



Plant Community Composition and Structure Monitoring at Devils Tower National Monument

2021 Data Report

Natural Resource Data Series NPS/NGPN/NRDS—2022/1369



**ON THIS PAGE**

Plant community composition and structure monitoring plot DETO_PCM_003 at Devil's Tower National Monument.
Photograph courtesy of the National Park Service.

ON THE COVER

NGPN field crew walking through Devils Tower National Monument
Photograph courtesy of the National Park Service

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Abstract

This report presents the results of vegetation monitoring efforts in 2021 at Devils Tower National Monument (DETO) by the Northern Great Plains Inventory and Monitoring Network (NGPN) and Fire Ecology Program (NGPFire). This was the eleventh 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 16 plots in the Southwest, Meadow and Graham Burn Units to collect plant community data prior to and 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 2021, monitoring crews identified 93 unique plant species in 24 monitoring plots. Of those species, 13 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 rare species observed in 2021. There were five state listed noxious weeds and one county listed weed species observed in 2021. Trees were present in only 19 of the plots and these were dominated by ponderosa pine. Seedling density was highly variable with some 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 for assistance and guidance with field work. The 2021 NGPN vegetation field crew—M. Davis, T. Bortz, A. Kuczera and A. Dahms—and the NGPFire crew—D. Swanson, I. Muirhead, M. Pahler, C. Fossum, and Jennifer McCoy—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 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 eight plant community plot visits and sixteen fire effects plot visits in 2021.

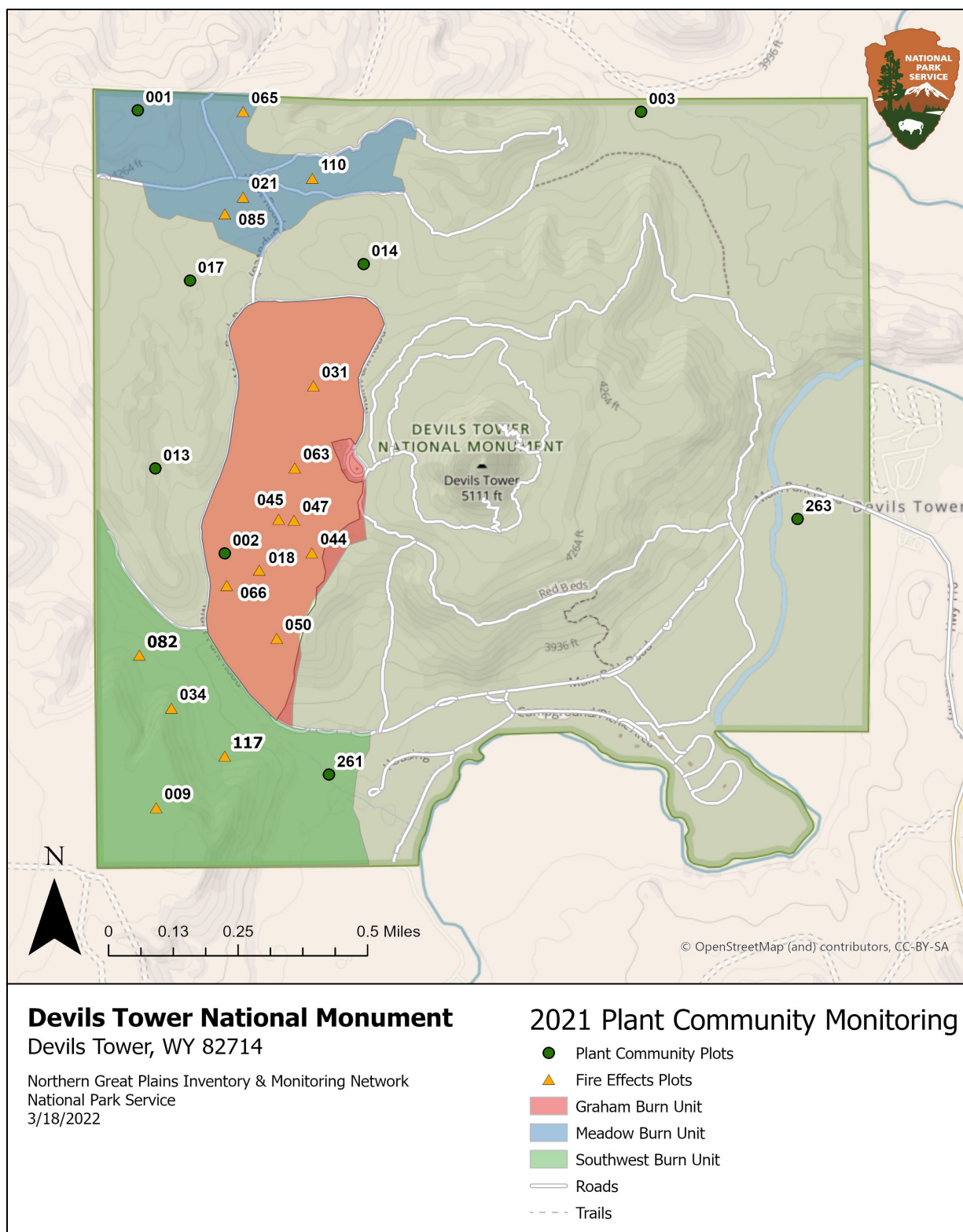


Figure 1. Map of Devils Tower National Monument plant community monitoring plots visited in 2021 by the Northern Great Plains Network Inventory & Monitoring Program (green) and the Fire Ecology Program (orange triangle). Prescribed burn unit areas are indicated by colored polygons on the map.

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 2021, the NGPN crew visited PCM plots in panels 5 and 1 between July 8–19 (Table 1). Of the eight plots, six were in upland habitat and two were in the riparian corridor (PCM_261 and PCM_263).

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 2021, eight sites were visited in the Graham Burn Unit in the western portion of the park, four sites were visited in the Southwest Burn Unit, and four sites were visited in the Meadow Burn Unit located in the northwestern portion of the park (Figure 1).

Table 1. Field journal for monitoring plot visits at Devils Tower National Monument in 2021. A total of 24 plots were visited by Northern Great Plains Inventory & Monitoring and Fire Ecology Programs.

Plot	Date Visited	Program	Notes
PCM_001	7/8/2021	NGPN	–
PCM_002	7/14/2021	NGPN	–
PCM_003	7/8/2021	NGPN	–
PCM_013	7/14/2021	NGPN	–
PCM_014	7/12/2021	NGPN	–
PCM_017	7/12/2021	NGPN	–
PCM_261	7/14/2021	NGPN	–
PCM_263	7/19/2021	NGPN	–
PCM_009	7/15/2021	FX	Southwest unit – preburn read
PCM_018	7/13/2021	FX	Graham unit – year 5 postburn read
PCM_021	7/14/2021	FX	Meadow unit – preburn read
PCM_031	7/13/2021	FX	Graham unit – year 5 postburn read
PCM_034	7/23/2021	FX	Southwest unit – preburn read
PCM_044	7/13/2021	FX	Graham unit – year 5 postburn read
PCM_045	8/5/2021	FX	Graham unit – year 5 postburn read
PCM_047	7/12/2021	FX	Graham unit – year 5 postburn read
PCM_050	7/13/2021	FX	Graham unit – year 5 postburn read
PCM_063	7/13/2021	FX	Graham unit – year 5 postburn read
PCM_065	7/14/2021	FX	Meadow unit – preburn read
PCM_066	7/13/2021	FX	Graham unit – year 5 postburn read
FPCM_082	7/24/2021	FX	Southwest unit – preburn read
FPCM_085	7/14/2021	FX	Meadow unit – preburn read
FPCM_110	7/14/2021	FX	Meadow unit – preburn read
FPCM_117	7/25/2021	FX	Southwest unit – preburn read

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 four of eight plots visited in the Graham unit, all four plots visited in the Meadow unit, and all four plots visited in the Southwest unit. They did not collect species presence data from quadrats in any of the plots visited.

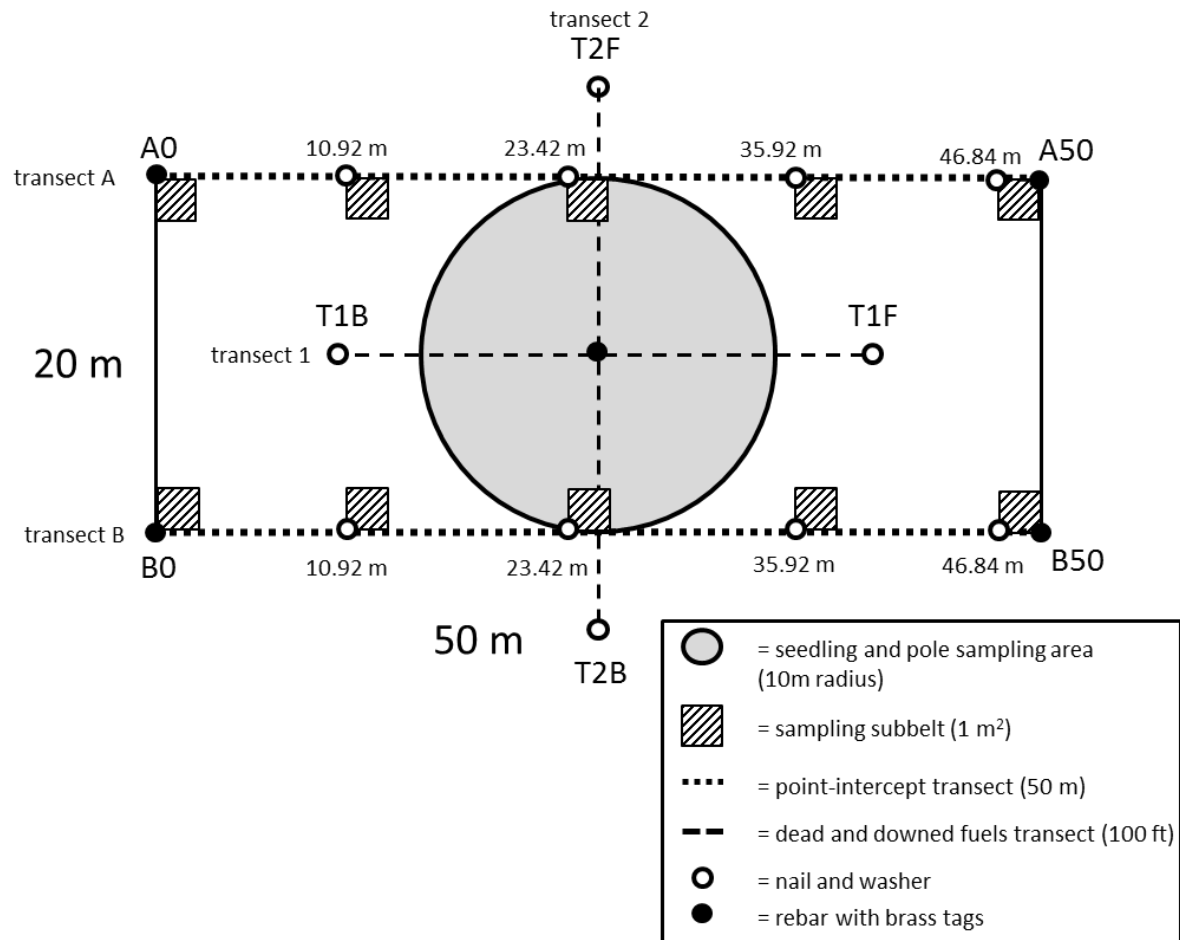


Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.

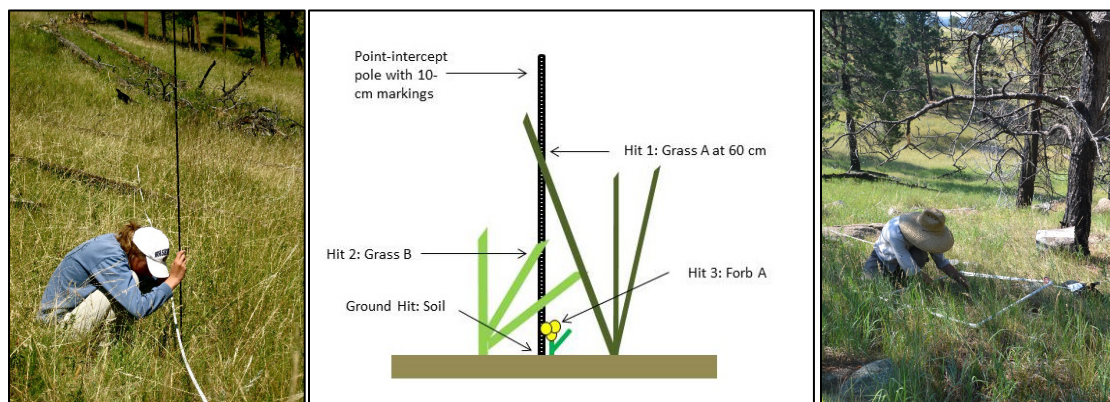


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

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 four plots in the Graham unit, 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 m^2 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 Invasive 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. These are species that are either highly uncommon or not currently present in the park.

Habitat	Scientific Name	Common Name
Riparian	<i>Heracleum mantegazzianum</i>	giant hogweed
Riparian	<i>Alliaria petiolata</i>	garlic mustard
Riparian	<i>Lepidium latifolium</i>	perennial pepperweed
Riparian	<i>Pueraria montana</i> var. <i>lobata</i>	kudzu
Riparian	<i>Myriophyllum spicatum</i>	Eurasian Watermilfoil
Riparian	<i>Iris pseudacorus</i>	yellow iris
Riparian	<i>Arundo donax</i>	giant reed
Riparian	<i>Polygonum cuspidatum</i> ; <i>P. sachalinense</i> ; <i>P.x bohemicum</i>	knotweeds
Riparian	<i>Rhamnus cathartica</i>	common buckthorn
Riparian	<i>Ailanthus altissima</i>	tree of heaven
Upland	<i>Falcaria vulgaris</i>	Sickle Weed
Upland	<i>Pastinaca sativa</i>	Wild Parsnip
Upland	<i>Acroptilon repens</i>	Russian Knapweed
Upland	<i>Centaurea solstitialis</i>	yellow star thistle
Upland	<i>Centaurea virgata</i> ; <i>C. diffusa</i> ; <i>C. jacea</i>	knapweeds
Upland	<i>Chondrilla juncea</i>	rush skeletonweed
Upland	<i>Hieracium aurantiacum</i> ; <i>H. caespitosum</i> ; <i>H. piloselloides</i>	orange, meadow, and tall hawkweed
Upland	<i>Senecio jacobaeae</i>	Tansy Ragwort
Upland	<i>Isatis tinctoria</i>	Dyer's woad
Upland	<i>Gypsophila paniculata</i>	baby's breath
Upland	<i>Dipsacus fullonum</i> & <i>D. laciniatus</i>	common teasel
Upland	<i>Euphorbia myrsinites</i> & <i>E. cyparissias</i>	myrtle spurge
Upland	<i>Salvia aethiopis</i> ; <i>S. pratensis</i>	Mediterranean and Meadow sage
Upland	<i>Lythrum salicaria</i>	Purple Loosestrife
Upland	<i>Taeniatherum caput-medusae</i>	medusahead
Upland	<i>Ventenata dubia</i>	African wiregrass
Upland	<i>Ranunculus acris</i>	Tall Buttercup
Upland	<i>Linaria dalmatica</i> ; <i>L. vulgaris</i>	toadflax
Upland	<i>Thymelaea passerina</i>	Spurge Flax

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 2022). 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 2021 was determined by cross-referencing with the [NatureServe](#) conservation status list, as well as the Wyoming 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 2021 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 475 vascular plant species on the [DETO species list](#), and NGPN and NGPFire monitoring crews identified a total of 93 species from 24 monitoring plots in 2021 (Table 3). Of these species, 13 are exotic. The 2021 species list was cross-referenced with state-wide rare and noxious exotic species lists for Wyoming. There were no state-listed rare species observed in 2021. There were five state listed noxious weeds and one county listed weed species observed in 2021.

Table 3. List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2021. 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 as “New”. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Symbol	Scientific Name	Common Name	Notes
Aceraceae	ACNE2	<i>Acer negundo</i>	boxelder	–
Agavaceae	YUGL	<i>Yucca glauca</i>	soapweed yucca	–
Asteraceae	ACMI2	<i>Achillea millefolium</i>	common yarrow	–
Asteraceae	AMPS	<i>Ambrosia psilostachya</i>	Cuman ragweed	–
Asteraceae	ANTEN	<i>Antennaria</i>	pussytoes	–
Asteraceae	ANPA4	<i>Antennaria parvifolia</i>	small-leaf pussytoes	–
Asteraceae	ARLU	<i>Artemisia ludoviciana</i>	white sagebrush	–
Asteraceae	BREU	<i>Brickellia eupatorioides</i>	false boneset	–
Asteraceae	CIAR4	<i>Cirsium arvense</i>	Canada thistle	Exotic, Noxious
Asteraceae	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle	–
Asteraceae	ECAN2	<i>Echinacea angustifolia</i>	blacksamson echinacea	–
Asteraceae	ERSU2	<i>Erigeron subtrinervis</i>	threenerve fleabane	–
Asteraceae	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed	–
Asteraceae	LIPU	<i>Liatis punctata</i>	dotted blazing star	–
Asteraceae	LYJU	<i>Lygodesmia juncea</i>	rush skeletonplant	–
Asteraceae	RACO3	<i>Ratibida columnifera</i>	upright prairie coneflower	–
Asteraceae	SOMI2	<i>Solidago missouriensis</i>	Missouri goldenrod	–
Asteraceae	SOMO	<i>Solidago mollis</i>	velvety goldenrod	–
Asteraceae	SYFA	<i>Symphyotrichum falcatum</i>	white prairie 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
Berberidaceae	BERE	<i>Berberis repens</i>	Oregon grape	–

Table 3 (continued). List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2021. 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 as “New”. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Symbol	Scientific Name	Common Name	Notes
Boraginaceae	CYOF	<i>Cynoglossum officinale</i>	houndstongue	Exotic, Noxious
Boraginaceae	LIIN2	<i>Lithospermum incisum</i>	narrowleaf stoneseed	–
Brassicaceae	ARPY4	<i>Arabis pycnocarpa</i>	creamflower rockcress	–
Campanulaceae	CARO2	<i>Campanula rotundifolia</i>	bluebell bellflower	–
Caprifoliaceae	SYOC	<i>Symphoricarpos occidentalis</i>	western snowberry	–
Caryophyllaceae	CEAR4	<i>Cerastium arvense</i>	field chickweed	–
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	CARO5	<i>Carex rossii</i>	Ross' sedge	–
Cyperaceae	CASP7	<i>Carex sprengelii</i>	Sprengel's sedge	–
Equisetaceae	EQLA	<i>Equisetum laevigatum</i>	smooth horsetail	–
Euphorbiaceae	EUES	<i>Euphorbia esula</i>	leafy spurge	Exotic, Noxious
Fabaceae	ASTRA	<i>Astragalus</i>	milkvetch	–
Fabaceae	ASAG2	<i>Astragalus agrestis</i>	purple milkvetch	–
Fabaceae	ASDR3	<i>Astragalus drummondii</i>	Drummond's milkvetch	–
Fabaceae	ASLA27	<i>Astragalus laxmannii</i>	Laxmann's milkvetch	–
Fabaceae	DAPU5	<i>Dalea purpurea</i>	purple prairie clover	–
Fabaceae	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	Crook County Declared Weed - Native
Fabaceae	OXSE	<i>Oxytropis sericea</i>	white locoweed	–
Fabaceae	PEAR6	<i>Pedimelum argophyllum</i>	silverleaf Indian breadroot	–
Fabaceae	PSLA3	<i>Psoraleidum lanceolatum</i>	lemon scurfpea	–
Fabaceae	THRH	<i>Thermopsis rhombifolia</i>	golden pea	–
Fabaceae	VIAM	<i>Vicia americana</i>	American vetch	–
Fagaceae	QUMA2	<i>Quercus macrocarpa</i>	bur oak	–
Liliaceae	ALTE	<i>Allium textile</i>	textile onion	–

Table 3 (continued). List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2021. 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 as “New”. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Symbol	Scientific Name	Common Name	Notes
Linaceae	LILE3	<i>Linum lewisii</i>	Lewis flax	–
Malvaceae	SPCO	<i>Sphaeralcea coccinea</i>	scarlet globemallow	–
Oleaceae	FRPE	<i>Fraxinus pennsylvanica</i>	green ash	–
Onagraceae	OESU99	<i>Oenothera suffrutescens</i>	scarlet beeblossom	–
Pinaceae	PIPO	<i>Pinus ponderosa</i>	ponderosa pine	–
Poaceae	AGCR	<i>Agropyron cristatum</i>	crested wheatgrass	Exotic
Poaceae	ANGE	<i>Andropogon gerardii</i>	big bluestem	–
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	BRTE	<i>Bromus tectorum</i>	cheatgrass	Exotic
Poaceae	CALO	<i>Calamovilfa longifolia</i>	prairie sandreed	–
Poaceae	DASP2	<i>Danthonia spicata</i>	poverty oatgrass	–
Poaceae	DIOL	<i>Dichanthelium oligosanthos</i>	Heller's rosette grass	–
Poaceae	DIWI5	<i>Dichanthelium wilcoxianum</i>	fall rosette grass	–
Poaceae	ELRE4	<i>Elymus repens</i>	quackgrass	Exotic, Noxious
Poaceae	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	–
Poaceae	FEID	<i>Festuca idahoensis</i>	Idaho fescue	–
Poaceae	FESA	<i>Festuca saximontana</i>	Rocky Mountain fescue	–
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	NAVI4	<i>Nassella viridula</i>	green needlegrass	–
Poaceae	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	–
Poaceae	POCO	<i>Poa compressa</i>	Canada bluegrass	Exotic
Poaceae	POPR	<i>Poa pratensis</i>	Kentucky bluegrass	Exotic
Poaceae	SCSC	<i>Schizachyrium scoparium</i>	little bluestem	–
Poaceae	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	–
Poaceae	PIMI7	<i>Piptatherum micranthum</i>	littleseed ricegrass	–

Table 3 (continued). List of all plant species identified in Devils Tower National Monument plant community and fire effects monitoring plots in 2021. 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 as “New”. Species considered rare, or of conservation concern, in Wyoming are indicated with their state conservation rank (WYS1, WYS2, or WYS3).

Family	Symbol	Scientific Name	Common Name	Notes
Polemoniaceae	PHAL3	<i>Phlox alyssifolia</i>	alyssumleaf phlox	–
Polemoniaceae	PHHO	<i>Phlox hoodii</i>	spiny phlox	–
Rosaceae	AMAL2	<i>Amelanchier alnifolia</i>	Saskatoon serviceberry	–
Rosaceae	PRVI	<i>Prunus virginiana</i>	chokecherry	–
Rubiaceae	GABO2	<i>Galium boreale</i>	northern bedstraw	–
Salicaceae	PODE3	<i>Populus deltoides</i>	eastern cottonwood	–
Salicaceae	SAAM2	<i>Salix amygdaloides</i>	peachleaf willow	–
Scrophulariaceae	PEGR7	<i>Penstemon grandiflorus</i>	large beardtongue	–
Scrophulariaceae	VETH	<i>Verbascum thapsus</i>	common mullein	Exotic, Noxious

Based on the number of unique species observed in each plot in 2021, PCM_017 had the greatest species richness with 42 species (Table 4). Plot PCM_017 also, had the greatest native species richness with 37 unique native species identified. Absolute cover calculations (Table 5) showed that absolute native species cover was greater than absolute exotic species cover in thirteen of twenty-four plots where cover data was collected. PCM_009 had the highest native species cover, and PCM_117 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 24 monitoring plot visits where herbaceous plant data were collected at Devils Tower National Monument in 2021. 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 Species
*FPCM_082	18	3	21
*FPCM_085	11	3	14
*FPCM_110	13	3	16
*FPCM_117	14	4	18
PCM_001	19	2	21
PCM_002	26	8	34
PCM_003	15	2	17
*PCM_009	6	2	8
PCM_013	20	3	23
PCM_014	35	3	38
PCM_017	37	5	42
*PCM_018	14	3	17
*PCM_021	15	1	16
*PCM_031	13	3	16
*PCM_034	19	4	23
*PCM_044	15	1	16
*PCM_045	11	4	15
*PCM_047	2	0	2
*PCM_050	2	1	3
*PCM_063	5	1	6
*PCM_065	18	3	21
*PCM_066	1	1	2
PCM_261	8	3	11
PCM_263	13	5	18

Table 5. Absolute percent cover of native and exotic plant species in plots monitored at Devils Tower National Monument in 2021. 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
FPCM_082	48	56
FPCM_085	56	47
FPCM_110	94	28
FPCM_117	47	77
PCM_001	54	15
PCM_002	82	26
PCM_003	11	62
PCM_009	120	12
PCM_013	46	54
PCM_014	81	10
PCM_017	59	10
PCM_018	67	10
PCM_021	84	60
PCM_031	71	20
PCM_034	46	6
PCM_044	61	12
PCM_045	67	10
PCM_065	75	66
PCM_261	63	47
PCM_263	58	58

Monitoring crews collected data at 24 monitoring plots, and of these plots, 19 had measurable woody species. The dominant woody species was ponderosa pine (Table 6). Plot FPCM_117 had the greatest tree density with an average 445 trees per hectare (Figure 4). FPCM_117 had the greatest seedling density with an average of 2,132 chokecherry seedlings per hectare. Surface fuels at plots with woody debris present averaged 12.2 tons per acre (Table 7).

Table 6. Woody species data from 19 long-term monitoring plots visited at Devil's Tower National Monument in 2021. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

Plot	Common Name	Status	DBH	Count	Density_hectares
DETO_FPCM_082	ponderosa pine	Live	Seedling	55	1750.48
DETO_FPCM_082	ponderosa pine	Live	Tree	10	318.47
DETO_FPCM_082	bur oak	Live	Seedling	6	190.96
DETO_FPCM_082	chokecherry	Live	Seedling	2	63.65
DETO_FPCM_082	Rocky Mountain juniper	Live	Seedling	2	63.65
DETO_FPCM_082	ponderosa pine	Live	Pole	1	31.85
DETO_FPCM_085	ponderosa pine	Live	Tree	1	10
DETO_FPCM_117	chokecherry	Live	Seedling	67	2132.4
DETO_FPCM_117	ponderosa pine	Live	Tree	14	445.86
DETO_FPCM_117	bur oak	Live	Seedling	4	127.31
DETO_FPCM_117	ponderosa pine	Live	Pole	1	31.85
DETO_PCM_001	ponderosa pine	Live	Tree	19	190
DETO_PCM_001	ponderosa pine	Dead	Tree	1	10
DETO_PCM_001	ponderosa pine	Live	Seedling	2	63.65
DETO_PCM_002	ponderosa pine	Live	Tree	11	110
DETO_PCM_003	bur oak	Live	Tree	8	80
DETO_PCM_003	bur oak	Dead	Tree	1	10
DETO_PCM_003	bur oak	Live	Seedling	1	31.83
DETO_PCM_013	ponderosa pine	Live	Seedling	5	159.13
DETO_PCM_017	ponderosa pine	Live	Seedling	52	1655
DETO_PCM_017	ponderosa pine	Live	Tree	19	190
DETO_PCM_017	ponderosa pine	Dead	Tree	1	10
DETO_PCM_017	ponderosa pine	Dead	Pole	1	31.85
DETO_PCM_017	bur oak	Live	Seedling	1	31.83
DETO_PCM_018	ponderosa pine	Live	Seedling	21	668.36
DETO_PCM_018	ponderosa pine	Live	Tree	6	60
DETO_PCM_018	Rocky Mountain juniper	Live	Seedling	2	63.65
DETO_PCM_018	ponderosa pine	Live	Pole	3	30
DETO_PCM_018	ponderosa pine	Dead	Pole	2	20
DETO_PCM_021	ponderosa pine	Live	Tree	1	31.85
DETO_PCM_021	ponderosa pine	Live	Seedling	3	95.48
DETO_PCM_031	ponderosa pine	Live	Tree	10	318.47
DETO_PCM_031	ponderosa pine	Live	Pole	1	31.85
DETO_PCM_034	ponderosa pine	Live	Seedling	11	350.1
DETO_PCM_034	ponderosa pine	Live	Tree	7	222.93

Table 6 (continued). Woody species data from 19 long-term monitoring plots visited at Devil's Tower National Monument in 2021. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

Plot	Common Name	Status	DBH	Count	Density_hectares
DETO_PCM_034	Rocky Mountain juniper	Dead	Tree	1	31.85
DETO_PCM_034	green ash	Live	Seedling	1	31.83
DETO_PCM_034	Rocky Mountain juniper	Live	Seedling	1	31.83
DETO_PCM_044	ponderosa pine	Live	Seedling	5	159.13
DETO_PCM_044	ponderosa pine	Dead	Pole	2	63.69
DETO_PCM_044	ponderosa pine	Live	Tree	9	286.62
DETO_PCM_044	ponderosa pine	Live	Pole	1	31.85
DETO_PCM_045	ponderosa pine	Live	Tree	4	127.39
DETO_PCM_045	ponderosa pine	Dead	Tree	2	63.69
DETO_PCM_047	ponderosa pine	Live	Tree	7	222.93
DETO_PCM_047	ponderosa pine	Live	Seedling	1	31.83
DETO_PCM_050	Rocky Mountain juniper	Dead	Pole	2	63.69
DETO_PCM_050	ponderosa pine	Live	Tree	3	95.54
DETO_PCM_050	ponderosa pine	Dead	Tree	1	31.85
DETO_PCM_063	chokecherry	Live	Seedling	4	127.31
DETO_PCM_063	ponderosa pine	Live	Seedling	3	95.48
DETO_PCM_063	bur oak	Dead	Pole	2	63.69
DETO_PCM_063	bur oak	Live	Seedling	1	31.83
DETO_PCM_063	ponderosa pine	Live	Tree	2	63.69
DETO_PCM_063	ponderosa pine	Dead	Tree	1	31.85
DETO_PCM_066	ponderosa pine	Live	Tree	7	222.93
DETO_PCM_066	ponderosa pine	Dead	Tree	1	31.85
DETO_PCM_263	eastern cottonwood	Live	Seedling	8	254.61
DETO_PCM_263	eastern cottonwood	Live	Pole	2	63.69
DETO_PCM_263	peachleaf willow	Live	Seedling	2	63.65
DETO_PCM_263	boxelder	Live	Tree	3	30



Figure 4. Long-term monitoring plot PCM_017 at Devils Tower National Monument is located in the northwestern portion of the park and had one of the highest tree densities recorded in 2021. Photograph courtesy of the National Park Service.

Table 7. Surface fuels data for wooded plots at Devils Tower National Monument in 2021.

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
PCM_001	0.14	0.95	0.00	1.09	2.22	0.00	3.30	8.54	2.82	14.66	0.5	0.7	1.2
PCM_002	0.10	0.41	0.00	0.51	0.00	0.00	0.51	3.17	1.18	4.85	0.2	0.3	0.5
PCM_013	0.00	0.00	0.00	0.00	0.93	2.20	3.13	0.97	0.58	4.68	0.1	0.1	0.2
PCM_014	0.04	0.14	0.00	0.18	0.00	0.00	0.18	0.79	0.98	1.95	0.0	0.2	0.3
PCM_017	0.02	0.00	0.73	0.75	3.37	2.74	6.86	4.49	2.00	13.34	0.3	0.5	0.8
PCM_263	0.00	0.12	0.63	0.76	0.00	0.69	1.45	0.16	0.40	2.01	0.0	0.2	0.3
FPCM_082	0.04	0.41	0.73	1.18	2.63	0.26	4.06	13.29	3.17	20.53	0.8	0.8	1.6
FPCM_085	0.02	0.00	0.00	0.02	0.00	0.30	0.32	0.97	1.76	3.05	0.1	0.4	0.5
FPCM_117	0.04	0.81	0.73	1.58	2.53	2.30	6.40	11.36	2.84	20.60	0.6	0.7	1.4
PCM_018	0.04	0.42	0.00	0.46	0.29	1.84	2.59	3.70	0.98	7.26	0.2	0.2	0.5
PCM_021	0.04	0.27	0.00	0.31	0.00	0.00	0.31	3.26	1.90	5.46	0.2	0.5	0.7
PCM_031	0.00	0.27	0.73	1.00	4.72	0.32	6.05	5.28	1.66	12.98	0.3	0.4	0.7
PCM_034	0.00	0.15	0.00	0.15	0.00	0.00	0.15	2.29	1.08	3.52	0.1	0.3	0.4
PCM_044	0.02	0.55	0.74	1.31	0.93	0.21	2.44	5.55	0.82	8.81	0.3	0.2	0.5
PCM_045	0.08	1.54	2.92	4.54	7.19	5.91	17.64	2.82	1.60	22.05	0.2	0.4	0.6
PCM_047	0.00	0.00	0.00	0.00	15.27	1.14	16.40	2.20	1.36	19.96	0.1	0.3	0.5
PCM_050	0.06	1.13	4.61	5.80	0.71	0.00	6.52	1.76	0.84	9.12	0.1	0.2	0.3
PCM_063	0.02	1.70	0.00	1.72	30.34	8.54	40.60	4.36	1.98	46.93	0.2	0.5	0.7
PCM_066	0.10	0.14	0.00	0.24	0.00	3.63	3.87	3.87	2.91	10.65	0.2	0.7	1.0

Disturbances were observed at eight of the plots visited in 2021. A variety of disturbance types were recorded, including grazing, animal trails, prairie dogs, and erosion. The most observed disturbances were animal trails and soil disturbance (Table 8).

Table 8. Disturbance type and area observed in 14 of 24 plots visited at Devil's Tower National Monument by the Northern Great Plains Network in 2021. The disturbance area was approximated out of a total area of 1000 m² or recorded as present.

Plot	Disturbance Type	Area (m²)
DETO_FPCM_082	Animal Trail	3
DETO_FPCM_110	Small Mammal	3
DETO_PCM_001	Grazing	7
DETO_PCM_002	Animal Trail	3
DETO_PCM_003	Animal Trail	10
DETO_PCM_014	Grazing	3
DETO_PCM_017	Soil Disturbance	4
DETO_PCM_017	Other	5
DETO_PCM_018	Animal Trail	11
DETO_PCM_031	Large Animal Trail	25
DETO_PCM_034	Animal Trail	12.5
DETO_PCM_063	Animal Trail	12
DETO_PCM_065	Animal Trail	5.5
DETO_PCM_066	Animal Trail	6
DETO_PCM_066	Wallow	1
DETO_PCM_263	Animal Trail	4
DETO_PCM_263	Soil Disturbance	2

Further Analysis

This Data Report is intended to provide a basic review of the data collected during the NGPN and NGPFire monitoring team's 2021 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](#).

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