



Plant Community Composition and Forest Structure Monitoring at Mount Rushmore National Memorial

2016 Data Report

Natural Resource Data Series NPS/NGPN/NRDS—2017/1103



**ON THIS PAGE**

NGPN crew member Logan LaFleur monitoring forest structure at Mount Rushmore National Memorial
Photograph courtesy of the National Park Service

ON THE COVER

Long-term monitoring plot MORU_PCM_063 at Mount Rushmore National Memorial
Photograph courtesy of the National Park Service

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Abstract

This report presents the results of vegetation and forest structure monitoring efforts in 2016 at Mount Rushmore National Memorial (MORU) by the Northern Great Plains Inventory and Monitoring Network (NGPN) and the Northern Great Plains Fire Effects (NGPFire) program.

During the seventh full year of field work at MORU, the NGPN field crew visited six long-term plant community monitoring (PCM) plots to collect plant community data. Crews captured data relating to species richness, herb-layer height, native and non-native species abundance, ground cover, and site disturbance from each of these plots. Additionally, NGPN and NGPFire collaborated to visit an additional 54 plots, for a total of 60, to collect data relating to forest structure and health. In each of the 60 plots, crews collected data relating to tree regeneration, tall shrub and tree density, and woody fuel load. These collective efforts are part of long-term monitoring to help better understand the condition of the plant communities and forests at MORU.

Our 2016 findings can be summarized as follows: Monitoring crews identified 76 vascular plant species in upland plots, of which 11 were exotic species. Average relative cover of exotic species ranged from 0% to 8%. No rare plants were observed. Seedlings and live trees ($\text{DBH} > 15 \text{ cm}$) were found in all 60 plots, and live poles ($2.54 \text{ cm} \leq \text{DBH} \leq 15 \text{ cm}$) were found in 34 plots. Disturbances were observed in all 60 plots, with tree removal (chipping, logging, and thinning) and fire (prescribed fire, pile burn, and wildfire) being the most common.

Acknowledgments

We thank 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 and the dispatch office for providing logistical support and safety checks. We also thank M. Bynum and D. Jackson for assistance in the field. The 2016 NGPN vegetation field crew of I. Ashton, C. Davis, L. Mickelson, S. Rockwood, W. Vogel, M. Davis, L. LaFleur, and K. Rugg, with the assistance of the Northern Great Plains Fire Effects crew of D. Swanson, E. Watson, I. Muirhead, and C. Tomford, collected all the data included in this report.

Introduction

Mount Rushmore National Memorial (MORU) is located in the central Black Hills and was established in 1941 with a mission to preserve and protect the sculptured visages of George Washington, Thomas Jefferson, Theodore Roosevelt, and Abraham Lincoln, as well as the surrounding land. Though it 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, and there are 459 vascular plant species listed on the park's certified species list (NRinfo: <https://irma.nps.gov/>). 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).

The Northern Great Plains Inventory & Monitoring Program (NGPN) began two vegetation monitoring efforts in MORU in 2010: one program to monitor understory vegetation annually (Ashton et al. 2013) and another program to survey of forest conditions that is repeated every five years (Ashton et al. 2012). Vegetation monitoring protocols and plot locations were chosen to represent the entire park and to coordinate efforts with the Northern Great Plains Fire Ecology Program (NGPFire). This report is intended to provide a timely release of basic data sets and data summaries from sampling efforts in 60 plots at MORU in 2016.

Methods

The NGPN Plant Community Composition and Structure Monitoring Protocol (Symstad et al. 2012a,b) 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 the protocol publications cited above, which are available at: <http://science.nature.nps.gov/im/units/ngpn/monitor/plants/plants.cfm>.

NGPN and NGPFire Monitoring Plots 2016

The NGPN and NGPFire implemented a survey to monitor plant community structure and composition at Mount Rushmore National Memorial (MORU) using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003, 2004). Using the GRTS design, NGPN selected 15 randomly located sites within MORU to install Plant Community Monitoring (PCM) plots. These 15 sites are organized into five panels containing three sites each. NGPN crews visit two panels (6 sites total) every year using a rotating sampling scheme, so that after five years all 15 sites will have been visited twice. In 2016, NGPN crews visited six sites (“Dual Plots,” Figure 1) in panel 1 and panel 5 during the week of July 11-14 (Table 1). 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.

Using the same GRTS sampling design, NGPN implemented a survey to monitor forest structure and fuel loads at MORU, with a final design including 60 randomly located sites (“Dual Plots” plus “Forest Structure Plots,” Figure 1). These sites were first surveyed in 2010 and will be resurveyed every five years, with the goal to report on the change in the condition of MORU forests over time. NGPN and NGPFire crews worked together in early fall to complete these additional 54 plots (Table 2).

Table 1. Field journal for Northern Great Plains Network plant community monitoring at Mount Rushmore National Memorial in 2016.

Date	Travel time	Crew #	Plots Read	Notes
Wednesday, May 4, 2016	1 hr	11	PCM_018	Started PCM_018—joint training day with staff from NGPN and NGPFire.
Monday July 11, 2016	1 hr	4	PCM_003 PCM_015	Plot PCM_003 had lots of poison ivy. Started PCM_015.
Tuesday July 12, 2016	1 hr	4	PCM_017 PCM_020	Steep plots, low diversity.
Wednesday July 13, 2016	1 hr	4	PCM_019 PCM_018	Finished PCM_018. The middle of plot PCM_019 was diverse.
Thursday July 14, 2016	1 hr	3	PCM_015	Finished PCM_015. Lots of trees and seedlings.

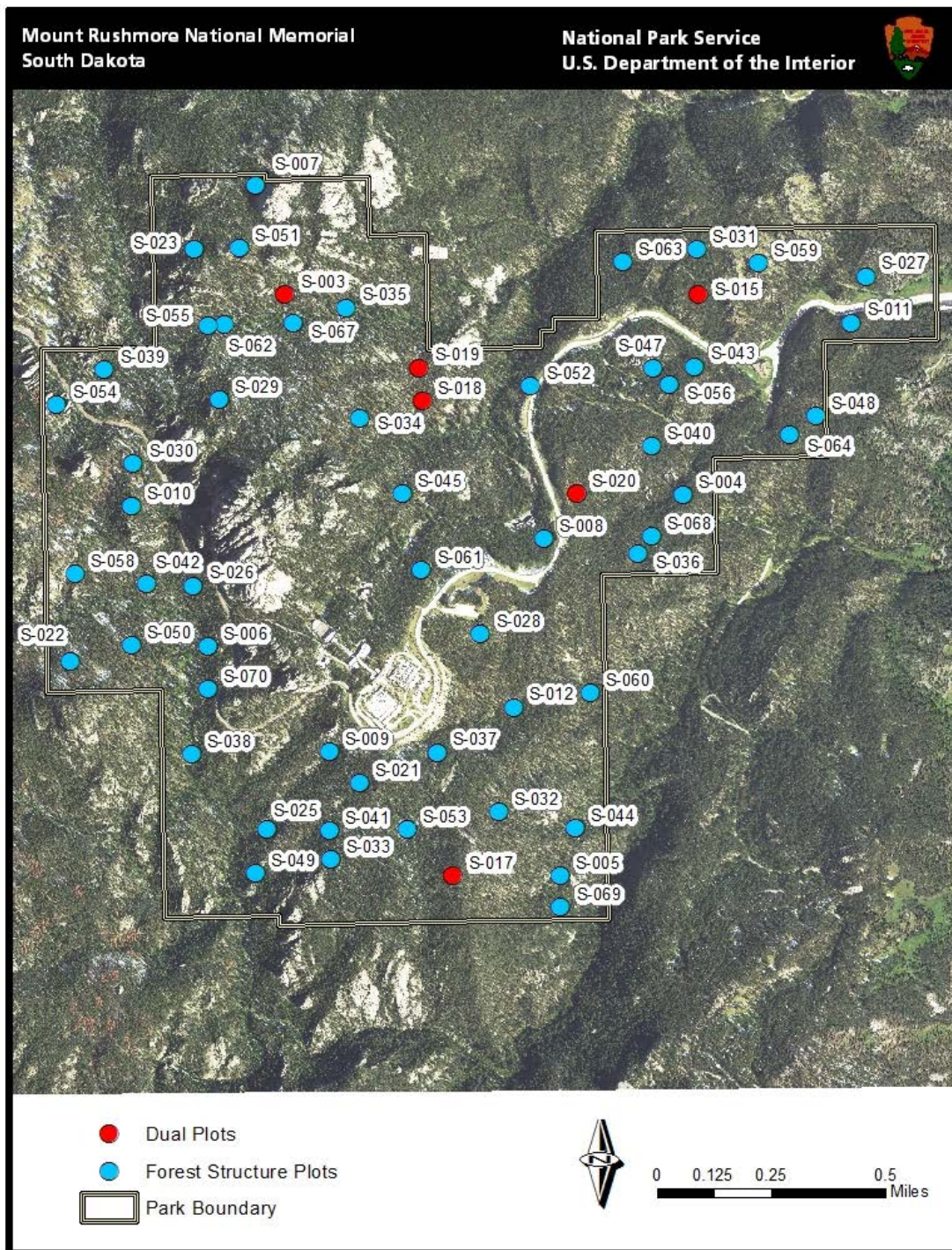


Figure 1. Map of Mount Rushmore National Memorial (MORU) plant community monitoring plots visited in 2016 by the Northern Great Plains Inventory & Monitoring Program (NGPN) and the Northern Great Plains Fire Effects Program (NGPFire). Plant Community and Forest Structure measurements were taken in 6 Dual Plots. In an additional 54 plots Forest Structure measurements only were taken.

Table 2. Field journal for Northern Great Plains Network and Northern Great Plains Fire Effects Program visits to forest structure monitoring plots at Mount Rushmore National Memorial in 2016. Most plots were surveyed with 3 or 4 crew members.

Date	Plots Read			# Plots Read
Wednesday, September 21, 2016	PCM_007 PCM_023 PCM_035	PCM_039 PCM_051 PCM_055	PCM_062 PCM_067	8
Thursday, September 22, 2016	PCM_006 PCM_022	PCM_029 PCM_030	PCM_029 PCM_030	6
Monday, September 26, 2016	PCM_010 PCM_026	PCM_038 PCM_042	PCM_058 PCM_070	6
Tuesday, September 27, 2016	PCM_009 PCM_021 PCM_025	PCM_032 PCM_033 PCM_037	PCM_041 PCM_049 PCM_053	9
Wednesday, September 28, 2016	PCM_011 PCM_027 PCM_040	PCM_043 PCM_047	PCM_052 PCM_056	7
Thursday, September 29, 2016	PCM_005	PCM_044	PCM_069	3
Tuesday, October 04, 2016	PCM_004 PCM_031	PCM_036 PCM_059	PCM_063 PCM_068	6
Wednesday, October 05, 2016	PCM_008 PCM_012	PCM_028 PCM_034	PCM_045 PCM_061	6
Thursday, October 06, 2016	PCM_060			1
Thursday, October 13, 2016	PCM_048	PCM_064		2

Plot Layout and Sampling

At each of the 6 Plant Community Monitoring sites (“Dual Plots”) visited, NGPN monitoring teams 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 and herb-layer (≤ 2 m) height and plant cover were collected on two 50 m transects (the long sides of the plot) using a point-intercept method (Figure 3). At 50 locations along each transects (every 1.0 m) a pole was dropped to the ground and all species that touched the pole were recorded, along with ground cover and the height of the top-most plant intercepted (Figure 3). Using this method, absolute canopy cover can be greater than 100% (particularly in wet years and productive sites) because we record multiple layers of plants. Species richness data from the point-intercept method were supplemented in plots read by NGPN with species presence data collected in five 1 m² quadrats located systematically along each transect (Figure 3).

When woody species were also 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 (live or dead), and condition (e.g., leaf-discoloration, insect-damaged, etc.) were recorded. When certain tall shrubs were encountered, these were measured at

root collar rather than DBH. Dead and downed woody fuel load data were collected at forested plots along two perpendicular, 100 foot (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).

For the 54 sites ("Forest Structure Plots") where Forest Structure Monitoring only occurred, seedlings and poles were measured as described above, but trees (DBH >15cm) were not tagged and only measured within the 10 m radius subplot. If there were fewer than 5 trees and poles observed of all species combined within the 10 m radius plot, the plot size was extended to 20 m radius (Figure 4) and all trees (DBH > 15 cm) within the larger area were measured. In 2016, it was necessary to extend the plot radius from 10 m to 20 m at two plots, PCM_042 and PCM_050. Dead and downed woody fuel load data were also collected at each of these forested plots.

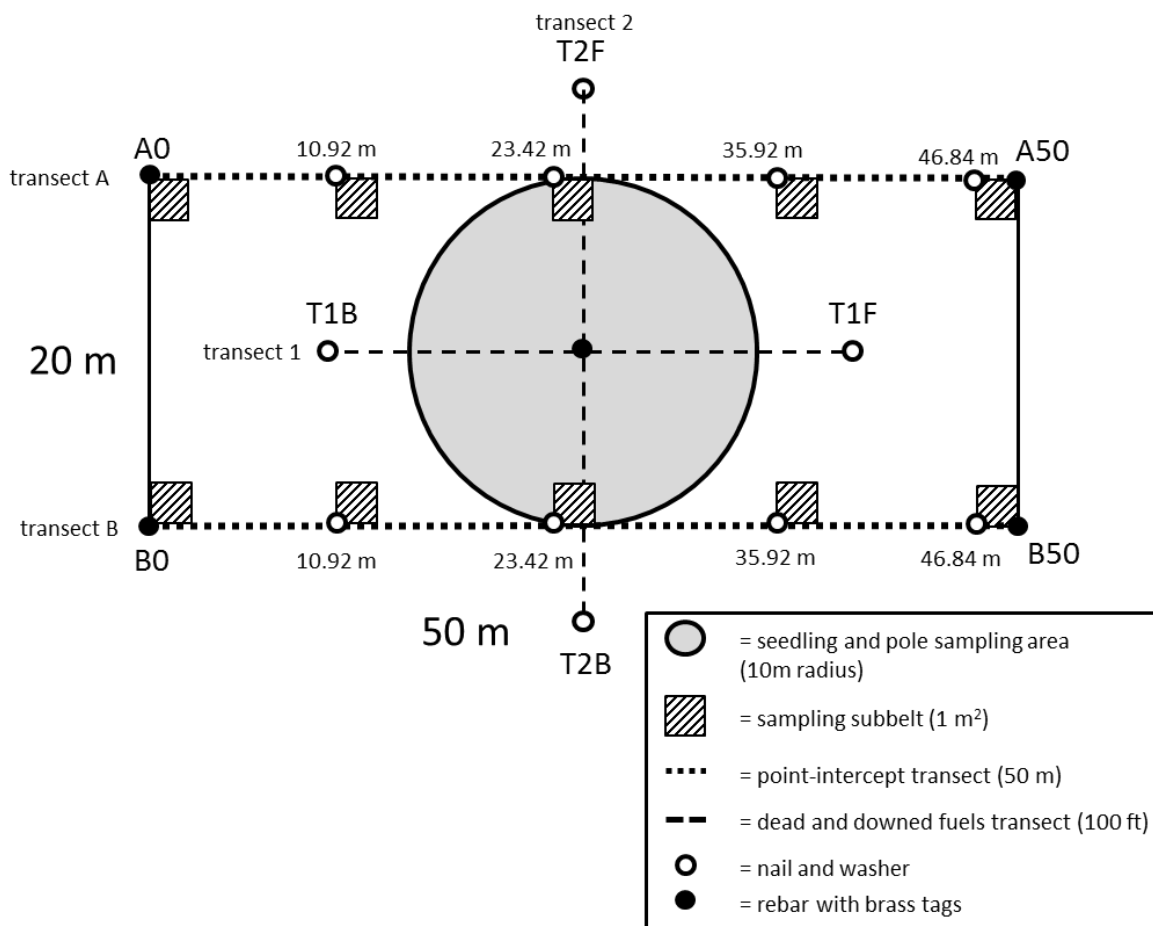


Figure 2. Long-term monitoring plot layout used for sampling vegetation in Mount Rushmore National Memorial.

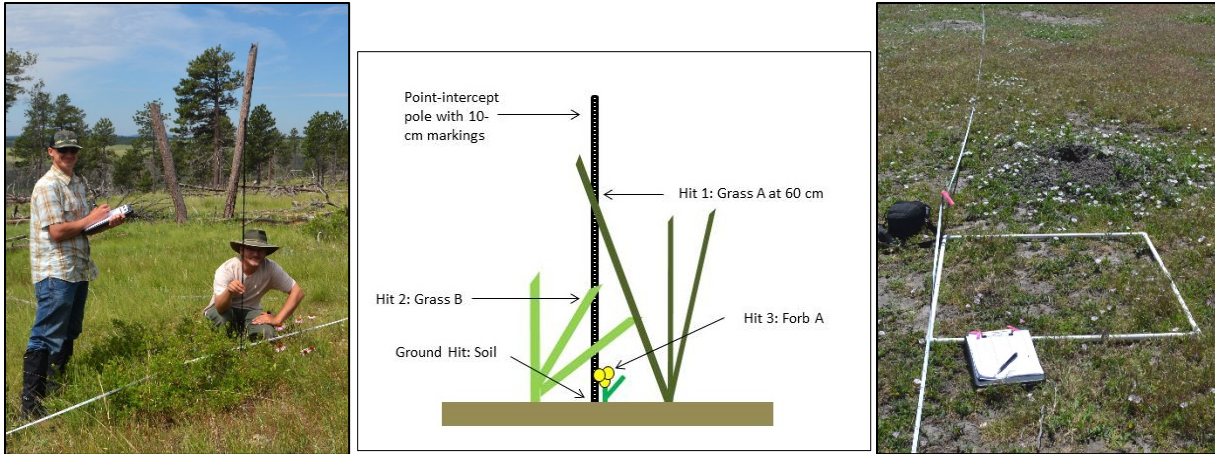


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and 1m² quadrats (right panel) to document plant diversity and abundance.

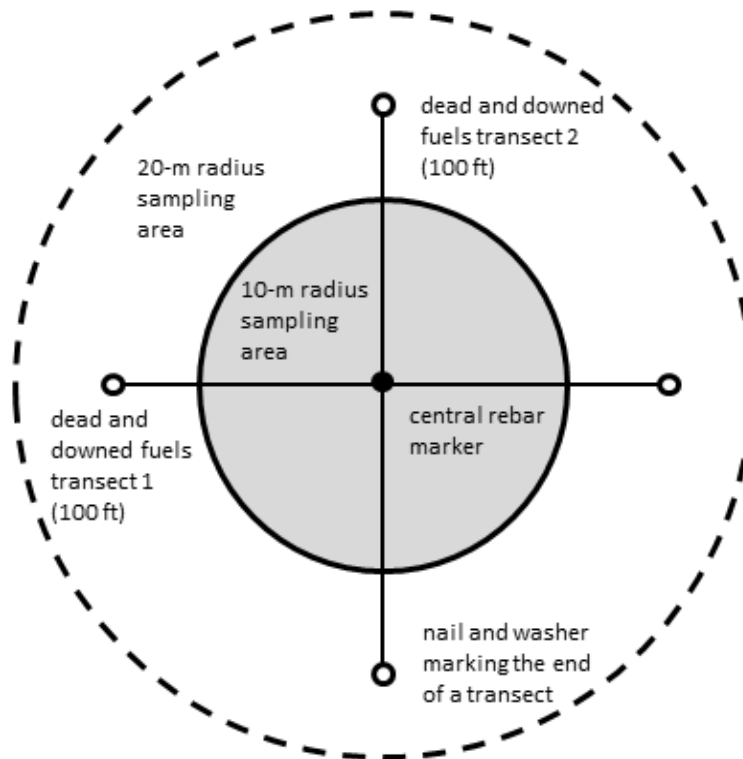


Figure 4. Forest Structure monitoring plot layout used in 60 forested plots at Mount Rushmore National Memorial.

At each plot that was visited, we surveyed the area for common disturbances and target species of interest to the park. Common disturbances included such things as animal trails, rodent mounds, and fire occurrence. For each disturbance type, the severity and approximate area (m²) was recorded. We also surveyed the area for exotic species that have the potential to spread into the park and cause significant ecological impacts (Table 3). These species were chosen in collaboration with the Midwest Invasive Plant Network, the Exotic Plant Management Team, park managers, and local weed experts. The information gathered from this procedure is critical for early detection and rapid response to such threats. In addition, all plots were thoroughly surveyed for more common exotic species of management concern at Mount Rushmore National Memorial (Table 4). 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. Crews also surveyed for plant species considered rare or vulnerable to loss in South Dakota that might occur at Mount Rushmore National Memorial (Table 5).

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

Table 4. Exotic species of management concern surveyed for at Mount Rushmore National Memorial in 2016.

Family	Scientific Name	Common Name
Apiaceae	<i>Heracleum mantegazzianum</i>	giant hogweed
Asteraceae	<i>Arctium minus</i>	common burdock
	<i>Artemisia absinthium</i>	absinth wormwood
	<i>Carduus nutans</i>	musk thistle
	<i>Centaurea diffusa</i>	diffuse knapweed
	<i>Centaurea solstitialis</i>	yellow star thistle
	<i>Centaurea stoebe</i>	spotted knapweed
	<i>Centaurea virgata</i>	squarrose knapweed
	<i>Chondrilla juncea</i>	rush skeletonweed
	<i>Cirsium arvense</i>	Canada thistle
	<i>Cirsium vulgare</i>	bull thistle
	<i>Hieracium aurantiacum</i>	orange hawkweed
	<i>Hieracium caespitosum</i>	meadow hawkweed
	<i>Onopordum acanthium</i>	Scotch thistle
	<i>Rhaponticum repens</i>	Russian knapweed/hardheads
	<i>Tanacetum vulgare</i>	common tansy
Boraginaceae	<i>Cynoglossum officinale</i>	houndstongue
Brassicaceae	<i>Alliaria petiolata</i>	garlic mustard
	<i>Isatis tinctoria</i>	Dyer's woad
	<i>Lepidium latifolium</i>	perennial pepperweed
Caryophyllaceae	<i>Gypsophila paniculata</i>	baby's breath
Clusiaceae	<i>Hypericum perforatum</i>	common St Johnswort
Dipsacaceae	<i>Dipsacus fullonum</i>	Fuller's teasel
	<i>Dipsacus laciniatus</i>	common teasel
Eleagnaceae	<i>Elaeagnus angustifolia</i>	Russian olive
Euphorbiaceae	<i>Euphorbia cyparissias</i>	cypress spurge
	<i>Euphorbia esula</i>	leafy spurge
	<i>Euphorbia myrsinites</i>	myrtle spurge
Fabaceae	<i>Pueraria montana</i> var. <i>lobata</i>	kudzu
Iridaceae	<i>Iris pseudacorus</i>	yellow iris
Lamiaceae	<i>Salvia aethiopis</i>	Mediterranean sage
Poaceae	<i>Arundo donax</i>	giant reed
	<i>Bromus inermis</i>	smooth brome
	<i>Bromus japonicus</i>	Japanese brome
	<i>Bromus tectorum</i>	cheatgrass
	<i>Taeniatherum caput-medusae</i>	medusahead
	<i>Ventenata dubia</i>	African wiregrass
Polygonaceae	<i>Polygonum cuspidatum</i>	Japanese knotweed
	<i>Polygonum sachalinense</i>	giant knotweed
	<i>Polygonum x bohemicum</i>	Bohemian knotweed
Rhamnaceae	<i>Rhamnus cathartica</i>	common buckthorn
Scrophulariaceae	<i>Linaria dalmatica</i>	Dalmatian toadflax
	<i>Linaria vulgaris</i>	yellow toadflax
	<i>Verbascum thapsus</i>	common mullein
Simaroubaceae	<i>Ailanthus altissima</i>	tree of heaven
Solanaceae	<i>Hyoscyamus niger</i>	black henbane
Tamariaceae	<i>Tamarix</i> ssp.	salt cedar

Table 5. Rare plant species surveyed for at Mount Rushmore National Memorial in 2016.

Scientific Name	Common Name
<i>Boechara divaricarpa/ Boechara holboellii</i>	limestone rockcress
<i>Botrychium multifidum</i>	leathery grapefern
<i>Carex bella</i>	elegant sedge
<i>Collinsia parviflora</i>	maiden blue-eyed Mary
<i>Cypripedium parviflorum</i>	lesser yellow lady's slipper
<i>Helianthemum bicknellii</i>	hoary frostweed
<i>Oxyria digyna</i>	alpine mountain sorrel
<i>Platanthera orbiculata</i>	lesser round-leaved orchid
<i>Viola selkirkii</i>	Selkirk's violet

Data Management and Analysis

FFI (FEAT/FIREMON Integrated; <http://frames.gov/ffi/>) was used as the primary software environment for managing the 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 2017). 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. The conservation status ranks of plant species in South Dakota is determined by the South Dakota Natural Heritage Program. For the purpose of this report, a species was considered rare if its conservation status rank was S1, S2, or S3. See Table 6 for a detailed definition of each conservation status rank.

Table 6. Definitions of state and global species conservation status ranks.

Status Rank*	Category	Definition
S1/G1	Critically imperiled	Due to extreme rarity (5 or fewer occurrences) or other factor(s) making it especially vulnerable to extirpation.
S2/G2	Imperiled	Due to rarity resulting from a very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation.
S3/G3	Vulnerable	Due to a restricted range, relatively few populations (often 80 or fewer), recent widespread declines, or other factors making it vulnerable to extirpation.
S4/G4	Apparently secure	Uncommon but not rare; some cause for concern due to declines or other factors.
S5/G5	Secure	Common, widespread and abundant.
S#S#/ G#G#	Range rank (e.g. S2S3)	Used to indicate uncertainty about the status of the species or community. Ranges cannot skip more than one rank.

* Adapted from NatureServe status assessment table (<http://www.natureserve.org/conservation-tools/conservation-status-assessment>)

After data for the sites were entered, 100% of records were verified with 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 identified by the crew or the automated queries, changes were made to the original datasheets and the FFI database as needed. Data summaries were produced using the FFI reporting and query tools. Species diversity is presented using species richness data which is simply a count of the species recorded in an area. Absolute cover was calculated from the point-intercept method, and is the total number of vegetation intercepts. This is often greater than 100% because more than one species can be intercepted per point due to overlapping vegetation. Relative cover is then calculated by dividing the absolute cover by the total absolute cover of the grouping of interest (native and exotic species in this report), and is therefore constrained between 0 and 100%.

Results

Monitoring crews identified 76 vascular plant species in upland plots visited at MORU in 2016, of which 11 were exotic species (Appendix A). No rare plant species were observed. One species, mountain ricegrass (*Piptatherum pungens*), is not on the certified park species list but there is some debate on whether it is or is not present in the park. NGPN is currently working with the Wyoming Natural Diversity Database (WYNDD) to locate voucher specimens for all species on the certified park species list. WYNDD will attempt to relocate and collect a voucher specimen of mountain ricegrass during fieldwork in 2017: if its presence can be verified, it will be added to the park species list. This effort will result in a more accurate reference for future monitoring work.

The total number of plant species observed by plot was compiled using both point-intercept and quadrat data collected (Table 7). The plot with the greatest species diversity, with a total of 42 species identified, was PCM_003, a plot located in the northern section of the park.

Absolute and relative cover were calculated using point-intercept data (Table 8). All six plots had high relative native species cover, ranging from 92% to 100%.

Ponderosa pine was the most commonly encountered tree at Mount Rushmore National Memorial in 2016 (Table 9). Nine other tree and tall shrub species were seen in the 60 forest structure plots that we surveyed. A total of 893 (808 live and 85 dead) mature trees and 494 (401 live and 93 dead) poles were measured. The largest tree found in our plots was a dead ponderosa pine located in PCM_038, measuring 75.4 cm DBH. The largest live tree found in our plots was a ponderosa pine located in PCM_039, measuring 69.0 cm DBH. Seedlings were observed in all 60 plots, and seedlings were found for all tree and tall shrub species encountered. Plot PCM_056 had the greatest ponderosa pine seedling recruitment, with an astonishing 705 seedlings counted in one quarter of a 10-m radius circle.

Table 7. Number of plant species observed at 6 plant community monitoring plots at Mount Rushmore National Memorial in 2016.

Plot Name	Exotic (number of plant species)	Native (number of plant species)	Total (number of plant species)
MORU_PCM_003	4	38	42
MORU_PCM_015	4	24	28
MORU_PCM_017	2	10	12
MORU_PCM_018	2	13	15
MORU_PCM_019	6	29	35
MORU_PCM_020	7	19	26

Table 8. Absolute and relative cover of exotic and native species observed in 6 plant community monitoring plots at Mount Rushmore National Memorial in 2016. Absolute cover includes overlapping species canopies and can be greater than 100%.

Plot Name	Absolute Cover (%)		Relative Cover (%)	
	Exotic	Native	Exotic	Native
MORU_PCM_003	0	25	0	100
MORU_PCM_015	0	9	0	100
MORU_PCM_017	0	4	0	100
MORU_PCM_018	0	6	0	100
MORU_PCM_019	1	12	8	92
MORU_PCM_020	0	11	0	100

Table 9. Number of plots with live trees, poles, and seedlings of each tree and tall shrub species seen at Mount Rushmore National Memorial during Forest Structure monitoring in 2016. A total of 60 plots were visited. (Trees: diameter at breast height (DBH) > 15 cm, poles: 2.54 cm ≤ DBH ≤ 15 cm, seedlings: DBH <2.54 cm.)

Species Name	Common Name	Number of plots with live trees	Number of plots with live poles	Number of plots with seedlings
<i>Amelanchier alnifolia</i>	serviceberry	-	1	18
<i>Betula papyrifera</i>	paper birch	3	9	17
<i>Juniperus scopulorum</i>	Rocky Mountain juniper	-	-	1
<i>Picea glauca</i>	white spruce	1	1	2
<i>Pinus ponderosa</i>	ponderosa pine	59	24	60
<i>Populus tremuloides</i>	quaking aspen	-	7	13
<i>Prunus pensylvanica</i>	pin cherry	-	1	10
<i>Prunus virginiana</i>	chokecherry	-	1	21
<i>Quercus macrocarpa</i>	bur oak	1	4	13
<i>Salix bebbiana</i>	Bebb willow	-	1	3
Total all species		60	34	60

When trees that were measured within a Plant Community or Forest Structure monitoring plot showed signs of mountain pine beetle (MPB) attack, they were given a condition code of either MPBB (MPB signs on a brown-needled tree) or MPBG (MPB signs, such as pitch tubes, on a green tree). Trees with signs of mountain pine beetle attack were recorded in 12 plots (Table 10). Plots with MPB trees were not localized in one area of the memorial.

Table 10. Plots with trees showing signs of mountain pine beetle (MPB) attack. Trees had either brown (MPBB) or green (MPBG) needles.

Plot	Number of MPBB trees	Number of MPBG trees	Total Number of MPB Trees
MORU_PCM_008	5	1	6
MORU_PCM_011		1	1
MORU_PCM_019		2	2
MORU_PCM_021	1		1
MORU_PCM_022	2		2
MORU_PCM_026	1	1	2
MORU_PCM_041	2		2
MORU_PCM_050		1	1
MORU_PCM_052		1	1
MORU_PCM_055	2		2
MORU_PCM_064			1
MORU_PCM_067	3		4
Total number of trees	16	9	25

Monitoring crews found a total of seven different target exotic species in 60 plots surveyed (Table 11). The most frequently observed target exotic species was Canada thistle. In six plots, no target exotic species were observed. None of the exotic species that are monitored as part of the early detection and rapid response program were found at Mount Rushmore National Memorial in 2016.

Table 11. Exotic target species found in plots surveyed by NGPN and NGPFire at Mount Rushmore National Memorial in 2016. A total of 60 plots were surveyed. Twelve plots had no exotic target species present.

Scientific Name	Common Name	Number of Plots
<i>Bromus inermis</i>	smooth brome	9
<i>Bromus japonicus</i>	Japanese brome	1
<i>Bromus tectorum</i>	cheatgrass	1
<i>Cirsium arvense</i>	Canada thistle	36
<i>Cirsium vulgare</i>	bull thistle	17
<i>Cynoglossum officinale</i>	houndstongue	21
<i>Verbascum thapsus</i>	common mullein	30

NGPN and NGPFire measured surface fuels in 60 plots in 2016 (Table 12). Surface fuels and dead and downed wood provide foraging habitat and refugia for small wildlife species, as well as substrate for mosses and fungi. Downed wood sometimes also provides “nursery” logs for vascular plant establishment. However, when surface fuels are too abundant in a forest they can increase the risk of

high intensity fires. NGPFire has developed a management target for surface fuels: the goal is to keep a range between 2 and 10 tons per acre within the Black Hills parks. We measured total surface fuels ranging between 3.42 tons per acre (PCM_037) and 85.10 tons per acre (PCM_026) at Mount Rushmore National Memorial.

Table 12. Surface fuels summary for 60 plots visited at Mount Rushmore National Memorial in 2016.

Plot Name	Average Tons per Acre										Avg. Depth (in.)		
	1-hr	10-hr	100-hr	1-100-hr	1000-hr sound	1000-hr rotten	1-1000-hr	Duff	Litter	Total	Duff	Litt	Total
MORU_PCM_003	0.00	0.29	2.24	2.52	4.69	0.00	7.22	16.90	4.89	29.01	1.0	1.2	2.2
MORU_PCM_004	0.02	0.55	0.73	1.29	0.00	13.10	14.39	23.86	2.36	40.60	1.4	0.6	1.9
MORU_PCM_005	0.04	0.15	2.21	2.40	3.22	4.69	10.31	13.38	2.85	26.54	0.8	0.7	1.5
MORU_PCM_006	0.06	0.14	0.00	0.20	1.66	15.59	17.45	6.69	1.62	25.76	0.4	0.4	0.8
MORU_PCM_007	0.16	1.09	0.00	1.24	1.85	3.11	6.21	22.01	3.69	31.91	1.3	0.9	2.2
MORU_PCM_008	0.08	0.95	0.00	1.03	4.05	0.53	5.61	12.50	3.63	21.74	0.7	0.9	1.6
MORU_PCM_009	0.12	0.43	0.00	0.55	0.61	2.31	3.47	9.07	0.72	13.26	0.5	0.2	0.7
MORU_PCM_010	0.02	0.00	0.00	0.02	0.00	3.92	3.94	7.92	1.62	13.48	0.5	0.4	0.9
MORU_PCM_011	0.06	0.70	0.73	1.49	0.64	0.00	2.13	6.78	0.60	9.50	0.4	0.2	0.5
MORU_PCM_012	0.12	0.56	2.97	3.65	3.25	11.10	18.00	3.43	0.60	22.03	0.2	0.2	0.3
MORU_PCM_015	0.06	0.82	0.73	1.61	0.59	1.08	3.29	16.64	5.75	25.67	0.9	1.4	2.4
MORU_PCM_017	0.06	0.70	0.00	0.77	6.81	1.90	9.47	6.87	4.13	20.47	0.4	1.0	1.4
MORU_PCM_018	0.04	1.10	1.49	2.63	0.26	0.00	2.90	14.44	2.40	19.73	0.8	0.6	1.4
MORU_PCM_019	0.10	1.23	1.47	2.80	5.62	0.00	8.43	25.44	5.27	39.14	1.4	1.3	2.8
MORU_PCM_020	0.12	0.43	0.00	0.55	5.80	10.49	16.83	19.10	4.41	40.35	1.1	1.1	2.2
MORU_PCM_021	0.04	0.27	1.46	1.77	0.00	5.18	6.96	11.53	1.68	20.17	0.7	0.4	1.1
MORU_PCM_022	0.16	1.37	0.73	2.26	5.51	2.93	10.69	20.25	1.62	32.56	1.2	0.4	1.6
MORU_PCM_023	0.06	1.23	0.00	1.29	8.56	8.44	18.30	18.22	4.69	41.21	1.0	1.2	2.2
MORU_PCM_025	0.02	0.14	1.55	1.71	10.40	29.58	41.70	8.71	1.74	52.16	0.5	0.4	0.9
MORU_PCM_026	0.02	0.00	0.73	0.75	65.08	3.34	69.17	12.50	3.43	85.10	0.7	0.9	1.6
MORU_PCM_027	0.00	0.27	0.73	1.00	0.00	4.80	5.80	6.16	1.22	13.18	0.4	0.3	0.7
MORU_PCM_028	0.06	0.00	0.78	0.84	0.50	0.00	1.35	1.85	1.38	4.57	0.1	0.3	0.5
MORU_PCM_029	0.10	0.28	1.49	1.87	8.36	5.27	15.50	8.98	1.16	25.64	0.5	0.3	0.8
MORU_PCM_030	0.08	0.68	1.47	2.23	0.00	0.00	2.23	9.15	1.84	13.22	0.5	0.5	1.0
MORU_PCM_031	0.04	1.51	2.20	3.75	3.24	8.49	15.48	9.59	4.49	29.57	0.5	1.1	1.7
MORU_PCM_032	0.02	0.30	0.81	1.13	1.11	1.58	3.82	8.27	2.00	14.09	0.5	0.5	1.0
MORU_PCM_033	0.18	0.14	0.00	0.31	7.70	9.74	17.75	17.08	1.20	36.03	1.0	0.3	1.3

Table 12, continued. Surface fuels summary for 60 plots visited at Mount Rushmore National Memorial in 2016.

Plot Name	Average Tons per Acre										Avg. Depth (in.)		
	1-hr	10-hr	100-hr	1-100-hr	1000-hr sound	1000-hr rotten	1-1000-hr	Duff	Litter	Total	Duff	Litt	Total
MORU_PCM_034	0.04	0.82	0.75	1.61	6.86	0.42	8.90	25.00	1.84	35.73	1.4	0.5	1.9
MORU_PCM_035	0.16	0.41	1.45	2.02	0.86	2.40	5.28	26.76	3.59	35.63	1.5	0.9	2.4
MORU_PCM_036	0.08	1.37	3.66	5.11	0.51	1.68	7.30	21.48	1.10	29.88	1.2	0.3	1.5
MORU_PCM_037	0.08	0.00	0.00	0.08	1.01	0.00	1.09	1.85	0.48	3.42	0.1	0.1	0.2
MORU_PCM_038	0.00	0.00	2.19	2.19	20.99	2.07	25.25	2.38	2.04	29.66	0.1	0.5	0.6
MORU_PCM_039	0.18	1.54	4.48	6.20	1.06	1.20	8.45	12.32	2.60	23.37	0.7	0.7	1.4
MORU_PCM_040	0.08	0.86	0.00	0.94	1.26	10.82	13.02	18.13	2.08	33.23	1.0	0.5	1.6
MORU_PCM_041	0.07	0.47	0.83	1.36	2.14	0.00	3.50	3.79	0.92	8.21	0.2	0.2	0.4
MORU_PCM_042	0.12	0.69	0.74	1.55	2.22	2.04	5.81	14.61	0.98	21.40	0.8	0.2	1.1
MORU_PCM_043	0.06	2.31	2.18	4.55	3.08	3.11	10.73	19.28	4.15	34.16	1.1	1.0	2.1
MORU_PCM_044	0.00	0.15	0.00	0.15	0.00	19.46	19.61	8.89	2.06	30.55	0.5	0.5	1.0
MORU_PCM_045	0.08	1.39	0.75	2.22	0.00	0.38	2.60	8.63	1.22	12.44	0.5	0.3	0.8
MORU_PCM_047	0.02	0.14	1.52	1.68	2.08	0.30	4.06	10.56	0.70	15.33	0.6	0.2	0.8
MORU_PCM_048	0.08	1.49	0.73	2.30	0.24	0.00	2.54	7.57	4.15	14.26	0.4	1.0	1.5
MORU_PCM_049	0.08	0.42	0.74	1.24	1.94	0.00	3.18	7.13	1.80	12.11	0.4	0.5	0.9
MORU_PCM_050	0.04	0.97	0.00	1.01	3.13	6.18	10.32	10.12	2.38	22.82	0.6	0.6	1.2
MORU_PCM_051	0.04	0.98	0.00	1.02	0.93	0.00	1.95	17.08	2.74	21.76	1.0	0.7	1.7
MORU_PCM_052	0.00	0.00	2.28	2.28	0.24	0.00	2.52	9.42	1.90	13.83	0.5	0.5	1.0
MORU_PCM_053	0.00	0.68	0.00	0.68	2.37	1.26	4.31	22.80	2.66	29.76	1.3	0.7	2.0
MORU_PCM_054	0.02	0.56	1.55	2.12	1.24	25.39	28.75	11.09	1.82	41.66	0.6	0.5	1.1
MORU_PCM_055	0.06	0.68	0.00	0.74	2.27	0.69	3.70	14.70	0.78	19.18	0.8	0.2	1.0
MORU_PCM_056	0.04	0.57	0.00	0.62	0.00	0.00	0.62	9.95	1.82	12.38	0.6	0.5	1.0
MORU_PCM_058	0.00	0.75	0.73	1.47	12.24	14.13	27.84	8.89	2.46	39.18	0.5	0.6	1.1
MORU_PCM_059	0.10	0.28	0.00	0.38	2.42	5.70	8.50	2.20	1.00	11.70	0.1	0.3	0.4
MORU_PCM_060	0.12	0.59	3.25	3.96	3.49	6.79	14.24	5.46	4.57	24.27	0.3	1.1	1.5
MORU_PCM_061	0.02	0.14	0.00	0.16	0.00	0.00	0.16	8.54	0.94	9.63	0.5	0.2	0.7
MORU_PCM_062	0.00	0.41	1.45	1.86	1.42	0.53	3.81	18.93	1.28	24.01	1.1	0.3	1.4
MORU_PCM_063	0.06	0.41	0.00	0.47	0.00	4.87	5.34	11.44	1.34	18.13	0.7	0.3	1.0
MORU_PCM_064	0.14	1.79	3.70	5.63	6.93	0.00	12.56	10.04	3.13	25.73	0.6	0.8	1.4
MORU_PCM_067	0.08	0.96	1.47	2.50	7.51	27.05	37.06	27.38	1.98	66.42	1.6	0.5	2.1

Table 12, continued. Surface fuels summary for 60 plots visited at Mount Rushmore National Memorial in 2016.

Plot Name	Average Tons per Acre										Avg. Depth (in.)		
	1-hr	10-hr	100-hr	1-100-hr	1000-hr sound	1000-hr rotten	1-1000-hr	Duff	Litter	Total	Duff	Litt	Total
MORU_PCM_068	0.04	0.55	0.74	1.33	0.32	2.80	4.44	10.65	3.33	18.43	0.6	0.8	1.4
MORU_PCM_069	0.06	0.42	0.74	1.22	5.13	14.09	20.45	13.20	6.83	40.48	0.8	1.7	2.5
MORU_PCM_070	0.35	0.16	0.86	1.37	0.00	0.00	1.37	8.80	3.09	13.27	0.5	0.8	1.3

Disturbances were observed in all 60 plots visited at MORU in 2016 (Table 13). Tree removal (including chipping, logging, and thinning) and fire (including prescribed fire, pile burns, and wildfire) were the most common disturbance types observed. Tree mortality due to mountain pine beetles was observed in 15 out of 60 plots.

Table 13. Disturbance types recorded in 60 plots visited within Mount Rushmore National Memorial during 2016.

Disturbance Type	Number of plots
Tree Removal	89
<i>Chipping</i>	<i>18</i>
<i>Logging</i>	<i>21</i>
<i>Thinning</i>	<i>50</i>
Fire	50
<i>Prescribed Fire</i>	<i>5</i>
<i>Pile Burn</i>	<i>12</i>
<i>Wildfire</i>	<i>33</i>
Mountain Pine Beetle	15
Animal	11
<i>Game Trail</i>	<i>2</i>
<i>Small Mammal (mounds)</i>	<i>3</i>
<i>Porcupine</i>	<i>2</i>
<i>Grazing</i>	<i>4</i>

Table 13, continued. Disturbance types recorded in 60 plots visited within Mount Rushmore National Memorial during 2016.

Disturbance Type	Number of plots
Other	16
<i>Flood</i>	<i>1</i>
<i>Erosion</i>	<i>1</i>
<i>Storm/Wind Damage</i>	<i>3</i>
<i>Road</i>	<i>2</i>
<i>Foot Trail/Vehicle Track</i>	<i>5</i>
<i>Human (trash, etc.)</i>	<i>2</i>
<i>Bulldozer Debris Field</i>	<i>1</i>
<i>Unburned Log Stacks</i>	<i>1</i>

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Appendix A: List of plant species found at MORU in 2016

Below is a list of all plant species identified in MORU long-term plant community monitoring plots in 2016. The species are grouped by plant family. An “X” in the exotic column means that the species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. The species in bold font are not on the certified species list. No plants that are rare at MORU were found in 2016.

Family	Symbol	Scientific Name	Common Name	Exotic
Anacardiaceae	TORY	<i>Toxicodendron rydbergii</i>	western poison ivy	
Apiaceae	ZIAP	<i>Zizia aptera</i>	meadow zizia	
Apocynaceae	APAN2	<i>Apocynum androsaemifolium</i>	spreading dogbane	
Asteraceae	ACMI2	<i>Achillea millefolium</i>	common yarrow	
	ANMI3	<i>Antennaria microphylla</i>	littleleaf pussytoes	
	ANPA4	<i>Antennaria parvifolia</i>	small-leaf pussytoes	
	ARLU	<i>Artemisia ludoviciana</i>	white sagebrush	
	CIAR4	<i>Cirsium arvense</i>	Canada thistle	X
	CIVU	<i>Cirsium vulgare</i>	bull thistle	X
	COCA5	<i>Conyza canadensis</i>	Canadian horseweed	
	HICA3	<i>Hieracium canadense</i>	Canadian hawkweed	
	LACA	<i>Lactuca canadensis</i>	Canada lettuce	
	PSMA11	<i>Pseudognaphalium macounii</i>	Macoun's cudweed	
	RUHI2	<i>Rudbeckia hirta</i>	blackeyed Susan	
	SERA	<i>Senecio rapifolius</i>	openwoods ragwort	
	SOMI2	<i>Solidago missouriensis</i>	Missouri goldenrod	
	SONE	<i>Solidago nemoralis</i>	gray goldenrod	
	SOSP2	<i>Solidago speciosa</i>	showy goldenrod	
	TAOF	<i>Taraxacum officinale</i>	common dandelion	X
	TRDU	<i>Tragopogon dubius</i>	yellow salsify	X
Betulaceae	BEPA	<i>Betula papyrifera</i>	paper birch	
	COCO6	<i>Corylus cornuta</i>	beaked hazelnut	
Boraginaceae	CYOF	<i>Cynoglossum officinale</i>	gypsyflower	X
Campanulaceae	CARO2	<i>Campanula rotundifolia</i>	bluebell bellflower	
	TRPE4	<i>Triodanis perfoliata</i>	clasping Venus' looking-glass	
Caprifoliaceae	SYAL	<i>Symphoricarpos albus</i>	common snowberry	
	SYOC	<i>Symphoricarpos occidentalis</i>	western snowberry	
Caryophyllaceae	CEFO2	<i>Cerastium fontanum</i>	common mouse-ear chickweed	X
Cupressaceae	JUCO6	<i>Juniperus communis</i>	common juniper	
	JUSC2	<i>Juniperus scopulorum</i>	Rocky Mountain juniper	
Cyperaceae	CABR10	<i>Carex brevior</i>	shortbeak sedge	
	CAFO3	<i>Carex foenea</i>	dryspike sedge	
	CAIN9	<i>Carex inops</i>	long-stolon sedge	
	CARI	<i>Carex richardsonii</i>	Richardson's sedge	

Family	Symbol	Scientific Name	Common Name	Exotic
	CAR05	<i>Carex rossii</i>	Ross' sedge	
Dryopteridaceae	CYFR2	<i>Cystopteris fragilis</i>	brittle bladderfern	
	WOSC	<i>Woodsia scopulina</i>	Rocky Mountain woodsia	
Ericaceae	ARUV	<i>Arctostaphylos uva-ursi</i>	kinnikinnick	
Fabaceae	AMCA6	<i>Amorpha canescens</i>	leadplant	
	ASLA27	<i>Astragalus laxmannii</i>	Laxmann's milkvetch	
	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	
	LAOC2	<i>Lathyrus ochroleucus</i>	cream pea	
	THRH	<i>Thermopsis rhombifolia</i>	prairie thermopsis	
	VIAM	<i>Vicia americana</i>	American vetch	
Fagaceae	QUMA2	<i>Quercus macrocarpa</i>	bur oak	
Grossulariaceae	RICE	<i>Ribes cereum</i>	wax currant	
Liliaceae	MAST4	<i>Maianthemum stellatum</i>	starry false lily of the valley	
Onagraceae	CHAN9	<i>Chamerion angustifolium</i>	fireweed	
Pinaceae	PIGL	<i>Picea glauca</i>	white spruce	
	PIPO	<i>Pinus ponderosa</i>	ponderosa pine	
Poaceae	AGHY	<i>Agrostis hyemalis</i>	winter bentgrass	
	AGSC5	<i>Agrostis scabra</i>	rough bentgrass	
	ANGE	<i>Andropogon gerardii</i>	big bluestem	
	BRIN2	<i>Bromus inermis</i>	smooth brome	X
	BRJA	<i>Bromus japonicus</i>	Japanese brome	X
	BRTE	<i>Bromus tectorum</i>	cheatgrass	X
	DASP2	<i>Danthonia spicata</i>	poverty oatgrass	
	DICHA2	<i>Dichanthelium</i>	rosette grass	
	DILE2	<i>Dichanthelium leibergii</i>	Leiberg's panicum	
	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	
	KOMA	<i>Koeleria macrantha</i>	prairie Junegrass	
	MURA	<i>Muhlenbergia racemosa</i>	marsh muhly	
	ORAS	<i>Oryzopsis asperifolia</i>	roughleaf ricegrass	
	PIPU7	<i>Piptatherum pungens</i>	mountain ricegrass	
	SCSC	<i>Schizachyrium scoparium</i>	little bluestem	
Primulaceae	PRPA99	<i>Primula pauciflora</i>	darkthroat shootingstar	
Rosaceae	AMAL2	<i>Amelanchier alnifolia</i>	Saskatoon serviceberry	
	DRFI3	<i>Drymocallis fissa</i>	bigflower cinquefoil	
	PRPE2	<i>Prunus pensylvanica</i>	pin cherry	
	PRVI	<i>Prunus virginiana</i>	chokecherry	
	SPBE2	<i>Spiraea betulifolia</i>	white spirea	
Salicaceae	POTR5	<i>Populus tremuloides</i>	quaking aspen	
	SABE2	<i>Salix bebbiana</i>	Bebb willow	
Scrophulariaceae	VETH	<i>Verbascum thapsus</i>	common mullein	X
Selaginellaceae	SERU	<i>Selaginella rupestris</i>	northern selaginella	
Violaceae	VIOLA	<i>Viola</i> spp.	violet	X

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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