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Natural Resource Stewardship and Science

Plant Community Composition and Structure Monitoring for Jewel Cave National Monument

2013 Annual Report

Natural Resource Data Series NPS/NGPN/NRDS—2014/611

ON THE COVER
Long-term monitoring plot at Jewel Cave National Monument, 2013
Photograph by: NPS

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Contents

Figures

Tables

Acknowledgments

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Introduction

The Black Hills is a 1.5 million ha (3.7 million acres) refuge of ponderosa pine (*Pinus ponderosa*) forest surrounded by the prairies of western South Dakota and eastern Wyoming. The ponderosa pine forest of the Black Hills is a unique ecosystem composed of species from the western Rocky Mountains, eastern deciduous forests, northern boreal forests, and the surrounding Great Plains (Larson and Johnson 2007). The National Park Service (NPS) plays an important role in preserving and restoring ponderosa woodlands within its boundaries. The stewardship goal of the NPS is to "preserve ecological integrity and cultural and historical authenticity" (NPS 2012); however, resource managers struggle with the grim reality that there have been fundamental changes in the disturbance regimes, such as climate and fire, that have historically maintained ponderosa woodlands, and there is the continual pressure of exotic invasive species. In recent years, mountain pine beetle (*Dendroctonus ponderosae*) outbreaks have been of particular concern because they are increasing throughout the Black Hills and have caused 100% mortality of ponderosa pines in some areas (Hocking et al. 2010). Long-term monitoring in national parks is essential to sound management of ponderosa woodlands because it can provide information on environmental quality and condition, benchmarks of ecological integrity, and early warning of declines in ecosystem health.

Jewel Cave National Monument (JECA) is located in the southwestern Black Hills and has a mission to preserve Jewel Cave, through management of the surface and subsurface ecosystem, while providing opportunities for the pursuit of scientific interests and public enjoyment. While this is a relatively small area (516 ha, 1274 ac), JECA contains diverse native ponderosa forest and grassland communities (Marriot and Hartment 1986, Ashton et al. 2012b). The Northern Great Plains Inventory & Monitoring Program (NGPN) began two vegetation monitoring efforts in JECA in 2011: a program to monitor understory vegetation annually (Ashton et al. 2012b) and a large survey of forest conditions that will be repeated every five years (Ashton et al. 2012a). Vegetation monitoring protocols and plot locations were chosen to represent the entire park and to coordinate efforts with the Northern Great Plains Fire Ecology Program (FireEP). The long-term objectives of the NGPN plant community monitoring effort (Symstad et al. 2012b) in JECA are to:

1. Determine park-wide status and long-term trends in vegetation species composition (e.g., exotic vs. native) and structure (e.g., cover, height) of herbaceous and shrub species.

2. Determine park-wide status (at 5-year intervals) and long-term trends of tree density by species, height class, diameter class, and fuel loads

3. Improve our understanding of the effects of external drivers and management actions on plant community species composition and structure by correlating changes in vegetation composition and structure with changes in climate, landscape patterns, atmospheric chemical composition, fire, and invasive plant control.

This report is intended to provide a timely release of basic data sets and data summaries from our sampling efforts at JECA in 2013, our third year of sampling. We visited 6 plots, and it will take 2 more years to visit every plot in the park twice (Figure 1). We expect to produce reports with more

in-depth data analysis and interpretation when we complete 5 years of sampling. In the interim, reports, spatial data, and data summaries can be provided for park management and interpretation upon request.

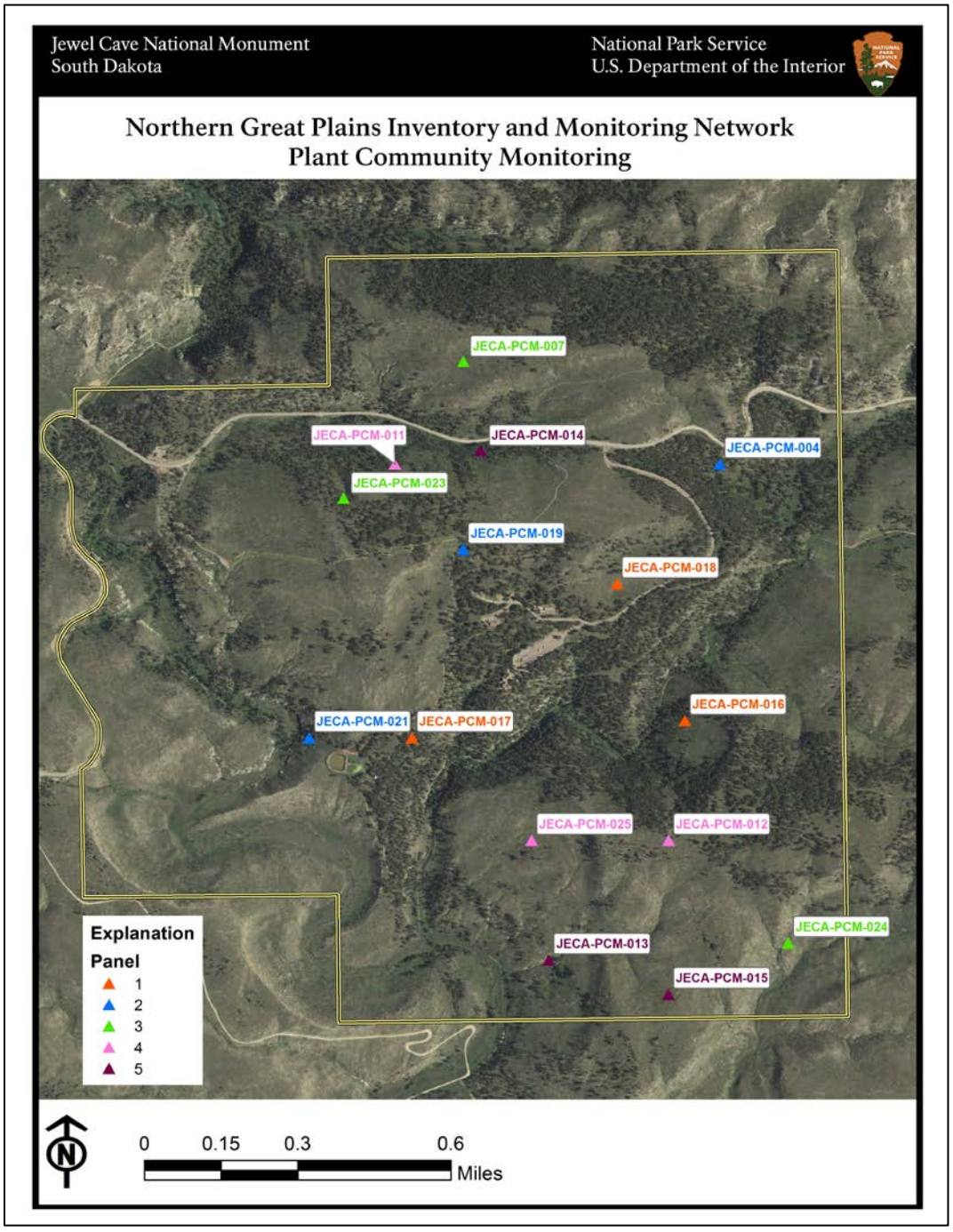


Figure 1. Map of Jewel Cave National Monument (JECA) and plant community monitoring (PCM) plots. Plots in panel 2 (blue) and panel 3 (green) were visited in 2013.

Methods

The NGPN Plant Community Composition and Structure Monitoring Protocol (Symstad et al. 2012b, a) describes in detail the methods used for sampling long-term plots. Below, we briefly describe the general approach. For those interested in more detail please see Symstad et al. 2012, available at http://science.nature.nps.gov/im/units/ngpn/monitor/plants.cfm.

Sample design

We implemented a survey to monitor plant community structure and composition in JECA using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003, 2004). Using a GRTS design, we selected 15 randomly located sites within JECA (Figure 1). We split these 15 sites into 5 panels with 3 sites each. We visit 2 panels (6 sites) every year, and after 5 years (2015) we will have visited all 15 sites twice. In 2011, we visited sites in panel 1 and panel 5, and in 2012 we visited sites in panel 1 and panel 2 (Figure 1). In 2013, we visited sites in panel 2 and panel 3 during the first week of July. Data from these randomly selected sites can be used to estimate condition of vegetation communities for the whole park and over time, can be used to discern trends in condition.

Plot layout and sampling

At each of the sites we visited, we recorded plant species cover and frequency in a rectangular, 50 m x 20 m (0.1 ha), permanent plot (Figure 2). Data on ground cover, herb-layer height $\leq$ 2 m, and plant cover were collected on two 50 m transects (the long sides of the plot) using a point-intercept method. Species richness data from the point-intercept method were supplemented with species presence data collected in 5 sets of nested square quadrats (0.01 m^2, 0.1 m^2, 1 m^2, and 10 m^2) located systematically along each transect (Figure 2). In 2013, sampling at JECA took an 8-person crew 4 days (see Appendix A for a detail of activities each day).

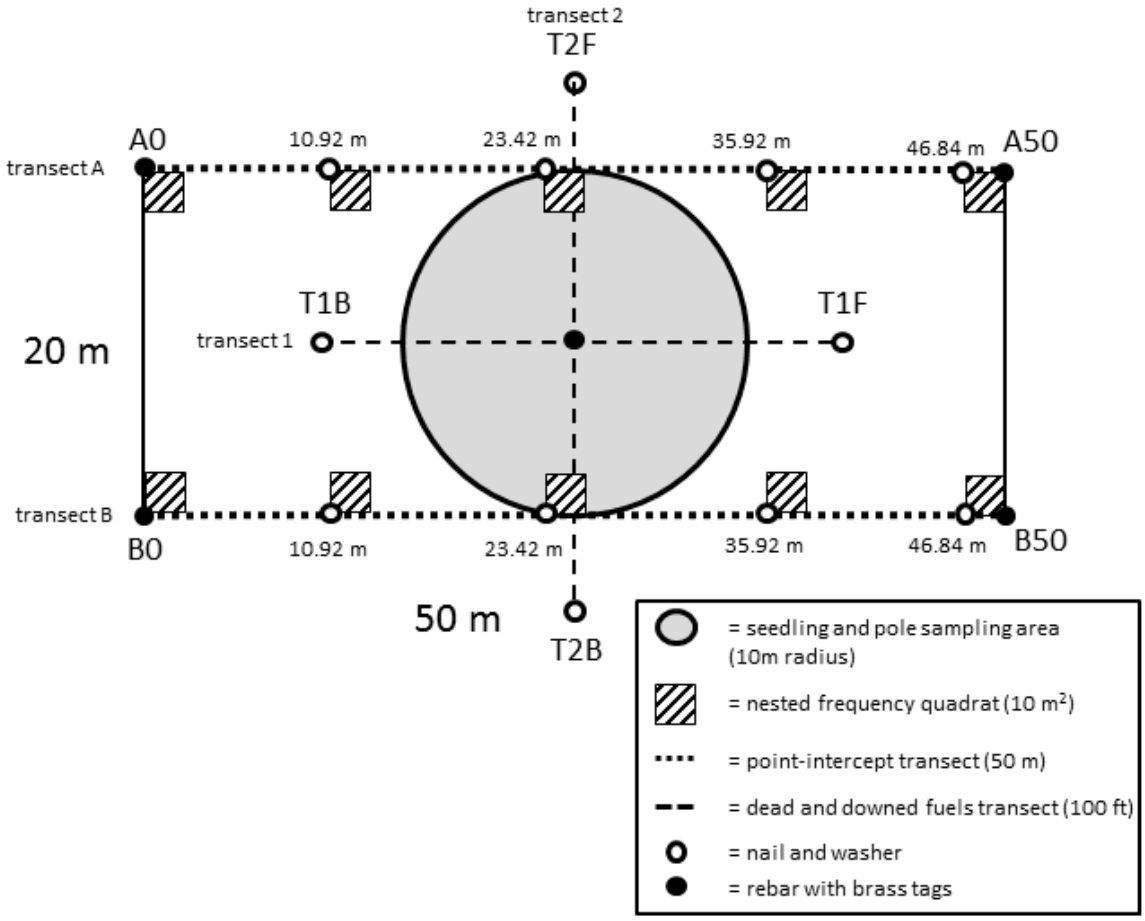


Figure 2. Long-term monitoring plot used for sampling vegetation in Jewel Cave National Monument.

When woody species were present, tree regeneration and tall shrub density data were collected within a 10 m radius subplot centered in the larger 50 m x 20 m plot (Figure 2). Trees with diameter at breast height (DBH) > 15 cm, located within the entire 0.1 ha plot, were mapped and tagged. For each tree, the species, DBH, status, and condition (e.g., leaf-discoloration, insect-damaged, etc.) were recorded. Dead and downed woody fuel load data were collected on two perpendicular, 100 ft (30.49 m) transects with midpoints at the center of the plot (Figure 2), following Brown's Line methods (Brown 1974, Brown et al. 1982).

At all plots, we also surveyed the area for common disturbances and target species of interest to the park. Common disturbances included such things as roads, rodent mounds, animal trails, and fire. For all plots, the type and severity of the disturbances were recorded. We also surveyed the area for exotic species that have the potential to spread into the park and cause significant ecological impacts (Table 1). For each target species that was present at a site, an abundance class was given on a scale from 1-5 where 1 = one individual, 2 = few individuals, 3 = cover of 1-5%, 4 = cover of 5-25%, and 5 = cover > 25% of the plot. The information gathered from this procedure is critical for early detection and rapid response to such threats. In addition, we noted the presence of plant species that are considered rare or vulnerable to loss in South Dakota, and may occur in JECA (Table 2).

Table 1. Exotic species surveyed for at Jewel Cave National Monument as part of the early detection and rapid response program within the Northern Great Plains Network.

Scientific Name	Common Name	Habitat
Alliaria petiolata	garlic mustard	Riparian
Polygonum cuspidatum; P. sachalinense; P.x bohemicum	knotweeds	Riparian
Pueraria montana var. lobata	kudzu	Riparian
Iris pseudacorus	yellow iris	Riparian
Ailanthus altissima	tree of heaven	Riparian
Lepidium latifolium	perennial pepperweed	Riparian
Arundo donax	giant reed	Riparian
Rhamnus cathartica	common buckthorn	Riparian
Heracleum mantegazzianum	giant hogweed	Riparian
Centaurea solstitialis	yellow star thistle	Upland
Hieracium aurantiacum; H. caespitosum	orange and meadow hawkweed	Upland
Isatis tinctoria	Dyer's woad	Upland
Taeniatherum caput-medusae	medusahead	Upland
Chondrilla juncea	rush skeletonweed	Upland
Gypsophila paniculata	baby's breath	Upland
Centaurea virgata; C.diffusa	knapweeds	Upland
Linaria dalmatica; L. vulgaris	toadflax	Upland
Euphorbia myrsinites & E. cyparissias	myrtle spurge	Upland
Dipsacus fullonum & D. laciniatus	common teasel	Upland
Salvia aethiopis	Mediterranean sage	Upland
Ventenata dubia	African wiregrass	Upland

Table 2. Rare species that were surveyed for during the 2013 field season at Jewel Cave National Monument.

Scientific Name	Common Name
Achnatherum robustum	sleepy grass
Boechara divaricarpa/ Boechara holboelli	limestone rockcress
Botrychium campestre	prairie moonwort
Botrychium lineare	narrowleaf grapefern
Botrychium lunaria	common moonwort
Erigeron ochroleucus	buff fleabane
Fritillaria atropurpurea	spotted fritillaria
Lobelia spicata	palespike Lobelia
Oenothera flava	yellow evening primrose
Oenothera laciniata	cutleaf evening primrose
Physaria montana	mountain bladderpod
Platanthera stricta	slender bog orchid
Thelesperma megapotamicum	Hopi tea
Townsendia exscapa	Easter daisy
Townsendia hookeri	Hooker's Townsend daisy

Data Management and Analysis

We used FFI (FEAT/FIREMON Integrated; http://frames.gov/ffi/) as the primary software environment for managing our sampling data. FFI is used by a variety of agencies (e.g., NPS, USDA Forest Service, U.S. Fish and Wildlife Service), has a national-level support system, and generally conforms to the Natural Resource Database Template standards established by the Inventory and Monitoring Program.

Species scientific names, codes, and common names are from the USDA Plants Database (USDA-NRCS 2012). However, nomenclature follows the Integrated Taxonomic Information System (ITIS) (http://www.itis.gov). In the few cases where ITIS recognizes a new name that was not in the USDA PLANTS database, the new name was used and a unique plant code was assigned.

After data for the sites were entered, 100% of records were verified to the original data sheet to minimize transcription errors. A further 10% of records were reviewed a second time. After all data were entered and verified, automated queries were developed to check for errors in the data. When errors were caught by the crew or the automated queries, changes were made to the original datasheets and the FFI database as needed.

Plant life forms (e.g., shrub, forb) were based on definitions from the USDA Plants Database (USDA-NRCS 2012). Warm-season grasses were identified primarily using a guide by Skinner (2010). Summaries were produced using the FFI reporting and query tools and statistical summaries and graphics were generated using R software (version 2.15.1).

We measured diversity at the plots in 3 ways: species richness, the Shannon Index, and Pielou's Index of Evenness. Species richness is simply a count of the species recorded in an area. The Shannon Index, H', is a measure of the number of species in an area and how even abundances are across the community. It typically ranges between 0 (low richness and evenness) to 3.5 (high species richness and evenness). Pielou's Index of Evenness, J', measures how even abundances are across taxa. It ranges between 0 and 1; values near 0 indicate dominance by a single species, and values near 1 indicate nearly equal abundance of all species present.

Disturbances were recorded in square meters and ranged from 0 (not present) to 2290 (the whole plot area) for each type of disturbance. We report the sum of all individual disturbances, so the value can be greater than 2290 m^2.

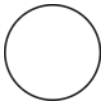
Reporting on Natural Resource Condition

Results were summarized in a Natural Resource Condition Table based on the templates from the State of the Park report series (http://www.nps.gov/stateoftheparks/). The goal is to improve park priority setting and to synthesize and communicate complex park condition information to the public in a clear and simple way. By focusing on specific indicators, such as exotic species cover, it will also be possible and straightforward to revisit the metric in subsequent years. The status and trend of each indicator is scored and assigned a corresponding symbol based on the key found in Table 3.

We chose a set of indicators and specific measures that can describe the condition of vegetation in the Northern Great Plains and the status of exotic plant invasions. The measures include: absolute herb-layer canopy cover, native species richness, evenness, relative cover of exotic species, and annual brome cover. Reference values were based on descriptions of historic condition and variation, past studies, and/or management targets. Current park condition was compared to a reference value, and status was scored as good condition, warrants moderate caution, or warrants significant concern based on this comparison (Table 3). Good condition was applied to values that fell within the range of the reference value, and significant concern was applied to conditions that fell outside the bounds

of the reference value. In some cases, reference conditions can be determined only after we have accumulated more years of data. When this is the case, we refer to these as “To be determined” and estimate condition based on our professional judgment.

Table 3. Key to the symbols used in the Natural Resource Condition Table. The background color represents the current status, the arrow summarizes the trend, and the thickness of the outside line represents the degree of confidence in the assessment. A symbol that does not contain an arrow indicates that there is insufficient information to assess a trend. Based on the State of the Park reports (http://www.nps.gov/stateoftheparks/).

Condition Status		Trend in Condition		Confidence in Assessment	
	Warrants Significant Concern		Condition is Improving		High
	Warrants Moderate Concern		Condition is Unchanging		Medium
	Resource is in Good Condition		Condition is Deteriorating		Low

Results and Discussion

Jewel Cave NM experienced severe to extreme drought conditions throughout the winter and into the spring of 2013. When the NGPN visited the park in July, recent wet weather allowed for some green-up, but overall the park was still experiencing abnormally dry conditions (Figure 3). Average herbaceous canopy cover was 90% (Table 4) in 2013, which was much higher than the previous year's 66% (Ashton et al. 2013). There was a large amount of standing litter on the ground with ground cover at the sites averaging 75% plant litter.

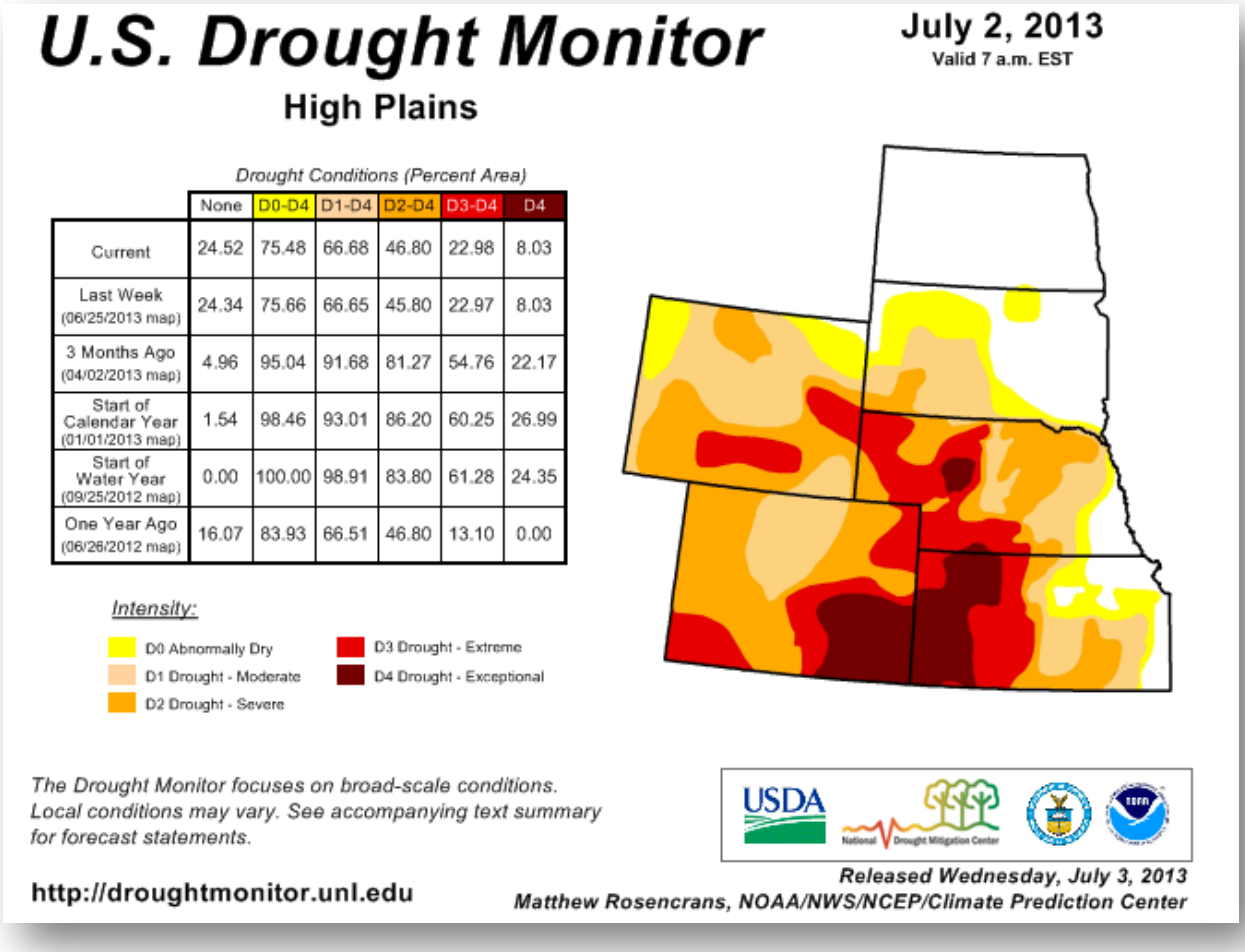


Figure 3. Drought conditions in early July 2013 in the Northern Great Plains. Jewel Cave National Monument experienced abnormally dry conditions at that time.

We found 142 plant species in 2013 at JECA (Appendix B). Graminoids, which includes grasses, sedges, and rushes, accounted for most of the vegetative cover at JECA, but trees, forbs, shrubs and subshrubs (defined as a low-growing shrub usually under 0.5m) were also present (Figure 4). We found 21 exotic species at the park, all of which were either forbs or graminoids. The shrubs, subshrubs, and trees were all native species.

There was some variation in species composition across the 6 sites. The most common species in the sites we visited were graminoids, and most were native species (Figure 5). We did not find any rare plants.

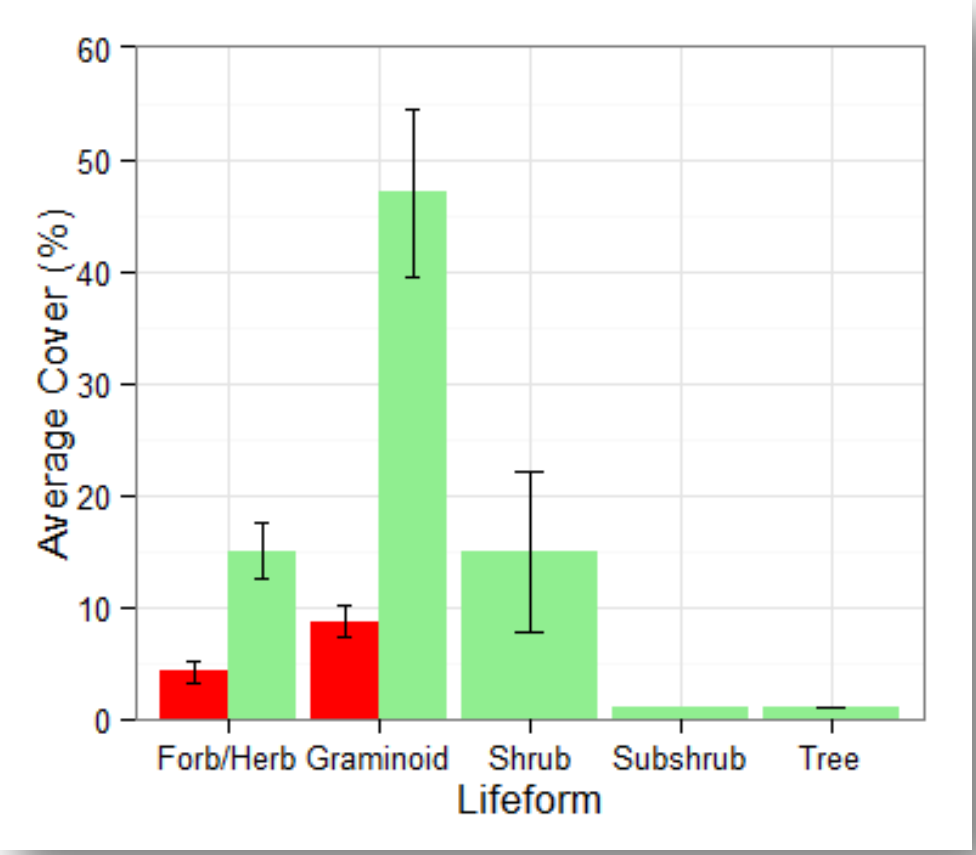


Figure 4. Average cover by lifeform and nativity in 6 plant community monitoring plots in Jewel Cave National Monument in 2013. Native (green) and exotic (red) graminoids were the most abundant lifeform across the plots. Bars represent means ± standard errors.

Table 4. Natural resource condition summary table for upland plant communities in Jewel Cave National Monument (JECA).

Indicator of Condition	Specific Measures	2013 Value (mean ± SE)	Reference Condition and Data Source	Condition Status/Trend	Rationale for Resource Condition
Upland Plant Community Structure and Composition	Absolute herb-layer canopy cover	90 ± 7 %	TBD [1]		JECA has a high herbaceous canopy cover and a moderate diversity of native plants. The condition assessment for canopy cover and evenness is based on professional judgment, but as we collect more data and understand the natural range of variability our confidence in these assessments will increase. Future work is needed to determine if the reference condition for native species richness is relevant for Black Hills Parks. Forest densities are similar to historic conditions and are characterized by a mosaic of open and closed canopy sites.
	Native species richness (based on average of 10 1m^2 quadrats per plot)	9 ± 0.2 species	8-18 species [2]		
	Evenness (based on point-intercept of 2-50m transects per plot)	0.84 ± 0.01	TBD [1]		
	Forest basal area (m^2/ha)	9.3 ± 3.5	15.3 ± 2.7 [3]		
Exotic Plant Early Detection and Management	Relative cover of exotic species	13 ± 2.2 %	≤ 10 % cover		In general, the sites in JECA had a moderate cover of exotic species. Only two sites had <10% exotic cover. Annual brome cover remains low, but Kentucky bluegrass is common throughout the park.
	Annual Brome cover	0.5 ± 0.3 %	≤ 10 % cover		
Fire and Fuel Dynamics	Total downed fuel loads	23.8 ± 3.6	Between 2 and 10		The current fire ecology program aims to maintain fuel loads of less than 10 tons/acre. The Jasper Fire in 2000 has led to a large amount of coarse woody debris throughout the park. Because the forest structure is open and lacking ladder and fine fuels the high total fuels is only of moderate concern.

References, Notes, and Data Sources:

1. To be determined when more data are available. 2. Symstad, A. J. and J. L. Jonas*. in press*. Using natural range of variation to set decision thresholds: a case study for Great Plains grasslands.in G. R. Gutenspergen, editor. Application of threshold concepts in natural resource decision making. Springer Verlag. 3. Brown, P. M. and B. Cook. 2006. Early settlement forest structure in Black Hills ponderosa pine forests. Forest Ecology and Management 223:284-290.

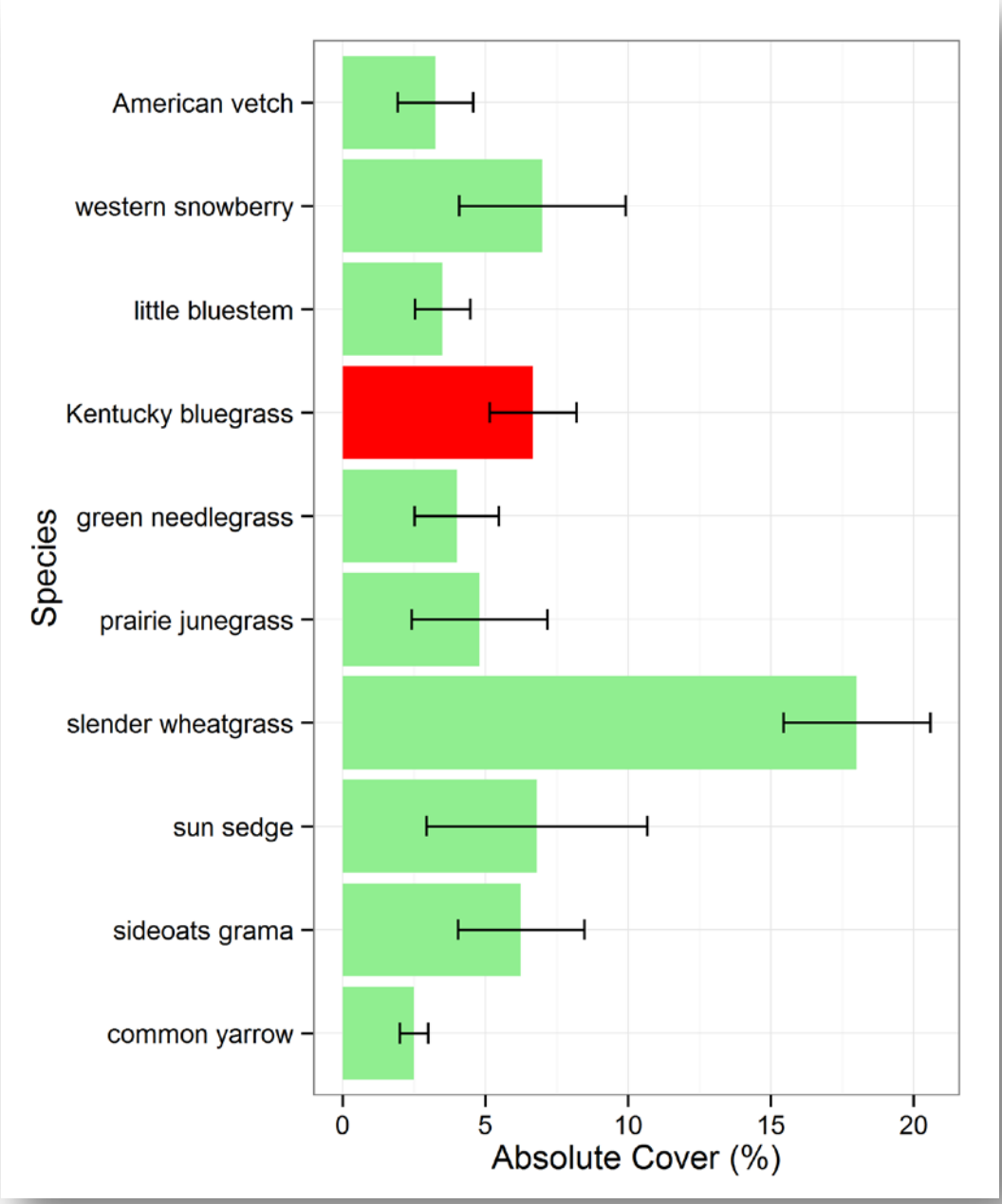


Figure 5. The average absolute cover of the 10 most common native (green) and exotic (red) plants recorded at Jewel Cave National Monument in 2013. Bars represent means ± standard errors.

Average species richness at each of the 6 plots was measured by point-intercept and in 1 m^2 and 10 m^2 quadrats (Table 5). On average, there are about 2 exotic species within the 1 m^2 quadrat (Table 5). From the point-intersect data, we found average plot diversity, H', to be 2.7 ± 0.06. Evenness, J', averaged 0.84 ± 0.01 across the plots (Table 4). When including only native species, average diversity and evenness were 2.5 ± 0.08 and 0.82 ± 0.01, respectively.

Table 5. Average plant species richness in 6 plots at Jewel Cave National Monument in 2013. Values represent means ± standard errors, n=6.

	Point-intercept	1 m^2 quadrats	10 m^2 quadrats
Species richness	24 ± 1.1	10 ± 0.3	23 ± 0.8
Native species richness	20 ± 1.1	9 ± 0.2	20 ± 1.0
Exotic species richness	4 ± 0.7	2 ± 0.2	3 ± 0.3
Graminoid species richness	10 ± 0.3	3 ± 0.3	6 ± 0.5
Forb species richness	11 ± 1.4	6 ± 0.3	15 ± 0.7

While there was some variation across sites, the plots we visited in JECA tended to have a moderate diversity of native plants compared to other mixed-grass prairies. Species richness in the mixed-grass prairie is determined by numerous factors including fire regime, grazing, prairie dog disturbance, and weather fluctuations (Symstad and Jonas 2011). While it is difficult to define a reference condition for species richness that can vary so much spatially and temporally, the natural range of variation over long-time periods may be a good starting point (Symstad and Jonas in press). Long-term records of species diversity in mixed-grass prairie from a relatively undisturbed site in eastern Montana vary between 8 and 18 species per square meter over the course of 13 years (Symstad and Jonas, in press). Since there are no long-term records of mixed-grass prairie diversity within the Black Hills, we are relying on these data as a reference condition. Future work is needed to develop a robust reference condition for plant communities in the Black Hills. Compared to the nearby mixed-grass prairie, JECA is within the natural range (Table 4, native richness in the 1 m^2 quadrat and Table 5). The highest diversity was seen in site PCM_021 (Figure 6). This site was characterized by a moderate canopy cover and had a high cover of shrubs, forbs, and grasses in the understory.

Figure 6. Long-term monitoring site PCM_021 at Jewel Cave National Monument. In 2013, we found it to have a high native plant diversity and low exotic cover relative to the other sites in the park.

The average relative cover of exotic species at sites in JECA was moderate (13 ± 2%; Table 4). However, like species richness, cover of exotic species varied considerably among sites (Table 6). Exotic cover at sites PCM_021and PCM_004 was below a proposed management target of 10%, but the other 4 sites surveyed were above this threshold. The highest cover of exotic species was 22%, found at PCM_019. Kentucky bluegrass accounted for a majority of the exotic cover in all plots, but other exotics were also abundant (Table 6). Reducing the cover of annual bromes remains a major challenge for many of the parks in the region, but annual brome cover is low at JECA.

Disturbance from grazing, small mammals, fire, and humans affects plant community structure and composition in mixed-grass prairie. For this reason, we measured the approximate area affected by

natural and human disturbances at each site we visited. In 2013, the most common disturbance was from fire, but there was also evidence of grazing and small mammal activity.

Table 6. Characteristics of the plant community at 6 plots in Jewel Cave National Monument in 2013 including average cover of annual bromes, exotic plant cover, and area of disturbance.

Plot	Native species richness in 1 m^2	Exotic cover (%)	Annual brome cover (%)	Disturbance within site (m^2)
JECA_PCM_004	9	9	0	2420
JECA_PCM_007	9	12	2	2290
JECA_PCM_019	10	22	0	2290
JECA_PCM_021	10	7	0	2450
JECA_PCM_023	9	15	0	2290
JECA_PCM_024	8	16	1	2540
Park Average	*9 ± 0.2*	*13 ± 2*	*0.5 ± 0.3*	-

Trees and/or seedlings were present in all 6 of the sites we visited in 2013. A more through assessment of forest structure was completed in 2011(Ashton et al. 2012a); however , the 2013 data provide a snapshot of condition at a subset of the plots. Serviceberry seedlings were very abundant (Table 7) at most sites. Plot PCM_024 and PCM_004 did not have any live ponderosa pines (Table 7). Overall, basal area at the park was similar to estimates of historic condition (Table 4) and slightly greater in 2013 than in 2011 (Ashton et al. 2012a). This difference is likely due to the difference in the number and location of plots sampled. Total downed fuel loads were high (24 tons/acre; Table 4) due to the large amount of coarse woody debris that has remained on the ground since the Jasper Fire. In 2016, NGPN is scheduled to repeat the thorough assessment of forest structure, fuel loads, and health.

Table 7. Seedling, pole, and tree densities at 6 plots in Jewel Cave National Monument in 2013.

	Seedling Density (seedlings/hectare)			Tree Density (trees/hectare)	
Plot	Serviceberry	Chokecherry	Ponderosa	Ponderosa poles	Ponderosa trees
JECA_PCM_004	-	-	-	77	65
JECA_PCM_007	1114	286	-	-	-
JECA_PCM_019	12858	-	127	13	36
JECA_PCM_021	4541	5177	-	232	69
JECA_PCM_023	19860	-	-	-	142
JECA_PCM_024	2673	-	-	-	-

Summary

In conclusion, we found that Jewel Cave National Monument has a moderate diversity of native plants, and species richness was within the range of natural variability for mixed-grass prairie. Future work is needed to develop reference conditions that are specific to the Black Hills. Forest densities are similar to historic conditions and characterized by a mosaic of open and closed canopy sites. Exotic plant cover was higher than in past years and was greater than 10% cover at most sites. Kentucky bluegrass was the most widespread and abundant exotic species. To retain ecological integrity and the high diversity of native plants in JECA, it is important to continue efforts to reduce the cover of invasive plants. Continued monitoring efforts will be critical to track changes in the condition of the vegetation communities in JECA.

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Appendix A: Field journal for plant community monitoring in JECA for the 2013 season

Plant community composition monitoring in Jewel Cave National Monument was completed using a crew of 8 people working approximately 4, 10-hour days.

Date	Day of week	Approximate Travel Time (hrs)	Housing	Sites Completed
July 1, 2013	Monday	2.5	N/A	PCM-019 PCM-004
July 2, 2013	Tuesday	2.5	N/A	PCM-024 (except fuels and seedlings) PCM-007 (point-intercept) PCM-023 (no trees or fuels)
July 3, 2013	Wednesday	2.5	N/A	PCM-007 (fuels, nested quadrats) PCM-021
July 17, 2013	Wednesday	2.5	N/A	PCM-007 (trees) PCM-023 (trees and fuels) PCM_024 (fuels and seedlings)

Appendix B: List of plant species found in 2013 at JECA

Family	Code	Scientific Name	Common Name	Exotic
Anacardiaceae	RHTR	*Rhus trilobata*	skunkbush sumac	
	TORY	*Toxicodendron rydbergii*	western poison ivy	
Apiaceae	LOFO	*Lomatium foeniculaceum*	desert biscuitroot	
	MUTE3	*Musineon tenuifolium*	slender wildparsley	
Apocynaceae	APAN2	*Apocynum androsaemifolium*	spreading dogbane	
Asclepiadaceae	ASOV	*Asclepias ovalifolia*	oval-leaf milkweed	
Asteraceae	ACMI2	*Achillea millefolium*	common yarrow	
	AMAR2	*Ambrosia artemisiifolia*	annual ragweed	
	ANPA4	*Antennaria parvifolia*	small-leaf pussytoes	
	ARFR4	*Artemisia frigida*	prairie sagewort	
	ARLU	*Artemisia ludoviciana*	white sagebrush	
	CIRSI	*Cirsium* species	thistle	*
	CIAR4	*Cirsium arvense*	Canada thistle	*
	CIUN	*Cirsium undulatum*	wavyleaf thistle	
	ECAN2	*Echinacea angustifolia*	blacksamson echinacea	
	ERFO3	*Erigeron formosissimus*	beautiful fleabane	
	ERSU2	*Erigeron subtrinervis*	threenerve fleabane	
	HEAN3	*Helianthus annuus*	common sunflower	
	HEPA19	*Helianthus pauciflorus*	stiff sunflower	
	LASE	*Lactuca serriola*	prickly lettuce	*
	LIPU	*Liatris punctata*	dotted blazing star	
	LYJU	*Lygodesmia juncea*	rush skeletonplant	
	PACA15	*Packera cana*	woolly groundsel	
	PAPL12	*Packera plattensis*	prairie groundsel	
	SOCA6	*Solidago canadensis*	Canada goldenrod	
	SOMI2	*Solidago missouriensis*	Missouri goldenrod	
	SOMO	*Solidago mollis*	velvety goldenrod	
	SONE	*Solidago nemoralis*	gray goldenrod	
	SYER	*Symphyotrichum ericoides*	white heath aster	
	SYLA3	*Symphyotrichum laeve*	smooth blue aster	
	SYOB	*Symphyotrichum oblongifolium*	aromatic aster	
	TAOF	*Taraxacum officinale*	common dandelion	*
	TEAC	*Tetraneuris acaulis*	stemless four-nerve daisy	
	TRDU	*Tragopogon dubius*	yellow salsify	*
Boraginaceae	CYOF	*Cynoglossum officinale*	houndstongue	*
	LIIN2	*Lithospermum incisum*	narrowleaf stoneseed	
	MELA3	*Mertensia lanceolata*	prairie bluebells	
Brassicaceae	CAMI2	*Camelina microcarpa*	littlepod false flax	*
	DEPI	*Descurainia pinnata*	western tansymustard	
	DESO2	*Descurainia sophia*	herb sophia	*
	ERCH9	*Erysimum cheiranthoides*	wormseed wallflower	*
	ERIN7	*Erysimum inconspicuum*	shy wallflower	

Family	Code	Scientific Name	Common Name	Exotic
Brassicaceae	SIAL2	*Sisymbrium altissimum*	tall tumblemustard	*
	THAR5	*Thlaspi arvense*	field pennycress	*
Campanulaceae	CARO2	*Campanula rotundifolia*	bluebell bellflower	
Caprifoliaceae	SYAL	*Symphoricarpos albus*	common snowberry	
	SYOC	*Symphoricarpos occidentalis*	western snowberry	
Chenopodiaceae	CHENO	*Chenopodium* species	goosefoot	*
	CHDE	*Chenopodium desiccatum*	aridland goosefoot	
Commelinaceae	TROC	*Tradescantia occidentalis*	prairie spiderwort	
Convolvulaceae	COAR4	*Convolvulus arvensis*	field bindweed	*
Cyperaceae	CAREX	*Carex* species	sedge	
	CAFI	*Carex filifolia*	threadleaf sedge	
	CAIN9	*Carex inops*	sun sedge	
	CARI	*Carex richardsonii*	Richardson's sedge	
	CARO5	*Carex rossii*	Ross' sedge	
Elaeagnaceae	SHCA	*Shepherdia canadensis*	russet buffaloberry	
Ericaceae	ARUV	*Arctostaphylos uva-ursi*	kinnikinnick	
Euphorbiaceae	EUBR	*Euphorbia brachycera*	horned spurge	
	EUES	*Euphorbia esula*	leafy spurge	*
Fabaceae	ASTRA	*Astragalus* species	milkvetch	
	ASAG2	*Astragalus agrestis*	purple milkvetch	
	ASCR2	*Astragalus crassicarpus*	groundplum milkvetch	
	ASDR3	*Astragalus drummondii*	Drummond's milkvetch	
	ASFL2	*Astragalus flexuosus*	flexile milkvetch	
	ASLA27	*Astragalus laxmannii*	Laxmann's milkvetch	
	ASMI10	*Astragalus missouriensis*	Missouri milkvetch	
	ASSP6	*Astragalus spatulatus*	tufted milkvetch	
	DACA7	*Dalea candida*	white prairie clover	
	DAPU5	*Dalea purpurea*	purple prairie clover	
	GLLE3	*Glycyrrhiza lepidota*	American licorice	
	MELU	*Medicago lupulina*	black medick	*
	MEOF	*Melilotus officinalis*	yellow sweetclover	*
	PEAR6	*Pediomelum argophyllum*	silverleaf Indian breadroot	
	PEES	*Pediomelum esculentum*	large Indian breadroot	
	PSTE5	*Psoralidium tenuiflorum*	slimflower scurfpea	
	VIAM	*Vicia americana*	American vetch	
Gentianaceae	FRSP	*Frasera speciosa*	elkweed	
Grossulariaceae	RICE	*Ribes cereum*	wax currant	
	RIHI	*Ribes hirtellum*	hairystem gooseberry	
	RIOX	*Ribes oxyacanthoides*	Canadian gooseberry	
Iridaceae	IRMI	*Iris missouriensis*	Rocky Mountain iris	
	SIMO2	*Sisyrinchium montanum*	strict blue-eyed grass	
Lamiaceae	HEDR	*Hedeoma drummondii*	Drummond's false pennyroyal	
	MOFI	*Monarda fistulosa*	wild bergamot	
Liliaceae	ALCE2	*Allium cernuum*	nodding onion	
	ALTE	*Allium textile*	textile onion	
	CANU3	*Calochortus nuttallii*	sego lily	
	LEMO4	*Leucocrinum montanum*	common starlily	

Family	Code	Scientific Name	Common Name	Exotic
Liliaceae	LIPH	*Lilium philadelphicum*	wood lily	
	MAST4	*Maianthemum stellatum*	starry false lily of the valley	
Linaceae	LILE3	*Linum lewisii*	Lewis flax	
Malvaceae	SPCO	*Sphaeralcea coccinea*	scarlet globemallow	
Melanthianceae	TOVE2	*Toxicoscordion venenosum*	meadow deathcamas	
Pinaceae	PIPO	*Pinus ponderosa*	ponderosa pine	
Poaceae	ACHY	*Achnatherum hymenoides*	Indian ricegrass	
	ACRI8	*Achnatherum richardsonii*	Richardson's needlegrass	
	ANGE	*Andropogon gerardii*	big bluestem	
	BOCU	*Bouteloua curtipendula*	sideoats grama	
	BOGR2	*Bouteloua gracilis*	blue grama	
	BRAN	*Bromus anomalus*	nodding brome	
	BRIN2	*Bromus inermis*	smooth brome	*
	BRTE	*Bromus tectorum*	cheatgrass	*
	CALO	*Calamovilfa longifolia*	prairie sandreed	
	DASP2	*Danthonia spicata*	poverty oatgrass	
	ELGL	*Elymus glaucus*	blue wildrye	
	ELTR7	*Elymus trachycaulus*	slender wheatgrass	
	ELVI3	*Elymus virginicus*	Virginia wildrye	
	HECO26	*Hesperostipa comata*	needle and thread	
	HESP11	*Hesperostipa spartea*	porcupinegrass	
	KOMA	*Koeleria macrantha*	prairie Junegrass	
	MUCU3	*Muhlenbergia cuspidata*	plains muhly	
	NAVI4	*Nassella viridula*	green needlegrass	
	ORAS	*Oryzopsis asperifolia*	roughleaf ricegrass	
	PACA6	*Panicum capillare*	witchgrass	
	PASM	*Pascopyrum smithii*	western wheatgrass	
	PIMI7	*Piptatherum micranthum*	littleseed ricegrass	
	POPR	*Poa pratensis*	Kentucky bluegrass	*
	SCSC	*Schizachyrium scoparium*	little bluestem	
	VUOC	*Vulpia octoflora*	sixweeks fescue	
Polemoniaceae	PHAL3	*Phlox alyssifolia*	alyssumleaf phlox	
	PHAN4	*Phlox andicola*	prairie phlox	
	PHHO	*Phlox hoodii*	spiny phlox	
Polygalaceae	POAL4	*Polygala alba*	white milkwort	
Ranunculaceae	ANCY	*Anemone cylindrica*	candle anemone	
Rosaceae	AMAL2	*Amelanchier alnifolia*	Saskatoon serviceberry	
	CEMO2	*Cercocarpus montanus*	alderleaf mountain mahogany	
	FRVI	*Fragaria virginiana*	Virginia strawberry	
	GETR	*Geum triflorum*	old man's whiskers	
	PHMO4	*Physocarpus monogynus*	mountain ninebark	
	POCO13	*Potentilla concinna*	elegant cinquefoil	
	PRVI	*Prunus virginiana*	chokecherry	
	ROAC	*Rosa acicularis*	prickly rose	
	ROAR3	*Rosa arkansana*	prairie rose	
	ROWO	*Rosa woodsii*	Woods' rose	
Rubiaceae	GABO2	*Galium boreale*	northern bedstraw	
Santalaceae	COUM	*Comandra umbellata*	bastard toadflax	

Family	Code	Scientific Name	Common Name	Exotic
Saxifragaceae	HERI	*Heuchera richardsonii*	Richardson's alumroot	
Scrophulariaceae	PEER	*Penstemon eriantherus*	fuzzytongue penstemon	
	VETH	*Verbascum thapsus*	common mullein	*
Solanaceae	PHLO4	*Physalis longifolia*	longleaf groundcherry	
Violaceae	VIOLA	*Viola* species	violet	*
	VIAD	*Viola adunca*	hookedspur violet	
	VICA4	*Viola canadensis*	Canadian white violet	
	VINU2	*Viola nuttallii*	Nuttall's violet	