



Plant Community Composition and Structure Monitoring at Devils Tower National Monument

2019 Data Report

Natural Resource Data Series NPS/DETO/NRDS—2019/1249





ON THIS PAGE

Plant community composition and structure monitoring plot DETO_PCM_007 at Devil's Tower National Monument, July 2019. Photograph courtesy of the National Park Service.

ON THE COVER

A view of the valley from monitoring plot PCM_008 at Devils Tower National Monument, 2019. Photograph courtesy of the National Park Service

Plant Community Composition and Structure Monitoring at Devils Tower National Monument

2019 Data Report

Natural Resource Data Series NPS/DETO/NRDS—2019/1249

Ryan M. Manuel¹, Daniel J. Swanson²

¹National Park Service
Northern Great Plains Inventory & Monitoring Network
820 Columbus St.
Rapid City, SD 57701

²National Park Service
Northern Great Plains Fire Management
26611 U.S. Hwy 385
Hot Springs, SD 57747

December 2019

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 those 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 the [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., and D. J. Swanson. 2019. Plant community composition and structure monitoring at Devils Tower National Monument: 2019 data report. Natural Resource Data Series NPS/DETO/NRDS—2019/1249. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	iv
Tables.....	v
Abstract.....	vi
Acknowledgments.....	vii
Introduction.....	1
Methods.....	3
Sample Design.....	3
Plant Community Plots.....	3
Plot Layout and Sampling.....	4
Data Management and Analysis.....	7
Results.....	9
Further Analysis.....	19
Literature Cited.....	20

Figures

	Page
Figure 1. Map of Devils Tower National Monument plant community monitoring plots visited in 2019 by the Northern Great Plains Network Inventory & Monitoring Program (green) and the Fire Ecology Program (red).	2
Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.....	6
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.....	6
Figure 4. Long-term monitoring plot PCM_011 at Devils Tower National Monument is located in the northern portion of the park and had the highest tree density in the park in 2019.....	15

Tables

	Page
Table 1. Field journal for monitoring plot visits at Devils Tower National Monument in 2019.....	4
Table 2. Exotic species included in the Northern Great Plains Network’s early detection and rapid response program.	7
Table 3. List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2019.....	9
Table 4. Total number of plant species identified in each of the 12 monitoring plot visits where herbaceous plant data were collected at Devils Tower National Monument in 2019.....	14
Table 5. Absolute percent cover of native and exotic plant species in plots monitored at Devils Tower National Monument in 2019.	15
Table 6. Woody species data from 10 long-term monitoring plots visited at Devil’s Tower National Monument in 2019.....	16
Table 7. Surface fuels data for wooded plots at Devils Tower National Monument in 2019.....	18
Table 8. Disturbance type and area observed in 8 of 15 plots visited at Devil’s Tower National Monument by the Northern Great Plains Network in 2019.	18

Abstract

This report presents the results of vegetation monitoring efforts in 2019 at Devils Tower National Monument (DETO) by the Northern Great Plains Inventory and Monitoring Network (NGPN) and Fire Ecology Program (NGPFire). This was the ninth year of combined monitoring efforts.

Crew members from NGPN visited eight long-term monitoring plots to collect data on the plant communities at DETO. The NGPFire crew visited an additional 8 plots in the North Terrace and Graham Burn Units to collect plant community data following prescribed fire. This work is part of a long-term monitoring effort designed to provide a better understanding of the condition of the vegetation community and how it changes over time and in response to prescribed fire. NGPN and NGPFire staff measured species richness, herb-layer height, native and non-native species abundance, ground cover, and site disturbance at each of the plots. In plots where woody species were present, tree regeneration, tall shrub density, tree density, and woody fuel loads were measured.

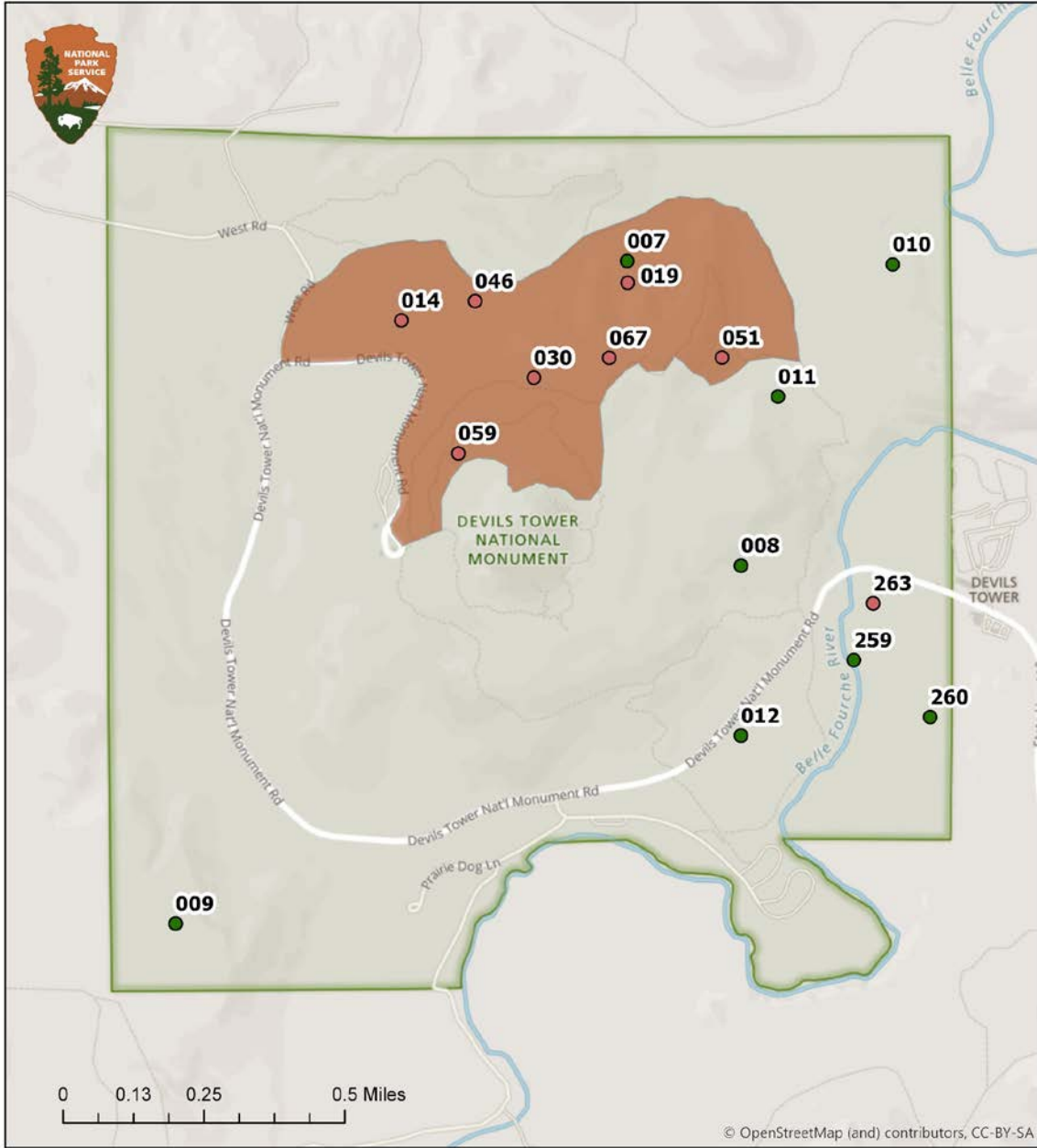
In 2019, monitoring crews identified 151 unique plant species in 14 monitoring plots. Of those species, 27 were exotic species. On average, the absolute cover of native species was greater than the absolute cover of exotic species. There were no state-listed noxious species or rare species observed in 2019. Trees were present in only 10 of the plots and these were dominated by ponderosa pine. Seedling density was highly variable with many sites having none and others had more than one thousand stems per hectare.

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 DETO, including H. Gage, M. Stover, G. Wood, N. Bossenbroek, and V. Ruud for assisting with field work. The 2019 NGPN vegetation field crew – S. Rockwood, T. Schaffner, and T. Bortz, – and NGPFire crew – D. Swanson, I. Muirhead, M. Pahler and L. Badertscher- collected the data included in this report.

Introduction

Devils Tower National Monument (DETO) was established in 1906 as America's first national monument, with a mission to protect and preserve the impressive rock tower and the lands around it. It is located in northeastern Wyoming on the edge of the Black Hills. The vegetation is a mosaic of ponderosa pine woodlands and mixed-grass prairie, with a narrow riparian corridor of cottonwoods. Vegetation monitoring began at DETO in 1997 by the Northern Great Plains Fire Ecology Program (NGPFire; Wienk et al. 2010). In 2011, the Northern Great Plains Inventory & Monitoring Network (NGPN) combined efforts with NGPFire to establish a coordinated vegetation monitoring protocol and plot locations were shifted to better represent the entire park (Symstad et al. 2012b; Figure 1). Combined sampling efforts began in 2011 (Ashton et al. 2012). In this report, we provide summaries of the vegetation data collected at seven plant community plot visits and seven fire effects plot visits in 2019.



Devils Tower National Monument
Devils Tower, WY 82714

Northern Great Plains Inventory & Monitoring Network
National Park Service
11/19/2019



2019 Plant Community Monitoring

- North Terrace Burn Unit (2017)
- Roads
- Trails
- Fire Effects Plots
- Plant Community Plots

Figure 1. Map of Devils Tower National Monument plant community monitoring plots visited in 2019 by the Northern Great Plains Network Inventory & Monitoring Program (green) and the Fire Ecology Program (red). Prescribed fire burn unit areas are indicated by colored polygons on the map.

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. The general approach is briefly described below. For more detail, please see the monitoring protocol and standard operating procedures, available at <https://www.nps.gov/im/ngpn/plant-communities.htm>.

Sample Design

Plant Community Plots

The NGPN team implemented a survey to monitor plant community structure and composition in DETO using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003 & 2004). Using the GRTS design, NGPN selected 20 randomly located sites within DETO to install Plant Community Monitoring (PCM) plots. These 20 plots are split into five panels containing four plots each. The NGPN visits eight PCM plots (two panels) annually using a rotating sampling scheme that includes four plots visited the previous year and four plots that have not been visited for five years (Figure 1). In a full five-year rotation, each plot will be visited twice. In 2019, the NGPN crew visited PCM plots in panels 3 and 4 during the week of July 8-10 (Table 1). Of the eight plots, six were in upland habitat and two were in the riparian corridor (PCM_259 and PCM_260). Due to more than 50% standing water PCM_260 was not read and given a dormant status.

The Northern Great Plains Fire Ecology Program (NGPFire) crew has established sites at DETO using the same GRTS design, but those plot locations are not randomly selected. Rather, they are focused in active burn units. When applicable, a PCM plot may also be visited from panel 1 through 5, but outside the schedule rotation described above. In 2019, seven sites were visited in the North Terrace Burn Unit in the northern portion of the park and one site (PCM_263) was visited in the Entrance Burn Unit in the southeastern portion of the park (Figure 1). Due to more than 50% standing water PCM_263 was not read and given a dormant status.

Table 1. Field journal for monitoring plot visits at Devils Tower National Monument in 2019. A total of 16 plots were visited by Northern Great Plains Inventory & Monitoring and Fire Ecology Programs. The general type of vegetation data collected at each plot is indicated in the plot type column where PC3 is plant community panel 3, PC4 is plant community panel 4, etc. and FS is a Forest Structure Plot.

Plot	Plot Type	Date Visited	Program	Notes
PCM_007	PC3	7/9/2019	NGPN	–
PCM_008	PC3	7/9/2019	NGPN	–
PCM_009	PC3	7/9/2019	NGPN	–
PCM_259	PC3	7/8/2019	NGPN	–
PCM_010	PC4	7/10/2019	NGPN	–
PCM_011	PC4	7/10/2019	NGPN	–
PCM_012	PC4	7/8/2019	NGPN	–
PCM_260	PC4	7/8/2019	NGPN	Not read due to standing water greater than 50%
PCM_067	FS	7/9/2019	FX	–
PCM_059	FS	7/9/2019	FX	–
PCM_051	FS	7/10/2019	FX	–
PCM_046	FS	7/8/2019	FX	–
PCM_030	FS	7/9/2019	FX	–
PCM_019	FS	7/10/2019	FX	–
PCM_014	PC5	7/10/2019	FX	–
PCM_263	PC1	7/11/2019	FX	Not read due to standing water greater than 50%

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 (≤ 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 m² quadrats located systematically along each transect (Figure 2). 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. NGPFire collected point-intercept data from five plots visited in the North Terrace unit but did not collect species presence data from quadrats.

When woody species were present within 38 m of plot center, tree regeneration and tall shrub density data were collected within a 10 m radius subplot centered in the larger 50 m x 20 m (0.1 ha) plot. Trees within the entire 0.1 ha plot with a diameter at breast height (DBH) of > 15 cm were mapped and tagged. For each tree, the species, DBH, status (live or dead), and condition (e.g., leaf-discoloration, insect-damaged) were recorded. For all poles ($2.54 \leq \text{DBH} \leq 15$ cm) located within the 10 m radius subplot, only the species, DBH, and status were recorded. Tree and tall shrub species with $\text{DBH} < 2.54$ 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 3), 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.

In six plots, NGPFire did not measure herbaceous plants and instead focused on trees. The methods used for forest structure monitoring were similar to those previously described for plant community monitoring plots. Data were collected for tree density and condition, seedling density, disturbance type and extent, and target species cover at each forest monitoring plot. There were some important differences between plant community and forest structure protocols. In forest structure plots (1) the plot size was smaller and data on trees were only collected within a 10 m radius around plot center (Figure 2 below; only the seedling and pole sampling area); (2) trees were not tagged; (3) neither point-intercept nor 1 m² quadrat data were collected; and (4) disturbances and target species were measured when they were located within a 50 ft radius of the center (Figure 2; Transect 1 and 2 are the diameters of the circle).

Common disturbances were assessed and documented at each plot. The type of disturbance, such as animal trails, erosion or prairie dogs was recorded. In 2018 a new category called soil disturbance was added, which is defined as loose, exposed soil from all sources. Plots were also assessed for the presence and abundance of target exotic species (Table 2), which is critical for early detection and rapid response to exotic species threats. These 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.

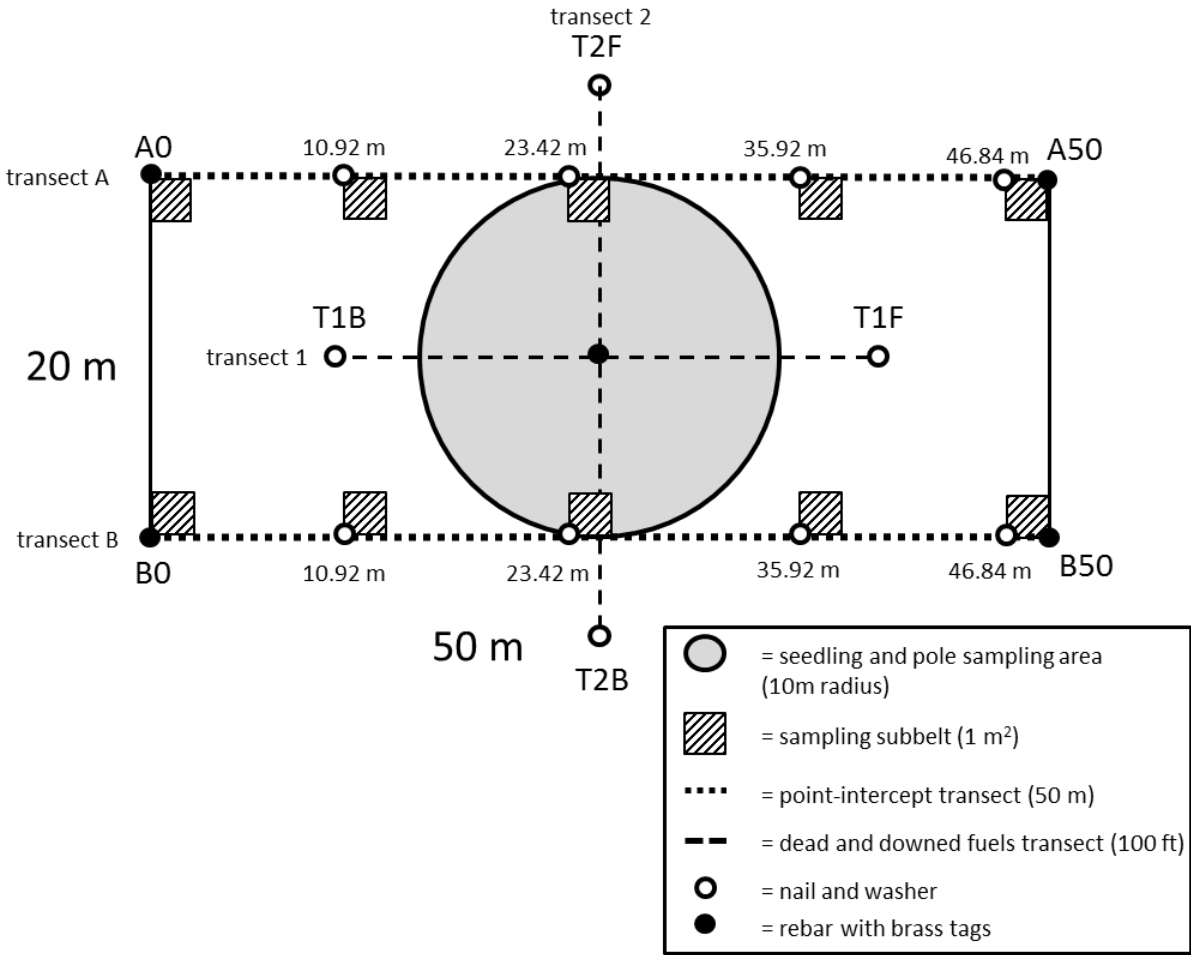


Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.

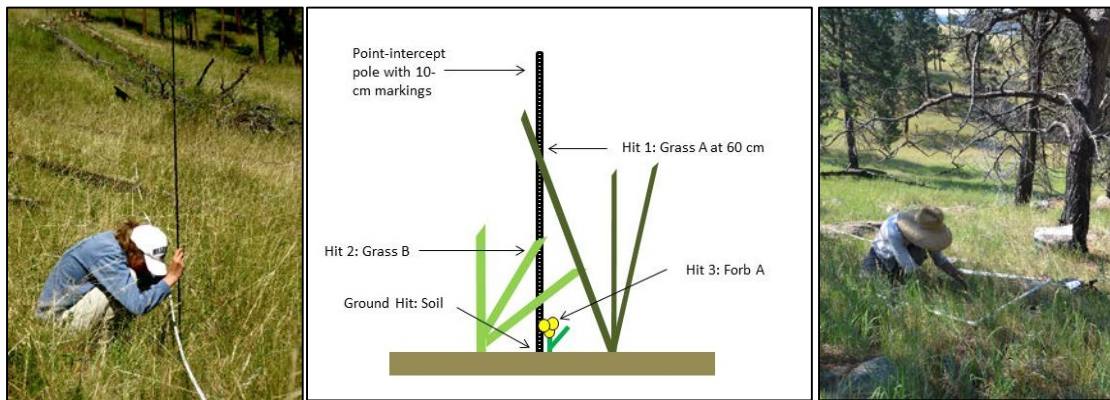


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

Table 2. Exotic species included in the Northern Great Plains Network’s early detection and rapid response program. These are species that are either highly uncommon or not currently present in the park.

Habitat	Scientific Name	Common Name
Riparian	<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
Upland	<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

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 2018). However, nomenclature follows the Integrated Taxonomic Information System (ITIS). In the few cases where ITIS recognized a new name that was not in the USDA PLANTS database, the new name was used, and a unique plant code was assigned.

After data 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. 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 DETO in 2019 was determined by cross-referencing with the [NatureServe](#) conservation status list, as well as the Nebraska rare plant species lists. For the purpose of this report, a species is considered rare or of conservation concern if its global (G) or state (S) conservation status rank is classified as critically imperiled (G1/S1), imperiled (G2/S2), or vulnerable (G3/S3). The 2019 species list was also cross-referenced with the list of county and state noxious weeds maintained by the [Wyoming Weed and Pest Council](#).

Results

There are 472 vascular plant species on the DETO species list, and NGPN and NGPFire monitoring crews identified a total of 151 species from 14 monitoring plots in 2019 (Table 3). Of these species, 27 are exotic or unknown origin species for the park. The 2019 species list was cross-referenced with state-wide rare and noxious exotic species lists for Wyoming. There were no state-listed rare or noxious species observed in 2019, but *Cirsium vulgare*, bull thistle is considered noxious in Crook County, WY.

Table 3. List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2019. In the Notes column, “Exotic” indicates that a 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. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Species Code	Scientific Name	Common Name	Notes
Aceraceae	ACNE2	<i>Acer negundo</i>	boxelder	–
Asclepiadaceae	ASPU	<i>Asclepias pumila</i>	plains milkweed	–
Asclepiadaceae	ASSP	<i>Asclepias speciosa</i>	showy milkweed	–
Asteraceae	ACMI2	<i>Achillea millefolium</i>	common yarrow	–
Asteraceae	AMPS	<i>Ambrosia psilostachya</i>	Cuman ragweed	–
Asteraceae	ANPA4	<i>Antennaria parvifolia</i>	small-leaf pussytoes	–
Asteraceae	ARLU	<i>Artemisia ludoviciana</i>	white sagebrush	–
Asteraceae	CIAR4	<i>Cirsium arvense</i>	Canada thistle	Exotic
Asteraceae	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle	–
Asteraceae	CIVU	<i>Cirsium vulgare</i>	bull thistle	Noxious/ Crook
Asteraceae	COCA5	<i>Conyza canadensis</i>	horseweed	–
Asteraceae	CORA4	<i>Conyza ramosissima</i>	dwarf horseweed	–
Asteraceae	ECAN2	<i>Echinacea angustifolia</i>	blacksamson echinacea	–
Asteraceae	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed	–
Asteraceae	HEAN3	<i>Helianthus annuus</i>	common sunflower	–
Asteraceae	LASE	<i>Lactuca serriola</i>	prickly lettuce	Exotic
Asteraceae	LIPU	<i>Liatris punctata</i>	dotted blazing star	–
Asteraceae	LOAR5	<i>Logfia arvensis</i>	field cottonrose	Exotic
Asteraceae	LYJU	<i>Lygodesmia juncea</i>	rush skeletonplant	–
Asteraceae	MUOB99	<i>Mulgedium oblongifolium</i>	blue lettuce	–
Asteraceae	PAPL12	<i>Packera plattensis</i>	prairie groundsel	–

Table 3 (continued). List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2019. In the Notes column, “Exotic” indicates that a 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. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Species Code	Scientific Name	Common Name	Notes
Asteraceae	PIOP	<i>Picradeniopsis oppositifolia</i>	oppositeleaf bahia	–
Asteraceae	PSMA11	<i>Pseudognaphalium macounii</i>	Macoun's cudweed	–
Asteraceae	RACO3	<i>Ratibida columnifera</i>	upright prairie coneflower	–
Asteraceae	SOMI2	<i>Solidago missouriensis</i>	Missouri goldenrod	–
Asteraceae	SONE	<i>Solidago nemoralis</i>	gray goldenrod	–
Asteraceae	SORI2	<i>Solidago rigida</i>	stiff goldenrod	–
Asteraceae	SYER	<i>Symphyotrichum ericoides</i>	white heath aster	–
Asteraceae	SYFA	<i>Symphyotrichum falcatum</i>	white prairie 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	–
Berberidaceae	BERE	<i>Berberis repens</i>	Oregon grape	–
Boraginaceae	CYOF	<i>Cynoglossum officinale</i>	houndstongue	Exotic
Boraginaceae	LAOC3	<i>Lappula occidentalis</i>	flatspine stickseed	–
Boraginaceae	LIIN2	<i>Lithospermum incisum</i>	narrowleaf stoneseed	–
Brassicaceae	ALDE	<i>Alyssum desertorum</i>	desert madwort	Exotic
Brassicaceae	ARPY4	<i>Arabis pycnocarpa</i>	creamflower rockcross	–
Brassicaceae	BOCO4	<i>Boechera collinsii</i>	Collins' rockcross	–
Brassicaceae	DEPI	<i>Descurainia pinnata</i>	western tansymustard	–
Brassicaceae	DRRE2	<i>Draba reptans</i>	Carolina draba	–
Brassicaceae	SIAL2	<i>Sisymbrium altissimum</i>	tall tumbledustard	Exotic
Brassicaceae	THAR5	<i>Thlaspi arvense</i>	field pennycress	Exotic
Cactaceae	OPFR	<i>Opuntia fragilis</i>	brittle 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	–
Caryophyllaceae	CEBR3	<i>Cerastium brachypodium</i>	shortstalk chickweed	–
Caryophyllaceae	SIAN2	<i>Silene antirrhina</i>	sleepy silene	–
Chenopodiaceae	CHENO	<i>Chenopodium</i>	goosefoot	Exotic

Table 3 (continued). List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2019. In the Notes column, “Exotic” indicates that a 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. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Species Code	Scientific Name	Common Name	Notes
Chenopodiaceae	CHSI2	<i>Chenopodium simplex</i>	mapleleaf goosefoot	–
Chenopodiaceae	SATR12	<i>Salsola tragus</i>	prickly Russian thistle	Exotic
Cupressaceae	JUSC2	<i>Juniperus scopulorum</i>	Rocky Mountain juniper	–
Cyperaceae	CADU6	<i>Carex duriuscula</i>	needleleaf sedge	–
Cyperaceae	CAEM2	<i>Carex emoryi</i>	Emory's sedge	–
Cyperaceae	CAFI	<i>Carex filifolia</i>	threadleaf sedge	–
Cyperaceae	CAIN9	<i>Carex inops</i>	sun sedge	–
Cyperaceae	CAPE11	<i>Carex peckii</i>	Peck's sedge	–
Cyperaceae	CAREX	<i>Carex</i>	sedge	–
Cyperaceae	CARO5	<i>Carex rossii</i>	Ross' sedge	–
Cyperaceae	CASP7	<i>Carex sprengeii</i>	Sprengel's sedge	–
Equisetaceae	EQLA	<i>Equisetum laevigatum</i>	smooth horsetail	–
Euphorbiaceae	EUES	<i>Euphorbia esula</i>	leafy spurge	Exotic
Euphorbiaceae	EUPHO	<i>Euphorbia</i>	spurge; sandmat	–
Fabaceae	ACAM99	<i>Acmispon americanus</i>	American bird's-foot trefoil	–
Fabaceae	ASAG2	<i>Astragalus agrestis</i>	purple milkvetch	–
Fabaceae	ASCR2	<i>Astragalus crassicaarpus</i>	groundplum milkvetch	–
Fabaceae	ASFL2	<i>Astragalus flexuosus</i>	flexile milkvetch	–
Fabaceae	ASLA27	<i>Astragalus laxmannii</i>	Laxmann's milkvetch	–
Fabaceae	ASLO4	<i>Astragalus lotiflorus</i>	lotus milkvetch	–
Fabaceae	ASMI10	<i>Astragalus missouriensis</i>	Missouri milkvetch	–
Fabaceae	ASTRA	<i>Astragalus</i>	milkvetch	–
Fabaceae	DACA7	<i>Dalea candida</i>	white prairie clover	–
Fabaceae	DAPU5	<i>Dalea purpurea</i>	purple prairie clover	–
Fabaceae	MELU	<i>Medicago lupulina</i>	black medick	Exotic
Fabaceae	MEOF	<i>Melilotus officinalis</i>	yellow sweetclover	Exotic
Fabaceae	PEAR6	<i>Pedimelum argophyllum</i>	silverleaf Indian breadroot	–
Fabaceae	PEES	<i>Pedimelum esculentum</i>	large Indian breadroot	–
Fabaceae	PSTE5	<i>Psoralidium tenuiflorum</i>	slimflower scurfpea	–
Fabaceae	THRH	<i>Thermopsis rhombifolia</i>	golden pea	–
Fabaceae	VIAM	<i>Vicia americana</i>	American vetch	–

Table 3 (continued). List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2019. In the Notes column, “Exotic” indicates that a 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. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Species Code	Scientific Name	Common Name	Notes
Fagaceae	QUMA2	<i>Quercus macrocarpa</i>	bur oak	–
Geraniaceae	GECA5	<i>Geranium carolinianum</i>	Carolina geranium	–
Iridaceae	SIMO2	<i>Sisyrinchium montanum</i>	strict blue-eyed grass	–
Lamiaceae	HEHI	<i>Hedeoma hispida</i>	rough false pennyroyal	–
Lamiaceae	MOFI	<i>Monarda fistulosa</i>	wild bergamot	–
Liliaceae	ALTE	<i>Allium textile</i>	textile onion	–
Liliaceae	CAGU	<i>Calochortus gunnisonii</i>	Gunnison's mariposa lily	–
Liliaceae	CANU3	<i>Calochortus nuttallii</i>	sego lily	–
Linaceae	LILE3	<i>Linum lewisii</i>	Lewis flax	–
Malvaceae	SPCO	<i>Sphaeralcea coccinea</i>	scarlet globemallow	–
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	–
Oxalidaceae	OXST	<i>Oxalis stricta</i>	common yellow woodsorrel	–
Pinaceae	PIPO	<i>Pinus ponderosa</i>	ponderosa pine	–
Plantaginaceae	PLPA2	<i>Plantago patagonica</i>	woolly plantain	–
Poaceae	ACNE9	<i>Achnatherum nelsonii</i>	Columbia needlegrass	–
Poaceae	ANGE	<i>Andropogon gerardii</i>	big bluestem	–
Poaceae	APIN	<i>Apera interrupta</i>	dense silkybent	Exotic
Poaceae	ARPU9	<i>Aristida purpurea</i>	purple threeawn	–
Poaceae	BOCU	<i>Bouteloua curtipendula</i>	sideoats grama	–
Poaceae	BODA2	<i>Bouteloua dactyloides</i>	buffalograss	–
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	BRTE	<i>Bromus tectorum</i>	cheatgrass	Exotic
Poaceae	CALO	<i>Calamovilfa longifolia</i>	prairie sandreed	–
Poaceae	DASP2	<i>Danthonia spicata</i>	poverty oatgrass	–
Poaceae	ELCA4	<i>Elymus canadensis</i>	Canada wildrye	–
Poaceae	ELRE4	<i>Elymus repens</i>	quackgrass	Exotic
Poaceae	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	–

Table 3 (continued). List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2019. In the Notes column, “Exotic” indicates that a 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. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Species Code	Scientific Name	Common Name	Notes
Poaceae	ELVI3	<i>Elymus virginicus</i>	Virginia wildrye	–
Poaceae	ELYMU	<i>Elymus</i>	wildrye	Exotic
Poaceae	HECO26	<i>Hesperostipa comata</i>	needle and thread	–
Poaceae	HESP11	<i>Hesperostipa spartea</i>	porcupinegrass	–
Poaceae	KOMA	<i>Koeleria macrantha</i>	prairie Junegrass	–
Poaceae	MUCU3	<i>Muhlenbergia cuspidata</i>	plains muhly	–
Poaceae	MURA	<i>Muhlenbergia racemosa</i>	marsh muhly	–
Poaceae	NAVI4	<i>Nassella viridula</i>	green needlegrass	–
Poaceae	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	–
Poaceae	POPR	<i>Poa pratensis</i>	Kentucky bluegrass	Exotic
Poaceae	SCPU	<i>Schizachne purpurascens</i>	false melic	–
Poaceae	SCSC	<i>Schizachyrium scoparium</i>	little bluestem	–
Poaceae	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	–
Poaceae	SPPE	<i>Spartina pectinata</i>	prairie cordgrass	–
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	POAV	<i>Polygonum aviculare</i>	prostrate knotweed	Exotic
Primulaceae	ANOC2	<i>Androsace occidentalis</i>	western rockjasmine	–
Ranunculaceae	ANCY	<i>Anemone cylindrica</i>	candle anemone	–
Ranunculaceae	ANPA19	<i>Anemone patens</i>	eastern pasqueflower	–
Rosaceae	PRVI	<i>Prunus virginiana</i>	chokecherry	–
Rubiaceae	GAAP2	<i>Galium aparine</i>	stickywilly	–
Rubiaceae	GABO2	<i>Galium boreale</i>	northern bedstraw	–
Salicaceae	POTR5	<i>Populus tremuloides</i>	quaking aspen	–
Scrophulariaceae	PEGR5	<i>Penstemon gracilis</i>	lilac penstemon	–
Scrophulariaceae	SYWY99	<i>Synthyris wyomingensis</i>	Wyoming kittentails	–
Scrophulariaceae	VEAR	<i>Veronica arvensis</i>	corn speedwell	Exotic
Scrophulariaceae	VEPE2	<i>Veronica peregrina</i>	neckweed	–
Scrophulariaceae	VETH	<i>Verbascum thapsus</i>	common mullein	Exotic
Selaginellaceae	SEDE2	<i>Selaginella densa</i>	lesser spikemoss	–
Solanaceae	PHHE5	<i>Physalis heterophylla</i>	clammy groundcherry	–
Solanaceae	SOTR	<i>Solanum triflorum</i>	cutleaf nightshade	–

Table 3 (continued). List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2019. In the Notes column, “Exotic” indicates that a 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. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Species Code	Scientific Name	Common Name	Notes
Unknown Family	UNKFORB	<i>Unknown forb</i>	unknown forb	Exotic
Unknown Family	UNKGRAMPER	<i>Unknown perennial graminoid</i>	unknown perennial graminoid	Exotic
Verbenaceae	VEBR	<i>Verbena bracteata</i>	bigbract verbena	–
Violaceae	VIAD	<i>Viola adunca</i>	hookedspur violet	–
Violaceae	VIOLA	<i>Viola</i>	violet	–

Based on the number of unique species observed in each plot in 2019, PCM_008 and PCM_011 had the greatest species richness with 48 total species each (Table 4). Plot PCM_011 had the greatest native species richness with 41 unique native species identified. Absolute cover calculations (Table 5) showed that absolute native species cover was greater than absolute exotic species cover in nine of twelve plots where cover data were collected. PCM_012 had the highest native species cover, and PCM_007 had the highest exotic species cover (Table 5). We found exotic species at every plant community plot in DETO and they were abundant in most plots.

Table 4. Total number of plant species identified in each of the 12 monitoring plot visits where herbaceous plant data were collected at Devils Tower National Monument in 2019. This is a count of all unique species identified in the plot using species data from point-intercept, quadrat, woody species, and target species protocols. Note that quadrat data was not collected in plots monitored by the Northern Great Plains Fire Ecology Program (indicated with an asterisk), resulting in lower species counts in those plots.

Plot	Native Species	Exotic Species	Total
DETO_PCM_007	24	11	35
DETO_PCM_008	39	9	48
DETO_PCM_009	17	8	25
DETO_PCM_010	36	8	44
DETO_PCM_011	41	7	48
DETO_PCM_012	28	13	41
DETO_PCM_014*	20	3	23
DETO_PCM_019*	22	8	30
DETO_PCM_030*	17	4	21
DETO_PCM_046*	18	5	23
DETO_PCM_051*	22	6	28
DETO_PCM_259	22	15	37

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

Plot	Absolute % Native Cover	Absolute % Exotic Cover
PCM_007	62	131
PCM_008	120	83
PCM_009	96	52
PCM_010	131	12
PCM_011	140	36
PCM_012	193	19
PCM_014	116	45
PCM_019	82	88
PCM_030	103	52
PCM_046	116	73
PCM_051	136	34
PCM_259	57	74

Monitoring crews collected data at 14 monitoring plots, and of these plots, 10 had measurable woody species. The dominant woody species was ponderosa pine (Table 6). Plot PCM_011 had the greatest tree density with an average 330 trees per hectare (Figure 4). PCM_030 had the greatest seedling density with an average of 15,340 ponderosa pine seedlings per hectare. Surface fuels at plots with woody debris present averaged 16.9 tons per acre (Table 7).



Figure 4. Long-term monitoring plot PCM_011 at Devils Tower National Monument is located in the northern portion of the park and had the highest tree density in the park in 2019. Photograph courtesy of the National Park Service.

Table 6. Woody species data from 10 long-term monitoring plots visited at Devil's Tower National Monument 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	Status	DBH	Density/ha
DETO_PCM_007	ponderosa pine	Live	Seedling	31.83
DETO_PCM_007	bur oak	Dead	Pole	31.85
DETO_PCM_007	bur oak	Live	Tree	10
DETO_PCM_007	ponderosa pine	Dead	Tree	20
DETO_PCM_007	ponderosa pine	Live	Tree	140
DETO_PCM_008	ponderosa pine	Dead	Tree	10
DETO_PCM_010	boxelder	Live	Seedling	286.44
DETO_PCM_010	bur oak	Live	Seedling	95.48
DETO_PCM_010	ponderosa pine	Live	Seedling	127.31
DETO_PCM_010	ponderosa pine	Dead	Tree	20
DETO_PCM_010	ponderosa pine	Live	Tree	110
DETO_PCM_011	ponderosa pine	Dead	Pole	31.85
DETO_PCM_011	ponderosa pine	Live	Pole	63.69
DETO_PCM_011	ponderosa pine	Dead	Tree	40
DETO_PCM_011	ponderosa pine	Live	Tree	330
DETO_PCM_019	ponderosa pine	Live	Seedling	222.79
DETO_PCM_019	ponderosa pine	Dead	Pole	31.85
DETO_PCM_019	ponderosa pine	Dead	Tree	63.69
DETO_PCM_019	ponderosa pine	Live	Tree	127.39
DETO_PCM_030	ponderosa pine	Live	Seedling	15340.55
DETO_PCM_030	bur oak	Dead	Pole	159.24
DETO_PCM_030	ponderosa pine	Dead	Pole	31.85
DETO_PCM_030	bur oak	Live	Tree	63.69
DETO_PCM_030	ponderosa pine	Dead	Tree	95.54
DETO_PCM_030	ponderosa pine	Live	Tree	191.08
DETO_PCM_046	ponderosa pine	Live	Seedling	477.4
DETO_PCM_046	bur oak	Live	Tree	159.24
DETO_PCM_046	ponderosa pine	Live	Tree	159.24
DETO_PCM_051	ponderosa pine	Live	Tree	31.85
DETO_PCM_059	chokecherry	Live	Seedling	5283.26
DETO_PCM_059	quaking aspen	Live	Seedling	986.63
DETO_PCM_059	bur oak	Live	Seedling	31.83
DETO_PCM_059	ponderosa pine	Live	Seedling	95.48
DETO_PCM_059	quaking aspen	Dead	Pole	31.85

Table 6 (continued). Woody species data from 10 long-term monitoring plots visited at Devil's Tower National Monument 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	Status	DBH	Density/ha
DETO_PCM_059	ponderosa pine	Dead	Pole	31.85
DETO_PCM_059	ponderosa pine	Live	Pole	254.78
DETO_PCM_059	ponderosa pine	Dead	Tree	31.85
DETO_PCM_059	ponderosa pine	Live	Tree	222.93
DETO_PCM_067	Rocky Mountain juniper	Live	Seedling	31.83
DETO_PCM_067	bur oak	Live	Seedling	63.65
DETO_PCM_067	ponderosa pine	Live	Seedling	190.96
DETO_PCM_067	Rocky Mountain juniper	Live	Pole	31.85
DETO_PCM_067	Rocky Mountain juniper	Dead	Tree	31.85
DETO_PCM_067	ponderosa pine	Live	Tree	31.85

Table 7. Surface fuels data for wooded plots at Devils Tower National Monument in 2019.

Plot	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	Litt	Total	Duff	Litt	Total
PCM_007	0.00	0.00	2.18	2.18	11.90	1.34	15.42	2.99	1.00	19.41	0.2	0.3	0.4
PCM_008	0.00	0.00	0.00	0.00	1.59	0.00	1.59	0.88	0.48	2.95	0.1	0.1	0.2
PCM_010	0.00	0.00	0.00	0.00	17.73	0.00	17.73	8.10	4.45	30.28	0.5	1.1	1.6
PCM_011	0.00	0.00	1.45	1.45	2.87	0.00	4.32	2.99	1.50	8.81	0.2	0.4	0.5
PCM_014	0.08	0.14	0.00	0.22	0.00	0.00	0.22	1.76	0.58	2.56	0.1	0.1	0.2
PCM_019	0.06	1.36	2.19	3.61	4.27	7.60	15.48	2.55	0.90	18.93	0.1	0.2	0.4
PCM_030	0.12	1.10	8.13	9.35	32.05	10.32	51.72	6.07	1.80	59.59	0.3	0.5	0.8
PCM_046	0.00	0.27	0.74	1.02	9.95	3.52	14.49	9.24	1.24	24.97	0.5	0.3	0.8
PCM_051	0.00	0.27	0.00	0.27	0.00	0.00	0.27	0.53	0.26	1.06	0.0	0.1	0.1
PCM_059	0.04	0.27	0.00	0.31	7.88	0.59	8.78	5.02	0.72	14.51	0.3	0.2	0.5
PCM_067	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.20	1.02	3.22	0.1	0.3	0.4

Disturbances were observed at eight of the plots visited in 2019. A variety of disturbance types were recorded, including grazing, animal trails, prairie dog, flood and erosion. The most commonly observed disturbances were animal trails and soil disturbance (Table 8).

Table 8. Disturbance type and area observed in 8 of 15 plots visited at Devil's Tower National Monument by the Northern Great Plains Network in 2019. The disturbance area was approximated out of a total area of 1000 m² or recorded as present.

Plot	Disturbance Type	Area (m ²)
PCM_007	Animal Trail	30
PCM_009	Grazing	1
PCM_010	Animal Trail	50
PCM_010	Soil Disturbance	50
PCM_011	Animal Trail	30
PCM_011	Soil Disturbance	20
PCM_012	Prairie Dog	1000
PCM_012	Soil Disturbance	50
PCM_030	Soil Disturbance	2
PCM_030	Wind	Present
PCM_046	Animal Trail	12
PCM_259	Flood	200

Further Analysis

This Data Report is intended to provide a basic review of the data collected during the NGPN and NGPFire monitoring team's 2019 visit to Devils Tower National Monument. A more detailed summary and analysis of data from 2011-2015 is available in Ashton and Davis 2016. All data included in this report is available upon request from the Northern Great Plains Inventory and Monitoring Network, as well as in the archives found in the [IRMA Data Store](#).

Literature Cited

- Ashton, I., M. Prowatzke, M. Bynum, T. Shepherd, S. K. Wilson, and K. Paintner-Green. 2012. Devils Tower National Monument plant community composition and structure monitoring: 2011 annual report. Natural Resource Technical Report NPS/NGPN/NRTR—2012/533. National Park Service, Fort Collins, Colorado.
- Ashton, I. W., and C. J. Davis. 2016. Plant community composition and structure monitoring for Devils Tower National Monument: 2011-2015 summary report. Natural Resource Data Series NPS/NGPN/NRR—2016/1244. National Park Service, Fort Collins, Colorado.
- 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. 2018. The PLANTS Database (<http://plants.usda.gov>, 24 January 2018). National Plant Data Team, Greensboro, NC 27401-4901 USA.
- Wienk, C., A. Thorstenson, J. Freeman, and D. Swanson. 2010. Northern Great Plains Fire Ecology Program review: 1997-2007. Natural Resource Report NPS/NRDS/NRDS—2010/112. National Park Service, Fort Collins, Colorado.

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 109/165833, December 2019

National Park Service
U.S. Department of the Interior



[Natural Resource Stewardship and Science](#)

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525