step process whereby mylar overlays, with the interpreted line work, were scanned into digital form. The essential principle behind this process was to match the scale and position of features on the photographs with the scale and position of the same features on the DOQQ. This was accomplished by readjusting the scale of the photography, shifting the origin of the photo, rotating the axes, and bending/warping

(rubber-sheeting) the photo between known control points (tic marks) and origin and destination points (links). The actual manipulation was conducted by computer program routines until the adjustment was considered a good fit by the technician. Any remaining land-use classes that were not already scanned were quickly transferred through on-screen digitizing. This process entered the interpreted line work from the photos into the GIS database by manually drawing digital lines over the DOQQ (using the mouse with the DOQQ on the computer screen as a background image). Finally, the digitized line work transferred by both methods was connected, and polygon attribute information was added to produce a completed digital coverage.

Transferred information was used to create vegetation polygon coverages and ancillary linear coverages in ArcInfo(tm) for each WICA DOQQ. Attribute information including vegetation map unit, location, and aerial photo number was subsequently entered for all polygons. All spatial data for WICA and the processes used are described in the WICA Metadata (Appendix 15).

8. Accuracy Assessment

The accuracy assessment (AA) for the WICA vegetation map consisted of preliminary planning and discussion, logistical planning, fieldwork, analysis of fieldwork, and computation of final results. Preliminary planning involved BOR (responsible for developing the GIS spatial database) and TNC (responsible for collecting the field AA data) personnel. After considerable discussion, a modified accuracy assessment procedure was determined using the protocols outlined in the Accuracy Assessment Procedures (TNC 1994).

The following guidelines for this procedure were adopted at this time:

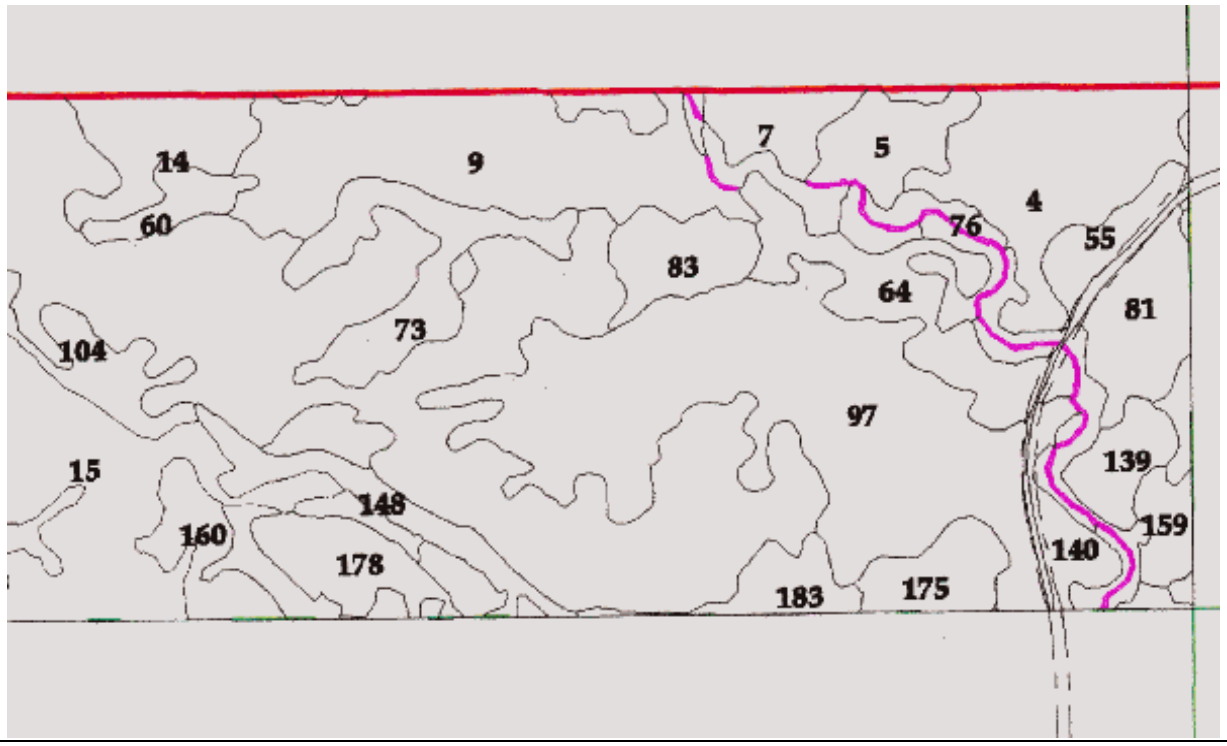
- Observations of vegetation classes were to be ground-based.
- Ground sampling techniques were to be similar to the Observation Points collected during initial classification.
- The number of samples per class would vary depending on abundance and size of classified polygons.

Logistical planning for the AA revolved around coordination of work schedules and division of work areas within the Park. WICA personnel were briefed on the AA process and invited to assist with data collection. The actual assessment was started as soon as preliminary vegetation maps had been prepared and delineated polygons were available. Assessment was done within Park boundaries and data points were not limited to the gradsects, but rather they were located based on relative ease of access and time constraints. Selecting random AA sampling sites beforehand was deemed unnecessary due to familiarity of the researchers with the vegetation distribution at WICA.

Field staff were provided with two sets of preliminary vegetation maps by the BOR. The first included labeled, colored polygons, which was used to select areas and polygons for sampling (i.e. to ensure a sufficient number of sampling points per type). In the second set, polygons were not colored, and were labeled only with unique identifiers or polygon identification numbers (poly id#'s). A key listing UTM coordinates for the centrum of each polygon accompanied this set of maps (Figure 13). Polygons and survey routes were chosen before going into the field, using the colored, labeled maps. The UTM coordinates for those polygons were recorded, and this list was taken into the field. In the field, investigators entered UTM coordinates into GPS PLGR units, and navigated to assessment points, assisted at times by the uncolored vegetation maps. The final point chosen for assessment was selected to be as representative as possible of the vegetation in the immediate area, and well away from stand boundaries.

AA data, including limited habitat and vegetation data, was recorded on field forms to document the classification decision made by the investigator (Appendix 7). This form was modified and expanded from previous forms to include fields for additional community types found within 50 meters of the actual assessment point. Modifications were made to help accommodate several types of difficult situations, such as AA points located in small inclusions, heterogeneous polygons/stands, and GPS PLGR inaccuracies.

All AA data were collected from late September through the first week of December 1998. The weather at this time was unusually warm and vegetation identifiable, although by November it had become rather difficult to estimate shrub cover due to loss of foliage. Total data collected



Wind Cave National Park: Mt. Coolidge quadrangle (se quarter)

X-Y Coordinates for Mt. Coolidge (se quarter) Vegetation Polygons
UTM ZONE 13, Datum NAD83

Poly ID#	Veg Code	X-Coord	Y-Coord	Poly ID#	Veg Code	X-Coord	Y-Coord
4	16	630,944	4,831,898	83	15	630,607	4,831,833
5	15	630,797	4,831,948	97	35	630,781	4,831,693
7	16	630,686	4,831,958	104	15	630,029	4,831,747
9	35	630,406	4,831,929	139	16	631,036	4,831,652
14	15	630,114	4,831,928	140	16	630,987	4,831,568
15	16	630,032	4,831,634	148	2	630,318	4,831,606
55	15	631,008	4,831,825	159	15	631,073	4,831,592
60	33	630,098	4,831,868	160	15	630,147	4,831,574
64	16	630,811	4,831,812	175	16	630,843	4,831,529
73	15	630,344	4,831,771	178	15	630,298	4,831,548
76	35	630,879	4,831,874	183	15	630,722	4,831,521
81	15	631,048	4,831,797				

Figure 15. Portion of a preliminary WICA vegetation map and key used for Accuracy Assessment.

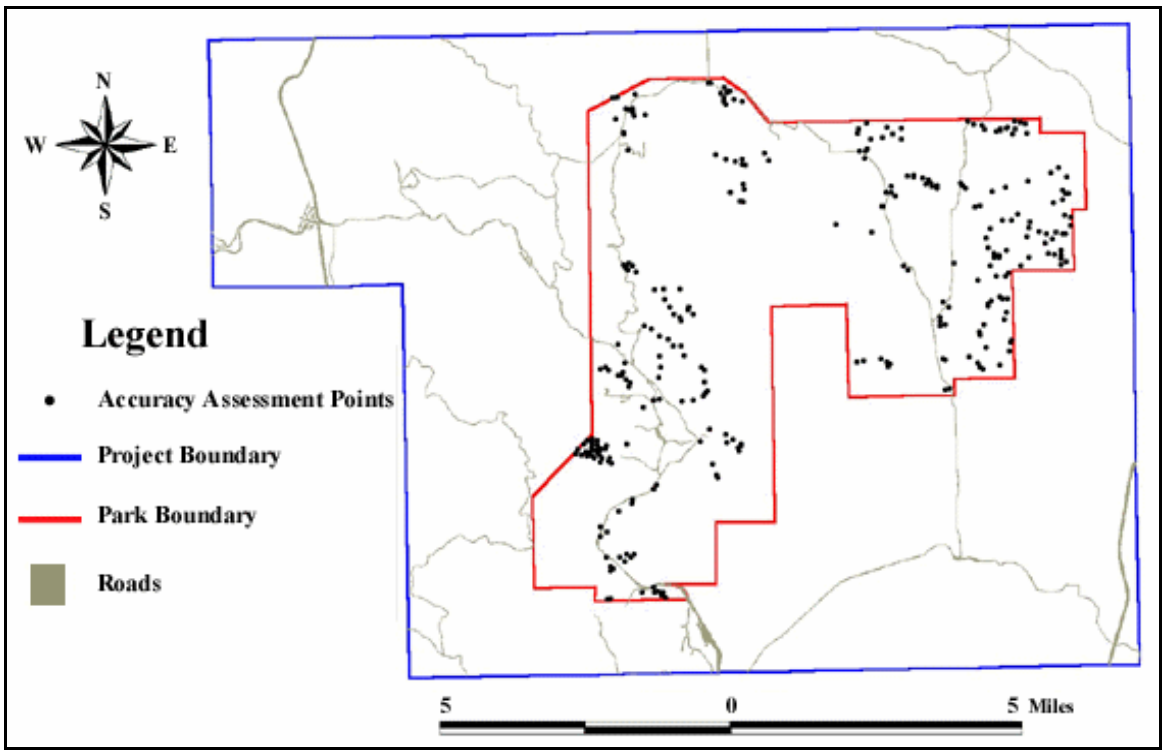


Figure 16. Map of the accuracy assessment locations sampled during summer and fall 1998.

came to 295 points (Figure 16), with more points collected within extensive types. AA points were not collected for several map units since they were either too small, on inaccessible private land, or the only known occurrence was already described by a plot or observation point.

Accuracy assessment of the WICA project area was conducted in February 1999. This involved the plotting of all accuracy data points onto semi-clear vellum and overlaying these on final vegetation maps. AA point numbers plotted alongside each point allowed for comparison with accuracy assessment data forms. A contingency table was set up to record the reference data (collected field data) versus the sample data (vegetation map) for each map unit.

Errors of commission (i.e. user's errors) for each class were calculated by dividing the number of correctly classified samples by the total number of samples that were classified as belonging to that map class. Errors of omission (i.e. producer's errors) for each class were calculated by dividing the number of samples that were classified correctly by the total number of reference samples in that class. Confidence intervals for each map class were calculated using one of the following methods depending on the normality and size of the data:

- For large sample sizes (n > 30), a normal distribution was assumed when

  1) np (5 and n (1-p) (5, and
  2) 0.2 <p>0.8
  where n = sample size and p = (number of correct samples / total number of samples) (Zar 1984 and Hay 1979).

- For normally distributed map classes the confidence intervals were calculated using the equations provided by Snedecor and Cochran (1967) in the Accuracy Assessment Procedures (TNC 1994).

- When the normal approximation was not valid (as determined from the above criteria), equations obtained from Zar (1984) were used to determine the lower and upper confidence intervals.

- For map classes containing small numbers of accuracy assessment points (n (30), calculated tables of probabilities based on the underlying binomial distribution (Natrella 1963) were referenced for the upper and lower confidence limits.

Overall total accuracy for WICA was calculated across all sampled map classes by dividing the number of correctly classified accuracy points by the total number of accuracy points. Confidence intervals for overall total accuracy were calculated using the equation for normally distributed data (see above). A Kappa Index (Foody 1992) was used to help account for any correct classification due to chance.

RESULTS

Vegetation Classfication and Characterization

The classification of vegetation for the WICA study area includes 28 community types comprised of eight forest and woodland types, five shrubland types, ten herbaceous types and five sparse vegetation types. The final classification is presented in Tables 2 and 3. A field key and detailed type descriptions are included in Appendices 8 and 9. Many of the plant community types sampled are typical of the ponderosa pine / prairie transition zone of the lower elevations of the Black Hills and are well represented in the WICA study area. In fact, WICA has been recognized as an exemplary site for Black Hills vegetation due to diversity, vegetation condition, stand size and the relative intactness of the landscape including the presence of many natural or simulated ecological processes (Marriott *et al*. Black Hills Community Inventory, in prep.).

In the study area, ponderosa pine forests and woodlands are most extensive in areas of higher elevation in the western part. The most mesophytic of these types is ponderosa pine / chokecherry forest, best developed on northerly aspects and on lower slopes near drainage bottoms. Ponderosa pine / sunsedge (Figure 17), ponderosa pine / western wheatgrass and ponderosa pine / little bluestem woodlands occur on a variety of slopes and aspects. The ponderosa pine / little bluestem community is often the most extensive type on drier sites. Boland Ridge (in the eastern part of the study area) also includes extensive pine cover, with the more xerophytic community types well represented. Sizeable stands of ponderosa pine / common juniper woodland are found only in the westernmost part of the study area, with only one stand inside Park boundaries. This type is very common in higher elevations of the Black Hills to the west and north.

Deciduous forests and woodlands generally are restricted to floodplains, drainage bottoms and toeslopes, with a few scattered trees found elsewhere. The boxelder/chokecherry type is the most common overall, occurring in drainages scattered throughout the Park. Other trees, such as American elm, were locally abundant. Two floodplain types, plains cottonwood / western snowberry woodland and green ash - American elm / western snowberry forest, are

Table 2. Vegetation classification for WICA. Types are grouped into physiognomic classes. Elcodes are included in the first column.

NVCS Association	Common Name
Hardwood Forests and Woodlands	
CEGL000628 *Acer negundo / Prunus virginiana* Forest	BOX ELDER/CHOKECHERRY FOREST
CEGL002082 *Fraxinus pennsylvanica - Ulmus americana / Symphoricarpos occidentalis* Forest	ASH - ELM/WOLFBERRY FOREST
CEGL000660 *Populus deltoides / Symphoricarpos occidentalis* Woodland	COTTONWOOD/WOLFBERRY - WESTERN ROSE FLOODPLAIN
Coniferous Forests and Woodlands	
CEGL000849 *Pinus ponderosa / Carex inops* ssp. *Heliophila* Woodland	PONDEROSA PINE/SEDGE WOODLAND
CEGL000188 *Pinus ponderosa / Pascopyrum smithii* Woodland	PONDEROSA PINE/WESTERN WHEATGRASS WOODLAND
CEGL000201 *Pinus ponderosa / Schizachyrium scoparium* Woodland	PONDEROSA PINE/LITTLE BLUESTEM WOODLAND
CEGL000859 *Pinus ponderosa / Juniperus communis* Woodland	PONDEROSA PINE/COMMON JUNIPER WOODLAND
CEGL000192 *Pinus ponderosa / Prunus virginiana* Forest	PONDEROSA PINE/CHOKECHERRY FOREST
Shrublands	
CEGL001086 *Cercocarpus montanus / Bouteloua curtipendula* Shrubland	MOUNTAIN MAHOGANY/SIDE-OATS GRAMA SHRUBLAND
CEGL001394 *Juniperus horizontalis / Schizachyrium scoparium* Dwarf-shrubland	CREEPING JUNIPER/LITTLE BLUESTEM DWARF-SHRUBLAND
CEGL001108 *Prunus virginiana* Shrubland	CHOKECHERRY SHRUBLAND
CEGL001131 *Symphoricarpos occidentalis* Shrubland [Provisional]	WOLFBERRY SHRUBLAND
CEGL001173 *Salix bebbiana* Shrubland	BEAKED WILLOW SCRUB

Table 2. (continued)

Herbaceous Vegetation, upland		
CEGL001681	*Schizachyrium scoparium – Bouteloua (curtipendula gracilis)* - *Carex filifolia* Herbaceous Vegetation	NORTHERN GREAT PLAINS LITTLE BLUESTEM PRAIRIE
CEGL002037	*Stipa comata* - *Bouteloua gracilis* - *Carex filifolia* Herbaceous Vegetation	NEEDLE-AND-THREAD - BLUE GRAMA MIXEDGRASS PRAIRIE
CEGL001583	*Pascopyrum smithii* - *Nassella viridula* Herbaceous Vegetation	WESTERN WHEATGRASS - GREEN NEEDLEGRASS MIXEDGRASS PRAIRIE
CEGL002205	*Andropogon gerardii* - *Schizachyrium scoparium* Northern Plains Hillslope Herbaceous Vegetation	NORTHERN PLAINS BIG BLUESTEM PRAIRIE
CEGL003081	*Poa pratensis* Herbaceous Vegetation	KENTUCKY BLUEGRASS HERBACEOUS VEGETATION
not yet coded	*Aristida purpurea – Dyssodia papposa* Herbaceous Vegetation	Purple Three-awn - Fetid Marigold Herbaceous Vegetation PRAIRIE DOG TOWN GRASSLAND COMPLEX
not yet coded	Introduced Weedy Graminoid Herbaceous Vegetation	
Herbaceous Vegetation, riparian/wet meadow		
CEGL001833	*Eleocharis palustris* Herbaceous Vegetation	CREEPING SPIKERUSH WET MEADOW
CEGL001477	*Spartina pectinata* - *Carex* spp. Herbaceous Vegetation	PRAIRIE CORDGRASS - SEDGE WET MEADOW
CEGL005263	Western Great Plains Streamside Vegetation	WESTERN GREAT PLAINS STREAMSIDE VEGETATION
Sparse Vegetation		
CEGL002055	*Pinus ponderosa* Limestone Cliff Sparse Vegetation	PONDEROSA PINE LIMESTONE CLIFF
CEGL002295	Black Hills Rock Outcrop Sparse Vegetation	BLACK HILLS ROCK OUTCROP
CEGL002294	Shale Barren Slope Sparse Vegetation	SHALE BARREN SLOPES
CEGL005261	Redbeds (Silt/sandstone) Sparse Vegetation	REDBEDS

Table 3. Vegetation classification for WICA. Types are arranged by ecological groups following the Black Hills Community Inventory (Marriott *et al.* in prep.). Elcodes are included in the first column.

NVCS Association	Common Name
Dry Coniferous Forests and Woodland	
CEGL000849 *Pinus ponderosa / Carex inops* ssp. *heliophila* Woodland	PONDEROSA PINE/SEDGE WOODLAND
CEGL000188 *Pinus ponderosa / Pascopyrum smithii* Woodland	PONDEROSA PINE/WESTERN WHEATGRASS WOODLAND
CEGL000201 *Pinus ponderosa / Schizachyrium scoparium* Woodland	PONDEROSA PINE/LITTLE BLUESTEM WOODLAND
Mesic Coniferous Forests and Woodlands	
CEGL000859 *Pinus ponderosa / Juniperus communis* Woodland	PONDEROSA PINE/COMMON JUNIPER WOODLAND
CEGL000192 *Pinus ponderosa / Prunus virginiana* Forest	PONDEROSA PINE/CHOKECHERRY FOREST
Dry Plains Shrublands	
CEGL001086 *Cercocarpus montanus / Bouteloua curtipendula* Shrubland	MOUNTAIN MAHOGANY/SIDE-OATS GRAMA SHRUBLAND
CEGL001394 *Juniperus horizontalis / Schizachyrium scoparium* Dwarf-shrubland	CREEPING JUNIPER/LITTLE BLUESTEM DWARF-SHRUBLAND
Mesic Plains Shrublands	
CEGL001108 *Prunus virginiana* Shrubland	CHOKECHERRY SHRUBLAND
Dry Mixedgrass Prairies	
CEGL001681 *Schizachyrium scoparium – Bouteloua (curtipendula, gracilis) - Carex filifolia* Herbaceous Vegetation	NORTHERN GREAT PLAINS LITTLE BLUESTEM PRAIRIE
CEGL002037 *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation	NEEDLE-AND-THREAD – BLUE GRAMA MIXEDGRASS PRAIRIE

Table 3. (continued)

Mesic Mixedgrass Prairies		
CEGL001583	*Pascopyrum smithii* - *Nassella viridula* Herbaceous Vegetation	WESTERN WHEATGRASS - GREEN NEEDLEGRASS MIXEDGRASS PRAIRIE
CEGL002205	*Andropogon gerardii* - *Schizachyrium scoparium* Northern Plains Hillslope Herbaceous Vegetation	NORTHERN PLAINS BIG BLUESTEM PRAIRIE
CEGL003081	*Poa pratensis* Herbaceous Vegetation	KENTUCKY BLUEGRASS HERBACEOUS VEGETATION
Prairie Dog Town Grassland Complex		
not yet coded	*Aristida purpurea – Dyssodia papposa* Herbaceous Vegetation	Purple Three-awn - Fetid Marigold Herbaceous Vegetation PRAIRIE DOG TOWN GRASSLAND COMPLEX
Introduced Weedy Graminoid Herbaceous Vegetation		
not yet coded	Introduced Weedy Graminoid Herbaceous Vegetation	
Black Hills Sparse Vegetation		
CEGL002055	*Pinus ponderosa* Limestone Cliff Sparse Vegetation	PONDEROSA PINE LIMESTONE CLIFF
CEGL002295	Black Hills Rock Outcrop Sparse Vegetation	BLACK HILLS ROCK OUTCROP
CEGL002294	Shale Barren Slope Sparse Vegetation	SHALE BARREN SLOPES
CEGL005261	Redbeds (Silt/sandstone) Sparse Vegetation	REDBEDS
not yet coded	Recent Burn Sparse Vegetation	
Plains Riparian Forests and Shrublands		
CEGL000628	*Acer negundo / Prunus virginiana* Forest	BOX ELDER/CHOKECHERRY FOREST
CEGL002082	*Fraxinus pennsylvanica* - *Ulmus americana / Symphoricarpos occidentalis* Forest	ASH - ELM/WOLFBERRY FOREST
CEGL000660	*Populus deltoides / Symphoricarpos occidentalis* Woodland	COTTONWOOD/WOLFBERRY - WESTERN ROSE FLOODPLAIN
CEGL001131	*Symphoricarpos occidentalis* Shrubland [Provisional]	WOLFBERRY SHRUBLAND

Table 3. (continued)

High Elevation Riparian Forests and Shrublands	
CEGL001173 *Salix bebbiana* Shrubland	BEAKED WILLOW SCRUB
Riparian/Wet Meadow Herbaceous Vegetation	
CEGL001833 *Eleocharis palustris* Herbaceous Vegetation	CREEPING SPIKERUSH WET MEADOW
CEGL001477 *Spartina pectinata* - *Carex* spp. Herbaceous Vegetation	PRAIRIE CORDGRASS - SEDGE WET MEADOW
CEGL005263 Western Great Plains Streamside Vegetation	WESTERN GREAT PLAINS STREAMSIDE VEGETATION

photo by H. Marriott

Figure 17. Ponderosa pine with a mixed graminoid understory dominated by sun sedge.

present but are primarily located on private lands in the southeast and were not accessible for survey. However, data was collected for a very small cottonwood stand in the northeast portion of the Park. Aspen and paper birch forests were surveyed in the northwest part of the study area on US Forest Service lands, but only scattered small patches and individual trees are found within the Park boundaries.

Four shrubland types are recognized for the study area. Extensive mountain mahogany / side-oats grama shrublands occur in areas underlain by the Minnekahta limestone in the central part of WICA and small scattered stands are found elsewhere. Western snowberry shrubland occurs in drainage bottoms and draws. It is a common type in draws of grasslands in the eastern part of the Park. The chokecherry shrubland is also frequently found in these draws, although often on slightly more mesic sites, such as the head of the draw or around rock outcrops. The two types may blend extensively in these situations. Three-leaved sumac is often present or actually

dominates many of the chokecherry stands and is also found as scattered patches on grassy slopes. Leadplant stands occurred in several grassland types, typically on slopes. Some of the best examples were found on uppermost slopes just below the summits of the broad benches in the northeast portion of the Park. Leadplant is not classified as a separate vegetation type (it was treated as a shrubby phase of several mixedgrass prairie types), but large stands above the minimum mapping unit were mapped.

One high-elevation riparian shrubland type occurs in the study area. A stand of beaked or Bebb's willow shrubland was sampled along a stream in the northwestern part of the project area, outside of the Park. This represents by far the most common riparian shrub type of higher elevations in the Black Hills (Marriott *et al*. Black Hills Community Inventory, in prep.).

Seven upland herbaceous vegetation types were included in the classification. The most mesophytic is the big bluestem - little bluestem herbaceous vegetation. This type is highly variable depending on the season's moisture. It typically occurs as large stands on steep rocky (cobbly) slopes of the broad benches in the northeast part of the Park and on rocky slopes on Boland Ridge. The cobbly talus may actually serve as a local aquifer allowing the big bluestem to thrive in these areas. Scattered stands were also observed throughout the Park and big bluestem was observed in other grassland types as well.

The western wheatgrass - green needlegrass and Kentucky bluegrass herbaceous vegetation types are common throughout the Park. The two types appear to occupy very similar habitats: flat to gently sloping areas of better soil development. On less favorable sites, two other types are found. Little bluestem - grama grass vegetation occurs on well developed, moderate-to-steep slopes often underlain with less developed silty to gravelly soils. Large stands of needle-and-thread - blue grama herbaceous vegetation occur on summits of broad benches in the northeast part of the Park, typically on rocky microsites, such as summit margins (Figure 18).

photo by H. Marriott

Figure 18. A needle-and-thread - blue grama grassland on a small hill with a high proportion of leadplant.

Two herbaceous types were newly created for this project. The purple three-awn - fetid marigold herbaceous vegetation (Prairie Dog Town Grassland Complex) is a type created to classify the vegetation occurring in prairie dog towns. Purple three-awn is often locally dominant both in the study area, and in other parts of the Black Hills. However, dominance varies locally as would be expected in this highly disturbed habitat. Big-bract verbena and fetid marigold are two of the more consistently present and common species. The Introduced Weedy Graminoid type is found throughout the Black Hills. This type includes stands of introduced graminoids growing on disturbed sites. The most common species are smooth brome, japanese brome and cheatgrass.

The diverse riparian vegetation occurring along many of the streams and wet meadows in the study area was classified using three riparian/wet meadow herbaceous types. Other types could have been included but these only occurred as small patches, which is typical for riparian types.

The prairie cordgrass - sedge community is found around seeps, springs and along slow-moving shallow streams. Cordgrass is not always present, and some stands could have been classified as Nebraska sedge communities if they were larger. A stand of pale spikerush herbaceous vegetation was found and sampled in a shallow pond within a large prairie dog town. The Western Great Plains Streamside Vegetation community is well developed along stretches of Highland and Beaver Creeks and is widespread at lower elevations throughout the Black Hills (Marriott pers. obs.).

Five sparse vegetation types are recognized for the study area. The Black Hills Rock Outcrop type (granites and schists) is found predominately in the northwest corner of the study area with much smaller outcrops in the Park. The Ponderosa Pine Limestone Cliff type occurs as small limestone outcrops associated with some of the larger streams in the central part of the Park. Redbeds Sparse Vegetation lies on small, badland-like exposures of the red Spearfish Formation in the Red Valley. Gypsum lenses are usually interspersed with this type. The Shale Barren Slope type is found in the outermost Hogback Rim region of the Black Hills, east of Boland Ridge. All exposures of this type within the study areas are privately owned and not accessible for survey. The Recent Burn sparse vegetation type was developed for this project. It includes recently burned stands, usually ponderosa pine, where the fire was sufficiently hot to kill most of the vegetation. Species composition was variable, consisting of early, often weedy and exotic, invaders such as Canada thistle (*Cirsium arvense*).

Vegetation Map Production

Map units

Thirty-eight map classes were recognized and used for WICA (Table 4). These were divided into 32 vegetation and geology units and six Anderson Level II (Anderson *et al*. 1976) land-use classes. These were developed through a combination of fieldwork, preliminary photo interpretation, and the NVCS vegetation association classification for WICA. Deviations from

Table 4. Map Units for WICA and corresponding NVCS classes.

Map Code	Map Unit	Elcode	NVCS Association
		Hardwood Forests and Woodlands	
40	Plains cottonwood / Western snowberry Woodland	CEGL000660	*Populus deltoides / Symphoricarpos occidentalis* Woodland
41	Boxelder / Chokecherry Forest	CEGL000628	*Acer negundo / Prunus virginiana* Forest
42	Bur oak Stand	(No corresponding class, Park Management Concern)	
43	Green ash - American elm / Western snowberry Forest	CEGL002082	*Fraxinus pennsylvanica - Ulmus americana / Symphoricarpos occidentalis* Forest
44	Birch - Aspen Stand	(No corresponding NVCS class, Park Management Concern)	
		Coniferous Forests and Woodlands	
45	Ponderosa pine Woodland Complex I (75%-100% cover)	CEGL000859 CEGL000849 CEGL000188	*Pinus ponderosa / Juniperus communis* Woodland *Pinus ponderosa / Carex inops* ssp. h*eliophila* Woodland *Pinus ponderosa / Pascopyrum smithii* Woodland
49	Young Ponderosa pine Dense Cover Complex	(No corresponding NVCS, Park Mangement Concern)	

Table 4. (continued).

46 Ponderosa pine / Little bluestem Woodland	CEGL000201 *Pinus ponderosa / Schizachyrium scoparium* Woodland
47 Ponderosa pine / Chokecherry Forest	CEGL000192 *Pinus ponderosa / Prunus virginiana* Forest
Shrublands	
30 Mountain mahogany / Side-oats grama Shrubland I (15%-50% cover)	CEGL001086 *Cercocarpus montanus / Bouteloua curtipendula* Shrubland
31 Mountain mahogany / Side-oats grama Shrubland II (50%-100% cover)	CEGL001086 *Cercocarpus montanus / Bouteloua curtipendula* Shrubland
32 Leadplant Shrubland	(No corresponding NVCS class, Park Management Concern)
33 Chokecherry Shrubland	CEGL001108 *Prunus virginiana* Shrubland
12 Chokecherry Shrubland (with burned ponderosa pine)	(Same NVCS class as above, Park Management Concern)
34 Beaked willow Shrubland	CEGL001173 *Salix bebbiana* Shrubland
35 Western snowberry Shrubland	CEGL001131 *Symphoricarpos occidentalis* Shrubland [Provisional]
36 Creeping juniper / Little bluestem Dwarf-shrubland	CEGL001394 *Juniperus horizontalis / Schizachyrium scoparium* Dwarf-shrubland

Table 4. (continued).

Herbaceous Vegetation, upland	
15 Little bluestem - Grama grass - Threadleaf sedge Herbaceous Vegetation	CEGL001681 *Schizachyrium scoparium – Bouteloua (curtipendula gracilis) - Carex filifolia* Herbaceous Vegetation
11 Little bluestem - Grama grass - Threadleaf sedge Herbaceous Vegetation (with burned ponderosa pine)	(Same NVCS classes as above, Park Management Concern)
16 Western wheatgrass - Kentucky bluegrass Complex	CEGL001583 *Pascopyrum smithii - Nassella viridula* Herbaceous Vegetation CEGL003081 *Poa pratensis* Herbaceous Vegetation CEGL002205 *Andropogon gerardii - Schizachyrium scoparium* Herbaceous Vegetation
13 Western wheatgrass - Kentucky bluegrass Complex (with burned ponderosa pine)	(Same NVCS class as above, Park Management Concern)
17 Introduced Weedy Graminoid Herbaceous Vegetation	(not yet coded) Introduced Weedy Graminoid Herbaceous Vegetation
18 Needle-and-thread - Blue grama - Threadleaf sedge Herbaceous Vegetation	CEGL002037 *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation
1 Purple three-awn - Fetid marigold Herbaceous Vegetation	(not yet coded) *Aristida purpurea - Dyssodia papposa* Herbaceous Vegetation

Table 4. (continued).

Herbaceous Vegetation, riparian/wet meadow	
14 Emergent Wetland Complex	CEGL001833 *Eleocharis palustris* Herbaceous Vegetation CEGL001477 *Spartina pectinata* - *Carex* ssp. Herbaceous Vegetation CEGL005263 Western Great Plains Streamside Streamside
Sparse Vegetation	
2 Ponderosa pine Limestone Cliff Sparse Vegetation	CEGL002055 *Pinus ponderosa* Limestone Cliff Sparse Vegetation
3 Redbeds Sparse Vegetation	CEGL005261 Redbeds (Silt/sandstone) Sparse Vegetation
4 Black Hills Rock Outcrop Sparse Vegetation	CEGL002295 Black Hills Rock Outcrop Sparse Vegetation
5 Shale Barren Slope Sparse Vegetation	CEGL002294 Shale Barrens Slopes Sparse Vegetation
6 White Sedimentary Rock Outcrop	(no corresponding NVCS class)
7 Bison Wallows	(no corresponding NVCS class, Park Management Concern)

the NVCS occurred when distinct photo signatures could not be discerned from aerial photography. This was the case for some of the dense ponderosa pine types and grassland types. Also, new map units that did not correspond to the NVCS types were used to provide more detail on vegetation deemed important for WICA's management needs. Finally, some map classes were added to explain certain geologic formations supporting sparse vegetation or which were devoid of vegetation. These included the shale barren slopes sparse vegetation and white sedimentary rock outcrop classes.

The ponderosa pine / common juniper, ponderosa pine / western wheatgrass, and ponderosa pine / sun sedge types could not be separated from each other on the aerial photography. This was largely due to the thick canopy of ponderosa pine masking any distinctive understory signature that might be present. Further, the intermingling of these types on various slopes, aspects, and topographic positions made predictive modeling impossible. After preliminary interpretation it was decided that accurate mapping of these 3 types would require the use of modified map units. The result was to create two ponderosa pine complexes based on canopy closure. Ponderosa pine complex I includes all stands with 75%-100% canopy closure, *i.e*. where the pine appeared on the photography as dense stands. Ponderosa pine complex II includes stands of pine that had a canopy of 15-75%.

A major management concern of the Park is the location and size of young, dense stands of ponderosa pine trees, commonly referred to as "doghair" stands. Since height of the pine trees could be observed on the aerial photography, a dense young age class was created to separate young "dog-hair stands from more mature, dense stands. This map unit did not correspond to an NVCS class but the understory of this type ranges from barren needles and duff, to sporadic common juniper, to small pockets of sun sedge.

For mapping purposes, the western wheatgrass - green needlegrass and Kentucky bluegrass types were combined into the western wheatgrass – Kentucky bluegrass herbaceous complex. This was largely a result of finding Kentucky bluegrass intermingled with western wheatgrass to some degree throughout the prairie regions of WICA. Separating these two on the aerial photography proved to be impossible. Large pockets of lead plant also occur within the Kentucky bluegrass

and western wheatgrass – green needlegrass types. These situations are viewed as local variations of the herbaceous types but are important for the Park's management. To address this condition a separate lead plant map unit was created.

Other Park management concerns include the location of rare deciduous trees and bison wallows. This led to the creation of bur oak stand, aspen-birch stand, and bison wallow map units. These types were not large enough to be sampled at WICA and are not included on the NVCS classification. However, individual deciduous trees and bison wallows could easily be observed on the aerial photography and readily separated from the surrounding vegetation. Additional reference material supplied by the Park helped locate these types accurately (Smith 1978). All three of these map units usually occur below the ½ hectare minimum mapping unit but are included on the maps as small polygons rather than points.

Recent burns within the ponderosa pine forests were readily observable on aerial photography. The resulting seral vegetation was identified as belonging to either the chokecherry shrubland, western wheatgrass – Kentucky bluegrass herbaceous vegetation, or little bluestem - grama grass types (Figure 19). To provide more detailed information on these types, separate map units were created that indicate when these type occur in burned ponderosa pine stands.

Aerial Photograph Interpretation

A brief description of each map unit (map code), their location in the project area, and photo signature characteristics follows:

Plains Cottonwood / Western Snowberry Woodland (40) mapping unit occurs exclusively along some of the major streams and drainages in the project area; especially in the southeastern portion along Beaver Creek. The presence of large plains cottonwood trees occurring within a floodplain or riparian corridor is characteristic of this class. The understory is composed of various shrubs and grasses including snowberry, chokecherry, and western wheatgrass. On the

photo by D. Cogan

Figure 19. A burned ponderosa pine slope now supporting mixed graminoids.

aerial photos, cottonwood crowns appear as large pink, coarse circles or ovals with a rough, pebbly texture. This class is separated from other riparian, deciduous woodlands due to the very large size of cottonwood crowns and overall canopy height (Figure 20A).

Boxelder / Chokecherry Forest (41) is common along the perennial and intermittent streams throughout the project area. The photo signature is a bright red to pink color with a coarse texture due to the height and canopy diameter of the trees. This class may mask or cover other wetland, stream, shrub, or grass classes (Figure 20B).

Bur Oak Stand (42) mapping unit occupies the South Fork of Lame Johnny Creek in Custer State Park and along Reeves Gulch within WICA. The photo signature is almost identical to the boxelder / chokecherry class, however individual bur oak trees often appear smaller and more discrete. Field verification of polygon borders was necessary for accurate mapping of this class (Figure 20C).

Green Ash - American Elm / Western Snowberry Forest (43) unit is rare within the project area and is only found in the southeast corner and within small enclosures of WICA. This class contains some of the same species and the photo signature is almost identical to the boxelder / chokecherry forest map unit (Figure 20D).

Birch - Aspen Stand (44) is a rare class within the WICA project area, restricted to forested uplands in the northern portion. Aspen and birch usually occur within or adjacent to one of the ponderosa pine classes. On aerial photos, aspen and birch trees give identical signatures of a deep, bright red that contrasted with the brown pine signature (Figure 20E).. This type is distinguished from other deciduous classes based on topographic position and location. Whereas the other deciduous types are restricted to floodplains and riparian corridors, aspen and birch stands occur on slopes, benches, valley bottoms, and along the margins of floodplains.

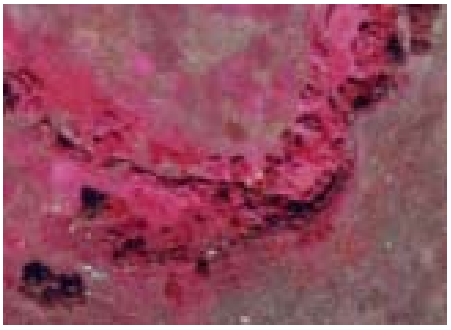
Ponderosa Pine Woodland Complex I (45) includes all forested areas with an approximate ponderosa pine crown density of 75%-100%. Included within this type are ponderosa pine / sun sedge, ponderosa pine / western wheatgrass, and ponderosa pine / common juniper associations. Understory signatures for this class are usually absent and soils supporting this type are typically thin with rock outcrops. On aerial photos, this category appears as a continuous, pebbled, brown layer with little if any color signature variation (Figure 21A).

Ponderosa Pine Woodland Complex II (48) includes forested areas with a probable ponderosa crown density of less than 75% but greater than 15%. Included within this type are ponderosa pine / sun sedge, ponderosa pine / western wheatgrass, and ponderosa pine / common juniper associations. Areas where ponderosa pine encroach onto deep, loamy soils are representative of this class. On aerial photos, this category appears as brown pebbles over a smooth red to pink undertone (Figure 21B). Areas that are in close proximity to grazed or disturbed grasslands are often completely dominated by Kentucky bluegrass yielding a bright red understory signature.

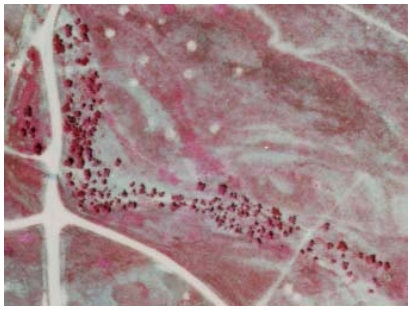
Young Ponderosa Pine Dense Cover Complex (49) unit includes all areas that were recently reforested by ponderosa pine (roughly <20 years old). Young ponderosa pine usually form

Figure 20. Representative photo-signatures for the deciduous tree map units. (all photography by Horizons, Inc. 1997).

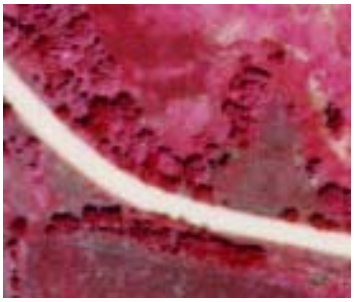
A) Plains Cottonwood / Western Snowberry Forest



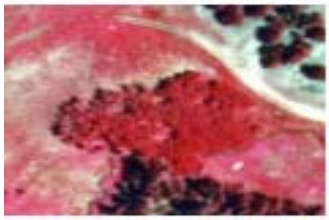
B) Boxelder / Chokecherry Forest



C) Bur Oak Stand



D) Green Ash - American Elm / Western Snowberry Forest



E) Birch-Aspen Stand

large, dense (dog-hair) stands next to older pine classes and/or burned areas. Mountain mahogany often occurs in close proximity to this class (especially along Wind Cave Canyon) making it difficult to discern. This class appears as small, brick red stipples between gray/pink grass signatures and brown mature pine signatures. Usually a fine network of drainages dissects this class as observed on aerial photography (Figure 21C).

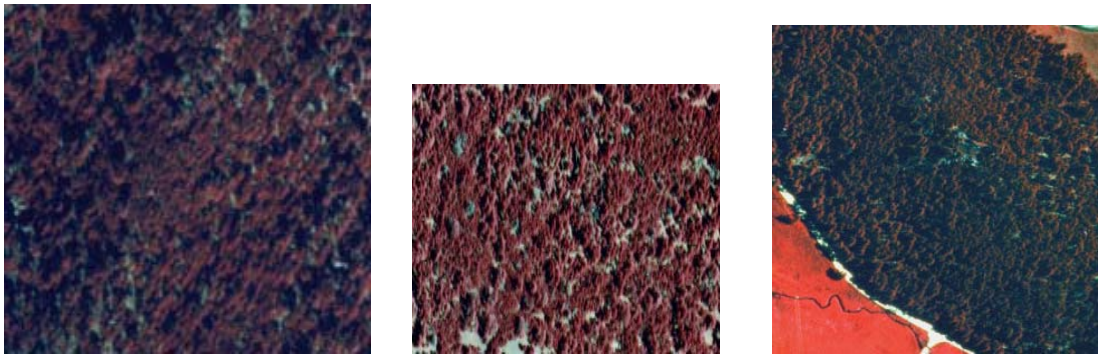
Ponderosa Pine / Little Bluestem Woodland (46) unit includes forested areas with a probable ponderosa crown density of less than 75% but greater than 15%. The semi-open to open canopy of this class supports an understory of grasses and sparse shrubs. Gravelly and sandy soils in these areas typically support little bluestem. On aerial photos, this category appears as brown pebbles over a light gray to white undertone (Figure 21D).

Ponderosa Pine / Chokecherry Forest (47) includes forested areas with a probable ponderosa crown density of less than 75% but greater than 15%. This class occurs in mesic areas such as forested drainages and north-facing slopes (probably representing an ecotone or a transition from dry woodlands to mesic grasslands/ shrublands). The photo signature for this class is relatively complex with brown pebbles and rough-textured bright red blotches (Figure 21E).

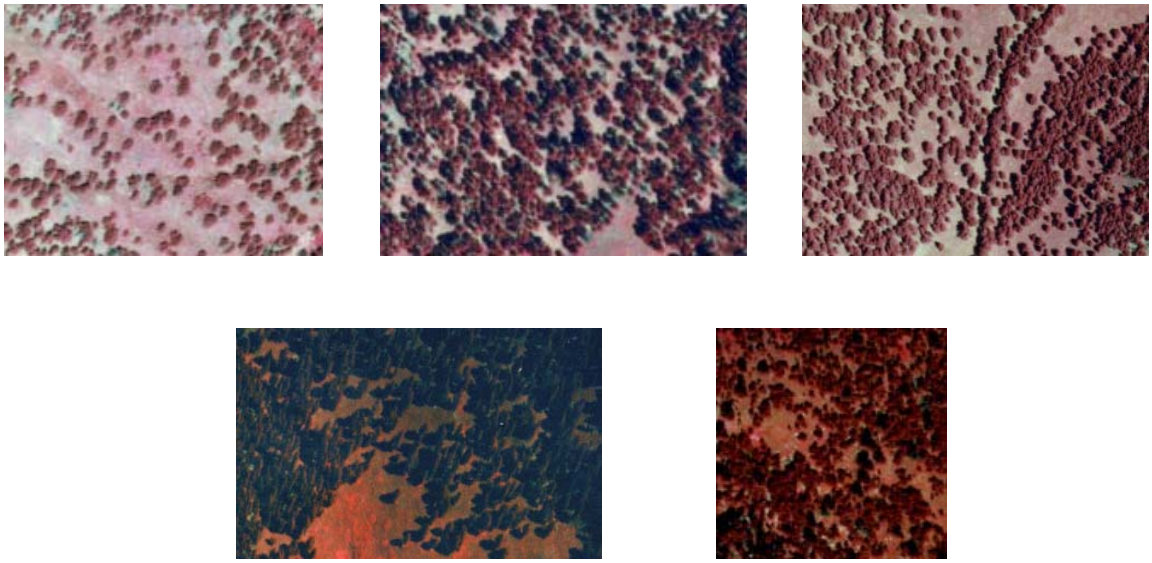
Mountain Mahogany / Sideoats Grama Shrubland I (30) is present along steep, dry, south-facing slopes throughout the Minnelusa foothills and especially the Wind Cave Canyon portion of the project area. Mountain mahogany cover on aerial photography ranges from 50% to less than 15%. Sideoats grama and little bluestem are the dominant grass species occurring in and around this type. Mountain mahogany appears as small, red-pebbled dots against a white to gray background on the aerial photography (Figure 22A).

Mountain Mahogany / Sideoats Grama Shrubland II (31) occurs along steep, north-facing slopes throughout the Minnelusa foothills and especially the Wind Cave Canyon portion of the project area. Mountain mahogany cover on the aerial photography ranges from about 100% - 50% (Figure 22B). Sideoats grama and little bluestem are the dominant grass species (Figure 23). Dense mountain mahogany appears as coarse, red, grainy blotches on the aerial photography

Figure 21. Representative photo-signatures for the ponderosa pine map units. (all photography by Horizons, Inc. 1997).



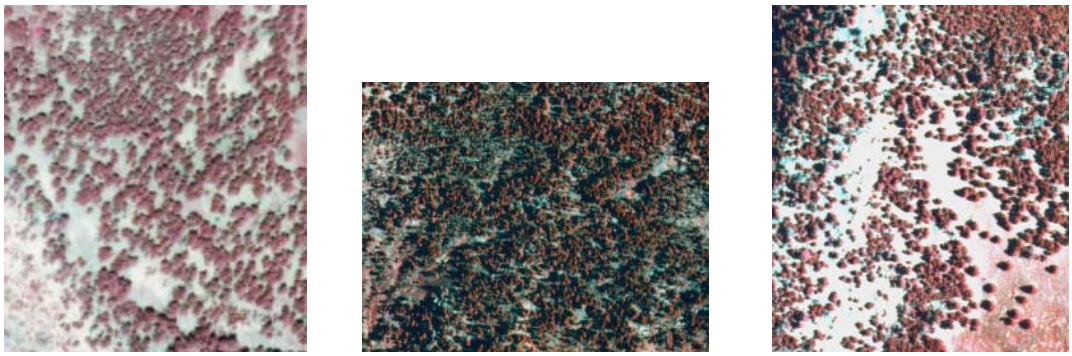
A) Ponderosa Pine Woodland Complex I



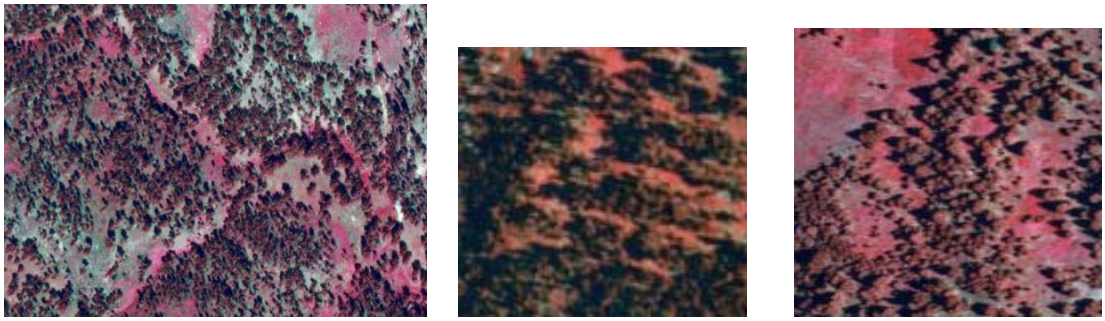
B) Ponderosa Pine Woodland Complex II

Figure 21. (continued).

C) Young Ponderosa Pine Dense Cover Complex



D) Ponderosa Pine / Little Bluestem Woodland



E) Ponderosa Pine / Chokecherry Forest

Lead Plant Shrubland (32) mapping unit occurs on some of the grassy slopes and knolls throughout the project area. This class is difficult to distinguish from the surrounding grassland types due to its short stature and the presence of a grass understory. The photo signature varies in color based on the grass component but usually contains some small pink to gray stipples (Figure 22C).

Chokecherry Shrubland (33) occurs throughout the project area on mesic slopes and drainages, along draws and deep swales, and on rocky soils. On slopes, three-leaved sumac shrubs are often present within this map unit and appear as dense circular blotches, bright red in color. Pure chokecherry stands give a similar red signature but occur in more linear or oval patterns. This class exhibited some height when viewed under stereo-magnification that allowed it to be separated from the western snowberry class (Figure 22D).

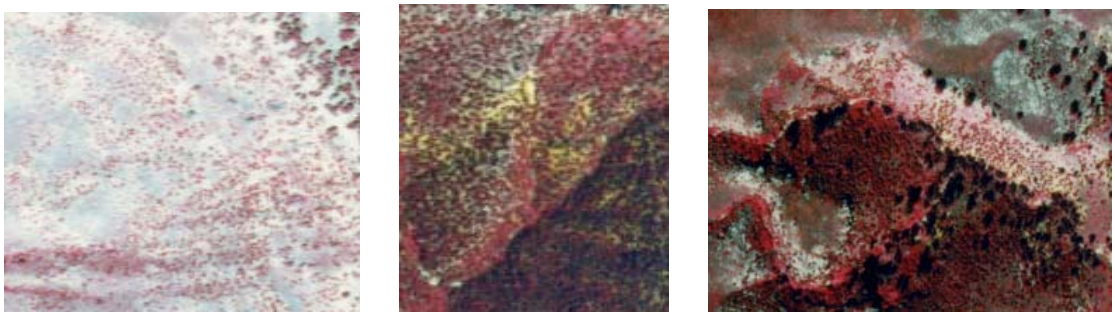
Chokecherry Shrubland (with burned ponderosa pine) (12) is identical to the above chokecherry class except that it occurs within burned ponderosa pine trees. The major species are various deciduous shrubs with a bright pink or red signature. Charred ponderosa pine stumps and standing dead trees are also observable, especially under magnification (Figure 22E).

Beaked Willow Shrubland (34) unit represents a limited riparian shrubland that exists only in the northwest portion of the study area along perennial streams. The photo signatures for this class are very bright red, linear ovals that exhibit a somewhat coarse texture (Figure 22F).

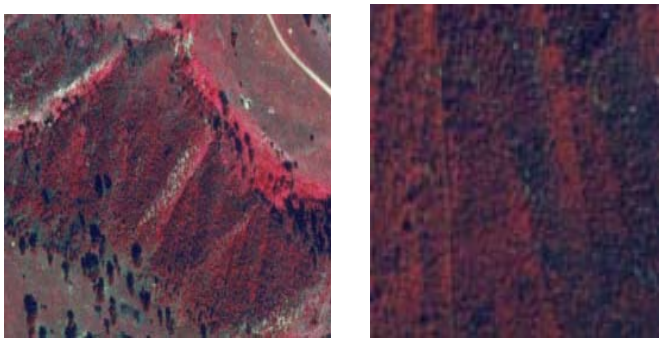
Western Snowberry Shrubland (35) is very common throughout the project area in mesic swales, draws, and drainages. The photo signature for snowberry varies slightly from red to pink and occurs as small blotches or linear "fingers". This class is distinguished from the 3-leaved sumac - chokecherry type by the lack of height under stereo-magnification (Figure 22G).

Creeping Juniper / Little Bluestem Shrubland (36) mapping unit is extremely rare in the project area. This class only occurs in two known locations. The aerial photo signature is nearly indistinguishable from the surrounding vegetation (Figure 22H).

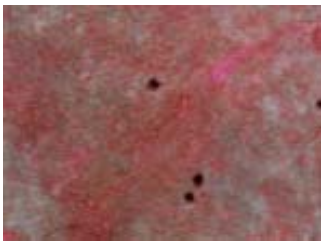
Figure 22. Representative photo-signatures for the shrub map units.
(all photography by Horizons, Inc. 1997).



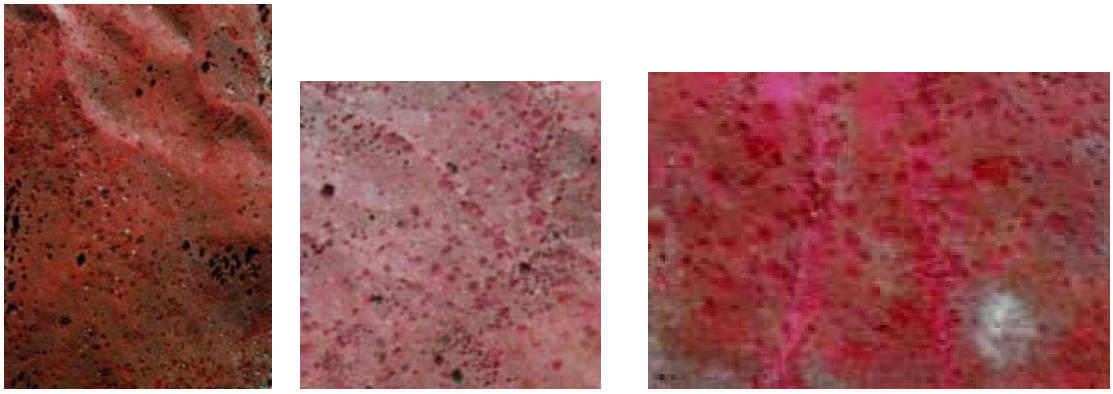
A) Mountain Mahogany / Side-oats Grama Shrubland I



B) Mountain Mahogany / Sideoats Grama Shrubland II



C) Lead Plant Shrubland

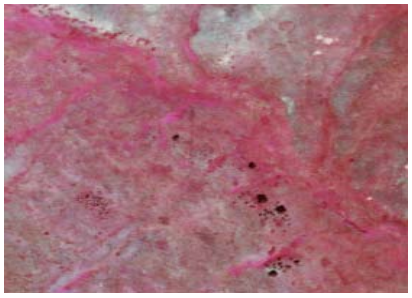


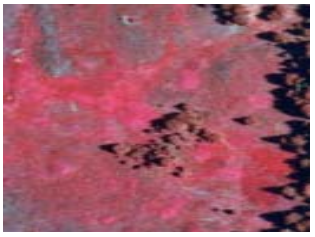
D) Chokecherry – Three-leaved Sumac Shrubland

Figure 22. (continued).

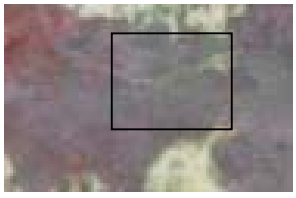
E) Chokecherry Shrubland (with burned ponderosa pine)

F) Beaked Willow Shrubland





G) Western Snowberry Shrubland



H) Creeping Juniper / Little Bluestem Dwarf-shrubland

Figure 23. An example of the dense mountain mahogany map unit occurring on a north-facing slope at WICA.

Emergent Wetland Herbaceous Complex (14) is used to map the limited herbaceous wetlands occurring within the project area. This class exhibits typical wetland signatures consisting of a pure dark blue to black color in open water, dark blue to black with red stipples in the emergent zone, and bright red for vegetation occurring along the margins (Figure 24A). Wetlands are identified and mapped to the extent of the associated vegetation. An "open water" mapping unit is used to classify any deep pools or flowing water devoid of vegetation
(Note: Small creeks, streams, and drainages are mapped as linear wetland features).

Little Bluestem - Grama Grass - Threadleaf Sedge Herbaceous Vegetation (15) typically occurs on sparse to barren gravelly slopes and knolls throughout the project area. The grama grass component consists of both side-oats grama and blue grama. The photo signature varies slightly from a smooth bright white to a smooth dull gray. A lack of photosynthetic activity and/or the presence of dead material likely causes these unique colors. This class is mapped to the extent of its characteristic barren or dull signature (Figure 24B).

Little Bluestem – Grama Grass - Threadleaf Sedge Herbaceous Vegetation (with burned ponderosa pine) (11) occurs throughout burned forested regions of the project area. This type is often found on tops of hills and mountains where the soils are gravelly and rocky. Little bluestem and side-oats grama are the dominant plant species and rock outcrops are usually associated with this type. On aerial photos, charred ponderosa pine stumps and standing dead trees are readily observed as small black "toothpicks". The background signature is a pale, rough white (Figure 24C).

Western Wheatgrass - Kentucky Bluegrass Complex (16) mapping unit represents the western wheatgrass - green needle grass and Kentucky bluegrass herbaceous vegetation types. This mapping unit is found throughout the project area on mesic loamy to clayey soils. The photo signature for this class ranges from olive green, to blue green, to light pink in color resulting from a combination of soil depth, moisture, grazing activity, and associated species (Figure 24D).

Western Wheatgrass - Kentucky Bluegrass Complex (with burned ponderosa pine) (13) is found throughout burned-forested regions of the project area. This is the most common of the burned classes and corresponds to the dominance of various grasses and sedges. The aerial photo signature for this type varies from a smooth bright red to a rough pink depending on topographic position and moisture availability. Charred ponderosa pine stumps and standing dead trees are always present (Figure 24E).

Introduced Weedy Graminoid Herbaceous Vegetation (17) represents the few introduced grassland components within the project area. Smooth brome, cheatgrass, and Japanese brome are the chief species and are currently restricted to road rights-of-way, heavily disturbed areas, and agricultural fields. Both grasses, when dominant, grazed, and/or mown give a mottled signature consisting of yellows, pinks, and reds. (Figure 24F).

Needle-and-thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation (18) unit occurs sparingly at WICA, increasing towards the northeast corner where it occupies cobbly, broad benches. This class likely corresponds to increased grazing pressure and/or a reduction in soil

moisture. The photo signature for this type is difficult to distinguish from little bluestem, although it tends to be darker in color (Figure 24G).

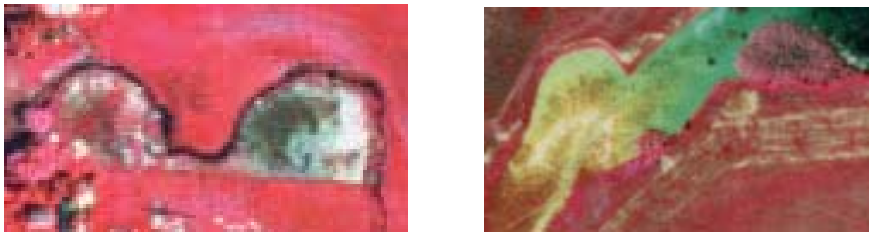
Purple Three-awn - Fetid Marigold Herbaceous Vegetation (1) mapping unit occurs in the grassland portions of the project area, occupying broad drainages, swales, terraces, and very gentle slopes. This type usually contains more forb cover and much less graminoid cover than the other herbaceous types. The photo signature always consists of small white stipples (prairie dog burrows) interspersed among various disturbed grassland signatures. Bison wallows and pocket gopher mounds may have given similar signatures but usually lack the corresponding disturbed grassland colors and small interconnecting trails. This class is mapped up to the obvious border of the undisturbed native grasslands (Figure 24H).

Ponderosa Pine Limestone Cliff Sparse Vegetation (2) is used sparingly to characterize the limestone cliffs and bluffs present in valleys along some of the major streams at WICA. This unit typically includes some sparse ponderosa pine and patches of shrubs and graminoids among limestone outcrops. The photo signature for this type is bright white with some small brown dots caused by high reflectance and the presence of a few ponderosa pine trees (Figure 25A).

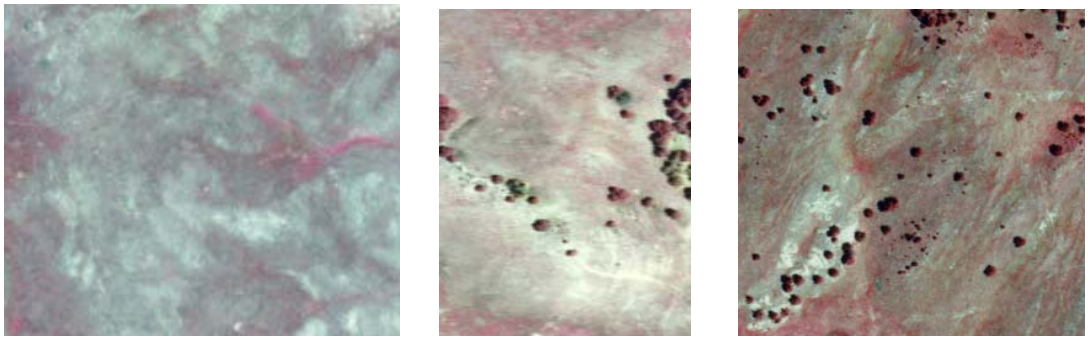
Redbeds Sparse Vegetation (3) mapping unit is used exclusively in the Red Valley region of WICA. This type corresponds to the red erosion faces occurring on some of the steeper hill slopes. Vegetation occurring on these formations is usually sparse, and includes both graminoids and various forbs. These areas appeared as smooth, dark yellow, almost barren, slopes (Figure 25B).

Black Hills Rock Outcrop Sparse Vegetation (4) is found in the northwest corner (CCA region) of the project area. These areas are characterized by large prominent rock outcrops, ridges, and similar formations. Some ponderosa pines are present as are associated stands of aspen and birch. The gray granite and schist rocks appears fractured (small cracks) on the aerial photography (Figure 25C).

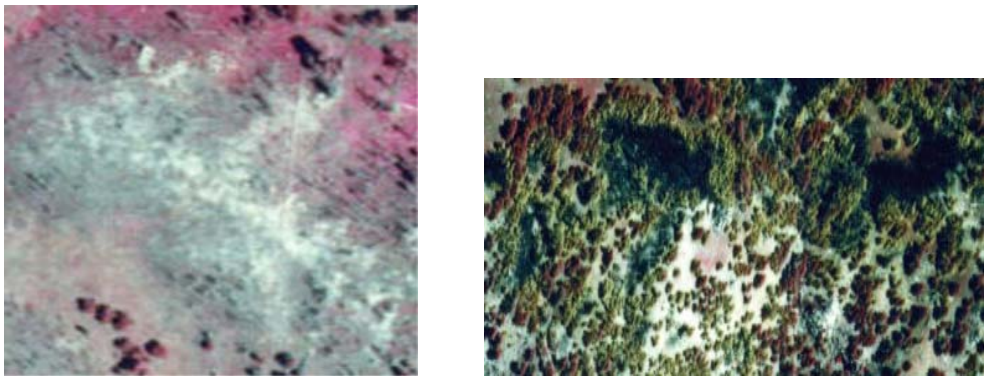
Figure 24. Representative photo-signatures for the herbaceous map units. (all photography by Horizons, Inc. 1997).



A) Emergent Wetland Herbaceous Complex

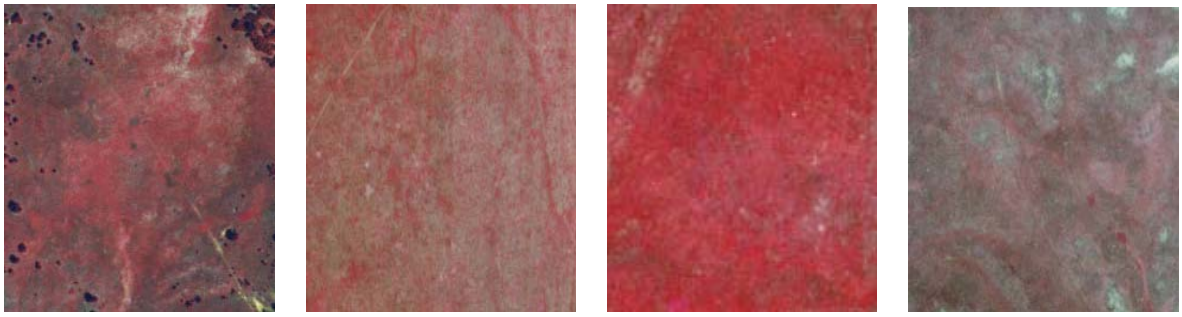


B) Little Bluestem - Grama Grass / Threadleaf Sedge Herbaceous Vegetation

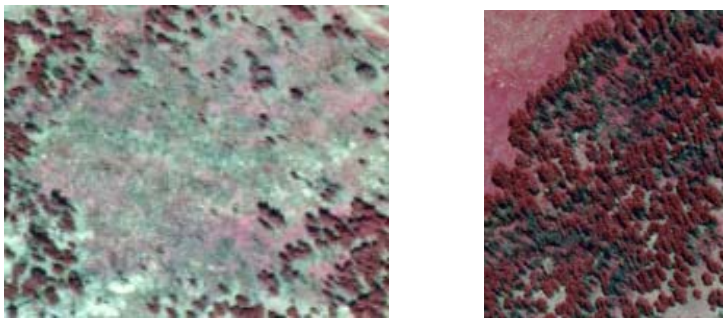


C) Little Bluestem - Grama Grass / Threadleaf Sedge Herbaceous Vegetation (with burned ponderosa pine)

Figure 24. (continued)



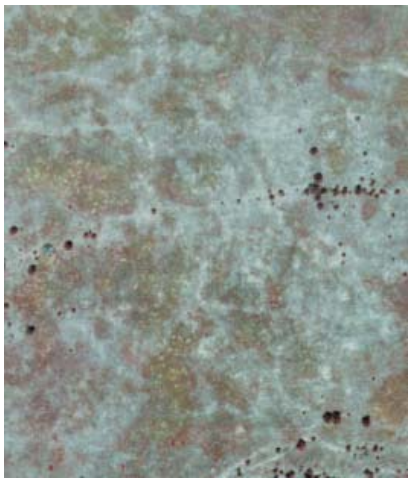
D) Western Wheatgrass - Kentucky Bluegrass Herbaceous Complex



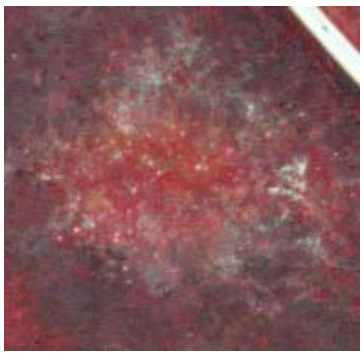
E) Western Wheatgrass - Kentucky Bluegrass Herbaceous Complex (with burned ponderosa pine)

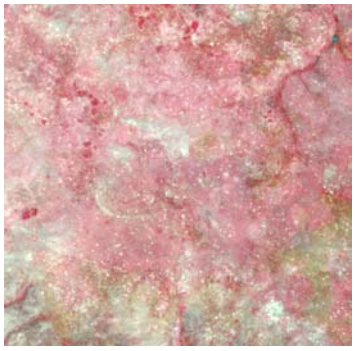
F) Introduced Weedy Graminoid Herbaceous Vegetation

Figure 24. (continued)



G) Needle-and-thread - Blue Grama / Threadleaf Sedge Herbaceous Vegetation





H) Purple three-awn / Fetid marigold Disturbed Vegetation

Shale Barren Slope Sparse Vegetation (5) mapping unit is located in the eastern portion of the environs outside the WICA boundary. This type is common on drainage slopes that are subject to water erosion. On the aerial photography, shale outcrops appear absolutely barren except for some wetland pockets in the lowest areas and are characterized by a dark blue signature (Figure 25D).

White Sedimentary Rock Outcrop (6) is used to address the unique geologic formations in the southern portion of the project area. Layers of white siltstone, sandstone, gypsum, and limestone occur here as caps on a large number of rolling hills and mounds. These appear to be almost completely devoid of vegetation and reflect a bright white photographic signature (Figure 25E).

Bison Wallows (7) are common in the grassland portions of this study. These correspond to disturbed areas used by bison as mineral licks and wallows. Wallows are usually small and interconnected by a network of many small trails. The signature for this type is apparent on aerial photography as dark yellow to light green circles or ovals (Figure 25F).

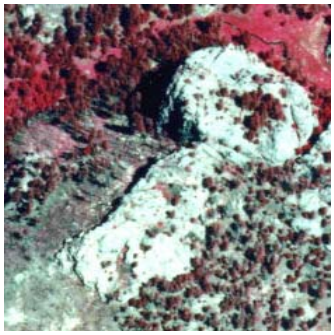
Transportation, Communications, and Utilities (51) land use class represents U.S., state, and other major highways, parking lots, disturbed powerline right-of-ways, and old railroad rights-of-way. Within WICA and surrounding public lands, this class is bounded primarily by native vegetation. In these instances, this map unit is restricted to the road surface or disturbed "core" area. In the remaining areas, the entire disturbed corridor is used as the mapping boundary where road-cuts, mowing, or other maintenance regularly occurs. Paved concrete surfaces on the aerial photographs reflect white, except where black patching occurred. Disturbed areas usually have a multi-colored mottled signature sharply contrasting with adjacent native vegetation (Figure 26A). (Note: Two-track roads and trails are mapped as linear features).

Mixed Urban or Built-up Land (52) corresponds to WICA facilities, developed land, and the town of Pringle, SD. This unit contains many possible photo signatures representing buildings, lawns, bare ground, and storage areas (Figure 26B).

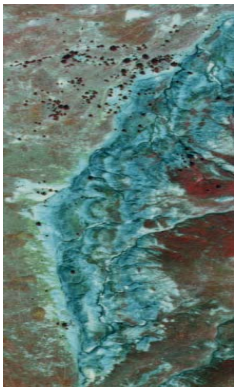
Figure 25. Photo-interpretive key to the sparse vegetation classes. (all photography by Horizons, Inc. 1997).

A) Ponderosa pine Limestone Cliff Sparse Vegetation

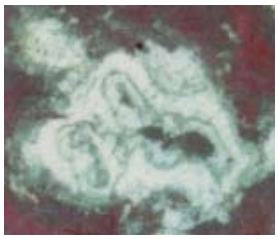
B) Redbeds Sparse Vegetation



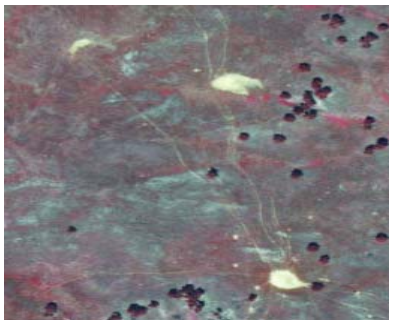
C) Black Hills Rock Outcrop Sparse Vegetation



D) Shale Barren Slopes Sparse Vegetation



E) White Sedimentary Rock Outcrop



F) Bison Wallows

Croplands and Pastures (53) land use class occurs in the project environs outside of WICA. Pastures and fields usually exhibit regular boundaries on relatively flat land, becoming more irregular in floodplains. This class contains various photo signatures ranging from bright red to dull green depending on whether the land is used for hay production, seeded, or fallow. Linear crop-lines are often present on the aerial photography (Figure 26C).

Other Agricultural Lands (55) within the project boundary include homesteads, ranch-sites, corrals, barnyards, and other high-use rural areas. The photo signature for these sites varies from a multi-colored mottled signature to a bright pinkish red. Regular fence lines and access roads are often present (Figure 26D).

Open Water (57) corresponds to standing water devoid of any observable vegetation. This includes wide streams, rivers, sewage pools, and deep ponds. The reflectance is often a smooth, blue to black color depending on turbidity and depth. Certain sun angles increase the reflectivity yielding pure white to gray colors (Figure 26E).

Strip Mines, Quarries, and Gravel Pits (59) map unit class represent areas in the mapping project where the soil and underlying material has been removed and drastically disturbed. These areas appear on the aerial photographs as dark pits or highly reflective rock out-crops. Access roads and dirt/rock piles are usually present (Figure 26F).

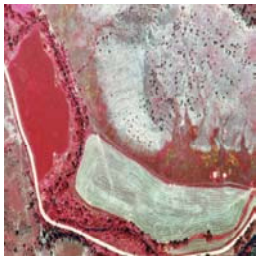
Digital Transfer

Vegetation coverages were created in ArcInfo™ (ESRI, Inc.) for each quarter quadrangle of the WICA study area. A list of quarter quadrangles can be found in Appendix 13. Total area and number of polygons per map unit were generated for each quarter quadrangle. The grand total of polygons and area for the entire study can be found in Table 5.

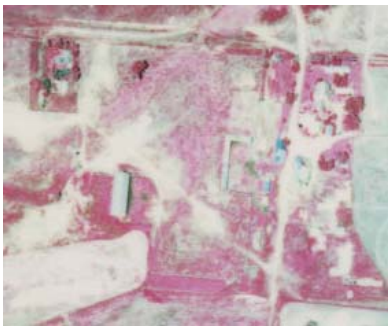
Figure 26. Photo-interpretative key for land-use map units.
(all photography by Horizons, Inc. 1997.)

A) Transportation, Communications, and Utilities

B) Mixed Urban or Built-up Land

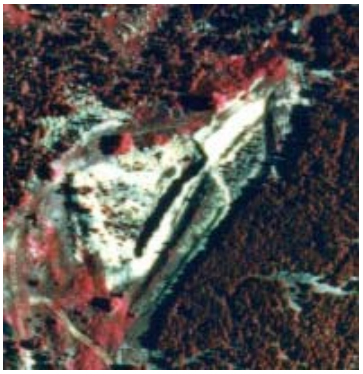


C) Croplands and Pastures



D) Other Agricultural Lands

E) Open Water



F) Strip Mines, Quarries, and Gravel Pits

Table 5. Total area (meters^2 / 4046.9acres/m^2 / 2.471 acres/hectare) and number of polygons per mapping unit. The map codes are described in Appendix 10.

Map Unit	WICA		Environs		Total	
	Hectares	Polygon	Hectares	Polygon	Hectares	Polygon
1	530.9	44	330.1	29	861.0	73
2	11.6	36	18.2	40	29.8	76
3	27.7	75	40.9	70	68.6	145
4	4.1	25	90.5	289	94.6	314
5	0	0	70.8	58	70.8	58
6	65.1	182	204.5	352	269.6	534
7	4.0	78	0.3	4	4.3	82
11	40.4	64	116.3	86	156.7	150
12	4.4	13	81.4	36	85.8	49
13	152.3	261	372.1	109	524.4	370
14	10.2	84	44.2	244	54.4	328
15	1896.8	1767	2363.1	2733	4259.9	4500
16	4328.7	1010	6417.9	1771	10,746.6	2781
17	2.7	15	37.1	56	39.8	71
18	89.3	11	197.0	46	286.3	57
30	153.0	121	425.5	146	578.5	267
31	41.4	50	146.4	125	187.8	175
32	130.2	71	3205	20	162.7	91
33	198.3	287	502.9	485	701.2	772
34	0	0	7.9	35	7.9	35
35	328.1	785	429.9	1287	758.0	2072
36	0.1	2	0	0	0.1	2
40	1.3	26	51.4	164	52.7	190
41	31.3	120	118.4	285	149.7	405
42	0.3	4	14.2	13	14.5	17
43	0	0	11.6	24	11.6	24
44	2.4	5	42.0	134	44.4	139
45	322.1	111	2392.1	299	2714.2	410
46	1110.2	552	3114.1	1100	4224.3	1652
47	262.2	224	738.6	469	1000.8	693
48	1404.4	615	3106.2	1173	4507.0	1788
49	162.0	171	833.3	373	995.3	544
51	54.3	18	199.7	29	254.0	47
52	15.2	38	62.0	54	77.2	92
53	5.4	2	1739.0	227	1744.4	229
55	0	0	112.1	92	112.1	92
57	1.4	6	26.7	90	28.1	96
59	0	0	41.4	38	41.4	38
Total	11,391.8	6873	24,528.7	12,585	35,920.5	19,458

Accuracy Assessment

The percentage of the Park that an individual map unit covered was reflected in the number of AA collected for that unit. For example, the western wheatgrass – Kentucky bluegrass (map class 16) had a final area of 4278.7 hectares within the Park and 64 AA points, whereas the ponderosa pine limestone cliff sparse vegetation (map code 2) had only 11.4 hectares and one AA point. Nine of the map units were not assessed due to a variety of reasons relating to their small size, accessibility, or lack of abundance. These include the following:

1. Black Hills Rock Outcrop Sparse Vegetation. This unit only occurs within WICA below the ½ hectare minimum mapping unit.

2. Shale Barren Slopes Sparse Vegetation. This unit only occurs on inaccessible private land in the eastern environs.

3. Introduced Weedy Graminoid Herbaceous Vegetation. Only one relatively inaccessible large site occurs within the project area. An observation point already represented this area.

4. Mountain Mahogany / Sideoats Grama Dense Shrubland. On the ground, dense stands of mountain mahogany could not be identified from sparse stands by the researchers. Density is easier to determine from the aerial photographs. For the purposes of AA, this unit was combined with the mountain mahogany / sideoats grama shrubland mapping class.

5. Beaked Willow Shrubland. This unit does not occur in WICA and was already represented by a sample plot.

6. Plains Cottonwood / Western Snowberry Forest. This unit occurs as small stands below the minimum mapping unit and mainly outside of WICA.

7. Bur Oak Stand. Only one very small stand occurs within WICA and it was not considered large enough to be a separate vegetation association. An observation point already represented this area.

8. Green Ash – American Elm / Western Snowberry Forest. This mapping unit is usually below the minimum mapping unit or intermingled with the boxelder / chokecherry forest mapping unit. The majority of this type was observed on private land outside of WICA.

9. Birch – Aspen Stand. This unit occurs as very small stands below the minimum mapping unit and is not considered large enough to be considered a vegetation association.

The majority of the remaining 23 map units ranged in accuracy from 100% to around 50% correct (both omission and commission error), yielding an overall total accuracy across all classes of 73.0% and a Kappa index of 69.8% (Table 6).

photo by H. Marriott

Figure 27. Bison grazing on western wheatgrass and green needlegrass at WICA.

Table 6. Contingency table for the WICA vegetation mapping accuracy assessment.

																	Reference Data (Accuracy Assessment Class)																Total	Comission	90% Confidence	
	Map Unit	1	2	3	4	5	6	7	11	12	13	14	15	16	17	18	30-	32	33	34	45	36	40	41	42	43	44	45	46	47	48	49	N	Error	Interval	
	Code																31																	% Correct	-	+
	1	6																															6	100	65.5	100
	2		1																														1	100	10.0	100
	3			1																													1	100	10.0	100
	4																																0	NA	-	-
	5																																0	NA	-	-
S	6			1			1						6																				8	12.5	1.3	41.8
A	7							1																									1	100	10.0	100
m	11								1	2	2																						5	20.0	2.1	62.1
p	12																																0	NA	-	-
L	13								1		8																						10	80.0	50.0	94.5
E	14											1																					1	100	10.0	100
	15												24	10		2			1														37	65.0	49.9	80.1
D	16												4	45							1												51	88.0	78.1	94.8
A	17																																0	NA	-	-
t	18													1		2																	3	66.7	19.6	96.5
A	30-31																7												1				8	87.5	58.2	98.7
	32												1	3				10															14	71.4	42.2	86.9
(M	33													2			3		10		1												16	62.5	38.1	81.1
A	34																																0	NA	-	-
p	35													2					2		11												15	73.3	50.0	87.8
	36																					1											1	100	10.0	100
C	40																																0	NA	-	-
L	41																		1					3									4	75.0	32.0	97.4
A	42																																0	NA	-	-
S	43																																0	NA	-	-
s)	44																																0	NA	-	-
	45																											5					5	100	62.1	100
	46												1				1												13		6	1	22	59.1	39.3	76.4
	47													1			1													8	9	1	20	40.0	22.1	63.3
	48										1		1																3	1	48	1	55	87.3	77.4	93.9
	49																													1		4	5	80.0	37.9	97.9
	Total N	6	1	2	0	0	1	1	2	2	11	1	37	64	0	4	12	10	14	0	13	1	0	3	0	0	0	5	17	10	65	7	289			
Omission Error																																				
% Correct		100	100	50	NA	NA	100	100	50	0.0	72.7	100	64.9	70.3	NA	50	58.3	100	71.4	NA	84.6	100	NA	100	NA	NA	NA	100	76.5	80	73.8	57.1				
90% Confidence Interval																																				
-		65.5	10	5.1	-	-	10	10	5.1	0	42.3	10	49.8	59.6	-	14.3	29.4	77.8	42.2	-	62.1	10	-	46.4	-	-	-	62.1	56.8	50	63.6	27.9				
+		100	100	94.9	-	-	100	100	94.9	68.4	89.5	100	80	81	-	85.7	81.6	100	86.9	-	95.8	100	-	100	-	-	-	100	89.3	94.5	84	83				
OVERALL TOTAL ACCURACY = 73.0%																																				
OVERALL KAPPA INDEX = 69.8%																																				
OVERALL TOTAL ACCURACY 90% LOWER AND UPPER CONFIDENCE INTERVAL =																	+	77.6	%	-	68.4	%													
(Omission and Commision errors were calculated using total accuracy)																	(Map Units 30 and 31 were combined for the A.A. since shrub density was not recorded on the reference data.)																	

DISCUSSION

Wind Cave National Park lies on an interface between the Northern Great Plains grasslands and the Black Hills ponderosa pine forests. The geology and topography of this region creates an ever-changing landscape mosaic of plant associations. This presents challenging vegetation classification, photographic interpretation, and digital transfer needs that were met and addressed in the USGS-NPS National Park vegetation mapping effort. Final accuracy for the vegetation map reflects the time and effort required to understand and appreciate the complex nature of WICA's vegetation.

Vegetation Classification and Characterization

Most of the vegetation found in the Wind Cave study area was classified using existing community types for the Black Hills. In a few cases, new types were created. All of the newly described types occur outside the study area as well, but were not described prior to this project.

Not all ponderosa pine stands found in the project area were easily classified, but the challenges encountered were not unexpected. Many workers have described ponderosa pine forests and woodlands of the Black Hills as being difficult to classify into discreet species assemblages. Types found in more extreme habitats (e.g. most mesic or most xeric) tend to be more consistent in terms of species composition and habitat characteristics. This situation also was found in the Wind Cave study area. Ponderosa pine / chokecherry forest was perhaps the most consistent pine type in terms of habitat characteristics (mesic), although the composition of the shrub stratum was quite variable in some areas. Ponderosa pine / little bluestem woodland is the most consistent pine type in terms of composition, and is usually found on the most xeric pine sites.

Vegetation Map Production

The USGS-NPS vegetation mapping projects are designed to produce both a vegetation classification and a set of map units. Typically the systems are very similar, but sometimes there is not a strict one-to-one correspondence between the two. Photographic interpretation centers around the ability to accurately and consistently delineate map units based on complex signatures. Vegetation characteristics that can be seen on aerial photography are not necessarily

the same as those apparent on the ground and vice versa. Effective field work and map verification work aided enormously in developing the map units and discerning the inherit variability of each photographic signature.

The final mapping scheme for WICA contains 5 basic elements:

a) NVCS associations represented by an unique photo-signature, e.g. western snowberry shrubland,

b) multiple NVCS associations that together are represented by unique signature, e.g. western wheatgrass - Kentucky bluegrass herbaceous complex,

c) stands of vegetation that were not addressed by the NVCS but are seen as management concerns for WICA and could be recognized on the aerial photography, e.g . birch-aspen stands and young ponderosa pine (doghair) stands,

d) wildlife associated units that were also identified as management concerns, e.g. Bison wallows,

e) geologic formations and land-use classes that were not addressed by the NVCS.

Crown density of ponderosa pine and mountain mahogany is also an important factor in the development of map units. For example, two distinct density classes of mountain mahogany shrubland were recognized on the aerial photography relating to north vs. south-facing slopes. However, researchers could see no clear distinction on the ground, especially with regards to species composition. WICA personnel determined that this was important information from a management standpoint, therefore two mountain mahogany map units were interpreted and mapped. The opposite situation was encountered in ponderosa pine stands. Community types distinguishable on the ground (based on species composition and understory structure) could not be recognized on aerial photos due to canopy cover. As a result, the three NVCS classes found in these situations were merged into a ponderosa pine complex. Again to provide additional information for the Park, this class was divided based on density as observed on the aerial photography.

The sheer amount and variability of grassland signatures made them difficult to distinguish and consistently interpret. Environmental factors such as grazing pressure (especially in the environs), moisture gradients, presence and density of forbs/shrubs, and soil diversity result in

several photographic signatures for each grassland unit. It was apparent early in this study, that Kentucky bluegrass could not be effectively separated from western wheatgrass. This is largely because both species are cool season, sod-forming grasses that occur in the same topographic positions. Therefore a western wheatgrass - Kentucky bluegrass complex mapping unit was created. Another grassland type that presented similar challenges is the needle-and-thread - blue grama / threadleaf sedge herbaceous vegetation association. This type is confined to a few dry plateaus and ridges within WICA and on some grazed areas in the environs. Here the photo signature is very similar to that of the little bluestem - grama grass / threadleaf sedge herbaceous vegetation type. Rather than combining the two, this type was primarily interpreted from the aerial photography using field notes and sample sites of known locations. Finally, some of the grassland slopes at WICA support large stands of leadplant. This shrub type is not considered widespread or typical of the region and is not listed in the NVCS. However at the urging of Park personnel, an attempt was made to interpret and map the leadplant type based on location and slope even though photographic signature were vague.

Prior vegetation mapping projects at other NPS sites in the Black Hills have shown that interpreting ponderosa pine types can be very difficult. Canopy closure, shadows, past forest fires, and logging/thinning can all cause situations where unique photographic signatures are either indistinguishable or extremely disordered. This uncertainty was addressed at WICA by using a stepwise photo interpretive process that sorted the pine types by canopy closure, understory signature, topographic positions, and slope/aspect. Initially, it was determined that the understory below ponderosa pine stands with greater than 80% canopy closure could not be distinguished. Instead, tree height was used to separate dense young (< 20 year old) ponderosa pine dog-hair stands from more mature (> 20 year old) thick stands. The second step was to match the undertone colors present on the aerial photography with NVCS classes. Field reconnaissance was used to match the red-pink understory colors with various graminoids (western wheatgrass, Kentucky bluegrass, oatgrasses, sun sedge, etc...), bright red to shrubs (mainly chokecherry), and pale white-blue to little bluestem (on the color infrared aerial photography). Finally, slope and aspect was used to predict understories of chokecherry along gentle to slightly steep north-facing slopes, and along forested drainageways.

Using the above interpretative processes and methods ordered the map units well, but still resulted in some photo interpretation discrepancies. Various factors dealing with the physiognomy of the vegetation caused some confusion in interpreting photographic signatures. For example, both the chokecherry and the ponderosa pine / chokecherry map units were assessed at relatively low accuracy. Tall forbs and poison ivy are both relatively common at WICA and are similar in height and morphology (e.g. broad leaf) to chokecherry. These characteristics caused areas dominated by either one to appear as chokecherry on the color infrared photography. Further, the timing of the accuracy assessment collection (Sept-Nov. 1998) may have resulted in these deciduous species being relatively inconspicuous and/or absent from the data collection.

Seasonal changes from the time of the aerial photography (June 1997) to the collection of accuracy assessment data (September-November 1998) also results in a change in dominance (with respect to foliar cover) from cool season to warm season grasses. For example, little bluestem is a warm season bunch grass that is somewhat innocuous in the spring but gradually changes to very prominent clumps of reddish - brown stems in the fall. The aerial photography records spring phenology where western wheatgrass and Kentucky bluegrass are the dominant actively growing plants, which would also be readily observable on the ground. Floristic composition changes in the fall, as areas with little bluestem become more pronounced. The distinctness of little bluestem at this time may cause an observer to classify it out of proportion to its actual dominance; especially if the litter layer is not examined for Kentucky bluegrass or western wheatgrass. Further review of WICA's seasonal plant phenology may be needed to ensure consistent sampling and classification at different times within the growing season.

Digital transfer and registration of information from aerial photographs to a spatial database proved to be a challenging task for WICA. This was largely due to the complex and intricate line work needed to delineate each photograph. To guarantee transfer of all the line work, scanning and multiple transformation processes using landmarks as controls were used for each aerial photograph overlay. Other transfer processes such as on-screen or zoom transfer received discussion and/or experimentation. However, these were either considered too time consuming or insufficient for the needs of this project. Scanning and multiple geographic transformations

efficiently produced digital polygons across the entire project area. Further editing and quality checking of the digital polygons created borders that tightly bounded corresponding features on the digital ortho-photo quarter quad (DOQQ) base map.

Ten map units were assessed at or near the 80% accuracy standard. These included the following (map codes): 1, 2, 7, 14, 32, 35, 36, 41, 45, 48 (Table 4). For the most part, these units correspond to associations or complexes that were either easily recognized on the aerial photography or occurred on predictable landscape locations. Eight map units were not assessed for accuracy due to their relative small size and inaccessibility. These classes covered only 10 hectares in WICA and represented less than 0.1% of WICA's total acreage. Map units that were lower in accuracy tended to be those not extensively sampled due to their rarity or were those that tended to intermingle along a broad ecotone. The assessment of accuracy for this project involved the basic comparison of vegetation polygons overlain with datapoints. GPS error (around 5 meters on average), DOQQ base-map error (approximately 10 meters), and data recording inconsistencies between different researchers were not factored into the assessment. Similarly 28 accuracy points considered to be in error with the map data had the correct map unit listed as occurring within a 50-meter radius. Further investigation using these factors could yield additional map accuracy increasing it to approximately 88%.

Some map units, although below the 80% accuracy, should be accepted as representative of their inherent variability. These include the ponderosa pine / little bluestem woodland (59.1% correct commission 76.5% correct omission, respectively) ponderosa pine chokecherry forest (40.0%, 80.0%), and little bluestem - grama grass / threadleaf sedge herbaceous vegetation (65.0%, 64.9%). These types often occur intermingled with other types forming large heterogeneous areas. To combine these with other classes would result in a reduction of map detail and a loss of potentially useful data.

Other map units with low accuracy lend themselves to be merged into larger, more accurate classes without a significant loss of information. These include 1) white sedimentary rock outcrop (map code 6), which could be combined with redbeds sparse vegetation (map code 3) in the confines of the Red Valley geographic formation where it occurs as a true rock outcrop.

Outside of the Red Valley, field research determined the vegetation on these sites to be sufficiently dense and consistent with little bluestem -grama grass / threadleaf sedge herbaceous vegetation. 2) The burned ponderosa pine / sparse vegetation class (map code 11) could readily be merged with the burned ponderosa pine / mixed shrubland (map code 12) yielding a new burned ponderosa pine / shrub-forb map unit at 100% accuracy. This would make sense from an ecological perspective since both were considered early seral associations by the researchers. 3) Needle-and-thread - blue grama / threadleaf sedge herbaceous vegetation map unit lends itself to be merged with either western wheatgrass - Kentucky bluegrass complex or little bluestem - grama grass / threadleaf sedge mapping unit depending on a thorough review of the floristic data. All three of these suggestions could be made using relatively straightforward GIS and database procedures and by themselves would increase initial overall total map accuracy to approximately 78%.

Recommendations for Future Projects

Several recommendations for future mapping projects have come out of the experience gained at WICA. It is strongly recommended that future mapping projects begin fieldwork with a reconnaissance step involving observation point data collection from a large number of points. This type of sampling is conducted relatively fast, and allows investigators to become familiar with plant communities and their variability in the study area. Following this step, representative stands within gradsects can be selected for more detailed vegetation plots. Data collected for observation points also supplements vegetation plot data in preparing community descriptions and provides an interim assessment of accuracy useful for photo-interpretation.

Developing two compatible classification systems (plant communities and map units) has proven to be challenging, not just at Wind Cave, but at other Parks in the Black Hills as well. It is important for users of the map that the two classifications be as similar as possible. At the beginning of future projects, more emphasis should be placed on developing a protocol for communication between photo-interpreters and field ecologists. A preliminary vegetation classification and an initial photo-signature classification with delineated polygons (at least for part of the study area) should be available early so that compatibility problems can be addressed.

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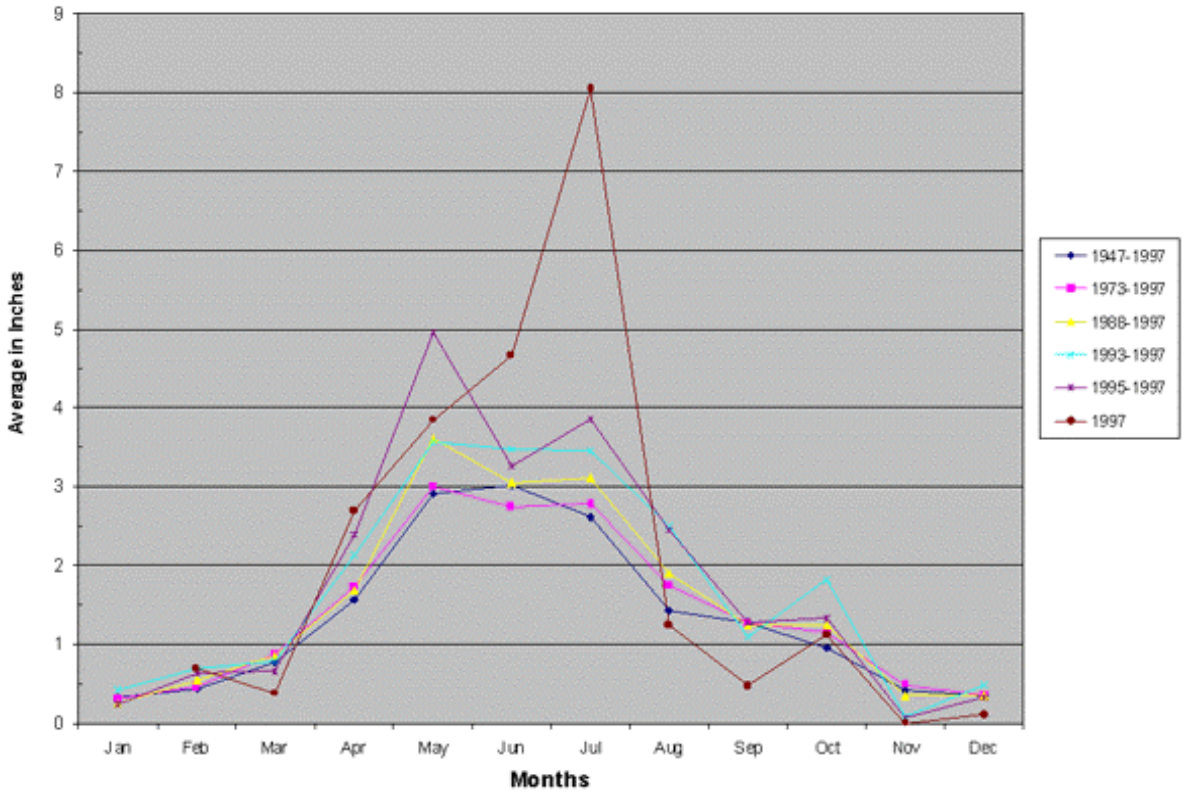
Appendix 1.

Average Monthly Precipitation Values for Hot Springs, SD.
Comparisons of 1997 values with the last 3, 5, 10, 15, and 50 year averages.

(Summarized from National Weather Service (NWS) and monthly precipitation data.)
(website: http://www.ncdc.noaa.gov/ol/climate/online/coop-precip.html).



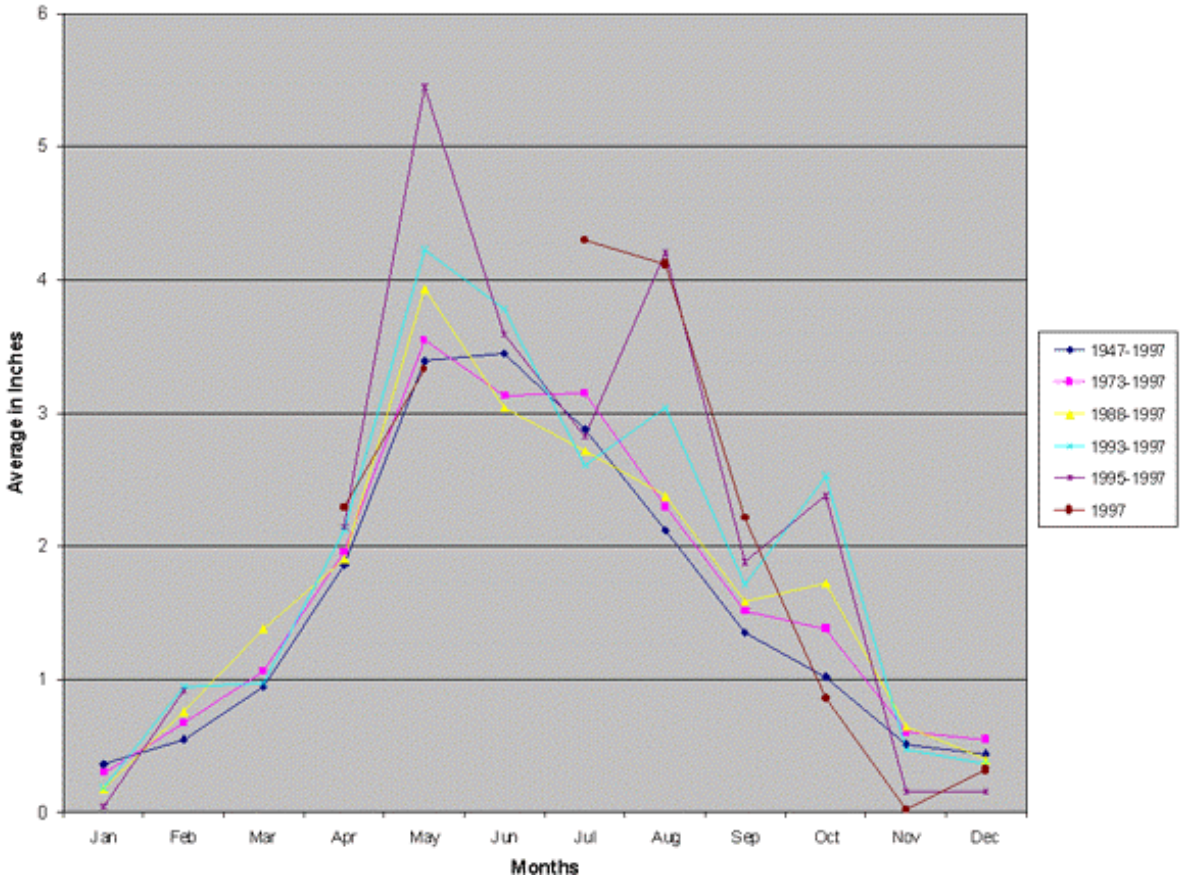
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1947-1997	0.33	0.44	0.77	1.56	2.91	3.02	2.61	1.43	1.28	0.95	0.41	0.34
1973-1997	0.32	0.46	0.88	1.74	3.01	2.75	2.79	1.75	1.27	1.16	0.49	0.36
1988-1997	0.26	0.55	0.87	1.69	3.62	3.05	3.12	1.91	1.25	1.25	0.35	0.36
1993-1997	0.43	0.69	0.79	2.14	3.57	3.48	3.46	2.50	1.10	1.82	0.09	0.49
1995-1997	0.24	0.64	0.66	2.39	4.96	3.26	3.86	2.45	1.28	1.33	0.07	0.33
1997	-	0.70	0.38	2.70	3.85	4.67	8.05	1.25	0.48	1.12	0	0.11

"- " indicates no average recorded for that month

Appendix 2.

Average Monthly Precipitation Values for Custer, SD.
Comparisons of 1997 values with the last 3, 5, 10, 15, and 50 year averages.

(Summarized from National Weather Service (NWS) and monthly precipitation data.)
(website: http://www.ncdc.noaa.gov/ol/climate/online/coop-precip.html).



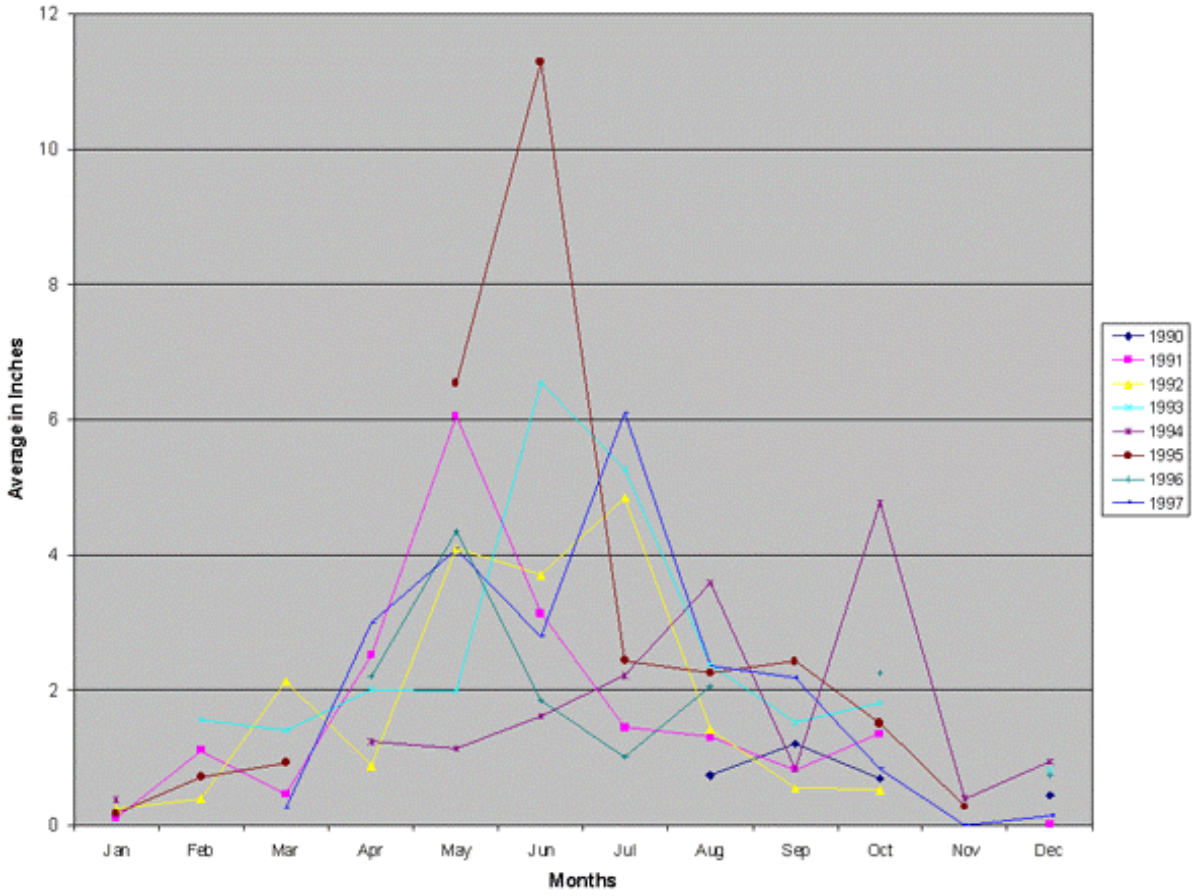
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1947-1997	0.36	0.55	0.95	1.86	3.39	3.45	2.88	2.12	1.35	1.02	0.51	0.44
1973-1997	0.30	0.67	1.06	1.95	3.55	3.13	3.15	2.30	1.51	1.38	0.61	0.55
1988-1997	0.17	0.76	1.38	1.90	3.93	3.04	2.72	2.38	1.58	1.72	0.64	0.40
1993-1997	0.19	0.95	0.97	2.12	4.23	3.78	2.61	3.04	1.71	2.53	0.48	0.37
1995-1997	0.04	0.92	-	2.15	5.45	3.59	2.83	4.21	1.88	2.38	0.16	0.16
1997	-	-	-	2.29	3.33	-	4.30	4.11	2.21	0.86	0.02	0.32

"- " indicates no average recorded for that month

Appendix 3.

Average Monthly Precipitation Values Collected at Wind Cave National Park. Comparisons of 1997 values with '96, '95, '94, '93, '92, '91, and '90 values.

(Summarized from National Weather Service (NWS) and monthly precipitation data.)
(website: http://www.ncdc.noaa.gov/ol/climate/online/coop-precip.html).



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1990	-	-	-	-	-	-	-	0.74	1.21	0.69	-	0.44
1991	0.12	1.11	0.46	2.52	6.05	3.13	1.45	1.30	0.82	1.36	-	0.01
1992	0.24	0.40	2.13	0.88	4.10	3.70	4.85	1.42	0.55	0.52	-	-
1993	-	1.56	1.41	2.01	1.99	6.55	5.27	2.39	1.52	1.82	-	0.82
1994	0.38	-	-	1.24	1.13	1.61	2.21	3.59	0.84	4.76	0.40	0.94
1995	0.17	0.71	0.92	-	6.54	11.3	2.44	2.25	2.42	1.51	0.29	-
1996	-	-	-	2.20	4.34	1.85	1.01	2.06	-	2.25	-	0.74
1997	-	-	0.26	3.00	4.09	2.79	6.10	2.35	2.18	0.84	0	0.14

"- " indicates no average recorded for that month

Appendix 4.

Major Soil Map Units and Descriptions for Wind Cave National Park.

(Summarized from: Soil Survey of Custer and Pennington Counties, Black Hills Parts, South Dakota (Ensz 1990); Soil Survey of Custer and Pennington Counties, Prairie Parts, South Dakota (Nielsen 1996)).

Code	Soil Name	Soil Description	Rock	Vegetation	Physiographic Features
BeB	Barnum-Winetti	complex, 0-6%		native grasses, thin stands of *Pipo*	RV and LP (low areas)
BdA	Barnum	very fine sandy loam, 0-3%		native grasses	RV (terraces and floodplains)
BrA	Bullfat	silt loam, 0-3%		native grasses	LP
BrB	Bullfat	silt loam, 3-6%		native grasses	LP
BsB	Bullfat-Cordeston	silt loams, 2-9%		native grasses and limited trees	CCA (meadows) and LP
BtE	Buska-Mocmount-Rock outcrop	complex, 10-40%	gr granite, schist	*Pipo* (70 s.i.)	CCA
BuE	Buska-Rock outcrop	complex, 10-40%	schist, granite	*Pipo* (70 s.i.) *Scsc*, *Rhtr*	CCA (Mt. sideslopes)
BvC	Buska-Virkula	loams, 2-15%		*Pipo* (70, 72 s.i.) native grasses	CCA (smooth slopes, ridges)
BwE	Butche-Rock Outcrop	complex, 9-60%	Sstone	*Pipo* (34 s.i.)	D. Hogback (Mts.)
CcE	Canyon-Bridget	complex 9-25%		native grasses	D. Hogback (uplands)
CdF	Canyon-Rock outcrop	complex 15-60%	gr-br L-Sstone shale	native grasses	D. Hogback (uplands)
CxC	Cordeston-Winetti	complex, 2-9%		native grasses clusters of trees	LP (low areas)
CvB	Cordeston	loam, 2-10%		native grasses (hardwoods)	CCA (floodplains Mt. meadows)
CwB	Cordeston-Marshbrook	loams, 0-6%		native grasses (wetlands)	CCA (floodplains Mt. meadows)
GuC	Gurney-Butche	complex, 2-9%		native grasses	D. Hogback (Mt. prairies)
GvD	Gypnevee-Rekop-Rock outcrop	complex, 6-15%	red-white alabaster	native grasses with sparse *Pipo*	RV (uplands)
HeE	Heely	channery loam, 9-30%		native grasses	CCA (Mt. prairies)
HfC	Heely-Cordeston	complex, 6-15%		native grasses	CCA (Mt prairies upland swale)
HgB	Hilger	cobbly loam, 0-6%		native grasses,encroached by *Pipo*	RV (high terraces) and LP
HgD	Hilger	cobbly loam, 6-40%		native grasses,encroached by *Pipo*	RV (high terraces) and LP
HmE	Hilger-Metre	complex, 10-40%		native grasses and scattered *Pipo*	RV (uplands)
HtG	Hopdraw-Sawdust-Rock Outcrop	complex, 40-80%	br L-Sstone ledges	*Pipo* (30, 45 s.i.), tall shrubs, *Jusc*	LP (southern part)
MhA	Marshbrook	loam, 0-3%		native grasses (wetlands)	CCA (floodplains in Mt. valleys)
MnC	Metre-Norrest	complex, 2-9%		native grasses	RV (upland meadows)
MtE	Mocmont-Rock outcrop	complex, 10-40%	gr granite (domes)	*Pipo* (65 s.i.)	CCA (Mt. slopes)
NaC	Navee	channery loam, 6-15%		native grasses	RV (terraces and alvl. fan
NcE	Navee-Gullied land	complex, 6-40%		native grasses	RV (low terraces, swales)

NfE	Nihill-Zigweid	complex, 15-50%		native grasses and limited *Pipo*	RV (upland ridges), LP (low)
NnE	Norrest-Fairburn-Metre	complex, 9-40%		native grasses and limited *Pipo*	RV (uplands)
PaE	Pactola-Virkula-Rock outcrop	complex, 10-40%	gray metamorphic	*Pipo* (60, 72 s.i.) and other trees	CCA (Mt. slopes)
PbD	Paunsaugunt-Gurney	complex, 2-15%		native grasses and *Rhtr-Cemo*	LP (low Mt. prairies)
PcD	Paunsaugunt- Rock outcrop	complex, 6-30%	br-pink Lstone.	*Pipo* (45 s.i.)	LP (low elevation mts.)
RhD	Rock outcrop - Butche	complex, 2-25%	Sstone	*Pipo* (35 s.i.)	D. Hogback, LP (low)
RfE	Rekop-Gypnevee-Rock outcrop	complex, 15-40%	pink-white gypsum	native grasses and sparse *Pipo*	RV (uplands)
RiG	Rock outcrop - Pactola	complex, 40-80	gr metamorphic	*Pipo* (55 s.i.)	CCA (Mt. slopes)
RkG	Rock outcrop-Mocomont	complex, 40-80%	gr granite	*Pipo* (60 s.i.)	CCA (peaks and canyons)
RmG	Rock outcrop-Rekop	complex, 40-80%	pink-white gypsum	native grasses	RV (uplands)
RnG	Rock outcrop - Sawdust	complex, 40-80%	br Lstone red Sstone	*Pipo* (45 s.i.)	LP (mts and canyons)
RsF	Rockoa - Rock outcrop	complex 25-60%	Sstone (shale)	*Pipo* (55 s.i.)	D. Hogback (Mts.)
ShD	Satanta-Canyon	loams, 6-15%		native grasses	D. Hogback (side slopes, fans)
SpE	Sawdust-Hopdraw-Paunsaugunt	complex, 10-40%		*Pipo* (50, 35, 45 s.i.)	LP (southern part)
SrE	Sawdust-Vanocker-Paunsaugunt	complex, 10-40%		*Pipo* (50, 62, 45 s.i.)	LP (low areas)
SwE	Shirttail	channery loam, 10-40%		native grasses and thin *Pipo*	CCA (Mt. slopes)
SxaE	Spearfish-Nevee	silt loam 9-30%,		native grasses	RV
SxbF	Spearfish-Rock outcrop	complex, 25-60%	red siltstone	native grasses and scattered *Pipo*	RV
TfB	Tilford	silt loam, 2-6%		native grasses	RV (terraces and uplands)
TfC	Tilford	silt loam, 6-15%		native grasses	RV (upland slopes)
TpC	Tilford-Paunsaugunt	complex, 6-9%		native grasses and some *Pipo*	RV uplands adjacent to LP
VcE	Vanocker-Citadel	complex, 10-40%		*Pipo* (62, 70 s.i.)	LP (low elevation Mts.)
VkE	Vanocker-Lakoa	complex, 10-40%		*Pipo* (62, 70 s.i.)	LP (low elevation Mts.)
VoG	Vanocker-Sawdust-Rock outcrop	complex, 40-80%	br Lstone y Sstone	*Pipo* (58, 45 s.i.)	LP (Mts. & canyon slopes)
WtB	Winetti	cobbly loam, 2-10%		native grasses and thin *Pipo*	RV (floodplains), LP (low)
ZnD	Zigweid-Nihill	complex, 6-15%		native grasses and sparse *Pipo*	RV and LP (old terraces)

RV = Red Valley, LP = Limestone Plateau, CCA = Central Crystalline Area, D. Hogback = Dakota Hogback

Lstone = Limestone, Sstone = Sandstone, s.i. = site index, Mt. = mountain, br = brown, y = yellow, gr = gray

Pipo = Pinus ponderosa, Rhtr = Rhus trilobata, Cemo = Cercocarpus montanus, Scsc = Schizachyrium scoparium, Jusc = Juniperus scopulorum

Appendix 5.

National Park Vegetation Mapping Program: Observation Point Form

IDENTIFIERS/LOCATORS

Plot Code_____ Polygon Code_____

Provisional Community Name_____

State _____ Park Name_____ Park Site Name_____

Quad Name_____ Quad Code_____

GPS file name_____ Field UTM X___ ___ ___ ___ ___ ___ mE Field UTM Y___ ___ ___ ___ ___ ___ mN

Please do not complete the following information when in the field.
Corrected UTM X___ ___ ___ ___ ___ ___ mE Corrected UTM Y___ ___ ___ ___ ___ ___ ___mN UTM Zone_____

Survey Date_____ Surveyors_____

ENVIRONMENTAL DESCRIPTION

Elevation _____ Slope_____ Aspect_____

Topographic Position_____

Landform_____

Cowardian System	Hydrologic Regime			
	Tidal	Non-Tidal		Salinity/Halinity Modifiers
____Upland	____Irregularly Exposed	____Permanently Flooded	____Saturated	____Saltwaters
____Riverine	____Regularly Flooded	____Semipermanetly Flooded	____Seasonally Flooded/Saturated	____Brackish
____Palustrine	____Irregularly Flooded	____Seasonally / Temporarily Flooded	____Intermittenly Flooded	____Freshwater
____Lacustrine	____Unknown			

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

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface		Height Scale for Strata	
Trees and Shrubs	____Broad-leaved	____Forest	01	0 - 10%	01	< 0.5 m
____Evergreen	____Needle-leaved	____Woodland	02	10 - 25%	02	0.5 -1 m
____Cold-deciduous	____Microphyllous	____Shrubland	03	25 - 60%	03	1-2 m
____Drought-deciduous	____Graminoid	____Dwarf Shrubland	04	60 - 100%	04	2-5 m
____Mixed evergreen - cold-deciduous	____Forb	____Herbaceous			05	5-10 m
	____Pteridophyte	____Nonvascular			06	10-15 m
____Mixed evergreen - drought-deciduous		____Sparsely Vegetated			07	15-20 m
					08	20-35 m
					09	35-50 m
Herbs					10	> 50 m
____Annual						
____Perennial						

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

Please see the table on the previous page for height and cover scales

Other Comments

Appendix 6.

National Park Vegetation Mapping Program: Plot Survey Form

IDENTIFIERS/LOCATORS

Plot Code_____ Polygon Code_____

Provisional Community Name_____

State _____ Park Name_____ Park Site Name_____

Quad Name_____ Quad Code_____

GPS file name_____ Field UTM X___ ___ ___ ___ ___ ___ mE Field UTM Y___ ___ ___ ___ ___ ___ mN

Please do not complete the following information when in the field.
Corrected UTM X___ ___ ___ ___ ___ ___ mE Corrected UTM Y___ ___ ___ ___ ___ ___ ___mN UTM Zone_____

Survey Date_____ Surveyors_____

Directions to Plot

Plot length_____ Plot width_____ Plot photos (y/n)___ Roll Number____ Frame Number_____ Plot Permanent (y/n)___

Plot Representativeness

ENVIRONMENTAL DESCRIPTION

Elevation _____ Slope_____ Aspect_____

Topographic Position_____

Landform_____

Surficial Geology

Cowardian System	Hydrologic Regime			
	Tidal	Non-Tidal		Salinity/Halinity Modifiers
____Upland	____Irregularly Exposed	____Permanently Flooded	____Saturated	____Saltwaters
____Riverine	____Regularly Flooded	____Semipermanetly Flooded	____Seasonally Flooded/Saturated	____Brackish
____Palustrine	____Irregularly Flooded	____Seasonally / Temporarily Flooded	____Intermittenly Flooded	____Freshwater
____Lacustrine	____Unknown			

Environmental Comments:	Soil Taxon/Description
	Unvegetated Surface: *(please use the cover scale below)* ____% Bedrock ____% Litter, duff ____% Wood (> 1 cm) ____% Large rocks (cobbles, boulders > 10 cm) ____% Small rocks (gravel, 0.2-10 cm) ____% Sand (0.1-2 mm) ____% Other:_____
Soil Texture ____sand ____sandy loam ____loam ____silt loam ____clay loam ____clay ____peat ____muck	Soil Drainage ____Rapidly drained ____Well drained ____Moderately drained ____Somewhat poorly drained ____Poorly drained ____Very poorly drained

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface		Height Scale for Strata	
Trees and Shrubs	____Broad-leaved	____Forest	01	0 - 10%	01	< 0.5 m
____Evergreen	____Needle-leaved	____Woodland	02	10 - 25%	02	0.5 -1 m
____Cold-deciduous	____Microphyllous	____Shrubland	03	25 - 60%	03	1-2 m
____Drought-deciduous	____Graminoid	____Dwarf Shrubland	04	60 - 100%	04	2-5 m
____Mixed evergreen - cold-deciduous	____Forb	____Herbaceous			05	5-10 m
	____Pteridophyte	____Nonvascular			06	10-15 m
____Mixed evergreen - drought-deciduous		____Sparsely Vegetated			07	15-20 m
					08	20-35 m
					09	35-50 m
Herbs					10	> 50 m
____Annual						
____Perennial						

Strata	Height	% Cover	Dominant species (if known)
T1 Emergent	_____	_____	_____
T2 Canopy	_____	_____	_____
T3 Sub-canopy	_____	_____	_____
S1 Tall Shrub	_____	_____	_____
S2 Short Shrub	_____	_____	_____
H Herbaceous	_____	_____	_____
N Non-vascular	_____	_____	_____
V Vine/liana	_____	_____	_____
E Epiphyte	_____	_____	_____

Please see the table on the previous page for height and cover scales

_____
Animal Evidence

_____
Natural and Anthropogenic Disturbance Comments

_____
Other Comments

Species/percent cover: Starting with the uppermost stratum, list all species with % cover for each species in the stratum. For forests and woodlands, on a separate line below each tree species, list the DBH of all trees above 10 cm diameter. Separate measurements with a comma. Put an asterick next to any species that are known diagnostics for a particular community in the classification. Also list speicies outside the plot.

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

Appendix 7.

National Park Vegetation Mapping Program: Accuracy Assessment Form and Instructions

ACCURACY ASSESSMENT FIELD FORM
USGS-NPS VEGETATION MAPPING PROGRAM

1. Plot Number_____ 2. Park Code_____ 3. Date_____

4. Observer(s)_____ 5. Datum_____ 6. Accuracy_____

7. UTM Coordinates: Easting__ __ __, __ __ __ Nothing__, __ __ __, __ __ __

8. UTM Zone_____ 9. Offset from Point: Easting_____m Northing_____m

10. Topographic Description_____

11. Elevation_____m 12. Aspect_____

13. Veg Assoc. at Site_____

14. Veg Assoc. 2 within 50m of Site_____

15. Veg Assoc. 3 within 50m of Site_____

16. Major Species Present (by strata)_____
_____
_____
_____

17. Canpoy Closure of Top Layer_____

18. Rationale for Classification_____
_____
_____
_____
_____

19. Comments_____
_____
_____
_____
_____

Instructions for Accuracy Assessment

The basic document for accuracy assessment is "Accuracy Assessment Procedures", developed by the Program in 1994. The document can be downloaded from the Program web site at http://biology.usgs.gov/npsveg. This accuracy assessment (AA) form is the result of an additional 4 years of field experience. The purpose of this form is to generate concise data to document the accuracy assesment procedure that occurred in the field and to compare it to the mapped data.

All navigation must occur with either a Y-code GPS receiver (e.g. Rockwell PLGR) or in real time differential mode if using other types of receivers. This unit allows the user to navigate to sites within a few meters of their actual locations. The AA sites will be selected using randomly located samples stratified according to the associations. Before beginning each morning, make sure the datum is set to NAD83, and that the projection system is UTM, with the proper zone. A comass is needed to estimate aspect.

The materials you should have before you begin are a 1) plots of the DOQQ's showing the polygon boundaries, but no information on polygon attributes, and the location of the AA sites with numbers, 2) AA site coordinates loaded into your GPS receiver, 3) the field key, and 4) association descriptions.

Once you have navigated to an accuracy assessment site, and the FOM (Figure of Merit) is at 1, if using a PLGR, observe the vegetation within a 50 meters radius of the site. To gauge how far 50 meters is, it is helpful to have the navigator pace 50 meters in one direction. Document what the vegetation community is at the site, and if there are more than one community present within a 50 meter radius, document those as well under Veg Assoc 2 & 3.

Specific Instructions:

1. Plot Number - self explanatory
2. Park Code - the four character code for the park (e.g. Voyageurs is VOYA, Scotts Bluff is SCBL)
3. Date - self explanatory
4. Observor(s) - self explanatory
5. Datum - the reference system for the projection, should be NAD83 (NAR on the PLGR)
6. Accuracy - the distance in meters the GPS receiver displays, if using a PLGR
7. UTM Coordinates - easting and northing in meters
8. UTM Zone - UTM zones in continental US range between 10 (126' W longitude on the Pacific Coast) and 19 (66' W longitude on the Alantic Coast)
9. Offset from Site - if you are unable to navigate directly to a site due to terrain problems (e.g. rivers, canyons), record the distance from the site displayed on your GPS receiver, record 0 if there is no offset
10. Topographic Description - where you are on the terrain; on the top of a hill, in a small valley, midslope on a south facing slope, etc.
11. Elevation - above sea level in meters
12. Aspect - using a compass estimate the aspect of the whole site, record in degrees of azimuth (0-360)
13. Veg Assoc at Site - use the field key determine the association directl on the AA site
14. Veg Assoc 2 within 50 m of Site - if a second vegetation association is found within 50 meters of the site, record that association.
15. Veg Assoc 3 within 50 m of Site - if a third vegetation association is found within 50 meters of the site, record that association
16. Major Species Present (by strata) - record the major and indicator species present
17. Canopy Closure of Top Layer - estimate canopy closure of top stratum, eliminating the contribution from lower strata.
18. Rationale for Classification - record the logical procedure you used to determine the vegetation association based on indicator species, major species, structure, etc.
19. Comments - all relevant information that does not fit into the fields above. Note such things as multiple associations near the site, indications of artificial influences on the vegetation, such as grazing, logging, animal presence or use, influences of elevation, aspect, water tables, etc.

Appendix 8.

Field Key to the NVSC Vegetation Associations at Wind Cave National Park

FIELD KEY TO THE PLANT COMMUNITIES OF WIND CAVE NATIONAL PARK

How to Use the Key---Go through the key on this page to arrive at the appropriate group of plant communities. On the following pages, communities are arranged by groups. Included are brief descriptions with relevant field characteristics for each type. Read through the appropriate group to find the type that matches best. It may be necessary to check other community types listed in the Similar types field.

There will be some stands that do not match any of the descriptions exactly. Many plant communities are variable in composition, and while the descriptions attempt to address variability, there will be exceptions. Stands can represent transition zones between two types. There can be small inclusions of one type in larger stands of another. It is important to survey sufficiently large stands when classifying, and to base decisions on representative areas within stands.

1. Vegetative cover greater than 10%; tree canopy cover usually greater than 20%, sometimes 10-20%
   FORESTS AND WOODLANDS

   1.1. Conifers with greater than 50% of total tree cover
   CONIFER FORESTS AND WOODLANDS

   1.2.1.2 Coniferous forest or woodland; shrub cover typically >20%.
   1.2.1.3 Coniferous forest or woodland; shrub cover typically <20%; understory graminoid-dominated

   1.2. Broadleaf trees with greater than 50% of total tree cover
   BROADLEAF FORESTS AND WOODLANDS

2. Vegetative cover greater than 10%; tree cover less than 10%; shrub cover typically greater than 20%
   SHRUBLANDS

3. Vegetative cover greater than 10%; tree cover less than 10%; shrub cover less than 20%; herbaceous cover usually greater than 20%, sometimes 10-20%
   HERBACEOUS VEGETATION

   3.1. Streamsides, wet meadows, ponds and other wet or seasonally-wet sites
   RIPARIAN/WET MEADOW HERBACEOUS VEGETATION

   3.2. Terrestrial, upland sites; i.e. rarely wet
   UPLAND HERBACEOUS VEGETATION

4. Vegetative cover less than 10%
   SPARSE VEGETATION

FORESTS AND WOODLANDS

1.1. CONIFER FORESTS AND WOODLANDS

1.2.1.2. Coniferous forest or woodland; shrub cover typically greater than 20%.

CEGL000859 *Pinus ponderosa / Juniperus communis* Woodland
PONDEROSA PINE/COMMON JUNIPER WOODLAND

Dominant or indicator species: Ponderosa pine dominates the canopy, and subcanopy if present. Common juniper is the most abundant shrub with cover often 20-50%. Where tree cover is dense, shrub cover is sparse. Herbaceous cover typically is sparse.
Variability: As for most of the pine types in the Black Hills, pine cover is variable but often is greater than 50%; there may not be a clear distinction between canopy and subcanopy. In stands with heavy pine cover, little herbaceous growth is present, and even common juniper may be sparse.
Habitat characteristics: This type occurs on moderate to steep slopes on all aspects except southerly.

CEGL000192 *Pinus ponderosa / Prunus virginiana* Forest
PONDEROSA PINE/CHOKECHERRY FOREST

Dominant or indicator species: Ponderosa pine dominates the canopy, and subcanopy if present. Chokecherry is the dominant shrub, with cover greater than 20%.
Variability: As for most of the pine types in the Black Hills, pine cover is variable, but usually is greater than 50%; there may not be a clear distinction between canopy and subcanopy. The chokecherry component is variable in height and cover. Other shrubs may be present including gooseberry, common juniper and ninebark.
Habitat characteristics: At WICA, this type typically occurs on lowermost slopes, often northerly.
Similar types: Stands with only dead trees standing (post burn) are classified as chokecherry shrubland.

1.2.1.3. Coniferous forest or woodland; shrub cover typically less than 20%; understory graminoid-dominated

CEGL000849 *Pinus ponderosa / Carex* inops ssp. heliophila Woodland
PONDEROSA PINE/SUNSEDGE WOODLAND

Dominant or indicator species: Ponderosa pine dominates the canopy, and subcanopy if present. Shrub cover typically is sparse or absent. The herbaceous stratum is graminoid-dominated, with sunsedge the most abundant species. Poverty oatgrass often is present.
Variability: As for most of the pine types in the Black Hills, pine cover is variable (20-60% or occasionally greater), and there may not be a clear distinction between canopy and subcanopy. Herbaceous cover is variable; with less herbaceous cover in stands with denser canopy cover.

Habitat characteristics: This type has been found on gentle to moderate slopes of all aspects, but is less common on northerly aspects.
Similar types: At WICA the ponderosa pine / sunsedge type often occurs in mosaics with ponderosa pine / western wheatgrass and ponderosa pine / little bluestem.

CEGL000188 *Pinus ponderosa / Pascopyrum smithii* Woodland
PONDEROSA PINE/WESTERN WHEATGRASS WOODLAND

Dominant or indicator species: Ponderosa pine dominates the canopy, and subcanopy if present. Shrubs usually are sparse or absent. The herbaceous stratum is variable in composition; abundant graminoids include western wheatgrass, green needlegrass, needle-and-thread and porcupine grass.
Variability: As for most of the pine types in the Black Hills, pine cover is variable (20-60% or occasionally 10-20%), and there may not be a clear distinction between canopy and subcanopy. Graminoid dominance can be variable even within stands. Western wheatgrass may be sparse or even absent. This type needs better definition in the Black Hills.
Habitat characteristics: This type occurs on gentle to moderately-steep slopes of all aspects.
Similar types: At WICA, the ponderosa pine / western wheatgrass type often occurs in mosaics with ponderosa pine / sunsedge and ponderosa pine / little bluestem.

CEGL000201 *Pinus ponderosa / Schizachyrium scoparium* Woodland
PONDEROSA PINE/LITTLE BLUESTEM WOODLAND

Dominant or indicator species: Ponderosa pine dominates the canopy, and subcanopy if present. Rocky Mountain juniper may be present but cover is less than 20%. Shrub cover is typically sparse. Little bluestem and other dry prairie graminoids such as side-oats grama dominate the herbaceous stratum.
Variability: As for most of the pine types in the Black Hills, pine cover is variable (20-60%; occasionally 10-20%);there may not be a clear distinction between canopy and subcanopy.
Habitat characteristics: This type occurs on gentle to steep SE-, S- and SW-facing slopes.
Similar types: At WICA, the ponderosa pine / little bluestem type often occurs in mosaics with ponderosa pine / western wheatgrass and ponderosa pine / sunsedge.

1.2. BROADLEAF FORESTS AND WOODLANDS

CEGL000660 *Populus deltoides / Symphoricarpos occidentalis* Woodland
COTTONWOOD/WESTERN SNOWBERRY FLOODPLAIN WOODLAND

Dominant or indicator species: Plains cottonwood is the dominant canopy species, with greater than 10% cover and greater than 50% of the total canopy cover. Western snowberry forms thickets in the understory. Other hardwoods such as boxelder and green ash may be present, but are not abundant.
Variability: Cottonwood cover is variable both among and within stands. Distribution is typically patchy. Other hardwoods may be present.

Habitat characteristics: Floodplains; level sites on alluvium.
Similar types: green ash - American elm / western snowberry forest.

CEGL002082 *Fraxinus pennsylvanica - Ulmus americana / Symphoricapos occidentails* Forest
GREEN ASH - AMERICAN ELM / WESTERN SN0WBERRY FOREST

Dominant or indicator species: Green ash with some cottonwood forms a closed canopy/subcanopy. Understory composition for this type is varied depending on the presence of grazing.
Variability: Not known for Black Hills stands.
Habitat characteristics: Floodplains; level sites on alluvium.
Similar types: Cottonwood/western snowberry floodplain woodland.

CEGL000628 *Acer negundo / Prunus virginiana* Forest
BOX ELDER / CHOKECHERRY FOREST

Dominant or indicator species: Boxelder is the most consistent canopy species, typically with greatest cover. Chokecherry may be absent. Western snowberry and 3-leaved sumac may be present. Other diagnostic understory species are not known for Black Hills stands.
Variability: Chokecherry is variable in cover and height, and occasionally absent. Hardwoods such as green ash, American elm, bur oak and paper birch may be present, or locally dominant.
Habitat characteristics: Drainage bottoms.

2. SHRUBLANDS

CEGL001173 *Salix bebbiana* Shrubland
BEAKED (BEBB=S) WILLOW SCRUB

Dominant or indicator species: Beaked (Bebb=s) willow dominates the shrub stratum. The herbaceous stratum typically includes riparian/wet meadow species, such as Canadian reedgrass, water sedge, beaked sedge, Nebraska sedge and redtop bent.
Variability: Herbaceous associates are variable.
Habitat characteristics: Streambanks and wet meadows at higher elevations.
Similar types: In the Black Hills, multiple riparian types often occur together in mosaics of small patches.

CEGL001086 *Cercocarpus montanus / Bouteloua curtipendula* Shrubland
MOUNTAIN MAHOGANY / SIDE-OATS GRAMA SHRUBLAND

Dominant or indicator species: Mountain mahogany strongly dominates this type. Herbaceous cover is variable; common species include side-oats grama and little bluestem. Scattered ponderosa pine or Rocky Mountain juniper may be present.
Variability: Shrub stratum is fairly consistent; herbaceous cover is variable.

Habitat characteristics: This type typically is found on rocky sites underlain by limestone. Small patches may occur in areas of other rock types.

CEGL001394 *Juniperus horizontalis / Schizachyrium scoparium* Dwarf-Shrubland
CREEPING JUNIPER / LITTLE BLUESTEM DWARF-SHRUBLAND

Dominant or indicator species: Creeping juniper is the dominant shrub, with greater than 20% cover. Herbaceous cover is highly variable, ranging from less than 10% on sparsely-vegetated sites to greater than 60% in grasslands.
Variability: See above.
Habitat characteristics: Only a few stands of this type have been surveyed in the Black Hills. Habitat is dry, but otherwise not well characterized.

CEGL001108 *Prunus virginiana* Shrubland
CHOKECHERRY SHRUBLAND

Dominant or indicator species: Shrub cover is greater than 50%, with chokecherry dominant, or co-dominant with 3-leaved sumac. Western snowberry may be present.
Variability: 3-leaved sumac and western snowberry are variable in cover, and may be absent.
Habitat characteristics: At WICA, this type occurs in drainage bottoms and on lower slopes, often in prairie. It also has been found around rock outcrops in those areas.
Similar types: This type may occur with western snowberry shrublands, with transition zones between the two. Ponderosa pine / chokecherry stands that have burned sufficiently to kill pine may exist for some period of time as chokecherry shrublands.

CEGL001131 *Symphoricarpos occidentalis* Shrubland
WESTERN SNOWBERRY SHRUBLAND

Dominant or indicator species: Western snowberry is strongly dominant, and total shrub cover often is greater than 60%.
Variability: This type may occur with chokecherry shrublands, with transition zones between the two.
Habitat characteristics: This type occurs in riparian zones, and on upland sites in dry draws and occasional slopes.
Similar types: Stands of this type may occur with chokecherry shrublands, with transition zones between the two.

3. HERBACEOUS VEGETATION

3.1. RIPARIAN/WET MEADOW HERBACEOUS VEGETATION

CEGL001477 *Spartina pectinata - Carex* spp. Herbaceous Vegetation
PRAIRIE CORDGRASS - SEDGE WET MEADOW

Dominant or indicator species: as named.

Variability: Graminoid dominance typically is patchy. In the Black Hills, multiple riparian types often occur together in mosaics of small patches.
Habitat characteristics: Stream banks and wet meadows.

CEGL005263 Western Great Plains Streamside Vegetation
WESTERN GREAT PLAINS STREAMSIDE VEGETATION
Dominant or indicator species: redtop bent, mannagrass, poison hemlock, willowherb, speedwell and others.
Variability: Dominance is variable and typically patchy. In the Black Hills, multiple riparian types often occur together in mosaics of small patches.
Habitat characteristics: Streambanks.

CEGL001833 *Eleocharis palustris* Herbaceous Vegetation
CREEPING SPIKERUSH WET MEADOW
Dominant or indicator species: as named.
Variability: This type may occur in mosaics with other wetland types.
Habitat characteristics: Wetlands with open water for at least part of the season.

3.2. UPLAND HERBACEOUS VEGETATION

CEGL001681 *Schizachyrium scoparium - Bouteloua (curtipendula, gracilis) / Carex filifolia* Herbaceous Vegetation
NORTHERN GREAT PLAINS LITTLE BLUESTEM PRAIRIE
Dominant or indicator species: Little bluestem is dominant, with side-oats and blue grama typically present. Thread-leaved sedge may be present. The more mesophytic grasses such as green needlegrass, needle-and-thread, western wheatgrass and Kentucky bluegrass are absent or minor components.
Variability: see above.
Habitat characteristics: At WICA, this type occurs on drier sites and on steeper slopes than the western wheatgrass - green needlegrass and Kentucky bluegrass types which prefer gently rolling terrain.
Similar types: The western wheatgrass - green needlegrass, Kentucky bluegrass and Northern Plains big bluestem prairie types can include patches of little bluestem.

CEGL002037 *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation
NEEDLE-AND-THREAD - BLUE GRAMA MIXEDGRASS PRAIRIE
Dominant or indicator species: as named.
Variability: Thread-leaved sedge may be absent.
Habitat characteristics: At WICA, this type occurs on rocky drier sites in prairies, and is best developed on the rocky summits of broad benches in the northeast part of the park.
Similar types: Western wheatgrass - green needlegrass herbaceous vegetation.

CEGL001583 *Pascopyrum smithii - Nassella viridula* Herbaceous Vegetation
WESTERN WHEATGRASS - GREEN NEEDLEGRASS MIXDGRASS PRAIRIE

Dominant or indicator species: as named.
Variability: Local dominance varies; in addition to the species named above, Kentucky bluegrass and needle-and-thread can be locally dominant. Scurfpea may be abundant.
Habitat characteristics: Rolling topography.
Similar types: needle-and-thread - blue grama mixedgrass prairie; Kentucky bluegrass herbaceous vegetation

CEGL003081 *Poa pratensis* Herbaceous Vegetation
KENTUCKY BLUEGRASS HERBACEOUS VEGETATION

Dominant or indicator species: as named.
Variability: Other graminoids may be present in small amounts. Scurfpea may be abundant.
Habitat characteristics: Rolling topography.
Similar types: western wheatgrass - green needlegrass herbaceous vegetation

CEGL002205 *Andropogon gerardii-Schizachyrium scoparium* N. Plains Hillslope Herb. Veg.
NORTHERN PLAINS BIG BLUESTEM PRAIRIE

Dominant or indicator species: Big bluestem is dominant, forming large patches to the exclusion of other species. Little bluestem is present, with variable cover.
Variability: Little bluestem cover is variable.
Habitat characteristics: Moderate to steep slopes of variable aspect, often rocky.
Similar types: Big bluestem may occur in many of the grassland types at WICA, and may be locally or seasonally dominant. Big bluestem dominance also can vary from year to year, based on the season's moisture regime.

new *Aristida purpurea - Dysodia papposa* Herbaceous Vegetation = Prairie Dog Town Grassland Complex
PURPLE THREE-AWN - FETID MARIGOLD HERBACEOUS VEGETATION = PRAIRIE DOG TOWN GRASSLAND COMPLEX

Dominant or indicator species: As is characteristic for recently-disturbed sites, species dominance is highly variable. Purple three-awn, fetid marigold and big-bract verbena are among the more common and consistent dominants.
Habitat characteristics: prairie dog towns.

new Introduced Weedy Graminoid Herbaceous Vegetation
INTRODUCED WEEDY GRAMINOID HERBACEOUS VEGETATION

Dominant or indicator species: Introduced graminoids such as smooth brome, Japanese brome and cheatgrass.
Habitat characteristics: Disturbed sites.

4. SPARSE VEGETATION

CEGL002055 *Pinus ponderosa* Limestone Cliff Sparse Vegetation
PONDEROSA PINE LIMESTONE CLIFF
Dominant or indicator species: This type consists of scattered ponderosa pine. Chokecherry and 3-leaved sumac often are associated with small outcrops.
Variability: Shrub and herbaceous cover and composition are variable.
Habitat characteristics: Limestone cliffs and outcrops.

CEGL002295 Black Hills Rock Outcrop Sparse Vegetation
BLACK HILLS ROCK OUTCROP
Dominant or indicator species: This type consists of scattered ponderosa pine. 3-leaved sumac, common juniper and bearberry may be present.
Variability: Shrub and herbaceous cover and composition are variable.
Habitat characteristics: Igneous and metamorphic rock outcrops.

CEGL002294 Shale Barrens Slopes Sparse Vegetation
SHALE BARREN SLOPES
Dominant or indicator species: Not known.
Variability: Not known.
Habitat characteristics: In the Wind Cave study area, this type occurs on gray shale on the east side of Boland Ridge. It is on private land, and was not surveyed.

CEGL005261 Siltstone (Redbeds) Plains Sparse Vegetation
REDBEDS (SILTSTONE) ROCK OUTCROP
Dominant or indicator species: A variety of graminoids and forbs are found in this type.
Variability: see aboveHabitat characteristics: This type develops on red soil derived from the silt- and sandstones of the Spearfish Formation. Badlands-like outcrops and gypsum lenses are common.

new Recent Burn Sparse Vegetation
RECENT BURN SPARSE VEGETATION
Dominant or indicator species: Invader species are present with patchy distribution. Mullein, Canada thistle, catnip and horseweed are among the more common.
Variability: This type is variable in composition. Dominance and cover can be quite patchy.
Habitat characteristics: This type includes recently-burned stands where fire was sufficiently hot to destroy most vegetative cover.

Appendix 9.

National Vegetation Classification System (NVCS) for Wind Cave National Park

- Created and compiled by Don Faber-Langendoen, Jim Drake, and Hollis Marriott of the TNC

NOTE: "*" Indicates a new formation to the National Vegetation Classification System

Pinus ponderosa / Prunus virginiana Forest

COMMON NAME	Ponderosa Pine / Choke Cherry Forest
SYNONYM	Ponderosa Pine/Chokecherry Forest
PHYSIOGNOMIC CLASS	Forest (I)
PHYSIOGNOMIC SUBCLASS	Evergreen forest (I.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen forest (I.A.8)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (I.A.8.N)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen forest (I.A.8.N.b)
ALLIANCE	*Pinus ponderosa* Forest Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community is found in eastern Montana, eastern and northern Wyoming, western South Dakota, and western Nebraska.

Wind Cave National Park

Ponderosa pine/chokecherry vegetation is common at Wind Cave NP. It is scattered throughout the forested areas west of NPS Rd. 5, and on Boland Ridge. Exemplary stands are found in Cold Brook Canyon near the west Park boundary, near the Centennial trailhead just above Beaver Creek and in the drainage bottom of the south fork of upper Blacktail Creek (east side of Boland Ridge.

ENVIRONMENTAL DESCRIPTION

Globally

This is one of the most mesic ponderosa pine communities. It occurs on gentle to moderate (2-40%) north facing slopes and close to streams (Hansen and Hoffman 1988). A few stands are on rolling uplands. The soils are sandy loam or loam.

Wind Cave National Park

Stands of ponderosa pine/chokecherry occur on moderately steep to steep slopes with northerly aspects. This community is more common on lower slopes, which tend to be more shaded and mesic than the slopes above.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Shrub	*Amelanchier alnifolia, Mahonia repens, Prunus virginiana*

Wind Cave National Park

Stratum	Species
Tree canopy	*Pinus ponderosa*
Shrub	*Prunus virginiana*
Herbaceous	*Carex inops* ssp. *heliophila, Muhlenbergia racemosa, Poa pratensis*

CHARACTERISTIC SPECIES

Globally

Pinus ponderosa, Prunus virginiana

Wind Cave National Park

Pinus ponderosa, Prunus virginiana

VEGETATION DESCRIPTION

Globally

This forest community has a closed canopy made up of *Pinus ponderosa*. Hansen and Hoffman (1988) found that the basal area ranged from 36.6-63.5 m2/ha in five stands in southeastern Montana. Seedlings and saplings of *Crataegus succulenta* and *Fraxinus pennsylvanica* are often scattered in the understory. These species may grow to be mature trees near streams. There are two shrub

layers in this community. Together they had an average cover of 87% in five stands sampled by Hansen and Hoffman (1988). The most prominent layer is approximately 1 meter tall and dominated by *Prunus virginiana. Amelanchier alnifolia* also contributes significantly to this layer. The lower shrub layer is approximately 50 cm tall. It is dominated by *Mahonia repens* with lesser amounts of *Ribes missouriense, Rosa woodsii*, and *Symphoricarpos albus*. The diversity of forbs is moderate, but most of the coverage of the herbaceous layer is provided by graminoids. *Apocynum androsaemifolium, Elymus caninus, Galium boreale, Schizachne purpurescens,* and *Maianthemum stellatum* are typical components of the herbaceous layer.

Wind Cave National Park
Stands of ponderosa pine/chokecherry are characterized by high canopy coverage, with ponderosa pine cover often greater than 60%. It is common to have a subcanopy of smaller pines as well. Shrub cover usually is greater than 25% and dominated by chokecherry. Codominants may include common juniper (*Juniperus communis*), ninebark (*Physocarpus monogynous*), snowberry (*Symphoricarpos albus*), poison ivy (*Toxicodendron pubescens*) and/or currants (*Ribes* spp.). Herbaceous cover is moderate (usually less than 50%), and commonly dominated by graminoids such as green needlegrass (*Nassella viridula*), Kentucky bluegrass (*Poa pratensis*), Canada wildrye *(Elymus canadensis*), marsh muhly (*Muhlenbergia racemosa*) and sunsedge (*Carex inops* ssp. *heliophila*).

The ponderosa pine/chokecherry type is fairly consistent in terms of tree and shrub species. However, other shrubs are occasionally codominant, including common juniper (*Juniperus communis*), ninebark (*Physocarpus monogynous*), snowberry *(Symphoricarpos albus*) poison ivy (*Toxicodendron pubescens*) and/or currants (*Ribes* spp.).

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4

DATABASE CODE CEGL000192

MAP UNITS
The ponderosa pine/chokecherry community corresponds to map unit 47, ponderosa pine/chokecherry forest, on the Wind Cave vegetation map. Chokecherry shrubland with standing dead trees and few or no living trees corresponds to map unit 12, chokecherry shrubland (with burned ponderosa pine).

COMMENTS
Wind Cave National Park
The ponderosa pine/chokecherry type grades into the ponderosa pine/common juniper type. Some stands were found that included significant amounts of both common juniper and chokecherry, making
classification difficult. Stands of chokecherry with standing dead trees (usually burned) and scattered or no living trees are classified as chokecherry shrubland, but are mapped as a burned type on the Wind Cave vegetation map.

REFERENCES
Hansen, P.L. and G.R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station General Technical Report RM-157. Fort Collins, CO. 68 p.

Hoffman, G.R. and R.R. Alexander. 1987. Forest vegetation of the Black Hills National Forest of South Dakota and Wyoming: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station Res. Pap. RM-276. Fort Collins, CO. 48 p.

Pfister, R.D., B.L. Kovalchik, S.F. Arno, and R.C. Presby. 1977. Forest habitat types of Montana. USDA Forest Service General Technical Report, INT-34. Intermountain Forest and Range Experiment Station, Ogden, UT. 174 pp.

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

Fraxinus pennsylvanica - Ulmus americana / Symphoricarpos occidentalis Forest

COMMON NAME	Green Ash - American Elm / Wolfberry Forest
SYNONYM	Ash - Elm / Wolfberry Forest
PHYSIOGNOMIC CLASS	Forest (I)
PHYSIOGNOMIC SUBCLASS	Deciduous forest (I.B)
PHYSIOGNOMIC GROUP	Cold-deciduous forest (I.B.2)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (I.B.2.N)
FORMATION	Lowland or submontane cold-deciduous forest (I.B.2.N.a)
ALLIANCE	*Fraxinus pennsylvanica - (Ulmus americana)* Forest Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community is found in southern Manitoba, North Dakota and South Dakota. Its range within these states and province is not known.

Wind Cave National Park

Mappable stands of green ash/western snowberry vegetation occur in drainages east of the Park. These areas are under private ownership, and were not accessible for survey.

ENVIRONMENTAL DESCRIPTION

Globally

This community occurs on upland sites along steep north-facing slopes and, occasionally, along intermittent drainages or near the bases of north-facing slopes of upland sites. Soils are moist to dry and poorly drained. Girard et al. (1989) found this community on silty clay and clay soils.

Wind Cave National Park

Mappable stands of green ash/western snowberry vegetation occur in drainages east of the Park. These areas are under private ownership, and were not accessible for survey.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Tree canopy	*Fraxinus pennsylvanica, Juniperus virginiana, Ulmus americana*
Short shrub	*Symphoricarpos occidentalis*

Wind Cave National Park

Stratum	Species
Information not available.	

CHARACTERISTIC SPECIES

Globally

Fraxinus pennsylvanica, Ulmus americana, Symphoricarpos occidentalis

Wind Cave National Park

Information not available.

VEGETATION DESCRIPTION

Globally

This community is a moderately to densely vegetated forest with an open to dense shrub understory. The average height of the tree layer varies from 5 to 8 meters (US Army Corps of Engineers 1979, Girard et al.1989). The tree layer is dominated by *Fraxinus pennsylvanica* and *Ulmus americana.* Widely scattered old *Populus deltoides* may occur. The shrub layer is dominated by *Symphoricarpos occidentalis*. Other shrubs that can be found are *Rosa woodsii, Juniperus scopulorum* (which can also be in the canopy or subcanopy), and *Prunus virginiana. Symphoricarpos occidentalis* tends to increase under grazing pressure and it may be

almost the only shrub where grazing has been intense. Herbaceous species that may be found in this community are *Pascopyrum smithii, Andropogon gerardii, Poa* spp., *Carex* spp. (wide leaf), *Rumex* spp., *Carex filifolia, Anemone cylindrica, Oryzopsis micrantha, Galium* spp., *Anemone canadensis, Taraxacum* spp., *Lappula* spp., *Conyza canadensis,* and *Circium* spp.

Wind Cave National Park
Mappable stands of green ash/western snowberry vegetation occur in drainages east of the Park. These areas are under private ownership, and were not accessible for survey.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3G5

DATABASE CODE CEGL002082

MAP UNITS
The green ash - American elm/western snowberry community corresponds to map unit 43, green ash - American elm/western snowberry forest, on the Wind Cave vegetation map.

COMMENTS

REFERENCES
Girard, M.M., H. Goetz, and A.J. Bjugstad. 1989. Native woodland habitat types of southwestern North Dakota. Research Paper RM-281. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 36 p.

U.S. Army Corps of Engineers. 1979. A cultural resources reconnaissance of the federal lands on the east bank of Lake Francis Case, South Dakota. U.S. Army Engineer District, Corps of Engineers, Omaha, NE.

Acer negundo / Prunus virginiana Forest

COMMON NAME	Ashleaf Maple / Choke Cherry Forest
SYNONYM	Box Elder / Chokecherry Forest
PHYSIOGNOMIC CLASS	Forest (I)
PHYSIOGNOMIC SUBCLASS	Deciduous forest (I.B)
PHYSIOGNOMIC GROUP	Cold-deciduous forest (I.B.2)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (I.B.2.N)
FORMATION	Temporarily flooded cold-deciduous forest (I.B.2.N.d)
ALLIANCE	*Acer negundo* Temporarily Flooded Forest Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This association is found in Montana, Wyoming, Colorado, and South Dakota.

Wind Cave National Park

Boxelder/chokecherry stands are found in drainages throughout Wind Cave NP. Exemplary stands occur in the Beaver Creek drainage up- and downstream from Highway 385, along Cold Spring Creek near the west Park entrance, along Highland Creek in the canyon west of NPS Rd. 5, and in the Blacktail drainage near the east Park boundary.

ENVIRONMENTAL DESCRIPTION

Globally

This community is found in mesic situations, usually near streams or rivers or broad alluvial floodplains at warm elevations.

Wind Cave National Park

The boxelder/chokecherry community typically occurs in drainage bottoms on level sites.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Tree canopy	*Acer negundo*
Shrub	*Cornus stolonifera, Prunus virginiana*

Wind Cave National Park

Stratum	Species
Tree canopy	*Acer negundo, Fraxinus pennsylvanica*
Shrub	*Prunus virginiana*

CHARACTERISTIC SPECIES

Globally

Acer negundo, Prunus virginiana

Wind Cave National Park

Acer negundo, Prunus virginiana

VEGETATION DESCRIPTION

Globally

This is an early successional community dominated by *Acer negundo. Populus tremuloides* may also be found. Tree density may be moderate to high. Shrubs are common and vary from short (<1 m) to tall (>2 m). *Prunus virginiana* and *Cornus stolonifera* are common. At Wind Cave NP, these woodlands vary in composition, with *Acer negundo* usually present, but *Prunus virginiana* frequently absent. Tree cover typically is in the 10 - 25% range. *Acer negundo* is most consistently present, but other tree species may be present or even common, including *Ulmus americana, Quercus macrocarpa, Fraxinus pennsylvanica* and *Populus deltoides*. Total shrub cover (tall and short shrubs) is often is greater than 50%. Other common species, in addition to *Prunus virginian*, include *Rhus trilobata, Symphoricarpos occidentalis, Ribes aureum* and *Rhus pubescens*. Herbaceous cover is variable, but usually less than

50%. Species composition varies; common species include *Poa pratensis, Monarda fistulosa* and *Apocynum cannibinum* (Hollis Marriott personal communication 1999). In Colorado, dense thickets of *Prunus virginiana* may occur. When left undisturbed, the shrub canopy can be very thick and nearly impenetrable. However, many stands in Colorado are in severely degraded states with very sparse shrub canopies (CO NHP personal communication 1998).

Wind Cave National Park
Boxelder/chokecherry woodlands vary in composition, with boxelder usually present, but chokecherry frequently absent. Tree cover typically is in the 10 - 25% range. Boxelder is most consistently present, but other tree species may be present or even common, including American elm (*Ulmus americana*), bur oak (*Quercus macrocarpa*), green ash (*Fraxinus pennsylvanica*) and Plains cottonwood (*Populus deltoides*). Total shrub cover (tall and short shrubs) often is greater than 50%. In addition to chokecherry, squaw-bush (*Rhus trilobata*), western snowberry (*Symphoricarpos occidentalis*), golden currant (*Ribes aureum*) and poison ivy (*Rhus pubescens*) may be common shrub components. Herbaceous cover is variable, but usually less than 50%. Species composition varies; common species include Kentucky bluegrass (Poa pratensis), wild bergamot bee-balm (*Monarda fistulosa*) and dogbane (*Apocynum cannibinum*).

The composition of this community varies. Boxelder is usually present, but chokecherry may be absent. Other tree species may be present or even common, including American elm (*Ulmus americana*), bur oak (*Quercus macrocarpa*), green ash (*Fraxinus pennsylvanica*) and Plains cottonwood (*Populus deltoides*).

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3

DATABASE CODE CEGL000628

MAP UNITS
The boxelder/chokecherry community corresponds to map unit 41, boxelder/chokecherry woodland, on the Wind Cave vegetation map. Isolated patches and trees of other hardwood species are mapped as 42, bur oak stand, and 44, birch-aspen woodland stand.

COMMENTS
Wind Cave National Park
Many of the boxelder/chokecherry stands at Wind Cave NP were visited for observation points, plots, or accuracy assessment points.

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

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

Osborn, R., G. Kittel, and M. Reid. 1998. Colorado Riparian Plant Associations and Western States Vegetation Classification. CDROM. U.S. Geological Survey, Mid-Continent Ecology Research Center, Fort Collins, CO.

Pinus ponderosa / Juniperus communis Woodland

COMMON NAME	Ponderosa Pine / Common Juniper Woodland
SYNONYM	Ponderosa Pine/Common Juniper Woodland
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community is found in eastern Montana, the Bighorn Mountains in northern Wyoming and the Black Hills of western South Dakota and eastern Wyoming.

Wind Cave National Park

Ponderosa pine/common juniper vegetation is uncommon at Wind Cave NP, and is restricted to the western part. It is more common to the west on Forest Service lands.

ENVIRONMENTAL DESCRIPTION

Globally

This community is most often found on moderate north and west facing slopes (Hansen and Hoffman 1987, Hoffman and Alexander 1987, Hoffman and Alexander 1976). The soils are shallow and loamy. They develop from limestone or igneous rock.

Wind Cave National Park

Stands of ponderosa pine/common juniper are best developed on moderately-steep to steep slopes with northerly aspects. Mappable stands are found only in the western part of the Park, which is underlain by granitic rocks. This community becomes more common to the west on National Forest lands.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Tree sub-canopy	*Pinus ponderosa*
Short shrub	*Juniperus communis*
Herbaceous	*Carex inops* ssp. *heliophila*

Wind Cave National Park

Stratum	Species
Tree canopy	*Pinus ponderosa*
Short shrub	*Juniperus communis, Prunus virginiana*
Herbaceous	*Carex inops* ssp. *heliophila, Danthonia spicata*

CHARACTERISTIC SPECIES

Globally

Achillea millefolium, Juniperus communis, Mahonia repens

Wind Cave National Park

Pinus ponderosa, Carex inops ssp. heliophila

VEGETATION DESCRIPTION

Globally

This community is dominated by *Pinus ponderosa* in the overstory. Other tree species that may be present are *Picea glauca* and *Populus tremuloides*. The canopy is usually moderately closed but can become nearly closed in stands that are not disturbed for long periods. There is a prominent low shrub layer whose most abundant component is *Juniperus communis.* This species covered an average of 25% (range of 4-42%) in 7 stands in the Black Hills of South Dakota and Wyoming (Hoffman and Alexander 1987). Total average cover by the shrub layer was 51% and by the herb layer was 8%. Other shrub species found in this community across its range are *Arctostaphylos uva-ursi, Mahonia repens, Spiraea betulifolia*, and *Symphoricarpos albus.* Typical herbaceous species are *Achillea millefolium, Carex inops* ssp. *heliophila, Schizachyrium scoparium, Fragaria* spp., and *Lathyrus ochroleucus* (McAdams et al.1998).

One site of this community in the Black Hills was reported to have significant Pinus flexilis in it (Thilenius 1970).

Wind Cave National Park
Stands of ponderosa pine/common juniper are characterized by high canopy coverage, with ponderosa pine cover often greater than 75%. A subcanopy of smaller pines may be present. The understory usually is sparse. Common juniper is present but not abundant, with shrub cover usually less than 20%. Codominants may include chokecherry (*Prunus virginiana*), ninebark (*Physocarpus monogynous*), snowberry (*Symphoricarpos albus*) and/or currants (*Ribes* spp.). Herbaceous cover typically is very sparse, often less than 5%. Poverty oatgrass (*Danthonia spicata*) and sunsedge (*Carex inops* ssp. *heliophila*) are the most consistently occurring species.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4?

DATABASE CODE CEGL000859

MAP UNITS
The ponderosa pine/common juniper community is one of the types included in map units 45 and 48, ponderosa pine woodland complex I and II, on the Wind Cave vegetation map. It is not mapped separately. Stands of dense young doghair are mapped as 49, young ponderosa pine dense cover complex.

COMMENTS
Wind Cave National Park
Ponderosa pine/common juniper appears to have become established where lack of disturbance has allowed dense pine canopy to develop. The ponderosa pine/common juniper type grades into the ponderosa pine/chokecherry type. Some stands were found that included significant amounts of both common juniper and chokecherry, making classification difficult. Dense stands of young pine are occasionally present. These young doghair stands are mapped separately on the Wind Cave vegetation map.

Ponderosa pine/common juniper vegetation is uncommon at Wind Cave NP, and only a few stands were surveyed.

REFERENCES
Hansen, P.L., and G.R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station Gen. Tech. Rep. RM-157. Fort Collins, CO. 68 p.

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Johnston, B.C. 1987. Plant associations of region two: potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mt. Reg. Lakewood, CO. 429 p.

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

Lynn, R., M. Larson, D. Hoeft, L. Todd, T. Raetz, L. Fager, and G. Barranco. No Date. Black Hills National Forest ecological land units study. USDA Forest Service, Black Hills National Forest.

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

Terwilliger, C., K. Hess and C. Wasser. 1979. Key to the preliminary habitat types of Region 2. Addendum to initial progress report for habitat type classification. Rocky Mountain Forest and Range Experiment Station, Fort Collins.

Thilenius, J.F. 1970. An isolated occurrence of limber pine (Pinus flexilis James) in the Black Hill of South Dakota. Am. Midl. Nat. 84(2):411-417.

Thilenius, J.F. 1971. Vascular plants of the Black Hills of South Dakota and adjacent Wyoming. USDA Forest Service Research Paper RM-71. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

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

Pinus ponderosa / Pascopyrum smithii Woodland

COMMON NAME	Ponderosa Pine / Western Wheatgrass Woodland
SYNONYM	Ponderosa Pine/Western Wheatgrass Woodland
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This association is found in Wyoming and South Dakota.

Wind Cave National Park

Ponderosa pine/western wheatgrass is a very common vegetation type at Wind Cave NP. It occupies large areas in the western half of the Park and on Boland Ridge. Smaller scattered stands are found elsewhere.

ENVIRONMENTAL DESCRIPTION

Globally

This type is best developed on gentle to moderately steep slopes of all aspects except south. On northerly aspects, and in stands with greater tree cover, the more mesophytic graminoids have greater cover. Drier sites may contain a more xerophytic mix of species.

Wind Cave National Park

Ponderosa pine/western wheatgrass stands are best developed on gentle to moderately steep slopes of all aspects except south. On northerly aspects, and in stands with greater tree cover, the more mesophytic graminoids have greater cover, such as porcupine grass (*Stipa spartea*), green needlegrass (*Nassella viridula*), Canada wildrye (*Elymus canadensis*), marsh muhly (*Muhlenbergia racemosa*) and prairie dropseed (*Sporobolus heterolepis*). Western wheatgrass, little bluestem (*Schizachyrium scoparium*), sunsedge (*Carex inops* ssp. *heliophila*) and needle-and-thread (*Stipa comata*) are the common dominants on drier sites.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Elymus canadensis, Nassella viridula, Pascopyrum smithii, Stipa comata*

Wind Cave National Park

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Elymus canadensis, Nassella viridula, Oryzopsis micrantha, Pascopyrum smithii, Stipa comata*

CHARACTERISTIC SPECIES

Globally

Pascopyrum smithii, Pinus ponderosa, Stipa comata

Wind Cave National Park

Pascopyrum smithii, Pinus ponderosa

VEGETATION DESCRIPTION

Globally

Stands are characterized by a somewhat-open canopy of *Pinus ponderosa*, with coverage in the 25 - 50% range. A subcanopy of smaller pines may be present. The shrub stratum is usually sparse, with *Amorpha canescens, Artemisia frigida, Rhus trilobata* and

Toxicodendron pubescens the most frequently found species. Herbaceous cover is typically greater than 75% and graminoid-dominated. Species composition is quite variable. On northerly aspects, and in stands with greater tree cover, the more mesophytic graminoids have greater cover, such as *Stipa spartea, Nassella viridula, Elymus canadensis, Muhlenbergia racemosa* and *Sporobolus heterolepis. Pascopyrum smithii, Schizachyrium scoparium, Carex inops* ssp. *heliophila*, and *Stipa comata* are the common dominants on drier sites. *Oryzopsis micrantha* is dominant at some sites (Marriot personal communication 1999).

Wind Cave National Park
Stands of ponderosa pine/western wheatgrass are characterized by a somewhat-open canopy of ponderosa pine (*Pinus ponderosa*), with coverage in the 25 - 50% range. A subcanopy of smaller pines may be present. The shrub stratum is usually sparse, with downy indigobush (*Amorpha canescens*), prairie sagebrush (*Artemisia frigida*), squaw-bush (*Rhus trilobata*) and poison ivy (*Toxicodendron pubescens*) the most frequently found species. Herbaceous cover is typically greater than 75% and graminoid-dominated. Species composition is quite variable. On northerly aspects, and in stands with greater tree cover, the more mesophytic graminoids have greater cover, such as porcupine grass (*Stipa spartea*), green needlegrass (*Nassella viridula*), Canada wildrye (*Elymus canadensis*), marsh muhly (*Muhlenbergia racemosa*) and prairie dropseed (*Sporobolus heterolepis*). Western wheatgrass, little bluestem (*Schizachyrium scoparium*), sunsedge (*Carex inops* ssp. *heliophila*) and needle-and-thread (*Stipa comata*) are the common dominants on drier sites. Little mountain-ricegrass (*Oryzopsis micrantha*) is dominant at some sites.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3

DATABASE CODE CEGL000188

MAP UNITS
The ponderosa pine/western wheatgrass community is one of the types included in map units 45 and 48, ponderosa pine woodland complex I and II, on the Wind Cave vegetation map. It is not mapped separately. Stands of dense young doghair are mapped as 49, young ponderosa pine dense cover complex. Western wheatgrass and Kentucky bluegrass types with standing dead trees and few or no living trees corresponds to map unit 13, Western wheatgrass - Kentucky bluegrass complex (with burned ponderosa pine).

COMMENTS
Wind Cave National Park
This type grades into both ponderosa pine/sunsedge and ponderosa pine/little bluestem types. Some stands are difficult to classify. Dense stands of young pine are occasionally present. These young doghair stands are mapped separately on the Wind Cave vegetation map. Grasslands with standing dead trees (usually burned) and scattered or no living trees are classified as the appropriate grassland type, but are mapped as a burned type on the Wind Cave vegetation map.

Much of Wind Cave NP is vegetated with the ponderosa pine/western wheatgrass community, and many stands were surveyed in preparing the vegetation map.

Graminoid dominance in the herbaceous stratum changes somewhat through the season with warm season grasses such as big bluestem (*Andropogon gerardii*) and prairie dropseed (*Sporobolus heterolepis*) becoming more dominant late in the season. Sunsedge (*Carex inops* ssp. *heliophila*) is more prominent early in the season.

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

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MacCracken, J.G., L.E. Alexander, and D.W. Uresk. 1983. An important lichen of southeastern Montana rangelands. Journal of Range Management 36(1):35-37.

Pinus ponderosa / Schizachyrium scoparium Woodland

COMMON NAME	Ponderosa Pine / Little Bluestem Woodland
SYNONYM	Ponderosa Pine/Little Bluestem Woodland
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a)
ALLIANCE	*Pinus ponderosa* Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community is found in Wyoming, Nebraska, South Dakota, and Montana; it may also occur in Oklahoma, Colorado, and New Mexico.

Wind Cave National Park

Ponderosa pine/little bluestem is a very common vegetation type at Wind Cave NP. It occupies large areas in the western half of the Park and on Boland Ridge, and smaller scattered stands are found elsewhere.

ENVIRONMENTAL DESCRIPTION

Globally

This ponderosa pine / little bluestem community type is a dry woodland found in the Great Plains. It usually occurs on south- and west-facing slopes of hills, rocky breaks, and watercourses.

Wind Cave National Park

Ponderosa pine/little bluestem stands are found on somewhat steep to steep mid- and upper slopes with southerly or westerly aspects.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Tree canopy	*Juniperus scopulorum, Pinus ponderosa*
Short shrub	*Rhus trilobata, Symphoricarpos occidentalis*
Herbaceous	*Schizachyrium scoparium*

Wind Cave National Park

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Bouteloua curtipendula, Schizachyrium scoparium*

CHARACTERISTIC SPECIES

Globally

Pinus ponderosa, Schizachyrium scoparium

Wind Cave National Park

Pinus ponderosa, Schizachyrium scoparium

VEGETATION DESCRIPTION

Globally

The overstory is dominated by *Pinus ponderosa* with *Juniperus scopulorum* often present. The shrub layer is composed of species such as *Juniperus scopulorum, Rhus trilobata*, and *Symphoricarpos* spp. *Schizachyrium scoparium* is the most abundant graminoid, often accompanied by *Pascopyrum smithii, Bouteloua curtipendula, Bouteloua gracilis, Stipa comata, Carex inops* ssp. *heliophila*, and *Carex foenea*. Common forbs include *Achillea millefolium, Phlox hoodii,* and *Allium* spp.

Wind Cave National Park
Stands of ponderosa pine/little bluestem typically have an open canopy of ponderosa pine, with cover between 10 and 30%. A subcanopy of smaller pines may be present. Shrub cover is sparse, usually less than 10%, with prairie sagebrush (*Artemisia frigida*), downy indigobush (*Amorpha canescens*), squaw-bush (*Rhus trilobata*) and poison ivy (*Toxicodendron pubescens*) the more frequently encountered species. Herbaceous cover most commonly is in the 25-50% range and occasionally greater, with little bluestem and sideoats grama (*Bouteloua curtipendula*) dominant. Other common herbaceous species include white sagebrush (*Artemisia ludoviciana*), western wheatgrass (*Pascopyrum smithii*) and needle-and-thread (*Stipa comata*).

Tree cover is somewhat variable, with dense stands of young pine occasionally present. These young doghair stands are mapped separately on the Wind Cave vegetation map.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3G4. There are probably fewer than 20 occurrences of this community rangewide. It is reported from Nebraska (where it is ranked S?), South Dakota (S?), Wyoming (S2?), and Montana (S2?); it may also occur in Oklahoma, Colorado, and New Mexico. One occurrence is currently documented from Nebraska. Historical acreage and trends are unknown.

DATABASE CODE CEGL000201

MAP UNITS
The ponderosa pine/little bluestem community corresponds to map unit 46, ponderosa pine/little bluestem woodland, on the Wind Cave vegetation map. Stands of dense young doghair are mapped as 49, young ponderosa pine dense cover complex. Little bluestem grassland with standing dead trees and few or no living trees corresponds to map unit 11, little bluestem - grama grass - threadleaf sedge herbaceous vegetation (with burned ponderosa pine).

COMMENTS
Wind Cave National Park
For the Wind Cave NP vegetation classification, *Pinus ponderosa / Schizachyrium scoparium* Wooded Herbaceous Vegetation is included in this type. This type grades into both ponderosa pine/sunsedge and ponderosa pine/western wheatgrass types. Some stands are difficult to classify. Dense stands of young pine are occasionally present. These young doghair stands are mapped separately on the Wind Cave vegetation map. Stands of little bluestem with standing dead trees (usually burned) and scattered or no living trees are classified as little bluestem grassland, but are mapped as a burned type on the Wind Cave vegetation map.

Much of Wind Cave NP is vegetated with the ponderosa pine/little bluestem community, and many stands were surveyed in preparing the vegetation map. Some stands of ponderosa pine/little bluestem are the result of relatively recent pine invasion of little bluestem prairie.

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Pinus ponderosa / Carex inops ssp. heliophila Woodland

COMMON NAME	Ponderosa Pine / Long-stolon Sedge Woodland
SYNONYM	Ponderosa Pine/Sunsedge Woodland
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.A.4.N)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a)
ALLIANCE	*Pinus ponderosa* Woodland Alliance
CLASSIFICATION CONFIDENCE LEVEL	1
USFWS WETLAND SYSTEM	Upland

RANGE

Globally

This association is found in Montana, Wyoming, western South Dakota, and Colorado.

Wind Cave National Park

The ponderosa pine/sunsedge community is widespread at Wind Cave NP. It is common in the western half of the Park and on Boland Ridge.

ENVIRONMENTAL DESCRIPTION

Globally

This community is often found on gentle and moderate south to west facing slopes (Hansen and Hoffman 1988, Hoffman and Alexander 1987).

Wind Cave National Park

Ponderosa pine/sunsedge stands typically occur on moderate to steep mid- and upper slopes of all aspects.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Tree canopy	*Pinus ponderosa*
Tree sub-canopy	*Juniperus scopulorum, Quercus macrocarpa*
Herbaceous	*Carex inops* ssp. *heliophila*

Wind Cave National Park

Stratum	Species
Tree canopy	*Pinus ponderosa*
Herbaceous	*Carex inops* ssp. *heliophila*

CHARACTERISTIC SPECIES

Globally

Carex inops ssp. *heliophila*

Wind Cave National Park

Carex inops ssp. *heliophila, Pinus ponderosa*

VEGETATION DESCRIPTION

Globally

The tree canopy and subcanopy are dominated by *Pinus ponderosa. Juniperus scopulorum* and *Quercus macrocarpa* are occasionally found in the subcanopy. Shrubs are infrequent in this type. The herbaceous layer is dominated by *Carex inops* ssp. *heliophila*, with inclusions of *Danthonia spicata, Schizachyrium scoparium,* and *Pseudoroegneria spicata* -- generally in areas with more open canopies. At Wind Cave NP, herbaceous cover is most commonly is in the 25-50% range and occasionally greater, with sunsedge dominant. Other common herbaceous species include *Artemisia ludoviciana, Danthonia spicata, Oryzopsis micrantha, Nassella viridula*, and *Poa pratensis* (Marriott personal communication 1999).

Wind Cave National Park

Stands of ponderosa pine/sunsedge typically have an open canopy of ponderosa pine, with cover between 20 and 50%. A subcanopy of smaller pines may be present. Shrub cover is sparse, usually less than 10%, with prairie sagebrush (Artemisia frigida), downy indigobush (Amorpha canescens), squaw-bush (Rhus trilobata) and poison ivy (Toxicodendron pubescens) the more frequently encountered species. Herbaceous cover most commonly is in the 25-50% range and occasionally greater, with sunsedge dominant. Other common herbaceous species include white sagebrush (Artemisia ludoviciana), poverty oatgrass (Danthonia spicata), little mountain-ricegrass (Oryzopsis micrantha), green needlegrass (Nassella viridula) and Kentucky bluegrass (Poa pratensis).

Tree cover is somewhat variable, with dense stands of young pine occasionally present. These young doghair stands are mapped separately on the Wind Cave vegetation map.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3

DATABASE CODE CEGL000849

MAP UNITS The ponderosa pine/sunsedge community is one of the types included in map units 45 and 48, ponderosa pine woodland complex I and II, on the Wind Cave vegetation map. It is not mapped separately. Stands of dense young doghair are mapped as 49, young ponderosa pine dense cover complex.

COMMENTS

Wind Cave National Park

This type grades into both ponderosa pine/little bluestem and ponderosa pine/western wheatgrass types. Some stands are difficult to classify. Dense stands of young pine are occasionally present. These young doghair stands are mapped separately on the Wind Cave vegetation map.

The ponderosa pine/sunsedgecommunity is common at Wind Cave NP, and many stands were surveyed in preparing the vegetation map. Sunsedge peaks relatively early in the growing season, often in June. Later in the season its cover decreases, and the cover of other graminoids may increase. What appears to be a ponderosa pine/sunsedge stand in June may become ponderosa pine with other graminoids dominant later in the summer.

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Populus deltoides / Symphoricarpos occidentalis Woodland

COMMON NAME	Eastern Cottonwood / Western Snowberry Woodland
SYNONYM	Cottonwood/Wolfberry - Western Rose Floodplain
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Deciduous woodland (II.B)
PHYSIOGNOMIC GROUP	Cold-deciduous woodland (II.B.2)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (II.B.2.N)
FORMATION	Temporarily flooded cold-deciduous woodland (II.B.2.N.b)
ALLIANCE	*Populus deltoides* Temporarily Flooded Woodland Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community occurs in three northern Great Plains ecoregional sections, where it is found in Colorado, Wyoming, North Dakota, and possibly South Dakota.

Wind Cave National Park

Mappable stands of plains cottonwood/western snowberry vegetation occur in drainages east of the Park. These areas are under private ownership, and were not accessible for survey.

ENVIRONMENTAL DESCRIPTION

Globally

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

Wind Cave National Park

Mappable stands of plains cottonwood/western snowberry vegetation occur in drainages east of the Park. These areas are under private ownership, and were not accessible for survey.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Tree canopy	*Populus deltoides*
Short shrub	*Symphoricarpos occidentalis*
Forb	*Maianthemum stellatum, Melilotus officinalis*
Graminoid	*Poa secunda*

Wind Cave National Park

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Globally

Populus deltoides, Symphoricarpos occidentalis

Wind Cave National Park

Information not available.

VEGETATION DESCRIPTION

Globally

This community is typically dominated by a single deciduous tree species, *Populus deltoides*. In some stands other species, such as *Acer negundo* and *Fraxinus pennsylvanica,* may contribute to the canopy. The tallest trees exceed 15 meters. *Populus deltoides* is a

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

Wind Cave National Park
Mappable stands of plains cottonwood/western snowberry vegetation occur in drainages east of the Park. These areas are under private ownership, and were not accessible for survey. A very small stand is found in a draw between NPS Rds. 5 and 6 in the northeast part of the Park. Isolated cottonwoods occur elsewhere in drainage bottoms in the Park.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G2G3. The total number of occurrences is unknown. Thirteen have been documented in North Dakota, where the community is ranked S1S2?. Although no other occurrences have been documented, the community is also reported from Wyoming (S2), Colorado (S2) and may occur in South Dakota (SP). It is found in three northern Great Plains ecoregional sections. The community occurs on medium to coarse textured soils on the floodplains of major rivers.

DATABASE CODE CEGL000660

MAP UNITS
The plains cottonwood/western snowberry community corresponds to map unit 40, plains cottonwood/western snowberry forest, on the Wind Cave vegetation map.

COMMENTS

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Cercocarpus montanus / Bouteloua curtipendula Shrubland

COMMON NAME	Alderleaf Mountain-mahogany / Sideoats Grama shrubland
SYNONYM	Mountain Mahogany / Side-oats Grama Shrubland
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (III.B.2.N)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a)
ALLIANCE	*Cercocarpus montanus* Shrubland Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community is found on slopes in the Black Hills of South Dakota and Wyoming and on some of the lower mountain slopes of eastern Wyoming. It is found on slopes below ponderosa pine forests and above herbaceous communities. It has been reported in and around the Wildcat Hills of western Nebraska and in New Mexico. Its disjunct occurrence in New Mexico needs further study.

Wind Cave National Park

Stands of mountain mahogany are best developed in areas of limestone, especially the Minnekahta limestone which underlies the surface immediately west of the Red Valley (west of NPS Rd. 5). Smaller stands occur elsewhere, for example on Boland Ridge.

ENVIRONMENTAL DESCRIPTION

Globally

This community is almost exclusively found on slopes. These slopes are 20-40% with a variety of aspects (Hoffman and Alexander 1987). Drought stress is severe due to relatively little precipitation, moderate to steep slopes, and thin, poorly developed soils. Soils are loams and clay loams. The parent material is sandstone or limestone (Johnston 1987).

Wind Cave National Park

Mountain mahogany/side-oats grama shrublands occur most commonly on somewhat steep to steep slopes of all aspects, and are best developed in areas underlain by limestone. Smaller stands occur in areas of sandstones, such as on Boland Ridge.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Shrub	*Cercocarpus montanus*
Herbaceous	*Bouteloua curtipendula*

Wind Cave National Park

Stratum	Species
Shrub	*Cercocarpus montanus, Rhus trilobata*
Herbaceous	*Bouteloua gracilis, Bouteloua curtipendula, Oryzopsis micrantha, Schizachyrium scoparium*

CHARACTERISTIC SPECIES

Globally

Bouteloua curtipendula, Cercocarpus monanus

Wind Cave National Park

Bouteloua curtipendula, Cercocarpus montanus

VEGETATION DESCRIPTION

Globally

Throughout its range, this community is a shrub-steppe community. Its physiognomy is similar to the chaparral of California. Vegetation cover is sparse to moderate. The dominant shrubs are evenly spaced with herbaceous species occurring in between

individual shrubs. The dominant species, *Cercocarpus montanus*, is approximately 2 meters tall. *Rhus trilobata* var. *trilobata*, the other common shrub species, also grows to 2 meters. The herbaceous species rarely grow taller than 1 meter. *Bouteloua curtipendula* is the most abundant herbaceous species. *Artemesia frigida* is a typical smaller shrub. Common herbaceous species are the forbs *Aristida purpurea, Aster oblongifolius, Hedeoma hispida*, and the grass *Oryzopsis hymenoides.*

Wind Cave National Park
Mountain mahogany/side-oats grama shrublands at Wind Cave NP typically have moderate shrub cover, in the 20-50% range. Structure and species composition of mountain mahogany stands are fairly consistent. Sometimes the shrub component can be split into tall and short strata. Mountain mahogany is strongly dominant; squaw-bush (*Rhus trilobata*) occurs frequently, and is occasionally common. Broom snakeweed (*Gutierrezia sarothrae*) and prairie sagebrush (*Artemisia frigida*) are common short shrubs. Herbaceous cover is variable, ranging from 10 to greater than 75%. Side-oats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*), green needlegrass (*Nassella viridula*), little mountain-ricegrass (*Oryzopsis micrantha*) and little bluestem (*Schizachyrium scoparium*) occur frequently.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5

DATABASE CODE CEGL001086

MAP UNITS
The mountain mahogany/side-oats grama community corresponds to map units 30 and 31, mountain mahogany / side-oats grama shrublands I and II, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
A few mountain mahogany stands were found with a significant ponderosa pine component, making classification difficult. Mountain mahogany/side-oats grama shrubland is limited in extend, and many of the stands were visited during preparation of the vegetation map.

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Prunus virginiana Shrubland

COMMON NAME	Choke Cherry Shrubland
SYNONYM	Chokecherry Shrubland
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (III.B.2.N)
FORMATION	Temperate cold-deciduous shrubland (III.B.2.N.a)
ALLIANCE	*Prunus virginiana* Shrubland Alliance
CLASSIFICATION CONFIDENCE LEVEL	2
USFWS WETLAND SYSTEM	Upland

RANGE

Globally

This association is found in Washington, Oregon, Idaho, Montana, Wyoming, western South Dakota, Colorado, and possibly Nevada.

Wind Cave National Park

Chokecherry shrublands are found throughout Wind Cave NP. Exemplary stands can be found in the bottoms and heads of draws in the prairie areas of the northeast part of the Park. Slopes with large stands of mixed shrubs in grassland can be found on the east side of Boland Ridge.

ENVIRONMENTAL DESCRIPTION

Globally

This association grows at the interface between the riparian areas and the adjacent upland. It usually occurs as small pockets on higher terraces or as narrow bands along the high water mark of steep banks and incised channels. It can also grow at the base of cliffs adjacent to rivers and streams where it forms impenetrable thickets.

Wind Cave National Park

Chokecherry shrubland is found in a variety of habitats. Slope varies from flat to very steep, with variable aspect. Stands are commonly found in the bottoms of draws and drainages. This type also occurs associated with rock outcrops. Some stands on slopes are the result of recent fire that killed the overlying canopy, converting ponderosa pine/chokecherry forest to chokecherry shrubland.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Shrub	*Prunus virginiana*

Wind Cave National Park

Stratum	Species
Shrub	*Amorpha canescens, Prunus virginiana, Rhus trilobata, Symphoricarpos occidentalis, Toxicodendron pubescens*

CHARACTERISTIC SPECIES

Globally

Prunus virginiana

Wind Cave National Park

Prunus virginiana

VEGETATION DESCRIPTION

Globally

The *Prunus virginiana* association is a medium-height (4-6 feet, 1.5-2 m) shrubland with dense vegetation which is almost impossible to walk through. Prunus virginiana is the most abundant shrub. Further review of the global type is necessary.

Wind Cave National Park
Chokecherry shrubland at Wind Cave NP is characterized by moderate to dense shrub cover, typically in the 25-75% range. Shrub cover is generally greater in drainage bottoms and on lowermost slopes, and less on slopes. Chokecherry may be the dominant shrub species, but often other species are codominant or dominant, especially on slopes, including squaw-bush (*Rhus trilobata*), downy indigo-bush (*Amorpha canescens*), western snowberry (*Symphoricarpos occidentalis*) and poison ivy (*Toxicodendron pubescens*). In drainage bottom situations, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in some grassland type, and graminoid cover can be greater than 75%.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4Q

DATABASE CODE CEGL001108

MAP UNITS
The chokecherry shrubland community corresponds to map unit 33, chokecherry shrubland, on the Wind Cave vegetation map. Chokecherry shrubland with standing dead trees and few or no living trees corresponds to map unit 12, chokecherry shrubland (with burned ponderosa pine).

COMMENTS
Wind Cave National Park
Chokecherry shrubland occurs as small stands in drainage bottoms. The stands of mixed shrubs on slopes can be somewhat larger. The chokecherry shrubland type frequently grades into the western snowberry shrubland type, and some stands are difficult to classify. On slopes, chokecherry may be uncommon or even absent; squaw-bush (*Rhus trilobata*) may be the dominant shrub in these situations. Chokecherry shrubland is a fairly common type at Wind Cave NP. Many stands were visited in preparing the vegetation map, as the type is variable and somewhat difficult to characterize.

Chokecherry shrublands on slopes are generally surrounded by grassland types. In drainage bottoms, stands are often adjacent to western snowberry shrubland, and the two types grade into each other. Chokecherry shrublands may also occur as inclusions in ponderosa pine types, as a result of fire and pine mortality.

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Salix bebbiana Shrubland

COMMON NAME	Gray Willow Shrubland
SYNONYM	Beaked Willow Scrub
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (III.B.2.N)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d)
ALLIANCE	*Salix bebbiana* Temporarily Flooded Shrubland Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Palustrine

RANGE

Globally

This community has been identified in the Black Hills of South Dakota and Wyoming. It also appears in Montana.

Wind Cave National Park

Bebb's willow shrubland does not occur in Wind Cave NP. It is found along streams in the area west of the Park.

ENVIRONMENTAL DESCRIPTION

Globally

This community is a briefly flooded scrub-shrub wetland on slightly to moderately alkaline soils, usually near low-gradient streams. The water table is well below the soil surface for over half the growing season. However, there are brief periods of several days to a few weeks when water is at the surface.

Wind Cave National Park

Bebb's willow shrubland occurs in narrow zones along streams in the Wind Cave NP area.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Shrub	*Salix bebbiana*
Herbaceous	*Carex* spp., *Scirpus* spp.

Wind Cave National Park

Stratum	Species
Shrub	*Salix bebbiana*

CHARACTERISTIC SPECIES

Globally

Salix bebbiana

Wind Cave National Park

Salix bebbiana

VEGETATION DESCRIPTION

Globally

This shrubland is typically dominated by a dense growth of shrubs 0.5-3 m tall. The most abundant species in the shrub layer are *Salix bebbiana, Salix scouleriana*, and *Salix fendleriana*. Other species found in this strata include *Betula occidentalis, Cornus sericea* ssp. sericea, *Salix exigua, Salix fluviatilis*, and *Prunus virginiana.* Multiple-stemmed trees and/or shrubs 1.5-5 m tall have 30-100% cover; single-stemmed trees have less than 30% cover. The herbaceous layer often contains *Scirpus* spp., *Carex* spp., *Triglochin palustris, Calamagrostis canadensis*, and *Equisetum* spp. along the wetter margins of the community. In the drier areas *Gentiana strictiflora, Prunella vulgaris, Pyrola asarifolia, Zizia cordata, Sanicula marilandica, Viola canadensis, Vicia americana*, and *Ranunculus macounii* are frequently present.

Wind Cave National Park
Bebb's Willow Shrubland is strongly dominated by Bebb's willow, with cover in the 50-75% range and sometimes greater. In the Wind Cave area, other shrubs that contribute minor cover are juneberry (*Amelanchier alnifolia*) and several species of currant (*Ribes* spp.). Herbaceous cover is sparse overall, but patches of western Great Plains streamside vegetation can be found in openings in the willows.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3?. Most sites have been impacted by grazing.

DATABASE CODE CEGL001173

MAP UNITS
The Bebb's willow community corresponds to map unit 34, Bebb Willow Shrubland, on the Wind Cave vegetation map.

COMMENTS

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Symphoricarpos occidentalis Shrubland

COMMON NAME	Western Snowberry Shrubland
SYNONYM	Wolfberry Shrubland
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B)
PHYSIOGNOMIC GROUP	Cold-deciduous shrubland (III.B.2)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (III.B.2.N)
FORMATION	Temporarily flooded cold-deciduous shrubland (III.B.2.N.d)
ALLIANCE	*Symphoricarpos occidentalis* Temporarily Flooded Shrubland Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community is widespread in western Montana and North Dakota. It is also present in South Dakota, Nebraska, Wyoming, and Saskatchewan.

Wind Cave National Park

Stands of western snowberry are found throughout Wind Cave NP, in both forested and prairie areas.

ENVIRONMENTAL DESCRIPTION

Globally

This community is found in mesic swales, depressions, ravines and floodplains. Some examples of this community experience intermittent and brief flooding. The soils are fertile and well drained to imperfectly drained silts and loams. The upper soil horizon is usually deep, although a thin layer of sand may be present if the site has been recently flooded (Jones 1995).

Wind Cave National Park

Western snowberry shrublands occur most commonly on level sites in the bottoms of draws, drainages and swales in both forested and prairie areas. Stands of western snowberry are found occasionally on gentle to moderate slopes of various aspects.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Shrub	*Symphoricarpos occidentalis*
Herbaceous	*Artemisia ludovicianan, Pascopyrum smithii*

Wind Cave National Park

Stratum	Species
Shrub	*Symphoricarpos occidentalis*
Herbaceous	*Artemisia ludoviciana, Nassella viridula, Poa pratensis*

CHARACTERISTIC SPECIES

Globally

Pascopyrum smithii, Symphoricarpos occidentalis

Wind Cave National Park

Nassella viridula, Poa pratensis, Symphoricarpos occidentalis

VEGETATION DESCRIPTION

Globally

Throughout its range this community is dominated by shrubs approximately 1 m tall. Shrub cover is typically greater than 50%. In places it can approach 100%. These shrubs form dense clumps that exclude most other species. *Symphoricarpos occidentalis* is the most common shrub, but *Rhus aromatica* (or *Rhus trilobata*) and *Prunus virginiana* can be locally abundant and can grow to 2-3 meters in places. Herbaceous species and smaller shrubs are most abundant at the edge of this community and in gaps between the clumps of taller shrubs where the shading is less complete. *Rosa woodsii* is a typical smaller shrub. *Achillea millefolium, Artemisia*

ludoviciana, Galium boreale, and *Pascopyrum smithii* are common herbaceous species of this community. Woody vines sometimes occur, including *Parthenocissus vitacea*.

The *Symphoricarpos occidentalis* shrubland type occurs as thickets thoughout its range. These thickets are surrounded by grasslans or occasionally tall shrublands (e.g., *Prunus virginana*)

Wind Cave National Park
Western snowberry shrublands at Wind Cave NP typically have dense shrub cover, in the 75-100% range. Western snowberry usually is strongly dominant, but occasionally other shrubs are codominant, including chokecherry (*Prunus virginiana*), downy indigobush (*Amorpha canescens*) and poison ivy (*Toxicodendron pubescens*). Herbaceous cover is sparse; green needlegrass (*Nassella viridula*), Kentucky bluegrass (*Poa pratensis*) and white sagebrush (*Artemisia ludoviciana*) occur frequently. Occasionally, herbaceous cover may be dense, with forbs such wild bergamot bee-balm (*Mondarda fistulosa*) or wild licorice (*Glycyrrhiza lepitoda*) overtopping the shrubs.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4G5

DATABASE CODE CEGL001131

MAP UNITS
The western snowberry community corresponds to map unit 35, western snowberry shrubland, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
The western snowberry type occasionally grades into chokecherry shrubland, and some stands are difficult to classify. Western snowberry shrubland is a common vegetation type at Wind Cave NP. Relatively few stands were visited during preparation of the vegetation map, as structure and composition of stands is quite consistent.

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Juniperus horizontalis / Schizachyrium scoparium Dwarf-shrubland

COMMON NAME	Creeping Juniper / Little Bluestem Dwarf-shrubland
SYNONYM	Creeping Juniper / Little Bluestem Dwarf- shrubland
PHYSIOGNOMIC CLASS	Dwarf-shrubland (IV)
PHYSIOGNOMIC SUBCLASS	Evergreen dwarf-shrubland (IV.A)
PHYSIOGNOMIC GROUP	Needle-leaved or microphyllous evergreen dwarf-shrubland (IV.A.1)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (IV.A.1.N)
FORMATION	Creeping or matted needle-leaved or microphyllous evergreen dwarf-shrubland (IV.A.1.N.b)
ALLIANCE	*Juniperus horizontalis* Dwarf-Shrubland Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community is found in South Dakota, North Dakota, southeast, central, and northeastern Montana, and southern Manitoba. Further details of its distribution within these states and province are not available.

Wind Cave National Park

Creeping juniper vegetation is rare at Wind Cave NP. It was found only in the Red Valley roughly east of the junction of NPS Rds. 5 and 6.

ENVIRONMENTAL DESCRIPTION

Globally

This association is found on silty loam, sandy loam, or clay loam soil and occurs on moderate to steep slopes, usually on upper slopes. In North Dakota, Montana, and South Dakota it is on north- and, rarely, west-facing slopes. In Manitoba it is thought to occur on dry south-facing slopes. Parent materials are sandstone, siltstone, claystone, and sandy glacial till.

Wind Cave National Park

Creeping juniper/little bluestem dwarf shrubland was found only in the Red Valley on sites underlain by the Spearfish Formation. Stands were found on mid to upper moderate to somewhat steep slopes with easterly aspects.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Dwarf-shrub	*Juniperus horizontalis*
Herbaceous	*Carex filifolia, Carex inops* ssp. *heliophila, Koeleria macrantha, Schizachyrium scoparium*

Wind Cave National Park

Stratum	Species
Dwarf-shrub	*Juniperus horizontalis*
Herbaceous	*Andropogon gerardii, Schizachyrium scoparium*

CHARACTERISTIC SPECIES

Globally

Juniperus horizontalis, Schizachyrium scoparium

Wind Cave National Park

Juniperus horizontalis, Schizachyrium scoparium

VEGETATION DESCRIPTION

Globally

This community is dominated by short shrubs and graminoids. Vegetation cover is moderate to high. The dominant species is usually *Juniperus horizontalis*, a mat forming shrub. Other low shrubs include *Artemisia frigida, Potentilla fruticosa, Symphoricarpos*

occidentalis, and *Rosa arkansana*. *Rhus trilobata* and *Prunus virginiana* are taller shrubs that may be present. The most abundant graminoid is *Schizachyrium scoparium*. Other common graminoids include *Calamovilfa longifolia, Carex filifolia, C. inops* ssp. *heliophila, C. eleocharis, Koeleria macrantha*, and *Muhlenbergia cuspidata*. Some of the forbs that are associated with this community are *Anemone patens, Campanula rotundifolia, Comandra umbellata, Echinacea angustifolia, Dalea purpurea, Galium boreale, Senecio plattensis*, and *Linum perenne*.

Wind Cave National Park
Stands of creeping juniper/little bluestem are characterized by moderate shrub cover, in the 25-50% range, with creeping juniper strongly dominant. Sand cherry (*Prunus pumila*) and broom snakeweed (*Gutierrezia sarothrae*) are often present but sparse. Herbaceous cover was highly variable in the stands visited, ranging from 15 to 60%. Little bluestem (*Schizachyrium scoparium*) and big bluestem (*Andropogon gerardii*) contributed the greatest cover. On the less vegetated sites, a much greater diversity of forbs was found.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4

DATABASE CODE CEGL001394

MAP UNITS
The creeping juniper/little bluestem community corresponds to map unit 36, creeping juniper/little bluestem dwarf shrubland, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
The stands of creeping juniper found at Wind Cave NP are small, less than 0.5 ha in size and usually surrounded by little bluestem prairie. Creeping juniper vegetation is rare at Wind Cave NP, and so only a few stands were visited.

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Andropogon gerardii - Schizachyrium scoparium Western Great Plains Herbaceous Vegetation

COMMON NAME	Big Bluestem - Little Bluestem Western Great Plains Herbaceous Vegetation
SYNONYM	Western Bluestem Tallgrass Prairie
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Tall sod temperate grassland (V.A.5.N.a)
ALLIANCE	*Andropogon gerardii - (Sorghastrum nutans)* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Upland

RANGE

Globally

The *Andropogon gerardii - Schizachyrium scoparium* Western Great Plains Herbaceous Vegetation association occurs along the eastern foothills of the Rocky Mountains in Colorado and on basalt outcrops in the southeastern portion of the state (CNHP 1997). Johnston (1987) indicates that this association also occurs in Montana, Nebraska, Kansas, and the Dakotas, but Colorado Natural Heritage Program ecologists believe these occurrences outside of Colorado differ from the Colorado element because the association structure differs and they lack midwestern species.

Wind Cave National Park

Big bluestem - little bluestem grassland is common on slopes in the eastern half of Wind Cave NP. Exemplary stands can be found on the west side of Boland Ridge, and on the slopes of the broad flat ridges found along the eastern half of the north Park boundary.

ENVIRONMENTAL DESCRIPTION

Globally

This community occurs in nearly level to gently sloping (0-20% slope), park-like openings in ponderosa pine forests at 3,700-4,100 ft elevation. Most stands occurred on east or north aspects. Mean annual precipitation is 38-48 cm. Soils are loamy: clay loam, sandy loam and sandy clay loam (Taylor and Holst 1976). Parent materials are sandstone, siltstone, and claystone (Veseth and Montagne 1980).

Wind Cave National Park

Big bluestem - little bluestem grassland occurs on somewhat steep to steep slopes that are often rocky. Aspect varies.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Herbaceous	*Andropogon gerardii, Bouteloua curtipendula, Calamovilfa longifolia, Carex inops* ssp. *heliophila, Festuca idahoensis, Schizachyrium scoparium*

Wind Cave National Park

Stratum	Species
Herbaceous	*Andropogon gerardii, Bouteloua curtipendula*

CHARACTERISTIC SPECIES

Globally

Andropogon gerardii, Schizachyrium scoparium

Wind Cave National Park

Andropogon gerardii, Schizachyrium scoparium

VEGETATION DESCRIPTION

Globally

Stands are dominated by the tall grasses *Andropogon gerardii* and *Schizachyrium scoparium*. *Calamovilfa longifolia* may be common on more coarse-textured soils, whereas *Festuca idahoensis* may be common in mesic stands. *Bouteloua curtipendula* and *Carex inops* ssp. *heliophila* are other important graminoids. Common forbs include *Psoralea argophylla* and *Artemisia ludoviciana*. *Gutierrezia sarothrae* is a common dwarf shrub (Taylor and Holst 1976, Culwell and Skow 1981, Culwell and Skow 1982, Pase and Thelinius 1968). At Wind Cave NP in South Dakota, this grassland type is dominated by *Andropogon gerardii*. Species distribution is patchy, with big bluestem often occupying large areas to the exclusion of other species. *Bouteloua curtipendula* may be codominant and *Schizachyrium scoparium* cover is sparse to absent (H. Marriott personal communication 1999).

Wind Cave National Park
Stands of big bluestem - little bluestem have moderate to dense herbaceous cover, typically in the 50 - 75% range, and often greater. This grassland type is dominated by big bluestem (*Andropogon gerardii*). Species distribution is patchy, with big bluestem often occupying large areas to the exclusion of other species. Side-oats grama (*Bouteloua curtipendula*) may be codominant. Little bluestem (*Schizachyrium scoparium*) cover is sparse, or the species may be absent altogether. Big bluestem cover typically increases though the growing season, but there may be little vegetative production and no flowering stems in extremely dry years. Big bluestem can be a late season dominant in other grassland types at Wind Cave NP also.

Big bluestem is a warm-season grass, becoming more dominant late in the growing season. Cover varies greatly with seasonal conditions, with abundant late season moisture being quite favorable. At Wind Cave NP, little bluestem maybe be sparse or absent stands of this type, and side-oats grama (*Bouteloua curtipendula*) is often abundant.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G2. The *Andropogon gerardii - Schizachyrium scoparium* association is a regional endemic that occurs along the eastern foothills of the Rocky Mountains in Colorado and on basalt outcrops in the southeastern portion of the state (CO NHP 1997). There are twenty documented occurrences of this association. Of these occurrences, none is ranked A, five are ranked B, and forty percent are not considered viable (ranked D or H). The region in which this association is found (Colorado's Front Range and southeast Colorado) have been surveyed to a large extent by the Colorado Natural Heritage Program, so few if any additional high-quality occurrences can be expected. This association is known from about 4000 acres. Over half this amount is contained within one occurrence. Given that a vast area where this association may have formerly occurred has been developed, converted to agricultural use, or invaded by weedy species, it can be confidently assumed that this association occurs in less than ten percent of its former habitat. This association remains very threatened by development along the Front Range, gravel mining operations (e.g., near Rocky Flats), and invasion by woody species in response to a lack of fire.

DATABASE CODE CEGL001463

MAP UNITS
Big bluestem was found in many habitats and vegetation types, but only stands dominated by big bluestem with little bluestem and/or side-oats grama were recognized as a big bluestem plant community. The big bluestem - little bluestem community is one of the types included in map unit 16, western wheatgrass - Kentucky bluegrass complex, on the Wind Cave vegetation map. It is not mapped separately.

COMMENTS
Wind Cave National Park
Patches of big bluestem can occur in little bluestem grasslands. However, the habitat of the big bluestem - little bluestem community differs. This type typically occurs on steeper, rocky slopes. In addition, big bluestem is strongly dominant, and little bluestem is often uncommon or even absent. Side-oats grama is often codominant.

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Pascopyrum smithii - Nassella viridula Herbaceous Vegetation

COMMON NAME	Western Wheatgrass - Green Needlegrass Herbaceous Vegetation
SYNONYM	Western Wheatgrass - Green Needlegrass Mixedgrass Prairie
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c)
ALLIANCE	*Pascopyrum smithii* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This community is found in Wyoming, Montana, Saskatchewan, Manitoba, North Dakota, and South Dakota. Details of its distribution within these states and provinces are not available.

Wind Cave National Park

Extensive areas of western wheatgrass - green needlegrass vegetation can be found in the eastern half and southwest quarter of the Park, which are predominantly grassland. In these areas, western wheatgrass - green needlegrass often occurs with Kentucky bluegrass and little bluestem vegetation. The little bluestem community typically occurs on steeper slopes, with Kentucky bluegrass and western wheatgrass vegetation on gentler slopes and in swales. Stands also occur in other areas of the Park in openings in forests and woodlands.

ENVIRONMENTAL DESCRIPTION

Globally

This community is found at the bottom of narrow valleys, on stream terraces, and on rolling uplands (Jones 1992, USFS 1992). The soils are usually sandy loams, silt loams, or clay loams. Soil profile is typically well developed. The parent material is siltsone and mixed sedimentary rock (USFS 1992). This community usually occurs on level or nearly level ground but sometimes may be on moderate slopes of any aspect.

Wind Cave National Park

Western wheatgrass - green needlegrass stands occur in a wide variety of habitats throughout the Park. Sites generally are flat to moderate in slope, and are found on all aspects.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Herbaceous	*Nassella viridula, Pascopyrum smithii*

Wind Cave National Park

Stratum	Species
Herbaceous	*Pascopyrum smithii, Poa pratensis, Nassella viridula, Stipa comata*

CHARACTERISTIC SPECIES

Globally

Nassella viridula, Pascopyrum smithii

Wind Cave National Park

Nassella viridula, Pascopyrum smithii

VEGETATION DESCRIPTION

Globally

This community is dominated by mid grasses. The vegetation cover tends to be moderate to high, with almost all of the canopy provided by graminoids (Redmann 1975, USFS 1992). The dominant species are *Pascopyrum smithii* and *Nassella viridula*, both of

which attain heights of 0.6-1.0 m, Other mid grasses in this community are *Stipa comata, Koeleria macrantha, Poa* spp., *Sporobolus cryptandrus*, and, on sandier soils, *Calamovilfa longifolia*. Shorter graminoids are common, including *Bouteloua gracilis, Carex eleocharis, Carex filifolia,* and *Carex inops* ssp. *heliophila*. Where it is present within the range of this community, *Carex pensylvanica* may be abundant (Redmann 1975). The forbs *Astragalus* spp., *Achillea millefolium, Sphaeralcea coccinnea, Artemisia ludoviciana*, and *Lepidium densiflorum* are also typical of this community. *Artemisia frigida* is the only shrub that is usually present, although Johnston (1987) reported that tree size *Juniperus scopulorum* may also be present.

Wind Cave National Park
Stands of western wheatgrass - green needlegrass typically have moderate to dense herbaceous cover, ranging from 50 to 100%. Dominant graminoids include western wheatgrass (*Pascopyrum smithii*), green needlegrass (*Nassella viridula*), needle-and-thread (*Stipa comata*) and Kentucky bluegrass (*Poa pratensis*). Species dominance varies locally within a stand. Other common herbaceous species include white sagebrush (*Artemisia ludoviciana*), scurf-pea (*Psoralidium tenuiflorum*) and naked-spike ambrosia (*Ambrosia psilostachya*). Big bluestem (*Andropogon gerardii*) may be present, with high coverage in wetter seasons. On steeper slopes, it is not uncommon to find significant amounts of downy indigo-bush(*Amorpha canescens*), with cover greater than 20%. These shrub stands are recognized as a separate map unit for the Wind Cave vegetation map.

In stands of western wheatgrass - green needlegrass at Wind Cave NP, species dominance varies within the stand. Western wheatgrass, green needlegrass, needle-and-thread (*Stipa comata*) and Kentucky bluegrass (*Poa pratensis*) all can be locally dominant, often to the exclusion of other species. For this reason, it is important to sample multiple points in characterizing a stand of this type.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4. The G4 rank is based on the broad geographic distribution and the relatively broad environmental requirements of this association. The prevalence of cheatgrass in many stands, though, may necessitate a review of this rank.

DATABASE CODE CEGL001583

MAP UNITS
The western wheatgrass - green needlegrass community is one of the types included in map unit 16, western wheatgrass - Kentucky bluegrass complex, on the Wind Cave vegetation map. It is not mapped separately. Western wheatgrass - green needlegrass stands with standing dead trees and few or no living trees corresponds to map unit 13, western wheatgrass - Kentucky bluegrass complex (with burned ponderosa pine). Western wheatgrass - green needlegrass stands with leadplant cover greater than 20% are mapped separately as map unit 32, lead plant shrubland.

COMMENTS
Wind Cave National Park
The western wheatgrass - green needlegrass type grades into the Kentucky bluegrass type, and some stands are difficult to classify. Western wheatgrass - green needlegrass often forms a mosaic with Kentucky bluegrass and little bluestem vegetation. The little bluestem community typically occurs on steeper slopes, with Kentucky bluegrass and western wheatgrass vegetation on gentler slopes and in swales. Big bluestem may be present in stands of western wheatgrass - green needlegrass. In favorable years, big bluestem will contribute significant cover during the later part of the growing season.

Western wheatgrass - green needlegrass herbaceous vegetation is very common. Many stands were visited in preparing the vegetation map. Extensive areas of western wheatgrass - green needlegrass vegetation can be found in the eastern half and southwest quarter of the Park, which are predominantly grassland. Smaller stands occur in other areas of the Park in openings in forests and woodlands.

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

COMMON NAME	Little Bluestem - (Sideoats Grama, Blue Grama) / Threadleaf Sedge Herbaceous Vegetation
SYNONYM	Northern Great Plains Little Bluestem Prairie
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c)
ALLIANCE	*Schizachyrium scoparium* - *Bouteloua curtipendula* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally

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

Wind Cave National Park

Extensive areas of little bluestem vegetation can be found in the eastern half and southwest quarter of the Park, which are predominantly grassland. In these areas, little bluestem often occurs with western wheatgrass and Kentucky bluegrass vegetation. The little bluestem community typically occurs on steeper slopes, with Kentucky bluegrass and western wheatgrass vegetation on gentler slopes and in swales. Stands also occur in other areas of the Park in openings in forests and woodlands.

ENVIRONMENTAL DESCRIPTION

Globally

This community is usually found on moderate to steep slopes with variable aspects. The soils are typically shallow and occur over sandstone or limestone.

Wind Cave National Park

Little bluestem stands occur on slopes of variable steepness and aspect, as well as on on level sites. However, sites generally are drier, steeper and/or have poorer soils than sites that support Kentucky bluegrass and western wheatgrass - green needlegrass vegetation types.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Herbaceous	*Schizachyrium scoparium*

Wind Cave National Park

Stratum	Species
Herbaceous	*Bouteloua curtipendula, Schizachyrium scoparium*

CHARACTERISTIC SPECIES

Globally

Bouteloua curtipendula, Bouteloua gracilis, Carex inops ssp. *heliophila, Schizachyrium scoparium*

Wind Cave National Park

Bouteloua curtipendula, Carex inops ssp. *heliophila, Schizachyrium scoparium*

VEGETATION DESCRIPTION

Globally

The vegetation is predominantly composed of graminoid species less than 1 m tall with moderate to high cover. The dominant species is *Schizachyrium scoparium* with *Bouteloua curtipendula, B. gracilis*, and *Carex filifolia* as associates or codominants. *Andropogon*

gerardii, Carex inops ssp. *heliophila, C. eleocharis, Koeleria macrantha* and *Calamovilfa longifolia* are often present. *C. longifolia* may be abundant on sandier soils. *Muhlenbergia cuspidata, Stipa comata, Pascopyrum smithii*, and *Nassella viridula* may also be present. Forbs do not contribute greatly to the canopy, but many species may be found in this community. Among the forbs that may be found are *Echinacea angustifolia, Aster oblongifolius, Gaura coccinea, Lygodesmia juncea, Helianthus pauciflorus* ssp. *pauciflorus, Rosa arkansana, Liatris punctata, Pediomelum argophyllum* (= *Psoralea argophylla*), *Aster ericoides, Dalea purpurea*, and *Campanula rotundifolia.*

Wind Cave National Park
Stands of little bluestem typically have somewhat sparse to moderate herbaceous cover, ranging from 20 to 75%. Little bluestem (*Schizachyrium scoparium*) is strongly dominant. Side-oats grama (*Bouteloua curtipendula*) occurs frequently, and may be codominant. Threadleaf sedge may or may not be present. Other frequently-occurring graminoids include blue grama (*Bouteloua gracilis*), hairy grama (*Bouteloua hirsuta*), junegrass (*Koeleria macrantha*) and needle-and-thread (*Stipa comata*). A wide variety of forbs may be present in small amounts, with white sagebrush (*Artemisia ludoviciana*) the most common. Low shrubs are often present, but with less than 20% cover typically. Prairie sagebrush (*Artemisia frigida*) is the most common shrub species found.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3

DATABASE CODE CEGL001681

MAP UNITS
The little bluestem - grama grass/threadleaf sedge community corresponds to map unit 15, little bluestem - grama grass/threadleaf sedge herbaceous vegetation, on the Wind Cave vegetation map. Little bluestem grassland with standing dead trees and few or no living trees corresponds to map unit 13, little bluestem - grama grass - threadleaf sedge herbaceous vegetation (with burned ponderosa pine).

COMMENTS
Wind Cave National Park
Significant amounts of little bluestem can be found occasionally in other grassland types, especially the western wheatgrass - green needlegrass type. Kentucky bluegrass often forms a mosaic with western wheatgrass and little bluestem vegetation. The little bluestem community typically occurs on steeper slopes, with Kentucky bluegrass and western wheatgrass vegetation on gentler slopes and in swales.

Little bluestem vegetation is very common. Many stands were visited in preparing the vegetation map. Extensive areas of Kentucky bluegrass vegetation can be found in the eastern half and southwest quarter of the Park, which are predominantly grassland. Smaller stands occur in other areas of the Park in openings in forests and woodlands.

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

Stipa comata - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation

COMMON NAME	Needle-and-thread - Blue Grama - Threadleaf Sedge Herbaceous Vegetation
SYNONYM	Needle-and-Thread Grass - Blue Grama Mixedgrass Prairie
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c)
ALLIANCE	*Stipa comata - Bouteloua gracilis* Herbaceous Alliance
CLASSIFICATION CONFIDENCE LEVEL	1
USFWS WETLAND SYSTEM	Upland

RANGE

Globally

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

Wind Cave National Park

Needle-and-thread - blue grama/threadleaf sedge vegetation is uncommon at Wind Cave NP. The largest stands were found in the northeast part of the Park on the summits of broad ridges with thinner, rockier soils. Small patches were found elsewhere as inclusions in other grassland types.

ENVIRONMENTAL DESCRIPTION

Globally

This community is found on flat to gently sloping sites, predominantly with sandy loam or loam soil. The soil is typically 40-100 cm deep.

Wind Cave National Park

Needle-and-thread - blue grama/threadleaf sedge grassland was found on flat to gently sloping sites, with southerly and easterly aspects. The largest stands were found in the northeast part of the Park on the summits of broad ridges with thinner, rockier soils. Small patches were found elsewhere as inclusions in other grassland types.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Herbaceous	*Bouteloua gracilis, Carex filifolia, Pascopyrum smithii, Stipa comata*

Wind Cave National Park

Stratum	Species
Herbaceous	*Bouteloua gracilis, Carex filifolia, Pascopyrum smithii, Stipa comata*

CHARACTERISTIC SPECIES

Globally

Bouteloua gracilis, Carex filifolia, Stipa comata

Wind Cave National Park

Bouteloua gracilis, Carex filifolia, Stipa comata

VEGETATION DESCRIPTION

Globally

This midgrass prairie community is dominated by graminoids that are usually between 0.5 and 1 m tall. The vegetation cover is moderate. The dominant species are *Bouteloua gracilis, Carex filifolia*, and *Stipa comata*, with *Stipa comata* usually the most dominant. *Pascopyrum smithii* is constant in this community and can be locally abundant. *Carex duriuscula* is not always present but is abundant at some sites. Forbs that are typical of this community are *Heterotheca villosa* var. *villosa, Guara coccinea, Liatris punctata,* and *Phlox hoodii*. Sandier areas often have *Calamovilfa longifolia* present. Shrubs rarely grow taller than the grasses, but *Artemisia frigida* is very common in this community. Other grasses that are likely to be present are *Aristida purpurea* var. *longiseta, Koeleria macrantha,* and *Sporobolus cryptandrus*. ^On 19 stands in west-central Montana the cover by the different strata was as

follows: shrubs - 6%, graminoids - 67%, forbs - 11%, bryophytes - 14%, litter - 55%, rock 4%, bare soil - 9% (Mueggler and Stewart 1978). Thilenius et al. (1995) found that the average cover on 14 stands in eastern Wyoming was 42%. Tolstead (1942) described this community as the climax on the level lands of the northern part of Cherry County, Nebraska.

Wind Cave National Park
Stands of needle-and-thread - blue grama/threadleaf sedge have moderate herbaceous cover, typically between 25 and 75%. Needle-and-thread (*Stipa comata*), blue grama (*Bouteloua gracilis*), and threadleaf sedge (*Carex filifolia*) are the dominants. Other frequently-occurring graminoids include western wheatgrass (*Pascopyrum smithii*), junegrass (*Koeleria macrantha*), buffalograss (*Buchloe dactyloides*) and little bluestem (*Schizachyrium scoparium*). Low shrubs are often present, but cover is sparse - less than 20% typically. Prairie sagebrush (*Artemisia frigida*) and downy indigo-bush (*Amorpha canescens*) are the most frequently occurring shrubs.

OTHER NOTEWORTHY SPECIES

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

DATABASE CODE CEGL002037

MAP UNITS
The needle-and-thread - blue grama/threadleaf sedge community corresponds to map unit 18, needle-and-thread - blue grama/threadleaf sedge herbaceous vegetation, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
Needle-and-thread - blue grama/threadleaf sedge vegetation is uncommon at Wind Cave NP, and only a few stands large enough for sampling and mapping were found.

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

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Poa pratensis Herbaceous Vegetation [Provisional]

COMMON NAME	Kentucky Bluegrass Herbaceous Vegetation
SYNONYM	
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	*Poa pratensis* Seasonally Flooded Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This association is found in California, Oregon, Washington, Idaho, Montana, Wyoming, and South Dakota.

Wind Cave National Park

Extensive areas of Kentucky bluegrass vegetation can be found in the eastern half and southwest quarter of the Park, which are predominantly grassland. In these areas, Kentucky bluegrass often occurs with western wheatgrass and little bluestem vegetation. The little bluestem community typically occurs on steeper slopes, with Kentucky bluegrass and western wheatgrass vegetation on gentler slopes and in swales. Stands also occur in other areas of the Park in openings in forests and woodlands.

ENVIRONMENTAL DESCRIPTION

Globally

This association is poorly defined throughout its range and needs further review.

Wind Cave National Park

Kentucky bluegrass stands occur in a wide variety of habitats throughout the Park. Sites generally are flat to moderate in slope, and are found on all aspects.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Herbaceous	*Poa pratensis*

Wind Cave National Park

Stratum	Species
Herbaceous	*Ambrosia ludoviciana, Artemisia psilostachya, Poa pratensis, Psoralidium tenuiflorum*

CHARACTERISTIC SPECIES

Globally

Poa pratensis

Wind Cave National Park

Poa pratensis

VEGETATION DESCRIPTION

Wind Cave National Park

Stands of Kentucky bluegrass (*Poa pratensis*) typically have moderate to dense herbaceous cover, ranging from 50 to 100%. Kentucky bluegrass contributes at least 75% of that cover. Other common herbaceous species include white sagebrush (*Artemisia ludoviciana*), scurf-pea (*Psoralidium tenuiflorum*) and naked-spike ambrosia (*Ambrosia psilostachya*). Big bluestem (*Andropogon gerardii*) may be present, with high coverage in wetter seasons. On steeper slopes, it is not uncommon to find significant amounts of downy indigo-bush (*Amorpha canescens*) with cover greater than 20%. These shrub stands are recognized as a separate map unit for the Wind Cave vegetation map.

Globally
Information not available.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK GW

DATABASE CODE CEGL003081

MAP UNITS
Kentucky bluegrass often is common or codominant in other grassland types. Only stands in which greater than 75% of the herbaceous cover is Kentucky bluegrass are classified as *Poa pratensis* Herbaceous Vegetation. The Kentucky bluegrass community is one of the types included in map unit 16, western wheatgrass - Kentucky bluegrass complex, on the Wind Cave vegetation map. It is not mapped separately. Kentucky bluegrass stands with standing dead trees and few or no living trees corresponds to map unit 13, western wheatgrass - Kentucky bluegrass complex (with burned ponderosa pine). Kentucky bluegrass stands with leadplant cover greater than 20% are mapped separately as map unit 32, leadplant shrubland.

COMMENTS
Wind Cave National Park
The Kentucky bluegrass type grades into the western wheatgrass - green needlegrass type, and some stands are difficult to classify. Only stands in which greater than 75% of the herbaceous cover is Kentucky bluegrass are classified as *Poa pratensis* Herbaceous Vegetation. Extensive areas of Kentucky bluegrass vegetation can be found in the eastern half and southwest quarter of the Park, which are predominantly grassland. Smaller stands occur in other areas of the Park in openings in forests and woodlands. Kentucky bluegrass often forms a mosaic with western wheatgrass and little bluestem vegetation. The little bluestem community typically occurs on steeper slopes, with Kentucky bluegrass and western wheatgrass vegetation on gentler slopes and in swales.

Kentucky bluegrass herbaceous vegetation is very common. Many stands were visited in preparing the vegetation map.

Kentucky bluegrass is an early, cool-season grass. At Wind Cave NP, stands were found that were dominated by Kentucky bluegrass early in the season, with big bluestem becoming dominant later in the summer.

REFERENCES
Sawyer, J.O. and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society, Sacramento, CA. 471 pp.

Spartina pectinata - Carex spp. Herbaceous Vegetation

COMMON NAME	Prairie Cordgrass - Sedge species Herbaceous Vegetation
SYNONYM	Prairie Cordgrass - Sedge Wet Meadow
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Temporarily flooded temperate or subpolar grassland (V.A.5.N.j)
ALLIANCE	*Spartina pectinata* Temporarily Flooded Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Palustrine

RANGE

Globally

This association is found in Montana and western South Dakota.

Wind Cave National Park

The prairie cordgrass - sedge vegetation type is uncommon. Stands were found in drainage bottoms in the north central part of the Park (Sanctuary and Centennial Trail areas).

ENVIRONMENTAL DESCRIPTION

Globally

At Wind Cave NP in South Dakota, prairie cordgrass - sedge stands occur in drainage bottoms where the soil is wet for at least part of the growing season (H. Marriot personal communication 1999).

Wind Cave National Park

Prairie cordgrass - sedge stands occur in drainage bottoms where the soil is wet for at least part of the growing season.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Herbaceous	*Eleocharis palustris, Carex nebrascensis, Spartina pectinata*

Wind Cave National Park

Stratum	Species
Herbaceous	*Eleocharis palustris, Carex nebrascensis, Spartina pectinata*

CHARACTERISTIC SPECIES

Globally

Eleocharis palustris, Carex nebrascensis, Spartina pectinata

Wind Cave National Park

Eleocharis palustris, Carex nebrascensis, Spartina pectinata

VEGETATION DESCRIPTION

Globally

At Wind Cave NP in South Dakota, this type has dense herbaceous cover, greater than 75%. Species dominance is patchy within stands, with various graminoids locally abundant, often to the exclusion of other species. In the single sampled stand, *Spartina pectinata, Carex nebrascensis,* and *Eleocharis palustris* were locally dominant. *Epilobium ciliatum* was common in shallow water (H. Marriott personal communication 1999).

Wind Cave National Park

Prairie cordgrass - sedge vegetation has dense herbaceous cover, greater than 75%. Species dominance is patchy within stands, with various graminoids locally abundant, often to the exclusion of other species. In the single stand sampled, cordgrass (*Spartina*

pectinata), Nebraska sedge (*Carex nebrascensis*) and pale spikerush (*Eleocharis palustris*) were locally dominant. Hairy willow-herb (*Epilobium ciliatum*) was common in shallow water.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G3?

DATABASE CODE CEGL001477

MAP UNITS
The prairie cordgrass - sedge community is one type included in map unit 14, emergent wetland herbaceous complex, on the Wind Cave vegetation map. It is not mapped separately.

COMMENTS
Wind Cave National Park
Stands of prairie cordgrass - sedge vegetation at Wind Cave NP are small. Only a few stands are sufficiently large to map and sample.

Cordgrass - sedge stands dry out later in the growing season during most years.

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

Eleocharis palustris Herbaceous Vegetation

COMMON NAME	Pale Spikerush Herbaceous Vegetation
SYNONYM	Creeping Spikerush Wet Meadow
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Seasonally flooded temperate or subpolar grassland (V.A.5.N.k)
ALLIANCE	*Eleocharis palustris* Seasonally Flooded Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 1

USFWS WETLAND SYSTEM Palustrine

RANGE

Globally

This widespread association is found in Colorado, Idaho, western South Dakota, Montana, Wyoming, Washington, Oregon, Utah, and Saskatchewan. It may also be in California and Nevada.

Wind Cave National Park

Pale spikerush vegetation is uncommon at Wind Cave NP. Only two stands in depressions were found. A small stand is located near the Highland Creek trailhead. A large stands was found and sampled on Bison Flats. Small patches occur elsewhere in the park, for example along streams.

ENVIRONMENTAL DESCRIPTION

Globally

In northwest Nebraska, this community occurs in small depressions in intermittent stream beds that flood early in the season and dry out by summer. Soils are silty clay formed from weathered siltstone and shale (Steinauer and Rolfsmeier 1997).

Wind Cave National Park

Pale spikerush vegetation is best developed in depressions on broad level sites (e.g. Bison Flats) that hold water for at least part of the growing season. Small patches occur elsewhere, for example along streams.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Herbcaceous	*Eleocharis palustris*

Wind Cave National Park

Stratum	Species
Herbaceous	*Eleocharis palustris*

CHARACTERISTIC SPECIES

Globally

Eleocharis palustris

Wind Cave National Park

Eleocharis palustris

VEGETATION DESCRIPTION

Globally

In northwest Nebraska, stands are dominated by submersed and emergent rooted vegetation under 1 m tall. *Eleocharis acicularis* and *Eleocharis palustris* commonly cover the bottoms of the pools and emerge above the water as the pools dry out. Ephemeral submersed aquatics, such as *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 Rolfsmeier 1997). At Wind Cave NP in South Dakota, pale spikerush vegetation is composed of nearly homogeneous stands of pale spikerush

(*Eleocharis palustris*). Other emergents, such as water smartweed (*Polygonum amphibium*), hairy water-fern (*Marsilia vestita*) and ovate spikerush (*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 roundleaf water-hyssop (*Bacopa rotundifolia*) and blue mud-plantain (*Heteranthera limosa*) (H. Marriott personal communication 1999).

Wind Cave National Park
Pale spikerush vegetation is composed of nearly homogeneous stands of pale spikerush (*Eleocharis palustris*). Other emergents, such as water smartweed (*Polygonum amphibium*), hairy water-fern (*Marsilia vestita*) and ovate spikerush (*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 roundleaf water-hyssop (*Bacopa rotundifolia*) and blue mud-plantain (*Heteranthera limosa*).

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G5

DATABASE CODE CEGL001833

MAP UNITS
The pale spikerush community is one type included in map unit 14, emergent wetland herbaceous complex, on the Wind Cave vegetation map. It is not mapped separately.

COMMENTS
Wind Cave National Park
Pale spikerush vegetation is uncommon at Wind Cave NP. Only two stands in depressions were found, and only one was large enough to sample. Small patches occur along streams also. Small patches of pale spikerush can be found also in stands classified as prairie cordgrass - sedge herbaceous vegetation, and western Great Plains streamside vegetation.

Pale spikerush stand size is dependent on the season's moisture. Pale spikerush stands dry out later in the growing season during most years.

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Scirpus spp. - Mixed Herbaceous Great Plains Streamside Herbaceous Vegetation

COMMON NAME	Bulrush - Mixed Herbaceous Great Plains Streamside Herbaceous Vegetation
SYNONYM	Western Great Plains Streamside Vegetation
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	Semipermanently flooded temperate or subpolar grassland (V.A.5.N.l)
ALLIANCE	*Typha (angustifolia, latifolia) - (Scirpus* spp.*)* Semipermanently Flooded Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Palustrine

RANGE

Globally

This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park

Western Great Plains streamside vegetation is found along streams that flow for much of the growing season. Exemplary stands can be found along Highland Creek from the north Park boundary south to where the stream disappears, and intermittently along Beaver Creek for much of its length.

ENVIRONMENTAL DESCRIPTION

Globally

This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park

Western Great Plains streamside vegetation is found in a narrow zone immediately adjacent to streams that flow during much of the growing season (some streams are seasonally-intermittent). This type of vegetation does not develop along streams with steep banks.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Information not available.	

Wind Cave National Park

Stratum	Species
Herbaceous	*Agrostis stolonifera, Glyceria grandis, Poa palustris, Scirpus palidus*

CHARACTERISTIC SPECIES

Globally

Information not available.

Wind Cave National Park

Agrostis stolonifera, Glyceria grandis, Poa palustris, Scirpus palidus

VEGETATION DESCRIPTION

Globally

This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park

Western Great Plains streamside vegetation is dominated by a mix of graminoids and forbs, with herbaceous cover approaching 100%. Dominance is patchy within stands; local dominants include redtop bent (*Agrostis stolonifera*), American mannagrass (*Glyceria grandis*), fowl bluegrass (*Poa palustris*), pale bulrush (*Scirpus pallidus*), pale spikerush (*Eleocharis palustris*), rice cutgrass

(*Leersia oryzoides*) rough bugleweed (*Lycopus asper*), western water-hemlock (*Cicuta douglasii*), and watercress (*Rorippa nasturtium-aquatica*).

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G?

DATABASE CODE CEGL005263

MAP UNITS
Western Great Plains streamside vegetation is one type included in map unit 14, emergent wetland herbaceous vegetation, on the Wind Cave vegetation map. It is not mapped separately.

COMMENTS
Wind Cave National Park
Western Great Plains streamside vegetation is infrequent at Wind Cave NP. Only a few stands are large enough to map, two of which were sampled during this project. Some streams on which this occurs are seasonally-intermittent.

REFERENCES

Bromus tectorum Herbaceous Vegetation [Provisional]

COMMON NAME	Cheatgrass Herbaceous Vegetation
SYNONYM	Cheatgrass Annual Grassland
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Annual graminoid or forb vegetation (V.D)
PHYSIOGNOMIC GROUP	Temperate or subpolar annual grasslands or forb vegetation (V.D.2)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.D.2.N)
FORMATION	Short temperate annual grassland (V.D.2.N.d)
ALLIANCE	*Bromus tectorum* Herbaceous Alliance

CLASSIFICATION CONFIDENCE LEVEL

USFWS WETLAND SYSTEM Upland

RANGE
Globally
This association was newly derived from Black Hills data and needs further rangewide review.

Wind Cave National Park
Most stands of weedy non-native graminoids at Wind Cave NP are small. Only one of mappable size was found, in the vicinity of the Sanctuary/Centennial trail junction. The type is most commonly found along roads.

ENVIRONMENTAL DESCRIPTION
Globally

Wind Cave National Park
Weedy non-native graminoid vegetation occurs on recently-disturbed areas, most commonly along roads. Small stands occur in prairie dog towns also.

MOST ABUNDANT SPECIES
Globally

Stratum	Species

Information not available.

Wind Cave National Park

Stratum	Species
Herbaceous	*Bromus japonicus, Bromus inermis, Bromus tectorum*

CHARACTERISTIC SPECIES
Globally
Information not available.

Wind Cave National Park
Bromus japonicus, Bromus inermis, Bromus tectorum

VEGETATION DESCRIPTION
Globally
This association was newly derived from Black Hills data and needs further rangewide review.

Wind Cave National Park
Weedy non-native graminoid vegetation is usually dominated by several perennial and annual bromegrasses, including smooth brome (*Bromus inermis*), Japanese brome (*Bromus japonicus*) and cheatgrass (*Bromus tectorum*). Cover is variable.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK GW

DATABASE CODE CEGL003019

MAP UNITS
Introduced weedy graminoid herbaceous vegetation corresponds to map unit 17, introduced grassland herbaceous alliance, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
Most stands of weedy non-native graminoids at Wind Cave NP are small. Only one of mappable size was found.

REFERENCES
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Cirsium arvense - Weedy Forb Great Plains Herbaceous Vegetation [Provisional]

COMMON NAME	Canada Thistle - Weedy Forb Herbaceous Vegetation [Provisional]
SYNONYM	Great Plains Weedy Meadows
PHYSIOGNOMIC CLASS	Herbaceous (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (V.A.5.N)
FORMATION	
ALLIANCE	[Not developed]

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE
Globally
This association was newly derived from Black Hills data and needs further rangewide review.

Wind Cave National Park
Recent burn sparse vegetation is found in areas of recent prescribed fires at Wind Cave NP.

ENVIRONMENTAL DESCRIPTION
Globally
This association was newly derived from Black Hills data and needs further rangewide review.

Wind Cave National Park
Recent burn sparse vegetation is found on sites of all aspects and slopes that have been well-burned within the past several years.

MOST ABUNDANT SPECIES
Globally

Stratum	Species

Information not available.

Wind Cave National Park

Stratum	Species
Herbaceous	*Cirsium arvense, Conyza canadensis, Oryzopsis micrantha, Verbascum thapsus*

CHARACTERISTIC SPECIES
Globally
Information not available.

Wind Cave National Park
Informatio not available.

VEGETATION DESCRIPTION
Globally
This association was newly derived from Black Hills data and needs further rangewide review.

Wind Cave National Park
Cover and species composition of recent burn sparse vegetation is quite variable, both among and within stands. Some areas support lush growth of early successional species; others are largely bare blackened soil. Common species include Canada thistle (*Cirsium arvense*), mullein (*Verbascum thapsus*), little mountain-ricegrass (*Oryzopsis micrantha*), hoarhound (*Marrubium vulgare*) and Canada horseweed (*Conyza canadensis*). Typically there is an overstory of standing dead trees.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK GW

DATABASE CODE CEGL005260

MAP UNITS
Recent burn sparse vegetation is one of the types included in map units 11, 12 and 13, burned ponderosa pine woodlands, on the Wind Cave vegetation map. It is not mapped separately.

COMMENTS
Wind Cave National Park
The recent burn sparse vegetation type develops only after fires hot enough to kill most of the understory. Recently-burned stands with intact shrub and/or herbaceous strata are classifed as the appropriate shrub or herbaceous vegetation type.

The recent burn sparse vegetation type is an early successional stage that develops on well-burned sites during the first few years following a fire. The recent burn sparse vegetation type often occurs in a mosaic with unburned or partially burned pine forest and woodland types.

A large percentage of the recent burn sparse vegetation at Wind Cave NP was visited during the mapping project.

REFERENCES

Prairie Dog Town Grassland Complex

COMMON NAME	Prairie Dog Town Grassland Complex
SYNONYM	Prairie Dog Town Grassland Complex
PHYSIOGNOMIC CLASS	Not applicable
PHYSIOGNOMIC SUBCLASS	Not applicable
PHYSIOGNOMIC GROUP	Not applicable
PHYSIOGNOMIC SUBGROUP	Not applicable
FORMATION	Not applicable
ALLIANCE	Not applicable

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE
Globally
This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park
Prairie dog towns are scattered throughout Wind Cave NP. The largest are in the southwest part of the Park.

ENVIRONMENTAL DESCRIPTION
Globally
This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park
Prairie dog town grassland complex is found on level to moderately sloping sites of all aspects, on highly-disturbed soil. This type is best developed in dog towns on flat to gently-rolling terrain.

MOST ABUNDANT SPECIES
Globally

Stratum	Species
Information not available.	

Wind Cave National Park

Stratum	Species
Herbaceous	*Aristida purpurea, Conyza ramosissima, Cirsium arvense, Dyssodia papposa, Verbena bracteata*

CHARACTERISTIC SPECIES
Globally
Information not available.

Wind Cave National Park
Aristida purpurea, Conyza ramosissima, Cirsium arvense, Dyssodia papposa, Verbena bracteata

VEGETATION DESCRIPTION
Globally
This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park
The prairie dog town grassland complex type is variable in terms of herbaceous cover, averaging from 20 to 50% with patches of 100% cover common. Purple three-awn (*Aristida purpurea*) is often strongly dominant locally, but distribution is intermittent. Stands typically are quite patchy in terms of species distribution, with dominance varying locally. Other local dominants include large-bract vervain (*Verbena bracteata*), Canada thistle (*Cirsium arvense*), common hoarhound (*Marrubium vulgare*), dwarf conyza (*Conyza ramosissima*) and fetid dogweed (*Dyssodia papposa*).

Prairie dog town grassland complexes are patchy in terms of species distribution, with dominance varying locally within a stand. This is typical of early successional species on disturbed sites.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G?

DATABASE CODE CECX002003

MAP UNITS
The prairie dog town grassland complex corresponds to map unit 1, purple three-awn - fetid marigold herbaceous vegetation, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
Prairie dog town grassland complex vegetation occurs on the naturally-disturbed soils of prairie dog towns. Prairie dog town grassland complex vegetation is quite patchy, and variable in terms of species distribution, with dominance varying locally within a stand. This is typical of early successional species on disturbed sites.

Prairie dog town grassland complexes at Wind Cave NP range from less than a half ha to over five ha in size. The prairie dog town grassland complex type was well-surveyed during preparation of the vegetation map.

REFERENCES

Redbeds (Siltstone, Sandstone, Gypsum) Sparse Vegetation

COMMON NAME	Redbeds (Siltstone, Sandstone, Gypsum) Sparse Vegetation
SYNONYM	Redbeds Rock Outcrop
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Consolidated rock sparse vegetation (VII.A)
PHYSIOGNOMIC GROUP	Sparsely vegetated cliffs (VII.A.1)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (VII.A.1.N)
FORMATION	Cliffs with sparse vascular vegetation (VII.A.1.N.a)
ALLIANCE	Rock Outcrop/Butte Sparsely Vegetated Alliance

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park

The redbeds sparse vegetation type is uncommon and restricted to the Red Valley in the eastern part of the Park.

ENVIRONMENTAL DESCRIPTION

Globally

This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park

Redbeds sparse vegetation is found in areas underlain by red sandstones and siltstones of the Spearfish Formation. Gypsum lenses are common, and form resistant bands and caps. Soils are poor, loose, and easily eroded. This type is found on level sites and slopes of varied steepness and aspect.

MOST ABUNDANT SPECIES

Globally

Stratum	Species
Information not available.	

Wind Cave National Park

Stratum	Species
Herbaceous	Variable

CHARACTERISTIC SPECIES

Globally

Information not available.

Wind Cave National Park

Heterotheca villosa, Paronychia depressa, Eriogonum pauciflorum

VEGETATION DESCRIPTION

Globally

This association has been derived based on data from the Black Hills. Rangewide information has not yet been compiled.

Wind Cave National Park

The redbeds sparse vegetation type typically has less than 10% vegetative cover. Species that are often present include sand cherry (*Prunus pumila*), prairie sagebrush (*Artemisia frigida*), needle-and-thread (*Stipa comata*), little bluestem (*Schizachyrium scoparium*), hairy golden-aster (*Heterotheca villosa*), Rocky Mountain nail-wort (*Paronychia depressa*) and wild buckwheat (*Eriogonum pauciflorum*).

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G?

DATABASE CODE CEGL005261

MAP UNITS
Redbeds sparse vegetation corresponds to map unit 3, gypsum rock outcrop/redbeds sparse vegetation, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
Redbeds sparse vegetation develops on naturally eroded sites underlain by the Spearfish Formation. They occur as small inclusions in grassland vegetation. Gypsum zones within the redbeds also are sparsely vegetated, with the same species commonly found.

The redbeds sparse vegetation type is uncommon and restricted to the Red Valley. Many of these stands were visited during vegetation mapping.

REFERENCES

Black Hills Granite/Metamorphic Rock Outcrop Sparse Vegetation

COMMON NAME	Black Hills Granite/Metamorphic Rock Outcrop Sparse Vegetation
SYNONYM	Black Hills Granite/Metamorphic Rock Outcrop
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Consolidated rock sparse vegetation (VII.A)
PHYSIOGNOMIC GROUP	Sparsely vegetated cliffs (VII.A.1)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (VII.A.1.N)
FORMATION	Cliffs with sparse vascular vegetation (VII.A.1.N.a)
ALLIANCE	Rock Outcrop/Butte Sparsely Vegetated Alliance

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This association is found in western South Dakota and may be related to rock outcrops in the Rocky Mountains.

Wind Cave National Park

No mappable stands of Black Hills rock outcrop sparse vegetation were found within Wind Cave NP. However, the type is common just west of the Park on Forest Service lands.

ENVIRONMENTAL DESCRIPTION

Globally

This community is found where granite or schist bedrock is exposed in the higher elevations of the Black Hills. Slopes range from none (flat) to steep. There is little soil development; what soil there is can be found in cracks and depressions in the rock surface.

Wind Cave National Park

Black Hills Rock Outcrop Sparse Vegetation occurs on large granite and schist outcrops.

MOST ABUNDANT SPECIES

Globally

Stratum	Species

Few vascular species occur in this association.

Wind Cave National Park

Stratum	Species

Few vascular species occur in this association.

CHARACTERISTIC SPECIES

Globally

Few vascular species occur in this association.

Wind Cave National Park

Few vascular species occur in this association.

VEGETATION DESCRIPTION

Globally

Few vascular plants grow in this community, although lichens are common. Widely scattered *Pinus ponderosa* grow in cracks and crevices. Dwarf-shrubs and herbaceous species, such as *Arctostaphylos uva-ursi, Juniperus communis, Campanula rotundifolia*, and *Carex inops* ssp. *heliophila*, can be found in soil pockets.

Wind Cave National Park

Black Hills rock outcrop sparse vegetation typically consists of scattered ponderosa pine trees, shrubs and herbaceous species growing in crevices and pockets of soil. Squaw-bush (*Rhus trilobata*), kinnikinnik (*Arctostaphylos uva-ursi*), chokecherry (*Prunus virginiana*) and harebell (*Campanula rotundifolia*) are often found at these sites.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G4G5

DATABASE CODE CEGL002295

MAP UNITS
This type includes granite and schist outcrops. Other rock outcrops found in the Black Hills are not included (e.g. limestones and sandstones). Black Hills rock outcrop sparse vegetation corresponds to map unit 4, granite/schist rock outcrop sparse vegetation, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
This type includes granite and schist outcrops. Other rock outcrops found in the Black Hills are not included (e.g. limestones and sandstones).

REFERENCES

Pinus ponderosa Limestone Cliff Sparse Vegetation

COMMON NAME	Ponderosa Pine Limestone Cliff Sparse Vegetation
SYNONYM	Ponderosa Pine Limestone Cliff
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Consolidated rock sparse vegetation (VII.A)
PHYSIOGNOMIC GROUP	Sparsely vegetated cliffs (VII.A.1)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (VII.A.1.N)
FORMATION	Cliffs with sparse vascular vegetation (VII.A.1.N.a)
ALLIANCE	Open Bluff/Cliff Sparsely Vegetated Alliance

CLASSIFICATION CONFIDENCE LEVEL 2

USFWS WETLAND SYSTEM Upland

RANGE

Globally

This association is found in western South Dakota and western Nebraska.

Wind Cave National Park

Limestone outcrops are common in the central part of Wind Cave NP (east of Hwy 387 and west of NPS Rd. 5). Large cliffs are found along drainages, especially where streams have cut through the Minnekahta limestone. Most outcrops are too small to map, and so occur as inclusions in other types. Some areas with clusters of small limestone outcrops have been mapped separately.

ENVIRONMENTAL DESCRIPTION

Globally

At Wind Cave NP in South Dakota,, stands are found around large exposures of Pahasapa and Minnekahta limestones. These outcrops occur on ridgetops, slopes and in drainage bottoms (H. Marriott personal communication 1999).

Wind Cave National Park

The ponderosa pine - limestone outcrop sparse vegetation type is found around large exposures of Pahasapa and Minnekahta limestones. These outcrops occur on ridgetops, slopes and in drainage bottoms.

MOST ABUNDANT SPECIES

Globally

Stratum	Species

Information not available.

Wind Cave National Park

Stratum	Species

Few vascular species occur in this association.

CHARACTERISTIC SPECIES

Globally

Information not available.

Wind Cave National Park

Few vascular species occur in this association.

VEGETATION DESCRIPTION

Globally

At Wind Cave NP in South Dakota, large outcrops of limestone have very sparse vegetative cover at most. Where smaller outcrops occur, they often are surrounded by some type of ponderosa pine forest or woodland. Several shrub species are often found associated with limestone rock outcrops, including *Prunus virginiana, Rhus trilobata* and *Toxicodendron pubescens* (H. Marriott personal communication 1999).

Wind Cave National Park
Large outcrops of limestone have very sparse vegetative cover at most. Where smaller outcrops occur, they often are surrounded by some type of ponderosa pine forest or woodland. Several shrub species are often found associated with limestone rock outcrops, including chokecherry (*Prunus virginiana*), squawbush (*Rhus trilobata*) and poison ivy (*Toxicodendron pubescens*).

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G?

DATABASE CODE CEGL002055

MAP UNITS
Ponderosa pine limestone cliff sparse vegetation corresponds to map unit 2, limestone rock outcrop sparse vegetation, on the Wind Cave vegetation map.

COMMENTS
Wind Cave National Park
Most limestone outcrops are small. Sizeable cliffs are found in canyons that cut through the Minnekahta limestone (east of Hwy 387 and west of NPS Rd. 5). Most outcrops are not mappable, including many of the larger cliffs which have very little horizontal area. Some areas with clusters of small limestone outcrops have mapped separately.

REFERENCES

Shale Barren Slopes Sparse Vegetation

COMMON NAME	Shale Barren Slopes Sparse Vegetation
SYNONYM	Shale Barren Slopes
PHYSIOGNOMIC CLASS	Sparse Vegetation (VII)
PHYSIOGNOMIC SUBCLASS	Consolidated rock sparse vegetation (VII.A)
PHYSIOGNOMIC GROUP	Sparsely vegetated cliffs (VII.A.1)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural (VII.A.1.N)
FORMATION	Cliffs with sparse vascular vegetation (VII.A.1.N.a)
ALLIANCE	Open Bluff/Cliff Sparsely Vegetated Alliance

CLASSIFICATION CONFIDENCE LEVEL 3

USFWS WETLAND SYSTEM Upland

RANGE
Globally
This association is found in South Dakota and North Dakota.

Wind Cave National Park
Mappable stands of shale barren slope sparse vegetation occur on the east slope of Boland Ridge, east of the Park boundary. This area is under private ownership, and was not accessible for survey.

ENVIRONMENTAL DESCRIPTION
Globally
More information is needed to determine the characteristics of this type. The type includes the Mowry Shale outcrops around the Black Hills and the Pierre Shale outcrops of central and western South Dakota. The Mowry Shale outcrops can grade into Quercus macrocarpa / Carex inops ssp. heliophila Woodland or Pinus ponderosa Woodlands, both with relatively sparse ground cover.

Wind Cave National Park
Mappable stands of shale barren slope sparse vegetation occur on the east slope of Boland Ridge, east of the Park boundary. This area is under private ownership, and was not accessible for survey.

MOST ABUNDANT SPECIES
Globally
Stratum Species
Information not available.

Wind Cave National Park
Stratum Species
Information not available.

CHARACTERISTIC SPECIES
Globally
Information not available.

Wind Cave National Park
Information not available.

VEGETATION DESCRIPTION
Globally
Information not available.

Wind Cave National Park
Mappable stands of shale barren slope sparse vegetation occur on the east slope of Boland Ridge, east of the Park boundary. This area is under private ownership, and was not accessible for survey.

OTHER NOTEWORTHY SPECIES

CONSERVATION RANK G?

DATABASE CODE CEGL002294

MAP UNITS
The shale barren slope sparse vegetation community corresponds to map unit 5, shale barren slopes sparse vegetation, on the Wind Cave vegetation map.

COMMENTS

REFERENCES

Appendix 10.

Wind Cave National Park Vegetation Mapping Classes and Map Codes

Wind Cave Vegetation Class Key

Map Code	Map Class Name
1	Purple Three-awn - Fetid Marigold Herbaceous Vegetation
2	Ponderosa Pine Limestone Cliff Sparse Vegetation
3	Redbeds Sparse Vegetation
4	Black Hills Rock Outcrop Sparse Vegetation
5	Shale Barren Slope Sparse Vegetation
6	White Sedimentary Rock Outcrop
7	Bison Wallows
11	Little Bluestem - Grama Grass - Threadleaf Sedge Herbaceous Vegetation (with burned ponderosa pine)
12	Chokecherry Shrubland (with burned ponderosa pine)
13	Western Wheatgrass - Kentucky Bluegrass Grassland Complex (with burned ponderosa pine)
14	Emergent Wetland Herbaceous Complex
15	Little Bluestem - Grama Grass - Threadleaf Sedge Herbaceous Vegetation
16	Western Wheatgrass - Kentucky Bluegrass Grassland Complex
17	Introduced Weedy Graminoid Herbaceous Vegetation
18	Needle-and-thread - Blue Grama – Threadleaf Sedge Herbaceous Vegetation
30	Mountain Mahogany / Sideoats Grama Shrubland I (15-50% cover)
31	Mountain Mahogany / Sideoats Grama Dense Shrubland II (50-100% cover)
32	Lead Plant Shrubland
33	Chokecherry Shrubland
34	Beaked Willow Shrubland
35	Western Snowberry Shrubland
36	Creeping Juniper / Little Bluestem Shrubland
40	Plains Cottonwood / Western Snowberry Forest
41	Boxelder / Chokecherry Forest
42	Bur Oak Stand
43	Green Ash - American Elm / Western Snowberry Forest
44	Birch - Aspen Stands
45	Ponderosa Pine Woodland Complex I (75-100% cover)
46	Ponderosa Pine / Little Bluestem Woodland
47	Ponderosa Pine / Chokecherry Forest
48	Ponderosa Pine Woodland Complex II (15-75% cover)
49	Young Ponderosa Pine Dense Cover Complex
51	Transportation, Communications, Utilities
52	Mixed Urban or Built-up Land
53	Croplands and Pastures
55	Other Agricultural Lands
57	Open Water
59	Strip Mines, Quarries, & Gravel Pits

Appendix 11.

Prairie Dog Mapping Protocols

Date: August 8, 1997

Reply To Attn Of: Glen Plumb, Ph.D., Wildlife Biologist, Badlands NP

Subject: Badlands National Park and Wall District 1997 Prairie Dog Aerial Photo Interpretation

To: Bruce Bessken, Chief RM Badlands National Park
Greg Schenbeck, USFS Nebraska National Forest
Jim Vonloh, US Bureau Reclamation
Tim Langer, North Carolina State University

On August 6, 1997, we met at Cedar Pass Park HQ library to develop simple, qualified and consistent methodology for interpreting prairie dog colonies from a series of June 1997 1:12,000 CIR aerial photos covering Badlands National Park and a large portion of USFS Wall District, Buffalo Gap National Grassland. The principal purpose of these photos is to support development of a plant community map of Badlands NP. An additional goal of the NPS and USFS is to produce a digital map delineating prairie dog colonies. After three hours of discussions we agreed on the following photo interpretation criteria.

1. There will be no minimum size threshold for interpreting prairie dog colonies, in contrast to the 0.5 hectare minimum size for other plant communities.

2. Prairie dog colonies are to be considered as distinct plant communities characterized principally by concentrations of whitened stipples indicative on mounded prairie dog burrows. Depending on disturbance story, soils and yearly climate, differences in the reflectance signature between prairie dog colony plant communities and adjacent uncolonized plant communities will vary substantially. It may be that the lack of apparent change in reflectance signature between the area of concentrated burrow mounds and adjacent area with no burrow mounds will indicate no change in predominate plant community classification while retaining a prairie dog colony classification. As such, two potential classesof prairie dog colonies will likely be interpreted. Photo interpretation criteria should include:

a) Prairie dog colony with substantial change in plant community: the linear edge is delineated by eliminating whitened stipples indicative of mounded prairie dog burrows which are greater than 0.10" (30 meters) from the contiguous concentration of whitened stipples indicative of mounded prairie dog burrows accompanied by an obvious whitened color change from surrounding plant community reflectance signature(s), or

b) Prairie dog colony with little apparent change in plant community: the linear edge is delineated by eliminating whitened stipples indicative of mounded prairie dog burrows which are greater than 0.10" (30 meters) from the contiguous concentration of whitened stipples indicative of mounded prairie dog burrows characterized by greater than 35 whitened mounded burrows per hectare and **not** accompanied by an obvious whitened color change from surrounding plant community reflectance signature(s).

3. When appropriate, prairie dog colony delineation will also incorporate physical features such as surface roads (not 2 track roads), erosion features, ephemeral gullies and washes, permanent water sources (i.e. creeks and stock dams) and major badlands topographic features (i.e. spires, ridges).

4. In the case where the two above classifications are contiguous, final prairie dog colony map could combine different but contiguous prairie dog colony plant communities.

Appendix 12.

Parks GIS Database Design, Layout, and Procedures

Created by Doug Crawford and Jay Carlson od the Bureau of Reclamation's RSGIS group 1997
Revised 01-19-98

Parks GIS Database
Design, Layout, and Procedures

I. Design and Layout - Each GIS park project directory should be set up as follows:

1. Each park project should have its own directory. Naming convention for the directory should be either the first four letters of its name, or if the name consists of two or more words, the first two letters of the first two words.

Example: Badlands directory name is: >badl=
Jewel Cave directory name is: >jeca=

2. The main project directory should consist primarily of directories / workspaces with very few individual files and no coverages/grids. All coverages/grids should be located in workspaces below the main project directory.

3. All coverages should be in datum NAD83. If you need a working coverage in nad27, put suffix '_d27' at the end of the coverage name. For a project such as Badlands which covers more than one utm zone, the final, main coverages should be in one particular zone and if you need working covers in another zone, indicate its difference by putting suffix '_z14' (for zone 14 for example) at the end of the coverage name. If you need to designate different datum and zone, use suffix 'z14d27' for example. This would limit your coverage name to 7 characters before the addition of the suffix.

4. Each park project directory should have the following sub-directories and workspaces. Naming convention for coverages should include either the four-letter park name (same as the directory name; ie; for Badlands it is 'badl') or the workspace name (ie: for bndry workspace, covers named 'bndrypark')

amls: This directory contains amls particular to its project. All AMLS associated with the shell menu are not located here - see item 6. below.

aspect: Workspace containing any aspect coverages.
Naming convention: <park>_asp

biology: Workspace containing all coverages related to biological features.
Note: this workspace has sub-workspaces named according to associated USGS quads.

Naming convention: biology/<quadname>/<quadname>_veg#
where # indicates the quarterquad area (1,2,3, or 4)

A 'base' coverage may exist (biology_base) which is used in creating all the individual quarter-quad '_veg' coverages.
If aerial photos will have mylars scanned, each quad biology workspace needs to

have a blank coverage named cirtics with is used for transforming arcs into the correct geo-space.

bndry: Workspace containing all boundary coverages.
Naming convention: bndrypark (Park boundary coverage)
bndryproj (GIS mapping project area)
bndryquad (Boundaries of all the 7.5m quads)
bndrygrds (Grad- sect boundaries)

data: Workspace containing all data point coverages.
Naming convention: dataobsv (Coverage of observation data points)
dataplot (Coverage of plot data points)

doqq: Directory of all the doqq files.
Naming convention: <quadname>#.bil & .hdr
Note: >quadname= needs to be the same as the attribute of the label point in the bndryquad coverage.

The >#> refers to the quarterquad area as follows:
= 1 for the nw quadrant
2 for the ne quadrant
3 for the se quadrant
4 for the sw quadrant

hydro: Workspace containing all hydrological coverages.
Naming convention: <park>_strm (Streams coverage)

manmade: Workspace containing all coverages of manmade features.
Naming convention: <park>_road
<park>_rail
<park>_bldg

menus: Directory of arc/info aml menus particular to its project. All menus associated with the shell menu are not located here - see item 6. below.

misc: Directory / Workspace containing miscellaneous files and special coverages.

plot: Directory / Workspace containing plot files, grids, etc.

slope: Workspace for slope coverage.
Naming convention: <park>_slp

soils: Workspace for soils coverages:
Naming convention: soil_park

soil_proj
soil_state

5. Each coverage should be setup for attributing as follows:

biology_veg: Polygon coverage with labels in each polygon with item '**veg_code**' (3 3 I) attributed with the proper vegetation *classification number*; item '**location**' (6 6 c) attributed with either *park* or *buffer*; item '**photo**' (4 4 I) attributed with the CIR *photo number* from which the polygons were derived; and item >pdog= (2 2 I) attribute with 0 (none) or 1 (yes). Also, the .aat file (for the arcs) should have the '**veg_code**' item and another item that indicates the type of arc called '**digtype**' (2 2 I) with attributes of :

1 = indicates arc derived from heads-up, on screen dig
2 = indicates arc derived from scanned mylar.
3 = border arc representing edge of gis study area
4 = border arc of the quarter-quad
5 = border arc representing park boundary

bndrypark: line coverage - no special attributing needed. Exception: THRO has three units (north, middle, south) therefor it is built as a polygon cover with labels in each unit with item '**unit**' (6 6 c) attributed with 'north', 'middle', or 'south'.

bndryproj: line coverage - no special attributing needed. Exception: same as bndrypark for THRO.

bndryquad: polygon coverage with labels in each quad with the following items:
quadname (8 8 c) - abbreviated name for each quad
fullname (20 20 c) - full quadname with 1st letter in caps
Exception: each quad label is also attributed with '**unit**' for THRO (same as bndrypark for THRO).

dataobsv &: dataplot point coverages of label points with items as follows:
plot_code (3 3 n) with plot number from plot data sheets
veg_code (14 14 c) with veg class text.
type (10 10 c) with broad veg type (eg: woodland)
x-coord and y-coord added with addxy command

6. Special considerations:

6.1) Note, ARC/Info=s maximum filename length is 13 characters, therefore, base cover names

should not exceed 9 characters so the >_veg#=, >_z##= or >_d##= (see 6.2 and 6.3 below) can be added.

6.2) For Badlands project, the GIS project area encompasses more than one utm zone, therefore, preliminary coverages may have a suffix on its covername, either '_z13' for zone 13 or '_z14' for zone 14. All final coverages should be in zone 13 and the '_z13' would be dropped from the covername.

6.3) For the Data point coverages, the data points usually were collected using GPS units set to datum NAD27, therefore preliminary coverages may have suffix '_d27' added to distinguish from (final) coverage in datum nad83. CAUTION: If you need coverages in nad27, do not re-project bndryquad into nad27 - the tics will be wrong - need to create a new bndryquad cover from scratch and name it bndryquad_d27.

7. Shell AMLs and MENUs. - At the main login directory, there is a directory called >shell=. It contains three sub-directories called 'amls', 'menus' , and 'misc'. The 'misc' directory contains miscellaneous files used by the shell amls and menus. The 'amls' and 'menus' directories contain files used by 'shell.aml'. You can use this shell to do most all of your arc/info work. To use it, you must have 'shell.aml' in your project directory and type &r shell from the arc prompt. If you have or make any changes to these amls and menus, please let Doug Crawford know.

Note, the database setup conventions mentioned under items 4. and 5. above must be maintained for 'shell.aml' to function properly.

II. Digital Orthophoto Quarter Quads. - The parks projects will be using DOQQ's as the basemap for transfer of information from the CIR photos to the GIS database. The images are stored on CD-ROM's and are located in Doug Crawford's (badl & wica) or Dan Cogan's (thro) office. As mentioned above, the naming convention for the doqq's should be <quadname>#.bil. In addition to the image, there needs to be a world header file and its name should be <quadname>#.hdr.

The filenames on the CD-ROM's (form USGS) do not match this format and will need to be renamed. The cd-rom=s also do not contain the needed .hdr files. The shell menu has an AAux Program@ named 'doqqhdr' that renames the file and creates the .hdr file.

The header file for each bil (.hdr) is a simple text file that should be set up as follows for display in Arc/Info:

nrows <value>	(Number of rows or lines in the image)
ncols <value>	(Number of columns or samples in the image)
skipbytes <value>	(Old header format = 4 x ncols; new format = ncols)
ulxmap <value>	(X-Coordinate of upper left pixel)
ulymap <value>	(Y-Coordinate of upper left pixel)
xdim 1	(Size of pixel in x direction in meters)

ydim 1 (Size of pixel in y direction in meters)
nbands 1 (These BIL=s only have one band)

All data for this file can be read from the image file. For the old file format, use program header.exe on DOS machine (note - all ':' must be deleted after the .hdr file is generated). For the new format, USGS has not made an executable file yet to read the header info directly into a text file so you have to read from the image file using the 'more' command at unix prompt.

III. Registration and Transfer Procedures. -

A. Introduction.

Data interpreted from aerial photography must often be joined together in one large file. In most cases these data must be geo-referenced, so that a point in the data can be explicitly associated with a point on the earth=s surface, so that:

1) The point can be located on a map or with a Global Positioning System receiver, for field checking.

2) Area can be measured in hectares, acres, etc. more accurately (since each photo scale varies).

3) Data interpreted on one photograph don=t overlap or have gaps with the adjacent photograph, due to distortion in the photograph introduced by aircraft pitch, roll, and yaw as well as elevation change of the aircraft relative to the ground.

There are various ways to get air photo classification linework onto a georegistered map base. Three main methods exist: (1) heads-up digitizing, (2) use of a projector such as a Map-o-Graph or Saltzman, and (3) scanning the air photo mylar overlay.

Briefly, heads-up digitizing is a procedure whereby the operator digitizes by hand and eye on a computer terminal screen showing a digital image of an ortho-rectified photo. By looking at similar features on both the aerial photograph from which the classification was made and on the orthophoto, the line drawn on the aerial photo overlay is transferred to the digital image, which is registered to coordinates on the earth. This technique should produce good results except where there is little feature contrast on the ortho, in which case the operator must estimate the shape and location of the linework. Using this technique, a curve on the photo may appear to be a series of short, differently-angled straight line segments, since it is easier to make a curve with a pencil or pen than it is with digitized discrete points. Depending on the density of digitized points, this may or may not be a problem. The analyst may set the digitizing software to calculate a pseudo-curve of many points by inputting as few as three points to define a curve.

The Saltzman or Map-o-Graph is a device which projects the image of an air photo onto a map base (orthophoto, topo quad map, etc.). By adjusting the scale of projection, the operator can match features from one image to the other. The classification lines, projected with the photo, can be traced on the orthophoto hard copy map base. This technique should produce good results if the scale of projection is accurate and the focus is crisp. In some places, the orthophoto can be dark and consequently the projected line to be traced is difficult to see. It can be difficult to get the scale precise enough to do all but a small area, and then either the photo or the map must be shifted to the next small area. The tracing of one line with another introduces an additional (small, the analyst hopes) source of error.

The third technique of scanning involves digital manipulation of the scanned mylar by first converting the scanned image into a line coverage and then geo-referencing the coverage (scale, shift, rotate, and rubber-sheet). It still relies on the human eye, just like the other two, but only for fine-tuning the transfer accuracy, not for the transfer itself. The essential idea is that the air photo overlay has a certain number of scanner inches for a particular distance on the ground; so does the orthophoto. If the scale of the overlay can be adjusted to the scale of the orthophoto, then the lines should match features of the orthophoto without any digitizing or tracing. The shift accounts for the different origin on each photo: approximately 0,0 on the air photo and probably some high number on the orthophoto (whose coordinates are determined by a map projection and grid system). The rotation occurs due to the unlikelihood of perfect alignment of axes between the air photo and the orthophotomap. Finally, the rubber sheeting occurs due to minor error in the scale, shift, and rotate procedures. Even if these things were perfect, there would be distortion in the air photo that has been removed from the orthophotomap, necessitating rubber-sheeting the air photo. Rubber sheeting involves the recording of origin and destination points (i.e., links) and the higher-order mathematical adjustment of locations to best fit the origin points to the new. If many adjustment links are used and are evenly distributed throughout the data, and locations linked actually represent the same place on the earth, the adjustment should be good.

B. Procedures and Techniques.

Transfer work for the parks projects will consist of two methods, either heads-up digitizing or scanning. Heads-up digitizing will be used whenever the CIR photo (1) does not include many complicated grassland polygons as these are the most difficult to transfer using heads-up digitizing, and (2) does not differ in time of photography from the doqq by more than a couple of years. This will usually mean photos that have polygon boundaries that are easy to see on the digital ortho image will be transferred using the heads-up method. All others will be scanned as describe below.

B.1 Manual Method. -

B.1.1) Mark photocontrol points (i.e., road junctions, farmhouses, boulders, other identifiable small points that don't move or disappear) on each Mylar. Six control points should be located for best results though a minimum of 4 are required for a projective transform and 3 for an affine transform plus one additional tic if you want an RMS error generated. Mark each control point with sequential ID numbers (Important if using the AML as described below). The control points are found by displaying the DOQQ in an ArcEdit session.

If you use the AML, choose coverage *bndrycirtics* as the editcoverage for displaying the DOQQ. When a control point is found, place (Add) a tic at the location with tic id same as the ID marked on the Mylar. Save *bndrycirtics* with the new tics you just added. Make sure the Tic ID you choose does not already exist in the coverage.

B.1.2) Scan Mylar (into scanner inches). - Both options below are for the Scansmith Scan software either on the color or B&W scanner:

a) Gray scale scan. - Scan as Gray scale, around 300dpi, tif image. This will produce a file about 5Meg in size. Using the Scansmith software, can crop and rotate the image as needed.

b) Line art scan. - Scan as linear, around 400 dpi, tif image, packbits option with the following additional settings:

Threshold:	For graphite line work - 125 to 150
	For green lead - 100
	For red lead - 75
Hysteresis:	7
Dynamic:	4

B.1.3) Use ***imagegrid*** (arc command) to convert scanned image (probably .tif format) into Arc Grid format.

B.1.4) Use ***gridline*** (arc command) to convert grid into arc/info line coverage format. Use the photo number (4 digits) in the arc cover name. Could also use Provec software to convert into line coverage.

B.1.5) In ArcEdit:

a) Edit line coverage fixing badly converted lines, dangles, and extraneous arcs such as those associated with the class numbers that are marked on the Mylars.

b) Add, or move, if necessary, tics until you have five or more tics located at the perimeter of the linework area. Must have at least five tics to do a projective transform.

c) Put labels where photocontrol marks exist on line coverage (with image or grid as backdrop to show marks, if necessary). Idea is to have labels at places that can be seen both on orthophotoquad and on air photo (the control points mentioned in step 1).

d) Instead of c), you can add tics to the line coverage at the photocontrol points AND a blank coverage in the exact real-world locations as shown on the ortho. Then bypass items B.1.6 and 7 below.

Alternative: Instead of turning the image into a line coverage, use the image as backdrop and digitize over the lines to make a line coverage, thereby avoiding possibly excessive editing of poorly scanable mylars.

B.1.6) Create an empty coverage containing only tics that are located in the real-world location of the photo as follows:

a) Determine scale factor between CIR photo and real-world units. Measure distance between two points on photo and same two points on digital. These points should be chosen such the line connecting them goes through the center area of the photo, and ideally should not be very close together, nor close to photo edge, nor be greatly different in elevation. These measurements will allow calculation of a rescaling factor, i.e., how many inches on the scan correspond to how many orthophotoquad units on the ground (typically in meters). The approximate number will be 12000/39.37 (air photo nominal scale 1:12,000 divided by 39.37 inches/meter). The actual number will usually be slightly above or below this number.

b) Rescale the line coverage using the scaling factor just calculated,. Copy the line coverage AND delete all arcs in the copy coverage. Go into tables or info (in arc), select the .tic file for the copy coverage. Subtract the lowest xtic and ytic values from the xtic and ytic items so that the lower left corner has value 0,0. Then multiply the xtic and ytic items by the rescaling factor. Example:

input tics 1,1; 1,6; 6,1; 6,6
Shift to: 0,0 0,5 5,0 5,5 Multiply by 12,000/39.37: 0,0; 0,1524; 1524,0; 1524,1524

c) Add appropriate x + y offsets to the output copy coverage tics in info, so that you will end up in approximate neighborhood of your ortho. That is, if the coordinates of the area of interest on your ortho are approximately x=100000 and y=500000, then in info or tables, calculate your x tics to be your x tics + 100000 and your y tics to be your y tics + 50000, in effect shifting the tics.

d) Now you have a copy coverage that is approximately the right size and position. You may want to make a backup copy before transforming. Transform (arc command) the scanned image line coverage to the empty (tics only) copy coverage. Try with the affine (default) option and with the projective (specifically for air photo) option and see which appears better.

B.1.7) Now, in ArcEdit, you may have to rotate or move the coverage to get it to line up approximately with the (backdrop) orthophotoquad features. You can use the multipleselect command in ArcEdit to select both the labels and the arcs simultaneously for movement/rotation. Don=t forget to make your snap distance small so that lines don=t snap together inappropriately.

B.1.8) Once things line up approximately (i.e., the best you can get from shift, rotate, & scale), add links from the label locations to the same feature locations on the (backdrop) orthophotoquad.. The more links, the better. Link any additional features you can make out (that are unlikely to have changed) between coverage and orthophotoquad, e.g., sharp points, small ponds, stream junctions, etc. Try to distribute the links throughout the coverage instead of clustering them in one portion. If a point on the cover is already exactly where it's supposed to be and you don=t want it to move, put a link of zero displacement (appears square) there. If you have trouble making one, copy it from the outside of the coverage, where outermost zero displacement links were automatically created when the Aeditfeature link@ and Aadd@ commands were selected. Read the arc info documentation on links and rubber sheeting. Make a backup copy of the coverage in case the rubber sheeting doesn=t come out the way you=d like.

B.1.9) Use the adjust command in ArcEdit to rubber sheet. Make sure snap distance is very small. If the results are bad, you can issue the oops command and go back (unless you issue a save command first).

B.1.10) Place the completed, converted coverage in the biology directory for final attribution and rubbersheeting to other linework. Naming convention for this coverage should be:
p####_arcs where #### is the photo number.

B.2 Automated Method using AML. - Run LINK program from the shell menu. This aml has been developed to automate the transfer process. The AML incorporates 3 steps as follows:

Step 1 - Establish Control Tics. - Step one starts an arcedit session where you will be adding at least 6 tics that are common 'control' points between the Cir photo and the doqq to a coverage named *cirtics*. Mark these control points on the mylar overlaying the cir photo and 'add' tics in coverage *cirtics* in exact same location as the photocontrol points marked on the mylar. Make sure tic id matches id on the mylar **AND** that the tic id number does not already exist in the coverage.

Quit and save at this point.

CAUTION: Do Not Build the *CIRTICS* coverage!

Step 2 - Scan the mylar and ftp it to your workspace. The scanned image file (.tif) needs to be in the same workspace as your biology "_veg" coverage.

Step 3 - Convert Scanned Image. - This session :

a. Converts the scanned image (.tif) into an arc coverage. The program names the coverage ***p####_1_scan***. (the #### refers to the cir photo number)

b. Starts an arcedit session so you can clean-up the arc coverage (which is not geo-referenced yet, ie, it is in digitizer inches) and add tics (and label points*). First, delete the 'generic' tics that where created when the image was converted into an arc coverage. Second, add tics at the locations that where marked on the mylar. *Third, at the location of each tic you have added, you need to add a label point. Set snapfeature to lab tic (sf lab tic), set the snapping tolerance to a circle surrounding the tic (snapping button on the menu under >TOLERANCES=), and add labels with the 'add' command. The labels should snap right to the tics. Last, edit linework as needed to clean up dangles and unclosed polygons that may not have come thru during the conversion.

c. Once the arc coverage has tics/labels added and arcs cleaned up, Quit (and save) and you will be asked to transform the coverage. Once the transform completes, the program will ask you to proceed, ie, is the RMS error acceptable. If the RMS is not ok, will need to stop and assess the situation ... otherwise, answer 'yes'. This step creates and intermediate coverage that will be named ***p####_2_xfrm***. (note, xfrm is abbreviation for transform)

d. The next session starts another arcedit session where you will be adding 'links' from the label points to the tics. After the transform, the tics have moved relative to the arcs/lables so this step adds links that will be used to 'adjust' or 'rubber-sheet' the linework according to the new (transformed) tic locations.

The editcover is ***p####_2_xfrm*** and the backcover is ***p####_3_ltic***. NOTE: the program copies the *cirtics* coverage to *p####_3_ltic* at this point. Also, the program sets snapping so that links snap to the tic in *p####_3_ltic*. However, the user needs to set the snapping distance tolerance with the 'snapping' button on the menu. Once you have added links from all the labels to tics, Quit (and save) and you will be asked to 'Adjust' the coverage. If you answer yes, you will be done converting and a coverage named ***p####_4_link*** is created.

e. After the adjust, your arcedit session will display the adjusted coverage and its associated doqq image. At this point, you need to examine the coverage for accuracy, ie, how well does the linework match features on the doqq. If everything looks ok and only minor changes are needed to the linework, type '&return' and the program with ask you if the *_4_link* coverage is acceptable. If you answer 'yes', the program will clean _4_link and a new and final coveage name ***p####_final*** is created. If you answer 'no', the program will terminate without creating the *_final* coverage and you will need to start the program again and edit either the *_1_scan* or *_2_xfrm* coverage in order to improve the result achieved in the *_4_link* coverage.

B.3 Editing. - The final arc coverage should be compared to the doqq and existing "_veg" coverage and erroneous linework should be cleaned up. You can build this coverage and add labels and attribute at this point or bring the arcs (get) into the main "_veg" coverage and attribute the lables there. Edge-matching should also be performed between the "_final" and "_veg" coverages.

IV. Edgematch, Merge, and Attribute Coverages.

The coverage produced from the transfer procedure (*p<photo_no>_final*) needs to be edge matched, attributed, and merged into the associated quarter-quad veg coverage (*<quadname>_veg#*). The polygons can be attributed either before or after it is merged. However, before it is merged, the "_final" coverage should be 'edge-matched' to any existing linework in the "_veg#" coverages. Suggested procedures are as follows:

A. Edgematch.

1. Start an arcedit session and choose the "**_final"** coverage as the edit coverage.

2. Display the "_veg#" coverage(s) associated with the edit coverage as a backcover. This may involve displaying more that one "_veg#" coverage if the A_final@ coverage overlaps into another quarter-quad area.

3. Edit arcs as needed to match to arcs in the backcover. Best edit commands to use are '**snap**', '**split**', '**vmove**', and '**extend**'. You can also display doqq=s to aid in the edge matching (you may need to fill in gaps via 'heads-up digitizing'). This step may show that arcs in the "_final" coverage are better than arcs in the "_veg#" coverage. If so, **save** the current editcoverage and then reverse coverages so that the "_veg#" coverage is the editcover and A_final@ is the backcover and edit arcs in "_veg#" to match those in "_final".

4. If you want to attribute polygons now, make "**_final**" the editcoverage and go to keyboard prompt and type **build**. If the build is successful, it will add labels to each polygon. If the build fails, you will need to quit and save. You will then be asked if you want to build, clean, or exit. Choose clean. When the clean is done, you will be asked to create labels - hit 'yes'. Get back into arcedit and begin attributing the polygon labels (see Section IV.C. below for attributing procedures).

B. Merge Coverage.

1. Start an arcedit session and select the "**_veg#**" coverage associated with the "_final" coverage as the edit cover.

2. On the AE menu, there is a button titled "**MENUS**". Click on it and there will be a list of programs you can run. Choose '**GetFeatures**'. Select the appropriate "_final" coverage from the pop-up list. The program will merge arcs (and labels) from "_final" into the current edit coverage. You will need to do some arc editing at this point to clean up dangles and to connect arcs as needed. Note, if you get

major snapping errors after the merge, check the PRECISION on your coverage as you may need to switch to double precision.

3. After all linework has been edited, you are ready to add labels and attribute. Note, even if you added and attributed labels in the "_final" coverage, there will be >new= polygons created in the "_veg#" coverage (due to the merge) that will need to have labels added and attributed. To add labels, either (1) go to keyboard prompt and type **build**; or (2), quit and save, build, and create labels from arc, i.e., using the List button on the main menu, go to the appropriate workspace, highlight the coverage you want, and hit the 'Create labels' button on the List menu.

C. Attribute Polygons. -

The vegetation coverages need to have the polygons attributed for 'veg_code', 'location', 'photo number', and for certain projects, 'pdog':

'veg_code': refers to the vegetation or land use classification.
'location' : refers to polygons that are in the >park= or outside the park (buffer).
'photo no': refers to the CIR photo number which the polygon was interpreted from.
'pdog': Some projects need two classifications for veg-code. If a polygon is for example a grassland type and it has prairie dog colony which has not resulted in complete mowing down of the grass, the polygon would be attributed '1' for the pdog item which would mean it includes pdog's. Answering 'yes' to the pdog menu item calc's the pdog item to '1'.

Each of these items can be attributed via the button titled '**ATTR**' on the AE menu. Note: the word 'cal' on the ATTR list means *calculate* which is the ArcEdit command to attribute a label or arc.

There are several ways that one can attribute the labels. What follows is the author's technique:

1. After new labels have been created, go to the SELECT button on the AE menu and choose 'Sel Photo No' (note, must do a save if the labels were created in arcedit before this button will recognize the new labels). Select '0' and all the new labels will be highlighted in red. May need to do a 'reselect' if there are other un-attributed labels in the coverage that are not associated with the photo you are working on. Once all the desired labels are selected, can attribute for 'photo no', 'location', and color ($symbol) all at once. I like to change the color of the labels so they stand out better plus the color tells me that I just attributed the labels for 'photo_no' and 'location'.

2. Next, select labels randomly for veg_code. Notice that after you calc the veg_code via the menu button, the color of the label point changes to green. This will help you see which labels have been attributed for veg_code and which ones have not.

D. Attribute Arcs

The vegetation coverages may need to have some arcs attributed with 'veg_code' for linear features such as wetlands. For example, if wetland was class 14 and you needed to attribute an arc as a linear wetland, select the arc, go to the **ATTR** button on the menu, select 'Cal Veg' and enter 14 at the prompt.

Also, all arcs should be attributed with 'digtype' as explained under section I. above. From the **ATTR** button on the menu, select 'Cal digtype' and select the appropriate number from the pop-up list. To repeat, the numbers are defined as follows:

1 = arcs derived from heads-up digitizing.
2 = arcs derived from scanning (Note: the Link program automatically calc's arcs in the A_final= coverage to digtype 2).
3 = arcs representing GIS project area boundary.
4 = arcs for the veg cover border (same as quarter-quad boundary).
5 = arcs representing a park boundary.

E. Put Features.

In certain instances you may have arcs (and labels) that fall outside of the "_veg#" cover=s boundary since the original CIR photo covered an area that overlapped into another doqq. You will need to 'put' those features into the neighboring "_veg#" coverage as follows:

1. Select the arcs that need to be moved.

2. From the **MENUS** button on the AE menu, chose '**PutFeatures**'. You will be asked where you want to put the features via pop-up menus. Once you select the correct coverage, the program will put the selected features into the selected coverage and then it will ask you if you want to delete the selected features in the current editcover. If the 'put' was successful, answer 'yes'. Do a **save** immediately after putting so as to save the features in the put-to coverage.

3. If there are any labels that need 'putting', select them and repeat step #2 above.

F. On-Screen QA/QC.

1. When you are done attributing for a particular photo or the entire veg coverage, there are several quick checks you can do to make sure that all labels have been attributed.

1.1 The '**Sel Photo No**.' item under the SELECT button on the AE menu. -. This will display all the photo_no=s that have been attributed and will list a '0' if there are any labels that have not been attributed for this item. It also will list all the photo numbers so if you typed the photo number wrong, that 'wrong' number will show up on the pop-up list so check the entire to list to make sure there are no typo's.

1.2 The '**Sel VegCode**' item under the SELECT button on the AE menu. - This will display all

the veg_codes that have been attributed and will list a '0' if there are any labels that have not been attributed for veg_code. It also will list all the veg_code numbers so if you typed the veg_code number wrong, that 'wrong' number will show up on the pop-up list so check the entire to list to make sure there are no typo's. Note: this button is set for editfeature label so you cannot use it check arcs that have been attributed for veg_code.

1.3 The '**Sel Location**' item under the SELECT button on the AE menu. - This will display all the location attributes and will list a >blank= for a label that has not been attributed for 'location'. You can also use this button to highlight all the labels that you attributed for in the 'park' or in the 'buffer' to see if you made any mistakes.

2. Once the veg cover is complete, there are two qaqc programs you should run on the entire coverage as follows:

2.1 The '**PhotoChk**' item under the MENUS button on the AE menu. - This program checks to see if you attributed all the polygons correctly related to the photo flight-line number. Follow the prompts given by the program. When the program completes, your screen will have the labels highlighted based on flightline - if there is a 'color' out of place or a label that is still white, it means that label has the wrong photo number or is not attributed at all.

2.1 The '**LblError**' item under the MENUS button on the AE menu. - This program checks for label errors, ie, it will check to see that all polygons have a label and/or check to see if there is a polygon that has more than one label - every polygon should have ONE label. NOTE: This program may not run if the coverage needs building - if it fails, quit and save and build the cover (do not do the build in arcedit) and then run the 'LblError' program again.

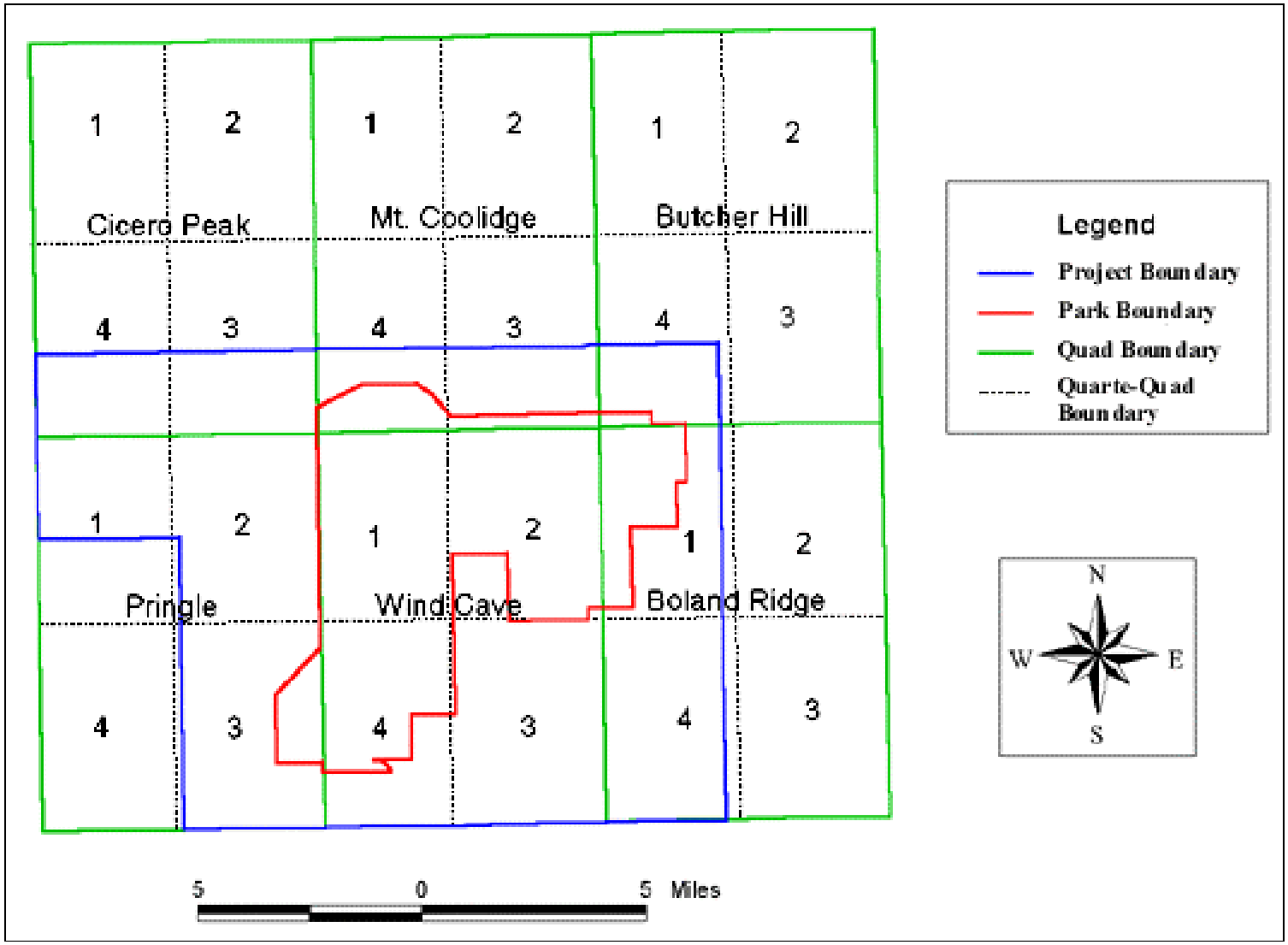
You may notice a lot of polygons that have duplicate labels. This usually arises when you have done some editing where you have deleted or changed a polygon that had a label in it. So whenever you edit a polygon, make sure to move or delete its label point.

Doug Crawford, Jay Carlson
Revised 01-19-98

Appendix 13.

USGS Digital-ortho Quarter Quadrangles (DOQQ's) used for the Wind Cave National Park Mapping Project.

USGS Catalog Number	7.5 Minute Quadrangle	Quadrant
04310329.NWS	Wind Cave	1 (Wind Cave nw)
04310329.NES	Wind Cave	2 (Wind Cave ne)
04310329.SES	Wind Cave	3 (Wind Cave se)
04310329.SWS	Wind Cave	4 (Wind Cave se)
04310322.SWS	Butcher Hill	4 (Butcher Hill sw)
04310330.SES	Boland Ridge	3 (Boland Ridge se)
04310330.SWS	Boland Ridge	4 Boland Ridge sw)
04310321.SES	Mt. Coolidge	3 (Mt. Coolidge se)
04310321.SWS	Mt. Coolidge	4 (Mt. Coolidge sw)
04310328.NWS	Pringle	1 (Pringle nw)
04310328.NES	Pringle	2 (Pringle ne)
04310328.SES	Pringle	3 (Pringle se)
04310320.SES	Cicero Peak	3 (Cicero Peak se)
04310320.SWS	Cicero Peak	4 (Cicero Peak.sw)


Cicero Peak
Mt. Coolidge
Butcher Hill
Pringle
Wind Cave
Boland Ridge
Legend
Project Boundary
Park Boundary
Quad Boundary
Quarte-Quad Boundary
N
W
E
S
5 0 5 Miles

Appendix 14.

Wind Cave National Park Species List

(Species obtained from all plot and observation data points collected in 1997 as part of the NPS-USGS National Mapping Program)

Family	Scientific Name	Common Name
Aceraceae	*Acer negundo L.*	boxelder
Agavaceae	*Yucca glauca Nutt.*	small soapweed
Amblystegiaceae	*Calliergon richardsonii (Mitt.) Kindb. in Warnst.*	Richardson's calliergon Moss
Anacardiaceae	*Rhus aromatica Ait.*	fragrant sumac
	Rhus trilobata Nutt.	skunkbush sumac
	Toxicodendron pubescens P. Mill.	Atlantic poison oak
	Toxicodendron rydbergii (Small ex Rydb.) Greene	western poison ivy
Apiaceae	*Cicuta maculata L.*	spotted water hemlock
	Heracleum sphondylium L.	eltrot
	Musineon tenuifolium (Nutt. ex Torr. & Gray) Coult. & Rose	slender wildparsley
	Osmorhiza berteroi DC.	Sweetcicely
	Osmorhiza depauperata Phil.	bluntseed sweetroot
	Osmorhiza longistylis (Torr.) DC.	longstyle sweetroot
	Sanicula L.	sanicle
	Sanicula marilandica L.	Maryland sanicle
	Zizia aptera (Gray) Fern.	meadow zizia
Apocynaceae	*Apocynum androsaemifolium L.*	spreading dogbane
	Apocynum cannabinum L.	Indianhemp
Araliaceae	*Aralia nudicaulis L.*	wild sarsaparilla
Asclepiadaceae	*Asclepias ovalifolia Dcne.*	ovalleaf milkweed
	Asclepias pumila (Gray) Vail	plains milkweed
	Asclepias speciosa Torr.	showy milkweed
	Asclepias verticillata L.	whorled milkweed
	Asclepias viridiflora Raf.	green milkweed
	Asclepias viridula Chapman	southern milkweed
Asteraceae	*Achillea millefolium L.*	common yarrow
	Adenocaulon bicolor Hook.	American trailplant
	Agoseris glauca (Pursh) Raf.	pale agoseris
	Ambrosia psilostachya DC.	Cuman ragweed
	Ambrosia trifida L.	great ragweed
	Anaphalis margaritacea (L.) Benth. & Hook. f.	western pearlyeverlasting
	Antennaria Gaertn.	Pussytoes
	Antennaria neglecta Greene	field pussytoes
	Antennaria parvifolia Nutt.	smallleaf pussytoes
	Antennaria plantaginifolia (L.) Richards.	woman's tobacco
	Arctium minus Bernh.	lesser burdock
	Arnica cordifolia Hook.	heartleaf arnica
	Arnica frigida C.A. Mey. ex Iljin	snow arnica
	Arnica lonchophylla Greene	longleaf arnica
	Arnica rydbergii Greene	Rydberg's arnica
	Arnoglossum atriplicifolium (L.) H.E. Robins.	Armoglossum
	Artemisia L.	sagebrush
	Artemisia campestris L.	field sagewort

Artemisia dracunculus L.	wormwood
Artemisia filifolia Torr.	sand sagebrush
Artemisia ludoviciana Nutt.	Louisiana sagewort
Aster L.	aster
Aster ciliolatus Lindl.	Lindley's aster
Aster ericoides L.	heath aster
Aster falcatus Lindl.	cluster aster
Aster laevis L.	smooth aster
Aster oblongifolius Nutt.	aromatic aster
Balsamorhiza sagittata (Pursh) Nutt.	arrowleaf balsamroot
Brickellia eupatorioides var. *eupatorioides (L.) Shinners*	false boneset
Cirsium P. Mill.	Thistle
Cirsium arvense (L.) Scop.	Canadian thistle
Cirsium flodmanii (Rydb.) Arthur	Flodman's thistle
Cirsium ochrocentrum Gray	yellowspine thistle
Cirsium undulatum (Nutt.) Spreng.	wavyleaf thistle
Cirsium vulgare (Savi) Ten.	bull thistle
Conyza Less.	horseweed
Conyza canadensis (L.) Cronq.	Canadian horseweed
Conyza ramosissima Cronq.	dwarf horseweed
Dyssodia papposa (Vent.) A.S. Hitchc.	fetid marigold
Echinacea Moench	purple coneflower
Echinacea angustifolia DC.	blacksamson echinacea
Echinacea pallida (Nutt.) Nutt.	pale purple coneflower
Ericameria pinifolia (Gray) Hall	pinebush
Erigeron L.	fleabane
Erigeron formosissimus Greene	beautiful fleabane
Erigeron speciosus (Lindl.) DC.	aspen fleabane
Erigeron strigosus Muhl. ex Willd.	prairie fleabane
Erigeron subtrinervis Rydb. ex Porter & Britt.	threenerve fleabane
Grindelia squarrosa (Pursh) Dunal	curlycup gumweed
Gutierrezia sarothrae (Pursh) Britt. & Rusby	broom snakeweed
Helianthus annuus L.	common sunflower
Heterotheca villosa (Pursh) Shinners	hairy goldenaster
Heterotheca villosa var. *villosa (Pursh) Shinners*	hairy goldenaster
Hieracium albiflorum Hook.	white hawkweed
Hieracium umbellatum L.	narrowleaf hawkweed
Lactuca L.	lettuce
Lactuca canadensis L.	Canada lettuce
Lactuca serriola L.	prickly lettuce
Lactuca tatarica var. *pulchella (Pursh) Breitung*	blue lettuce
Liatris Gaertn. ex Schreb.	gayfeather
Liatris punctata Hook.	dotted gayfeather
Liatris spicata (L.) Willd.	dense gayfeather
Lygodesmia juncea (Pursh) D. Don ex Hook.	rush skeletonplant
Machaeranthera pinnatifida ssp. *-pinnatifida* var. *pinnatifida (Hook.) Shinners*	lacy tansyaster
Nothocalais cuspidata (Pursh) Greene	sharppoint microseris
Oligoneuron rigidum var. rigidum (L.) Small	goldenrod
Ratibida columnifera (Nutt.) Woot. & Standl.	upright prairie coneflower
Rudbeckia hirta L.	blackeyed Susan
Senecio canus Hook.	woolly groundsel
Senecio L.	groundsel
Senecio integerrimus Nutt.	lambstongue groundsel
Senecio plattensis Nutt.	prairie groundsel

	Senecio pseudaureus Rydb.	falsegold groundsel
	Senecio rapifolius Nutt.	openwoods groundsel
	Senecio vulgaris L.	common groundsel
	Solidago L.	goldenrod
	Solidago canadensis L.	Canada goldenrod
	Solidago missouriensis Nutt.	Missouri goldenrod
	Solidago speciosa Nutt.	showy goldenrod
	Stenotus acaulis var. *acaulis (Nutt.) Nutt.*	stemless goldenweed
	Taraxacum G.H. Weber ex Wiggers	dandelion
	Taraxacum officinale G.H. Weber ex Wiggers	common dandelion
	Tetraneuris acaulis var. acaulis (Pursh) Greene	stemless hymenoxys
	Tragopogon dubius Scop.	yellow salsify
Berberidaceae	*Mahonia repens (Lindl.) G. Don*	Oregongrape
Betulaceae	*Betula neoalaskana Sarg.*	Alaska paper birch
	Betula papyrifera Marsh.	paper birch
	Corylus cornuta Marsh.	beaked hazelnut
	Ostrya virginiana (P. Mill.) K. Koch	eastern hophornbeam
Boraginaceae	*Cryptantha Lehm. ex G. Don*	cryptantha
	Cryptantha celosioides (Eastw.) Payson	buttecandle
	Cynoglossum L.	hound's tongue
	Cynoglossum officinale L.	gypsyflower
	Cynoglossum virginianum var. *boreale (Fern.) -Cooperrider*	wild comfrey
	Hackelia deflexa (Wahlenb.) Opiz	nodding stickseed
	Lithospermum incisum Lehm.	narrowleaf gromwell
	Mertensia lanceolata (Pursh) DC.	lanceleaf bluebells
	Onosmodium molle Michx.	smooth onosmodium
Brassicaceae	*Alyssum L.*	
	Arabis X divaricarpa A. Nels. (pro sp.)	spreadingpod rockcress
	Erysimum inconspicuum (S. Wats.) MacM.	shy wallflower
Cactaceae	*Echinocereus Engelm.*	hedgehog cactus
	Echinocereus viridiflorus Engelm.	nylon hedgehog cactus
	Escobaria missouriensis var. missouriensis -(Sweet) D.R. Hunt	Missouri foxtail cactus
	Opuntia P. Mill.	pricklypear
	Opuntia fragilis (Nutt.) Haw.	brittle pricklypear
	Opuntia humifusa (Raf.) Raf.	pricklypear
	Opuntia polyacantha Haw.	plains pricklypear
Campanulaceae	*Campanula rotundifolia L.*	bluebell bellflower
	Triodanis perfoliata (L.) Nieuwl.	clasping Venus' lookingglass
Caprifoliaceae	*Linnaea borealis L.*	twinflower
	Lonicera dioica L.	limber honeysuckle
	Symphoricarpos Duham.	snowberry
	Symphoricarpos albus (L.) Blake	common snowberry
	Symphoricarpos occidentalis Hook.	western snowberry
Caryophyllaceae	*Cerastium arvense L.*	field chickweed
	Cerastium nutans Raf.	nodding chickweed
	Moehringia lateriflora (L.) Fenzl	bluntleaf sandwort

	Paronychia depressa (Torr. & Gray) Nutt. -ex A. Nels.	spreading nailwort
	Silene L.	silene
	Silene antirrhina L.	sleepy silene
	Silene latifolia ssp. *alba (P. Mill.) Greuter & Burdet*	bladder campion
Chenopodiaceae	*Krascheninnikovia lanata (Pursh) Guldenstaedt*	winterfat
Cistaceae	*Helianthemum bicknellii Fern.*	hoary frostweed
Clusiaceae	*Hypericum perforatum L.*	common St. Johnswort
Commelinaceae	*Tradescantia bracteata Small ex Britt.*	longbract spiderwort
	Tradescantia occidentalis (Britt.) Smyth	prairie spiderwort
Convolvulaceae	*Calystegia sepium (L.) R. Br.*	hedge false bindweed
	Convolvulus L.	bindweed
	Evolvulus nuttallianus J.A. Schultes	shaggy dwarf morningglory
Cornaceae	*Cornus canadensis L*.	bunchberry dogwood
Cucurbitaceae	*Echinocystis lobata (Michx.) Torr. & Gray*	wild cucumber
Cupressaceae	*Juniperus communis L.*	common juniper
	Juniperus horizontalis Moench	creeping juniper
	Juniperus scopulorum Sarg.	Rocky Mountain juniper
Cyperaceae	*Carex L*.	sedge
	Carex aurea Nutt.	golden sedge
	Carex bebbii Olney ex Fern.	Bebb's sedge
	Carex blanda Dewey	eastern woodland sedge
	Carex brevior (Dewey) Mackenzie	fescue sedge
	Carex concinna R. Br.	low northern sedge
	Carex deweyana Schwein.	Dewey sedge
	Carex filifolia Nutt.	threadleaf sedge
	Carex foenea Willd.	dryspike sedge
	Carex inops ssp. *heliophila (Mackenzie) Crins*	sun sedge
	Carex microptera Mackenzie	smallwing sedge
	Carex peckii Howe	Peck's sedge
	Carex richardsonii R. Br.	Richardson's sedge
	Carex rossii Boott	Ross' sedge
	Carex saximontana Mackenzie	Rocky Mountain sedge
	Carex sprengelii Dewey ex Spreng.	Sprengel's sedge
	Carex torreyi Tuckerman	Torrey's sedge
	Carex xerantica Bailey	whitescale sedge
	Scirpus microcarpus J.& K. Presl	panicled bulrush
Dennstaedtiaceae	*Pteridium aquilinum (L.) Kuhn*	western brackenfern
Dryopteridaceae	*Cystopteris fragilis (L.) Bernh.*	brittle bladderfern
	Woodsia R. Br.	woodsia
	Woodsia oregana D.C. Eat.	Oregon woodsia
Elaeagnaceae	*Shepherdia canadensis (L.) Nutt.*	russet buffaloberry

Equisetaceae	*Equisetum laevigatum A. Braun*	smooth horsetail
Ericaceae	*Arctostaphylos uva-ursi (L.) Spreng.*	kinnikinnick
	Vaccinium scoparium Leib. ex Coville	grouse whortleberry
Euphorbiaceae	*Chamaesyce fendleri (Torr. & Gray) Small*	Fendler's sandmat
	Chamaesyce glyptosperma (Engelm.) Small	ribseed sandmat
	Chamaesyce maculata (L.) Small	spotted sandmat
	Euphorbia L.	spurge
	Euphorbia spathulata Lam.	warty spurge
Fabaceae	*Amorpha L.*	indigobush
	Amorpha canescens Pursh	leadplant
	Amorpha fruticosa L.	desert indigobush
	Amorpha nana Nutt.	dwarf indigobush
	Astragalus L.	milkvetch
	Astragalus adsurgens Pallas	standing milkvetch
	Astragalus alpinus L.	alpine milkvetch
	Astragalus crassicarpus Nutt.	groundplum milkvetch
	Astragalus flexuosus (Hook.) Dougl. ex G. Don	flexile milkvetch
	Astragalus gilviflorus Sheldon	plains milkvetch
	Astragalus gracilis Nutt.	slender milkvetch
	Astragalus miser Dougl.	weedy milkvetch
	Astragalus spatulatus Sheldon	tufted milkvetch
	Dalea L.	prairieclover
	Dalea candida var. *candida Willd.*	white prairieclover
	Dalea purpurea var. *purpurea Vent.*	violet prairieclover
	Glycyrrhiza lepidota Pursh	American licorice
	Hedysarum alpinum L.	alpine sweetvetch
	Lathyrus L.	peavine
	Lathyrus ochroleucus Hook.	cream peavine
	Lupinus argenteus Pursh	silvery lupine
	Medicago lupulina L.	black medick
	Melilotus officinalis (L.) Lam.	yellow sweetclover
	Oxytropis campestris (L.) DC.	cold mountain crazyweed
	Oxytropis lambertii Pursh	Lambert's crazyweed
	Oxytropis sericea Nutt.	silvery oxytrope
	Pediomelum Rydb.	pediomelum
	Pediomelum argophyllum (Pursh) J. Grimes	silverleaf scurfpea
	Psoralidium argophyllum (Pursh) Rydb.	silverleaf scurfpea
	Pediomelum esculentum (Pursh) Rydb.	breadroot scurfpea
	Psoralidium tenuiflorum (Pursh) Rydb.	slimflower scurfpea
	Thermopsis rhombifolia (Nutt. ex Pursh) Nutt. -ex Richards.	prairie thermopsis
	Trifolium hybridum L.	alsike clover
	Trifolium reflexum L.	buffalo clover
	Trifolium repens L.	white clover
	Vicia americana Muhl. ex Willd.	American vetch
Fagaceae	*Quercus macrocarpa Michx.*	bur oak
Gentianaceae	*Frasera speciosa Dougl. ex Griseb.*	showy frasera
	Gentianella amarella ssp. *acuta (Michx.) J. Gillett*	autumn dwarfgentian
	Halenia deflexa (Sm.) Griseb.	American spurredgentian
	Geranium L.	geranium

	Geranium bicknellii Britt.	Bicknell's cranesbill
	Geranium richardsonii Fisch. & Trautv.	Richardson's geranium
Grossulariaceae	*Ribes L.*	currant
	Ribes amarum McClatchie	bitter gooseberry
	Ribes aureum Pursh	golden currant
	Ribes aureum var. *villosum DC.*	golden currant
	Ribes cereum Dougl.	wax currant
	Ribes lacustre (Pers.) Poir.	prickly currant
	Ribes missouriense Nutt.	Missouri gooseberry
	Ribes oxyacanthoides ssp. *setosum (Lindl.) Sinnott*	inland gooseberry
Iridaceae	*Iris missouriensis Nutt.*	Rocky Mountain iris
	Sisyrinchium angustifolium P. Mill.	narrowleaf blueeyed grass
	Sisyrinchium montanum Greene	mountain blueeyed grass
Juncaceae	*Juncus confusus Coville*	Colorado rush
Lamiaceae	*Galeopsis bifida Boenn.*	splitlip hempnettle
	Hedeoma Pers.	falsepennyroyal
	Hedeoma hispida Pursh	rough falsepennyroyal
	Leonurus cardiaca L.	common motherwort
	Lycopus americanus Muhl. ex W. Bart.	American waterhorehound
	Mentha arvensis L.	wild mint
	Monarda fistulosa L.	wildbergamot beebalm
	Monarda L.	beebalm
	Nepeta cataria L.	catnip
Liliaceae	*Allium L.*	wild onion
	Allium canadense L.	meadow garlic
	Allium cernuum Roth	nodding onion
	Allium textile A. Nels. & J.F. Macbr.	textile onion
	Calochortus nuttallii Torr. & Gray	sego lily
	Disporum trachycarpum (S. Wats.) Benth. -& Hook. f.	roughfruit fairybells
	Lilium philadelphicum L.	wood lily
	Maianthemum canadense Desf.	Canada beadruby
	Maianthemum racemosum ssp. racemosum -(L.) Link	feather Solomon's seal
	Maianthemum stellatum (L.) Link	starry false Solomon's seal
	Polygonatum biflorum (Walt.) Ell.	King Solomon's seal
	Zigadenus elegans Pursh	mountain deathcamas
	Zigadenus venenosus S. Wats.	meadow deathcamas
Linaceae	*Linum perenne L.*	blue flax
Loasaceae	*Mentzelia oligosperma Nutt. ex Sims*	chickenthief
Malvaceae	*Sphaeralcea coccinea (Nutt.) Rydb.*	scarlet globemallow
Monotropaceae	*Pterospora andromedea Nutt.*	woodland pinedrops
Nyctaginaceae	*Abronia fragrans Nutt. ex Hook.*	snowball sand verbena
	Mirabilis hirsuta (Pursh) MacM.	hairy four o'clock
	Mirabilis linearis (Pursh) Heimerl	narrowleaf four o'clock

Oleaceae	*Fraxinus pennsylvanica Marsh.*	green ash
Onagraceae	*Calylophus serrulatus (Nutt.) Raven*	yellow sundrops
	Circaea alpina L.	small enchanter's nightshade
	Epilobium angustifolium L.	fireweed
	Epilobium halleanum Hausskn.	glandular willowherb
	Gaura coccinea Nutt. ex Pursh	scarlet beeblossom
	Oenothera coronopifolia Torr. & Gray	crownleaf eveningprimrose
	Oenothera villosa Thunb.	hairy eveningprimrose
Orchidaceae	*Coeloglossum viride var. viride (L.) Hartman*	longbract frog orchid
	Corallorrhiza maculata (Raf.) Raf.	summer coralroot
	Goodyera oblongifolia Raf.	western rattlesnake plantain
	Goodyera repens (L.) R. Br. ex Ait. f.	lesser rattlesnake plantain
Orobanchaceae	Orobanche fasciculata Nutt.	clustered broomrape
Oxalidaceae	*Oxalis L.*	woodsorrel
Pinaceae	*Picea glauca (Moench) Voss*	white spruce
Pinaceae	*Pinus ponderosa P.& C. Lawson*	ponderosa pine
Plantaginaceae	*Plantago L.*	plantain
	Plantago patagonica Jacq.	woolly plantain
Poaceae	*Achnatherum hymenoides -(Roemer & J.A. Schultes) Barkworth*	
	Achnatherum occidentale ssp. *occidentale -(Thurb. ex S. Wats.) Barkworth*	
	Achnatherum richardsonii (Link) Barkworth	
	Agropyron Gaertn.	wheatgrass
	Agrostis L.	
	Agrostis hyemalis (Walt.) B.S.P.	winter bentgrass
	Agrostis scabra Willd.	rough bentgrass
	Agrostis stolonifera L.	creeping bentgrass
	Andropogon gerardii Vitman	big bluestem
	Aristida purpurascens Poir.	arrowfeather threeawn
	Aristida purpurea Nutt.	purple threeawn
	Aristida purpurea var. *longiseta (Steud.) Vasey*	Fendler threeawn
	Bouteloua curtipendula (Michx.) Torr.	sideoats grama
	Bouteloua gracilis (Willd. ex Kunth) Lag. -ex Griffiths	blue grama
	Bouteloua hirsuta Lag.	hairy grama
	Bromus anomalus Rupr. ex Fourn.	nodding brome
	Bromus ciliatus L.	fringed brome
	Bromus inermis Leyss.	smooth brome
	Bromus japonicus Thunb. ex Murr.	Japanese brome
	Bromus pubescens Muhl. ex Willd.	hairy woodland brome
	Bromus tectorum L.	cheatgrass
	Buchloe dactyloides (Nutt.) Engelm.	buffalograss
	Calamagrostis canadensis (Michx.) Beauv.	bluejoint
	Calamovilfa longifolia (Hook.) Scribn.	prairie sandreed
	Danthonia intermedia Vasey	timber oatgrass
	Danthonia spicata (L.) Beauv. -ex Roemer & J.A. Schultes	poverty danthonia

Dichanthelium (A.S. Hitchc. & Chase) Gould	rosette grass
Dichanthelium acuminatum (Sw.)	
-Gould & C.A. Clark	tapered rosette grass
Dichanthelium leibergii (Vasey) Freckmann	Leiberg's panicum
Dichanthelium oligosanthes (J.A. Schultes) Gould	Heller's rosette grass
Dichanthelium oligosanthes var. *scribnerianum*	
-(Nash) Gould	Scribner's rosette grass
Dichanthelium wilcoxianum (Vasey) Freckmann	fall panicum
Distichlis spicata (L.) Greene	inland saltgrass
Elymus L.	wildrye
Elymus canadensis L.	Canada wildrye
Elymus caninus (L.) L.	bearded wheatgrass
Elymus elymoides (Raf.) Swezey	bottlebrush squirreltail
Elymus elymoides ssp. *elymoides (Raf.) Swezey*	
Elymus elymoides ssp. *hordeoides*	
-(Suksdorf) Barkworth	
Elymus lanceolatus ssp. *lanceolatus*	
-(Scribn. & J.G. Sm.) Gould	thickspick wheatgrass
Elymus trachycaulus (Link) Gould ex Shinners	slender wheatgrass
Elymus trachycaulus ssp. subsecundus	
-(Link) A.& D. Love	slender wheatgrass
Elymus trachycaulus ssp. trachycaulus	
-(Link) Gould ex Shinners	slender wheatgrass
Elymus virginicus L.	Virginia wildrye
Elytrigia repens var. *repens (L.) Desv.*	
-ex B.D. Jackson	quackgrass
Festuca L. *fescue*	
Festuca idahoensis Elmer	Idaho fescue
Festuca octoflora Walt. = Vulpia octoflora	
-var. *octoflora*	sixweeks fescue
Festuca ovina L.	sheep fescue
Festuca subulata Trin.	bearded fescue
Glyceria R. Br.	mannagrass
Glyceria grandis S. Wats.	American mannagrass
Hesperostipa comata ssp. *comata (Trin. & Rupr.)*	
-Barkworth	needle-and-thread
Hesperostipa spartea (Trin.) Barkworth	porcupine grass
Koeleria Pers.	koeleria
Koeleria macrantha (Ledeb.) J.A. Schultes	prairie Junegrass
Leymus innovatus (Beal) Pilger	downy ryegrass
Melica subulata (Griseb.) Scribn.	Alaska oniongrass
Muhlenbergia cuspidata (Torr. ex Hook.) Rydb.	plains muhly
Muhlenbergia racemosa (Michx.) B.S.P.	marsh muhly
Nassella viridula (Trin.) Barkworth	green needlegrass
Oryzopsis asperifolia Michx.	roughleaf ricegrass
Oryzopsis micrantha (Trin. & Rupr.) Thurb.	
= Piptatherum micranthum	Little seeded ricegrass
Oryzopsis pungens (Torr. ex Spreng.) A.S. Hitchc.	mountain ricegrass
Panicum virgatum L.	switchgrass
Pascopyrum smithii (Rydb.) A. Love	western wheatgrass
Phleum pratense L.	timothy
Piptatherum micranthum (Trin. & Rupr.) Barkworth	
Poa L.	bluegrass
Poa compressa L.	Canada bluegrass
Poa interior Rydb.	inland bluegrass
Poa palustris L.	fowl bluegrass

	Poa pratensis L.	Kentucky bluegrass
	Schizachne purpurascens (Torr.) Swallen	false melic
	Schizachyrium scoparium (Michx.) Nash	little bluestem
	Spartina pectinata Link	prairie cordgrass
	Sporobolus R. Br.	dropseed
	Sporobolus airoides (Torr.) Torr.	alkali sacaton
	Sporobolus cryptandrus (Torr.) Gray	sand dropseed
	Sporobolus heterolepis (Gray) Gray	prairie dropseed
	Stipa comata Trin. & Rupr. = *Hesperostipa comata* ssp. *Comata*	needle-and-thread
	Stipa spartea Trin. = Hesperostipa spartea	porcupine grass
	Vulpia octoflora var. *octoflora (Walt.) Rydb*.	sixweeks fescue
Polemoniaceae	*Collomia linearis Nutt*.	narrowleaf mountaintrumpet
	Phlox alyssifolia Greene	alyssumleaf phlox
	Phlox andicola E. Nels.	prairie phlox
	Phlox gracilis ssp. *gracilis (Hook.) Greene*	slender phlox
	Phlox hoodii Richards.	spiny phlox
Polygalaceae	*Polygala alba Nutt.*	white milkwort
	Polygala senega L.	Seneca snakeroot
	Polygala verticillata L.	whorled milkwort
	Eriogonum pauciflorum Pursh	fewflower buckwheat
	Polygonum arenastrum Jord. ex Boreau	ovalleaf knotweed
	Polygonum convolvulus L.	black bindweed
	Rumex crispus L.	curly dock
	Polypodium hesperium Maxon	western polypody
Portulacaceae	*Claytonia perfoliata* ssp. *perfoliata Donn ex Willd.*	miner's lettuce
	Portulaca oleracea L.	little hogweed
Primulaceae	*Androsace septentrionalis L.*	pygmyflower rockjasmine
	Dodecatheon meadia ssp. *meadia L*.	pride of Ohio
	Lysimachia ciliata L.	fringed loosestrife
Pteridaceae	*Cheilanthes feei T. Moore*	slender lipfern
	Pellaea atropurpurea (L.) Link	purple cliffbrake
Pyrolaceae	*Chimaphila umbellata (L.) W. Bart*.	pipsissewa
	Orthilia secunda (L.) House	sidebells wintergreen
	Pyrola asarifolia Michx.	liverleaf wintergreen
	Pyrola chlorantha Sw.	greenflowered wintergreen
	Pyrola elliptica Nutt.	waxflower shinleaf
Ranunculaceae	*Aconitum columbianum Nutt*.	Columbian monkshood
	Actaea rubra (Ait.) Willd.	red baneberry
	Anemone L.	anemone
	Anemone canadensis L.	Canadian anemone
	Anemone cylindrica Gray	candle anemone
	Anemone multifida Poir.	Pacific anemone
	Anemone virginiana var. *virginiana L*.	tall thimbleweed
	Aquilegia canadensis L.	red columbine
	Clematis columbiana var. *columbiana (Nutt.) -Torr. & Gray*	rock clematis
	Clematis columbiana var. *tenuiloba (Gray) -J. Pringle*	rock clematis

	Clematis ligusticifolia Nutt.	western white clematis
	Delphinium nuttallianum Pritz. ex Walp.	Nuttal's larkspur
	Pulsatilla patens ssp. *patens (L.) P. Mill.*	American pasqueflower
	Ranunculus abortivus L.	littleleaf buttercup
	Ranunculus macounii Britt.	Macoun's buttercup
	Thalictrum aquilegifolium L.	columbine meadowrue
	Thalictrum dasycarpum Fisch. & Ave-Lall.	purple meadowrue
	Thalictrum L.	meadowrue
	Thalictrum dioicum L.	early meadowrue
	Thalictrum venulosum Trel.	veiny meadowrue
Rhamnaceae	*Ceanothus L.*	
	Ceanothus velutinus Dougl. ex Hook.	snowbrush ceanothus
	Rhamnus alnifolia L'Her.	alderleaf buckthorn
	Rhamnus cathartica L.	common buckthorn
Rosaceae	*Agrimonia striata Michx.*	roadside agrimony
	Amelanchier alnifolia (Nutt.) Nutt. ex M. Roemer	Saskatoon serviceberry
	Amelanchier humilis Wieg.	low serviceberry
	Cercocarpus montanus Raf.	true mountain mahogany
	Coleogyne ramosissima Torr.	blackbrush
	Crataegus succulenta Schrad. ex Link	fleshy hawthorn
	Fragaria L.	strawberry
	Fragaria virginiana Duchesne	Virginia strawberry
	Geum triflorum Pursh	prairiesmoke
	Physocarpus monogynus (Torr.) Coult.	mountain ninebark
	Physocarpus opulifolius (L.) Maxim.	common ninebark
	Potentilla L.	cinquefoil
	Potentilla concinna Richards.	elegant cinquefoil
	Potentilla fissa Nutt.	bigflower cinquefoil
	Potentilla gracilis Dougl. ex Hook.	northwest cinquefoil
	Potentilla hippiana Lehm.	woolly cinquefoil
	Prunus L.	prunus
	Prunus americana Marsh.	American plum
	Prunus pumila var. *besseyi (Bailey) Gleason*	western sandcherry
	Prunus virginiana L.	common chokecherry
	Rosa L.	rose
	Rosa acicularis Lindl.	prickly rose
	Rosa arkansana Porter	prairie rose
	Rosa woodsii Lindl.	Woods' rose
	Rubus L.	blackberry
	Rubus idaeus L.	American red raspberry
	Rubus occidentalis L.	black raspberry
	Rubus parviflorus Nutt.	thimbleberry
	Rubus pubescens Raf.	dwarf red blackberry
	Spiraea betulifolia Pallas	white spirea
Rubiaceae	*Galium aparine L.*	stickywilly
	Galium boreale L.	northern bedstraw
	Galium obtusum Bigelow	bluntleaf bedstraw
	Galium triflorum Michx.	fragrant bedstraw
Salicaceae	*Populus deltoides Bartr. ex Marsh.*	eastern cottonwood
	Populus tremuloides Michx.	quaking aspen
	Salix L.	willow
	Salix scouleriana Barratt ex Hook.	Scouler's willow

Santalaceae	*Comandra umbellata (L.) Nutt*.	bastard toadflax
Saxifragaceae	*Heuchera parviflora Bartl*.	littleflower alumroot
	Heuchera richardsonii R. Br.	Richardson's alumroot
	Lithophragma parviflorum (Hook.) Nutt. ex Torr. & Gray	smallflower woodlandstar
Scrophulariaceae	*Besseya wyomingensis (A. Nels.) Rydb.*	Wyoming besseya
	Castilleja sulphurea Rydb.	sulphur Indian paintbrush
	Orthocarpus luteus Nutt.	yellow owlclover
	Penstemon gracilis Nutt.	lilac penstemon
	Verbascum thapsus L.	common mullein
Selaginellaceae	*Selaginella densa Rydb.*	lesser spikemoss
Smilacaceae	*Smilax herbacea L.*	smooth carrionflower
Solanaceae	*Physalis L.*	groundcherry
	Physalis longifolia Nutt.	longleaf groundcherry
	Solanum triflorum Nutt.	cutleaf nightshade
Ulmaceae	*Celtis occidentalis L.*	hackberry
	Ulmus americana L.	American elm
	Ulmus rubra Muhl.	slippery elm
Urticaceae	*Parietaria pensylvanica Muhl. ex Willd.*	Pennsylvania pellitory
	Urtica dioica L.	stinging nettle
Verbenaceae	*Phryma leptostachya L*.	American lopseed
	Verbena bracteata Lag. & Rodr.	bigbract verbena
	Verbena hastata L.	swamp verbena
	Verbena stricta Vent.	hoary verbena
Violaceae	*Viola L.*	violet
	Viola adunca Sm.	hookedspur violet
	Viola canadensis L.	Canadian white violet
	Viola pedatifida G. Don	prairie violet
	Viola renifolia Gray	white violet
Vitaceae	*Parthenocissus quinquefolia (L.) Planch.*	Virginia creeper
	Parthenocissus vitacea (Knerr) A.S. Hitchc.	woodbine
(Various)	Cryptogams	
	Ferns spp.	
	Mosses and Lichens	

Appendix 15.

Metadata for theWind Cave National Park Mapping Project

Wind Cave National Park, Spatial Vegetation Data Metadata

Identification_Information:
Citation:
Citation_Information:
Originator:
Remote Sensing and GIS Group, Technical Service Center, US Bureau of Reclamation, Mail Code D-8260, POB 25007, Denver CO 80225
Publication_Date: 1999
Title:
Wind Cave National Park Spatial Vegetation Data; Cover Type / Association level of the National Vegetation Classification System
Geospatial_Data_Presentation_Form: Map
Series_Information:
Series_Name: USGS-NPS Vegetation Mapping Program
Issue_Identification: None
Publication_Information:
Publication_Place: Denver, CO
Publisher: USGS-BRD
Other_Citation_Details: Created under contract to the USGS-BRD-CBI
Online_Linkage: http://www.usbr.gov/pmts/rsgis/
Online_Linkage: http://biology.usgs.gov/npsveg/wica/index.html#geospatial_veg_info
Description:
Abstract:
This geospatial database covers vegetation land cover and land use for Wind Cave National Park and surrounding areas and is authorized as part of the USGS/NPS Vegetation Mapping Program http://biology.usgs.gov/npsveg. The program is administered by the Biological Resources Division (BRD) of the United States Geological Survey (USGS). This mapping effort was performed by the US Bureau of Reclamation's (USBR) Remote Sensing and GIS Group, Technical Service Center, Denver, CO. The vegetation mapping program is part of a larger Inventory and Monitoring (I&M) program started by the National Park Service (NPS) http://science.nature.nps.gov/im/. I&M goals are, among others, to map the vegetation of all national parks and monuments and provide a baseline inventory of vegetation. The USGS/BRD is responsible for overall management and oversight of all ongoing mapping efforts. The mapped vegetation reflects conditions that existed during the specific year and season that the aerial photographs were taken. There is a margin of error inherent in the use of aerial photographs. Therefore, a detailed ground and historical analysis of a single site may result in a revision of the vegetation alliance boundaries established through photographic interpretation.
Purpose:
The purposes of the mapping effort are varied and include the following: Provides support for NPS Resources Management; Promotes vegetation-related research for both NPS and USGS/BRD; Provides support for NPS Planning and Compliance; Adds to the information base for NPS Interpretation; and Assists in NPS Operations.
Supplemental_Information:
The following vegetation and land use classes were mapped for this project: LAND USE: 51 Transportation Communications, and Utilities; 52 Mixed Urban or Built-up Land; 53 Croplands and Pasture; 55 Other

Agricultural Land; 57 Open Water; 59 Strip Mines, Quarries, and Gravel Pits. VEGETATION: 1 Purple three-awn - Fetid marigold Herbaceous Vegetation; 2 Ponderosa pine Limestone Rock Outcrop; 3 Red Beds Spares Vegetation; 4 Black Hills Rock Outcrop Sparse Vegetation; 6 Bison Wallows; 11 Little Bluestem -Sideouts grama Herbaceous Alliance (with burned ponderosa pine; 12 Chokechery Shrubland with burned ponderosa pine; 13 Western Wheatgrass - Kentucky Complex with burned ponderosa pine; 14 Emergent Wetland Herbaceous Vegetation 15 Little Bluestem - Grama Grass Herbaceous Vegetation; 16 Western Wheatgrass - Kentucky Bluegrass Complex; 17 Introduced Weedy Graminoid Herbaceous Vegetation ; 18 Needle-and-thread - Blue Grama-Threadlead Sedge Herbaceous Vegetation; 30 Mt Mahogany / Sideoats Grama Shrubland I; 31 Mt Mahogany / Sideoats Grama Shrubland II ; 32 Lead Plant Shrubland; 33 Chokecherry Shrubland; 34 Bebb Willow Shrubland; 35 Western Snowberry Shrubland; 40 Plains Cottonwood / Western snowberry Woodland; 41 Boxelder / Chokecherry Forest; 42 Bur Oak Stand; 43 Green Ash - American Elm / Chokecherry Forest; 44 Birch - Aspen Stand; 45 Ponderosa Pine Woodland Complex I; 46 Ponderoas Pine / Little Bluestem Woodland; 47 Ponderosa Pine / Chokecherry Forest; 48 Ponderosa Pine Woodland Complex II; 49 Young Ponderosa Pine Dense Cover Complex.

Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 199706
Currentness_Reference: Source Photography Date

Status:
Progress: Complete
Maintenance_and_Update_Frequency: None Planned

Spatial_Domain:
Bounding_Coordinates:
West_Bounding_Coordinate: -103.6194
East_Bounding_Coordinate: -103.3222
North_Bounding_Coordinate: 43.65139
South_Bounding_Coordinate: 43.50639
Description_of_Geographic_Extent:
Wind Cave National Park, SD including approx 5 mile buffer around park which includes private lands and portions of Custer State Park and Black Hills National Forest.

Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: association
Theme_Keyword: alliance
Theme_Keyword: land cover
Theme_Keyword: land use
Theme_Keyword: vegetation
Theme_Keyword: National Park Service
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Wind Cave
Place_Keyword: Pringle
Place_Keyword: South Dakota
Place_Keyword: National Park
Place_Keyword: Wind Cave National Park

Taxonomy:
Keywords/Taxon:
Taxonomic_Keyword_Thesaurus: None
Taxonomic_Keywords: Plants

Taxonomic_Keywords: vegetation
Taxonomic_Keywords: National Vegetation Classification System
Taxonomic_System:
Classification_System/Authority:
Classification_System_Citation:
Citation_Information:
Originator: U.S. Government; Federal Geographic Data Committee
Publication_Date: 19971022
Title: National Vegetation Classification Standard (NVCS)
Geospatial_Data_Presentation_Form: document
Publication_Information:
Publication_Place: Washington D.C.
Publisher: Federal Geographic Data Committee
Online_Linkage: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/index_html
Taxonomic_Procedures:
Sequence of field test data and observation plots, and CIR photo signature field observations.
General_Taxonomic_Coverage:
Refer to complete listing of mapped plant alliances/associations under Supplemental Information above.
Taxonomic_Classification:
Taxon_Rank_Name: Kingdom
Taxon_Rank_Value: Plantae
Access_Constraints: None
Use_Constraints:
Any person using the information presented here should fully understand the
data collection and compilation procedures, as described in the metadata,
before beginning analysis. The burden for determining fitness for use lies
entirely with the user. For purposes of publication or dissemination, citations
or credit should be given to the U.S. Geological Survey, and the National Park
Service, and the U.S. Bureau of Reclamation.
Point_of_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: USGS-NPS Vegetation Mapping Program Coordinator
Contact_Organization: U.S. Geological Survey, Center for Biological Informatics
Contact_Address:
Address_Type: mailing and physical address
Address:
U.S. Geological Survey, Center for Biological Informatics, MS 302, Room 8000, Building 810,
Denver Federal Center
City: Denver
State_or_Province: Colorado
Postal_Code: 80225
Contact_Voice_Telephone: (303) 202-4220
Contact_Facsimile_Telephone: 303-202-4229
Contact_Facsimile_Telephone: 303-202-4219 (org)
Contact_Electronic_Mail_Address: gs-b-npsveg@usgs.gov
Browse_Graphic:
Browse_Graphic_File_Name: http://biology.usgs.gov/npsveg/wica/images/wicaveg.pdf
Browse_Graphic_File_Description:
Graphic file showing vegetation distribution of Wind Cave NP and environs, by ecological
subgroups. Low resolution for web browser - 424 KB file size.
Browse_Graphic_File_Type: PDF
Data_Set_Credit: Jay Carlson, Dan Cogan, Doug Crawford, Trudy Myer, and Jim Von Loh of USBR
Native_Data_Set_Environment: UNIX-ARC/INFO

Data_Quality_Information:

Attribute_Accuracy:
Attribute_Accuracy_Report:
These data have an overall accuracy of 73 % (69.8% Kappa index) within a 90% confidence interval of 77.6% upper limit and 68.4% lower limit.
Logical_Consistency_Report:
All polygon features are checked for topology and existance of label points using the ARC/INFO software. Each polygon begins and ends at the same point with the node feature. All nodes are checked for error so that there are no unintentional dangling features . There are no duplicate lines or polygons. All nodes will snap together and close polygons based on a specified tolerance. If the node is not within the tolerance it is adjusted manually. The tests for logical consistency are performed in ARC/INFO using certain commands.
Completeness_Report:
All data that can be photo-interpreted is digitized in accordance with the minimun mapping unit of .5 hectares. This includes features that fall into the NVCS vegetation (landcover) classification and the Anderson Level II land use classification. Minimum mapping unit is .5 hectares but some classes below the MMU are included such as wetlands; prominent stands of vegetation; and polygons cut off by other features and boarders. Roads (out to visible disturbed ground right-of-way or fence line) wider than approx 10 meters were digitized as polygons and attributed accordingly. Roads visible on the DOQQ's but thinner than 10 meters were digitized as lines. Wet drainages were digitized as lines and attributed with code #14. Dry drainages thinner than 10 meters were not digitized.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
USGS DOQQ's were used as basemap to acquire geospatial horizontal locations.
Lineage:
Methodology:
Methodology_Type: Field and Remote Sensing
Methodology_Identifier:
Methodology_Keyword_Thesaurus: None
Methodology_Keyword: photo-interpretation
Methodology_Keyword: Field Methods for Vegetation Mapping
Methodology_Keyword: ground truth
Methodology_Keyword: reconnaissance
Methodology_Keyword: gradsect
Methodology_Keyword: observation
Methodology_Keyword: plot
Methodology_Keyword: photo signatures
Methodology_Keyword: ground verification
Methodology_Keyword: stereoscope
Methodology_Description:
All vegetation and land use classes were interpreted and mapped from 1:12,000 scale, color infrared photography flown in June 1997. Color prints were developed from the CIR negatives and have an approximate 20% overlap east-to-west and 60% north-to-south. Data from the photos was interpreted on mlyar overlays. Vegetation was delineated and classified on the mylars using a combination of field and remote sensing techniques. Field techniques followed the standards described in Field Methods for Vegetation Mapping (The Nature Conservancy, 1994). These included preliminary reconnaissance, environmental stratification of the study area using a gradsect approach (Austin and Heyligers, 1989), and observation point and detailed plot data collection. Multiple plot and

observation data were collected for each unique vegetation association found within the study area. Biological, environmental, locational, and biological interactions/historical/disturbance data were collected at each sample point using the standard plot survey or observation point form developed by The Nature Conservancy (1994). Remote sensing techniques included ground verification of unique photo signatures, stereoscopic magnification, and photo interpretation of the vegetation and land-use practices using standard photo interpretation characteristics such as tone, texture, color, pattern, topographic position, and shadow. Soil maps were also used to aid in proper interpretation. Photographs were examined using a stereoscope as needed and light tables. A detailed photo-interpretation key is provided in the USBR Technical Memorandum cited elsewhere in this document.

Methodology_Citation:
Citation_Information:
Originator: Austin, M.P. and P.C. Heyligers
Publication_Date: 1989
Title:
Vegetation survey design for conservation: Gradsect sampling of forests in northeastern New South Wales
Geospatial_Data_Presentation_Form: document
Edition: Biological Conservation, Vol 50
Other_Citation_Details: pp 13-32

Methodology:
Methodology_Type: Field
Methodology_Description: See above
Methodology_Citation:
Citation_Information:
Originator: The Nature Conservancy
Publication_Date: 1994
Title: Field Methods for Vegetation Mapping
Geospatial_Data_Presentation_Form: document
Edition: NPS Vegetation Mapping Program, Final Draft
Online_Linkage: http://biology.usgs.gov/npsveg/fieldmethods/index.html

Source_Information:
Source_Citation:
Citation_Information:
Originator: Horizons, Inc., POB 3134, Rapid City, SD 57709
Originator: Voice: 605-343-0280; Fax: 605-343-0305
Originator: EMail: eng@horizonsinc.com
Publication_Date: 199706
Title: Aerial CIR Photos
Geospatial_Data_Presentation_Form: image
Online_Linkage: http://www.horizonsinc.com
Online_Linkage: http://biology.usgs.gov/npsveg/wica/photos.pdf
Source_Scale_Denominator: 12000
Type_of_Source_Media: Color Prints
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 199706
Source_Currentness_Reference: Ground Condition
Source_Citation_Abbreviation: None
Source_Contribution:
These aerial photographs were the basis for the photointerpretation process.

Source_Information:
Source_Citation:

Citation_Information:
Originator: USGS
Publication_Date: 1997
Title: Digital Orthophoto Quarter Quadrangles (DOQQ)
Geospatial_Data_Presentation_Form: Remote-Sensing Image
Series_Information:
Series_Name: Boland Ridge, Butcher Hill, Cicero Peak, Mt Cooldige, Pringle, & Wind Cave
Issue_Identification: USGS 7.5m quads in South Dakota
Other_Citation_Details: Refer to USGS web site for metadata information
Online_Linkage: http://edcsns17.cr.usgs.gov/EarthExplorer/
Source_Scale_Denominator: 12000
Type_of_Source_Media: Digital
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1995
Source_Currentness_Reference: Ground Condition
Source_Citation_Abbreviation: None
Source_Contribution: The DOQQ's were used as basemap for transfer work.
Source_Information:
Source_Citation:
Citation_Information:
Originator: USGS/BRD, Center for Biological Informatics
Publication_Date: 19990430
Title: Vegetation Procedure Report
Geospatial_Data_Presentation_Form: report
Series_Information:
Series_Name: Boland Ridge, Butcher Hill, Cicero Peak, Mt Cooldige, Pringle, & Wind Cave
Issue_Identification: USGS 7.5m quads in South Dakota
Other_Citation_Details: Refer to USGS web site for metadata information
Online_Linkage: http://edcsns17.cr.usgs.gov/EarthExplorer/
Online_Linkage: http://biology.usgs.gov/npsveg/wica/wicarpt.pdf
Source_Scale_Denominator: 12000
Type_of_Source_Media: Digital
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1995
Source_Currentness_Reference: Ground Condition
Source_Citation_Abbreviation: None
Source_Contribution: The DOQQ's were used as basemap for transfer work.
Process_Step:
Process_Description:
Vegetation information on the mylars (discussed above under methods) were transfered into the GIS database using two methods, either heads-up digitizing or scanning. METHOD I: Heads-up digitizing will be used in areas where there are strong visible transitions between vegetation types (i.e., have boundaries that are easy to see on the digital ortho image). Briefly, heads-up digitizing is a procedure whereby the operator digitizes by hand and eye on a computer terminal screen showing a digital image of an ortho-rectified photo. By looking at similar features on both the aerial photograph (from which the classification was made on mylar) and on the orthophoto, the line drawn on the aerial photo overlay is transferred to the digital image, which is registered to coordinates on the earth. This technique should produce good results except where there is little feature contrast on the ortho, in which

case the operator will usually scan the photo to transfer those features. METHOD II: Photos that are too difficult to accurately transfer via heads-up will be scanned, ie, the mylars will be scanned, not the actual CIR photo. Before the mylar is scanned, it will be marked with control points that correspond to visible points on the DOQQ. Six control points should be located for best results though a minimum of 4 are required for a projective transform. The GIS software was used to convert the scanned mylar into a geo-referenced coverage which was then attributed and combined with the larger vegetation coverage associated with the quarter quad area. The entire transfer and editing sequence was automated via an in-house ARC/INFO AML. The final vegetation coverages consist of (1) Quarter-quad boarder, (2) Park and GIS project area boundary arcs, if applicable, and (3) vegetation polygons and linear features. Another step involved heads-up digitizing of roads visible on the CIR/DOQQ in accordance with the criteria discussed under the Completness Report above.

Process_Date: 1998

Process_Contact:

Contact_Information:

Contact_Organization_Primary:

Contact_Organization:

Remote Sensing and GIS Group, Technical Service Center, US Bureau of Reclamation

Contact_Address:

Address_Type: Mailing Address

Address: POB 25007

City: Denver

State_or_Province: CO

Postal_Code: 80225

Country: USA

Contact_Voice_Telephone: 303-446-2283

Contact_Facsimile_Telephone: 303-445-6337

Contact_Electronic_Mail_Address: jvonloh@do.usbr.gov

Hours_of_Service: 7:30 a.m. to 4:00 p.m. Monday Thru Friday, MST

Process_Step:

Process_Description:

Data plot and obseravtion coverages: Coverages for the plot and observation data points were created from the plot and observation data sheets. The coordinates on the data sheets were in datum NAD27. Once the coverages were finalized they were reprojected into datum NAD83.

Process_Date: 1998

Spatial_Data_Organization_Information:

Direct_Spatial_Reference_Method: Vector

Spatial_Reference_Information:

Horizontal_Coordinate_System_Definition:

Planar:

Grid_Coordinate_System:

Grid_Coordinate_System_Name: Universal Transverse Mercator

Universal_Transverse_Mercator:

UTM_Zone_Number: 13

Transverse_Mercator:

Longitude_of_Central_Meridian: -105

Latitude_of_Projection_Origin: 0

False_Easting: 500000

False_Northing: 0

Scale_Factor_at_Central_Meridian: .9996
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 1
Ordinate_Resolution: 1
Planar_Distance_Units: meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodedic Reference System 80
Semi-major_Axis: 6378137
Denominator_of_Flattening_Ratio: 298.257

Entity_and_Attribute_Information:
Overview_Description:
Entity_and_Attribute_Overview:
VEGETATION COVERAGES: Due to the large size of the database, vegetation coverages were named according to associated USGS 7.5m quads and the quarterquad quadrant as follows: <quadname>_veg# with # refering to the quarter quadrant as follows: 1 - Northwest quadrant; 2 - Northeast quadrant; 3 - Southeast quadrant; 4 - Southwest quadrant. Coding Information: Polygon coverage with labels in each polygon with the following custom items: (veg_code - 3 3 I) coded with vegetation classification number. See Supplemental Info under Id Info above for complete listing of attribute codes and their descriptions; (photo - 6 6 I) coded with associated CIR photo number; (location - 6 6 C) coded according to whether the polygon is in the park or buffer area. Also, each arc was coded as follows: (digtype - 2 2 I) coded to identify how the arc was transferred into the database or type of arc as follows: 1 = heads-up, on screen digitizing; 2 = scanned mylar; 3 = arc associated with gis study area border; 4 = arc associated with quarterquad border; 5 = arc associated with park border. (veg_code - 3 3 I) linear wetland features coded with vegetation classification number. BOUNDARY COVERAGES: bndrypark - Park boundary coverage. This coverage was digitized from USGS 7.5m quads. bndryproj - GIS mapping project area. This coverage was derived from markings on a 1:100k map provided to us by the USGS/BRD. bndryquad - Boundaries of all the 7.5m quads. This coverage was created via an in-house AML that creates tics based on lower left and upper right coordinates for the desired area. The program created tics every 7.5 minutes and then arcs were snapped to the tics to create the quad borders. Coding Information: bndrypark - line coverage - no custom attributing. bndryproj - line coverage - no custom attributing. bndryquad - polygon coverage with labels in each quad polygon with the following items: (quadname - 8 8 c) - abbreviated name for each quad; (fullname - 20 20 c) - full quadname. DATA COVERAGES: dataobsv - Point coverage of observation data points. dataplot - Point coverage of plot data points. Coding Information: Label points with items as follows: (plot_code - 3 3 n) coded with plot number from plot data sheets; (veg_code - 14 14 c) coded with veg class text; (type - 10 10 c) coded with broad vegetation class (eg: woodland). Note1: x-coord and y-coord added with ARC/INFO "addxy" command. Note2: Field data points were collected with GPS units set to datum NAD27. All coverages were re-projected into Datum NAD83 so the x- y- coordinates will not match those shown on the data sheets. OTHER COVERAGES: sec_roads - Line coverage of secondary roads digitized from USGS DOQQ. The parks projects will be using DOQQ's as the basemap for transfer of information from the CIR photos to the GIS database. The DOQQ's are standard USGS

product and are in datum of NAD83.
Entity_and_Attribute_Detail_Citation:
Wind Cave National Park, USGS/NPS Vegetation Mapping Program, Technical Memorandum No. 8260-99-03, USBR

Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person: USGS-NPS Vegetation Mapping Program Coordinator
Contact_Organization:
U.S. Geological Survey, Center for Biological Informatics
Contact_Address:
Address_Type: mailing and physical address
Address:
U.S. Geological Survey, Center for Biological Informatics, MS 302, Room 8000, Building 810, Denver Federal Center
City: Denver
State_or_Province: Colorado
Postal_Code: 80225
Contact_Voice_Telephone: (303) 202-4220
Contact_Facsimile_Telephone: 303-202-4229
Contact_Facsimile_Telephone: 303-202-4219 (org)
Contact_Electronic_Mail_Address: gs-b-npsveg@usgs.gov
Resource_Description: Wind Cave National Park Vegetation Map
Distribution_Liability:
The U.S. Geological Survey and the National Park Service shall not be held liable for improper or incorrect use of the data described and/or contained herein. These data and related graphics (if available) are not legal documents and are not intended to be used as such.

The information contained in these data is dynamic and may change over time. The data are not better than the original sources from which they were derived. It is the responsibility of the data user to use the data appropriately and consistent within the limitations of geospatial data in general and these data in particular. Any related graphics (if available) are intended to aid the data user in acquiring relevant data; it is not approriate to use the related graphics as data.

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Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: HTML
Digital_Transfer_Option:
Online_Option:
Computer_Contact_Information:
Network_Address:
Network_Resource_Name: http://biology.usgs.gov/npsveg/wica/index.html#geospatial_veg_info

Fees: None

Metadata_Reference_Information:
Metadata_Date: 20012022
Metadata_Review_Date: 20071108
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: USGS-NPS Vegetation Mapping Program Coordinator
Contact_Address:
Address_Type: mailing and physical address
Address:
U.S. Geological Survey, Center for Biological Informatics, MS 302,
Room 8000, Building 810, Denver Federal Center
City: Denver
State_or_Province: Colorado
Postal_Code: 80225
Country: USA
Contact_Voice_Telephone: (303) 202-4220
Contact_Facsimile_Telephone: (303) 202-4219
Contact_Electronic_Mail_Address: gs-b-npsveg@usgs.gov
Metadata_Standard_Name: FGDC-STD-001.1-1999 Content Standard for Digital Geospatial Metadata, 1998 Part 1: Biological Data Profile, 1999
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Extensions:
Online_Linkage: http://metadata.nbii.gov/portal/community/Communities/Toolkit/Metadata/FGDC_Metadata/
Profile_Name: Biological Data Profile FGDC-STD-001.1-1999