



Plant Community Composition and Structure Monitoring at Badlands National Park

2019 Data Report

Natural Resource Data Series NPS/BADL/NRDS—2019/1244



**ON THIS PAGE**

The vibrant flowers of Dwarf false indigo, *Amorpha nana*, were seen at plot PCM_0082 in Badlands National Park this year. Photograph courtesy of the National Park Service

ON THE COVER

Northern Great Plains Inventory & Monitoring crew members identifying plants at a plot in Badlands National Park. Photograph courtesy of the National Park Service

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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.

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Abstract

This report presents the results of vegetation monitoring efforts in 2019 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 ninth year of combined monitoring efforts.

Crew members from NGPN visited 19 long-term monitoring plots to collect data on the plant communities at BADL. Data collection at two plots was incomplete, and a 20th plot was 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. In plots where woody species were present, tree regeneration, tall shrub density, tree density, and woody fuel loads were also measured. The NGPFire crew visited and collected vegetation data at an additional 12 plots in the Pinnacles, Sheep Mountain, and Heck Table Burn Units to better understand the effects of prescribed fire on vegetation.

In 2019, the monitoring crews identified 186 unique plant species in 31 monitoring plots. Of those species, 32 were exotic species. In a majority of plots (20 out of 31), there was a greater percent of native species cover compared to exotic species cover. However, exotic plants were found at every plot in BADL. One rare species, Barr's milkvetch (*Astragalus barrii*), was observed during our surveys.

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 field work including A. Fowler, C. Knutson, B. Amdor and S. Leach. The 2019 NGPN vegetation field crew—C. Davis, I. Ashton, R. Manuel, T. Schaffner, M. Davis, T. Bortz, E. Duda, and S. Rockwood — and NGPFire crew—D. Swanson, I. Muirhead, M. Pahler, and L. Badertscher—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 31 plots during the spring and summer of 2019. 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 2019, the NGPN crew visited sites in panels 3, 4, 8, and 9 (Figure 1). Sampling was completed by two NGPN crews over nine days (Table 1). Data collection at two plots was incomplete, and a 20th plot was not visited, due to weather and time constraints. Four of the plots were visited for the first time in 2019 and rebar markers were installed (Table 1).

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 Sheep Mountain and Heck Table Units in the western portion of the park were burned October, 28, 2018, and the Pinnacles Unit in the northern part of the park was burned May 16, 2019. In 2019, the NGPFire crew visited and collected vegetation data from seven sites in the Sheep Mountain and Heck Table Units and five sites in the Pinnacles Unit (Table 1).

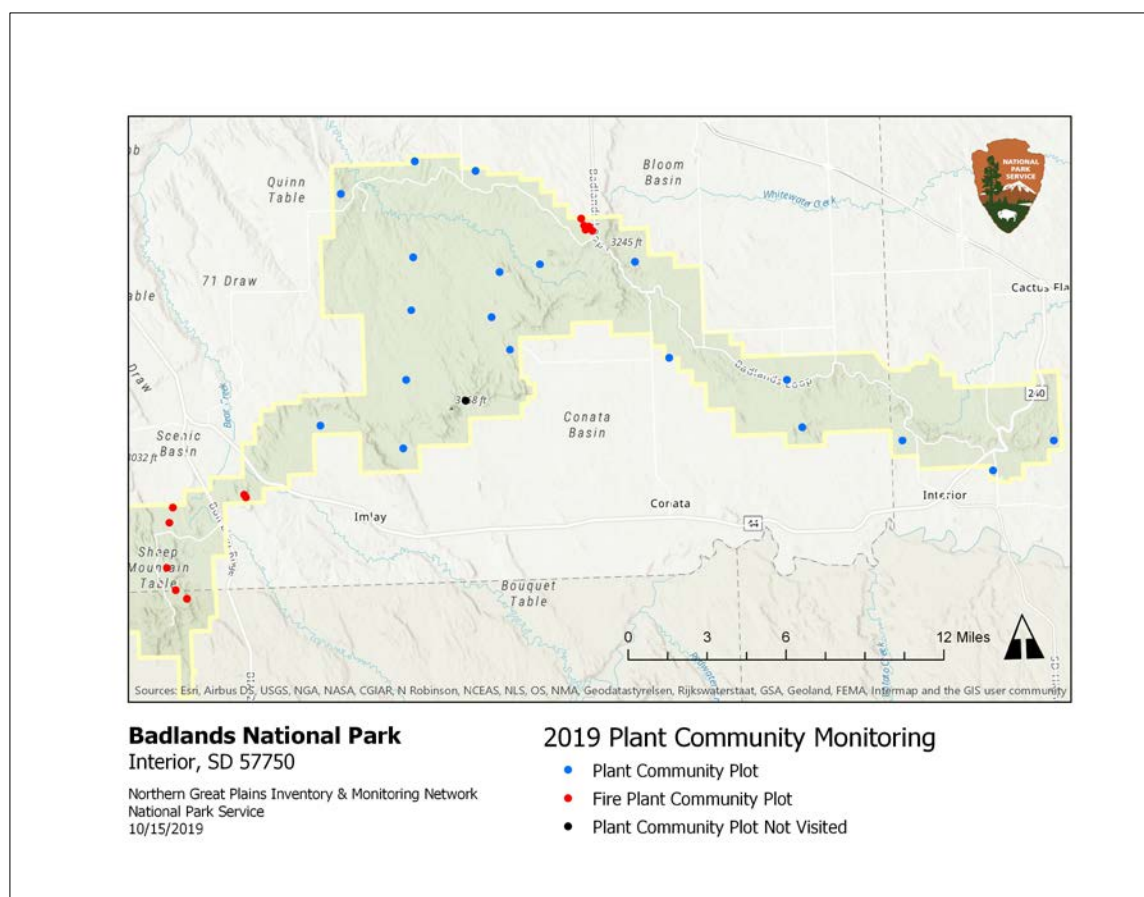


Figure 1. Map of Badlands National Park plant community monitoring plots visited in 2019 by the Northern Great Plains Network Inventory & Monitoring Program (blue) and the Northern Great Plains Fire Ecology Program (red). One plant community monitoring plot that was scheduled to be visited by the Northern Great Plains Network Inventory & Monitoring Program in 2019 was not visited due to time constraints (black).

Table 1. Field journal for monitoring plot visits at Badlands National Park in 2019. A total of 31 plots were visited by Northern Great Plains Inventory & Monitoring and Fire Ecology Programs. All FPCM plots were visited by the Fire Ecology Program.

Date Visited	Plot Name	Field Notes
May 23, 2019	PCM_0077	—
June 4, 2019	PCM_0034	Most of plot was read June 4, 2019 (everything except B-line quadrats); finished plot June 11, 2019.
June 4, 2019	PCM_0114	Tree transect plot. Plot survey not complete due to weather. On June 4, 2019, Point-intercept data on A-line, Fuels, Disturbance, and Target Species data were collected. On June 12, 2019, Point-intercept data on B-line were collected. Quadrat, Tree, and Seedling data were not collected.
June 5, 2019	PCM_0025	—
June 5, 2019	PCM_0037	—

Table 1 (continued). Field journal for monitoring plot visits at Badlands National Park in 2019. A total of 31 plots were visited by Northern Great Plains Inventory & Monitoring and Fire Ecology Programs. All FPCM plots were visited by the Fire Ecology Program.

Date Visited	Plot Name	Field Notes
June 5, 2019	PCM_0084	Plot installed this year.
June 6, 2019	PCM_0029	–
June 6, 2019	PCM_0032	–
June 10, 2019	PCM_0031	–
June 10, 2019	PCM_0074	–
June 10, 2019	FPCM_2107	Sheep Mountain Unit
June 10, 2019	FPCM_2283	Sheep Mountain Unit
June 11, 2019	PCM_0022	Plot survey not complete (B-line quadrats not read) due to weather.
June 11, 2019	PCM_0072	–
June 11, 2019	PCM_0089	Plot installed this year.
June 11, 2019	FPCM_0428	Pinnacles Unit
June 11, 2019	FPCM_0684	Pinnacles Unit
June 11, 2019	FPCM_1196	Pinnacles Unit
June 11, 2019	FPCM_1452	Pinnacles Unit
June 11, 2019	FPCM_1708	Pinnacles Unit
June 12, 2019	PCM_0023	–
June 12, 2019	PCM_0071	–
June 12, 2019	PCM_0082	Tree transect plot. Plot installed this year. Although no trees are in the plot, tree transects were installed because of trees present within a 38m radius of plot center.
June 12, 2019	FPCM_2319	Heck Table Unit
June 12, 2019	FPCM_2459	Sheep Mountain Unit
June 12, 2019	FPCM_3087	Heck Table Unit
June 13, 2019	FPCM_2635	Sheep Mountain Unit
June 13, 2019	FPCM_2651	Sheep Mountain Unit
June 26, 2019	PCM_0083	Plot installed this year.
June 27, 2019	PCM_0039	–
June 27, 2019	PCM_0090	Plot installed this year.
N/A	PCM_0027	Plot not visited due to time constraints.

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 all FPCM plots but did not collect species presence data from the quadrats.

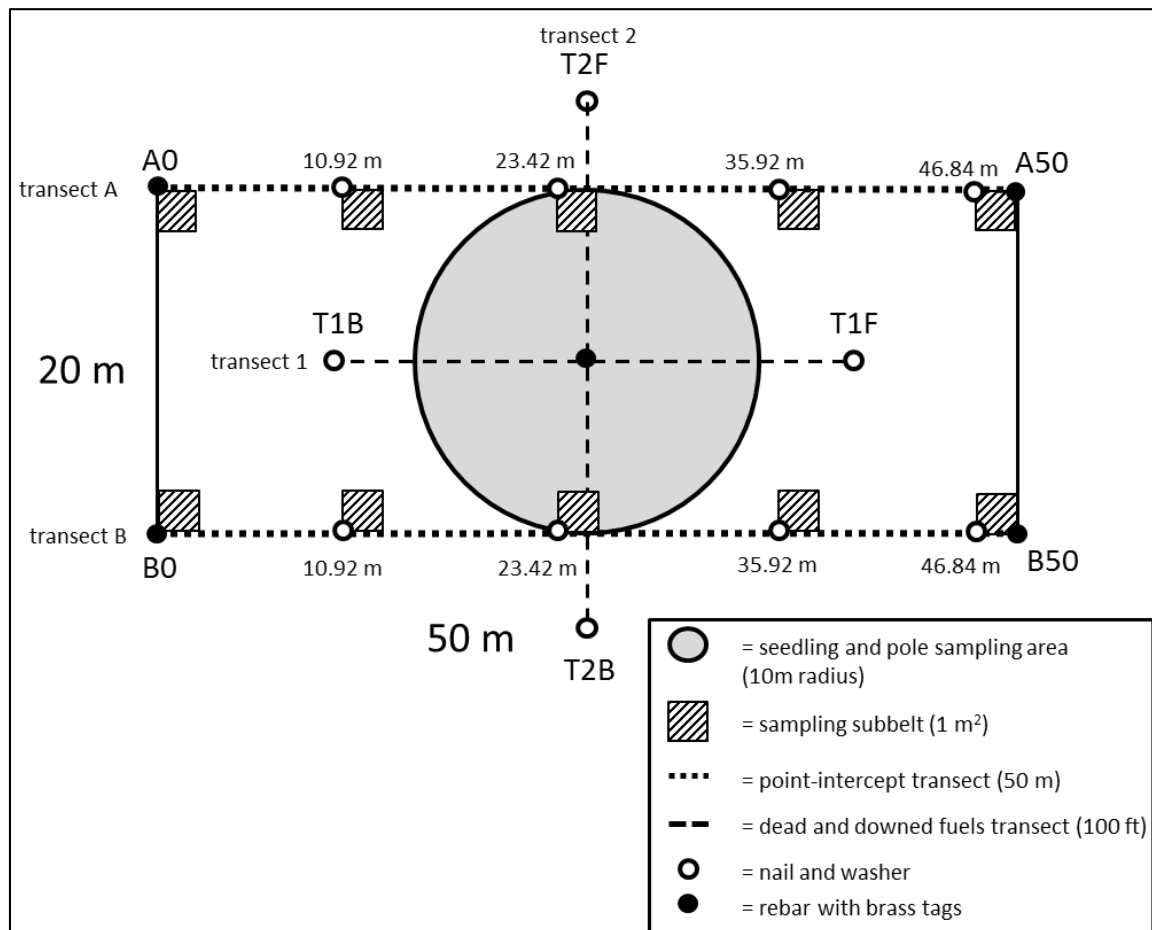


Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.

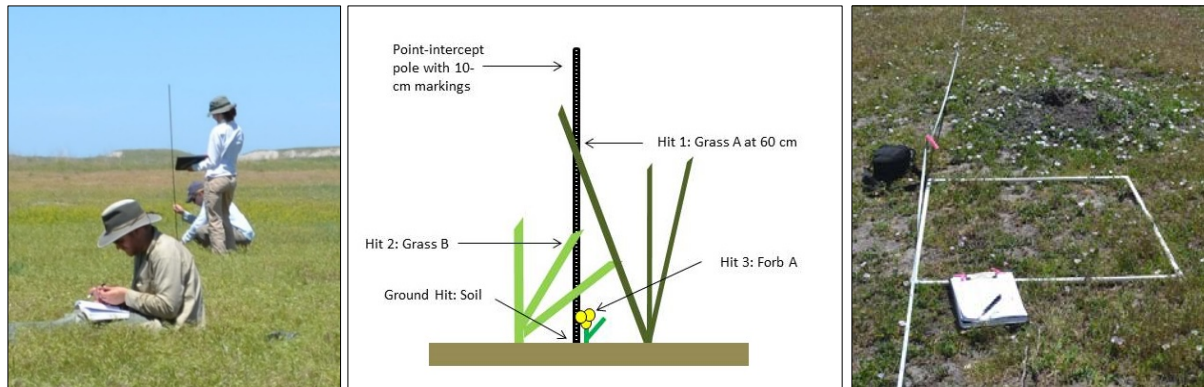


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

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 Exotic Plant Management Team, park managers, and local weed experts. Each target species was assigned an abundance class from 1–5, based on an ocular estimate of cover, where 1 = one individual, 2 = few individuals, 3 = cover of 1–5%, 4 = cover of 5–25%, and 5 = cover $> 25\%$ of the plot.

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

Habitat	Scientific Name	Common Name
Riparian	<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 aethiopis</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 BADL in 2019 was determined by cross-referencing with the NatureServe conservation status list, as well as the South Dakota 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 South Dakota Department of Agriculture.

Results

There are 444 vascular plant species on the [BADL species list](#), and NGPN and NGPFire monitoring crews identified a total of 186 species from 31 monitoring plots in 2019 (Table 3). Of these species, 32 are exotic species for the park. The 2019 species list was cross-referenced with state-wide rare and noxious exotic species lists for South Dakota. One rare plant, Barr's milkvetch (*Astragalus barrii*), was observed during our surveys. Barr's milkvetch, a regional endemic, is ranked vulnerable at the global and state level (G3/S3) by [NatureServe](#). We also 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*), field bindweed (*Convolvulus arvensis*), and common mullein (*Verbascum thapsus*).

Table 3. List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank.

Family	Species Code	Scientific Name	Common Name	Notes
Aceraceae	ACNE2	<i>Acer negundo</i>	boxelder	–
Anacardiaceae	RHAR4	<i>Rhus aromatica</i>	fragrant sumac	–
Anacardiaceae	TORY	<i>Toxicodendron rydbergii</i>	western poison ivy	–
Apiaceae	LOFO	<i>Lomatium foeniculaceum</i>	desert biscuitroot	–
Apiaceae	LOMA3	<i>Lomatium macrocarpum</i>	bigseed biscuitroot	–
Apiaceae	MUDI	<i>Musineon divaricatum</i>	leafy wildparsley	–
Asclepiadaceae	ASPU	<i>Asclepias pumila</i>	plains milkweed	–
Asteraceae	ACMI2	<i>Achillea millefolium</i>	common yarrow	–
Asteraceae	AMAR2	<i>Ambrosia artemisiifolia</i>	annual ragweed	–
Asteraceae	AMPS	<i>Ambrosia psilostachya</i>	Cuman ragweed	–
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 State Noxious Weed
Asteraceae	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle	–
Asteraceae	COCA5	<i>Conyza canadensis</i>	horseweed	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank.

Family	Species Code	Scientific Name	Common Name	Notes
Asteraceae	CORA4	<i>Conyza ramosissima</i>	dwarf horseweed	–
Asteraceae	ECAN2	<i>Echinacea angustifolia</i>	blacksamson echinacea	–
Asteraceae	ERCA4	<i>Erigeron canus</i>	hoary fleabane	–
Asteraceae	ERNA10	<i>Ericameria nauseosa</i>	rubber rabbitbrush	–
Asteraceae	ERST3	<i>Erigeron strigosus</i>	prairie fleabane	–
Asteraceae	ERSU2	<i>Erigeron subtrinervis</i>	threenerve fleabane	–
Asteraceae	GRSQ	<i>Grindelia squarrosa</i>	curlycup gumweed	–
Asteraceae	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed	–
Asteraceae	HELIA3	<i>Helianthus</i>	sunflower	–
Asteraceae	HEMA2	<i>Helianthus maximiliani</i>	Maximilian sunflower	–
Asteraceae	HEVI4	<i>Heterotheca villosa</i>	hairy false goldenaster	–
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	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	PIOP	<i>Picradeniopsis oppositifolia</i>	oppositeleaf bahia	–
Asteraceae	RACO3	<i>Ratibida columnifera</i>	upright prairie coneflower	–
Asteraceae	RUHI2	<i>Rudbeckia hirta</i>	blackeyed Susan	–
Asteraceae	SOMI2	<i>Solidago missouriensis</i>	Missouri goldenrod	–
Asteraceae	SOMO	<i>Solidago mollis</i>	velvety goldenrod	–
Asteraceae	SORI2	<i>Solidago rigida</i>	stiff goldenrod	–
Asteraceae	SYER	<i>Symphyotrichum ericoides</i>	white heath aster	–
Asteraceae	SYLA3	<i>Symphyotrichum laeve</i>	smooth blue 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
Boraginaceae	CRCE	<i>Cryptantha celosioides</i>	buttecandle	–
Boraginaceae	LAOC3	<i>Lappula occidentalis</i>	flatspine stickseed	–
Boraginaceae	LASQ	<i>Lappula squarrosa</i>	European stickseed	Exotic

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank.

Family	Species Code	Scientific Name	Common Name	Notes
Boraginaceae	ONBE	<i>Onosmodium bejariense</i>	soft-hair marbleseed	–
Brassicaceae	ALDE	<i>Alyssum desertorum</i>	desert madwort	Exotic
Brassicaceae	ARHI	<i>Arabis hirsuta</i>	hairy rockcress	–
Brassicaceae	BOHO99	<i>Boechera holboellii</i>	Holboell's rockcress	–
Brassicaceae	CAMI2	<i>Camelina microcarpa</i>	littlepod false flax	Exotic
Brassicaceae	DEPI	<i>Descurainia pinnata</i>	western tansymustard	–
Brassicaceae	DESO2	<i>Descurainia sophia</i>	herb sophia	Exotic
Brassicaceae	DRRE2	<i>Draba reptans</i>	Carolina draba	–
Brassicaceae	ERCA14	<i>Erysimum capitatum</i>	sanddune wallflower	–
Brassicaceae	ERRE4	<i>Erysimum repandum</i>	spreading wallflower	Exotic
Brassicaceae	ERYSI	<i>Erysimum</i>	wallflower	Exotic
Brassicaceae	LEDE	<i>Lepidium densiflorum</i>	common pepperweed	–
Brassicaceae	PHLU99	<i>Physaria ludoviciana</i>	foothill bladderpod	–
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	–
Cactaceae	OPMA2	<i>Opuntia macrorhiza</i>	twistspine pricklypear	–
Cactaceae	OPPO	<i>Opuntia polyacantha</i>	plains pricklypear	–
Campanulaceae	TRLE3	<i>Triodanis leptocarpa</i>	slimpod Venus' looking-glass	–
Campanulaceae	TRPE4	<i>Triodanis perfoliata</i>	clasping Venus' looking-glass	–
Caprifoliaceae	SYOC	<i>Symphoricarpos occidentalis</i>	western snowberry	–
Caryophyllaceae	CEAR4	<i>Cerastium arvense</i>	field chickweed	–
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	ATGA	<i>Atriplex gardneri</i>	Gardner's 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

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank.

Family	Species Code	Scientific Name	Common Name	Notes
Commelinaceae	TRBR	<i>Tradescantia bracteata</i>	longbract spiderwort	–
Convolvulaceae	COAR4	<i>Convolvulus arvensis</i>	field bindweed	Exotic; SD County Noxious Weed
Cupressaceae	JUSC2	<i>Juniperus scopulorum</i>	Rocky Mountain juniper	–
Cyperaceae	CABR10	<i>Carex brevior</i>	shortbeak sedge	–
Cyperaceae	CADU6	<i>Carex duriuscula</i>	needleleaf sedge	–
Cyperaceae	CAFI	<i>Carex filifolia</i>	threadleaf sedge	–
Cyperaceae	CAIN9	<i>Carex inops</i>	sun sedge	–
Cyperaceae	CAREX	<i>Carex</i>	sedge	–
Cyperaceae	ELPA3	<i>Eleocharis palustris</i>	common spikerush	–
Euphorbiaceae	EUPHO	<i>Euphorbia</i>	spurge; sandmat	–
Euphorbiaceae	EUSP	<i>Euphorbia spathulata</i>	warty spurge	–
Fabaceae	ACAM99	<i>Acmispon americanus</i>	American bird's-foot trefoil	–
Fabaceae	AMCA6	<i>Amorpha canescens</i>	leadplant	–
Fabaceae	AMNA	<i>Amorpha nana</i>	dwarf false indigo	–
Fabaceae	ASAG2	<i>Astragalus agrestis</i>	purple milkvetch	–
Fabaceae	ASBA	<i>Astragalus barrii</i>	Barr's milkvetch	Rare (G3/S3)
Fabaceae	ASMI10	<i>Astragalus missouriensis</i>	Missouri milkvetch	–
Fabaceae	ASRA2	<i>Astragalus racemosus</i>	cream milkvetch	–
Fabaceae	DAPU5	<i>Dalea purpurea</i>	purple prairie clover	–
Fabaceae	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	–
Fabaceae	LAPO2	<i>Lathyrus polymorphus</i>	manystem pea	–
Fabaceae	MELU	<i>Medicago lupulina</i>	black medick	Exotic
Fabaceae	MEOF	<i>Melilotus officinalis</i>	yellow sweetclover	Exotic
Fabaceae	OXLA3	<i>Oxytropis lambertii</i>	purple locoweed	–
Fabaceae	OXSE	<i>Oxytropis sericea</i>	white locoweed	–
Fabaceae	PEAR6	<i>Pedimelum argophyllum</i>	silverleaf Indian breadroot	–
Fabaceae	PECU3	<i>Pedimelum cuspidatum</i>	largebract Indian breadroot	–
Fabaceae	PSTE5	<i>Psoralegium tenuiflorum</i>	slimflower scurfpea	–
Fabaceae	VIAM	<i>Vicia americana</i>	American vetch	–
Geraniaceae	GECA5	<i>Geranium carolinianum</i>	Carolina geranium	–
Hydrophyllaceae	ELNY	<i>Ellisia nyctelea</i>	Aunt Lucy	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank.

Family	Species Code	Scientific Name	Common Name	Notes
Juncaceae	JUIN2	<i>Juncus interior</i>	inland rush	–
Lamiaceae	HEHI	<i>Hedeoma hispida</i>	rough false pennyroyal	–
Liliaceae	ALTE	<i>Allium textile</i>	textile onion	–
Liliaceae	MAST4	<i>Maianthemum stellatum</i>	starry false lily of the valley	–
Linaceae	LIRI	<i>Linum rigidum</i>	stiffstem flax	–
Malvaceae	SPCO	<i>Sphaeralcea coccinea</i>	scarlet globemallow	–
Melanthiaceae	TOVE2	<i>Toxicoscordion venenosum</i>	meadow deathcamas	–
Oleaceae	FRPE	<i>Fraxinus pennsylvanica</i>	green ash	–
Onagraceae	OECE2	<i>Oenothera cespitosa</i>	tufted evening primrose	–
Onagraceae	OECU2	<i>Oenothera curtiflora</i>	velvetweed	–
Onagraceae	OESU99	<i>Oenothera suffrutescens</i>	scarlet beeblossom	–
Oxalidaceae	OXDI2	<i>Oxalis dillenii</i>	slender yellow woodsorrel	–
Oxalidaceae	OXST	<i>Oxalis stricta</i>	common yellow woodsorrel	–
Plantaginaceae	PLEL	<i>Plantago elongata</i>	prairie plantain	–
Plantaginaceae	PLPA2	<i>Plantago patagonica</i>	woolly plantain	–
Poaceae	ACHY	<i>Achnatherum hymenoides</i>	Indian ricegrass	–
Poaceae	AGCR	<i>Agropyron cristatum</i>	crested wheatgrass	Exotic
Poaceae	ANGE	<i>Andropogon gerardii</i>	big bluestem	–
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	DIOL	<i>Dichanthelium oligosanthos</i>	Heller's rosette grass	–
Poaceae	ELEL5	<i>Elymus elymoides</i>	squirreltail	–
Poaceae	ELLA3	<i>Elymus lanceolatus</i>	thickspike wheatgrass	–
Poaceae	ELRE4	<i>Elymus repens</i>	quackgrass	Exotic
Poaceae	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	–
Poaceae	ELYMU	<i>Elymus</i>	wildrye	Exotic

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank.

Family	Species Code	Scientific Name	Common Name	Notes
Poaceae	HECO26	<i>Hesperostipa comata</i>	needle and thread	–
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	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	–
Poaceae	SEVI4	<i>Setaria viridis</i>	green bristlegrass	Exotic
Poaceae	SPCO16	<i>Sporobolus compositus</i>	composite dropseed	–
Poaceae	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	–
Poaceae	SPHE	<i>Sporobolus heterolepis</i>	prairie dropseed	–
Poaceae	VUOC	<i>Vulpia octoflora</i>	sixweeks fescue	–
Polemoniaceae	PHAN4	<i>Phlox andicola</i>	prairie phlox	–
Polemoniaceae	PHHO	<i>Phlox hoodii</i>	spiny phlox	–
Polygonaceae	ERFL4	<i>Eriogonum flavum</i>	alpine golden buckwheat	–
Polygonaceae	ERPA9	<i>Eriogonum pauciflorum</i>	fewflower buckwheat	–
Polygonaceae	FACO	<i>Fallopia convolvulus</i>	black bindweed	Exotic
Polygonaceae	POAV	<i>Polygonum aviculare</i>	prostrate knotweed	Exotic
Polygonaceae	RUCR	<i>Rumex crispus</i>	curly dock	Exotic
Primulaceae	ANOC2	<i>Androsace occidentalis</i>	western rockjasmine	–
Ranunculaceae	ANPA	<i>Anemone parviflora</i>	smallflowered anemone	–
Ranunculaceae	DECA3	<i>Delphinium carolinianum</i>	Carolina larkspur	–
Ranunculaceae	MYMI2	<i>Myosurus minimus</i>	tiny mousetail	–
Rosaceae	PRVI	<i>Prunus virginiana</i>	chokecherry	–
Rosaceae	ROWO	<i>Rosa woodsii</i>	Woods' rose	–
Rubiaceae	GAAP2	<i>Galium aparine</i>	stickywilly	–
Santalaceae	COUM	<i>Comandra umbellata</i>	bastard toadflax	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community 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. Rare species are designated in the Notes column as Rare, along with their conservation rank.

Family	Species Code	Scientific Name	Common Name	Notes
Scrophulariaceae	PEAL2	<i>Penstemon albidus</i>	white penstemon	–
Scrophulariaceae	PEER	<i>Penstemon eriantherus</i>	fuzzytongue penstemon	–
Scrophulariaceae	PEGR5	<i>Penstemon gracilis</i>	lilac penstemon	–
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; SD County Noxious Weed
Solanaceae	PHHE5	<i>Physalis heterophylla</i>	clammy groundcherry	–
Solanaceae	PHLO4	<i>Physalis longifolia</i>	longleaf groundcherry	–
Solanaceae	SORO	<i>Solanum rostratum</i>	buffalobur nightshade	–
Ulmaceae	CEOC	<i>Celtis occidentalis</i>	common hackberry	–
Unknown Family	UNKFORB	Unknown forb	unknown forb	Exotic
Unknown Family	UNKFORB ANN	Unknown annual forb	unknown annual forb	Exotic
Urticaceae	PAPE5	<i>Parietaria pensylvanica</i>	Pennsylvania pellitory	–
Verbenaceae	VEBR	<i>Verbena bracteata</i>	bigbract verbena	–
Verbenaceae	VEST	<i>Verbena stricta</i>	hoary verbena	–
Violaceae	VINU2	<i>Viola nuttallii</i>	Nuttall's violet; yellow prairie violet	–
Vitaceae	PAVI5	<i>Parthenocissus vitacea</i>	woodbine	–

Based on the total count of species observed in each plot in 2019, PCM_0032 had the highest number with 74 total species (Table 4). Plots PCM_0074, PCM_0082, and PCM_0083 were the plots with the most native diversity; each had 57 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 (20 out of 31) of plots. BADL_PCM_0034 had the highest absolute native species cover, and PCM_0039 had the highest absolute exotic species cover (Table 5; Figure 5). We found exotic species at every plot in BADL. One exotic species in particular, yellow sweetclover (*Melilotus officinalis*), was especially abundant this year. Yellow sweetclover was present in all 19 plots visited by NGPN, plus in an additional two plots visited by NGPFire on Sheep Mountain.

Table 4. Total number of plant species identified in each of the 31 plots monitored at Badlands National Park (BADL) 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 from BADL_PCM_0114, BADL_PCM_0022 (quadrat data was collected from only 5, not 10, quadrats), or the FPCM plots, resulting in a lower species count.

MacroPlot Name	Exotic Species	Native Species	Total species
BADL_FPCM_0428	3	7	10
BADL_FPCM_0684	5	14	19
BADL_FPCM_1196	1	5	6
BADL_FPCM_1452	1	6	7
BADL_FPCM_1708	2	5	7
BADL_PCM_0022	20	37	57
BADL_PCM_0023	10	48	58
BADL_PCM_0025	13	29	42
BADL_PCM_0029	16	33	49
BADL_PCM_0031	8	38	46
BADL_PCM_0032	22	52	74
BADL_PCM_0034	21	40	61
BADL_PCM_0037	8	18	26
BADL_PCM_0039	21	39	60
BADL_PCM_0071	9	14	23
BADL_PCM_0072	7	23	30
BADL_PCM_0074	11	57	68
BADL_PCM_0077	13	38	51
BADL_PCM_0082	14	57	71
BADL_PCM_0083	12	57	69
BADL_PCM_0084	31	31	62
BADL_PCM_0089	26	37	63
BADL_PCM_0090	7	49	56
BADL_PCM_0114	11	31	42
BADLS_FPCM_2107	3	13	16
BADLS_FPCM_2283	4	11	15
BADLS_FPCM_2319	5	6	11
BADLS_FPCM_2459	3	11	14
BADLS_FPCM_2635	3	10	13
BADLS_FPCM_2651	5	7	12
BADLS_FPCM_3087	5	6	11



Figure 4. Plot PCM_0082 was one of the plots with the most native species diversity in 2019. 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 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 % Exotic Cover	Absolute % Native Cover
BADL_FPCM_0428	83	27
BADL_FPCM_0684	77	55
BADL_FPCM_1196	71	19
BADL_FPCM_1452	68	31
BADL_FPCM_1708	82	17
BADL_PCM_0022	164	87
BADL_PCM_0023	44	102
BADL_PCM_0025	60	40
BADL_PCM_0029	139	156
BADL_PCM_0031	9	50
BADL_PCM_0032	146	165
BADL_PCM_0034	77	230
BADL_PCM_0037	10	89

Table 5 (continued). Absolute percent cover of native and exotic plant species in plots monitored at Badlands National Park 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 % Exotic Cover	Absolute % Native Cover
BADL_PCM_0039	241	112
BADL_PCM_0071	27	21
BADL_PCM_0072	22	36
BADL_PCM_0074	64	116
BADL_PCM_0077	64	90
BADL_PCM_0082	99	166
BADL_PCM_0083	41	90
BADL_PCM_0084	165	76
BADL_PCM_0089	68	186
BADL_PCM_0090	38	125
BADL_PCM_0114	132	129
BADLS_FPCM_2107	34	174
BADLS_FPCM_2283	13	121
BADLS_FPCM_2319	47	92
BADLS_FPCM_2459	17	156
BADLS_FPCM_2635	5	161
BADLS_FPCM_2651	40	121
BADLS_FPCM_3087	48	133



Figure 5. Yellow sweetclover (*Melilotus officinalis*), a common exotic plant at Badlands National Park, in bloom at plot PCM_0039. This plot had the highest absolute exotic species cover in 2019. Photograph courtesy of the National Park Service.

The NGPN monitoring crew collected woody species data at two plots in 2019: PCM_0082 and PCM_0114. At plot PCM_0082, no trees or seedlings were present within the plot, although there were Rocky Mountain juniper (*Juniperus scopulorum*) trees nearby. At plot PCM_0114, trees and seedlings were present, but data was not collected due to approaching thunderstorms. We measured surface fuels at PCM_0114 and found it averaged 7.23 tons per acre (Table 6). At plot PCM_0082, we did not measure fuels because no fuels crossed the tree transects.

Table 6. Surface fuels summary for one wooded plot at Badlands National Park 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_0114	0.00	0.00	1.38	1.38	0.41	0.00	1.79	3.73	1.72	7.23	0.2	0.2	0.4

Disturbances occurred at many of the plots visited in 2019 (Table 7). There was a variety of disturbances observed, including grazing, animal trails, flooding, fire, erosion, and soil disturbance. The most common disturbance observed was soil disturbance.

Table 7. Disturbance types and occurrence in plant community monitoring plots visited in 2019 at Badlands National Park.

Plot	Disturbance Type	Area (m ²) or Present/Absent
BADL_PCM_0022	Erosion	65
BADL_PCM_0022	Soil Disturbance	75
BADL_PCM_0023	Animal Trail	15
BADL_PCM_0023	Graz	5
BADL_PCM_0023	Wallow	25
BADL_PCM_0023	Soil Disturbance	35
BADL_PCM_0032	Animal Trail	12
BADL_PCM_0032	Graz	4
BADL_PCM_0032	Soil Disturbance	12
BADL_PCM_0034	Off-Road	20
BADL_PCM_0034	Prairie Dog	250
BADL_PCM_0034	Soil Disturbance	20
BADL_PCM_0037	Flood	1000
BADL_PCM_0039	Wallow	22
BADL_PCM_0039	Soil Disturbance	24
BADL_PCM_0071	Animal Trail	15
BADL_PCM_0071	Graz	5
BADL_PCM_0071	Flood	75
BADL_PCM_0071	Soil Disturbance	75
BADL_PCM_0074	Animal Trail	25
BADL_PCM_0074	Flood	5
BADL_PCM_0074	Erosion	10
BADL_PCM_0074	Soil Disturbance	45
BADL_PCM_0082	Wallow	5
BADL_PCM_0082	Small Mammal	1
BADL_PCM_0082	Soil Disturbance	6
BADL_PCM_0083	Flood	500
BADL_PCM_0083	Erosion	2
BADL_PCM_0083	Soil Disturbance	5
BADL_PCM_0084	Prairie Dog	7
BADL_PCM_0084	Small Mammal	5
BADL_PCM_0084	Soil Disturbance	12
BADL_PCM_0089	Off-Road	20
BADL_PCM_0089	Animal Trail	10
BADL_PCM_0089	Graz	200
BADL_PCM_0089	Prairie Dog	230

Table 7 (continued). Disturbance types and occurrence in plant community monitoring plots visited in 2019 at Badlands National Park.

Plot	Disturbance Type	Area (m ²) or Present/Absent
BADL_PCM_0089	Flood	800
BADL_PCM_0089	Soil Disturbance	10
BADL_PCM_0090	Animal Trail	30
BADL_PCM_0090	Graz	250
BADL_PCM_0090	Flood	20
BADL_PCM_0090	Soil Disturbance	70
BADL_PCM_0114	Animal Trails	200
BADL_PCM_0114	Erosion	25
BADL_PCM_0114	Soil Disturbance	225
BADLS_FPCM_2107	Soil Disturbance	1.8
BADLS_FPCM_2283	Soil Disturbance	1.9
BADLS_FPCM_2319	Fire	Present
BADLS_FPCM_3087	Fire	Present

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 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](#).

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