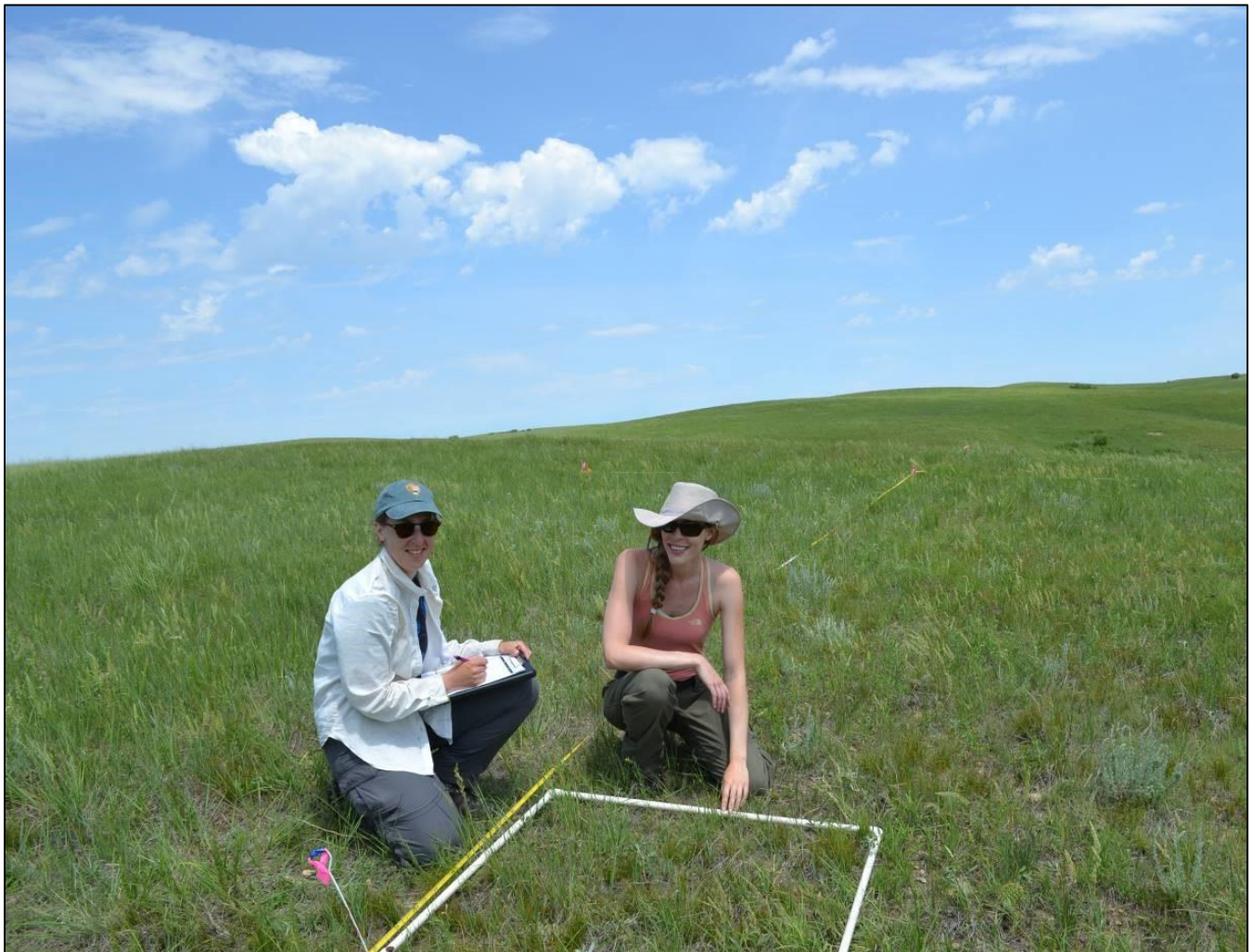




Plant Community Composition and Structure Monitoring at Badlands National Park

2018 Data Report

Natural Resource Data Series NPS/NGPN/NRDS—2018/1207



ON THE COVER

Northern Great Plains Inventory & Monitoring crew members, S. Rockwood and R. Oltjenbruns identifying plant species at a plot in Badlands National Park.

Photograph courtesy of the National Park Service

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of those protocols.

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Abstract

This report presents the results of vegetation monitoring efforts in 2018 at Badlands National Park (BADL) by the Northern Great Plains Inventory and Monitoring Network (NGPN) and Fire Ecology Program (NGPFire). This was the eighth year of combined monitoring efforts.

Crew members from NGPN visited 20 long-term monitoring plots to collect data on the plant communities at BADL. 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 an additional 13 plots in the Door and Heck Table Burn Unit to better understand the effects of prescribed fire on vegetation.

In 2018, the monitoring crews identified 194 unique plant species in 33 monitoring plots. Of those species, 39 were exotic species. On average, the absolute cover of exotic species was much greater than the absolute cover of native species. No rare species were observed in any of the plots.

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 D. Thornburgh, C. Serratos, B. Amdor, P. hart, O. Rengo, and J. Mills. The 2018 NGPN vegetation field crew—C. Davis, I. Ashton, R. Manuel, T. Schaffner, M. Davis, R. Oltjenbruns, and S. Rockwood — and NGPFire crew- D. Swanson, K. Ronsani, I. Muirhead, and J. Roy- 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 33 plots during the spring and summer of 2017. 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 2018, the NGPN crew visited sites in panels 2, 3, 7, and 8 (Figure 1). Sampling was completed by two NGPN crews over eight days (Table 1). Three of the plots were visited for the first time in 2018 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. In 2018, six sites were visited in the Door Unit in the eastern portion of the park and seven sites were visited in the Heck Table Unit in the western portion of the park (Figure 1).

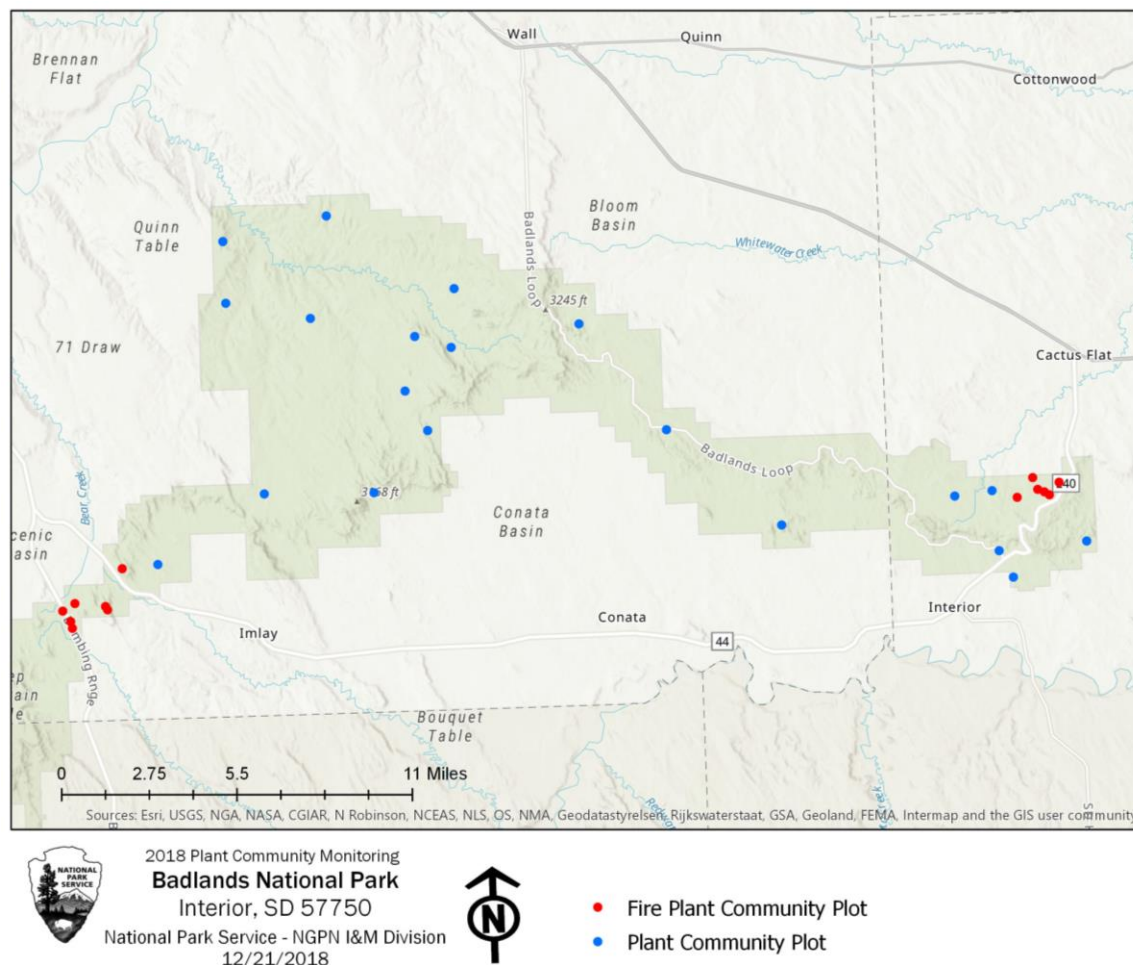


Figure 1. Map of Badlands National Park plant community monitoring plots visited in 2018 by the Northern Great Plains Network Inventory & Monitoring Program (blue) and the Fire Ecology Program (red).

Table 1. Field journal for monitoring plot visits at Badlands National Park in 2018. A total of 33 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 4, 2018	PCM_0063	Prairie dog roadside plot, lots of little forbs
	PCM_0072	–
June 5, 2018	PCM_0012	–
	PCM_0016	Long hike
	PCM_0074	Installed
June 6, 2018	PCM_0015	Collected navigation info for 2-track driving route
	PCM_0023	–
	PCM_0071	Installed plot
	PCM_0077	–
June 7, 2018	PCM_0018	Plot coordinates recollected, diverse plot
	PCM_0025	Plot inaccessible from badland fins south of Prairie Wind parking
June 11, 2018	FPCM_0834	Door Unit
	PCM_0114	Installed, hardwood forest present
June 12, 2018	FPCM_0130	Door Unit
	FPCM_0189	Door Unit
	FPCM_0509	Door Unit
	FPCM_0621	Door Unit
	PCM_0022	–
	PCM_0027	–
	PCM_0064	–
June 13, 2018	FPCM_1024	Heck Table
	FPCM_2319	Heck Table
	FPCM_3087	Heck Table
	FPCM_4731	Heck Table
	PCM_0029	–
	PCM_0062	New tree transect installed
June 14, 2018	FPCM_3451	Heck Table
	FPCM_4475	Heck Table
	PCM_0013	–
	PCM_0061	–
June 19, 2018	FPCM_0578	Door Unit
	FPCM_2299	Heck Table

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.

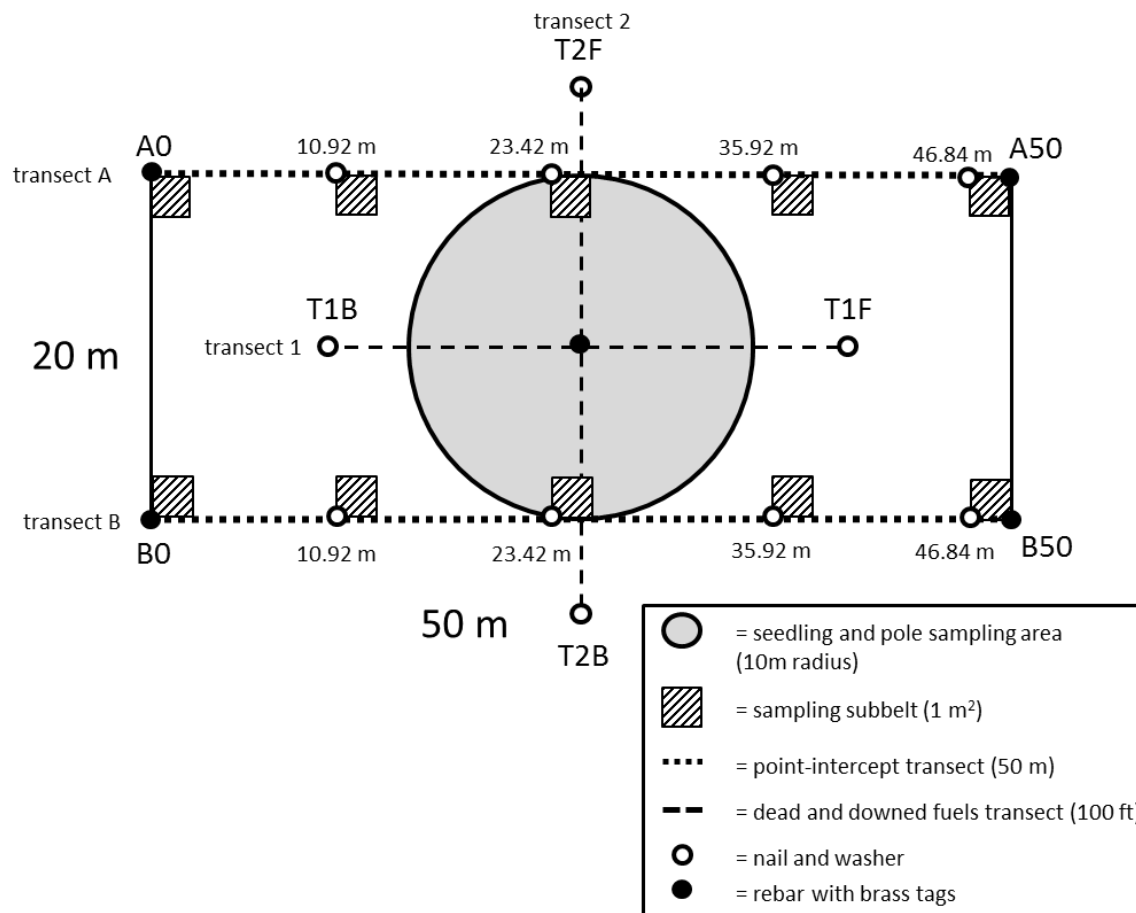


Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.

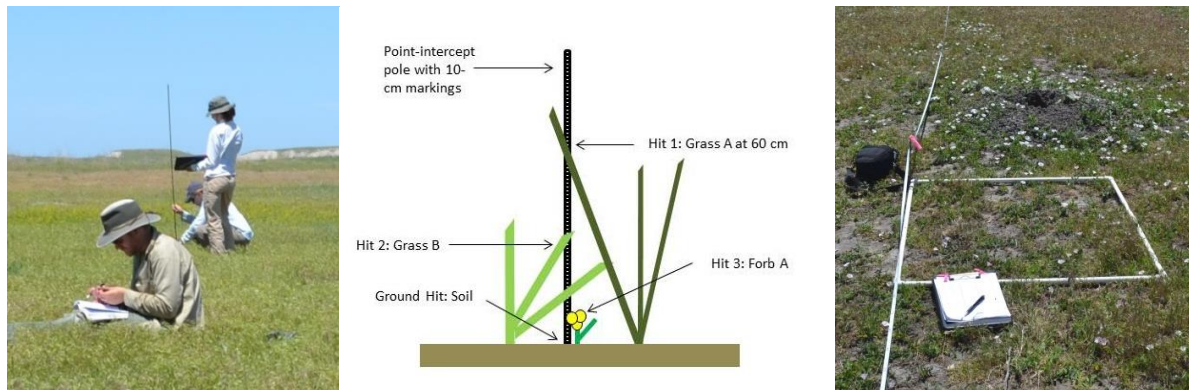


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

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 DBH < 2.54 cm (seedlings) were tallied by species within the 10 m radius subplot. In 2018, NGPN changed the way these species counts were made. Previously, once the count for a species had reached 100, seedlings of that species were not counted in the following quarters and a calculated estimate was made when the data was analyzed. Now, all seedling species present are always counted or estimated in all four quarters of the 10 m radius subplot while in the field. 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. In 2018 a new category called soil disturbance was added, which is defined as loose, exposed soil from all sources. Plots were also assessed for the presence and abundance of target exotic species (Table 2), which is critical for early detection and rapid response to exotic species threats. These species were chosen in collaboration with the Midwest Invasive Plant Network, Northern Great Plains Exotic Plant Management Team, park managers, and local weed experts. Each target species was assigned an abundance class from 1–5, based on an ocular estimate of cover, where 1 = one individual, 2 = few individuals, 3 = cover of 1–5%, 4 = cover of 5–25%, and 5 = cover $> 25\%$ of the plot.

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. 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 2018 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 2018 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 194 species from 33 monitoring plots in 2018 (Table 3). Of these species, 39 are exotic species for the park. The 2018 species list was cross-referenced with state-wide rare and noxious exotic species lists for South Dakota. No rare plant species were identified by either crew. One species matched the Jackson County, South Dakota noxious species list: nodding plumeless thistle (*Caardus nutans*). When the plant species identified in 2018 were cross-referenced with the NPSpecies list for BADL, we found that nodding plumeless thistle was not on the list. However, when it was discussed with the exotic plant managers, it was already known to exist in the park (personal communication B.Hauk June, 2108). When plants are seen in subsequent years, a voucher specimen should be collected so that it can be added to the park herbarium collection.

Table 3. List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
Agavaceae	YUGL	<i>Yucca glauca</i>	soapweed yucca	–
Amaranthaceae	AMRE	<i>Amaranthus retroflexus</i>	redroot pigweed	–
Anacardiaceae	RHTR	<i>Rhus trilobata</i>	skunkbush 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	–
Asclepiadaceae	ASVI	<i>Asclepias viridiflora</i>	green comet milkweed	–
Asteraceae	ACMI2	<i>Achillea millefolium</i>	common yarrow	–
Asteraceae	AMAR2	<i>Ambrosia artemisiifolia</i>	common 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	ARLO7	<i>Artemisia longifolia</i>	longleaf sagebrush	–
Asteraceae	ARLU	<i>Artemisia ludoviciana</i>	white sagebrush	–
Asteraceae	BREU	<i>Brickellia eupatorioides</i>	false boneset	–
Asteraceae	CANU4	<i>Carduus nutans</i>	nodding plumeless thistle	Exotic; Noxious Jackson Co.; new
Asteraceae	CIAR4	<i>Cirsium arvense</i>	Canada thistle	Exotic –Noxious SD
Asteraceae	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle	–
Asteraceae	COCA5	<i>Conyza canadensis</i>	horseweed	–
Asteraceae	DYPA	<i>Dyssodia papposa</i>	fetid marigold	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
Asteraceae	ECAN2	<i>Echinacea angustifolia</i>	blacksamson echinacea	–
Asteraceae	ERIGE2	<i>Erigeron</i>	fleabane	–
Asteraceae	ERNA10	<i>Ericameria nauseosa</i>	rubber rabbitbrush	–
Asteraceae	ERST3	<i>Erigeron strigosus</i>	prairie fleabane	–
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	exotic
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	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	RAC03	<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	TEAC	<i>Tetraneuris acaulis</i>	stemless four-nerve daisy	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
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
Boraginaceae	LIIN2	<i>Lithospermum incisum</i>	narrowleaf stoneseed	–
Brassicaceae	ALDE	<i>Alyssum desertorum</i>	desert madwort	exotic
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	LEDE	<i>Lepidium densiflorum</i>	common pepperweed	–
Brassicaceae	PHLU99	<i>Physaria ludoviciana</i>	foothill bladderpod	–
Brassicaceae	SIAL2	<i>Sisymbrium altissimum</i>	tall tumbledmustard	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	–
Caprifoliaceae	SYOC	<i>Symphoricarpos occidentalis</i>	western snowberry	–
Caryophyllaceae	SIAN2	<i>Silene antirrhina</i>	sleepy silene	–
Chenopodiaceae	ATAR2	<i>Atriplex argentea</i>	silverscale saltbush	–
Chenopodiaceae	ATCA2	<i>Atriplex canescens</i>	fourwing saltbush	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
Chenopodiaceae	ATGA	<i>Atriplex gardneri</i>	Gardner's saltbush	–
Chenopodiaceae	ATRIP	<i>Atriplex</i>	saltbush	–
Chenopodiaceae	CHAL7	<i>Chenopodium album</i>	lambsquarters	exotic
Chenopodiaceae	CHENO	<i>Chenopodium</i>	goosefoot	exotic
Chenopodiaceae	CHIN2	<i>Chenopodium incanum</i>	mealy goosefoot	–
Chenopodiaceae	HAGL	<i>Halogeton glomeratus</i>	saltlover	exotic
Chenopodiaceae	KOSC	<i>Kochia scoparia</i>	burningbush; kochia	exotic
Chenopodiaceae	KRLA2	<i>Krascheninnikovia lanata</i>	winterfat	–
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	–
Commelinaceae	TROC	<i>Tradescantia occidentalis</i>	prairie spiderwort	–
Convolvulaceae	COAR4	<i>Convolvulus arvensis</i>	field bindweed	exotic
Convolvulaceae	IPLE	<i>Ipomoea leptophylla</i>	bush morning-glory	–
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	–
Euphorbiaceae	EUBR	<i>Euphorbia brachycera</i>	horned spurge	–
Euphorbiaceae	EUMA7	<i>Euphorbia maculata</i>	spotted sandmat	–
Euphorbiaceae	EUMA8	<i>Euphorbia marginata</i>	snow on the mountain	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
Euphorbiaceae	EUPHO	<i>Euphorbia</i>	spurge; sandmat	exotic
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	ASMI10	<i>Astragalus missouriensis</i>	Missouri milkvetch	–
Fabaceae	ASRA2	<i>Astragalus racemosus</i>	cream milkvetch	–
Fabaceae	ASTRA	<i>Astragalus</i>	milkvetch	–
Fabaceae	DAAU	<i>Dalea aurea</i>	golden prairie clover	–
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	MESA	<i>Medicago sativa</i>	alfalfa	exotic
Fabaceae	PEAR6	<i>Pedimelum argophyllum</i>	silverleaf Indian breadroot	–
Fabaceae	PECU3	<i>Pedimelum cuspidatum</i>	largebract Indian breadroot	–
Fabaceae	PEES	<i>Pedimelum esculentum</i>	large Indian breadroot	–
Fabaceae	PSTE5	<i>Psoraleidum tenuiflorum</i>	slimflower scurfpea	–
Fabaceae	VIAM	<i>Vicia americana</i>	American vetch	–
Hydrophyllaceae	ELNY	<i>Ellisia nyctelea</i>	Aunt Lucy	–
Lamiaceae	HEDR	<i>Hedeoma drummondii</i>	Drummond's false pennyroyal	–
Lamiaceae	HEHI	<i>Hedeoma hispida</i>	rough false pennyroyal	–
Lamiaceae	NECA2	<i>Nepeta cataria</i>	catnip	exotic

Table 3 (continued). List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
Liliaceae	ALTE	<i>Allium textile</i>	textile onion	–
Liliaceae	CANU3	<i>Calochortus nuttallii</i>	sego lily	–
Liliaceae	LEMO4	<i>Leucocrinum montanum</i>	common starlily	–
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	OENU	<i>Oenothera nuttallii</i>	Nuttall's evening primrose	–
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

Table 3 (continued). List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
Poaceae	CALO	<i>Calamovilfa longifolia</i>	prairie sandreed	–
Poaceae	DISP	<i>Distichlis spicata</i>	saltgrass	–
Poaceae	ELEL5	<i>Elymus elymoides</i>	squirreltail	–
Poaceae	ELRE4	<i>Elymus repens</i>	quackgrass	exotic
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	MUSQ3	<i>Munroa squarrosa</i>	false buffalograss	–
Poaceae	NAVI4	<i>Nassella viridula</i>	green needlegrass	–
Poaceae	PACA6	<i>Panicum capillare</i>	witchgrass	–
Poaceae	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	–
Poaceae	PAVI2	<i>Panicum virgatum</i>	switchgrass	–
Poaceae	PIMI7	<i>Piptatherum micranthum</i>	littleseed ricegrass	–
Poaceae	POA	<i>Poa</i>	bluegrass	exotic
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	SPCO16	<i>Sporobolus compositus</i>	composite dropseed	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
Poaceae	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	–
Poaceae	VUOC	<i>Vulpia octoflora</i>	sixweeks fescue	–
Polemoniaceae	PHAL3	<i>Phlox alyssifolia</i>	alyssumleaf phlox	–
Polemoniaceae	PHAN4	<i>Phlox andicola</i>	prairie phlox	–
Polemoniaceae	PHHO	<i>Phlox hoodii</i>	spiny phlox	–
Polygalaceae	POAL4	<i>Polygala alba</i>	white milkwort	–
Polygonaceae	ERPA9	<i>Eriogonum pauciflorum</i>	fewflower buckwheat	–
Polygonaceae	FACO	<i>Fallopia convolvulus</i>	black bindweed	exotic
Polygonaceae	RUOC3	<i>Rumex occidentalis</i>	Western dock	–
Ranunculaceae	ANEMO	<i>Anemone</i>	anemone	exotic
Ranunculaceae	DECA3	<i>Delphinium carolinianum</i>	Carolina larkspur	–
Rosaceae	PRPU3	<i>Prunus pumila</i>	sandcherry	–
Rosaceae	PRVI	<i>Prunus virginiana</i>	chokecherry	–
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	VERON	<i>Veronica</i>	speedwell	exotic
Scrophulariaceae	VETH	<i>Verbascum thapsus</i>	common mullein	exotic
Smilacaceae	SMLA3	<i>Smilax lasioneura</i>	Blue Ridge carrionflower	–
Solanaceae	PHLO4	<i>Physalis longifolia</i>	longleaf groundcherry	–
Solanaceae	PHVI5	<i>Physalis virginiana</i>	Virginia groundcherry	–

Table 3 (continued). List of all plant species identified in Badlands National Park plant community monitoring plots in 2018. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State or county noxious weed species are designated in the Notes column. Species that are not on the NPS species list are indicated in as new.

Family	Species Code	Scientific Name	Common Name	Notes
Solanaceae	SORO	<i>Solanum rostratum</i>	buffalobur nightshade	–
Solanaceae	SOTR	<i>Solanum triflorum</i>	cutleaf nightshade	–
Ulmaceae	ULAM	<i>Ulmus americana</i>	American elm	–
Unknown Family	UNKFORB	Unknown forb	unknown forb	exotic
Unknown Family	UNKFORBANN	Unknown annual forb	unknown annual forb	exotic
Unknown Family	UNKGRAM	Unknown graminoid	unknown graminoid	exotic
Unknown Family	UNKGRAMANN	Unknown annual graminoid	unknown annual graminoid	exotic
Urticaceae	PAPE5	<i>Parietaria pensylvanica</i>	Pennsylvania pellitory	–
Verbenaceae	VEBR	<i>Verbena bracteata</i>	bigbract verbena	–
Violaceae	VINU2	<i>Viola nuttallii</i>	Nuttall's violet; yellow prairie violet	–

Based on the total count of species observed in each plots in 2018, PCM_0114 had the highest number with 97 total species (Table 4). Plot PCM_0114 and PCM_0018 were the plots with the most native diversity; each had 73 native species. Absolute cover calculations (Table 5) reflected a greater percent of native species cover compared to exotic species cover in only 8 plots.

BADLS_FPCM_4475 had the highest absolute native species cover, and PCM_0013 had the highest absolute exotic species cover (Table 5). We found exotic species at every plot in BADL and they were abundant in most plots.

Table 4. Total number of plant species identified in each of the 33 plots monitored at Badlands National Park (BADL) in 2018. 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 the FPCM plots, resulting in a lower species count.

MacroPlot Name	Exotic Species	Native Species	Total species
BADL_FPCM_0130	7	12	19
BADL_FPCM_0189	14	23	37
BADL_FPCM_0509	6	9	15
BADL_FPCM_0578	4	12	16
BADL_FPCM_0621	7	21	28
BADL_FPCM_0834	7	17	24
BADL_FPCM_1024	5	10	15
BADL_PCM_0012	14	47	61
BADL_PCM_0013	23	28	51
BADL_PCM_0015	13	23	36
BADL_PCM_0016	16	39	55
BADL_PCM_0018	5	73	78
BADL_PCM_0022	10	13	23
BADL_PCM_0023	11	44	55
BADL_PCM_0025	14	22	36
BADL_PCM_0027	5	11	16
BADL_PCM_0029	7	14	21
BADL_PCM_0061	20	41	61
BADL_PCM_0062	18	49	67
BADL_PCM_0063	6	20	26
BADL_PCM_0064	3	21	24
BADL_PCM_0065	12	44	56
BADL_PCM_0071	10	13	23
BADL_PCM_0072	13	17	30
BADL_PCM_0074	15	50	65

Table 4 (continued). Total number of plant species identified in each of the 33 plots monitored at Badlands National Park (BADL) in 2018. 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 the FPCM plots, resulting in a lower species count.

MacroPlot Name	Exotic Species	Native Species	Total species
BADL_PCM_0077	19	49	68
BADL_PCM_0114	24	73	97
BADLS_FPCM_2299	7	14	21
BADLS_FPCM_2319	4	8	12
BADLS_FPCM_3087	5	10	15
BADLS_FPCM_3451	6	13	19
BADLS_FPCM_4475	13	16	29
BADLS_FPCM_4731	8	14	22

Table 5. Absolute percent cover of native and exotic plant species in plots monitored at Badlands National Park in 2018. 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_0130	117	114
BADL_FPCM_0189	216	127
BADL_FPCM_0509	186	96
BADL_FPCM_0578	199	137
BADL_FPCM_0621	143	151
BADL_FPCM_0834	118	167
BADL_FPCM_1024	155	159
BADL_PCM_0012	114	106
BADL_PCM_0013	224	90
BADL_PCM_0015	174	151
BADL_PCM_0016	111	55
BADL_PCM_0018	102	169
BADL_PCM_0022	203	82
BADL_PCM_0023	114	123
BADL_PCM_0025	142	43
BADL_PCM_0027	105	10
BADL_PCM_0029	208	160
BADL_PCM_0061	179	143
BADL_PCM_0062	138	107

Table 5 (continued). Absolute percent cover of native and exotic plant species in plots monitored at Badlands National Park in 2018. 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_0063	151	30
BADL_PCM_0064	106	33
BADL_PCM_0065	125	115
BADL_PCM_0071	102	15
BADL_PCM_0072	109	10
BADL_PCM_0074	125	91
BADL_PCM_0077	179	147
BADL_PCM_0114	180	115
BADLS_FPCM_2299	115	126
BADLS_FPCM_2319	169	105
BADLS_FPCM_3087	160	149
BADLS_FPCM_3451	144	155
BADLS_FPCM_4475	163	194
BADLS_FPCM_4731	158	139

The NGPN monitoring crew collected woody species data in only one plot in 2018, PCM_0114 (Figure 4). We found three live American elm (*U. Americana*), four live Rocky Mountain junipers (*J. scopulorum*) and 5 live green ash (*F. pennsylvanica*). There were also 1 to 2 dead individuals of each species. PCM_0114 was also the only plot to contain seedlings. We found 5 American elm, 1 Rocky Mountain juniper, 1 green ash, and 4 chokecherry seedlings (*P.virginiana*). We also measured surface fuels at PCM_0114 and found it averaged 10.6 tons per acre (Table 6).



Figure 4. Long-term monitoring plot PCM_0114 at Badlands National Park is located in a woody draw and was the only location in 2018 to have tree species present. It was also the most diverse plot. Photograph courtesy of the National Park Service.

Table 6. Surface fuels summary for one wooded plot at Badlands National Park in 2018.

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	0.33	2.06	2.39	0.41	0.00	2.80	3.83	3.99	10.62	0.2	0.5	0.7

Disturbances occurred at many of the plots visited in 2018 (Table 7). There was a variety of disturbances observed, including grazing, animal trails, a road, and erosion. This year, NGPN began assessing the total area of exposed soil disturbance.

Table 7. Disturbance types and occurrence in plant community monitoring plots visited in 2018 at Badlands National Park.

Plot	Disturbance Type	Area (m²)
BADL_FPCM_0509	Soil Disturbance	27
BADL_PCM_0012	Animal Trail	5
BADL_PCM_0012	Soil Disturbance	15
BADL_PCM_0012	Wallow	10
BADL_PCM_0013	Small Mammal	1
BADL_PCM_0013	Soil Disturbance	1
BADL_PCM_0015	Grazing	10
BADL_PCM_0015	Small Mammal	4
BADL_PCM_0015	Soil Disturbance	4
BADL_PCM_0016	Animal Trail	50
BADL_PCM_0022	Grazing	20
BADL_PCM_0022	Animal Trail	10
BADL_PCM_0022	Erosion	65
BADL_PCM_0022	Soil Disturbance	75
BADL_PCM_0023	Grazing	10
BADL_PCM_0023	Animal Trail	2
BADL_PCM_0023	Other	35
BADL_PCM_0023	Soil Disturbance	15
BADL_PCM_0023	Wallow	5
BADL_PCM_0025	Flood	2
BADL_PCM_0027	Erosion	100
BADL_PCM_0027	Soil Disturbance	100
BADL_PCM_0061	Erosion	12
BADL_PCM_0061	Soil Disturbance	12
BADL_PCM_0062	Erosion	55
BADL_PCM_0062	Small Mammal	4
BADL_PCM_0062	Soil Disturbance	59
BADL_PCM_0063	Prairie Dog	1000
BADL_PCM_0063	Soil Disturbance	20
BADL_PCM_0064	Flood	300
BADL_PCM_0064	Erosion	300
BADL_PCM_0064	Soil Disturbance	300
BADL_PCM_0065	Erosion	10
BADL_PCM_0071	Erosion	750
BADL_PCM_0071	Soil Disturbance	750

Table 7 (continued). Disturbance types and occurrence in plant community monitoring plots visited in 2018 at Badlands National Park.

Plot	Disturbance Type	Area (m ²)
BADL_PCM_0072	Erosion	20
BADL_PCM_0072	Soil Disturbance	20
BADL_PCM_0077	Animal Trail	10
BADL_PCM_0077	Small Mammal	5
BADL_PCM_0077	Soil Disturbance	5
BADL_PCM_0114	Animal Trail	50
BADLS_FPCM_3087	Soil Disturbance	1
BADLS_FPCM_3451	Soil Disturbance	10

Further Analysis

This Data Report is intended to provide a basic review of the data collected during the NGPN and NGPFire monitoring team's 2018 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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