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Plant Community Composition and Structure Monitoring for Fort Union Trading Post National Historic Site

2012 Annual Report

Natural Resource Technical Report NPS/NGPN/NRTR—2013/675

ON THE COVER
Long-term monitoring plot PCM_130 in the Bodmer Unit of Fort Union Trading Post National Historic Site, 2012.
Photograph by: NGPN

Plant Community Composition and Structure Monitoring for Fort Union Trading Post National Historic Site

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Natural Resource Technical Report NPS/NGPN/NRTR—2013/675

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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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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

Fort Union Trading Post National Historic Site (FOUS) protects 444 acres of northern mixed-grass prairie and riparian forests. The Northern Great Plains Inventory & Monitoring Network surveyed 6 long-term monitoring plots in FOUS 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 FOUS. 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.

FOUS protects a remnant of native northern mixed-grass prairie in the Bodmer Overlook Unit and more disturbed areas in the upland fields surrounding the fort. A few sites in the park have a high cover of exotic species and to retain ecological integrity it is important to continue efforts to reduce the cover of invasive plants. Allowing for natural disturbances such as fire may be critical to maintaining plant diversity in FOUS, but it should be balanced with the need to protect intact native communities and prevent further invasions of exotic species. Continued monitoring efforts will be critical to track changes in the condition of the vegetation communities in FOUS.

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 FOUS, particularly Andy Banta for providing logistical support and safety checks. The 2012 NGPN vegetation field crew of Isabel Ashton, Timothy Pine, Lauren Baur, and Gretchen Addington collected the NGPN data included in this report. We thank Stephen Wilson for invaluable support and instruction on managing data in the FFI database and for assistance with the GIS data.

Introduction

During the last century, much of the prairie within the Northern Great Plains has been plowed for cropland, converted to livestock pasture, or otherwise developed, making it one of the most threatened ecosystems in the United States. Within North Dakota, greater than 71% of the area of native mixed-grass prairie has been lost since European settlement (Samson and Knopf 1994). The National Park Service (NPS) plays an important role in preserving and restoring some of the last pieces of intact 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 grim reality that there have been fundamental changes in the disturbance regimes, such as climate, fire, and large ungulate grazing, that have historically maintained prairies, and there is the continual pressure of exotic invasive species. Long-term monitoring in national parks is essential to sound management of prairie landscapes because it can provide information on environmental quality and condition, benchmarks of ecological integrity, and early warning of declines in ecosystem health.

Fort Union Trading Post National Historic Site (FOUS) was established in 1966 with a mission to commemorate the significant role played by Fort Union as a fur trading post on the Upper Missouri River. The trading post sits on 444 acres of upland mixed-grass prairie and riparian forests. The Northern Great Plains Inventory & Monitoring Program (NGPN) began vegetation monitoring at FOUS in 2011(Ashton et al. 2012), and surveys using similar methods were done in 2010 for the vegetation management plan (Symstad 2011). Vegetation monitoring protocols and plot locations were chosen to represent the upland terraces and Bodmer overlook unit 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 FOUS 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. 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 FOUS in 2012, our second year of sampling. NGPN visited 6 plots (Figure 1). Not all plots are visited every year, and we expect 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.

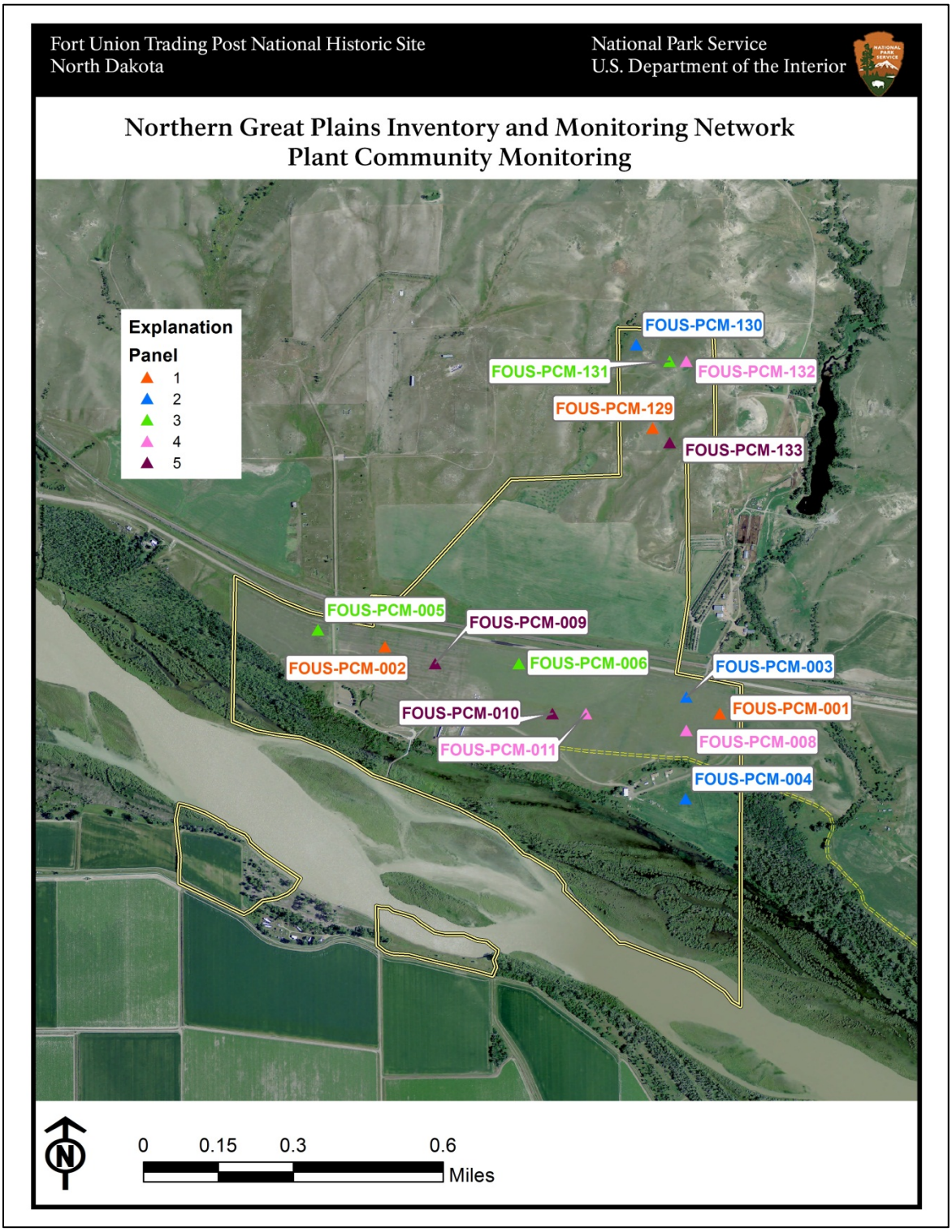


Figure 1. Map of plant community monitoring plots at Fort Union Trading Post National Historic Site (FOUS). Plant community monitoring plots in Panel 1 (orange) and Panel 2 (blue) were surveyed in 2012.

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 FOUS 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 FOUS. 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 2012, we visited sites in Panel 1 and Panel 2 (Figure 1) in late 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 and again at 10 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 $\leq$ 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 2012, sampling at FOUS took a 4-person crew approximately 88 crew hours with travel time (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, located within the entire 0.1 ha plot, were mapped and tagged. In 2012, we found a green ash (*Fraxinus pennsylvanica*) seedling in PCM_130, but that was the only site with trees or tall shrubs. .

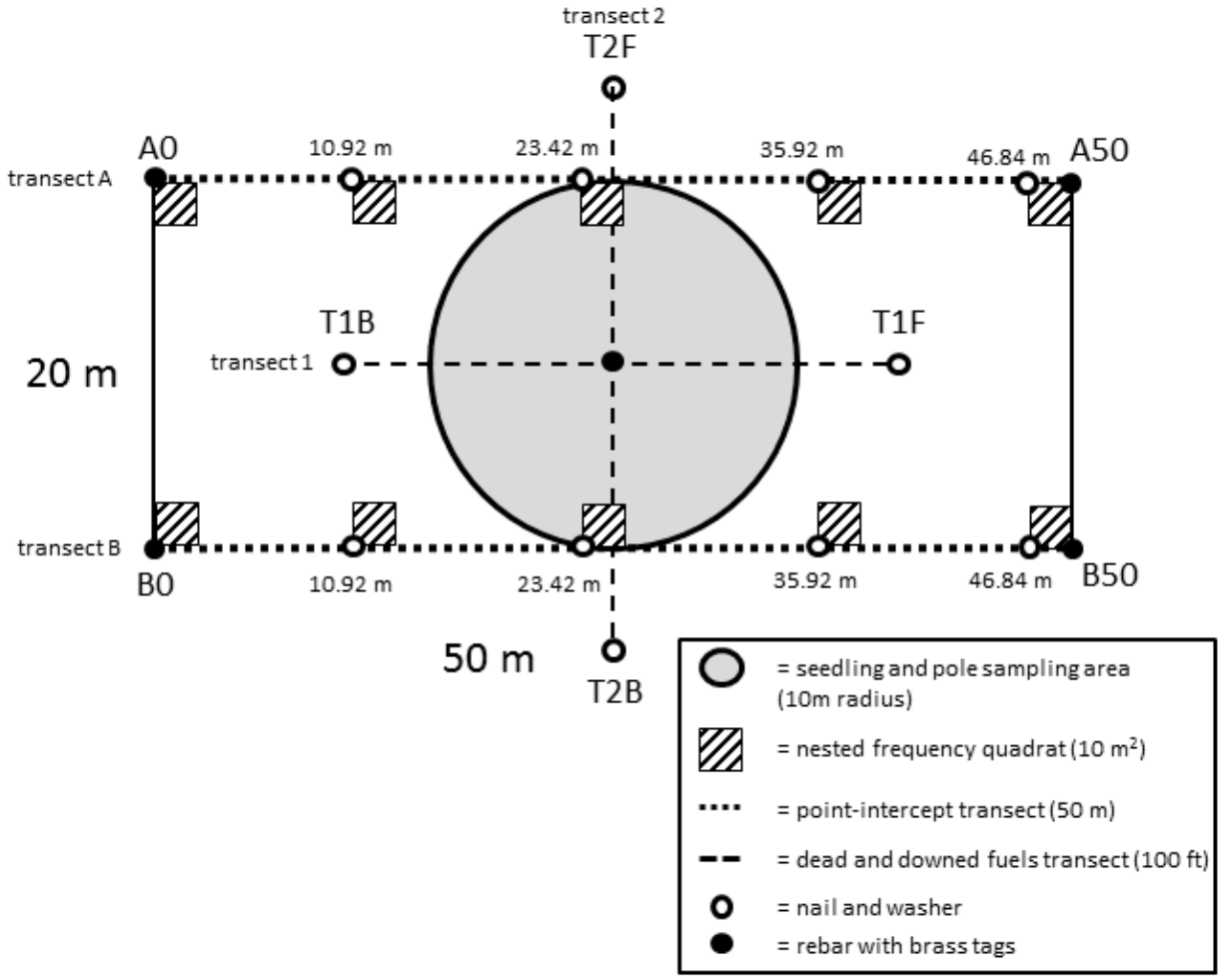


Figure 2. Long-term monitoring plot used for sampling vegetation in Fort Union Trading Post National Historic Site.

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 rodent mounds, animal trails, and fire. For all plots, the type and severity of the disturbances were recorded. 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 North Dakota, and may occur in FOUS. The FOUS target species list for 2012 can be found in Table 1.

Table 1. Exotic species of management concern at Fort Union Trading Post National Historic Site and rare species that were surveyed for during the 2012 field season.

Exotic Species	
Scientific Name	Common Name
Artemisia absinthium	absinth wormwood
Carduus nutans	musk thistle
Centaurea stoebe	spotted knapweed
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Convolvulus arvensis	field bindweed
Elaeagnus angustifolia	Russian olive
Euphorbia esula	leafy spurge
Linaria dalmatica	Dalmatian toadflax
Linaria vulgaris	yellow toadflax
Rhaponticum repens	Russian knapweed
Tamarix spp.	tamarisk
Tanacetum vulgare	common tansy
Rare Species	
Oxytropis sericea	white locoweed

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.

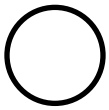
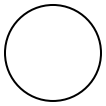
Reporting on Natural Resource Condition

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, and relative cover of exotic species. Reference values were based on descriptions of historic condition and variation, past studies, and/or the desired conditions described in the Vegetation Management Plan (Symstad 2011). 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

Despite fairly dry conditions, NGPN found 84 plant species in 2012 at FOUS (Appendix B). Graminoids, which include grasses, sedges, and rushes, accounted for most of the vegetative cover at FOUS (Figure 3). Average plant canopy cover was 141 ± 12.8% (Table 3) in 2012 (it can be over 100% because we record multiple layers of vegetation). The productive summer in 2011 and a relatively dry winter and spring in 2012 contributed to a large amount of standing litter on the ground (ground cover at sites averaged 74% plant litter).

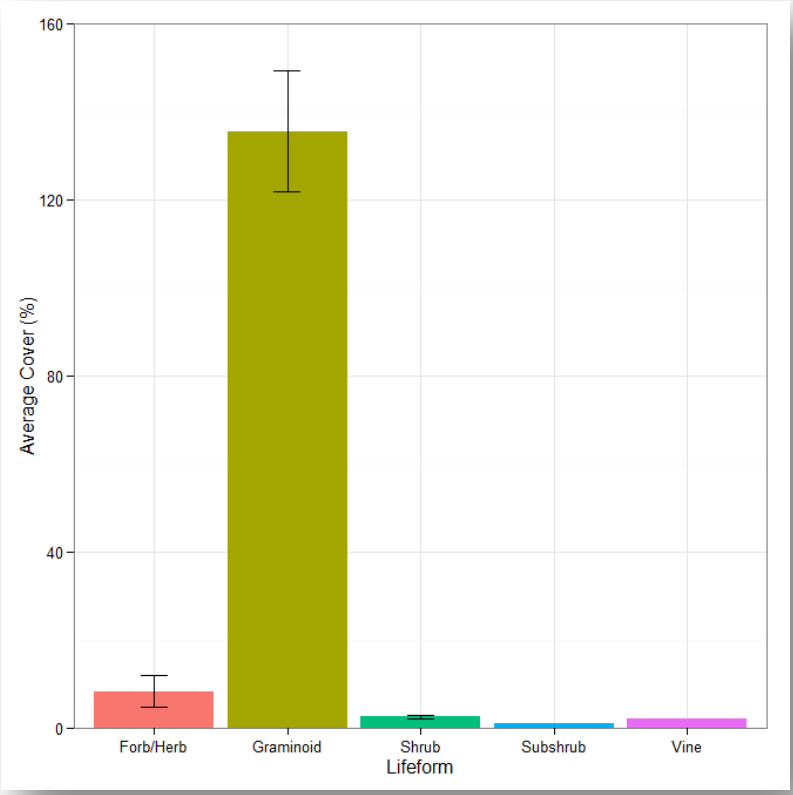


Figure 3. Average cover by life forms in 6 plant community monitoring plots in Fort Union Trading Post National Historic Site in 2012. Bars represent means ± standard errors. Graminoids were the most abundant life-form across all the plots at FOUS which is the desired condition for the Upland terraces and Bodmer Overlook Unit (Symstad 2011).

There was a great deal of variation in species composition across the 6 sites. The most common species found from the point-intercept were graminoids, and most were native species (Figure 4). Kentucky blue grass (*Poa pratensis*), green bristlegrass (*Setaria viridis*) and smooth brome (*Bromus inermis*) were the most common exotic species. We did not encounter any rare species.

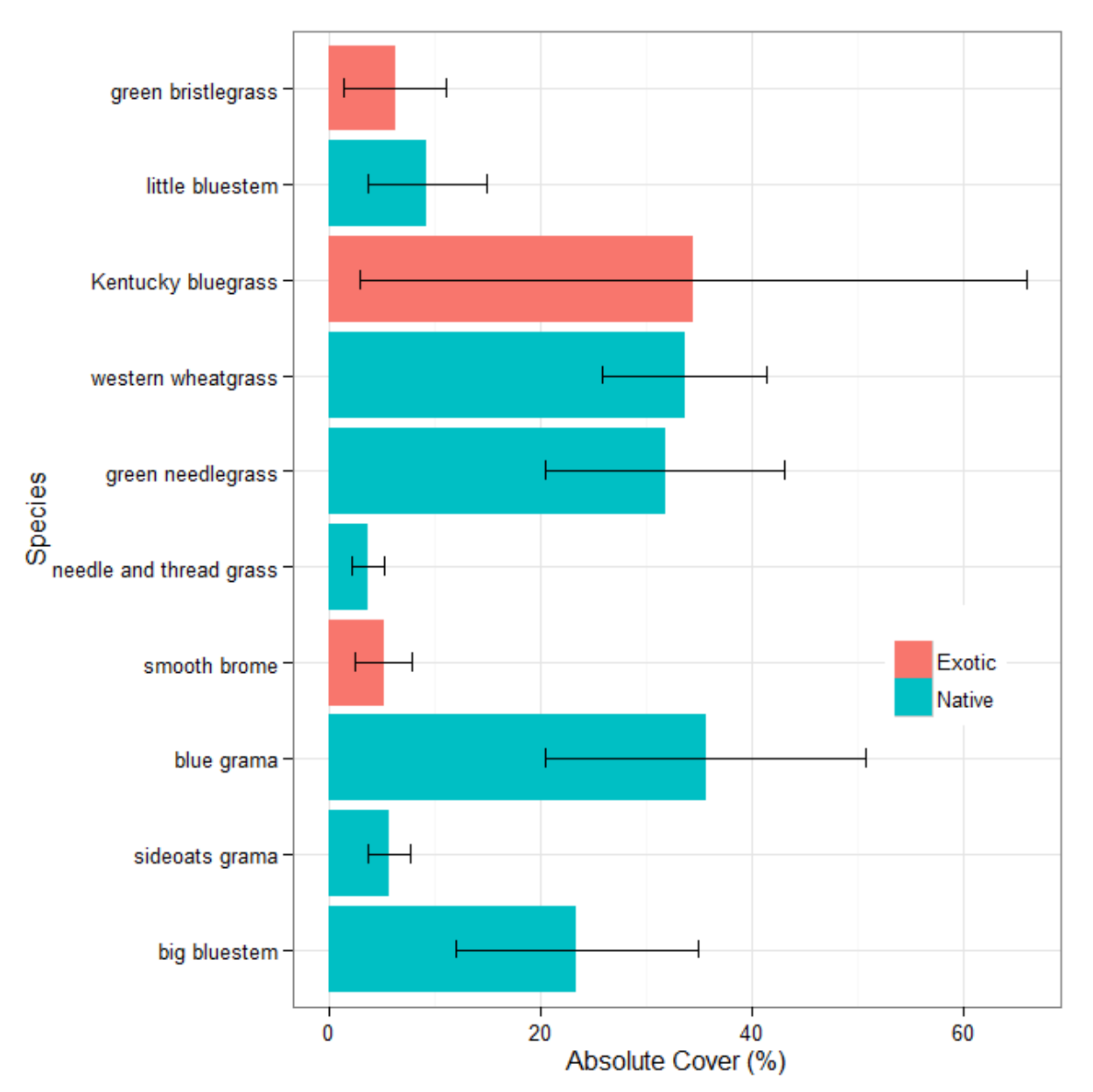
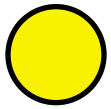
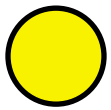


Figure 4. The average absolute cover of the 10 most common native (blue) and exotic (red) plants recorded at 6 sites at Fort Union Trading Post National Historic Site in 2012. Bars represent means ± standard errors.

Table 3. Natural resource condition summary table for upland plant communities in Fort Union Trading Post National Historic Site (FOUS).

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	141 ± 12.8 %	TBD		FOUS protects and manages small remnants of native mixed-grass prairie. The park is characterized by lower native species richness around the fort which falls slightly below the natural range of variability for northern mixed-grass prairie. Plots within the Bodmer Overlook contain more native species and are generally in good condition. 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
	Native species richness (based on average of 10 1m^2 quadrats per plot)	6 ± 1.7 species	8-18 species [(1)]		
	Evenness (based on point-intercept of 2-50m transects per plot)	0.71 ± 0.04	TBD		
Exotic Plant Early Detection and Management	Relative cover of exotic species	11 ± 6.2 %	≤10 % cover [(2)]		FOUS has determined that the desired condition for vegetation in upland areas comprises ≤ 10% total cover of exotic species. On average, the plots visited in 2012 had exotic cover slightly above this value. However, there was a great deal of variation across the park. Four of 6 sites met the desired condition including both of the sites in the Bodmer Overlook. Two other sites had very high exotic cover. To maintain the park as a whole at the desired condition, the best strategy will be to target management and restoration efforts in these areas of high exotic cover.

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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. Symstad, A. J. 2011. A vegetation management plan for Fort Union Trading Post National Historic Site: Final report for interagency agreement number F154910005 (April 2012). Natural Resource Technical Report NPS/FOUS/NRR—2012/502. National Park Service, Fort Collins, Colorado.

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 2 exotic species found in each 10 m^2 quadrat (Table 4). Most of the species we found were graminoids (Table 4), which is consistent with cover estimates (Figure 3). From the point-intercept data, we found average plot diversity, H', to be 1.7 ± 0.31. Evenness, J', averaged 0.71 ± 0.04 across the plots (Table 3). When including only native species, average diversity and evenness were 1.5 ± 0.3 and 0.78 ± 0.05, respectively.

Table 4. Average plant species richness plant community monitoring plots at Fort Union Trading Post National Historic Site in 2012. Values represent means ± standard errors, n=6

	Point-intercept	**1 m^2 quadrats**	**10 m^2 quadrats**
Species richness	12 ± 3.2	7 ± 1.7	11 ± 2.7
Native species richness	10 ± 3.3	6 ± 1.7	9 ± 2.9
Exotic species richness	2 ± 0.7	1 ± 0.3	2 ± 0.5
Graminoid species richness	9 ± 1.6	5 ± 0.8	7 ± 1.0
Forb species richness	3 ± 1.4	2 ± 0.9	4 ± 1.3

There was a great deal of variation in species richness across sites, and the plots found in the Bodmer Overlook Unit had more native species than the areas surrounding the fort (Table 5). 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). 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 (Symstad and Jonas *in press*). Species richness in the upland areas surrounding the fort fall below the natural range, but the plots in the Bodmer Overlook Unit fall within it (Table 5). The Bodmer Overlook should be managed to maintain this native prairie. Restoration efforts in the terraces surrounding the fort are still visible, and it will take time before these areas are established and maintain a native diversity more typical of mixed-grass prairie (Figure 5).

Table 5. Characteristics of the plant community in 6 plots at Fort Union Trading Post National Historic Site in 2012 including average native species richness, exotic plant cover, and area of disturbance.

Management Unit	**Plot**	**Average native species richness 1 m^2 plots**	**Exotic cover (%)**	**Disturbance within site (m2)**
Upland Terrace	FOUS_PCM_001	2	1	310
	FOUS_PCM_002	6.6	22	1000
	FOUS_PCM_003	2.5	5	165
	FOUS_PCM_004	4.7	38	25
	Site Average	*4 ± 1.1 species*	*16.4 ± 8.4 %*	-
Bodmer Overlook	FOUS_PCM_129	13.4	1	20
	FOUS_PCM_130	8.6	2	26
	Site Average	*11 ± 2.4 species*	*1.3 ± 0.5%*	-

The average relative cover of exotic species at sites in FOUS was moderate (11 ± 6.2%; Table 3). However, like species richness, cover of exotic species varied considerably between the Bodmer Overlook unit and the upland terraces surrounding the fort (Table 5). Plot PCM_002 and PCM_004 both had a high cover of exotic species (Table 5). The most abundant exotic plants at site PCM_002 were green bristlegrass and smooth brome, but the targeted exotic species Canada thistle and field bindweed were also present in low abundance. We found Canada thistle in PCM_004, but Kentucky bluegrass was the most abundant exotic species at that site.

Disturbance from grazing, rodents, 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 2012, plots PCM_001, PCM_002, and PCM_003 had been recently mowed. In the Bodmer Overlook unit, plots had some small mammal disturbance and a few old cow patties. In the future, when we have more data we hope to examine the relationship between disturbance and plant composition.

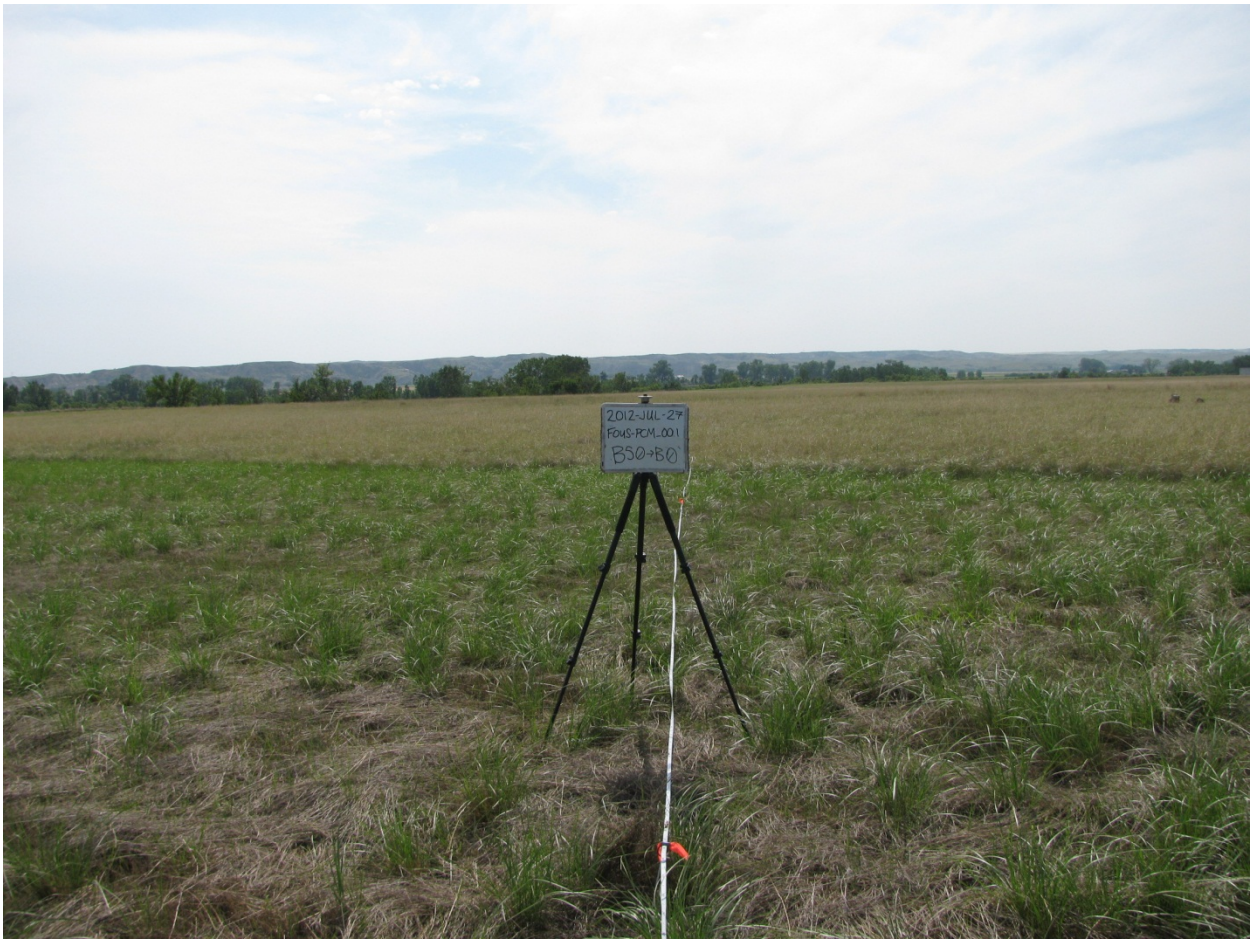

Figure 5. Photograph of a long-term monitoring plot within the upland terrace surrounding the fort at Fort Union Trading Post National Historic Site. This site is within a field that had been planted with native species and encompasses two different management regimes.

In conclusion, FOUS protects a remnant of native northern mixed-grass prairie in the Bodmer Overlook Unit and more disturbed areas in the upland fields surrounding the fort. A few sites in

the park have a high cover of exotic species, and to retain ecological integrity it is important to continue efforts to reduce the cover of invasive plants. Allowing for natural disturbances such as fire may be critical to maintaining plant diversity in FOUS, but it should be balanced with the need to protect intact native communities and prevent further invasions of exotic species. Continued monitoring efforts will be critical to track changes in the condition of the vegetation communities in FOUS.

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

Plant community composition monitoring in FOUS was completed using a crew of 4 people working 2.5 10-hour days. We spent 88 total crew hours at FOUS.

Date	Day of week	Approximate Travel Time (hrs)	Housing	Sites Completed	Notes
Jul 27, 2012	Friday	2	Missouri Flats Inn Williston, ND	PCM-001	1 plot surveyed
Jun 28, 2012	Saturday	1.25	Missouri Flats Inn Williston, ND	PCM-002 PCM-003 PCM-004 PCM-005	3 plots surveyed 1 plot established
Jun 29, 2012	Sunday	1.25	Missouri Flats Inn Williston, ND	PCM-006 PCM-129 PCM-130	2 plot surveyed 1 plot established
Jun 30,2012	Thursday	6	N/A	N/A	Travel

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

Species found in monitoring plots at Fort Union Trading Post National Historic Site 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	
Asteraceae	ARFR4	*Artemisia frigida*	fringed sagebrush	
	CIAR4	*Cirsium arvense*	Canada thistle	*
	COCA5	*Conyza canadensis*	horseweed	
	ECAN2	*Echinacea angustifolia*	blacksamson echinacea	
	GUSA2	*Gutierrezia sarothrae*	broom snakeweed	
	HENU	*Helianthus nuttallii*	Nuttall's sunflower	
	HEVI4	*Heterotheca villosa*	hairy goldenaster	
	HYFI	*Hymenopappus filifolius*	fineleaf hymenopappus	
	LASE	*Lactuca serriola*	prickly lettuce	*
	LIPU	*Liatris punctata*	dotted blazing star	
	LYJU	*Lygodesmia juncea*	rush skeletonplant	
	RACO3	*Ratibida columnifera*	prairie coneflower	
	SOMI2	*Solidago missouriensis*	Missouri goldenrod	
	SYER	*Symphyotrichum ericoides*	white heath 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	LIIN2	*Lithospermum incisum*	fringed puccoon	
Brassicaceae	CAMI2	*Camelina microcarpa*	littlepod false flax	*
	ERAS2	***Erysimum asperum***	**western wallflower**	
	THAR5	*Thlaspi arvense*	field pennycress	*
Cactaceae	ESVI2	*Escobaria vivipara*	spinystar	
	OPMA2	***Opuntia macrorhiza***	**twistspine pricklypear**	
	OPPO	*Opuntia polyacantha*	plains pricklypear	
Caprifoliaceae	SYOC	*Symphoricarpos occidentalis*	western snowberry	
Chenopodiaceae	CHAL7	*Chenopodium album*	lambsquarters	*
	KOSC	*Kochia scoparia*	common kochia	*
	KRLA2	*Krascheninnikovia lanata*	winterfat	
	SATR12	*Salsola tragus*	prickly Russian thistle	*
Convolvulaceae	COAR4	*Convolvulus arvensis*	field bindweed	*
Cyperaceae	CADU6	*Carex duriuscula*	needleleaf sedge	

Family	Species Code	Scientific Name	Common Name	Exotic
Cyperaceae	CAFI	*Carex filifolia*	threadleaf sedge	
	CAIN9	***Carex inops***	**long-stolon sedge**	
Euphorbiaceae	EUGL3	*Euphorbia glyptosperma*	ribseed sandmat	
Fabaceae	ASTRA	*Astragalus*	milkvetch	
	ASFL2	*Astragalus flexuosus*	flexile milkvetch	
	ASGI5	*Astragalus gilviflorus*	plains milkvetch	
	ASMI10	*Astragalus missouriensis*	Missouri milkvetch	
	ASPE5	*Astragalus pectinatus*	narrowleaf milkvetch	
	DACA7	*Dalea candida*	white prairie clover	
	DAPU5	*Dalea purpurea*	violet prairie clover	
	MELU	***Medicago lupulina***	**black medic**	*****
Linaceae	LILE3	*Linum lewisii*	blue flax	
	LIRI	*Linum rigidum*	stiffstem flax	
Malvaceae	SPCO	*Sphaeralcea coccinea*	scarlet globemallow	
Oleaceae	FRPE	*Fraxinus pennsylvanica*	green ash	
Onagraceae	OESU99	*Oenothera suffrutescens*	scarlet beeblossom	
Poaceae	AGCR	*Agropyron cristatum*	crested wheatgrass	*
	ANGE	*Andropogon gerardii*	big bluestem	
	ARPU9	*Aristida purpurea*	purple threeawn	
	BOCU	*Bouteloua curtipendula*	sideoats grama	
	BOGR2	*Bouteloua gracilis*	blue grama	
	BRIN2	*Bromus inermis*	smooth brome	*
	CALO	*Calamovilfa longifolia*	prairie sandreed	
	ELCA4	*Elymus canadensis*	Canada wildrye	
	ELEL5	***Elymus elymoides***	**squirreltail**	
	ELTR7	*Elymus trachycaulus*	slender wheatgrass	
	HECO26	*Hesperostipa comata*	needle and thread	
	KOMA	*Koeleria macrantha*	junegrass	
	MUCU3	*Muhlenbergia cuspidata*	plains muhly	
	MUSQ3	***Munroa squarrosa***	**false buffalograss**	
	NAVI4	*Nassella viridula*	green needlegrass	
	PACA6	*Panicum capillare*	common panic grass	
	PAVI2	*Panicum virgatum*	switchgrass	
	PASM	*Pascopyrum smithii*	western wheatgrass	
	POPR	*Poa pratensis*	Kentucky bluegrass	*
	PSSP6	***Pseudoroegneria spicata***	**bluebunch wheatgrass**	
	SCSC	*Schizachyrium scoparium*	little bluestem	
	SEVI4	*Setaria viridis*	green bristlegrass	*
Polemoniaceae	PHAL3	*Phlox alyssifolia*	alyssum-leaf phlox	
	PHHO	*Phlox hoodii*	spiny phlox	

Family	Species Code	Scientific Name	Common Name	Exotic
Polygalaceae	POAL4	*Polygala alba*	white milkwort	
Polygonaceae	ERFL4	*Eriogonum flavum*	alpine golden buckwheat	
	ERPA9	*Eriogonum pauciflorum*	fewflower buckwheat	
Ranunculaceae	ANCY	*Anemone cylindrica*	candle anemone	
	ANMU	***Anemone multifida***	**Pacific anemone**	
	ANPA19	*Anemone patens*	eastern pasqueflower	
Rosaceae	ROAR3	*Rosa arkansana*	prairie wildrose	
Santalaceae	COUM	*Comandra umbellata*	bastard toadflax	
Scrophulariaceae	PEGR5	*Penstemon gracilis*	lilac penstemon	
	PEGR7	*Penstemon grandiflorus*	large beardtongue	
Unknown Family	UNKFORB	*Unknown forb*	unknown forb	*
Verbenaceae	**VEST**	***Verbena stricta***	**hoary verbena**	

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