



Plant Community Composition and Structure Monitoring at Badlands National Park

2021 Data Report

Natural Resource Data Series NPS/NGPN/NRDS—2022/1368



**ON THIS PAGE**

Photo of long-term monitoring plot PCM_0004 in Badlands National Park.

Photograph courtesy of the National Park Service.

ON THE COVER

Overview of Badlands National Park from a vista point. Photo taken by L. Etienne Dupret.

Photograph courtesy of the National Park Service.

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September 2022

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

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Please cite this publication as:

Dupret, L. E., and D. J. Swanson. 2022. Plant community composition and structure monitoring at Badlands National Park: 2021 data report. Natural Resource Data Series NPS/NGPN/NRDS—2022/1368. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/2293475>

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Abstract

This report presents the results of vegetation monitoring efforts in 2021 at Badlands National Park (BADL) by the Northern Great Plains Inventory and Monitoring Network (NGPN) and the Northern Great Plains Fire Ecology Program (NGPFire). This was the eleventh year of combined monitoring efforts.

Crew members from NGPN visited 17 long-term monitoring plots to collect data on the plant communities at BADL. Three plots were not visited, due to weather and time constraints. 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. NGPN staff measured species richness, herb-layer height, native and non-native species abundance, ground cover, and site disturbance at each plot. No woody species were present so tree regeneration, tall shrub density, tree density, and woody fuel loads were not measured. The NGPFire crew visited and collected vegetation data at an additional 13 plots in the Door and Castle Burn Units to better understand the effects of prescribed fire on vegetation.

The monitoring crews identified 139 unique plant species in 30 monitoring plots in 2021. Of those species, 26 were exotic species. In most plots (24 out of 30), there was a greater percent of native species cover compared to exotic species cover. However, exotic plants were found at every plot in BADL.

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 BADL for providing logistical support and help with routes, particularly E. Childers and W. Thompson. We thank the staff at NGPN and BADL for their help with logistics. The 2021 NGPN vegetation field crew—M. Davis, T. Bortz, A. Kuczera and A. Dahms—and the NGPFire crew—D. Swanson, M. Pahler, I. Muirhead, C. Fossum, and Jennifer McCoy—collected the data included in this report.

Introduction

Badlands National Park (BADL) was established in 1939 as a National Monument, and in 1978 became a National Park to protect and preserve 242,756 acres of rugged badlands, mixed-grass prairie, and rich fossil deposits. The vegetation is a mosaic of sparsely vegetated badlands, native mixed-grass prairie, woody draws, and exotic grasslands. Vegetation monitoring began at BADL in 1998 by the Northern Great Plains Fire Ecology Program (NGPFire; Wienk et al. 2010). The Northern Great Plains Inventory & Monitoring Program (NGPN) began vegetation monitoring within BADL during 2011 (Ashton et al. 2012). Vegetation monitoring protocols and plot locations were chosen to represent the entire park and to coordinate efforts with the Northern Great Plains Fire Ecology Program (NGPFire). Over 120 plots have been established by NGPFire and NGPN in BADL, and combined sampling efforts began in 2011. In this report, we provide summaries of the data collected at 30 plots during the spring and summer of 2021. For a more in-depth data report on long-term trends at BADL, refer to the 2011–2015 summary report (Ashton and Davis 2016).

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

The NGPN team implemented a survey to monitor plant community structure and composition at BADL using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003, 2004). Using a GRTS design, 100 randomly located sites were selected within BADL to be established as Plant Community Monitoring plots (PCM plots). These sites were split into ten panels, with ten sites in each panel. An NGPN crew visits five plots from four panels (twenty PCM plots total) during June every year, using a rotating sampling scheme that consists of half the plots visited the previous year, and the remaining plots having been visited five years prior. Data from these randomly selected sites can be used to estimate the condition of vegetation communities for the whole park and to discern trends in condition over time. In 2021, the NGPN crew visited a total of 17 sites in panels 1, 5 and 10 (Figure 1). Sampling was completed by one NGPN crew over nine days (Table 1). Three plots were not visited, due to weather and time constraints.

The NGPFire crew has established sites using the same GRTS design, but those plot locations are not randomly selected. Rather, they are focused in active burn units. As part of the prescribed fire program, the Door Burn Unit in the eastern portion of the park were burned November 7, 2021. The NGPFire crew visited and collected vegetation data from six sites in the Castle Unit and seven sites in the Door Unit (Table 1) in 2021.

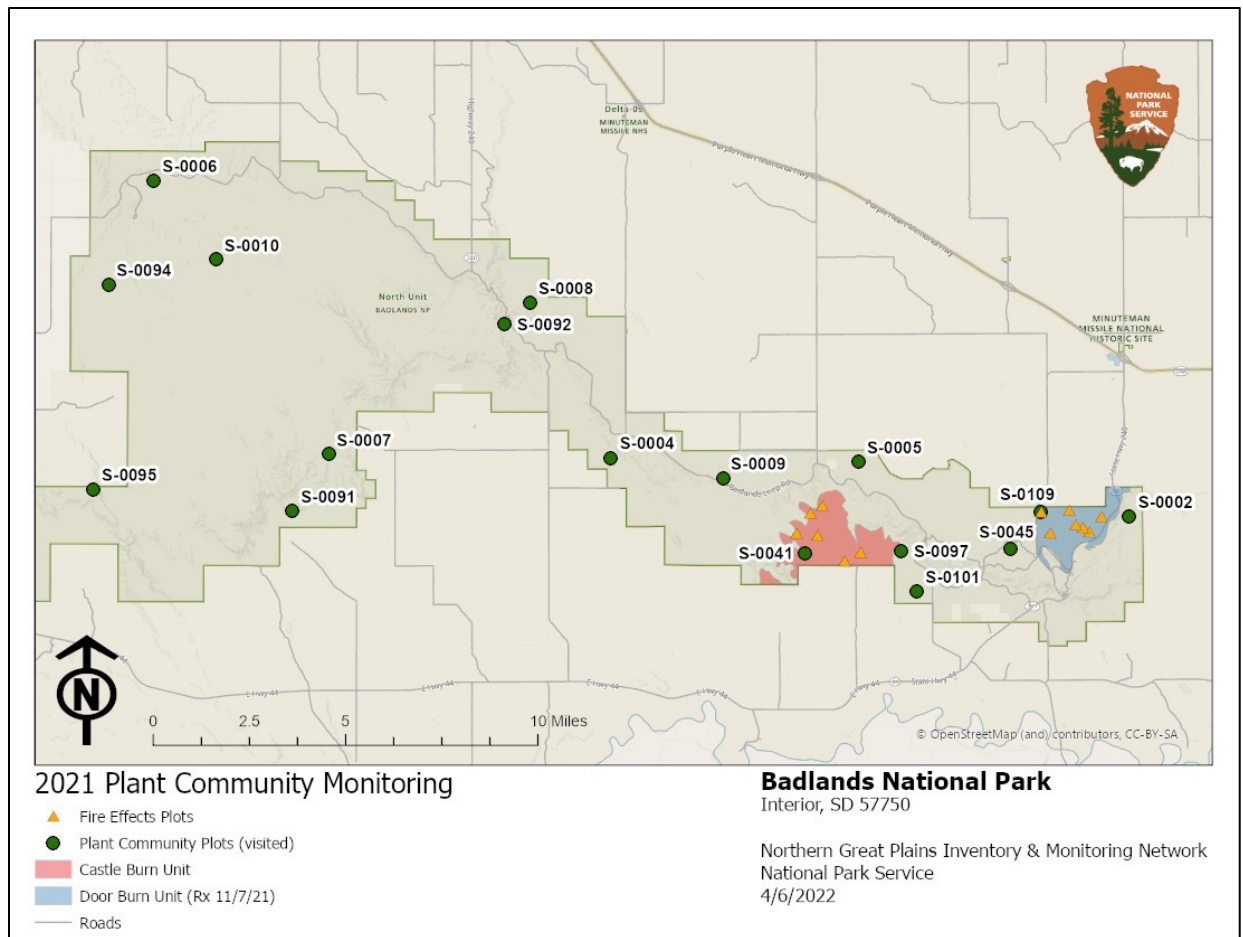


Figure 1. Map of Badlands National Park plant community monitoring plots visited in 2021 by the Northern Great Plains Network Inventory & Monitoring Program (green) and the Northern Great Plains Fire Ecology Program (orange triangles). Prescribed burn unit areas are indicated by colored polygons on the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

Table 1. Field journal for monitoring plot visits at Badlands National Park in 2021. A total of 30 plots were visited by Northern Great Plains Inventory & Monitoring and Fire Ecology Programs. All FPCM plots were visited by the Fire Ecology Program.

Plot	Date Visited	Program	Notes
BADL_PCM_0002	5/25/2021	NGPN	–
BADL_PCM_0004	6/2/2021	NGPN	–
BADL_PCM_0005	6/2/2021	NGPN	–
BADL_PCM_0006	6/3/2021	NGPN	–
BADL_PCM_0007	6/10/2021	NGPN	–
BADL_PCM_0008	6/8/2021	NGPN	–
BADL_PCM_0009	6/2/2021	NGPN	–
BADL_PCM_0010	6/3/2021	NGPN	–
BADL_PCM_0041	6/1/2021	NGPN	–
BADL_PCM_0045	5/27/2021	NGPN	–
BADL_PCM_0091	6/10/2021	NGPN	–
BADL_PCM_0092	6/8/2021	NGPN	–
BADL_PCM_0094	6/3/2021	NGPN	–
BADL_PCM_0095	6/9/2021	NGPN	–
BADL_PCM_0097	5/26/2021	NGPN	–
BADL_PCM_0101	5/26/2021	NGPN	–
BADL_PCM_0109	5/27/2021	NGPN	–
BADL_FPCM_0130	6/15/2021	FX	Door Burn Unit – preburn read
BADL_FPCM_0130	11/8/2021	FX	Door Burn Unit – immediate postburn read
BADL_FPCM_0189	6/15/2021	FX	Door Burn Unit – preburn read
BADL_FPCM_0189	11/8/2021	FX	Door Burn Unit – immediate postburn read
BADL_FPCM_0361	6/16/2021	FX	Castle Burn Unit – year 10 postburn read
BADL_FPCM_0481	6/16/2021	FX	Castle Burn Unit – year 10 postburn read
BADL_FPCM_0509	6/15/2021	FX	Door Burn Unit – preburn read
BADL_FPCM_0509	11/8/2021	FX	Door Burn Unit – immediate postburn read
BADL_FPCM_0553	6/14/2021	FX	Castle Burn Unit – year 10 postburn read
BADL_FPCM_0578	6/15/2021	FX	Door Burn Unit – preburn read
BADL_FPCM_0578	11/8/2021	FX	Door Burn Unit – immediate postburn read
BADL_FPCM_0621	6/17/2021	FX	Door Burn Unit – preburn read
BADL_FPCM_0621	11/8/2021	FX	Door Burn Unit – immediate postburn read
BADL_FPCM_0834	6/15/2021	FX	Door Burn Unit – preburn read
BADL_FPCM_0834	11/8/2021	FX	Door Burn Unit – immediate postburn read
BADL_FPCM_0921	6/14/2021	FX	Castle Burn Unit – year 10 postburn read
BADL_PCM_0021	6/16/2021	FX	Castle Burn Unit – year 10 postburn read
BADL_PCM_0105	6/16/2021	FX	Castle Burn Unit – year 10 postburn read
BADL_PCM_0109	11/8/2021	FX	Door Burn Unit – immediate postburn 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 at twelve of thirteen plots but did not collect species presence data from the quadrats from any plots.

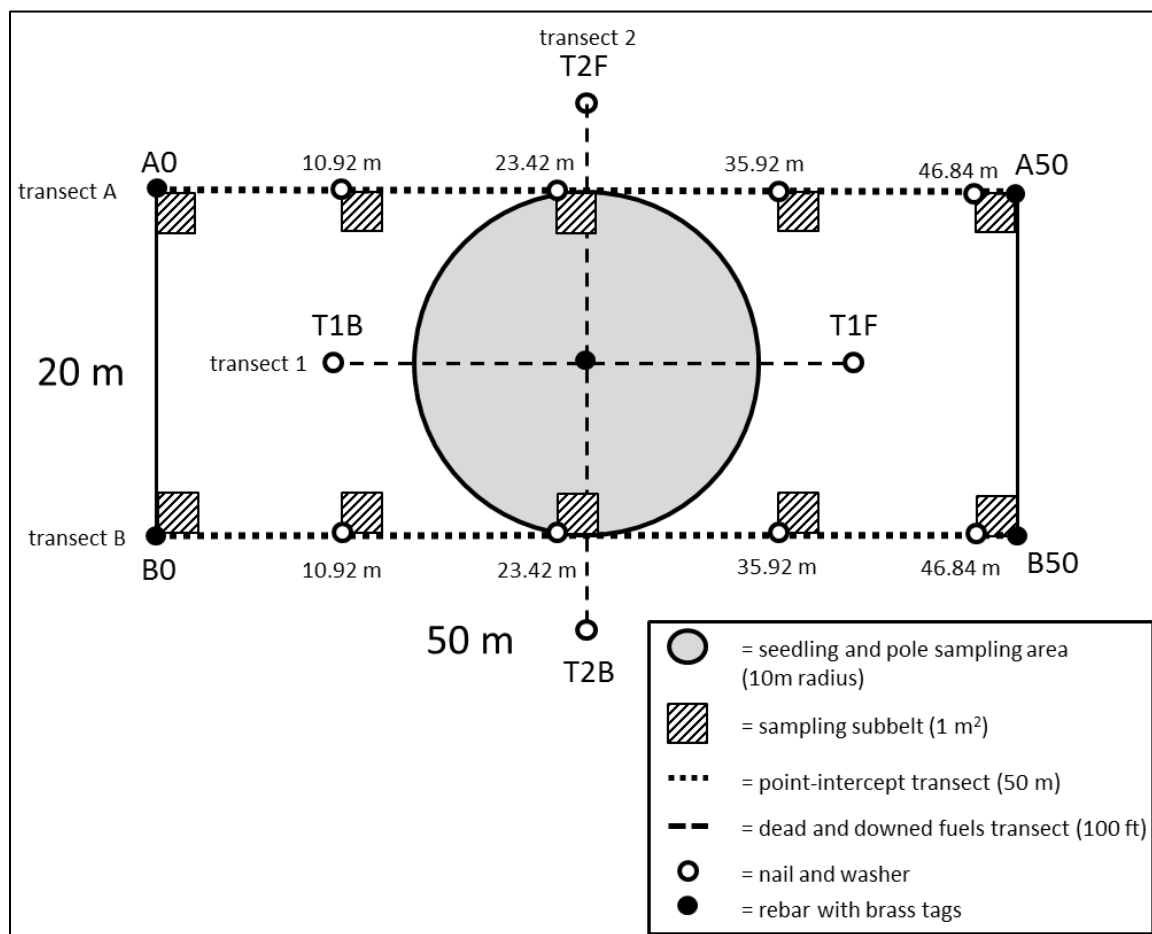


Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.

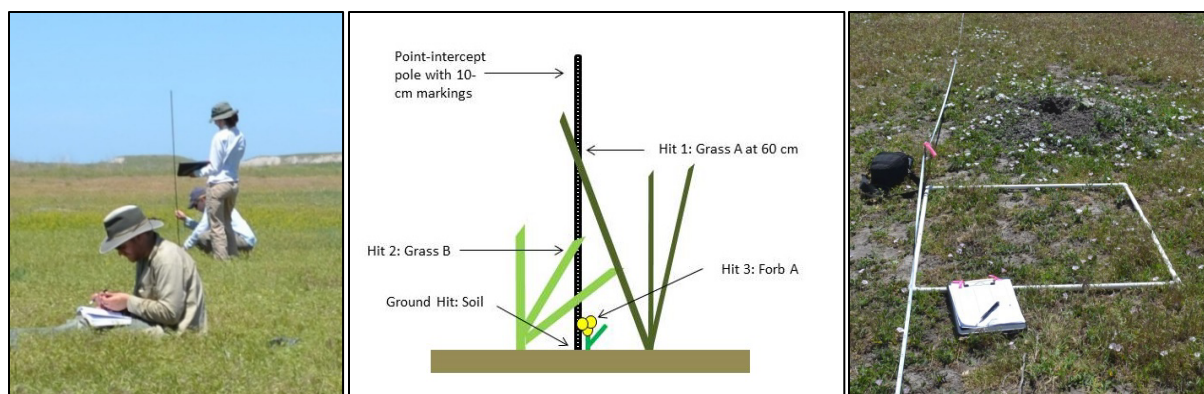


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

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 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. Now, we only count one sprout per stump. 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.

Common disturbances were assessed and documented at each plot. The type of disturbance, such as animal trails, erosion or prairie dogs was recorded, and the area of the disturbance was estimated in m^2 . For some large-scale disturbances like fire, the disturbance was recorded as either present or absent. 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.

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 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 4.1.2). 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 BADL in 2021 was determined by cross-referencing with the [NatureServe](#) conservation status list, as well as the South Dakota rare plant species lists. For 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 [South Dakota Department of Agriculture](#).

Results

There are 448 vascular plant species on the [BADL species list](#), and NGPN and NGPFire monitoring crews identified a total of 139 species from 30 monitoring plots in 2021 (Table 3). Of these species, 26 are exotic species for the park. The 2021 species list was cross-referenced with state-wide rare and noxious exotic species lists for South Dakota. No rare plant species were found at the park in 2021. However, we found several plants that are considered noxious weeds in South Dakota at the state or county level: Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), and common mullein (*Verbascum thapsus*).

Table 3. List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank but no rare species were found in 2021.

Family	Species Code	Scientific Name	Common Name	Notes
Agavaceae	YUGL	<i>Yucca glauca</i>	soapweed yucca	–
Anacardiaceae	TORY	<i>Toxicodendron rydbergii</i>	western poison ivy	–
Apiaceae	LOFO	<i>Lomatium foeniculaceum</i>	desert biscuitroot	–
Apiaceae	MUDI	<i>Musineon divaricatum</i>	leafy wildparsley	–
Asclepiadaceae	ASPU	<i>Asclepias pumila</i>	plains milkweed	–
Asclepiadaceae	ASVE	<i>Asclepias verticillata</i>	whorled milkweed	–
Asteraceae	ACMI2	<i>Achillea millefolium</i>	common yarrow	–
Asteraceae	ARCA12	<i>Artemisia campestris</i>	field sagewort	–
Asteraceae	ARCA13	<i>Artemisia cana</i>	silver sagebrush	–
Asteraceae	ARDR4	<i>Artemisia dracunculus</i>	tarragon	–
Asteraceae	ARFR4	<i>Artemisia frigida</i>	fringed sagewort	–
Asteraceae	ARLU	<i>Artemisia ludoviciana</i>	white sagebrush	–
Asteraceae	BREU	<i>Brickellia eupatorioides</i>	false boneset	–
Asteraceae	CANU4	<i>Carduus nutans</i>	musk thistle	Exotic; SD County Noxious Weed
Asteraceae	CIAR4	<i>Cirsium arvense</i>	Canada thistle	Exotic; SD County Noxious Weed
Asteraceae	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle	–
Asteraceae	CIVU	<i>Cirsium vulgare</i>	bull thistle	Exotic
Asteraceae	COCA5	<i>Conyza canadensis</i>	horseweed	–
Asteraceae	ERCA4	<i>Erigeron canus</i>	hoary fleabane	–
Asteraceae	ERIGE2	<i>Erigeron</i>	fleabane	–
Asteraceae	ERNA10	<i>Ericameria nauseosa</i>	rubber rabbitbrush	–
Asteraceae	ERPU2	<i>Erigeron pumilus</i>	shaggy fleabane	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank but no rare species were found in 2021.

Family	Species Code	Scientific Name	Common Name	Notes
Asteraceae	GRSQ	<i>Grindelia squarrosa</i>	curlycup gumweed	–
Asteraceae	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed	–
Asteraceae	HEAN3	<i>Helianthus annuus</i>	common sunflower	–
Asteraceae	HELIA3	<i>Helianthus</i>	sunflower	–
Asteraceae	LASE	<i>Lactuca serriola</i>	prickly lettuce	Exotic
Asteraceae	MUOB99	<i>Mulgedium oblongifolium</i>	blue lettuce	–
Asteraceae	NOCU	<i>Nothocalais cuspidata</i>	prairie false dandelion	–
Asteraceae	PAPL12	<i>Packera plattensis</i>	prairie groundsel	–
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	SYER	<i>Symphyotrichum ericoides</i>	white heath aster	–
Asteraceae	SYMPH4	<i>Symphyotrichum</i>	aster	–
Asteraceae	SYOB	<i>Symphyotrichum oblongifolium</i>	aromatic aster	–
Asteraceae	TAOF	<i>Taraxacum officinale</i>	common dandelion	Exotic
Asteraceae	TRDU	<i>Tragopogon dubius</i>	yellow salsify	Exotic
Asteraceae	SORI2	<i>Solidago rigida</i>	stiff goldenrod	–
Boraginaceae	CRCE	<i>Cryptantha celosioides</i>	buttecandle	–
Boraginaceae	LAOC3	<i>Lappula occidentalis</i>	flatspine stickseed	–
Boraginaceae	LASQ	<i>Lappula squarrosa</i>	European stickseed	Exotic
Brassicaceae	ARHI	<i>Arabis hirsuta</i>	hairy rockcress	–
Brassicaceae	CAMI2	<i>Camelina microcarpa</i>	littlepod false flax	Exotic
Brassicaceae	DEPI	<i>Descurainia pinnata</i>	western tansymustard	–
Brassicaceae	DESO2	<i>Descurainia sophia</i>	herb sophia	Exotic
Brassicaceae	DRRE2	<i>Draba reptans</i>	Carolina draba	–
Brassicaceae	LEDE	<i>Lepidium densiflorum</i>	common pepperweed	–
Brassicaceae	SIAL2	<i>Sisymbrium altissimum</i>	tall tumbledmustard	Exotic
Cactaceae	OPFR	<i>Opuntia fragilis</i>	brittle pricklypear	–
Cactaceae	OPMA2	<i>Opuntia macrorhiza</i>	twistspine pricklypear	–
Cactaceae	OPPO	<i>Opuntia polyacantha</i>	plains pricklypear	–
Caprifoliaceae	SYOC	<i>Symphoricarpos occidentalis</i>	western snowberry	–
Caryophyllaceae	CEAR4	<i>Cerastium arvense</i>	field chickweed	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank but no rare species were found in 2021.

Family	Species Code	Scientific Name	Common Name	Notes
Caryophyllaceae	SIAN2	<i>Silene antirrhina</i>	sleepy silene	–
Chenopodiaceae	ATAR2	<i>Atriplex argentea</i>	silverscale saltbush	–
Chenopodiaceae	ATCA2	<i>Atriplex canescens</i>	fourwing saltbush	–
Chenopodiaceae	CHENO	<i>Chenopodium</i>	goosefoot	Exotic
Chenopodiaceae	HAGL	<i>Halogeton glomeratus</i>	saltlover	Exotic
Chenopodiaceae	KOSC	<i>Kochia scoparia</i>	burningbush; kochia	Exotic
Chenopodiaceae	MONU	<i>Monolepis nuttalliana</i>	Nuttall's povertyweed	–
Chenopodiaceae	SATR12	<i>Salsola tragus</i>	prickly Russian thistle	Exotic
Commelinaceae	TRBR	<i>Tradescantia bracteata</i>	longbract spiderwort	–
Convolvulaceae	COAR4	<i>Convolvulus arvensis</i>	field bindweed	Exotic
Cyperaceae	CADU6	<i>Carex duriuscula</i>	needleleaf sedge	–
Cyperaceae	CAFI	<i>Carex filifolia</i>	threadleaf sedge	–
Cyperaceae	CAREX	<i>Carex</i>	sedge	–
Euphorbiaceae	EUGL3	<i>Euphorbia glyptosperma</i>	ribseed sandmat	–
Euphorbiaceae	EUMA8	<i>Euphorbia marginata</i>	snow on the mountain	–
Euphorbiaceae	EUPHO	<i>Euphorbia</i>	spurge; sandmat	–
Euphorbiaceae	EUSP	<i>Euphorbia spathulata</i>	warty spurge	–
Fabaceae	AMNA	<i>Amorpha nana</i>	dwarf false indigo	–
Fabaceae	ASMI10	<i>Astragalus missouriensis</i>	Missouri milkvetch	–
Fabaceae	ASRA2	<i>Astragalus racemosus</i>	cream milkvetch	–
Fabaceae	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	–
Fabaceae	LUPU	<i>Lupinus pusillus</i>	rusty lupine	–
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	PSTE5	<i>Psoralidium tenuiflorum</i>	slimflower scurfpea	–
Fabaceae	VIAM	<i>Vicia americana</i>	American vetch	–
Hydrophyllaceae	ELNY	<i>Ellisia nyctelea</i>	Aunt Lucy	–
Lamiaceae	HEHI	<i>Hedeoma hispida</i>	rough false pennyroyal	–
Liliaceae	ALTE	<i>Allium textile</i>	textile onion	–
Liliaceae	CANU3	<i>Calochortus nuttallii</i>	sego lily	–
Linaceae	LIRI	<i>Linum rigidum</i>	stiffstem flax	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank but no rare species were found in 2021.

Family	Species Code	Scientific Name	Common Name	Notes
Malvaceae	SPCO	<i>Sphaeralcea coccinea</i>	scarlet globemallow	–
Melanthiaceae	TOVE2	<i>Toxicoscordion venenosum</i>	meadow deathcamas	–
Onagraceae	OECE2	<i>Oenothera cespitosa</i>	tufted evening primrose	–
Onagraceae	OESU99	<i>Oenothera suffrutescens</i>	scarlet beeblossom	–
Oxalidaceae	OXDI2	<i>Oxalis dillenii</i>	slender yellow woodsorrel	–
Plantaginaceae	PLPA2	<i>Plantago patagonica</i>	woolly plantain	–
Poaceae	ACHY	<i>Achnatherum hymenoides</i>	Indian ricegrass	–
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	DISP	<i>Distichlis spicata</i>	saltgrass	–
Poaceae	ELEL5	<i>Elymus elymoides</i>	squirreltail	–
Poaceae	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	–
Poaceae	HECO26	<i>Hesperostipa comata</i>	needle and thread	–
Poaceae	HOJU	<i>Hordeum jubatum</i>	foxtail barley	–
Poaceae	HOPU	<i>Hordeum pusillum</i>	little barley	–
Poaceae	KOMA	<i>Koeleria macrantha</i>	prairie Junegrass	–
Poaceae	MUCU3	<i>Muhlenbergia cuspidata</i>	plains muhly	–
Poaceae	MUPA99	<i>Muhlenbergia paniculata</i>	tumblegrass	–
Poaceae	MURA	<i>Muhlenbergia racemosa</i>	marsh muhly	–
Poaceae	NAVI4	<i>Nassella viridula</i>	green needlegrass	–
Poaceae	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	–
Poaceae	PAVI2	<i>Panicum virgatum</i>	switchgrass	–
Poaceae	POCO	<i>Poa compressa</i>	Canada bluegrass	Exotic
Poaceae	POPR	<i>Poa pratensis</i>	Kentucky bluegrass	Exotic
Poaceae	POSE	<i>Poa secunda</i>	Sandberg bluegrass	–
Poaceae	SCSC	<i>Schizachyrium scoparium</i>	little bluestem	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank but no rare species were found in 2021.

Family	Species Code	Scientific Name	Common Name	Notes
Poaceae	SPCO16	<i>Sporobolus compositus</i>	composite dropseed	–
Poaceae	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	–
Poaceae	VUOC	<i>Vulpia octoflora</i>	sixweeks fescue	–
Polemoniaceae	COLI2	<i>Collomia linearis</i>	tiny trumpet	–
Polemoniaceae	PHAN4	<i>Phlox andicola</i>	prairie phlox	–
Polemoniaceae	PHHO	<i>Phlox hoodii</i>	spiny phlox	–
Polygonaceae	ERPA9	<i>Eriogonum pauciflorum</i>	fewflower buckwheat	–
Polygonaceae	FACO	<i>Fallopia convolvulus</i>	black bindweed	Exotic
Polygonaceae	PORA3	<i>Polygonum ramosissimum</i>	bushy knotweed	–
Polygonaceae	RUMEX	<i>Rumex</i>	dock	Exotic
Ranunculaceae	DECA3	<i>Delphinium carolinianum</i>	Carolina larkspur	–
Rosaceae	ROAR3	<i>Rosa arkansana</i>	prairie rose	–
Rosaceae	ROWO	<i>Rosa woodsii</i>	Woods' rose	–
Rubiaceae	GAAP2	<i>Galium aparine</i>	stickywilly	–
Santalaceae	COUM	<i>Comandra umbellata</i>	bastard toadflax	–
Scrophulariaceae	PEER	<i>Penstemon eriantherus</i>	fuzzytongue penstemon	–
Scrophulariaceae	VETH	<i>Verbascum thapsus</i>	common mullein	Exotic; SD County Noxious Weed
Solanaceae	PHLO4	<i>Physalis longifolia</i>	longleaf groundcherry	–
Solanaceae	PHYSA	<i>Physalis</i>	groundcherry	Exotic
Solanaceae	SOTR	<i>Solanum triflorum</i>	cutleaf nightshade	–
Violaceae	VINU2	<i>Viola nuttallii</i>	Nuttall's violet	–

Based on the total count of species observed in each plot in 2021, PCM_00005 had the highest number with 39 total species (Table 4). Plots PCM_0005, was also the plot with the most native diversity with 29 native species (Figure 4). Absolute cover calculations (Table 5) reflected a greater percent of native species cover compared to exotic species cover in the majority (24 out of 30) of plots. FPCM_0621 had the highest absolute native species cover, and PCM_0010 had the highest absolute exotic species cover (Table 5). We found exotic species at every plot in BADL. One exotic species, yellow sweetclover (*Melilotus officinalis*), was especially abundant this year. Yellow sweetclover was present in all 30 plots visited by NGPN and NGPFire crews.

Table 4. Total number of plant species identified in each of the 30 plots monitored at Badlands National Park (BADL) 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 from any plots visited by the NGPFire crew, resulting in a lower species count.

Plot	Native Species	Exotic Species	Total Species
FPCM_0130	10	5	15
FPCM_0189	13	4	17
FPCM_0361	12	3	15
FPCM_0481	13	5	18
FPCM_0509	5	3	8
FPCM_0553	14	7	21
FPCM_0578	8	4	12
FPCM_0621	22	6	28
FPCM_0834	9	9	18
FPCM_0921	11	5	16
PCM_0002	11	8	19
PCM_0004	15	10	25
PCM_0005	29	10	39
PCM_0006	13	10	23
PCM_0007	18	9	27
PCM_0008	24	6	30
PCM_0009	11	6	17
PCM_0010	13	13	26
PCM_0021	15	4	19
PCM_0041	26	6	32
PCM_0045	25	11	36
PCM_0091	28	7	35
PCM_0092	8	4	12
PCM_0094	25	8	33
PCM_0095	17	6	23
PCM_0097	17	8	25

Table 4 (continued). Total number of plant species identified in each of the 30 plots monitored at Badlands National Park (BADL) 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 from any plots visited by the NGPFire crew, resulting in a lower species count.

Plot	Native Species	Exotic Species	Total Species
PCM_0101	7	5	12
PCM_0105	13	4	17
PCM_0109	21	13	34



Figure 4. Plot PCM_0005 had the most native species diversity in 2021. Photograph courtesy of the National Park Service.

Table 5. Absolute percent cover of native and exotic plant species in plots monitored at Badlands National Park 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
BADL_FPCM_0130	102	21
BADL_FPCM_0189	71	79
BADL_FPCM_0361	99	27
BADL_FPCM_0481	123	43
BADL_FPCM_0509	72	89
BADL_FPCM_0553	124	42
BADL_FPCM_0578	62	93
BADL_FPCM_0621	137	18
BADL_FPCM_0834	96	34
BADL_FPCM_0921	99	49
BADL_PCM_0002	30	11
BADL_PCM_0004	26	22
BADL_PCM_0005	74	14
BADL_PCM_0006	73	52
BADL_PCM_0007	128	103
BADL_PCM_0008	39	10
BADL_PCM_0009	92	24
BADL_PCM_0010	52	115
BADL_PCM_0021	95	10
BADL_PCM_0041	48	2
BADL_PCM_0045	35	30
BADL_PCM_0091	56	38
BADL_PCM_0092	13	5
BADL_PCM_0094	78	31
BADL_PCM_0095	41	100
BADL_PCM_0097	103	62
BADL_PCM_0101	71	6
BADL_PCM_0105	98	38
BADL_PCM_0109	76	39

In 2021, no trees or seedlings were present in plots visited by the NGPN and NGPFire monitoring crews. As a result, no surface fuel was found in any of the plots visited that year.

Disturbances occurred at many of the plots visited in 2021 (Table 6). There was a variety of disturbances observed, including grazing, animal trails, flooding, prescribed fire (Door RX 11/7/2021

in Table 6), erosion, and soil disturbance. The most common disturbance observed was soil disturbance.

Table 6. Disturbance types and occurrence in plant community monitoring plots visited in 2021 at Badlands National Park. The disturbance area was approximated out of a total area of 1000 m².

Plot	Disturbance Type	Area (m ²)
BADL_FPCM_0130	Door Rx 11/7/2021	1000
BADL_FPCM_0189	Door Rx 11/7/2021	1000
BADL_FPCM_0509	Door Rx 11/7/2021	1000
BADL_FPCM_0509	Small Mammal	21
BADL_FPCM_0578	Door Rx 11/7/21	995
BADL_FPCM_0621	Door Rx 11/7/21	970
BADL_FPCM_0834	Door Rx 11/7/21	960
BADL_PCM_0002	Erosion	1000
BADL_PCM_0002	Soil Disturbance	1000
BADL_PCM_0004	Flood	1000
BADL_PCM_0005	Erosion	20
BADL_PCM_0005	Soil Disturbance	50
BADL_PCM_0006	Animal Trail	50
BADL_PCM_0006	Grazing	50
BADL_PCM_0006	Flood	300
BADL_PCM_0006	Wallow	10
BADL_PCM_0006	Soil Disturbance	40
BADL_PCM_0007	Animal Trail	20
BADL_PCM_0007	Erosion	3
BADL_PCM_0008	Flood	30
BADL_PCM_0008	Erosion	450
BADL_PCM_0008	Soil Disturbance	480
BADL_PCM_0008	Other	12
BADL_PCM_0009	Off-Road	80
BADL_PCM_0009	Prairie Dog	5
BADL_PCM_0010	Prairie Dog	15
BADL_PCM_0041	Flood	500
BADL_PCM_0041	Erosion	500
BADL_PCM_0041	Soil Disturbance	200
BADL_PCM_0045	Erosion	65
BADL_PCM_0091	Erosion	500
BADL_PCM_0091	Soil Disturbance	500
BADL_PCM_0092	Erosion	200

Table 6 (continued). Disturbance types and occurrence in plant community monitoring plots visited in 2021 at Badlands National Park. The disturbance area was approximated out of a total area of 1000 m².

Plot	Disturbance Type	Area (m²)
BADL_PCM_0092	Soil Disturbance	200
BADL_PCM_0094	Animal Trail	35
BADL_PCM_0094	Grazing	10
BADL_PCM_0094	Small Mammal	8
BADL_PCM_0094	Soil Disturbance	55
BADL_PCM_0105	Small Mammal	0.5
BADL_PCM_0109	Small Mammal	5
BADL_PCM_0109	Door Rx 11/7/21	970

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 Badlands National Park. 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. Badlands National Park 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 Badlands National Park: 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. 2022. 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. 2022. The PLANTS Database (<http://plants.usda.gov>, 28 March 2022). 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.

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NPS 137/185252, September 2022

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