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Natural Resource Stewardship and Science

Plant Community Composition and Structure Monitoring at Theodore Roosevelt National Park

2019 Data Report

Natural Resource Data Series NPS/THRO/NRDS—2019/1250

ON THIS PAGE
Plant community composition and structure monitoring plot THRON_PCM_008 at Theodore Roosevelt National Park, July 2019. Photograph courtesy of the National Park Service.

ON THE COVER
Landscape view taken from monitoring plot THROS_PCM_0024 at Theodore Roosevelt National Park, August 2019. Photograph courtesy of the National Park Service.

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Abstract

This report presents the results of vegetation monitoring work conducted in 2019 at Theodore Roosevelt National Park (THRO) by the Northern Great Plains Inventory and Monitoring Network (NGPN) and the Northern Great Plains Fire Ecology (NGPFire) program.

During the ninth consecutive year of data collection, the NGPN field crew visited fifteen long-term plant community monitoring (PCM) plots to collect data to assess plant communities at THRO. Four scheduled PCM plot installs in THRO's south unit and one PCM plot install in THRO's North unit were not visited or completed in 2019. The compliance required for installation of permanent rebar and nails had not yet been completed at the time of fieldwork. These five PCM plots may be installed on a future visit. The NGPFire crew visited three PCM plots and eight long-term fire plant community (FPCM) plots to collect data and assess fire effects following prescribed burns at the park. Two of these FPCM plots (THRON_FPCM_0103 and THRON_FPCM_0167) were not read within the Sheep burn unit since they did not burn in the 2019 Sheep prescribed fire. This monitoring work is part of a long-term monitoring effort with the goal of sampling 20 of 100 randomly located 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 collected data relating to species richness, herb-layer height, abundance of native and non-native species, ground cover, and site disturbance in each of the 15 visited plots. In plots where woody species were present, NGPN measured tree regeneration, tall shrub and tree density, and woody fuel load. The NGPFire crew collected data relating to herb-layer height, abundance of native and non-native species, and ground cover. In addition to the above-mentioned vegetation indices, the NGPFire crew also collected species richness data in the one plot monitored within the Jones Creek unit.

Monitoring crews identified 194 species in the 24 monitoring plots visited in 2019 at THRO, 25 of which were exotic species. The average absolute cover of exotic species was 45% and 151% for native species. Tree density, health, and seedling regeneration, as well as woody fuel loads, were recorded at 9 plots. The most common disturbances observed were the result of animal activity (e.g., grazing, game trails, and prairie dogs).

Liatris punctata observed in Theodore Roosevelt National Park (NPS /RYAN MANUEL)

Acknowledgments

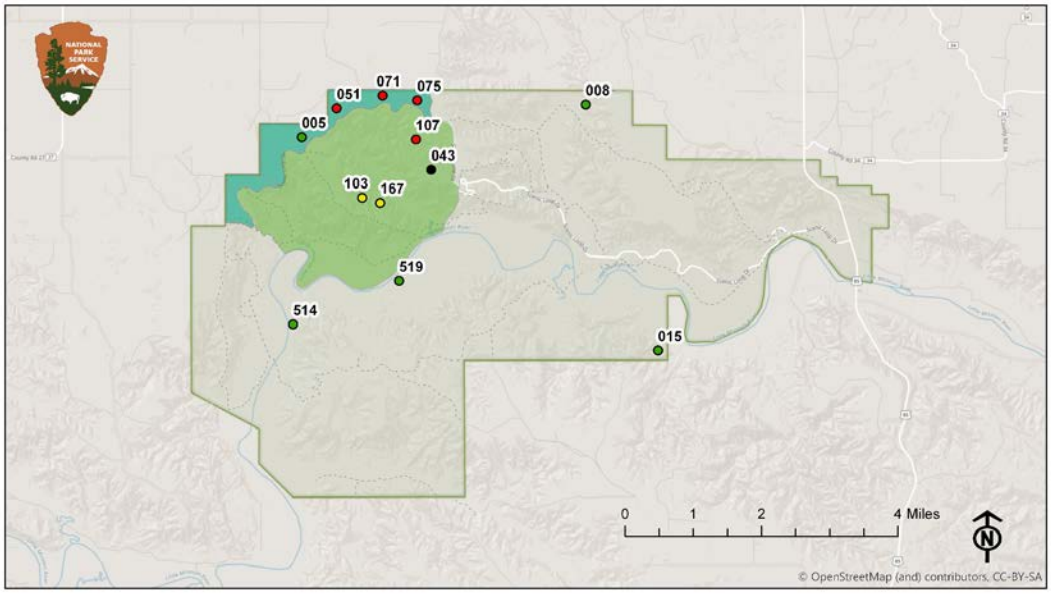
We thank all the authors of the Northern Great Plains Plant Community Monitoring Protocol, particularly A. Symstad, for outstanding guidance on data collection and reporting. Thank you to the staff at THRO, particularly Grant Geis for his logistical support and safety checks. The 2019 NGPN vegetation field crew of S. Rockwood, M. Davis, R. Manuel, T. Schaffner, E. Duda, and T. Bortz with the assistance of the Northern Great Plains Fire Ecology crew of D. Swanson, I. Muirhead, M. Pahler and L. Badertscher, collected all the data included in this report.

Introduction

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 (NGPFire).

The long-term objectives of the NGPN plant community monitoring effort (Symstad et al. 2012b) in THRO are to 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, determine status (at 10-year intervals) and long-term trends of tree density by species, height class, and diameter class in the riparian forest, and 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.

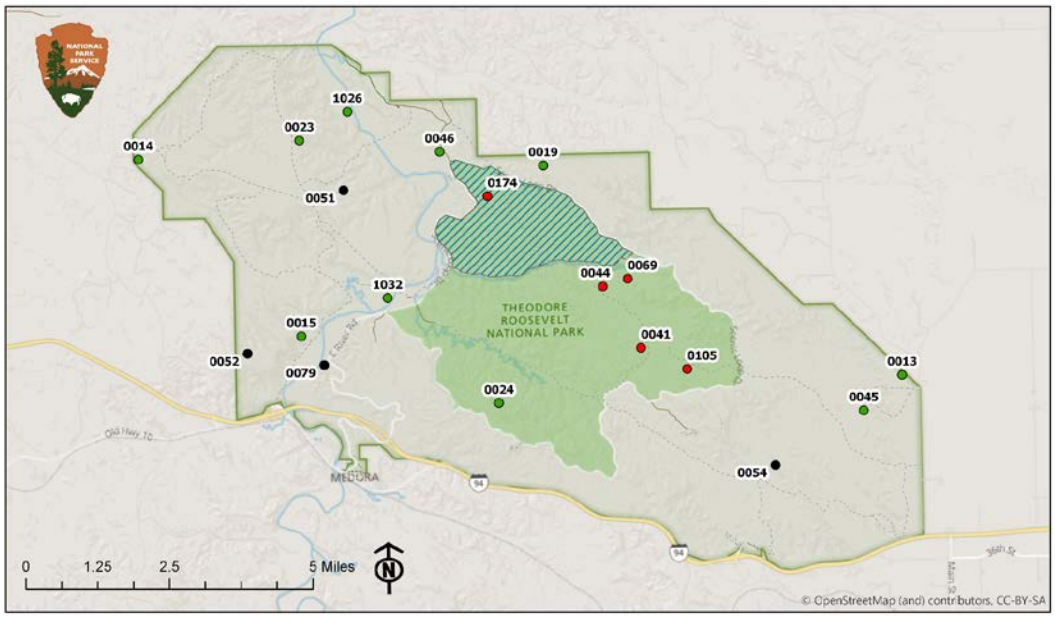
This report is intended to provide a timely release of basic data sets and data summaries from our sampling efforts at THRO in 2019, NGPN's ninth year of sampling vegetation. NGPN visited 15 plots and NGPFire visited a total of 11 plots in the south unit and north unit.



Theodore Roosevelt National Park
North Unit
Medora, ND 58645

Northern Great Plains Inventory & Monitoring Network
National Park Service
November 2019

2019 Plant Community Monitoring
- Plant Community Plots
- Plant Community Plots (Not Visited)
- Fire Effects Plots
- Fire Effects Plots (Not burned or read)
- Sheep Burn Unit (2019)
- Northwest Burn Unit (2019)
- Trails
- Roads



Theodore Roosevelt National Park
South Unit
Medora, ND 58645

Northern Great Plains Inventory & Monitoring Network
National Park Service
November 2019

2019 Plant Community Monitoring
- Jones Creek Burn Unit (2014)
- Donut Hole Burn Unit (2018)
- Trails
- Paved
- Gravel
- Grass
- Plant Community Plots
- Fire Effects Plots
- Plant Community Plots (Not Visited)

Figure 1. Maps of plant community and fire effects monitoring plots surveyed in 2019 in the north unit (top) and south unit (bottom) of Theodore Roosevelt National Park.

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 the protocol publications cited above, and available at https://www.nps.gov/im/ngpn/plant-communities.htm.

Sample Design

The NGPN and NGPFire 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 the GRTS design, NGPN selected 100 randomly located sites within the north unit and the south unit. These sites were divided into 10 monitoring panels with 10 sites each. Originally, NGPN planned on visiting two panels (28 sites) every year. However, due to logistical constraints on the NGPN and Fire Ecology Programs, the number of anticipated site visits per year was reduced to the current 20 per year. In 2019, 15 sites were visited during the last 10 days of July and the second week of August (Table 1). Four scheduled PCM plot installs in THRO's south unit and one PCM plot install in THRO's North unit were not visited or completed in 2019. The approval required for installation of permanent rebar and nails had not yet been granted. These five PCM plots may be installed on a future visit once compliance requirements have been met. 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.

NGPFire established and monitored a number of new Fire Plant Community monitoring (FPCM) plots focused on active burn units using the same GRTS sampling schema. When a previously installed PCM plot was located within an active burn unit, those plots were monitored as long as they meet specified fire effects monitoring parameters (e.g. minimum distance to burn perimeter, sufficient vegetation to burn, stratum definition). NGPFire visits sites based on a 1, 2, 5, and 10 year sampling schedule. In 2019 NGPFire monitored one plot within the Jones Creek unit, which was burned in the Donut Hole RX (2018), as a year 2 read. Four additional plots were monitored within the greater Donut Hole unit as year 2 reads following the 2018 Donut Hole prescribed fire (Table 1). In addition, three plots were monitored as year 1 reads in the NW Corner and one in the Sheep unit following these prescribed fires on May 16, 2019.

Table 1. Field journal for Northern Great Plains Network (NGPN) and Northern Great Plains Fire Ecology Program (NGPFire) plant community monitoring (PCM and FPCM) visits at Theodore Roosevelt National Park (THRO) in 2019. Four NGPFire crew members visited 11 plots. The burn units associated with the 11 plots visited by NGPFire are included in the field notes along with burn details. Six NGPN crew members completed 15 plots with the assistance of NGPN GIS tech Amy Fowler at three plots.

Date Visited	Plot Name	Burn Unit	Field Notes
7/18/2019	FPCM_0174	Jones Creek	B line only, 100pts and 5 quads; year 2 read
7/19/2019	FPCM_0105	Donut Hole	A&B transects, year 2 read
7/19/2019	PCM_0044	Donut Hole	A&B transects, year 2 read
7/18/2019	PCM_0069	Donut Hole	A&B tansects, year 2 read
7/19/2019	PCM_0041	Donut Hole	A&B transects, year 2 read
7/21/2019	FPCM-0107	Sheep	Sheep RX (May 2019), A transect, 100 pts, year 1 read
7/21/2019	FPCM-0103	Sheep	Plot did not burn in Sheep RX (May 16, 2019), so we did not read plot.
7/21/2019	FPCM-0167	Sheep	Plot did not burn in Sheep RX (May 16, 2019), so we did not read plot.
7/20/2019	FPCM-051	NW Corner	NW Corner RX (May 16, 2019), A&B transects; year 1 read
7/20/2019	FPCM-071	NW Corner	NW Corner RX (May 16, 2019), A&B transects; year 1 read
7/20/2019	FPCM-075	NW Corner	NW Corner RX (May 16, 2019), A&B transects; year 1 read
7/22/2019	PCM_005	–	–
7/23/2019	PCM_514	–	–
7/23/2019	PCM_519	–	Did not have time to read trees, seedlings, or fuels
7/24/2019	PCM_008	–	Recollected points using ipad
7/25/2019	PCM_015	–	Recorded navigation route and recollected points using ipad
7/26/2019	PCM_0046	–	–
7/27/2019	PCM_0045	–	–
7/27/2019	PCM_0013	–	–
7/28/2019	PCM_0019	–	–
7/28/2019	PCM_0014	–	–
8/5/2019	PCM_0024	–	–
8/6/2019	PCM_0023	–	Plot points recollected w/ Arrow 100; Poison Ivy
8/6/2019	PCM_1026	–	–
8/7/2019	PCM_0015	–	–
8/7/2019	PCM_1032	–	Plot partially buried due to flood plain. Recollected the located points w/ Arrow 100

Plot Layout and Sampling

At each site visited, the NGPN crew recorded plant species cover and frequency in a rectangular, 50 m x 20 m (0.1 ha), permanent plot (Figure 2). Data on ground cover, herb-layer height ($\leq$ 2 m), and plant cover were collected on two 50 m transects (the long sides of the plot) using a point-intercept method (Figure 3). Species richness data from the point-intercept method were supplemented with species presence data collected in five 1 m^2 quadrats located systematically along each transect

(Figure 2). The NGPN crew measured species presence at ten quadrats per plot. If a plant species was identified in the plot but was not included on the verified park species list, a voucher plant specimen was collected when possible and submitted to a botanist for independent verification. NGP fire collected point-intercept data, but quadrat data was only collect from 5 quadrats within one plot in 2019.

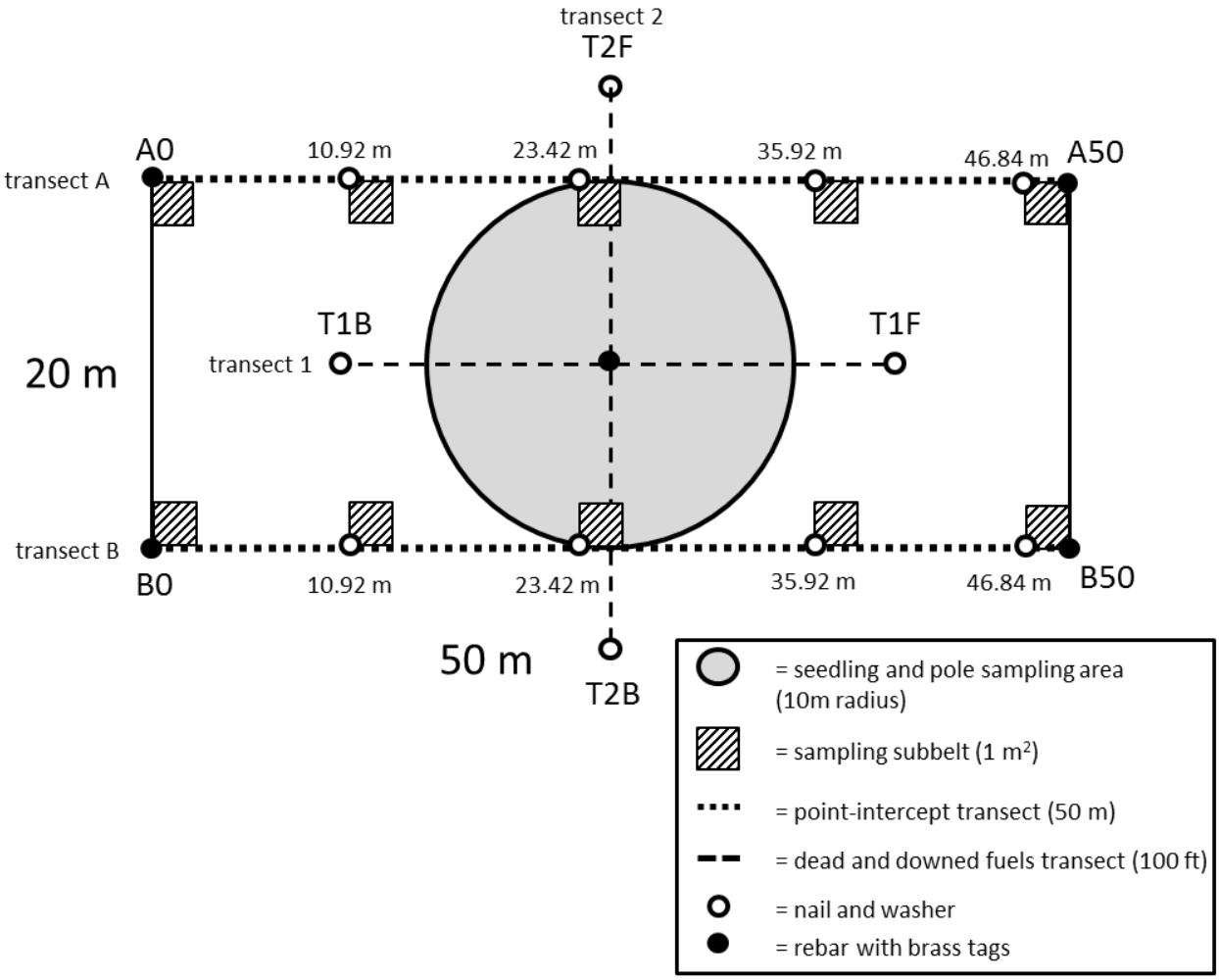


Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring and Fire Ecology programs.

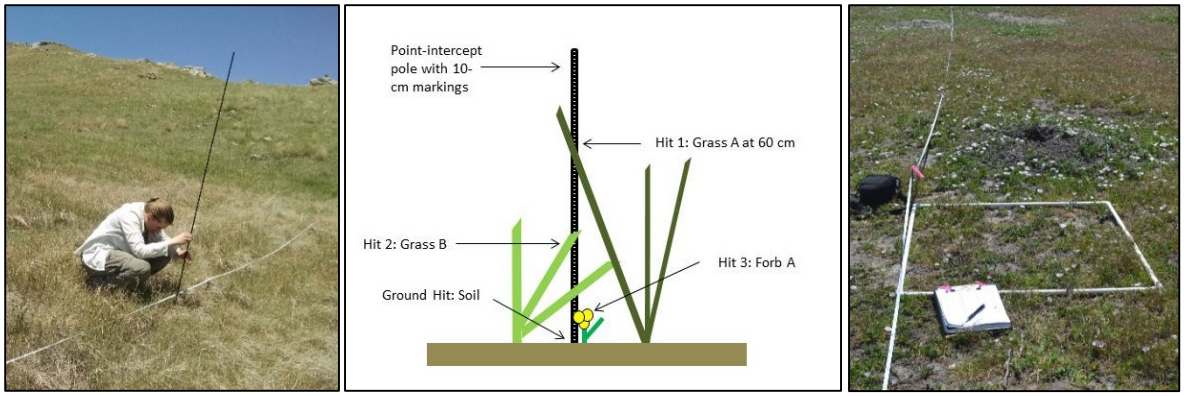


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

When woody species were present within 38 m of plot center, monitoring crews collected tree regeneration and tall shrub density data within a 10 m radius subplot centered in the larger 50 m x 20 m (0.1 ha) plot. Trees with diameter at breast height (DBH) > 15 cm, present within the 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. For all poles ($2.54 \leq DBH \leq 15$ cm) located within the 10 m radius subplot, only DBH and status were recorded. Tree and tall shrub species with DBH < 2.54 cm (seedlings) were tallied by species within the 10 m radius subplot. In 2019, NGPN changed the way these seedling counts were made. Previously, stump sprouts (stems originating between ground level and 137 cm on the bole of trees that have died or been cut) were tallied individually, often resulting in a high number of stump sprouts counted. As of 2019, only one sprout per stump is counted. Dead and downed woody fuel load data were collected along two perpendicular 100 ft (30.49 m) transects (fuel lines) with midpoints at the center of the plot (Figure 2), following Brown's Line methods (Brown 1974, Brown et al. 1982). Fuel load data were only collected if at least one piece of woody litter or fuel intersected a fuel line.

The NGPN crew assessed and documented common disturbances at each plot. The disturbance type, which included rodent mounds, animal trails, and fire, as well as the approximate area (m^2) of each disturbance was recorded. Plots were also assessed for the presence and abundance of target exotic species (Table 2), a critical step in the early detection and rapid response to exotic species threats. These target species were chosen in collaboration with the Midwest Invasive Plant Network, Northern Great Plains Exotic Plant Management Team, park managers, and local weed experts. Each target species was assigned an abundance class from 1-5, based on an ocular estimate of cover, where 1 = one individual, 2 = few individuals, 3 = cover of 1-5%, 4 = cover of 5-25%, and 5 = cover > 25% of the plot.

Table 2. Exotic species included in the Northern Great Plains Network's early detection and rapid response program.

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

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 and R software (R version 3.6.1). 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 2019 was determined by cross-referencing with the NatureServe conservation status list, as well as the North Dakota rare plant species list. For the purpose of this report, a species was considered rare or of conservation concern if its state or global conservation status rank was critically imperiled (S1/G1), imperiled (S1/G2), or vulnerable (S3/G3). More information on conservation ranks can be found at the NatureServe website. The 2019 species list was also cross-referenced with the list of noxious weeds maintained by the North Dakota Department of Agriculture.

Results

There are 554 vascular plant species on the verified THRO species list, and monitoring crews observed 194 of these species in 2019 (Table 3). Of these plant species, 25 are exotic species at THRO.

Table 3. A list of all plant species identified in Theodore Roosevelt National Park's long-term plant community monitoring plots in 2019. 'Exotic' in the notes column indicates that the species is invasive, or non-native. Species considered rare are marked with the appropriate state conservation ranks. If a species is noxious in the state of North Dakota, it is indicated in the notes column as Noxious - ND. If a species is noxious in an individual county within the state, it is indicated in the notes column as Noxious – County name.

Family	Symbol	Scientific Name	Common Name	Notes
Agavaceae	YUGL	*Yucca glauca*	soapweed yucca	–
Amaranthaceae	STDI99	*Stutzia dioica*	scurfless saltbush	–
Anacardiaceae	RHAR4	*Rhus aromatica*	fragrant sumac	–
Anacardiaceae	TORY	*Toxicodendron rydbergii*	western poison ivy	–
Apocynaceae	APAN2	*Apocynum androsaemifolium*	spreading dogbane	–
Asclepiadaceae	ASPU	*Asclepias pumila*	plains milkweed	–
Asteraceae	ACMI2	*Achillea millefolium*	common yarrow	–
Asteraceae	AGGL	*Agoseris glauca*	pale agoseris	–
Asteraceae	AMPS	*Ambrosia psilostachya*	Cuman ragweed	–
Asteraceae	ANPA4	*Antennaria parvifolia*	small-leaf pussytoes	–
Asteraceae	ANTEN	*Antennaria*	pussytoes	–
Asteraceae	ARCA12	*Artemisia campestris*	field sagewort	–
Asteraceae	ARCA13	*Artemisia cana*	silver sagebrush	–
Asteraceae	ARDR4	*Artemisia dracunculus*	tarragon	–
Asteraceae	ARFR4	*Artemisia frigida*	fringed sagewort	–
Asteraceae	ARLU	*Artemisia ludoviciana*	white sagebrush	–
Asteraceae	ARTR2	*Artemisia tridentata*	big sagebrush	–
Asteraceae	CIAR4	*Cirsium arvense*	Canada thistle	Noxious-ND
Asteraceae	CIUN	*Cirsium undulatum*	wavyleaf thistle	–
Asteraceae	COCA5	*Conyza canadensis*	horseweed	–
Asteraceae	ECAN2	*Echinacea angustifolia*	blacksamson echinacea	–
Asteraceae	ERIGE2	*Erigeron*	fleabane	–
Asteraceae	ERNA10	*Ericameria nauseosa*	rubber rabbitbrush	–
Asteraceae	ERST3	*Erigeron strigosus*	prairie fleabane	–
Asteraceae	GUSA2	*Gutierrezia sarothrae*	broom snakeweed	–
Asteraceae	HEAN3	*Helianthus annuus*	common sunflower	–

Table 3 (continued). A list of all plant species identified in Theodore Roosevelt National Park's long-term plant community monitoring plots in 2019. 'Exotic' in the notes column indicates that the species is invasive, or non-native. Species considered rare are marked with the appropriate state conservation ranks. If a species is noxious in the state of North Dakota, it is indicated in the notes column as Noxious - ND. If a species is noxious in an individual county within the state, it is indicated in the notes column as Noxious – County name.

Family	Symbol	Scientific Name	Common Name	Notes
Asteraceae	HELIA3	*Helianthus*	sunflower	–
Asteraceae	HEMA2	*Helianthus maximiliani*	Maximilian sunflower	–
Asteraceae	HEPA19	*Helianthus pauciflorus*	stiff sunflower	–
Asteraceae	HEVI4	*Heterotheca villosa*	hairy false goldenaster	–
Asteraceae	LIPU	*Liatris punctata*	dotted blazing star	–
Asteraceae	LYJU	*Lygodesmia juncea*	rush skeletonplant	–
Asteraceae	MUOB99	*Mulgedium oblongifolium*	blue lettuce	–
Asteraceae	PAPL12	*Packera plattensis*	prairie groundsel	–
Asteraceae	RACO3	*Ratibida columnifera*	upright prairie coneflower	–
Asteraceae	SOAR2	*Sonchus arvensis*	field sowthistle	Exotic
Asteraceae	SOCA6	*Solidago canadensis*	Canada goldenrod	–
Asteraceae	SOMI2	*Solidago missouriensis*	Missouri goldenrod	–
Asteraceae	SOMO	*Solidago mollis*	velvety goldenrod	–
Asteraceae	SONE	*Solidago nemoralis*	gray goldenrod	–
Asteraceae	SOPT4	*Solidago ptarmicoides*	prairie goldenrod	–
Asteraceae	SORI2	*Solidago rigida*	stiff goldenrod	–
Asteraceae	SYER	*Symphyotrichum ericoides*	white heath aster	–
Asteraceae	SYLA3	*Symphyotrichum laeve*	smooth blue aster	–
Asteraceae	SYLA6	*Symphyotrichum lanceolatum*	white panicle aster	–
Asteraceae	SYMPH4	*Symphyotrichum*	aster	–
Asteraceae	SYOB	*Symphyotrichum oblongifolium*	aromatic aster	–
Asteraceae	TAOF	*Taraxacum officinale*	common dandelion	Exotic
Asteraceae	TEAC	*Tetraneuris acaulis*	stemless four-nerve daisy	–
Asteraceae	TRDU	*Tragopogon dubius*	yellow salsify	Exotic
Asteraceae	XASP99	*Xanthisma spinulosum*	lacy tansyaster	–
Asteraceae	XAST	*Xanthium strumarium*	cocklebur	–
Boraginaceae	HADE	*Hackelia deflexa*	nodding stickseed	–
Boraginaceae	LAOC3	*Lappula occidentalis*	flatspine stickseed	–
Boraginaceae	LASQ	*Lappula squarrosa*	European stickseed	Exotic
Boraginaceae	LIIN2	*Lithospermum incisum*	narrowleaf stoneseed	–
Brassicaceae	CAMI2	*Camelina microcarpa*	littlepod false flax	Exotic

Table 3 (continued). A list of all plant species identified in Theodore Roosevelt National Park's long-term plant community monitoring plots in 2019. 'Exotic' in the notes column indicates that the species is invasive, or non-native. Species considered rare are marked with the appropriate state conservation ranks. If a species is noxious in the state of North Dakota, it is indicated in the notes column as Noxious - ND. If a species is noxious in an individual county within the state, it is indicated in the notes column as Noxious – County name.

Family	Symbol	Scientific Name	Common Name	Notes
Brassicaceae	DEPI	*Descurainia pinnata*	western tansymustard	–
Brassicaceae	ERYSI	*Erysimum*	wallflower	Exotic
Brassicaceae	LEDE	*Lepidium densiflorum*	common pepperweed	–
Brassicaceae	PHLU99	*Physaria ludoviciana*	foothill bladderpod	–
Brassicaceae	THAR5	*Thlaspi arvense*	field pennycress	Exotic
Cactaceae	OPFR	*Opuntia fragilis*	brittle pricklypear	–
Cactaceae	OPPO	*Opuntia polyacantha*	plains pricklypear	–
Campanulaceae	CARO2	*Campanula rotundifolia*	bluebell bellflower	–
Caprifoliaceae	SYOC	*Symphoricarpos occidentalis*	western snowberry	–
Caryophyllaceae	CEAR4	*Cerastium arvense*	field chickweed	–
Caryophyllaceae	SIAN2	*Silene antirrhina*	sleepy silene	–
Caryophyllaceae	SILEN	*Silene*	catchfly	Exotic
Chenopodiaceae	ATCA2	*Atriplex canescens*	fourwing saltbush	–
Chenopodiaceae	CHENO	*Chenopodium*	goosefoot	Exotic
Chenopodiaceae	KRLA2	*Krascheninnikovia lanata*	winterfat	–
Chenopodiaceae	SATR12	*Salsola tragus*	prickly Russian thistle	Exotic
Chenopodiaceae	SAVE4	*Sarcobatus vermiculatus*	greasewood	–
Convolvulaceae	COAR4	*Convolvulus arvensis*	field bindweed	Exotic
Cupressaceae	JUCO6	*Juniperus communis*	common juniper	–
Cupressaceae	JUHO2	*Juniperus horizontalis*	creeping juniper	–
Cupressaceae	JUSC2	*Juniperus scopulorum*	Rocky mountain juniper	–
Cupressaceae	JUSC2	*Juniperus scopulorum*	Rocky Mountain juniper	–
Cyperaceae	CADU6	*Carex duriuscula*	needleleaf sedge	–
Cyperaceae	CAFI	*Carex filifolia*	threadleaf sedge	–
Cyperaceae	CAIN9	*Carex inops*	sun sedge	–
Cyperaceae	CAREX	*Carex*	sedge	–
Cyperaceae	CASA9	*Carex saximontana*	Rocky Mountain sedge	–
Dryopteridaceae	CYFR2	*Cystopteris fragilis*	brittle bladderfern	–
Elaeagnaceae	SHAR	*Shepherdia argentea*	silver buffaloberry	–
Elaeagnaceae	SHCA	*Shepherdia canadensis*	russet buffaloberry	–
Elaegnaceae	SHAR	*Shepherdia argentea*	buffaloberry	–
Equisetaceae	EQLA	*Equisetum laevigatum*	smooth horsetail	–

Table 3 (continued). A list of all plant species identified in Theodore Roosevelt National Park's long-term plant community monitoring plots in 2019. 'Exotic' in the notes column indicates that the species is invasive, or non-native. Species considered rare are marked with the appropriate state conservation ranks. If a species is noxious in the state of North Dakota, it is indicated in the notes column as Noxious - ND. If a species is noxious in an individual county within the state, it is indicated in the notes column as Noxious – County name.

Family	Symbol	Scientific Name	Common Name	Notes
Euphorbiaceae	EUES	*Euphorbia esula*	leafy spurge	Noxious-ND
Euphorbiaceae	EUSE4	*Euphorbia serpens*	matted sandmat	–
Euphorbiaceae	EUSP	*Euphorbia spathulata*	warty spurge	–
Fabaceae	ASAG2	*Astragalus agrestis*	purple milkvetch	–
Fabaceae	ASFL2	*Astragalus flexuosus*	flexile milkvetch	–
Fabaceae	ASGI5	*Astragalus gilviflorus*	plains milkvetch	–
Fabaceae	ASLA27	*Astragalus laxmannii*	Laxmann's milkvetch	–
Fabaceae	ASMI10	*Astragalus missouriensis*	Missouri milkvetch	–
Fabaceae	ASTRA	*Astragalus*	milkvetch	–
Fabaceae	DACA7	*Dalea candida*	white prairie clover	–
Fabaceae	DAPU5	*Dalea purpurea*	purple prairie clover	–
Fabaceae	GLLE3	*Glycyrrhiza lepidota*	American licorice	–
Fabaceae	HEBO	*Hedysarum boreale*	Utah sweetvetch	–
Fabaceae	MELU	*Medicago lupulina*	black medick	Exotic
Fabaceae	MEOF	*Melilotus officinalis*	yellow sweetclover	Exotic
Fabaceae	OXLA3	*Oxytropis lambertii*	purple locoweed	–
Fabaceae	OXSE	*Oxytropis sericea*	white locoweed	S1/G5
Fabaceae	OXYTR	*Oxytropis*	locoweed	–
Fabaceae	PEAR6	*Pediomelum argophyllum*	silverleaf Indian breadroot	–
Fabaceae	PEES	*Pediomelum esculentum*	large Indian breadroot	–
Fabaceae	PSLA3	*Psoralidium lanceolatum*	lemon scurfpea	–
Fabaceae	THRH	*Thermopsis rhombifolia*	golden pea	–
Fabaceae	VIAM	*Vicia americana*	American vetch	–
Gentianaceae	GEAM3	*Gentianella amarella*	autumn dwarf gentian	–
Grossulariaceae	RIAU	*Ribes aureum*	golden currant	–
Grossulariaceae	RIOX	*Ribes oxyacanthoides*	Canadian gooseberry	–
Lamiaceae	HEHI	*Hedeoma hispida*	rough false pennyroyal	–
Lamiaceae	MOFI	*Monarda fistulosa*	wild bergamot	–
Liliaceae	ALTE	*Allium textile*	textile onion	–
Liliaceae	MAST4	*Maianthemum stellatum*	starry false lily of the valley	–
Linaceae	LILE3	*Linum lewisii*	Lewis flax	–
Linaceae	LIRI	*Linum rigidum*	stiffstem flax	–

Table 3 (continued). A list of all plant species identified in Theodore Roosevelt National Park's long-term plant community monitoring plots in 2019. 'Exotic' in the notes column indicates that the species is invasive, or non-native. Species considered rare are marked with the appropriate state conservation ranks. If a species is noxious in the state of North Dakota, it is indicated in the notes column as Noxious - ND. If a species is noxious in an individual county within the state, it is indicated in the notes column as Noxious – County name.

Family	Symbol	Scientific Name	Common Name	Notes
Malvaceae	SPCO	*Sphaeralcea coccinea*	scarlet globemallow	–
Oleaceae	FRPE	*Fraxinus pennsylvanica*	green ash	–
Onagraceae	OESE3	*Oenothera serrulata*	yellow sundrops	–
Onagraceae	OESU99	*Oenothera suffrutescens*	scarlet beeblossom	–
Orobanchaceae	ORLU	*Orobanche ludoviciana*	Louisiana broomrape	–
Plantaginaceae	PLPA2	*Plantago patagonica*	woolly plantain	–
Poaceae	AGCR	*Agropyron cristatum*	crested wheatgrass	Exotic
Poaceae	ANGE	*Andropogon gerardii*	big bluestem	–
Poaceae	ARPU9	*Aristida purpurea*	purple threeawn	–
Poaceae	BOCU	*Bouteloua curtipendula*	sideoats grama	–
Poaceae	BODA2	*Bouteloua dactyloides*	buffalograss	–
Poaceae	BOGR2	*Bouteloua gracilis*	blue grama	–
Poaceae	BOHI2	*Bouteloua hirsuta*	hairy grama	–
Poaceae	BRIN2	*Bromus inermis*	smooth brome	Exotic
Poaceae	BRJA	*Bromus japonicus*	Japanese brome	Exotic
Poaceae	CALO	*Calamovilfa longifolia*	prairie sandreed	–
Poaceae	DASP2	*Danthonia spicata*	poverty oatgrass	–
Poaceae	DISP	*Distichlis spicata*	saltgrass	–
Poaceae	DIWI5	*Dichanthelium wilcoxianum*	fall rosette grass	–
Poaceae	ELCA4	*Elymus canadensis*	Canada wildrye	–
Poaceae	ELLA3	*Elymus lanceolatus*	thickspike wheatgrass	–
Poaceae	ELRE4	*Elymus repens*	quackgrass	Exotic
Poaceae	ELTR7	*Elymus trachycaulus*	slender wheatgrass	–
Poaceae	HECO26	*Hesperostipa comata*	needle and thread	–
Poaceae	HESP11	*Hesperostipa spartea*	porcupinegrass	–
Poaceae	KOMA	*Koeleria macrantha*	prairie Junegrass	–
Poaceae	MUCU3	*Muhlenbergia cuspidata*	plains muhly	–
Poaceae	MUPA99	*Muhlenbergia paniculata*	tumblegrass	–
Poaceae	MURA	*Muhlenbergia racemosa*	marsh muhly	–
Poaceae	NAVI4	*Nassella viridula*	green needlegrass	–
Poaceae	PASM	*Pascopyrum smithii*	western wheatgrass	–
Poaceae	PAVI2	*Panicum virgatum*	switchgrass	–

Table 3 (continued). A list of all plant species identified in Theodore Roosevelt National Park's long-term plant community monitoring plots in 2019. 'Exotic' in the notes column indicates that the species is invasive, or non-native. Species considered rare are marked with the appropriate state conservation ranks. If a species is noxious in the state of North Dakota, it is indicated in the notes column as Noxious - ND. If a species is noxious in an individual county within the state, it is indicated in the notes column as Noxious – County name.

Family	Symbol	Scientific Name	Common Name	Notes
Poaceae	PIMI7	*Piptatherum micranthum*	littleseed ricegrass	–
Poaceae	PONE	*Poa nemoralis*	wood bluegrass	–
Poaceae	POPR	*Poa pratensis*	Kentucky bluegrass	Exotic
Poaceae	POSE	*Poa secunda*	Sandberg bluegrass	–
Poaceae	SCSC	*Schizachyrium scoparium*	little bluestem	–
Poaceae	SPCR	*Sporobolus cryptandrus*	sand dropseed	–
Poaceae	VUOC	*Vulpia octoflora*	sixweeks fescue	–
Polemoniaceae	COLI2	*Collomia linearis*	tiny trumpet	–
Polemoniaceae	PHHO	*Phlox hoodii*	spiny phlox	–
Polygalaceae	POAL4	*Polygala alba*	white milkwort	–
Polygonaceae	ERIOG	*Eriogonum*	buckwheat	–
Polygonaceae	FACO	*Fallopia convolvulus*	black bindweed	Exotic
Polygonaceae	POAV	*Polygonum aviculare*	prostrate knotweed	Exotic
Ranunculaceae	ANCY	*Anemone cylindrica*	candle anemone	–
Ranunculaceae	ANPA19	*Anemone patens*	eastern pasqueflower	–
Ranunculaceae	CLLI2	*Clematis ligusticifolia*	western white clematis	–
Rosaceae	AMAL2	*Amelanchier alnifolia*	Saskatoon serviceberry	–
Rosaceae	DAFR6	*Dasiphora fruticosa*	shrubby cinquefoil	–
Rosaceae	DRAR8	*Drymocallis arguta*	tall cinquefoil	–
Rosaceae	GETR	*Geum triflorum*	prairie smoke	–
Rosaceae	POPE8	*Potentilla pensylvanica*	Pennsylvania cinquefoil	–
Rosaceae	POTEN	*Potentilla*	cinquefoil	Exotic
Rosaceae	PRVI	*Prunus virginiana*	chokecherry	–
Rosaceae	ROAR3	*Rosa arkansana*	prairie rose	–
Rosaceae	ROWO	*Rosa woodsii*	Woods' rose	–
Rubiaceae	GAAP2	*Galium aparine*	stickywilly	–
Rubiaceae	GABO2	*Galium boreale*	northern bedstraw	–
Santalaceae	COUM	*Comandra umbellata*	bastard toadflax	–
Saxifragaceae	HERI	*Heuchera richardsonii*	Richardson's alumroot	–
Scrophulariaceae	ORLU2	*Orthocarpus luteus*	yellow owl's-clover	–
Scrophulariaceae	PEER	*Penstemon eriantherus*	fuzzytongue penstemon	–
Scrophulariaceae	PEGR5	*Penstemon gracilis*	lilac penstemon	–

Table 3 (continued). A list of all plant species identified in Theodore Roosevelt National Park's long-term plant community monitoring plots in 2019. 'Exotic' in the notes column indicates that the species is invasive, or non-native. Species considered rare are marked with the appropriate state conservation ranks. If a species is noxious in the state of North Dakota, it is indicated in the notes column as Noxious - ND. If a species is noxious in an individual county within the state, it is indicated in the notes column as Noxious – County name.

Family	Symbol	Scientific Name	Common Name	Notes
Scrophulariaceae	PENST	*Penstemon*	beardtongue	–
Scrophulariaceae	VEPE2	*Veronica peregrina*	neckweed	–
Selaginellaceae	SEDE2	*Selaginella densa*	lesser spikemoss	–
Unknown family	UNKFORB	*Unknown forb*	unknown forb	Exotic
Unknown family	UNKGRAM	*Unknown graminoid*	unknown graminoid	Exotic
Urticaceae	PAPE5	*Parietaria pensylvanica*	Pennsylvania pellitory	–
Violaceae	VINU2	*Viola nuttallii*	Nuttall's violet; yellow prairie violet	–
Violaceae	VIPE2	*Viola pedatifida*	prairie violet	–
Vitaceae	PAVI5	*Parthenocissus vitacea*	woodbine	–

Based on the total count of unique species observed in all plots in 2019, PCM_0019 had the highest number with 106 total species, followed by PCM_0015 with 101 species (Table 4). PCM_0019 and PCM_0015 had the most native species, both totaling more than 90. Nine plots visited in 2019 each had more than 60 unique species identified within the plot. Absolute cover calculations (Table 5) showed that plots visited by NGPN and NGPFire had greater native species cover compared with exotic species cover. Plot FPCM_0105, had only one exotic species (*Poa pratensis*) recorded using the point-intercept method. Plot PCM_1026 had the highest absolute cover of exotic species (119%), and PCM_0019 had the highest absolute cover of native species at 260%.

Table 4. Total number of plant species identified in plots monitored at Theodore Roosevelt National Park in 2019. This is a count of all unique species identified in the plot using species data from point-intercept, quadrat, woody species, and early detection exotic species protocols. Note that quadrat data were not collected from plots with *, resulting in a lower total species count.

Plot Name	Native Species	Exotic Species	Total Species
THRON_FPCM_051*	19	4	23
THRON_FPCM_071*	18	3	21
THRON_FPCM_075*	24	4	28
THRON_FPCM_107*	28	3	31
THRON_PCM_005	46	9	55
THRON_PCM_008	69	10	79
THRON_PCM_015	54	11	65

Table 4 (continued). Total number of plant species identified in plots monitored at Theodore Roosevelt National Park in 2019. This is a count of all unique species identified in the plot using species data from point-intercept, quadrat, woody species, and early detection exotic species protocols. Note that quadrat data were not collected from plots with *, resulting in a lower total species count.

Plot Name	Native Species	Exotic Species	Total Species
THRON_PCM_514	47	7	54
THRON_PCM_519	29	11	40
THROS_FPCM_0105*	25	1	26
THROS_FPCM_0174	77	9	86
THROS_PCM_0013	26	13	39
THROS_PCM_0014	69	7	76
THROS_PCM_0015	93	8	101
THROS_PCM_0019	96	10	106
THROS_PCM_0023	84	9	93
THROS_PCM_0024	62	10	72
THROS_PCM_0041*	28	3	31
THROS_PCM_0044*	34	2	36
THROS_PCM_0045	33	7	40
THROS_PCM_0046	80	2	82
THROS_PCM_0069*	30	3	33
THROS_PCM_1026	23	15	38
THROS_PCM_1032	22	12	34

Table 5. Absolute percent cover of native and exotic plant species in plots monitored at Theodore Roosevelt National Park in 2019. Absolute percent cover was calculated using the point-intercept data. This includes overlapping species canopies, which can result in values greater than 100%.

	Absolute Cover %	
Plot	Native Species	Exotic Species
THRON_FPCM_051	90	57
THRON_FPCM_071	80	73
THRON_FPCM_075	149	62
THRON_FPCM_107	106	5
THRON_PCM_005	69	77
THRON_PCM_008	136	54
THRON_PCM_015	147	40
THRON_PCM_514	272	90
THRON_PCM_519	170	43

Table 5 (continued). Absolute percent cover of native and exotic plant species in plots monitored at Theodore Roosevelt National Park in 2019. Absolute percent cover was calculated using the point-intercept data. This includes overlapping species canopies, which can result in values greater than 100%.

	Absolute Cover %	
Plot	**Native Species**	**Exotic Species**
THROS_FPCM_0105	135	2
THROS_FPCM_0174	165	43
THROS_PCM_0013	26	115
THROS_PCM_0014	185	6
THROS_PCM_0015	201	22
THROS_PCM_0019	260	59
THROS_PCM_0023	231	34
THROS_PCM_0024	161	13
THROS_PCM_0041	183	28
THROS_PCM_0044	151	14
THROS_PCM_0045	68	10
THROS_PCM_0046	176	0
THROS_PCM_0069	151	19
THROS_PCM_1026	138	119
THROS_PCM_1032	167	95

The NGPN crew collected woody species data at 10 plots in 2019. Five unique species of trees and shrubs were identified, with Rocky Mountain juniper (*Juniperus scopulorum*) being the most frequently observed species.

Table 6. Woody species densities from 10 long-term monitoring plots visited at Theodore Roosevelt National Park in 2019. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

Plot Name	Common Name	DBH	Status	Density hectares
THRON_PCM_005	chokecherry	Seedling	Live	3373.65
THRON_PCM_008	Rocky mountain juniper	Seedling	Live	1400.38
THRON_PCM_008	chokecherry	Seedling	Live	922.98
THRON_PCM_008	green ash	Seedling	Live	63.65
THRON_PCM_008	Rocky mountain juniper	Pole	Live	127.39
THRON_PCM_008	Rocky mountain juniper	Tree	Live	90
THRON_PCM_015	Rocky mountain juniper	Seedling	Live	31.83
THRON_PCM_015	chokecherry	Seedling	Live	5983.45
THRON_PCM_015	green ash	Seedling	Live	159.13

Table 6 (continued). Woody species densities from 10 long-term monitoring plots visited at Theodore Roosevelt National Park in 2019. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

Plot Name	Common Name	DBH	Status	Density hectares
THRON_PCM_015	Rocky mountain juniper	Pole	Live	127.39
THRON_PCM_015	Rocky mountain juniper	Tree	Live	230
THRON_PCM_514	Rocky mountain juniper	Seedling	Live	381.92
THRON_PCM_514	chokecherry	Seedling	Live	63.65
THRON_PCM_514	green ash	Seedling	Live	1432.21
THRON_PCM_514	green ash	Pole	Live	31.85
THROS_PCM_0014	silver buffaloberry	Seedling	Live	286.44
THROS_PCM_0014	Rocky mountain juniper	Pole	Live	31.85
THROS_PCM_0014	Rocky mountain juniper	Tree	Live	10
THROS_PCM_0015	Rocky mountain juniper	Seedling	Live	732.02
THROS_PCM_0015	chokecherry	Seedling	Live	18236.79
THROS_PCM_0015	serviceberry	Seedling	Live	5983.45
THROS_PCM_0015	green ash	Seedling	Live	2259.71
THROS_PCM_0015	Rocky mountain juniper	Pole	Dead	31.85
THROS_PCM_0015	Rocky mountain juniper	Pole	Live	31.85
THROS_PCM_0015	chokecherry	Pole	Live	987.26
THROS_PCM_0015	green ash	Pole	Live	63.69
THROS_PCM_0015	Rocky mountain juniper	Tree	Dead	10
THROS_PCM_0015	Rocky mountain juniper	Tree	Live	80
THROS_PCM_0019	chokecherry	Seedling	Live	7352.01
THROS_PCM_0019	silver buffaloberry	Seedling	Live	350.1
THROS_PCM_0019	silver buffaloberry	Seedling	Live	190.96
THROS_PCM_0023	Rocky mountain juniper	Seedling	Live	31.83
THROS_PCM_0023	silver buffaloberry	Seedling	Live	1368.56
THROS_PCM_0023	silver buffaloberry	Pole	Live	63.69
THROS_PCM_0024	Rocky mountain juniper	Seedling	Live	190.96
THROS_PCM_0024	Rocky mountain juniper	Pole	Live	31.85
THROS_PCM_0024	Rocky mountain juniper	Tree	Live	30
THROS_PCM_0046	chokecherry	Seedling	Live	31.83
THROS_PCM_0046	Rocky mountain juniper	Pole	Live	31.85
THROS_PCM_0046	Rocky mountain juniper	Tree	Live	20

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. NGPN observed measurable surface fuels in three plots at THRO in 2019 (Table 7).

Table 7. Surface fuels summary for three plots visited in 2019 at Theodore Roosevelt National Park by Northern Great Plains Network.

	Average Tons per Acre										Avg. Depth (in.)		
Macroplot	1-hr	10-hr	100-hr	1-100-hr	1000-hr sound	1000-hr rotten	1-1000-hr	Duff	Litter	Total	Duff	Litt	Total
THRON_PCM_008	0.01	0.17	0.00	0.17	0.00	0.00	0.17	4.43	4.27	8.88	0.2	0.5	0.8
THROS_PCM_0015	0.01	0.84	0.69	1.54	0.35	0.00	1.89	3.83	3.51	9.23	0.2	0.4	0.6
THROS_PCM_0024	0.00	0.00	0.00	0.00	0.26	0.00	0.26	0.00	0.88	1.14	0.0	0.1	0.1

Disturbances were observed in 12 of the 15 plots visited at THRO by NGPN in 2019 (Table 8). NGPFire did not collect disturbance data at the 9 plots they monitored. The most common disturbances were the results of animal activity, including grazing, animal trails, bison wallows, and prairie dog mounds. All 15 plots visited by NGPN were also assessed for the presence of early detection exotic species, and none were observed in 2019.

Table 8. Disturbance type and size (area in m^2) observed in 12 plots visited at Theodore Roosevelt National Park by Northern Great Plains Network in 2019. The disturbance area was approximated as a proportion of the total plot area of 1000 m^2 or recorded as present.

Plot	Disturbance Type	Area (m^2)
THRON_PCM_005	Fire	Present
THRON_PCM_005	Grazing	300
THRON_PCM_005	Wallow	15
THRON_PCM_005	Soil Disturbance	15
THRON_PCM_005	Animal Trail	10
THRON_PCM_008	Animal Trail	5
THRON_PCM_008	Grazing	5
THRON_PCM_008	Soil Disturbance	3
THRON_PCM_008	Small Mammal	1
THRON_PCM_015	Animal Trail	25
THRON_PCM_015	Soil Disturbance	15
THRON_PCM_015	Wallow	3
THRON_PCM_015	Grazing	2
THRON_PCM_015	Small Mammal	1
THRON_PCM_514	Animal Trail	25
THRON_PCM_514	Small Mammal	2

Table 8 (continued). Disturbance type and size (area in m2) observed in 12 plots visited at Theodore Roosevelt National Park by Northern Great Plains Network in 2019. The disturbance area was approximated as a proportion of the total plot area of 1000 m2 or recorded as present.

Plot	Disturbance Type	Area (m^2)
THRON_PCM_514	Soil Disturbance	2
THRON_PCM_519	Animal Trail	20
THRON_PCM_519	Soil Disturbance	10
THROS_PCM_0013	Soil Disturbance	15
THROS_PCM_0013	Soil Disturbance	15
THROS_PCM_0014	Small Mammal	5
THROS_PCM_0014	Soil Disturbance	5
THROS_PCM_0015	Animal Trail	20
THROS_PCM_0015	Soil Disturbance	12
THROS_PCM_0015	Erosion	10
THROS_PCM_0019	Animal Trail	50
THROS_PCM_0019	Soil Disturbance	28
THROS_PCM_0023	Animal Trail	2
THROS_PCM_0046	Animal Trail	20
THROS_PCM_0046	Grazing	5
THROS_PCM_0046	Soil Disturbance	3
THROS_PCM_0046	Erosion	2
THROS_PCM_1032	Flood	1000
THROS_PCM_1032	Soil Disturbance	215
THROS_PCM_1032	Wallow	15
THROS_PCM_1032	Grazing	10

Further Analysis

This 2019 Data Summary Report is intended to provide a basic review of the data collected during the NGPN team's 2019 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 it is archived at https://irma.nps.gov/DataStore. For an in-depth data analysis on long-term trends at THRO, refer to the 2011–2016 summary report (Ashton and Davis 2017).

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. W. and C. J. Davis. 2017. Plant community composition and structure at Theodore Roosevelt National Park: 2011-2016 summary report. Natural Resource Report NPS/NGPN/NRR—2017/1497. National Park Service, Fort Collins, Colorado.

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.

R Core Team. 2019. R: A language and environment for statistical computing. Vienna, Austria. https://www.R-project.org

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. 2017. The PLANTS Database (http://plants.usda.gov, 06 February 2017). National Plant Data Team, Greensboro, NC 27401-4901 USA.

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