



Plant Community Composition and Structure Monitoring for Theodore Roosevelt National Park

2017 Data Report

Natural Resource Data Series NPS/NGPN/NRDS—2018/1169





ON THIS PAGE

Liatris punctata; Theodore Roosevelt National Park (North Unit), July 2017.
Photograph courtesy of National Park Service.

ON THE COVER

Crew members navigating to a monitoring plot, 2017
Photograph courtesy of the National Park Service

Plant Community Composition and Structure Monitoring for Theodore Roosevelt National Park

2017 Data Report

Natural Resource Data Series NPS/NGPN/NRDS—2018/1169

Ryan M. Manuel

National Park Service
Northern Great Plains Inventory & Monitoring Network
231 E. St. Joseph Street
Rapid City, SD 57701

May 2018

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

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

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

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.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from [Northern Great Plains Inventory & Monitoring website](#) and the [Natural Resource Publications Management website](#). If you have difficulty accessing information in this publication, particularly if using assistive technology, please email irma@nps.gov.

Please cite this publication as:

Manuel, R. M. 2018. Plant community composition and structure monitoring for Theodore Roosevelt National Park: 2017 data report. Natural Resource Data Series NPS/NGPN/NRDS—2018/1169. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	iv
Tables.....	iv
Abstract.....	v
Acknowledgments.....	vi
Introduction.....	1
Methods.....	3
Sample Design.....	3
Plot Layout and Sampling	4
Data Management and Analysis	6
Results.....	9
Further Analysis.....	23
Literature Cited	25

Figures

	Page
Figure 1. Map of the plant community monitoring plots surveyed in 2017 in the north unit (top) and south unit (bottom) of Theodore Roosevelt National Park.	2
Figure 2. Long-term monitoring plot layout used for sampling vegetation in Theodore Roosevelt National Park.	5
Figure 3. The Northern Great Plains Network Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and 1m ² quadrats (right panel) to document plant diversity and abundance.....	5
Figure 4. Transect photo of plot PCM_0003 at Theodore Roosevelt National Park (South Unit), July 2017. Photograph courtesy of the National Park Service.	19

Tables

	Page
Table 1. Vegetation monitoring field schedule in Theodore Roosevelt National Park during the 2017 field season..	3
Table 2. Exotic species surveyed for at Theodore Roosevelt National Park as part of the early detection and rapid response program within the Northern Great Plains Network.	6
Table 3. List of all plant species identified in THRO long-term plant community monitoring plots in 2017.....	9
Table 4. Number of plant species per plot observed in 21 plant community monitoring (PCM) plots and 4 fire plant community monitoring plots (FPCM) at Theodore Roosevelt National Park in 2017.	15
Table 5. Absolute cover of native and exotic species in plots monitored at Theodore Roosevelt National Park in 2017	16
Table 6. Number of trees and tall shrubs by plot and DBH class in twelve plant community monitoring plots (PCM) at Theodore Roosevelt National Park.....	17
Table 7. Surface fuels summary from the seven PCM plots containing measurable surface fuels in 2017 at Theodore Roosevelt National Park.....	20
Table 8. Disturbance types and area sizes recorded in twenty plots visited within Theodore Roosevelt National Park during 2017.....	21

Abstract

This report presents the results of vegetation monitoring efforts in 2017 at Theodore Roosevelt National Park (THRO) by the Northern Great Plains Inventory and Monitoring Network (NGPN), along with Northern Great Plains Fire Ecology Program (NGPFEP).

During the seventh full year of field work, crew members from NGPN visited 20 plant community monitoring plots to collect data on the vegetation at THRO. This is part of a long-term monitoring effort that aspires to sample 20 of 140 randomly located upland plots every year, so that each plot is visited for two consecutive years and then rested for eight years, on a ten-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 20 plots. During the 2017 season, NGPFEP visited an additional four fire plant community monitoring plots and one plant community monitoring plot. NGPFEP collected data on herb-layer height, native and exotic species abundance, and ground cover in the Northwest section of THRO. All data collected by NGPN and NGPFEP in 2017 is included in this report.

Our 2017 findings can be summarized as follows: The crews observed 185 vascular plant species, of those species, 24 were exotic. Grasses, sedges, and forbs made up the bulk of the plant cover. Native plant diversity was considerably higher, and exotic plant cover lower, in the upland areas than in the riparian areas. Eight species of tree and tall shrub species were observed, and woody fuel loads were moderate in the areas where they were found. Overall, the park's vegetation seems to be in good condition, though exotic plants remain a significant challenge to park management.

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 THRO for providing logistical support and safety checks, particularly the law enforcement team. We thank J. Folluo for volunteering and helping with lots of fieldwork. The 2017 NGPN vegetation field crew of I. Ashton, C. Davis, S. Rockwood, M. Davis, L. LaFleur, R. Manuel, and R. Oltjenbruns and the NGPFEP crew of D. Swanson, M. Whitman, I. Muirhead, and T. Schaffner collected all the data included in this report.

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.

Located in southwestern North Dakota, Theodore Roosevelt National Park (THRO) encompasses 70,477 acres in the Little Missouri River Badlands. THRO is composed of three discrete management units, each of which is a patchwork of mixed-grass prairie, clay buttes, bottomland forest, and open shrublands. The three park units (North, South, and Elkhorn Ranch Site) are connected by the Little Missouri River. The park would like more information regarding the condition of native grasslands and woody draws because of the large number of exotic species, but a lack of data in the past made estimates of condition in these and other plant communities difficult (Amberg et al. 2014). The Northern Great Plains Inventory & Monitoring Program (NGPN) began vegetation monitoring efforts in THRO in 2011 (Ashton et al. 2012). Vegetation monitoring protocols and plot locations were chosen to represent the north and south unit and to coordinate efforts with the Northern Great Plains Fire Ecology Program (NGPFEP). The long-term objectives of the NGPN plant community monitoring effort (Symstad et al. 2012b) in THRO 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-year intervals) and long-term trends of tree density by species, height class, and diameter class in the riparian forest.
3. Improve our understanding of the effects of external drivers and management actions on plant community species composition and structure by correlating changes in vegetation composition and structure with changes in climate, landscape patterns, atmospheric chemical composition, fire, and invasive plant control.

This report is intended to provide a timely release of basic data sets and data summaries from our sampling efforts at THRO in 2017, our seventh year of sampling vegetation. NGPN visited 20 plots in the south unit and north unit, and the NGPFEP visited 5 plots in the north unit (Figure 1).

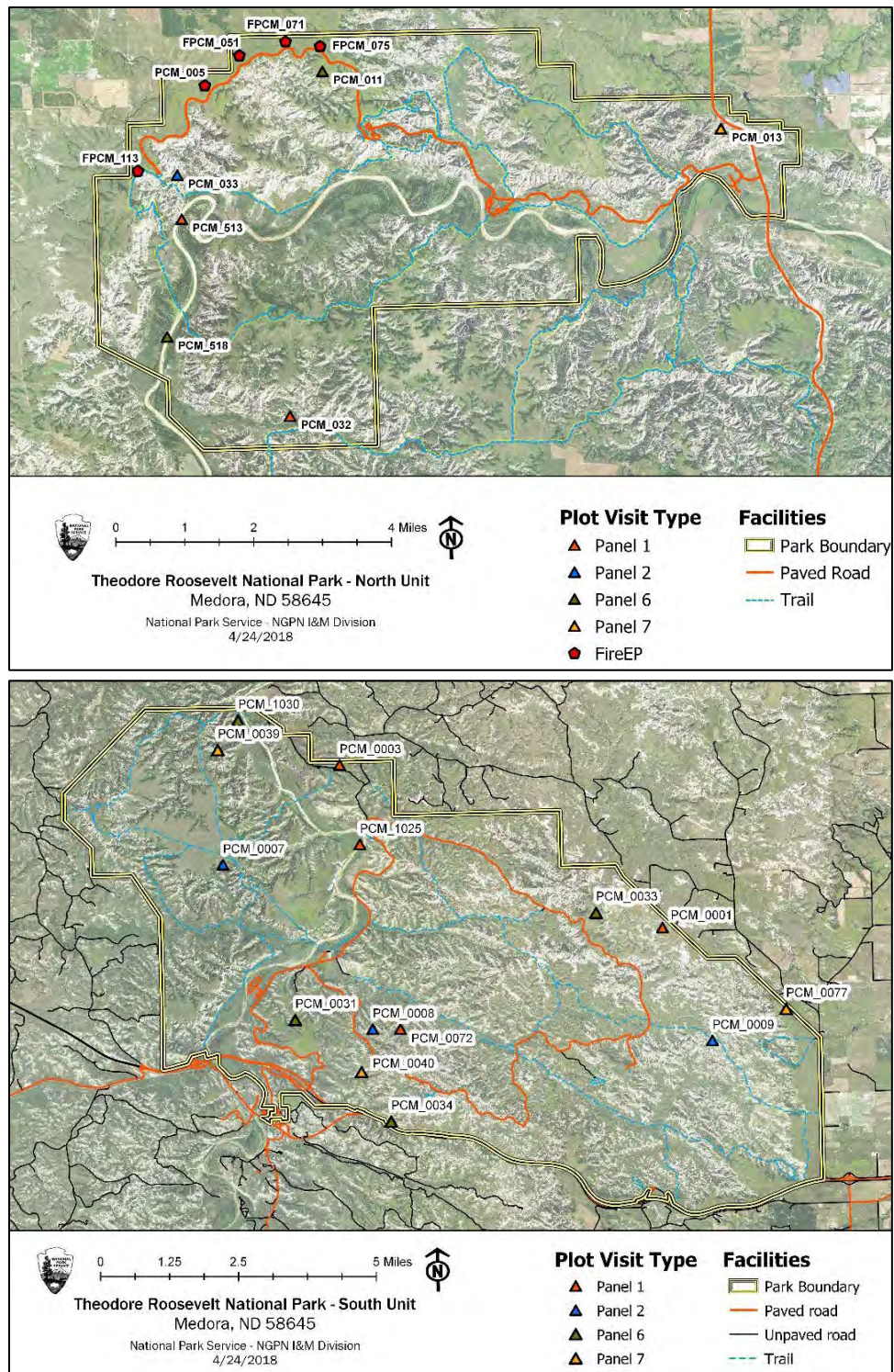


Figure 1. Map of the plant community monitoring plots surveyed in 2017 in the north unit (top) and south unit (bottom) of Theodore Roosevelt National Park. In the north unit, THRON_PCM_005 was surveyed by the Northern Great Plains Fire Effects Program.

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 THRO using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003, 2004). Using a GRTS design, we selected 50 randomly located sites within the north unit of THRO and 90 randomly located sites in the south unit. We split these 140 sites into 10 panels with 14 sites each. We hoped to visit two panels (28 sites) every year. However due to logistical constraints on the NGPN and Fire Ecology Programs, the number of anticipated sites visit per year was reduced to 20. In 2017, all 20 sites were successfully visited during the last 10 days of July and second week of August. 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.

Table 1. Vegetation monitoring field schedule in Theodore Roosevelt National Park during the 2017 field season. The 20 PCM monitoring plots were completed with a crew of two or more from the Northern Great Plains Network. FPCM plots along with PCM_005 were completed by the Fire Effects Program. Notes include crew size, time spent at each plot, and additional plot information.

Date Visited	Plot	Notes
7/22/2017	FPCM-051	Crew of 4; 2 hrs, Point-Intercept Only
7/22/2017	FPCM-071	Crew of 4; 2 hrs, Point-Intercept Only
7/22/2017	FPCM-075	Crew of 4; 2 hrs, Point-Intercept Only
7/22/2017	PCM-005	Crew of 4; 2 hrs, Point-Intercept Only
7/23/2017	FPCM-113	Crew of 4; 2 hrs, Point-Intercept Only
7/24/2017	PCM-011	Crew of 4; 2 hrs
7/25/2017	PCM-013	Crew of 4; Rejected & Uninstalled; 8 hrs
7/26/2017	PCM-032	Crew of 4; 5.5 hrs
7/27/2017	PCM-518	Crew of 4; 8.5 hrs
7/27/2017	PCM-033	Crew of 4; 4 hrs
7/28/2017	PCM-0033	Crew of 3 + J. Folluo (THRO intern/ volunteer); 5 hrs
7/28/2017	PCM-513	Crew of 4; 2 hrs
7/29/2017	PCM-0039	Crew of 3 + J. Folluo (THRO intern/ volunteer); 8 hrs
7/30/2017	PCM-0008	Crew of 3; 4 hrs
7/30/2017	PCM-0009	Crew of 3; 5 hrs
7/31/2017	PCM-0001	Crew of 3; 2.5 hrs
8/7/2017	PCM-0031	Crew of 3; 3 hrs

Table 1 (continued). Vegetation monitoring field schedule in Theodore Roosevelt National Park during the 2017 field season. The 20 PCM monitoring plots were completed with a crew of two or more from the Northern Great Plains Network. FPCM plots along with PCM_005 were completed by the Fire Effects Program. Notes include crew size, time spent at each plot, and additional plot information.

Date Visited	Plot	Notes
8/7/2017	PCM-0072	Crew of 2 + C. Serratos (NGPN-GIS Tech); 3 hrs
8/8/2017	PCM-0003	Crew of 3; 2.5 hrs
8/8/2017	PCM-0034	Crew of 2 + C. Serratos (NGPN-GIS Tech) & J. Folluo (THRO intern/ volunteer) 3.5 hrs
8/8/2017	PCM-0040	Crew of 2 + C. Serratos (NGPN-GIS Tech) & J. Folluo (THRO intern/ volunteer); 3.5 hrs
8/8/2017	PCM-1030	Crew of 3; 3 hrs
8/9/2017	PCM-0007	Crew of 2 + C. Serratos (NGPN-GIS Tech); 3.75 hrs
8/9/2017	PCM-0077	Crew of 3; 2.75 hrs
8/9/2017	PCM-1025	Crew of 3; 2.5 hrs

Plot Layout and Sampling

At each of the sites visited, monitoring crews 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 along two 50 m transects (the long sides of the plot) using a point-intercept method. At 50 locations along each transect, once every 1 meter, a pole was dropped to the ground and all species that touched the pole were recorded, along with ground cover and canopy height (Figure 3). Species richness data from the point-intercept method were supplemented with species presence data collected in five 1 m² quadrats located systematically along each transect (Figure 2 and Figure 3). In FPCM plots, data from quadrats were not collected.

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. Junipers are tagged and measured at root collar, rather than breast height. In juniper and cottonwood forests, 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). 2013 was the first year that NGPN collected fuels data in THRO.

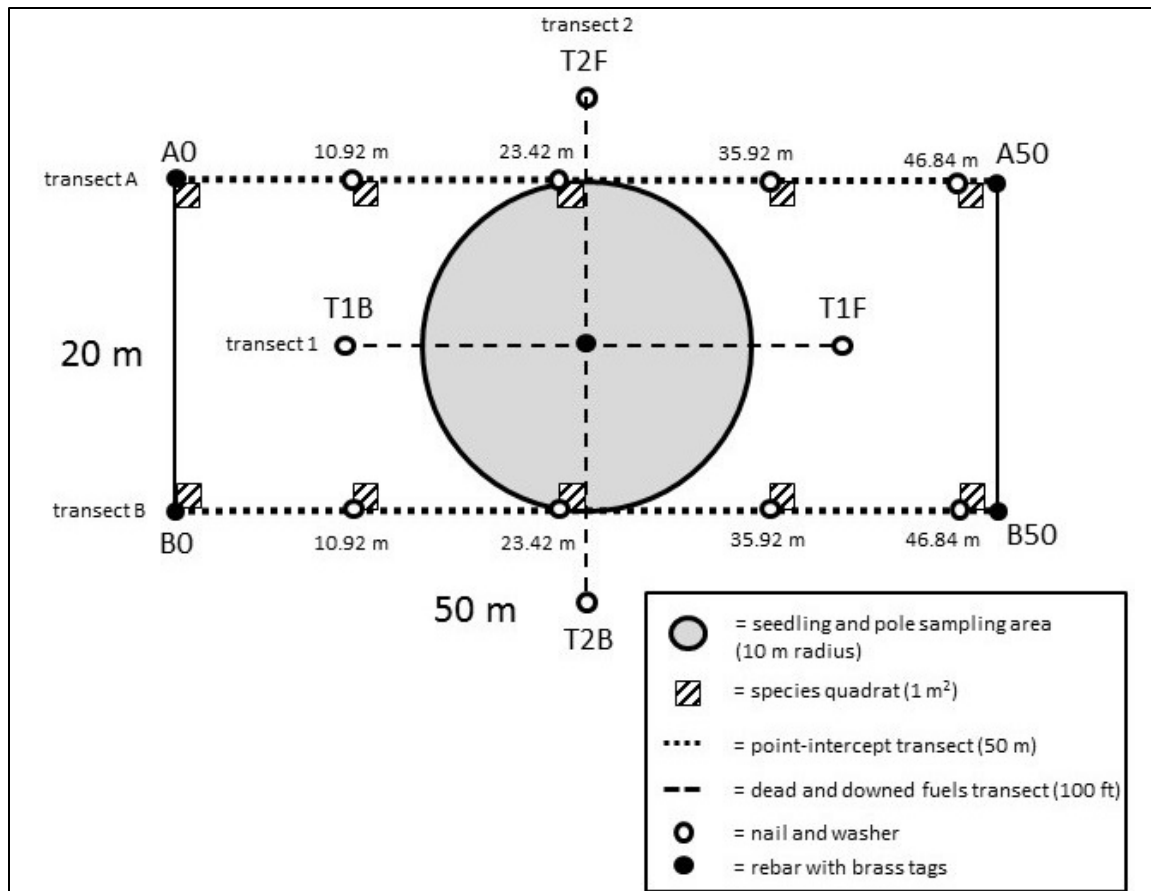


Figure 2. Long-term monitoring plot layout used for sampling vegetation in Theodore Roosevelt National Park.

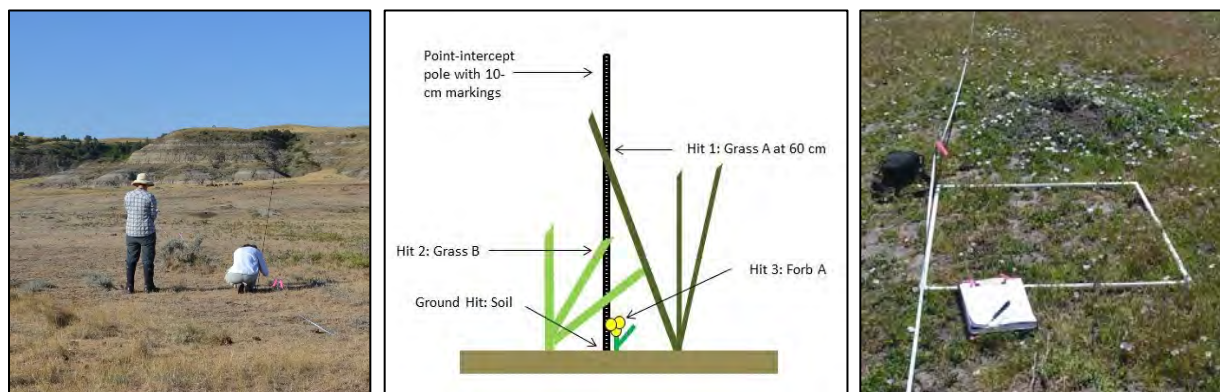


Figure 3. The Northern Great Plains Network Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and 1m² quadrats (right panel) to document plant diversity and abundance.

At all plots, we also surveyed the area for common disturbances and target species of interest to the park. Common disturbances included such things as roads, rodent mounds, animal trails, and fire. For all plots, the type and severity of the disturbances were recorded. We also surveyed the area for exotic species that have the potential to spread into the park and cause significant ecological impacts

(Table 2). 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.

Table 2. Exotic species surveyed for at Theodore Roosevelt National Park 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 aethiopsis</i>	Mediterranean sage	Upland
<i>Ventenata dubia</i>	African wiregrass	Upland

Data Management and Analysis

FFI (FEAT/FIREMON Integrated; <http://frames.gov/ffi/>) was the primary software environment used 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, common names, and native status are from the USDA Plants Database (USDA-NRCS 2017). However, nomenclature follows the [Integrated Taxonomic Information System](#) (ITIS). 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. In the case where there is not enough evidence for genus and species identification, a special code for the

unknown species was created. These are then designated as an exotic species in the total count, but omitted from the species list.

After data were entered in the database, 100% of records were verified with the original data sheets to minimize transcription errors, followed by a 10% review of records to confirm accuracy. After all data were entered and verified, automated queries were used to check for any remaining errors in the data. When errors were identified by the crew or the automated queries, corrections were made to the original datasheets and the FFI database.

Data summaries were produced using the FFI reporting and query tools. The number of species encountered in each plot was calculated using data from point-intercept, quadrat, woody species, and target species protocols. Absolute cover was calculated using point-intercept data 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.

The conservation status rank of plant species observed at THRO in 2017 was determined by cross-referencing with the NatureServe conservation status list, as well as the North Dakota rare plant species list and the list of rare species which may potentially occur in THRO or have been documented in the park (Heidel 1990). For the purpose of this report, a species was considered rare or of conservation concern if the state or global conservation status rank was critically imperiled (S1/G1), imperiled (S2/G2), or vulnerable (S3/G3). More information on conservation ranks can be found at the [NatureServe](#) website. The 2017 species list was also cross-referenced with the list of noxious weeds maintained by the [North Dakota Department of Agriculture](#).

Results

There are a total of 600 plant species recorded on the THRO species list, and monitoring crews recorded 185 species across 25 monitoring plots visited in 2017 at THRO (Table 3). Of the plant species observed, 24 are exotic species at THRO. All exotics recorded were either forbs or graminoids (grasses, sedges, and rushes). All identified trees and shrubs were native species. There was one unidentified shrub which we conservatively categorized as exotic. No target early detection exotic species were documented in 2017 (Table 2). One rare species, *Oxytropis sericea*, was recorded in the 2017 visits to THRO. *O. sericea*'s state conservation status rank is listed as (S1) critically imperiled.

Table 3. List of all plant species identified in THRO long-term plant community monitoring plots in 2017. The species are grouped by plant family. In the notes column 'S1' represents a rare species with a state conservation status rank (S1) critically imperiled and G5 indicates it is globally secure. 'Exotic' means that 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. Species on North Dakota's list of noxious species are indicated with 'ND'. An en-dash in the notes column is indicative of a native species.

Family	Code	Scientific	Common Name	Notes
Agavaceae	YUGL	<i>Yucca glauca</i>	soapweed yucca	–
Amaranthaceae	STDI99	<i>Stutzia dioica</i>	suckleys saltbush	–
Anacardiaceae	RHTR	<i>Rhus trilobata</i>	skunkbush sumac	–
Anacardiaceae	TORY	<i>Toxicodendron rydbergii</i>	western poison ivy	–
Apocynaceae	APCA	<i>Apocynum cannabinum</i>	Indianhemp	–
Asclepiadaceae	ASSP	<i>Asclepias speciosa</i>	showy milkweed	–
Asteraceae	ACMI2	<i>Achillea millefolium</i>	common yarrow	–
Asteraceae	AMAR2	<i>Ambrosia artemisiifolia</i>	annual ragweed	Exotic
Asteraceae	AMPS	<i>Ambrosia psilostachya</i>	Cuman ragweed	–
Asteraceae	ANTEN	<i>Antennaria</i>	pussytoes	–
Asteraceae	ANMI3	<i>Antennaria microphylla</i>	littleleaf pussytoes	–
Asteraceae	ANPA4	<i>Antennaria parvifolia</i>	small-leaf pussytoes	–
Asteraceae	ARCA12	<i>Artemisia campestris</i>	field sagewort	–
Asteraceae	ARCA13	<i>Artemisia cana</i>	silver sagebrush	–
Asteraceae	ARDR4	<i>Artemisia dracunculus</i>	tarragon	–
Asteraceae	ARFR4	<i>Artemisia frigida</i>	prairie sagewort	–
Asteraceae	ARLU	<i>Artemisia ludoviciana</i>	white sagebrush	–
Asteraceae	ARTR2	<i>Artemisia tridentata</i>	big sagebrush	–
Asteraceae	CIAR4	<i>Cirsium arvense</i>	Canada thistle	ND
Asteraceae	CIFL	<i>Cirsium flodmanii</i>	Flodman's thistle	–
Asteraceae	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle	–
Asteraceae	COCA5	<i>Conyza canadensis</i>	Canadian horseweed	–

Table 3 (continued). List of all plant species identified in THRO long-term plant community monitoring plots in 2017. The species are grouped by plant family. In the notes column 'S1' represents a rare species with a state conservation status rank (S1) critically imperiled and G5 indicates it is globally secure. 'Exotic' means that 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. Species on North Dakota's list of noxious species are indicated with 'ND'. An en-dash in the notes column is indicative of a native species.

Family	Code	Scientific	Common Name	Notes
Asteraceae	DICA18	<i>Dieteria canescens</i>	hoary tansyaster	–
Asteraceae	ECAN2	<i>Echinacea angustifolia</i>	blacksamson echinacea	–
Asteraceae	ERNA10	<i>Ericameria nauseosa</i>	rubber rabbitbrush	–
Asteraceae	ERIGE2	<i>Erigeron</i>	fleabane	–
Asteraceae	ERCA4	<i>Erigeron canus</i>	hoary fleabane	–
Asteraceae	ERST3	<i>Erigeron strigosus</i>	prairie fleabane	–
Asteraceae	GRSQ	<i>Grindelia squarrosa</i>	curlycup gumweed	–
Asteraceae	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed	–
Asteraceae	HELIA3	<i>Helianthus</i>	sunflower	–
Asteraceae	HEPA19	<i>Helianthus pauciflorus</i>	stiff sunflower	–
Asteraceae	HEVI4	<i>Heterotheca villosa</i>	hairy false goldenaster	–
Asteraceae	LIPU	<i>Liatris punctata</i>	dotted blazing star	–
Asteraceae	LYJU	<i>Lygodesmia juncea</i>	rush skeletonplant	–
Asteraceae	MUOB99	<i>Mulgedium oblongifolium</i>	blue lettuce	–
Asteraceae	RACO3	<i>Ratibida columnifera</i>	upright prairie coneflower	–
Asteraceae	SOLID	<i>Solidago</i>	goldenrod	–
Asteraceae	SOCA6	<i>Solidago canadensis</i>	Canada goldenrod	–
Asteraceae	SOMI2	<i>Solidago missouriensis</i>	Missouri goldenrod	–
Asteraceae	SOMO	<i>Solidago mollis</i>	velvety goldenrod	–
Asteraceae	SONE	<i>Solidago nemoralis</i>	gray goldenrod	–
Asteraceae	SORI2	<i>Solidago rigida</i>	stiff goldenrod	–
Asteraceae	SOAR2	<i>Sonchus arvensis</i>	field sowthistle	Exotic
Asteraceae	SYMPH4	<i>Symphyotrichum</i>	aster	–
Asteraceae	SYER	<i>Symphyotrichum ericoides</i>	white heath aster	–
Asteraceae	SYLA3	<i>Symphyotrichum laeve</i>	smooth blue aster	–
Asteraceae	SYOB	<i>Symphyotrichum oblongifolium</i>	aromatic aster	–
Asteraceae	TAOF	<i>Taraxacum officinale</i>	common dandelion	Exotic
Asteraceae	TEAC	<i>Tetraneuris acaulis</i>	stemless four-nerve daisy	–
Asteraceae	TRDU	<i>Tragopogon dubius</i>	yellow salsify	Exotic
Asteraceae	XASP99	<i>Xanthisma spinulosum</i>	lacy tansyaster	–
Boraginaceae	LAOC3	<i>Lappula occidentalis</i>	flatspine stickseed	–
Boraginaceae	LASQ	<i>Lappula squarrosa</i>	European stickseed	Exotic

Table 3 (continued). List of all plant species identified in THRO long-term plant community monitoring plots in 2017. The species are grouped by plant family. In the notes column 'S1' represents a rare species with a state conservation status rank (S1) critically imperiled and G5 indicates it is globally secure. 'Exotic' means that 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. Species on North Dakota's list of noxious species are indicated with 'ND'. An en-dash in the notes column is indicative of a native species.

Family	Code	Scientific	Common Name	Notes
Boraginaceae	LIIN2	<i>Lithospermum incisum</i>	narrowleaf stoneseed	–
Brassicaceae	ALDE	<i>Alyssum desertorum</i>	desert madwort	Exotic
Brassicaceae	ARDR	<i>Arabis drummondii</i>	Drummond's rockcress	–
Brassicaceae	BOHO99	<i>Boechera holboellii</i>	Holboell's rockcress	–
Brassicaceae	CAMI2	<i>Camelina microcarpa</i>	littlepod false flax	Exotic
Brassicaceae	DEPI	<i>Descurainia pinnata</i>	western tansymustard	–
Brassicaceae	ERYSI	<i>Erysimum</i>	wallflower	Exotic
Brassicaceae	PHYSA2	<i>Physaria</i>	twinpod	–
Brassicaceae	PHLU99	<i>Physaria ludoviciana</i>	foothill bladderpod	–
Cactaceae	ESVI2	<i>Escobaria vivipara</i>	spinystar	–
Cactaceae	OPPO	<i>Opuntia polyacantha</i>	plains pricklypear	–
Campanulaceae	CARO2	<i>Campanula rotundifolia</i>	bluebell bellflower	–
Caprifoliaceae	SYOC	<i>Symphoricarpos occidentalis</i>	western snowberry	–
Caryophyllaceae	CEAR4	<i>Cerastium arvense</i>	field chickweed	–
Chenopodiaceae	ATCA2	<i>Atriplex canescens</i>	fourwing saltbush	–
Chenopodiaceae	ATCO	<i>Atriplex confertifolia</i>	shadscale saltbush	–
Chenopodiaceae	CHENO	<i>Chenopodium</i>	goosefoot	Exotic
Chenopodiaceae	CHDE	<i>Chenopodium desiccatum</i>	aridland goosefoot	–
Chenopodiaceae	KRLA2	<i>Krascheninnikovia lanata</i>	winterfat	–
Chenopodiaceae	SATR12	<i>Salsola tragus</i>	prickly Russian thistle	Exotic
Chenopodiaceae	SAVE4	<i>Sarcobatus vermiculatus</i>	greasewood	–
Chenopodiaceae	SUNI	<i>Suaeda nigra</i>	mojave seablight	–
Cupressaceae	JUCO6	<i>Juniperus communis</i>	common juniper	–
Cupressaceae	JUHO2	<i>Juniperus horizontalis</i>	creeping juniper	–
Cupressaceae	JUSC2	<i>Juniperus scopulorum</i>	Rocky Mountain juniper	–
Cyperaceae	BOMA7	<i>Bolboschoenus maritimus</i>	cosmopolitan bulrush	–
Cyperaceae	CAREX	<i>Carex</i>	sedge	–
Cyperaceae	CADU6	<i>Carex duriuscula</i>	needleleaf sedge	–
Cyperaceae	CAEB2	<i>Carex eburnea</i>	bristleleaf sedge	–
Cyperaceae	CAFI	<i>Carex filifolia</i>	threadleaf sedge	–
Cyperaceae	CAIN9	<i>Carex inops</i>	long-stolon sedge	–
Dryopteridaceae	CYFR2	<i>Cystopteris fragilis</i>	brittle bladderfern	–
Elaeagnaceae	SHAR	<i>Shepherdia argentea</i>	silver buffaloberry	–

Table 3 (continued). List of all plant species identified in THRO long-term plant community monitoring plots in 2017. The species are grouped by plant family. In the notes column 'S1' represents a rare species with a state conservation status rank (S1) critically imperiled and G5 indicates it is globally secure. 'Exotic' means that 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. Species on North Dakota's list of noxious species are indicated with 'ND'. An en-dash in the notes column is indicative of a native species.

Family	Code	Scientific	Common Name	Notes
Equisetaceae	EQAR	<i>Equisetum arvense</i>	field horsetail	–
Equisetaceae	EQLA	<i>Equisetum laevigatum</i>	smooth horsetail	–
Euphorbiaceae	EUES	<i>Euphorbia esula</i>	leafy spurge	ND
Fabaceae	ASTRA	<i>Astragalus</i>	milkvetch	–
Fabaceae	ASAG2	<i>Astragalus agrestis</i>	purple milkvetch	–
Fabaceae	ASFL2	<i>Astragalus flexuosus</i>	flexile milkvetch	–
Fabaceae	ASGI5	<i>Astragalus gilviflorus</i>	plains milkvetch	–
Fabaceae	DACA7	<i>Dalea candida</i>	white prairie clover	–
Fabaceae	DAPU5	<i>Dalea purpurea</i>	purple prairie clover	–
Fabaceae	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	–
Fabaceae	LAOC2	<i>Lathyrus ochroleucus</i>	cream pea	–
Fabaceae	MELU	<i>Medicago lupulina</i>	black medick	Exotic
Fabaceae	MEOF	<i>Melilotus officinalis</i>	yellow sweetclover	Exotic
Fabaceae	OXYTR	<i>Oxytropis</i>	locoweed	–
Fabaceae	OXLA3	<i>Oxytropis lambertii</i>	purple locoweed	–
Fabaceae	OXSE	<i>Oxytropis sericea</i>	white locoweed	S1/G5
Fabaceae	PEAR6	<i>Pedimelum argophyllum</i>	silverleaf Indian breadroot	–
Fabaceae	PEES	<i>Pedimelum esculentum</i>	large Indian breadroot	–
Fabaceae	PSLA3	<i>Psoralegium lanceolatum</i>	lemon scurfpea	–
Fabaceae	VIAM	<i>Vicia americana</i>	American vetch	–
Grossulariaceae	RIAU	<i>Ribes aureum</i>	golden currant	–
Grossulariaceae	RIOX	<i>Ribes oxycanthoides</i>	Canadian gooseberry	–
Iridaceae	SIAN3	<i>Sisyrinchium angustifolium</i>	narrowleaf blue-eyed grass	–
Juncaginaceae	TRMA20	<i>Triglochin maritima</i>	seaside arrowgrass	–
Lamiaceae	HEDR	<i>Hedeoma drummondii</i>	Drummond's false pennyroyal	–
Lamiaceae	HEHI	<i>Hedeoma hispida</i>	rough false pennyroyal	–
Lamiaceae	MOFI	<i>Monarda fistulosa</i>	wild bergamot	–
Liliaceae	CANU3	<i>Calochortus nuttallii</i>	sego lily	–
Liliaceae	MAST4	<i>Maianthemum stellatum</i>	starry false lily of the valley	–
Liliaceae	PRTR4	<i>Prosartes trachycarpa</i>	roughfruit fairybells	–
Linaceae	LILE3	<i>Linum lewisii</i>	Lewis flax	–
Linaceae	LIRI	<i>Linum rigidum</i>	stiffstem flax	–
Malvaceae	SPCO	<i>Sphaeralcea coccinea</i>	scarlet globemallow	–

Table 3 (continued). List of all plant species identified in THRO long-term plant community monitoring plots in 2017. The species are grouped by plant family. In the notes column 'S1' represents a rare species with a state conservation status rank (S1) critically imperiled and G5 indicates it is globally secure. 'Exotic' means that 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. Species on North Dakota's list of noxious species are indicated with 'ND'. An en-dash in the notes column is indicative of a native species.

Family	Code	Scientific	Common Name	Notes
Nyctaginaceae	MILI3	<i>Mirabilis linearis</i>	narrowleaf four o'clock	–
Oleaceae	FRPE	<i>Fraxinus pennsylvanica</i>	green ash	–
Onagraceae	OESU99	<i>Oenothera suffrutescens</i>	scarlet beeblossom	–
Plantaginaceae	PLPA2	<i>Plantago patagonica</i>	woolly plantain	–
Poaceae	ACHY	<i>Achnatherum hymenoides</i>	Indian ricegrass	–
Poaceae	AGCR	<i>Agropyron cristatum</i>	crested wheatgrass	Exotic
Poaceae	AGSC5	<i>Agrostis scabra</i>	rough bentgrass	–
Poaceae	ARPU9	<i>Aristida purpurea</i>	purple threeawn	–
Poaceae	BOCU	<i>Bouteloua curtipendula</i>	sideoats grama	–
Poaceae	BOGR2	<i>Bouteloua gracilis</i>	blue grama	–
Poaceae	BRIN2	<i>Bromus inermis</i>	smooth brome	Exotic
Poaceae	BRJA	<i>Bromus japonicus</i>	Japanese brome	Exotic
Poaceae	CALO	<i>Calamovilfa longifolia</i>	prairie sandreed	–
Poaceae	DISP	<i>Distichlis spicata</i>	saltgrass	–
Poaceae	ELCA4	<i>Elymus canadensis</i>	Canada wildrye	–
Poaceae	ELCA11	<i>Elymus caninus</i>	bearded wheatgrass	–
Poaceae	ELRE4	<i>Elymus repens</i>	quackgrass	Exotic
Poaceae	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	–
Poaceae	HECO26	<i>Hesperostipa comata</i>	needle and thread	–
Poaceae	HESP11	<i>Hesperostipa spartea</i>	porcupinegrass	–
Poaceae	HOJU	<i>Hordeum jubatum</i>	foxtail barley	–
Poaceae	KOMA	<i>Koeleria macrantha</i>	prairie Junegrass	–
Poaceae	MUCU3	<i>Muhlenbergia cuspidata</i>	plains muhly	–
Poaceae	MUPA99	<i>Muhlenbergia paniculata</i>	tumblegrass	–
Poaceae	MURA	<i>Muhlenbergia racemosa</i>	marsh muhly	–
Poaceae	MUSQ3	<i>Munroa squarrosa</i>	false buffalograss	Exotic
Poaceae	NAVI4	<i>Nassella viridula</i>	green needlegrass	–
Poaceae	PACA6	<i>Panicum capillare</i>	witchgrass	–
Poaceae	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	–
Poaceae	PIMI7	<i>Piptatherum micranthum</i>	littleseed ricegrass	–
Poaceae	POCO	<i>Poa compressa</i>	Canada bluegrass	Exotic
Poaceae	POPR	<i>Poa pratensis</i>	Kentucky bluegrass	Exotic
Poaceae	PSSP6	<i>Pseudoroegneria spicata</i>	bluebunch wheatgrass	–

Table 3 (continued). List of all plant species identified in THRO long-term plant community monitoring plots in 2017. The species are grouped by plant family. In the notes column 'S1' represents a rare species with a state conservation status rank (S1) critically imperiled and G5 indicates it is globally secure. 'Exotic' means that 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. Species on North Dakota's list of noxious species are indicated with 'ND'. An en-dash in the notes column is indicative of a native species.

Family	Code	Scientific	Common Name	Notes
Poaceae	SCSC	<i>Schizachyrium scoparium</i>	little bluestem	–
Poaceae	SPPE	<i>Spartina pectinata</i>	prairie cordgrass	–
Poaceae	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	–
Poaceae	VUOC	<i>Vulpia octoflora</i>	sixweeks fescue	–
Polemoniaceae	PHHO	<i>Phlox hoodii</i>	spiny phlox	–
Polygalaceae	POAL4	<i>Polygala alba</i>	white milkwort	–
Polygonaceae	ERFL4	<i>Eriogonum flavum</i>	alpine golden buckwheat	–
Polygonaceae	ERPA9	<i>Eriogonum pauciflorum</i>	fewflower buckwheat	–
Primulaceae	ANOC2	<i>Androsace occidentalis</i>	western rockjasmine	–
Ranunculaceae	ANEMO	<i>Anemone</i>	anemone	–
Ranunculaceae	ANPA19	<i>Anemone patens</i>	eastern pasqueflower	–
Ranunculaceae	CLLI2	<i>Clematis ligusticifolia</i>	western white clematis	–
Ranunculaceae	RACY	<i>Ranunculus cymbalaria</i>	alkali buttercup	–
Rosaceae	AMAL2	<i>Amelanchier alnifolia</i>	Saskatoon serviceberry	–
Rosaceae	FRVE	<i>Fragaria vesca</i>	woodland strawberry	–
Rosaceae	FRVI	<i>Fragaria virginiana</i>	Virginia strawberry	–
Rosaceae	POPE8	<i>Potentilla pensylvanica</i>	Pennsylvania cinquefoil	–
Rosaceae	PRVI	<i>Prunus virginiana</i>	chokecherry	–
Rosaceae	ROAR3	<i>Rosa arkansana</i>	prairie rose	–
Rosaceae	ROWO	<i>Rosa woodsii</i>	Woods' rose	–
Rubiaceae	GABO2	<i>Galium boreale</i>	northern bedstraw	–
Salicaceae	PODE3	<i>Populus deltoides</i>	eastern cottonwood	–
Salicaceae	SALIX	<i>Salix</i>	willow	–
Salicaceae	SAEX	<i>Salix exigua</i>	narrowleaf willow	–
Santalaceae	COUM	<i>Comandra umbellata</i>	bastard toadflax	–
Saxifragaceae	HERI	<i>Heuchera richardsonii</i>	Richardson's alumroot	–
Scrophulariaceae	ORLU2	<i>Orthocarpus luteus</i>	yellow owl's-clover	–
Selaginellaceae	SEDE2	<i>Selaginella densa</i>	lesser spikemoss	–
Ulmaceae	ULAM	<i>Ulmus americana</i>	American elm	–
Unknown family	UNKFORB	Unknown forb	unknown forb	Exotic
Unknown family	UNKGRAM	Unknown graminoid	unknown graminoid	Exotic
Unknown family	UNKSHRUB	Unknown shrub	unknown shrub	Exotic

Total number of plant species observed in each plot at THRO was compiled using data from point-intercept, quadrat, woody species, and target species survey methods (Table 5). The most diverse plots, each with a total of 51 species identified, were PCM_0003 and PCM_0031. These plots were a combination of upland mixed-grass and light sage brush vegetation types. Plot PCM_0003 also contained the highest number of native plant species (Figure 4).

Table 4. Number of plant species per plot observed in 21 plant community monitoring (PCM) plots and 4 fire plant community monitoring plots (FPCM) at Theodore Roosevelt National Park in 2017. Note the total number of species identified in all four FPCM plots and in PCM_005 is lower than the remaining PCM plots because data from the 1m² quadrats was not collected.

Unit	Plot Name	Native (number of plant species)	Invasive (number of plant species)	Total (number of species)
North Unit	FPCM_051	21	4	25
	FPCM_071	16	5	21
	FPCM_075	24	4	28
	FPCM_113	27	1	28
	PCM_005	21	2	23
	PCM_011	28	5	33
	PCM_013	42	8	50
	PCM_032	31	5	36
	PCM_033	35	2	37
	PCM_513	27	7	34
	PCM_518	38	10	48
South Unit	PCM_0001	35	5	40
	PCM_0003	48	3	51
	PCM_0007	34	7	41
	PCM_0008	37	3	40
	PCM_0009	29	4	33
	PCM_0031	44	7	51
	PCM_0033	40	6	46
	PCM_0034	41	5	46
	PCM_0039	37	4	41
	PCM_0040	34	2	36
	PCM_0072	32	5	37
	PCM_0077	25	7	32
	PCM_1025	10	4	14
	PCM_1030	22	1	23

Calculations of absolute cover were done using only point-intercept data (Table 6). Plots FPCM_075 and FPCM_113 had the highest absolute native cover. These plots were both located in the northwest portion of the North Unit.

Table 5. Absolute cover of native and exotic species in plots monitored at Theodore Roosevelt National Park in 2017. Absolute cover includes overlapping canopies and can be greater than 100%.

Unit	Plot Name	Absolute Cover (%)	
		Native	Exotic
North Unit	FPCM_051	111	211
	FPCM_071	78	187
	FPCM_075	162	171
	FPCM_113	162	117
	PCM_005	110	180
	PCM_011	90	191
	PCM_013	140	106
	PCM_032	82	126
	PCM_033	70	97
	PCM_513	47	149
	PCM_518	91	136
South Unit	PCM_0001	39	125
	PCM_0003	146	108
	PCM_0007	97	109
	PCM_0008	130	147
	PCM_0009	78	121
	PCM_0031	137	111
	PCM_0033	66	138
	PCM_0034	126	110
	PCM_0039	115	105
	PCM_0040	103	102
	PCM_0072	138	102
	PCM_0077	58	198
	PCM_1025	49	204
	PCM_1030	114	130

Live trees, poles and seedlings were present in 12 of the 20 sites observed in 2017 (Table 7). Data collected included species name, size class based on diameter at breast height (DBH), status, total number of individuals, and density per hectare. DBH categories are tree (DBH>15 cm), pole (2.54 cm≤DBH≤15 cm), and seedling (DBH<2.54 cm). There were eight species of tree and tall shrub observed in THRO in 2017. There was significant tree regeneration in plot PCM_013. However, plot PCM_013 has since been discontinued and uninstalled after discovering significant damage to substrate from previous visits due to steep slopes and unstable soils. The damage consisted of broken juniper limbs, eroding soil, and loss of mossy ground cover. These damages were sustained in 2011, remaining visible after 5 years.

Table 6. Number of trees and tall shrubs by plot and DBH class in twelve plant community monitoring plots (PCM) at Theodore Roosevelt National Park. DBH categories are tree (DBH>15 cm), pole (2.54 cm≤DBH≤15 cm), and seedling (DBH<2.54 cm).

Unit	MacroPlot Name	Common Name	DBH	Status	Total Individuals	Density/ha
North Unit	PCM_013	Saskatoon serviceberry	Seedling	Alive	140	8911.52
	PCM_013	Rocky Mountain juniper	Tree	Alive	38	380
	PCM_013	Rocky Mountain juniper	Tree	Dead	6	60
	PCM_013	Rocky Mountain juniper	Pole	Alive	16	509.55
	PCM_013	Rocky Mountain juniper	Pole	Dead	5	159.24
	PCM_013	Rocky Mountain juniper	Seedling	Alive	51	1623.17
	PCM_013	Green ash	Tree	Alive	6	60
	PCM_013	Green ash	Pole	Alive	12	382.17
	PCM_013	Green ash	Pole	Dead	6	191.08
	PCM_013	Green ash	Seedling	Alive	103	3278.17
	PCM_013	Chokecherry	Seedling	Alive	176	22406.11
	PCM_013	American elm	Seedling	Alive	3	95.48
	PCM_033	Rocky Mountain juniper	Tree	Alive	35	350
	PCM_033	Rocky Mountain juniper	Tree	Dead	1	10
	PCM_033	Rocky Mountain juniper	Pole	Alive	13	414.01
	PCM_033	Rocky Mountain juniper	Seedling	Alive	104	13239.97
	PCM_033	Green ash	Seedling	Alive	3	95.48
	PCM_513	Willow	Seedling	Alive	7	222.79
	PCM_513	Plains cottonwood	Tree	Alive	1	10
	PCM_513	Plains cottonwood	Seedling	Alive	54	1718.65
	PCM_513	Plains cottonwood	Seedling	Alive	4	127.31
	PCM_513	Green ash	Seedling	Alive	7	222.79
	PCM_518	Rocky Mountain juniper	Tree	Alive	7	70
	PCM_518	Rocky Mountain juniper	Tree	Dead	1	10
	PCM_518	Rocky Mountain juniper	Pole	Alive	7	222.93
	PCM_518	Rocky Mountain juniper	Seedling	Alive	2	63.65
	PCM_518	Plains cottonwood	Tree	Alive	2	20
	PCM_518	Green ash	Seedling	Alive	134	17059.2
	PCM_518	Chokecherry	Pole	Alive	1	31.85
	PCM_518	Chokecherry	Seedling	Alive	114	14513.05
South Unit	PCM_0003	Silver buffaloberry	Seedling	Alive	74	2355.19
	PCM_0007	Rocky Mountain juniper	Tree	Alive	5	50
	PCM_0007	Rocky Mountain juniper	Pole	Alive	9	286.62
	PCM_0007	Rocky Mountain juniper	Seedling	Alive	29	922.98

Table 6 (continued). Number of trees and tall shrubs by plot and DBH class in twelve plant community monitoring plots (PCM) at Theodore Roosevelt National Park. DBH categories are tree (DBH>15 cm), pole (2.54 cm≤DBH≤15 cm), and seedling (DBH<2.54 cm).

Unit	MacroPlot Name	Common Name	DBH	Status	Total Individuals	Density/ha
South Unit (cont'd)	PCM_0008	Rocky Mountain juniper	Tree	Alive	2	20
	PCM_0008	Rocky Mountain juniper	Pole	Alive	2	63.69
	PCM_0008	Rocky Mountain juniper	Seedling	Alive	4	127.31
	PCM_0008	Green ash	Tree	Alive	5	50
	PCM_0008	Green ash	Tree	Dead	1	10
	PCM_0008	Green ash	Pole	Alive	1	31.85
	PCM_0008	Green ash	Pole	Alive	1	10
	PCM_0008	Green ash	Seedling	Alive	101	6429.03
	PCM_0031	Green ash	Tree	Alive	4	40
	PCM_0031	Green ash	Tree	Dead	1	10
	PCM_0031	Green ash	Pole	Alive	8	254.78
	PCM_0031	Green ash	Seedling	Alive	27	859.33
	PCM_0031	Chokecherry	Seedling	Alive	249	15849.78
	PCM_0034	Rocky Mountain juniper	Tree	Alive	6	60
	PCM_0034	Rocky Mountain juniper	Pole	Alive	2	63.69
	PCM_0039	Silver buffaloberry	Pole	Dead	2	63.69
	PCM_0039	Rocky Mountain juniper	Tree	Alive	3	30
	PCM_0039	Rocky Mountain juniper	Seedling	Alive	4	127.31
	PCM_0040	Rocky Mountain juniper	Pole	Alive	1	31.85
	PCM_0072	Rocky Mountain juniper	Tree	Alive	1	10



Figure 4. Transect photo of plot PCM_0003 at Theodore Roosevelt National Park (South Unit), July 2017. Photograph courtesy of the National Park Service.

Dead and downed wood, and surface fuels, 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. Of all the plots visited by the NGPN crews in 2017, only seven contained measurable surface fuels (Table 8).

Table 7. Surface fuels summary from the seven PCM plots containing measurable surface fuels in 2017 at Theodore Roosevelt National Park.

Unit	MacroPlot	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
North Unit	PCM_013	0.18	1.19	3.45	4.83	1.39	0.21	6.43	17.83	7.19	31.45	0.9	0.9	1.8
	PCM_032	0.05	0.16	0.00	0.21	0.00	0.00	0.21	1.91	2.60	4.72	0.1	0.3	0.4
	PCM_033	0.20	0.00	0.00	0.20	0.00	0.00	0.20	2.62	3.59	6.41	0.1	0.5	0.6
	PCM_513	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.36	1.15	2.51	0.1	0.7	0.8
	PCM_518	0.12	1.31	0.67	2.11	0.00	0.00	2.11	0.30	2.95	5.36	0.0	0.4	0.4
South Unit	PCM_0007	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.44	0.0	0.1	0.1
	PCM_0031	0.41	0.32	0.00	0.73	0.99	0.00	1.71	3.81	1.62	7.14	0.4	1.0	1.3

Disturbances were present in all 20 plant community monitoring plots observed at THRO during 2017 (Table 8). The most common disturbance type observed was animal use, which includes trails, wallows, grazing, and trampled or missing vegetation.

Table 8. Disturbance types and area sizes recorded in twenty plots visited within Theodore Roosevelt National Park during 2017. The size was approximated out of a total area of 1000 m².

Unit	MacroPlot Name	Disturbance type	Size (m ²)	Comments
North Unit	PCM_011	Animal Trail	30	trampled veg & bison scat
	PCM_011	Grazing	35	–
	PCM_011	Small Mammal	45	–
	PCM_013	Other	200	human-caused erosion; moss removed; vegetation uprooted due to steep slopes and human traffic
	PCM_032	Animal Trail	25	–
	PCM_032	Grazing	900	–
	PCM_032	Erosion	25	5m ² erosion at A50; 20m ² at B50
	PCM_033	Animal Trail	20	–
	PCM_033	Erosion	180	water runoff & badland erosion
	PCM_513	Animal Trail	45	–
	PCM_513	Flood	60	some flattened veg and debris piles throughout
	PCM_513	Erosion	240	b-line is slightly shifted; some washers/rebar not found
	PCM_513	Other	30	beaver presence; they have brought down all but one tree in plot
	PCM_518	Animal Trail	35	–
	PCM_518	Flood	500	the river runs parallel to plot; and much of plot is in flood plain; there is also a significant drainage area in middle of plot; crossing through Q4 and Q3 and into the river.
	PCM_518	Erosion	480	almost all of Q2 and Q3 are eroding
South Unit	PCM_0001	Animal Trail	2	–
	PCM_0001	Grazing	500	–
	PCM_0001	Wallow	4	–
	PCM_0001	Prairie Dog	1000	–
	PCM_0001	Drought	1000	severe drought
	PCM_0003	Animal Trail	50	one trail runs parallel of B line; through Q2 and Q3; another trail runs perpendicular to B line; near 50 end of transect
	PCM_0003	Wallow	30	there is one larger wallow in Q3 near T1B; and a smaller set of wallows along the trails in Q2 near T1F and B50
	PCM_0007	Animal Trail	150	trails parallel to A and B transect lines; as well as along T2 transect

Table 8 (continued). Disturbance types and area sizes recorded in twenty plots visited within Theodore Roosevelt National Park during 2017. The size was approximated out of a total area of 1000 m².

Unit	MacroPlot Name	Disturbance type	Size (m ²)	Comments
South Unit (continued)	PCM_0007	Wallow	15	wallows near B0
	PCM_0007	Erosion	250	steep eroding slopes especially in Q2
	PCM_0007	Drought	1000	severe drought
	PCM_0008	Animal Trail	70	–
	PCM_0008	Grazing	5	–
	PCM_0008	Drought	1000	severe drought
	PCM_0009	Animal Trail	20	horse and bison
	PCM_0009	Grazing	10	–
	PCM_0009	Drought	1000	severe drought
	PCM_0031	Animal Trail	40	some minor; one major across plot
	PCM_0031	Grazing	100	–
	PCM_0033	Prairie Dog	1000	–
	PCM_0033	Drought	1000	Severe drought
	PCM_0034	Animal Trail	15	light game trail
	PCM_0034	Grazing	20	light herbivory throughout plot
	PCM_0034	Erosion	10	light erosion between A50 and B50
	PCM_0039	Animal Trail	20	–
	PCM_0040	Erosion	200	drainage
	PCM_0072	Animal Trail	10	Light trail use
	PCM_0072	Small Mammal	15	small mammal holes
	PCM_0072	Erosion	30	light erosion due to steep slopes
	PCM_0072	Drought	1000	severe drought
	PCM_0077	Drought	1000	severe drought; very dry vegetation
	PCM_1025	Animal Trail	20	light animal trails
	PCM_1030	Grazing	25	–
	PCM_1030	Wallow	3	–

Further Analysis

This 2017 Data Summary Report is intended to provide a basic review of the data collected during the NGPN and NGPFEP's 2017 visit to Theodore Roosevelt National Park. All data included in this report is available upon request from the Northern Great Plains Inventory and Monitoring Network, and is archived at <https://irma.nps.gov/DataStore>.

Literature Cited

- Amberg, S., K. Kilkus, M. R. Komp, A. J. Nadeau, K. Stark, L. Danielson, S. Gardner, E. Iverson, E. Norton, and B. Drazkowski. 2014. Theodore Roosevelt National Park: Natural resource condition assessment. Natural Resource Report NPS/THRO/NRR--2014/776. National Park Service, Fort Collins, CO.
- Ashton, I., M. Prowatzke, M. Bynum, T. Shepherd, S. K. Wilson, and K. Paintner-Green. 2012. Theodore Roosevelt National Park plant community composition and structure monitoring: 2011 annual report. Natural Resource Technical Report NPS/NGPN/NRTR—2012/545. 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.
- Heidel, B. 1990. Inventory of Rare Plant Species in Theodore Roosevelt National Park North Dakota Natural Heritage Inventory. North Dakota Parks and Recreation Department. , Bismarck, ND.
- Samson, F. and F. Knopf. 1994. Prairie conservation in North America. *BioScience* 44:418-421.
- Skinner, Q. D. 2010. Field guide to Wyoming grasses. Education Resources Publishing, Cumming, GA.
- 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., 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.

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.

NPS 920/145187, May 2018

National Park Service
U.S. Department of the Interior



[Natural Resource Stewardship and Science](#)

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525