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Natural Resource Stewardship and Science

Plant Community Composition and Structure Monitoring for Mount Rushmore National Memorial

2014 Annual Report

Natural Resource Data Series NPS/NGPN/NRDS—2015/766

ON THE COVER
Long-term monitoring plot PCM-008 at Mount Rushmore National Memorial, 2014
Photograph courtesy of the National Park Service

Plant Community Composition and Structure Monitoring for Mount Rushmore National Memorial

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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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Abstract

This report presents the results of vegetation monitoring efforts in 2014 at Mount Rushmore National Memorial (MORU) by the Northern Great Plains Inventory and Monitoring Network (NGPN).

During the fourth full year of field work, crew members from NGPN visited six plant community monitoring plots to collect data on the vegetation at MORU. This is part of a long-term monitoring effort that will sample six of 15 randomly located upland plots every year, so that each plot is visited for two consecutive years and then rested for three years, on a five-year rotating basis. NGPN staff captured data relating to species richness, herb-layer height, abundance of individual native and non-native species, ground cover, and site disturbance on each of the six plots.

Our 2014 findings can be summarized as follows: The crew observed 126 vascular plant species in upland plots, with an average of 3.6 native species occurring within any given 1 m^2 quadrat sampled. Grasses, sedges, and shrubs made up the bulk of the plant cover, while non-native species represented about 0.5% of cover. Forests in MORU are generally in good condition.

Acknowledgments

We thank all the authors of the NGPN Plant Community Monitoring Protocol, particularly A. Symstad, for outstanding guidance on data collection and reporting. Thank you to the staff at MORU, particularly B. Weisman, S. Davis, and D. Hart and dispatch for providing logistical support and safety checks. M. Bynum helped for four days in the field and served as the primary botanist. The 2014 NGPN vegetation field crew of K. Legner, R. Manuel, and F. Sewell, along with M. Bynum, collected all the data included in this report.

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 (Figure 1). 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 mosaic of open and closed canopy forests maintains a relatively high diversity of vascular plants with an estimate of 1000 species in the Black Hills (Larson and Johnson 2007).

Mount Rushmore National Memorial (MORU), located in the Black Hills, has a mission to preserve and protect the sculptured visages of George Washington, Thomas Jefferson, Theodore Roosevelt, and Abraham Lincoln, as well as the land surrounding it. While this is a relatively small area (517 ha, 1278 ac), MORU contains the second-largest area of old growth ponderosa pine forest in the Black Hills (Symstad and Bynum 2007). Ponderosa pine is the dominant plant throughout the park, but there are 459 vascular plant species listed on the park's species list (https://irma.nps.gov/NPSpecies/Search/SpeciesList/MORU). Plant diversity is highest in the small areas of the park that contain wetlands and deciduous canopy cover. There is a lower diversity of plants found under the closed-canopy of ponderosa pines, but the pristine condition of the older forest stands provides a valuable reference condition for Black Hills forests (Hoffman and Hansen 1986). Scientifically credible information on the current status and long-term trends of the composition and diversity of the forests in MORU is critical to increase our understanding of how changes in forest cover are impacting the understory.

The Northern Great Plains Inventory & Monitoring Program (NGPN) began vegetation monitoring at MORU in 2010 (Ashton et al. 2013). The long-term objectives of the NGPN plant community monitoring (PCM) effort (Symstad et al. 2012b) in MORU 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 status (at 5-yr intervals) and long-term trends of tree density by species, height class, and diameter class in lowland areas near targeted perennial streams.

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 the six sites we visited at MORU in 2014 (Figure 1). Previous reports document the recent park-wide status of the understory vegetation (Ashton and Prowatzke 2014) and forest health and fuel loads (Ashton et al. 2012).

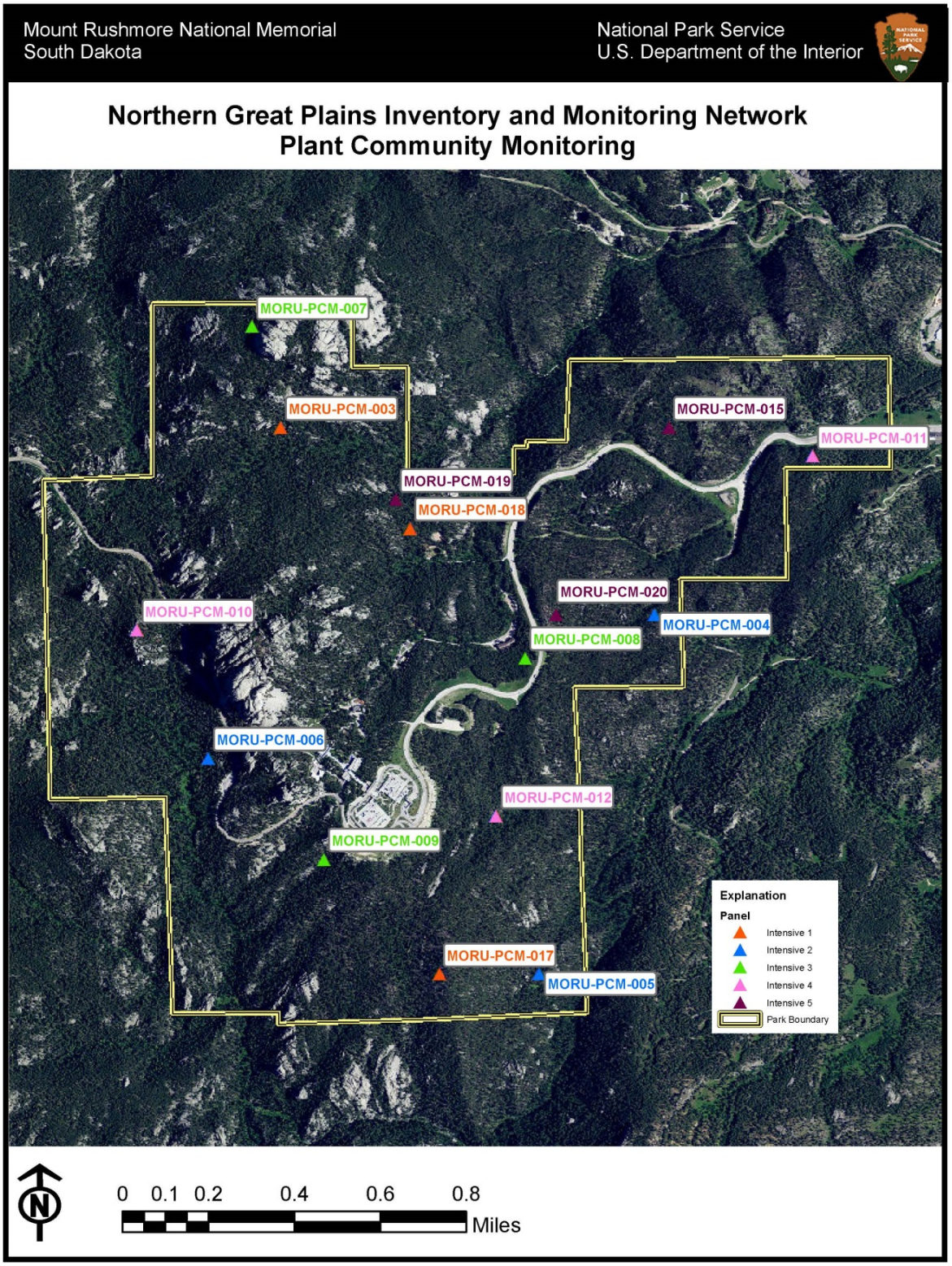

Figure 1. Map of Mount Rushmore National Memorial and plant community monitoring plots. Plots in panel 3 (green) and panel 4 (pink) were visited in 2014.

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. 2012a, 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 MORU 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 MORU (Figure 1). We split these 15 sites into five panels with three sites each. As part of our pilot monitoring efforts we visited all 15 plots in 2010 during the second half of July. Since then, we visited two panels (six sites) every year. In 2011, we visited sites in panel 1 and panel 5. In 2012, we visited sites in panel 1 and panel 2. In 2013, we visited sites in panel 2 and panel 3, and in 2014, we visited sites in panel 3 and panel 4 during the last week of June (Figure 1). This report only summarizes the data from 2014. 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 ≤ 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 five 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 2014, sampling at MORU took a four-person crew approximately 165 crew hours with travel time (see Appendix A for a detail of activities each day).

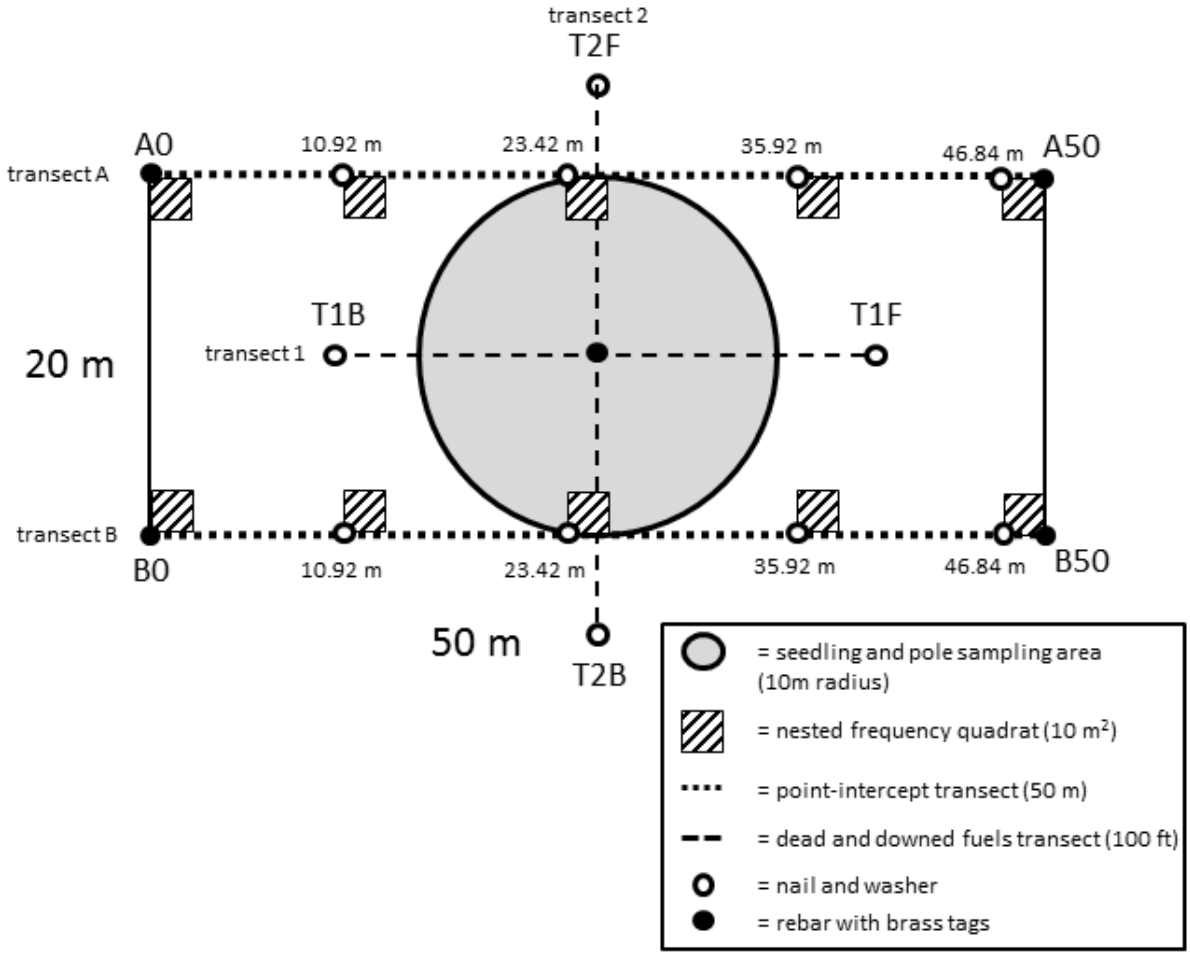

Figure 2. Long-term monitoring plot layout used for sampling vegetation in Mount Rushmore National Memorial.

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 recently spread into the Northern Great Plains and 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 which may potentially occur in MORU (Table 2).

Table 1. Exotic species surveyed for at Mount Rushmore National Memorial 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 2014 field season at Mount Rushmore National Memorial.

Scientific Name	Common Name
Boechera divaricarpa	limestone rockcress
Boechera holboellii	limestone rockcress
Botrychium multifidum	leathery grapefern
Carex bella	elegant sedge
Cypripedium parviflorum	lesser yellow lady's slipper
Helianthemum bicknellii	hoary frostweed
Oxyria digyna	alpine mountain sorrel
Platanthera orbiculata	lesser round-leaved orchid
Viola selkirkii	Selkirk's violet

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). Summaries were produced using the FFI reporting and query tools, and statistical summaries and graphics were generated using R software (version 3.1.2).

We measured diversity at the plots in three 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 concern, 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

Mount Rushmore National Memorial experienced slightly elevated precipitation levels in 2014 (http://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:USC00393868/detail). At the time of NGPN's visit, precipitation for the year was about one inch above the 30-year normal (Figure 3).

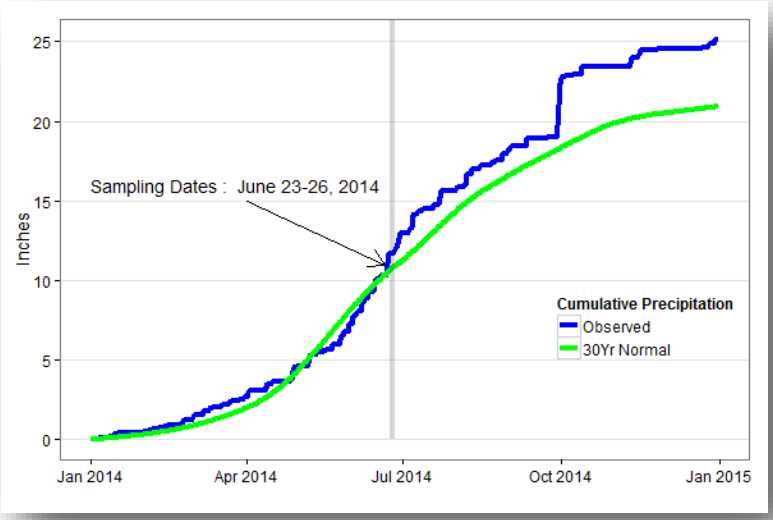

Figure 3. Observed and 30-year (1981-2010) normal precipitation near Mount Rushmore National Memorial. Timing of NGPN visit is shown by vertical gray bar.

Average herbaceous canopy cover was 28% (Table 4) in 2014, which was 6% higher than the previous year (Ashton and Prowatzke 2014). There was a large amount of litter on the ground with ground cover at the sites averaging 73% plant litter, 19% bedrock or rock, and 6% woody debris.

We found 126 plant species in 2014 at MORU (Appendix B). Graminoids (which includes grasses, sedges, and rushes) and shrubs accounted for most of the vegetative cover at MORU, but trees and forbs were also abundant (Figure 4). We found 19 exotic species at the park, all of which were either forbs or graminoids. No exotic target species were found at any sites in 2014.

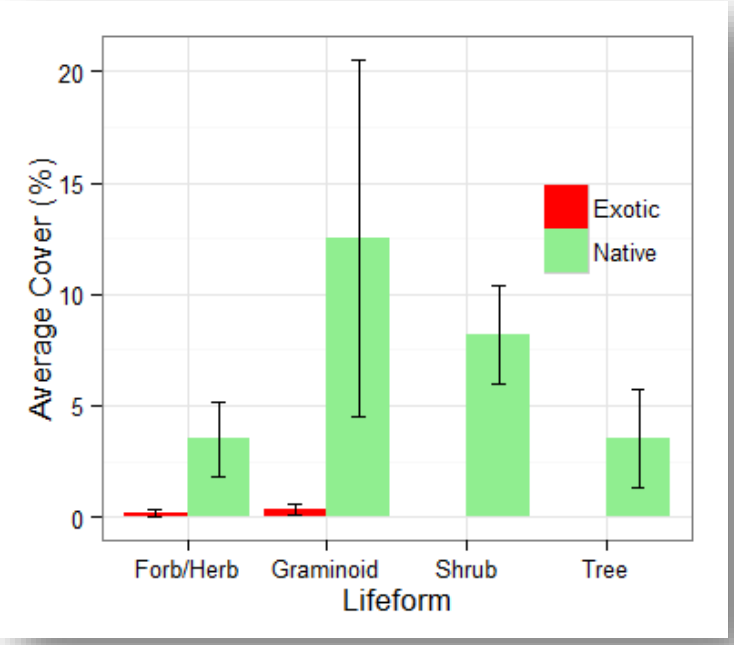

Figure 4. Average cover by lifeform in six plant community monitoring plots in Mount Rushmore National Memorial in 2014. Graminoids and shrubs were the most abundant lifeform found in the understory across the plots. Bars represent means ± standard errors.

There was some variation in species composition across the six sites. The most common species encountered on the transect lines were common juniper (*Juniperus communis*) and Richardson's sedge (*Carex richardsonii*). Of the 10 most common species, all were native (Figure 5). No rare target species were found at any sites in 2014.

Table 4. Natural resource condition summary table for upland plant communities in Mount Rushmore National Memorial (MORU).

Indicator of Condition	Specific Measures	2014 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	28 ± 7.5%	TBD [1]		The mission of many NPS park units is to maintain native plant diversity. MORU has a low diversity of native plants and a low cover of understory plants, which is consistent with older ponderosa forests with high conservation value and closed canopies. Current forest basal area is similar to the historic range in 1870 (2). A recent thinning action (2010-2011) reduced forest basal area and the risk of high intensity fires. At this time, our condition assessments for understory vegetation 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)	3.6 ± 0.8 species	TBD [1]		
	Evenness (based on point-intercept of 2-50m transects per plot)	0.84 ± 0.05	TBD [1]		
	Forest basal area (m^2/ha)	25.6 ± 4.0	23.6 ± 2.2[2]		
Exotic Plant Early Detection and Management	Relative cover of exotic species	1.1 ± 0.7 %	≤ 5% cover		In general, the sites in MORU had a low cover of exotic species. Only one site had >1% exotic cover.
Fire and Fuel Dynamics	Total downed fuel loads (tons/acre)	31 ± 6.2	Between 2 and 15		The current fire ecology program aims to maintain fuel loads of less than 10 tons/acre, but in thick forests of MORU there is expected to be a range of conditions. High values are a result of a thick layer of litter and duff on the forest floor in some areas and downed heavy fuels in others.

References, Notes, and Data Sources:

1. To be determined when more data are available 2. Brown, P. M., C. L. Wienk, and A. J. Symstad. 2008. Fire and forest history at Mount Rushmore. Ecological Applications 18:1984-1999.

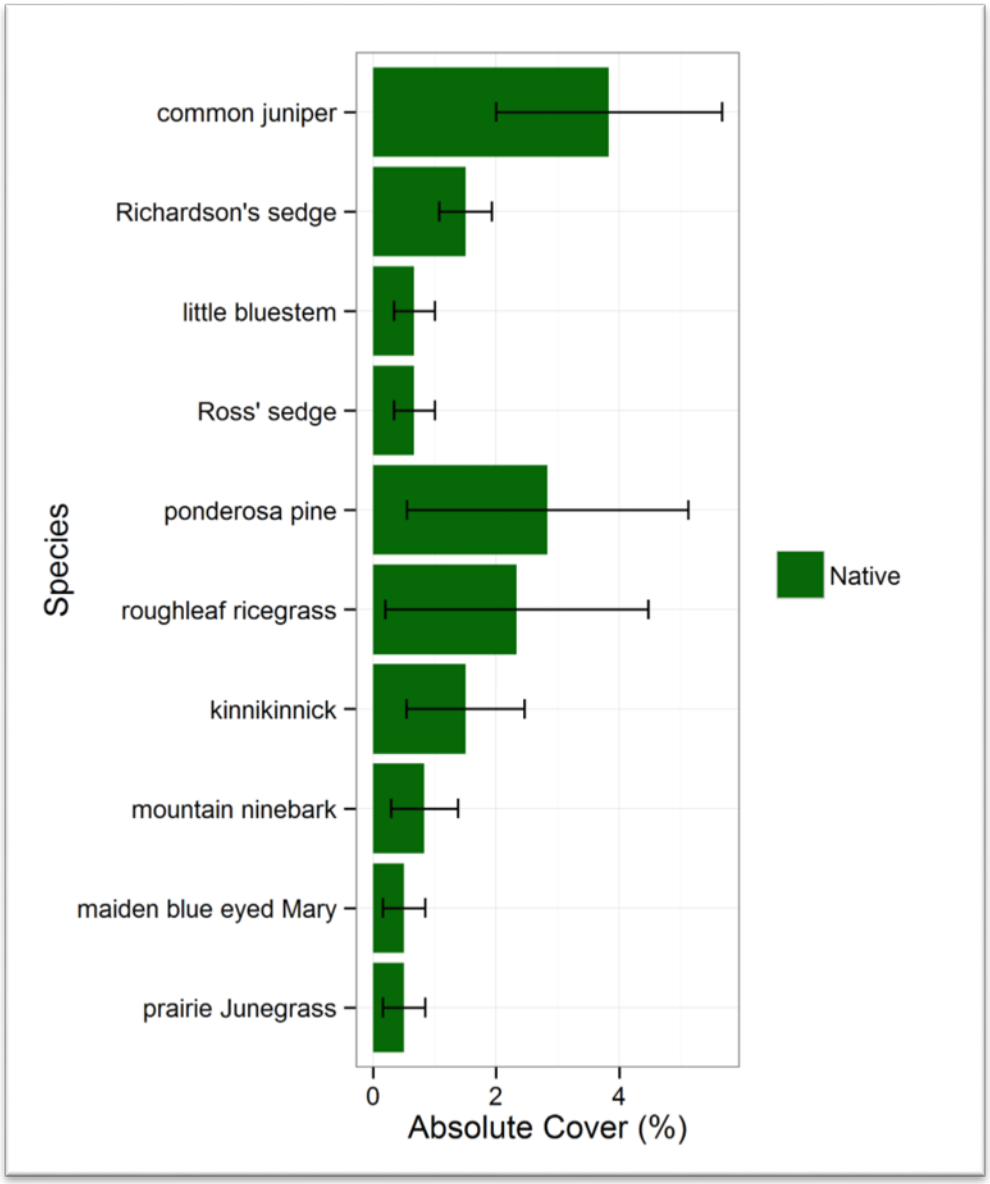

Figure 5. The average absolute cover of the 10 most common plants recorded at Mount Rushmore National Memorial in 2014. All were native species. Bars represent means ± standard errors.

Average species richness at each of the six plots was measured by point-intercept and by 1 m^2 and 10 m^2 quadrats (Table 5). From the point-intersect data, we found average plot diversity, H', to be 1.7 ± 0.3, and evenness, J', averaged 0.84 ± 0.05 across the plots (Table 4). The average diversity values were the same (upon rounding) when only native species were included, though the standard error of J' increased slightly ± 0.06 when only native species were included.

Table 5. Average plant species richness in six plots at Mount Rushmore National Memorial in 2014. Values represent means ± standard errors, n=6.

	Point-intercept	1 m^2 quadrats	10 m^2 quadrats
Species richness	10 ± 2.8	4.0 ± 0.9	12 ± 1.7
Native species richness	10 ± 2.6	3.6 ± 0.8	11 ± 1.3
Exotic species richness	0.5 ± 0.3	0.4 ± 0.2	1.4 ± 0.4
Graminoid species richness	4 ± 1.1	1.3 ± 0.4	3 ± 0.5
Forb species richness	2 ± 0.9	1.8 ± 0.5	5 ± 1.1

While there was some variation across sites (Table 6), the plots we visited in MORU tended to have a low diversity of native plants when compared to neighboring park units with a larger grassland component. For instance, Wind Cave National Park had an average diversity (H') of 2.5 and averaged 12 native species per square meter in 2014 (Prowatzke and Wilson 2015). Despite a low diversity of plant species, the forest stands in MORU are prime examples of late-stage ponderosa forest that are of high conservation value (Hoffman and Hansen, 1986). MORU also maintains a very low cover of exotic plants (Table 6). While we do not yet have defined reference conditions for upland plant communities in MORU, we choose to interpret the 2014 values as representative of a forest in good condition (Table 4). They are very similar to the values seen in past years (Ashton and Prowatzke 2014).

Table 6. Characteristics of the plant community at six plots in Mount Rushmore National Memorial in 2014 including native species richness, exotic plant cover, and area of disturbance.

Plot	Native species richness in 1 m^2	Exotic cover (%)	Cumulative area of disturbance (m^2)
MORU_PCM_007	2	0	20
MORU_PCM_008	6	2	241
MORU_PCM_009	6	0	19
MORU_PCM_010	1	0	50
MORU_PCM_011	2	0	4580
MORU_PCM_012	4	1	140
Park Average	*3.6 ± 0.8*	*0.5 ± 0.3*	-

Disturbance from grazing, fire, and humans affects plant community structure and composition. For this reason, we measured the approximate area affected by natural and human disturbances at each site we visited. In 2014, the most common disturbance was from fires and burn piles, but there was also evidence of trail use, tree thinning, storm damage, and garbage.

In 2010, we visited 60 sites in MORU and reported on overall forest health and fuel loads (Ashton et al. 2012). In 2014, we visited only a small subset of these plots. From these six plots, we found that average basal area was reduced since 2010 from 30 to 26 m^2/ha (Table 4). This reduction could be due to the thinning operations in the past several years, or it may simply be chance that the six plots included in 2014 were of lower than average density. These six plots indicate a forest density near historic levels. Average total downed fuel loads were much higher than in previous years (Ashton et al. 2012) and higher than the reference condition (Table 4). In one plot (PCM-011), this can be attributed to a thick layer of litter and duff, a byproduct of thinning and chipping operations. However, at PCM-007 and PCM-012, the majority of the fuels are 1000-hour fuels (downed woody

debris >3” diameter). Although the fuel loads are higher than desired, the range of fuel types and conditions may be expected in a dynamic ponderosa pine forest (Figure 6).

Figure 6. Contrast of downed fuel load types at two long-term monitoring plots at Mount Rushmore National Memorial. PCM-011 (left) has fuel loads of 53 tons/acre; a thick layer of pine litter, chips, and duff on the forest floor comprises over 90% of the fuel load. PCM-012 (right) has fuel loads of 38 tons/acre, 1000-hour fuels comprise over 60% of the fuel load. Both totals are well above management targets.

Summary

Understory plant community plots measured in 2014 at MORU are in good condition. The mission of many NPS park units includes maintaining native plant diversity. MORU has a low diversity of native plants and a low cover of understory plants, but this is consistent with older ponderosa forests with high conservation value. The recent mechanical thinning project has increased woody fuel loads on the forest floor. In 2016, when we conduct another comprehensive survey of forest health, we will attempt to determine whether this has long-term implications.

Literature Cited

Ashton, I. W. and M. Prowatzke. 2014. Plant community composition and structure monitoring for Mount Rushmore National Memorial: 2013 annual report. Natural Resource Data Series NPS/NGPN/ NRDS—2014/617. National Park Service, Fort Collins, CO.

Ashton, I. W., M. Prowatzke, M. Bynum, T. Shepherd, S. K. Wilson, K. Paintner-Green. 2013. Plant community composition and structure monitoring at Mount Rushmore National Memorial: 2010-2012 status report. Natural Resource Technical Report NPS/NGPN/NRTR—2013/677. National Park Service, Fort Collins, CO.

Ashton, I. W., M. Prowatzke, M. Bynum, T. Shepherd, S. K. Wilson, K. Paintner-Green, and D. Swanson. 2012. Status of forest structure and fuel loads at Mount Rushmore National Memorial: 2010-2011 report. Natural Resource Technical Report NPS/NGPN/NRTR—2012/590. National Park Service, Fort Collins, CO.

Brown, J. K. 1974. Handbook for inventorying downed material. General Technical Report INT-16. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Brown, J. K., R. D. Oberhue, and C. M. Johnston. 1982. Inventorying surface fuels and biomass in the Interior West. General Technical Report INT-129. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Brown, P. M., C. L. Wienk, and A. J. Symstad. 2008. Fire and forest history at Mount Rushmore. Ecological Applications 18:1984-1999.

Hoffman, G. R. and P. L. Hansen. 1986. Vegetation baseline study of Mount Rushmore National Monument. University of South Dakota, Vermillion, SD.

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.

Prowatzke, M. and S. K. Wilson. 2015. Plant community composition and structure monitoring for Wind Cave National Park: 2014 annual report. Natural Resource Data Series NPS/NGPN/NRDS—2015/765. National Park Service, Fort Collins, CO.

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 M. Bynum. 2007. Conservation Value of Mount Rushmore National Memorial's Forest. Natural Areas Journal 27:293-301.

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 MORU for the 2014 season

The majority of the plant community composition monitoring in Mount Rushmore National Monument was completed using a crew of four people working four, 10-hour days. M. Bynum served as the fourth crew member and botanist. We spent 165 total crew hours.

Date	Day of week	Approximate Travel Time (hrs)	Housing	Sites Completed
June 23, 2014	Monday	1.25	N/A	PCM-007 PCM-009
June 24, 2014	Tuesday	1.25	N/A	PCM-010
June 25, 2014	Wednesday	1.25	N/A	PCM-008 PCM-011
June 26, 2014	Thursday	1.25	N/A	PCM-012

Appendix B: List of plant species found in 2014 at MORU

Family	Code	Scientific Name	Common Name	Exotic
Amaranthaceae	AMRE	*Amaranthus retroflexus*	redroot amaranth	
Anacardiaceae	TORY	*Toxicodendron rydbergii*	western poison ivy	
Apiaceae	SAMA2	*Sanicula marilandica*	Maryland sanicle	
Apocynaceae	APAN2	*Apocynum androsaemifolium*	spreading dogbane	
Araliaceae	ARNU2	*Aralia nudicaulis*	wild sarsaparilla	
Aspleniaceae	ASSE	*Asplenium septentrionale*	forked spleenwort	
Asteraceae	ACMI2	*Achillea millefolium*	common yarrow	
	AMPS	*Ambrosia psilostachya*	Cuman ragweed	
	ANMI3	*Antennaria microphylla*	littleleaf pussytoes	
	ANNE	*Antennaria neglecta*	field pussytoes	
	ANPA4	*Antennaria parvifolia*	small-leaf pussytoes	
	CIAR4	*Cirsium arvense*	Canada thistle	*
	CIVU	*Cirsium vulgare*	bull thistle	*
	COCA5	*Conyza canadensis*	Canadian horseweed	
	GRSQ	*Grindelia squarrosa*	curlycup gumweed	
	HEVI4	*Heterotheca villosa*	hairy false goldenaster	
	HICA3	*Hieracium canadense*	Canadian hawkweed	
	LASE	*Lactuca serriola*	prickly lettuce	*
	PACA15	*Packera cana*	woolly groundsel	
	PSMA11	*Pseudognaphalium macounii*	Macoun's cudweed	
	SERA	*Senecio rapifolius*	openwoods ragwort	
	SOMI2	*Solidago missouriensis*	Missouri goldenrod	
	SONE	*Solidago nemoralis*	gray goldenrod	
	SOSP2	*Solidago speciosa*	showy goldenrod	
	SYLA3	*Symphyotrichum laeve*	smooth blue aster	
	TAOF	*Taraxacum officinale*	common dandelion	*
	TRDU	*Tragopogon dubius*	yellow salsify	*
Betulaceae	BEPA	*Betula papyrifera*	paper birch	
	COCO6	*Corylus cornuta*	beaked hazelnut	
Boraginaceae	CRFE3	*Cryptantha fendleri*	sanddune cryptantha	
	CYOF	*Cynoglossum officinale*	gypsyflower	*
Brassicaceae	ARPY4	*Arabis pycnocarpa*	creamflower rockcress	
	BOCO4	*Boechera collinsii*	Collins' rockcress	
	BODI4	*Boechera divaricarpa*	spreadingpod rockcress	
Campanulaceae	CARO2	*Campanula rotundifolia*	bluebell bellflower	
	TRPE4	*Triodanis perfoliata*	clasping Venus' looking-glass	
Caprifoliaceae	SYAL	*Symphoricarpos albus*	common snowberry	
	SYOC	*Symphoricarpos occidentalis*	western snowberry	
Caryophyllaceae	CEFO2	*Cerastium fontanum*	common mouse-ear chickweed	*
	SIAN2	*Silene antirrhina*	sleepy silene	
Chenopodiaceae	CHAL7	*Chenopodium album*	lambsquarters	*
	CHLE4	*Chenopodium leptophyllum*	narrowleaf goosefoot	
	CHSI2	*Chenopodium simplex*	mapleleaf goosefoot	
Commelinaceae	TROC	*Tradescantia occidentalis*	prairie spiderwort	
Crassulaceae	SELA	*Sedum lanceolatum*	spearleaf stonecrop	
Cupressaceae	JUCO6	*Juniperus communis*	common juniper	

Cyperaceae	CAFO3	*Carex foenea*	dryspike sedge	
Cyperaceae	CAIN9	*Carex inops*	long-stolon sedge	
	CAREX	*Carex* sp.	sedge	
	CARI	*Carex richardsonii*	Richardson's sedge	
	CARO5	*Carex rossii*	Ross' sedge	
Dryopteridaceae	CYFR2	*Cystopteris fragilis*	brittle bladderfern	
	WOSC	*Woodsia scopulina*	Rocky Mountain woodsia	
Elaeagnaceae	SHCA	*Shepherdia canadensis*	russet buffaloberry	
Ericaceae	ARUV	*Arctostaphylos uva-ursi*	kinnikinnick	
Fabaceae	ASLA27	*Astragalus laxmannii*	Laxmann's milkvetch	
	LAOC2	*Lathyrus ochroleucus*	cream pea	
	MELU	*Medicago lupulina*	black medick	*
	MEOF	*Melilotus officinalis*	yellow sweetclover	*
	PEAR6	*Pediomelum argophyllum*	silverleaf Indian breadroot	
	PEES	*Pediomelum esculentum*	large Indian breadroot	
	THRH	*Thermopsis rhombifolia*	prairie thermopsis	
	VIAM	*Vicia americana*	American vetch	
Fagaceae	QUMA2	*Quercus macrocarpa*	bur oak	
Grossulariaceae	RICE	*Ribes cereum*	wax currant	
	RIOX	*Ribes oxyacanthoides*	Canadian gooseberry	
Lamiaceae	HEDR	*Hedeoma drummondii*	Drummond's false pennyroyal	
	MOFI	*Monarda fistulosa*	wild bergamot	
Liliaceae	MAST4	*Maianthemum stellatum*	starry false lily of the valley	
Melanthiaceae	ANEL5	*Anticlea elegans*	mountain deathcamas	
Onagraceae	CHAN9	*Chamerion angustifolium*	fireweed	
	EPBR3	*Epilobium brachycarpum*	tall annual willowherb	
	EPCI	*Epilobium ciliatum*	fringed willowherb	
	OEBI	*Oenothera biennis*	common evening-primrose	
Orchidaceae	COWI5	*Corallorhiza wisteriana*	spring coralroot	
Pinaceae	PIGL	*Picea glauca*	white spruce	
	PIPO	*Pinus ponderosa*	ponderosa pine	
Poaceae	ACNE9	*Achnatherum nelsonii*	Columbia needlegrass	
	AGSC5	*Agrostis scabra*	rough bentgrass	
	BOGR2	*Bouteloua gracilis*	blue grama	
	BRIN2	*Bromus inermis*	smooth brome	*
	BRPO2	*Bromus porteri*	Porter brome	
	BRTE	*Bromus tectorum*	cheatgrass	*
	DASP2	*Danthonia spicata*	poverty oatgrass	
	DILE2	*Dichanthelium leibergii*	Leiberg's panicum	
	DILI2	*Dichanthelium linearifolium*	slimleaf panicgrass	
	DIOL	*Dichanthelium oligosanthes*	Heller's rosette grass	
	ELCA4	*Elymus canadensis*	Canada wildrye	
	ELTR7	*Elymus trachycaulus*	slender wheatgrass	
	FESA	*Festuca saximontana*	Rocky Mountain fescue	
	KOMA	*Koeleria macrantha*	prairie Junegrass	
	MURA	*Muhlenbergia racemosa*	marsh muhly	
	NAVI4	*Nassella viridula*	green needlegrass	
	ORAS	*Oryzopsis asperifolia*	roughleaf ricegrass	
	PIMI7	*Piptatherum micranthum*	littleseed ricegrass	
	PIPU7	*Piptatherum pungens*	mountain ricegrass	

	POPR	*Poa pratensis*	Kentucky bluegrass	*
Poaceae	SCAR7	*Schedonorus arundinaceus*	tall fescue	*
	SCSC	*Schizachyrium scoparium*	little bluestem	
Polygonaceae	FACO	*Fallopia convolvulus*	black bindweed	*
Primulaceae	PRPA99	*Primula pauciflora*	darkthroat shootingstar	
Pyrolaceae	PYCH	*Pyrola chlorantha*	greenflowered wintergreen	
Ranunculaceae	ANCY	*Anemone cylindrica*	candle anemone	
	ANPA19	*Anemone patens*	eastern pasqueflower	
	THVE	*Thalictrum venulosum*	veiny meadow-rue	
Rosaceae	AMAL2	*Amelanchier alnifolia*	Saskatoon serviceberry	
	DRFI3	*Drymocallis fissa*	bigflower cinquefoil	
	PHMO4	*Physocarpus monogynus*	mountain ninebark	
	PRVI	*Prunus virginiana*	chokecherry	
	ROAC	*Rosa acicularis*	prickly rose	
	ROWO	*Rosa woodsii*	Woods' rose	
	SPBE2	*Spiraea betulifolia*	white spirea	
Rubiaceae	GABO2	*Galium boreale*	northern bedstraw	
	GATR3	*Galium triflorum*	fragrant bedstraw	
Salicaceae	POTR5	*Populus tremuloides*	quaking aspen	
	SABE2	*Salix bebbiana*	Bebb willow	
Saxifragaceae	HERI	*Heuchera richardsonii*	Richardson's alumroot	
Scrophulariaceae	COPA3	*Collinsia parviflora*	maiden blue eyed Mary	
	PEGR5	*Penstemon gracilis*	lilac penstemon	
	VETH	*Verbascum thapsus*	common mullein	*
Selaginellaceae	SERU	*Selaginella rupestris*	northern selaginella	
Solanaceae	PHVI5	*Physalis virginiana*	Virginia groundcherry	
Unknown family	UNKFORB	Unknown forb	unknown forb	*
	UNKGRAM	Unknown graminoid	unknown graminoid	*
Violaceae	VIAD	*Viola adunca*	hookedspur violet	
	VIOLA	*Viola* sp.	violet	*

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