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Plant Community Composition and Structure Monitoring for Wind Cave National Park

2012 Annual Report

Natural Resource Technical Report NPS/NGPN/NRTR—2013/678

ON THE COVER
Long-term plant community monitoring plot PCM_0008 in Wind Cave National Park, 2012.
Photograph by: NGPN

Plant Community Composition and Structure Monitoring for Wind Cave National Park

2012 Annual Report

Natural Resource Technical Report NPS/NGPN/NRTR—2013/678

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This report is available from the Northern Great Plains Inventory & Monitoring Network website http://science.nature.nps.gov/im/units/ngpn/monitor/plants.cfm and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

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Executive Summary

The Northern Great Plains Inventory & Monitoring Network surveyed 14 long-term monitoring plots in Wind Cave National Park (WICA) in 2012 as part of an effort to better understand the condition of plant communities in the park. We measured plant diversity and cover, looked for the presence of exotic species that are of concern to park management, and evaluated the amount of human and natural disturbance at all plots. This effort was the second year in a multiple-year venture to document the current status and long-term trends in plant communities in WICA. At the end of five years, there will be an in-depth report describing the status of the plant community. In this report, we provide a simple summary of our results from sampling in 2012.

We found that Wind Cave National Park has a high diversity of native plants. Dry conditions in 2012 tended to reduce plant diversity compared to 2011, but species richness was still within the range of natural variability for mixed-grass prairie. We found 2 rare plants in our surveys: nylon hedgehog cactus and buff fleabane. Average cover of exotic species was moderate, with 6 of 14 sites having greater than 10% exotic cover. Kentucky bluegrass was the most widespread and abundant exotic species. Japanese brome and/or cheatgrass were present at most sites and have the potential to alter ecosystem structure and function. In some but not all cases, disturbance correlated with higher exotic cover. To retain ecological integrity in WICA and the high diversity of native plants, 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 WICA.

Acknowledgments

We thank all the authors of the NGPN Plant Community Monitoring Protocol, particularly Amy Symstad, for outstanding guidance on data collection and reporting. We greatly appreciate the staff at WICA for providing logistical support and safety checks. We also thank the staff at WICA for providing help in the field. Beth Burkhart, Zach Mergen, Joann Miller, and Richard Stecher all assisted with monitoring. Amy Symstad and Mike Bynum also joined us. The 2012 NGPN vegetation field crew consisted of Isabel Ashton, Michael Prowatzke, Timothy Pine, Lauren Baur, Daina Jackson, Ryan Manuel, Anine Smith, and Gretchen Addington. We thank Stephen Wilson for invaluable support and instruction on managing data in the FFI database and for assistance with the GIS data.

Introduction

The Black Hills is a 1.5 million ha refuge of ponderosa pine (*Pinus ponderosa*) forest surrounded by the mixed-grass prairies of western South Dakota and eastern Wyoming. 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 and mixed-grass prairies 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 reality that there have been fundamental changes in the disturbance regimes, such as climate, fire, and large ungulate grazing, that have historically maintained ponderosa woodlands and native prairies, 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 because it can provide information on environmental quality and condition, benchmarks of ecological integrity, and early warning of declines in ecosystem health.

Wind Cave National Park (WICA) is located in the southern Black Hills with a purpose to protect the unique Wind Cave resources and preserve and enhance the mixed-grass prairie and native wildlife, while providing for the enjoyment of the public. The 33,851 acres of WICA is a mosaic of ponderosa forest and mixed-grass prairie, with approximately 30% covered by ponderosa pine forests. While some areas show evidence of overgrazing and high exotic species cover, the native plant communities within the upland areas of WICA are considered to be in good condition (Komp et al. 2011). The Northern Great Plains Inventory & Monitoring Program (NGPN) began vegetation monitoring efforts in WICA in 2011 (Ashton et al. 2012). Vegetation monitoring protocols and plot locations were chosen to represent the entire park (based on the 2010 boundary) 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 WICA 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 WICA in 2012, our second year of sampling understory vegetation. NGPN visited 14 plots (Figure 1). Since not all plots are visited every year, it will take 3 more years to visit every plot in the park. 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. In 2012, we also completed a comprehensive survey of forest health at 90 sites within the park. The results from the forest survey will be described in a separate report expected to be published spring 2013.

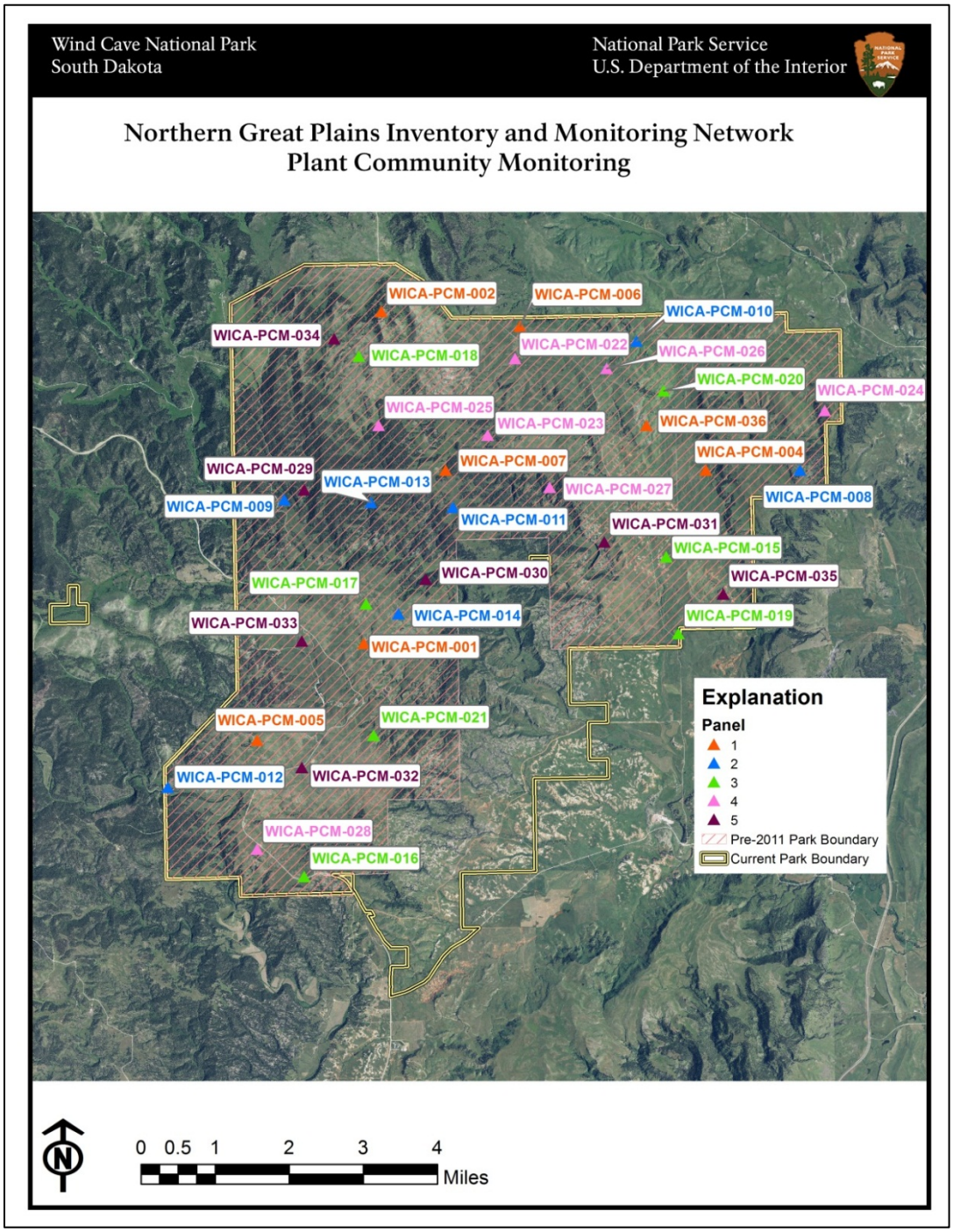

Figure 1. Map of Wind Cave National Park (WICA) and plant community monitoring plots surveyed in 2012. Plots in panel 1 (orange) and panel 2 (blue) were surveyed in 2012.

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

NGPN implemented a survey to monitor plant community structure and composition in WICA using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003, 2004). Using a GRTS design, we selected 35 randomly located sites within WICA. We split these 35 sites into 5 panels with 7 sites each. We visit 2 panels (14 sites) every year, and after 5 years we will have visited all 35 sites twice. In 2012, we visited sites in panel 1 and panel 2 (Figure 1) during the second and third week of July.

When implemented successfully, probability-based survey designs allow for unbiased inference from sampled sites to un-sampled elements of the resource of interest (Hansen et al. 1983), and with repeat visits it allows for discerning trends in that resource (Larsen et al. 1995). In other words, after 5 years, we can use data from our randomly selected sites to estimate the ecological integrity of vegetation communities for the whole park.

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 ≤ 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 2012, sampling at WICA took two 5-person crews approximately six 10-hour days (see Appendix A for a detail of activities each day).

Plant species were identified in the field to species level and not to lower taxonomic groupings (e.g., subspecies or variety). This was a change from the data collected in 2011 by NGPN where plants were identified to the lowest taxonomic level possible. The change was made in coordination with the FireEP because it better reflects the botanical skills of the crew and simplifies data management and analysis. When we were unable to identify a plant, the plant was assigned a unique identifier and collected or photographed. Most of these unknowns were subsequently identified in the office; however, in some cases identification was impossible. In these cases, the species was classified by growth form and, where possible, lifecycle (e.g., annual graminoid).

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 were mapped and tagged. For each tree, the species, DBH, status, and condition (e.g., leaf-discoloration, insect-damaged, etc.) were recorded. In ponderosa pine woodlands, dead and downed woody fuel load data were collected on two perpendicular 100 ft (30.48 m) transects centered at the center of the plot (Figure 2). These plots

were a subset of 90 plots that were visited as part of the more comprehensive survey of WICA forests completed in 2012. Rather than repeat the analysis and interpretation of tree and fuel data for this subset, it will be included in a more comprehensive report on the status of WICA's forests.

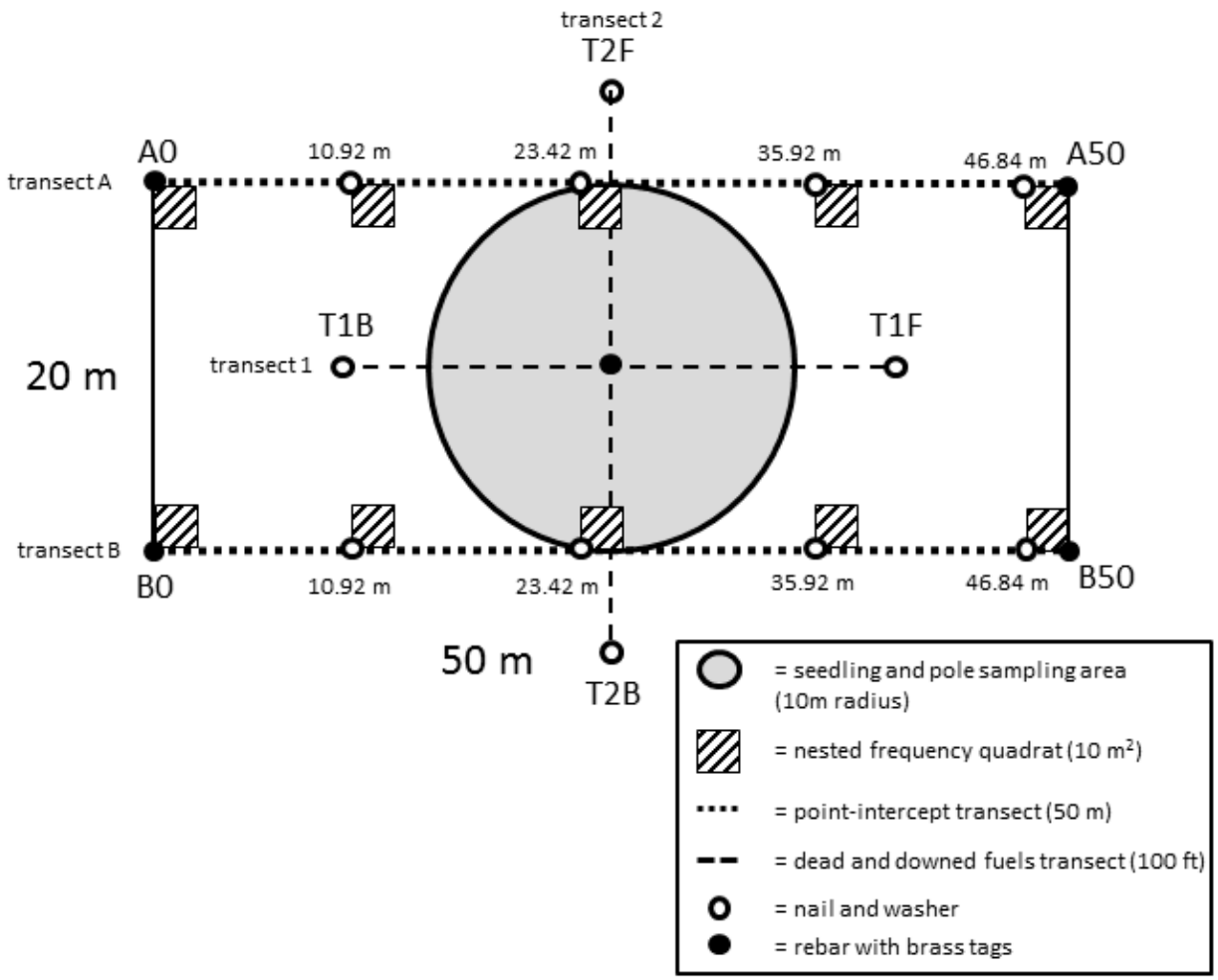

Figure 2. Long-term monitoring plot used for sampling vegetation in Wind Cave National Park.

At all plots, we completed a rapid qualitative assessment of 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, severity, and approximate area of the disturbances were recorded where the disturbance was obvious (i.e. heavy grazing, large mounds are included while light grazing was not). The target species lists were developed in cooperation with the park and NGPN staff during the winter and spring prior to the field season. Usually, these are invasive and/or exotic species that are not currently widespread in the park but pose a significant threat if allowed to establish. 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, this method tracks the presence of plant species that are considered rare or vulnerable to loss in South Dakota, and may occur in WICA. The WICA target species list for 2012 can be found in Table 1.

Table 1. Exotic species of management concern at Wind Cave National Park and rare species that were surveyed for during the 2012 field season.

Exotic Species			**Rare species**	
Scientific Name	Common Name		**Scientific Name**	**Common Name**
Bromus japonicus	Japanese brome		*Achnatherum robustum*	sleepy grass
Bromus tectorum	cheatgrass		*Botrychium campestre*	prairie moonwort
Carduus nutans	musk thistle		*Botrychium lineare*	narrowleaf grapefern
Centaurea stoebe	spotted knapweed		*Botrychium simplex*	little grapefern
Cirsium arvense	Canada thistle		*Clematis hirsutissima*	hairy clematis
Cirsium vulgare	bull thistle		*Cryptantha cana*	silver-mounded candleflower
Convolvulus arvensis	field bindweed		*Cypripedium parviflorum*	lesser yellow lady's slipper
Cynoglossum officinale	houndstongue		*Echinocereus viridiflorus*	nylon hedgehog cactus
Elaeagnus angustifolia	Russian olive		*Elymus diversiglumis*	interrupted wildrye
Euphorbia esula	leafy spurge		*Ericameria parryi*	Parry's rabbitbrush
Hyoscyamus niger	black henbane		*Erigeron acris*	bitter fleabane
Hypericum perforatum	common St. Johnswort		*Erigeron ochroleucus*	buff fleabane
Leucanthemum vulgare	oxeye daisy		*Ipomopsis spicata*	spiked ipomopsis
Linaria dalmatica	Dalmatian toadflax		*Phleum alpinum*	alpine timothy
Linaria vulgaris	yellow toadflax		*Physaria arenosa*	sidesaddle bladderpod
Marrubium vulgare	horehound		*Thelesperma megapotamicum*	Hopi tea
Onopordum acanthium	Scotch thistle		*Townsendia exscapa*	Easter daisy
Potentilla recta	sulphur cinquefoil		*Townsendia hookeri*	Hooker's Townsend daisy
Rhaponticum repens	Russian knapweed		*Viburnum edule*	squashberry
Salsola tragus	Russian thistle			
Sonchus arvensis	perennial sowthistle			
Tamarix spp.	tamarisk			
Tanacetum vulgare	common tansy			
Verbascum thapsus	common mullein			

Data Management and Analysis

NGPN 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 datasheet 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). 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). Peilou's Index of Evenness, J', measures how even abundances are across taxa. It ranges between 0 and 1, where lower numbers indicate that a community is not even or that just a few species make up the majority of the total cover.

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://www1.nrintra.nps.gov/im/stateoftheparks/index.cfm). The goal of the Natural Resource Condition Table is to improve park priority settings 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 or total fuel loads, it will be possible and straightforward to compare conditions in subsequent years. The status, trend, and confidence of assessments for each indicator is scored and assigned a corresponding symbol based on the key found in Table 2.

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, caution, or significant concern based on this comparison (Table 2). 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. Trend was scored in a similar fashion and categorized as improving, unchanging, deteriorating, or insufficient information.

Confidence in status and trend assessments within the Natural Resource Condition Table was scored as high, medium, or low. Confidence primarily reflects the quality of the data collected, rather than the quality of the reference condition. Confidence in the data summarizes three

aspects of data quality: how well data represent the resource, quality of methods, and the length of the record.

Table 2. 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://www1.nrintra.nps.gov/im/stateoftheparks/index.cfm).

Status		**Trend**		**Confidence**	
	Significant Concern		Condition is Improving		High
	Caution		Condition is Unchanging		Medium
	Good Condition		Condition is Deteriorating		Low

Results and Discussion

The vegetation at WICA experienced a very dry winter and spring, and when the field crews visited the park in July, there was less green vegetation than in previous years (Figure 3). Total precipitation in the 2011 water year (October- September) was 22 in (558 mm) compared to 14 in (367 mm) during 2012. Average absolute canopy cover was 107% (Table 3) in 2012 (it can be over 100% because we record multiple layers of vegetation). The productive summer in 2011 and a dry winter and spring in 2012 contributed to a large amount of standing litter on the ground (ground cover at sites averaged 78% plant litter). Despite the dry conditions, NGPN found 213 plant species in 2012 at WICA (Appendix B). Graminoids, which includes grasses, sedges, and rushes, accounted for most of the vegetative cover at WICA, but forbs and shrubs were also abundant (Figure 4).

Figure 3. A vegetation transect at plot PCM_0004 in Wind Cave National Park in 2011 (top panel) and 2012 (bottom panel). Both photographs were taken in early July.

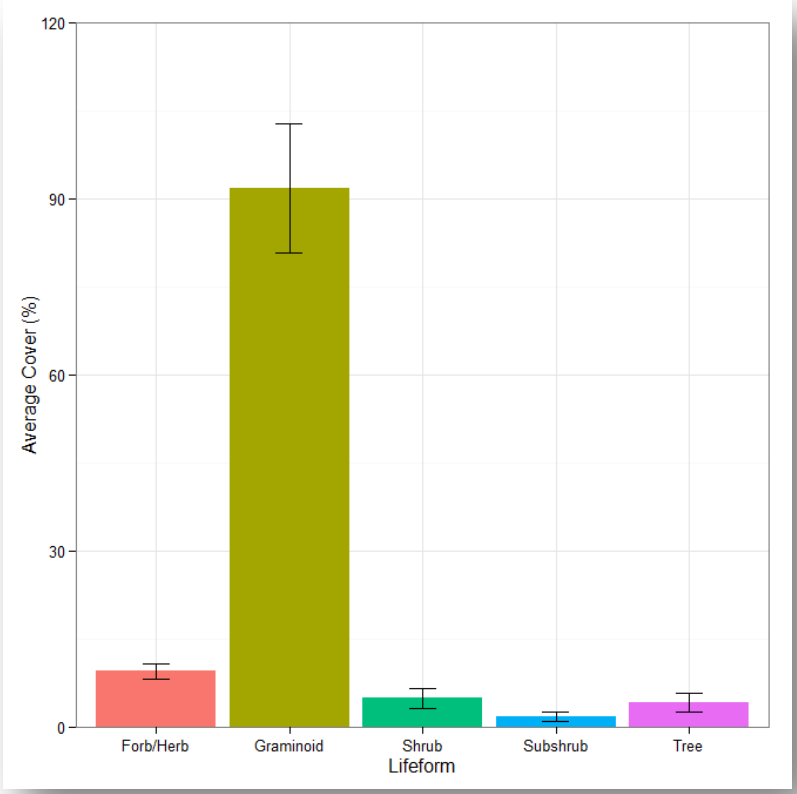

Figure 4. Average cover by life forms in 14 plant community monitoring plots in Wind Cave National Park in 2012. Bars represent means ± standard errors. Graminoids were the most abundant life-form across all the plots at Wind Cave National Park.

There was a great deal of variation in species composition across the 14 sites. The most common species found from the point-intercept method were graminoids (Figure 5), with the only exception being slimflower scurfpea (*Psoralidium tenuiflorum*). We found 2 rare plants in the 2012 field effort: nylon hedgehog cactus *(Echinocereus viridiflorus*) and buff fleabane (*Erigeron ochroleucus*). The cactus is fairly common in the rocky grassland sites within WICA, and we recorded it at 3 sites PCM_0006, PCM_0008, and PCM_0011. Buff fleabane was found at site PCM_0036.

Species richness varies with respect to the scale on which it is examined. Table 4 presents average species richness, taken from the point-intercept method, 1 m^2 quadrats, and 10 m^2 quadrats for the monitoring plots in 2012. On average, there are about 19 native and 2 exotic species found in each 10 m^2 quadrat (Table 4). We tended to find a higher number of graminoid species along transects when compared to surveying the 10 m^2 plot (Table 4). From the point-intercept data, we found average plot diversity, H', to be 2.4 ± 0.06. Evenness, J', averaged 0.80 ± 0.02 across the plots (Table 3). When including only native species, average diversity and evenness were 2.2 ± 0.07 and 0.79 ± 0.02, respectively.

Table 3. Natural resource condition summary table for upland plant communities in Wind Cave National Park.

Indicator of Condition	Specific Measures	2012 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	106.5 ± 11.5 %	TBD		Wind Cave National Park has a high diversity of native plants. The mixed-grass prairie tends to have higher diversity than the understory of ponderosa pine forests. Dry conditions in 2012 led to lower species richness than past years, but it was still within the range of natural variability. At this time, condition assessments for canopy cover and evenness are based on professional judgment, but as we collect more data and understand the natural range of variability our confidence in these assessments will increase.
	Native species richness (based on average of 10 $1m^2$ quadrats per plot)	9 ± 0.8 species	8 -18 species [(1)]		
	Evenness (based on point-intercept of 2-50m transects per plot)	0.80 ± 0.02	TBD		
Exotic Plant Early Detection and Management	Relative cover of exotic species	11 ± 2.7 %	≤ 10 % cover		Average cover of exotic species was moderate, and 6 of 14 sites were above 10% exotic cover. Kentucky bluegrass was the most widespread and abundant exotic species. Annual bromes, which are problematic invaders for many of the parks in the region, are found only in low abundance but are common throughout the park.
	Annual brome cover	2 ± 0.6 %	≤ 10 % cover		

References and Data Sources: 1. 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; 2. Brown, P. M. and B. Cook. 2006. Early settlement forest structure in Black Hills ponderosa pine forests. Forest Ecology and Management 223:284-290.

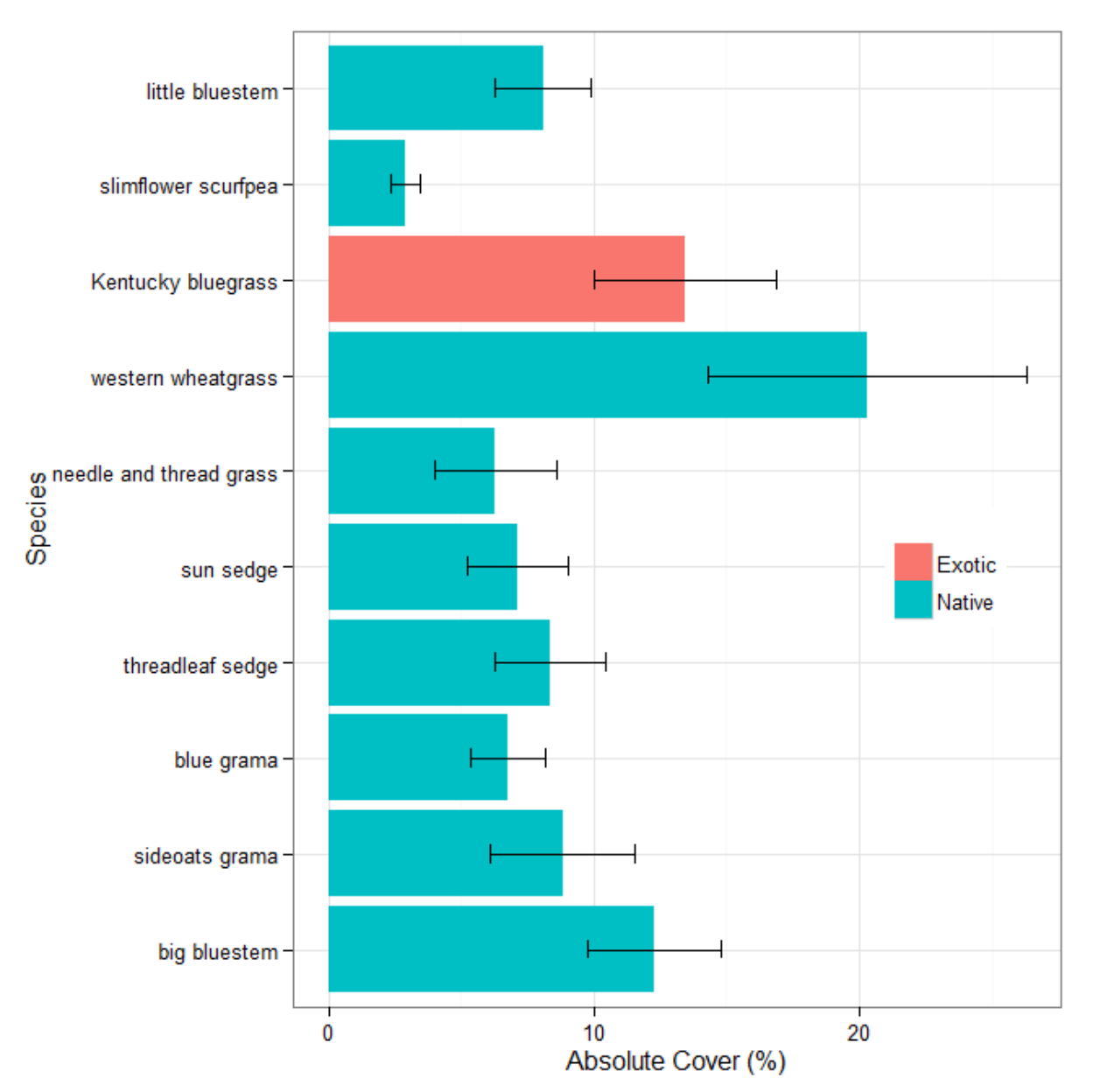

Figure 5. The average absolute cover of the 10 most common native (blue) and exotic (red) plants recorded at 14 sites at Wind Cave National Park in 2012. Bars represent means ± standard errors. Kentucky bluegrass was the only common exotic species.

Species richness in the mixed-grass prairie is determined by numerous factors including fire regime, large ungulate grazing, prairie dog disturbance, and weather fluctuations (Symstad and Jonas 2011). Along with species composition, species richness also varied across sites (Table 5). For instance, average native species richness ranged from 16 species per m^2 in plot PCM_014 (mixed-grass prairie, Figure 6) to 5 species per m^2 in plots PCM_007 and PCM_013 (forested plots, Figure 6). PCM_007 had an intact canopy of ponderosa pine with little understory growth and only a small area of disturbance (Table 5) while PCM_013 was an open canopy forest that had been burned and was heavily grazed. 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 in a moderately grazed site in Montana ranged between 8 and 18 species per square meter (10-90th percentile range) between 1933-1945 and the range for a relatively undisturbed site in Kansas from 1932-1972 was between 3 and 15 species per square meter (Symstad and Jonas, *in press*). There was a drop of approximately 2 species in average native species richness in the 1-m^2 quadrats in 2012 compared to 2011 (Ashton et al. 2012) likely due to dry conditions, but richness was still within the range of natural variability.

Table 4. Average plant species richness plant community monitoring plots at Wind Cave National Park in 2012. Values represent means ± standard errors, n=14.

	Point-intercept	**1 m^2 quadrats**	**10 m^2 quadrats**
Total species richness	19 ± 1.1	10 ± 0.8	21 ± 1.3
Native species richness	17 ± 1.1	9 ± 0.8	19 ± 1.4
Exotic species richness	2 ± 0.3	1 ± 0.2	2 ± 0.3
Graminoid species richness	12 ± 0.7	5 ± 0.4	8 ± 05
Forb species richness	6 ± 0.7	4 ± 0.5	10 ± 0.9

Table 5. Characteristics of the plant community in 14 plots at Wind Cave National Park in 2012 including average native species richness, exotic plant cover, cover of annual bromes, and area of disturbance.

Plot	**Average native species richness 1 m^2 plots**	**Exotic cover (%)**	**Annual brome cover (%)**	**Kentucky bluegrass cover (%)**	**Disturbance within site (m^2)**
WICA_PCM_001	8	19	5	13	15
WICA_PCM_002	9	2	2	0	1000
WICA_PCM_004	8	2	2	0	2000
WICA_PCM_005	14	1	0	1	5
WICA_PCM_006	12	2	0	2	510
WICA_PCM_007	5	4	0	0	100
WICA_PCM_008	8	5	0	5	10
WICA_PCM_009	11	17	0	15	2980
WICA_PCM_010	8	21	2	18	50
WICA_PCM_011	11	15	6	9	2300
WICA_PCM_012	7	9	7	0	2430
WICA_PCM_013	5	36	4	23	4580
WICA_PCM_014	16	1	0	0	20
WICA_PCM_036	11	15	2	13	251
Site Average	*9 ± 0.8 species*	*11 ± 2.7 %*	*2.1 ± 0.6 %*	*7.1 ± 2.1%*	*1161 ± 389*

Figure 6. Three long-term monitoring plots in Wind Cave National Park that represent a gradient from high native species richness to low native species richness. PCM_014 (left) has a large number of native species while PCM_007 (middle) and PCM_013 (right) have much fewer.

The average relative cover of exotic species at sites in WICA was moderate (11%; Table 3). Much of the exotic cover at sites in WICA was due to the presence of Kentucky bluegrass (Table 5). We found 8 targeted exotic species in the 14 plots surveyed (Table 6). A major management challenge for parks in the region is to control the spread of cheatgrass and Japanese brome (annual bromes). The most common target species encountered was Japanese brome, but it was generally in low abundance (Table 5, Table 6). In some cases, brome was present at the site (e.g., PCM_0005 and PCM_0006; Table 6) but not found along the transects (Table 5). The presence of annual bromes in mixed-grass prairie is associated with decreased productivity and altered nutrient cycling (Ogle et al. 2003), and there is strong evidence from regions further west that cheatgrass alters fire regimes and the persistence of native species (D'Antonio and Vitousek 2003).

Table 6. Cover class of target species at 14 plots at WICA in 2012. 1 = one individual, 2 = few individuals, 3 = cover 1-5% of site, 4 = cover 5-25% of site, 5 = cover > 25% of site.

Site	Japanese brome	Mullein	Canada thistle	Houndstongue	Cheatgrass	Bull thistle	Horehound	Field bindweed
WICA_PCM_001	3	-	-	2	-	-	-	-
WICA_PCM_002	2	2	2		2	-	-	-
WICA_PCM_004	2	-	-	-	-	-	-	-
WICA_PCM_005	2	-	-		-	-	-	-
WICA_PCM_006	2	-	-	-	-	-	-	-
WICA_PCM_007	-	1	-	2	-	-	-	-
WICA_PCM_008	2	-	-	-	-	-	-	-
WICA_PCM_009	2	2	2	2	-	-	-	-
WICA_PCM_010	2	2	-	-	-	-	-	-
WICA_PCM_011	4	4	3	2	-	-	-	-
WICA_PCM_012	2	2	2	-	2	-	2	-
WICA_PCM_013	2	4	4	2	-	2	-	1
WICA_PCM_014	2	-	-	-	-	-	-	-
WICA_PCM_036	2	-	-	-	-	-	-	-

Disturbance from grazing, rodents, fire, and humans affects plant community structure and composition in mixed-grass prairie and ponderosa woodlands. For this reason, we measured the approximate area affected by natural and human disturbances at each site we visited. This method is a rapid assessment of disturbance and picks up only the areas of obvious impact to most observers (i.e. heavy grazing is included while light grazing was not). In 2012, the type of disturbance varied and included fire, animal trails, small mammal excavations, grazing, and bison wallows. There was natural disturbance evident in all plots (Table 5). PCM_013 (Figure 6) had the highest cover of exotics (36%; Table 5) and was also the site with the largest area of disturbance. While there is some inherent error among observers in such a rapid and qualitative assessment, large sample sizes and more long-term data will allow us to estimate how these disturbances affect species diversity.

Conclusions

In conclusion, we found that Wind Cave National Park has a large diversity of native plants. A reduction in precipitation of more than 8 in in 2012 compared to 2011 tended to reduce plant diversity, but species richness was still within the range of natural variability for mixed-grass prairie. Average cover of exotic species was moderate, with 6 of 14 sites having greater than 10% exotic cover. Kentucky bluegrass was the most widespread and abundant exotic species. Japanese brome and/or cheatgrass were present at most sites and have the potential to alter ecosystem structure and function. In some but not all cases, disturbance correlated with higher exotic cover. To retain ecological integrity in WICA and the high diversity of native plants, 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 WICA.

Literature Cited

Ashton, I., M. Prowatzke, M. Bynum, T. Shepherd, S. K. Wilson, and K. Paintner-Green. 2012. Wind Cave National Park plant community composition and structure monitoring: 2011 annual report. Natural Resource Technical Report NPS/NGPN/NRTR—2012/534. National Park Service, Fort Collins, Colorado.

D'Antonio, C. M. and P. M. Vitousek. 2003. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23:63-87.

Hansen, M. H., W. G. Madow, and B. J. Tepping. 1983. An evaluation of model-dependent and probability-sampling inferences in sample-surveys. Journal Of The American Statistical Association 78:776-793.

Hocking, C. M., E. L. Krantz, and G. J. Josten. 2010. South Dakota statewide assessment of forest resources. South Dakota Department of Agriculture. http://sdda.sd.gov/forestry/current-news/assessment.aspx.

Komp, M. R., K. J. Stark, A. J. Nadeau, S. Amberg, E. Iverson, L. Danzinger, L. Danielson, and B. Drazkowski. 2011. Wind Cave National Park: Natural resource condition assessment. Natural Resource Report NPS/WICA/NRR—2011/478. National Park Service, Fort Collins, Colorado.

Larsen, D. P., N. S. Urquhart, and D. L. Kugler. 1995. Regional-scale trend monitoring of indicators of trophic condition of lakes. Water Resources Bulletin 31:117-140.

Larson, G. E. and J. R. Johnson. 2007. Plants of the Black Hills and Bear Lodge Mountains, 2nd edition. South Dakota State University, Brookings, SD.

NPS. 2012. Revisiting Leopold: Resource stewardship in the National Parks: A report of the National Park System Advisory Board Science Committee. http://www.nps.gov/calltoaction/PDF/LeopoldReport_2012.pdf.

Ogle, S. M., W. A. Reiners, and K. G. Gerow. 2003. Impacts of exotic annual brome grasses (*Bromus spp.*) on ecosystem properties of northern mixed grass prairie. The American Midland Naturalist 149:46-58.

Stevens, D. L. and A. R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. Environmetrics 14:593-610.

Stevens, D. L. and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal Of The American Statistical Association 99:262-278.

Symstad, A. J. and J. L. Jonas. 2011. Incorporating biodiversity into rangeland health: plant species richness and diversity in Great Plains grasslands. Rangeland Ecology & Management 64:555-572.

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.

Symstad, A. J., R.A. Gitzen, C. L. Wienk, M. R. Bynum, D. J. Swanson, A. D. Thorstenson, and K. J. Paintner. 2012a. Plant community composition and structure monitoring protocol for the Northern Great Plains I&M Network-Standard Operating Procedures: version 1.01. Natural Resource Report NPS/NGPN/ NRR-2012/489.1.

Symstad, A. J., R.A. Gitzen, C. L. Wienk, M. R. Bynum, D. J. Swanson, A. D. Thorstenson, and K. J. Paintner. 2012b. Plant community composition and structure monitoring protocol for the Northern Great Plains I&M Network: version 1.01. Natural Resource Report NPS/NGPN/ NRR-2012/489.

USDA-NRCS. 2012. The PLANTS Database (http://plants.usda.gov, 24 January 2012). National Plant Data Team, Greensboro, NC 27401-4901 USA.

Appendix A: Field journal for plant community monitoring in WICA for the 2012 season

Plant community composition monitoring in WICA was completed using 2 crews of 4 to 6 people working six 10-hour days. We used help from WICA staff, Amy Symstad, and Mike Bynum.

Date	Day of week	Approximate Travel Time (hrs)	Housing	Sites Completed
Jul 9, 2012	Monday	2.5	N/A	PCM-0001 PCM-0005
Jul 10, 2012	Tuesday	2.5	N/A	PCM-0002 PCM-0006 PCM-0009
Jul 11, 2012	Wednesday	2.5	N/A	PCM-0011 PCM-0012
Jul 12, 2012	Thursday	2.5	N/A	PCM-0004 PCM-0013 PCM-0036
Jul 16, 2012	Monday	2.5	N/A	PCM-0010 PCM-0008
Jul 18, 2012	Wednesday	2.5	N/A	PCM-0007 PCM-0014

Appendix B: List of plant species found in 2012 at WICA

Species found in monitoring plots at Wind Cave National Park in 2012. Species in bold are not on the park's certified species list.

Family	Species Code	Scientific Name	Common Name	Exotic
Agavaceae	YUGL	*Yucca glauca*	yucca	
Amaranthaceae	AMBL	*Amaranthus blitoides*	mat amaranth	*
	AMRE	*Amaranthus retroflexus*	redroot pigweed	
Anacardiaceae	RHTR	*Rhus trilobata*	skunkbush sumac	
	TORY	*Toxicodendron rydbergii*	western poison ivy	
Apiaceae	MUTE3	*Musineon tenuifolium*	slender wildparsley	
Apocynaceae	APAN2	*Apocynum androsaemifolium*	spreading dogbane	
Asclepiadaceae	ASOV	*Asclepias ovalifolia*	oval-leaf milkweed	
	ASPU	*Asclepias pumila*	plains milkweed	
	ASSP	*Asclepias speciosa*	showy milkweed	
	ASST	*Asclepias stenophylla*	slimleaf milkweed	
	ASVI	*Asclepias viridiflora*	green milkweed	
Asteraceae	ACMI2	*Achillea millefolium*	common yarrow	
	AGGL	*Agoseris glauca*	prairie dandelion	
	AMPS	*Ambrosia psilostachya*	western ragweed	
	ANMI3	*Antennaria microphylla*	littleleaf pussytoes	
	ANPA4	*Antennaria parvifolia*	smalleaf pussytoes	
	ARCA12	*Artemisia campestris*	common sagewort	
	ARDR4	*Artemisia dracunculus*	tarragon	
	ARFR4	*Artemisia frigida*	fringed sagebrush	
	ARLU	*Artemisia ludoviciana*	white sagebrush	
	BREU	*Brickellia eupatorioides*	false boneset	
	CIAR4	*Cirsium arvense*	Canada thistle	*
	CIUN	*Cirsium undulatum*	wavyleaf thistle	
	CIVU	*Cirsium vulgare*	bull thistle	*
	COCA5	*Conyza canadensis*	horseweed	
	CORA4	*Conyza ramosissima*	dwarf horseweed	
	DYPA	*Dyssodia papposa*	fetid marigold	
	ECAN2	*Echinacea angustifolia*	blacksamson echinacea	
	ERCA4	*Erigeron canus*	hoary fleabane	
	ERFL	*Erigeron flagellaris*	trailing fleabane	
	EROC	*Erigeron ochroleucus*	buff fleabane	
	ERPU2	***Erigeron pumilus***	**shaggy fleabane**	
	ERST3	*Erigeron strigosus*	prairie fleabane	
	GNPA	*Gnaphalium palustre*	cudweed	
	GRSQ	*Grindelia squarrosa*	curlycup gumweed	
	GUSA2	*Gutierrezia sarothrae*	broom snakeweed	
	HEPA19	*Helianthus pauciflorus*	stiff sunflower	
	HEVI4	*Heterotheca villosa*	hairy false goldenaster	
	LASE	*Lactuca serriola*	wild lettuce	*
	LIPU	*Liatris punctata*	dotted blazing star	

Family	Species Code	Scientific Name	Common Name	Exotic
Asteraceae	LYJU	*Lygodesmia juncea*	rush skeletonplant	
	PSMA11	*Pseudognaphalium macounii*	Macoun's cudweed	
	RACO3	*Ratibida columnifera*	prairie coneflower	
	SOLID	*Solidago* spp.	goldenrod spp.	
	SOMI2	*Solidago missouriensis*	Missouri goldenrod	
	SOMO	*Solidago mollis*	velvety goldenrod	
	SONE	*Solidago nemoralis*	gray goldenrod	
	SORI2	*Solidago rigida*	stiff goldenrod	
	SOSP2	*Solidago speciosa*	noble goldenrod, showy 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*	common salsify, goatsbeard	*
	XASP99	*Xanthisma spinulosum*	lacy tansyaster	
Boraginaceae	CYOF	*Cynoglossum officinale*	houndstongue	*
	LAOC3	*Lappula occidentalis*	flatspine stickseed	
	LIIN2	*Lithospermum incisum*	narrowleaf pucoon	
	MELA3	*Mertensia lanceolata*	lanceleaf bluebells	
	ONBE	*Onosmodium bejariense*	soft-hair marbleseed	
Brassicaceae	ARHI	*Arabis hirsuta*	hairy rockcress	
	DRABA	*Draba* spp.	draba	
	DRRE2	*Draba reptans*	creeping draba	
	ERAS2	***Erysimum asperum***	**western wallflower**	
	LEDE	*Lepidium densiflorum*	common pepperweed	
	PHLU99	*Physaria ludoviciana*	silver bladderpod	
	SIAL2	*Sisymbrium altissimum*	tall tumblemustard	*
	THAR5	*Thlaspi arvense*	field pennycress	*
	TUGL	*Turritis glabra*	tower rockcress	
Cactaceae	ECVI2	*Echinocereus viridiflorus*	nylon hedgehog cactus	
	ESMI3	*Escobaria missouriensis*	Missouri foxtail cactus	
	ESVI2	*Escobaria vivipara*	spinystar	
	OPFR	*Opuntia fragilis*	brittle pricklypear	
	OPMA2	*Opuntia macrorhiza*	grassland pricklypear	
	OPPO	*Opuntia polyacantha*	plains pricklypear	
Campanulaceae	CARO2	*Campanula rotundifolia*	roundleaf harebell	
	TRPE4	*Triodanis perfoliata*	Venus' looking-glass	
Caprifoliaceae	SYOC	*Symphoricarpos occidentalis*	western snowberry	

Family	Species Code	Scientific Name	Common Name	Exotic
Caryophyllaceae	PADE4	*Paronychia depressa*	spreading nailwort	
	SIAN2	*Silene antirrhina*	sleepy campion	
	SIDR	*Silene drummondii*	Drummond's campion	
Chenopodiaceae	CHBE4	*Chenopodium berlandieri*	pitseed goosefoot	
Chenopodiaceae	CHDE	*Chenopodium desiccatum*	arid goosefoot	
Cistaceae	HEBI2	*Helianthemum bicknellii*	hoary frostweed	
Commelinaceae	TRBR	*Tradescantia bracteata*	bracted spiderwort	
	TROC	*Tradescantia occidentalis*	prairie spiderwort	
Convolvulaceae	COAR4	*Convolvulus arvensis*	field bindweed	*
	EVNU	*Evolvulus nuttallianus*	shaggy dwarf morning-glory	
Cupressaceae	JUSC2	*Juniperus scopulorum*	Rocky Mountain juniper	
Cyperaceae	CAREX	*Carex* spp.	sedge	
	CABR10	*Carex brevior*	shortbeak sedge	
	CADU6	*Carex duriuscula*	needleleaf sedge	
	CAFI	*Carex filifolia*	threadleaf sedge	
	CAIN9	*Carex inops*	long-stolon sedge	
	CARO5	***Carex rossii***	**Ross sedge**	
Dryopteridaceae	WOSC	*Woodsia scopulina*	Rocky Mountain cliff fern	
Ericaceae	ARUV	*Arctostaphylos uva-ursi*	kinnikinnick	
Euphorbiaceae	EUBR	*Euphorbia brachycera*	horned spurge	
	EUDE4	*Euphorbia dentata*	toothed spurge	
	EUGL3	*Euphorbia glyptosperma*	ridgeseed spurge	
	EUSE5	*Euphorbia serpyllifolia*	thymeleaf sandmat	
Fabaceae	AMCA6	*Amorpha canescens*	leadplant	
	ASTRA	*Astragalus* spp.	milkvetch	
	ASAG2	*Astragalus agrestis*	purple milkvetch	
	ASBI2	*Astragalus bisulcatus*	twogrooved milkvetch	
	ASCR2	*Astragalus crassicarpus*	groundplum milkvetch	
	ASGI5	*Astragalus gilviflorus*	plains milkvetch	
	ASGR3	*Astragalus gracilis*	slender milkvetch	
	ASLA27	*Astragalus laxmannii*	Laxmann's milkvetch	
	ASMU99	***Astragalus multiflorus***	**looseflower milkvetch**	
	DACA7	*Dalea candida*	white prairie clover	
	DAPU5	*Dalea purpurea*	violet prairie clover	
	GLLE3	*Glycyrrhiza lepidota*	wild licorice	
	MELU	*Medicago lupulina*	black medic	*
	MEOF	*Melilotus officinalis*	yellow sweetclover	*
	OXSE	*Oxytropis sericea*	white locoweed	
	PEAR6	*Pediomelum argophyllum*	silverleaf scurfpea	
	PEES	*Pediomelum esculentum*	breadroot scurfpea	

Family	Species Code	Scientific Name	Common Name	Exotic
	PSTE5	*Psoralidium tenuiflorum*	slimflower scurfpea	
	VIAM	*Vicia americana*	American vetch	
Grossulariaceae	RICE	*Ribes cereum*	wax currant	
	RIOX	*Ribes oxyacanthoides*	Canadian gooseberry	
Iridaceae	SIMO2	*Sisyrinchium montanum*	mountain blue-eyed grass	
Lamiaceae	HEDR	*Hedeoma drummondii*	Drummond's false pennyroyal	
	HEHI	*Hedeoma hispida*	false pennyroyal	
	MAVU	*Marrubium vulgare*	horehound	*
	MOFI	*Monarda fistulosa*	wild bergamot	
	NECA2	*Nepeta cataria*	catnip	*
	SARE3	*Salvia reflexa*	lanceleaf sage	
Liliaceae	ALCE2	*Allium cernuum*	nodding onion	
	MAST4	*Maianthemum stellatum*	false Solomons seal	
Linaceae	LIRI	*Linum rigidum*	stiffstem flax	
Malvaceae	SPCO	*Sphaeralcea coccinea*	scarlet globemallow	
Nyctaginaceae	MILI3	*Mirabilis linearis*	narrowleaf four-o'clock	
Onagraceae	OESE3	*Oenothera serrulata*	yellow sundrops	
	OESU99	*Oenothera suffrutescens*	scarlet beeblossom	
Oxalidaceae	OXST	*Oxalis stricta*	yellow woodsorrel	
Pinaceae	PIPO	*Pinus ponderosa*	ponderosa pine	
Plantaginaceae	PLPA2	*Plantago patagonica*	woolly plantain	
	SYWY99	*Synthyris wyomingensis*	Wyoming kittentails	
Poaceae	AGSC5	*Agrostis scabra*	ticklegrass	
	ANGE	*Andropogon gerardii*	big bluestem	
	ARPU9	*Aristida purpurea*	purple threeawn	
	BOCU	*Bouteloua curtipendula*	sideoats grama	
	BODA2	*Bouteloua dactyloides*	buffalograss	
	BOGR2	*Bouteloua gracilis*	blue grama	
	BOHI2	*Bouteloua hirsuta*	hairy grama	
	BRIN2	*Bromus inermis*	smooth brome	*
	BRJA	*Bromus japonicus*	Japanese brome	*
	BRTE	*Bromus tectorum*	cheatgrass	*
	CALO	*Calamovilfa longifolia*	prairie sandreed	
	DASP2	*Danthonia spicata*	poverty oatgrass	
	DILI2	*Dichanthelium linearifolium*	slimleaf panicum	
	DIOL	*Dichanthelium oligosanthes*	Scribners panicum	
	ELCA4	*Elymus canadensis*	Canada wildrye	
	ELEL5	*Elymus elymoides*	squirreltail	
	ELRE4	*Elymus repens*	quackgrass	*
	ELTR7	*Elymus trachycaulus*	slender wheatgrass	

Family	Species Code	Scientific Name	Common Name	Exotic
	FESA	*Festuca saximontana*	Rocky Mountain fescue	
	HECO26	*Hesperostipa comata*	needle and thread	
Poaceae	HESP11	*Hesperostipa spartea*	porcupinegrass	
	KOMA	*Koeleria macrantha*	junegrass	
	MUCU3	*Muhlenbergia cuspidata*	plains muhly	
	MUPA99	*Muhlenbergia paniculata*	tumblegrass	
	MURA	*Muhlenbergia racemosa*	green muhly	
	NAVI4	*Nassella viridula*	green needlegrass	
	PAVI2	*Panicum virgatum*	switchgrass	
	PASM	*Pascopyrum smithii*	western wheatgrass	
	PIMI7	*Piptatherum micranthum*	littleseed ricegrass	
	POCO	*Poa compressa*	Canada bluegrass	*
	POPR	*Poa pratensis*	Kentucky bluegrass	*
	SCPR4	*Schedonorus pratensis*	meadow fescue	*
	SCSC	*Schizachyrium scoparium*	little bluestem	
	SONU2	*Sorghastrum nutans*	Indiangrass	
	SPCR	*Sporobolus cryptandrus*	sand dropseed	
	SPHE	*Sporobolus heterolepis*	prairie dropseed	
	VUOC	*Vulpia octoflora*	sixweeks fescue	
Polemoniaceae	COLI2	*Collomia linearis*	slenderleaf collomia	
	PHAL3	*Phlox alyssifolia*	alyssum-leaf phlox	
	PHAN4	*Phlox andicola*	prairie phlox	
	PHHO	*Phlox hoodii*	spiny phlox	
Polygalaceae	POAL4	*Polygala alba*	white milkwort	
Polygonaceae	ERAN4	*Eriogonum annuum*	wild buckwheat	
	FACO	*Fallopia convolvulus*	black bindweed	*
Portulacaceae	PHPA29	*Phemeranthus parviflorus*	sunbright	
Ranunculaceae	ANCY	*Anemone cylindrica*	candle anemone	
	ANPA19	*Anemone patens*	eastern pasqueflower	
Rosaceae	CEMO2	*Cercocarpus montanus*	mountain-mahogany	
	POCO13	*Potentilla concinna*	elegant cinquefoil	
	POHI6	*Potentilla hippiana*	woolly cinquefoil	
	POPE8	*Potentilla pensylvanica*	prairie cinquefoil	
	PRAM	*Prunus americana*	American plum	
	PRPU3	*Prunus pumila*	sand cherry	
	PRVI	*Prunus virginiana*	chokecherry	
	ROAR3	*Rosa arkansana*	prairie rose	
	ROWO	*Rosa woodsii*	Woods' rose	
	RUSA99	*Rubus sachalinensis*	grayleaf red raspberry	
Rubiaceae	GABO2	*Galium boreale*	northern bedstraw	

Family	Species Code	Scientific Name	Common Name	Exotic
Santalaceae	COUM	*Comandra umbellata*	bastard toadflax	
Scrophulariaceae	CASE5	*Castilleja sessiliflora*	Great Plains Indian paintbrush	
Scrophulariaceae	PEGR5	*Penstemon gracilis*	slender penstemon	
	PEGR7	*Penstemon grandiflorus*	largeflowered penstemon	
	VETH	*Verbascum thapsus*	common mullein	*
	VEPE2	*Veronica peregrina*	purslane speedwell	
Selaginellaceae	SEDE2	*Selaginella densa*	dense clubmoss	
Solanaceae	PHYSA	*Physalis* spp.	groundcherry	
	PHLO4	*Physalis longifolia*	common groundcherry	
	PHVI5	*Physalis virginiana*	Virginia groundcherry	
Ulmaceae	ULAM	*Ulmus americana*	American elm	
	ULPU	*Ulmus pumila*	Siberian elm	*
Unknown family	UNKFORB	Unknown forb	unknown forb	*
	UNKGRAM	Unknown graminoid	unknown graminoid	*
Urticaceae	PAPE5	*Parietaria pensylvanica*	Pennsylvania pellitory	
Verbenaceae	VEBR	*Verbena bracteata*	bigbract verbena	
	VEST	*Verbena stricta*	woolly verbena	
Violaceae	VIOLA	*Viola* spp.	violet	*
	VIAD	*Viola adunca*	hookedspur violet	
	VINU2	*Viola nuttallii*	Nuttall's violet	

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

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