



Plant Community Composition and Structure Monitoring for Badlands National Park

2016 Data Report

Natural Resource Data Series NPS/NGPN/NRDS—2017/1087





ON THIS PAGE

Northern Great Plains Network crew monitoring vegetation in Plant Community Composition and Structure Monitoring plot PCM-0101 at Badlands National Park, June 2016.

Photograph courtesy of Joseph Ladd, National Park Service.

ON THE COVER

Plant Community Composition and Structure Monitoring plot PCM-0007 at Badlands National Park, June 2016.

Photograph courtesy of the National Park Service.

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This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. 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 the protocols.

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Abstract

This report presents the results of vegetation monitoring efforts in 2016 at Badlands National Park (BADL) by the Northern Great Plains Network Inventory and Monitoring program (NGPN) and the Northern Great Plains Fire Effects (NGPFire) program.

During the sixth full year of field work, crew members from NGPN visited twenty long-term plant community monitoring (PCM) plots to collect data on the plant communities at BADL, and NGPFire crew visited two additional PCM plots plus ten fire plant community monitoring (FPCM) plots. This effort is part of a long-term monitoring program in order to better understand the condition of the sparsely vegetated badland, woody draw, and mixed-grass prairie regions in BADL. NGPN and NGPFire staff recorded data relating to species richness, herb-layer height, abundance of individual native and non-native species, ground cover, and site disturbance on each of the twenty-two plots. In plots where woody species were present, crews also measured tree regeneration, tall shrub and tree density, and woody fuel load.

Our 2016 findings can be summarized as follows: Monitoring crews recorded 163 species across 32 monitoring plots visited in 2016 at BADL, of which 33 plant species were exotic. None of the exotics identified were on the target list for the early detection and rapid response program in the NGPN parks. No rare native species were documented. Trees, poles, and seedlings were only located at a single plot and woody fuel loads were recorded at two of the twenty-two plots. The most common disturbances observed were animal use and erosion.

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We thank 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 safety checks. The 2016 NGPN vegetation field crew of: C. Davis, S. Rockwood, W. Vogel, and M. Davis, I. Ashton, L. Mickelson, K. Rugg, and L. LaFleur, with the assistance of the Northern Great Plains Fire Effects crew (D. Swanson, E. Watson, I. Muirhead, and C. Tomford), collected all 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 with a mission 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. 2011](#)). 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 (FireEP). A total of 127 plots were established by NGPFire and NGPN in BADL, and combined sampling efforts began in 2011 ([Ashton et al. 2012](#)). In this report, we provide summaries of the data collected at 32 plots during the spring and summer of 2016. Please refer to the “Northern Great Plains Fire Ecology Annual Report: Calendar Year 2016” for park burn unit analysis and interpretation of the 2016 monitoring results accessible on the Data Store <https://irma.nps.gov/DataStore>.

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. Below, we briefly describe the general approach. For those interested in more detail, please see the protocol publications cited above, and available at <http://science.nature.nps.gov/im/units/ngpn/monitor/plants.cfm>.

NGPN and NGPFire Monitoring Plots 2016

The NGPN and NGPFire implemented a survey to monitor plant community structure and composition in BADL using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003,2004). Using a GRTS design, NGPN selected 100 randomly located sites within the north unit of BADL where Community Monitoring (PCM) plots would be established. The NGPN aims to visit 20 of 100 PCM plots every year using a rotating sampling scheme, where 10 sites were visited in the previous year and 10 sites are new visits. This allows each plot to be visited for two consecutive years and then rested for eight years, on a ten-year rotating basis. . After 5 years (2011-2015), 50 PCM plots were visited at least twice during the survey season (generally mid-June). With the current sampling scheme, it will take the NGPN 20 years to monitor all 100 plots. In 2016, May 17th to June 20th, the NGPN crew visited PCM plots in half of panel 1, half of panel 6, all of panel 5 (Figure 1) (Table 1).

When a PCM plot was located within an active burn unit, NGPFire added additional monitoring visits based on a preburn, 1, 2, 5, and 10 year post-burn sampling schedule. NGPFire also established and monitored a number of new sites using the same GRTS sampling schema focused in active burn units (Fire FPCM plots). A total of 84 FPCM plots have been established from 2011-2015 by NGPFire and NGPN. In 2016, NGPFire visited 2 additional PCM plots and 10 FPCM plots (Figure 1).

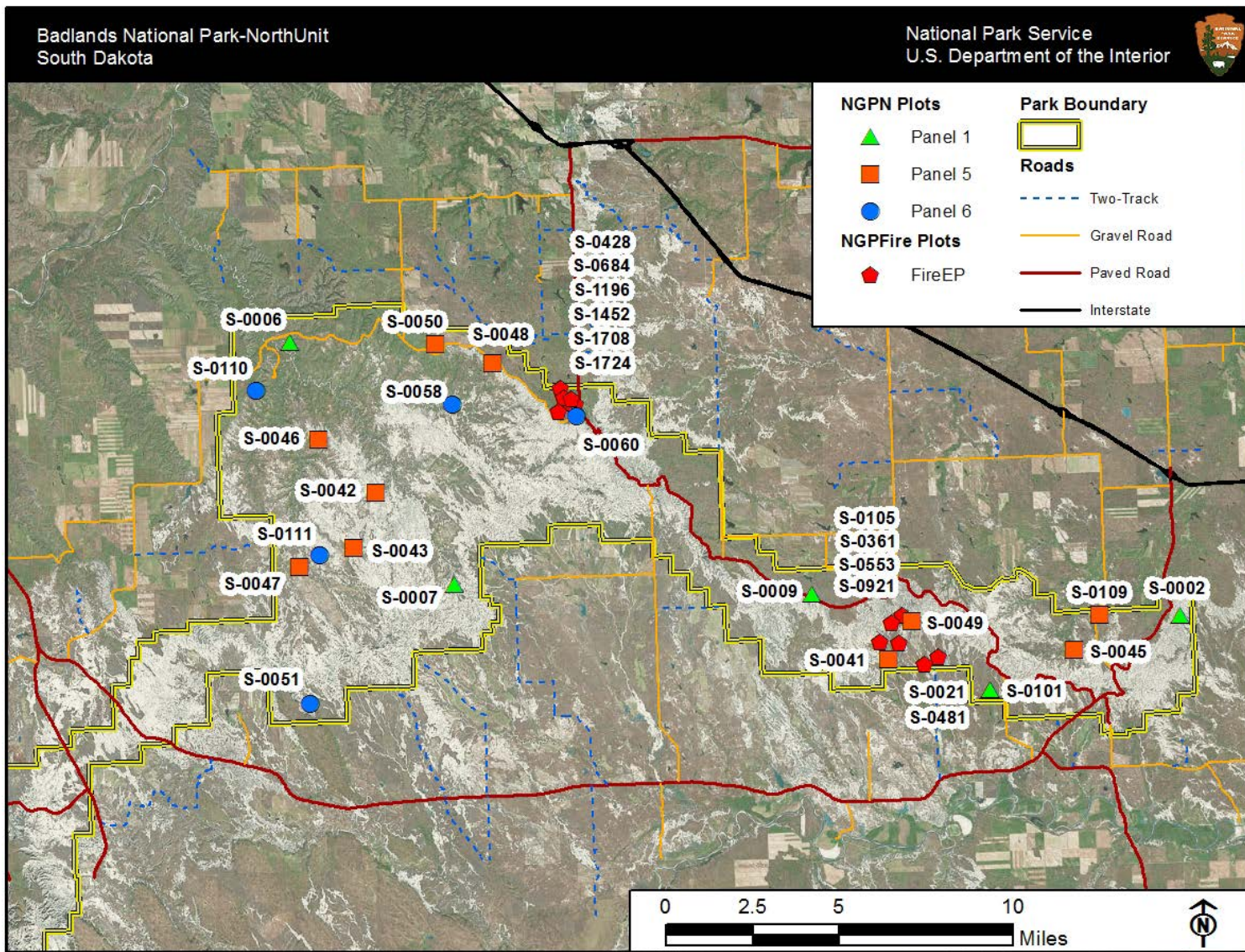


Figure 1. Map of Badlands National Park plant community monitoring (PCM) plots visited in 2016. Twenty-two PCM plots and ten fire plant community monitoring (FPCM) plots were monitored in 2016. Five Panel 1 plots (green circles), ten Panel 5 plots (blue squares), and five Panel 6 plots (red triangles) were visited by NGPN. Two additional PCM plots, plus ten FPCM plots were visited by NGPFire (red pentagons).

Table 1. Vegetation monitoring field schedule in Badlands National Park during the 2016 field season. Monitoring was completed with a crew of two to five people from the Northern Great Plains Network and Northern Great Plains Fire Effects Program. PCM and FPCM plots located within an active burn unit were visited based on a preburn, 1, 2, 5, and 10 year post-burn sampling schedule.

Date	Housing	Plots Read	Plot Notes (time needed, etc.)
Tuesday May 17, 2016	N/A	BADL_PCM_0109	4 person crew, 4.5 hrs
Wednesday May 18, 2016	N/A	BADL_PCM_0048	4 person crew, 2 hrs
		BADL_PCM_0006	4 person crew 2.5 hrs
		BADL_PCM_0045	3 person crew, 5 hrs
Wednesday June 1, 2016	N/A	BADL_PCM_0046	4 person crew, 6.5 hrs
		BADL_PCM_0051	4 person crew, 5.5 hrs
Monday June 6, 2016	Ann's Motel, Wall	BADL_FPCM_0684	4 person crew; Pinnacles unit; Year 5 Post-burn
		BADL_FPCM_1196	4 person crew; Pinnacles unit; Year 5 Post-burn
		BADL_FPCM_1452	4 person crew; Pinnacles unit; Year 5 Post-burn
		BADL_FPCM_1708	4 person crew; Pinnacles unit; Year 5 Post-burn
Tuesday June 7, 2016	Ann's Motel, Wall	BADL_FPCM_0481	4 person crew; Castle unit; Year 5 Post-burn
		BADL_FPCM_0553	4 person crew; Castle unit; Year 5 Post-burn
		BADL_FPCM_0921	4 person crew; Castle unit; Year 5 Post-burn
		BADL_PCM_0021	4 person crew; Castle unit; Year 5 Post-burn
Wednesday June 8, 2016	Ann's Motel, Wall	BADL_PCM_0105	4 person crew; Castle unit; Year 5 Post-burn
		BADL_FPCM_0361	4 person crew; Castle unit; Year 5 Post-burn
		BADL_FPCM_0428	4 person crew; Pinnacles unit; Year 5 Post-burn
		BADL_FPCM_1724	4 person crew; Pinnacles unit; Year 5 Post-burn
Monday June 13, 2016	Super 8, Wall (1 crew)	BADL_PCM_0047	5 crew, plot occupied by bison, not sampled
		BADL_PCM_0101	4 crew, 2 hrs
		BADL_PCM_0002	4 crew, 2.75 hrs
Tuesday June 14, 2016	Super 8, Wall (1 crew)	BADL_PCM_0110	5 crew, 5 hrs
		BADL_PCM_0007	3 crew, 5.5 hrs
		BADL_PCM_0060	3 crew, 2 hrs
Wednesday June 15, 2016	Super 8, Wall (1 crew)	BADL_PCM_0047	2 crew, 7.5 hrs
		BADL_PCM_0041	3 crew, 3 hrs
		BADL_PCM_0049	3 crew, 5 hrs
Thursday June 16, 2016	Super 8, Wall (1 crew)	BADL_PCM_0009	3 crew, 2.75 hrs
		BADL_PCM_0058	5 crew, 2.5 hrs
Monday June 20, 2016	N/A	BADL_PCM_0042	5 crew, 5 hrs
		BADL_PCM_0050	5 crew, 3 hrs
		BADL_PCM_0111	4 crew
		BADL_PCM_0043	4 crew

Plot Layout and Sampling

At each of the sites visited, monitoring crews 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 along two 50 m transects (the long sides of the plot) using a point-intercept method. At 50 locations along each transect, once every 1 meter, a pole was dropped to the ground and all species that touched the pole were recorded, along with ground cover and canopy height (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) (Figure 3).

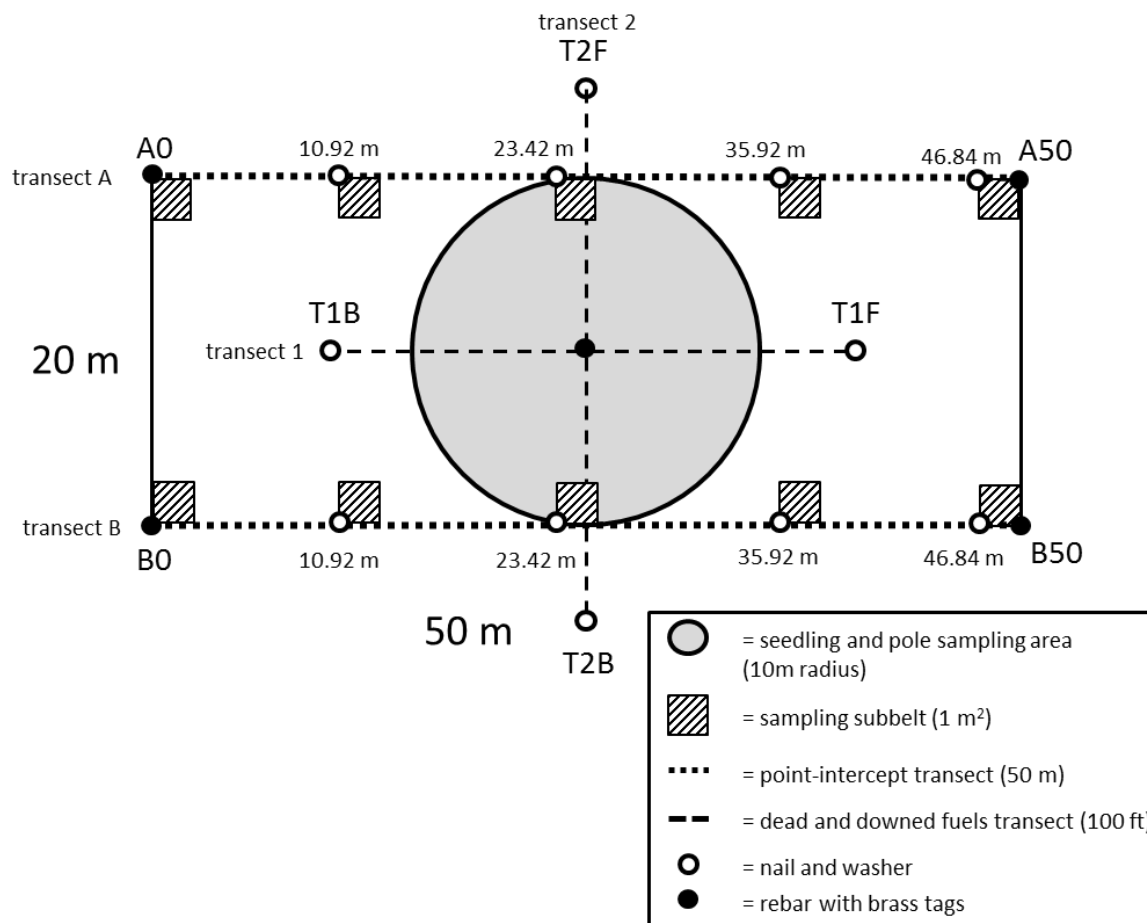


Figure 2. Long-term monitoring plot layout used for sampling vegetation in Badlands National Park.

When woody species were also present, tree regeneration and tall shrub density data were collected within a 10 m radius subplot centered in the larger 50 m x 20 m plot (Figure 2). Trees with diameter at breast height (DBH) > 15 cm, located within the entire 0.1 ha plot, were mapped and tagged. For each tree, the species, DBH, status (live or dead), and condition (e.g., leaf-discoloration, insect-damaged, etc.) were recorded. Dead and downed woody fuel load data were also collected at these forested plots along two perpendicular, 100 foot (30.49 m) transects with midpoints at the center of

the plot (Figure 2), following Brown's Line methods (Brown 1974, Brown et al. 1982). Trees are rare in BADL, and were only observed in one plot in 2016 (PCM_110).

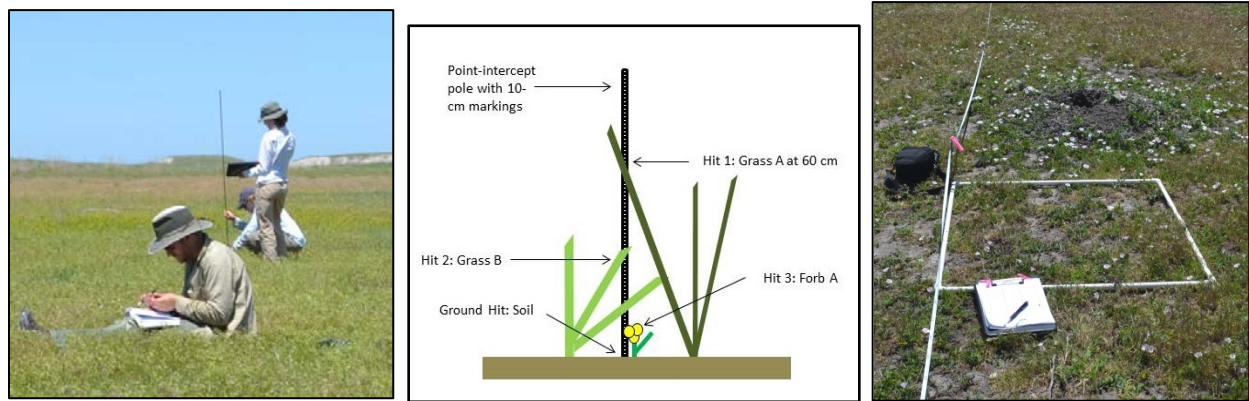


Figure 3. The Northern Great Plains Network Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and 1m² quadrats (right panel) to document plant diversity and abundance.

Disturbances and target species of interest were also assessed and documented at each plot visited by the NGPN field crew. Common disturbances included animal use and erosion. At each plot, the type, severity, and approximate area (m²) of the disturbances was recorded. The NGPN crew also surveyed the area for early-detection exotic species, which have the potential to spread into the park and cause significant ecological impacts (Table 2). These species were chosen in collaboration with the Midwest Invasive Plant Network, the Exotic Plant Management Team, park managers, and local weed experts. For each target species present, an abundance class was given on a scale from 1-5 where 1 = one individual, 2 = few individuals, 3 = cover of 1-5%, 4 = cover of 5-25%, and 5 = cover > 25% of the plot. The information gathered from this procedure is critical for early detection and rapid response to such threats. In addition to NGPN's list of early-detection exotic species, the South Dakota Department of Agriculture maintains a list of noxious exotic species in the state (<http://sdda.sd.gov/ag-Services/weed-and-pest-control>) and BADL also has a list of exotic species of management concern (Table 2).

Table 2. Exotic species included in NGPN's early detection and rapid response program and exotic species identified as species of management concern by Badlands National Park. An "SD" in the "State Status" column indicates species listed on South Dakota's noxious species list.

System	Habitat	Species Name	Common Name	State Status
NGPN Early Detection and Rapid Response	Riparian	<i>Polygonum cuspidatum</i> ; <i>P. sachalinense</i> ; <i>P. x bohemicum</i>	knotweeds	SD
		<i>Pueraria montana</i> var. <i>lobata</i>	kudzu	—
		<i>Iris pseudacorus</i>	yellow iris	—
		<i>Ailanthus altissima</i>	tree of heaven	—
		<i>Lepidium latifolium</i>	perennial pepperweed	—
		<i>Arundo donax</i>	giant reed	—
		<i>Rhamnus cathartica</i>	common buckthorn	—
		<i>Heracleum mantegazzianum</i>	giant hogweed	—
	Upland	<i>Centaurea solstitialis</i>	yellow star thistle	—
		<i>Hieracium aurantiacum</i> ; <i>H. caespitosum</i>	orange and meadow hawkweed	—
		<i>Isatis tinctoria</i>	Dyer's woad	—
		<i>Taeniatherum caput-medusae</i>	medusahead	—
		<i>Chondrilla juncea</i>	rush skeletonweed	—
		<i>Gypsophila paniculata</i>	baby's breath	—
		<i>Centaurea virgata</i> ; <i>C. diffusa</i>	knapweeds	SD
		<i>Linaria dalmatica</i> ; <i>L. vulgaris</i>	toadflax	SD
		<i>Euphorbia myrsinites</i> & <i>E. cyparissias</i>	myrtle spurge	—
		<i>Dipsacus fullonum</i> & <i>D. laciniatus</i>	common teasel	—
		<i>Salvia aethiopis</i>	Mediterranean sage	—
		<i>Ventenata dubia</i>	African wiregrass	—
Badlands National Park Exotic Species of Management Concern	Riparian	<i>Elaeagnus angustifolia</i>	Russian olive	—
		<i>Tamarix</i> spp.	tamarisk	—
	Upland	<i>Euphorbia esula</i>	leafy spurge	—
		<i>Falcaria vulgaris</i>	sickleweed	—
		<i>Poa bulbosa</i>	bulbous bluegrass	—

Table 2 (continued). Exotic species included in NGPN's early detection and rapid response program and exotic species identified as species of management concern by Badlands National Park. An "SD" in the "State Status" column indicates species listed on South Dakota's noxious species list.

System	Habitat	Species Name	Common Name	State Status
Badlands National Park Exotic Species of Management Concern (continued)	Upland (continued)	<i>Potentilla recta</i>	sulphur cinquefoil	SD
		<i>Rhaponticum repens</i>	Russian knapweed	–
		<i>Sideritis montana</i>	mountain ironwort	–
		<i>Tanacetum vulgare</i> *	common tansy	SD
		<i>Thymelaea passerina</i>	spurge flax	–

The conservation status ranks of plant species in South Dakota is determined by the South Dakota Natural Heritage Program (SDNHP). For the purpose of this report, a species was considered rare if its conservation status rank was S1, S2, or S3. See Table 3 for a detailed definition of each conservation status rank.

Table 3. Definitions of state and global species conservation status ranks. Adapted from NatureServe status assessment table (<http://www.natureserve.org/conservation-tools/conservation-status-assessment>)

Status Rank	Category	Definition
S1/G1	Critically imperiled	Due to extreme rarity (5 or fewer occurrences) or other factor(s) making it especially vulnerable to extirpation.
S2/G2	Imperiled	Due to rarity resulting from a very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation.
S3/G3	Vulnerable	Due to a restricted range, relatively few populations (often 80 or fewer), recent widespread declines, or other factors making it vulnerable to extirpation.
S4/G4	Apparently secure	Uncommon but not rare; some cause for concern due to declines or other factors.
S5/G5	Secure	Common, widespread and abundant.
S#S#/ G#G#	Range rank (e.g. S2S3)	Used to indicate uncertainty about the status of the species or community. Ranges cannot skip more than one rank.

Data Management and Analysis

FFI (FEAT/FIREMON Integrated; <http://frames.gov/ffi/>) was used as the primary software environment for managing the 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, and common names are from the USDA Plants Database (USDA-NRCS 2016). However, nomenclature follows the Integrated Taxonomic Information System (ITIS) (<http://www.itis.gov>). In the few cases where ITIS recognizes 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 for the sites were entered, 100% of records were verified to the original data sheet to minimize transcription errors. A further 10% of records were reviewed a second time. After all data were entered and verified, automated queries were used to check for errors in the data. When errors were identified by the crew or the automated queries, changes were made to the original datasheets and the FFI database as needed.

Results

There are a total of 634 plant species recorded on the [BADL species list](#), and monitoring crews recorded 163 species across 32 monitoring plots visited in 2016 at BADL (Table 4). Of the plant species observed, 31 are exotic species at BADL. All exotics recorded were either forbs or graminoids (grasses, sedges, and rushes). All trees and shrubs were native species. No target early detection exotic species were documented in 2016 (Table 2), and no rare native species were observed or recorded at BADL in 2016.

Table 4. List of all plant species identified in BADL long-term plant community monitoring plots in 2016. The species are grouped by plant family. An “X” in the exotic column means that 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. Species that are on South Dakota’s list of noxious species are indicated with “SD” in the exotic column. Species of conservation concern in South Dakota are marked in the final column and the state conservation ranks are provided. Conservation rank definitions are in Table 3 of this report

Family	Code	Scientific Name	Common Name	Exotic	Rare
Anacardiaceae	TORY	<i>Toxicodendron rydbergii</i>	western poison ivy		
Apiaceae	LOMAT	<i>Lomatium</i>	desertparsley		
	MUDI	<i>Musineon divaricatum</i>	leafy wildparsley		
Asclepiadaceae	ASPU	<i>Asclepias pumila</i>	plains milkweed		
Asteraceae	DIPR2	<i>Diaperia prolifera</i>	bighead pygmycudweed		
	ACMI2	<i>Achillea millefolium</i>	common yarrow		
	AMAR2	<i>Ambrosia artemisiifolia</i>	annual ragweed		
	ANPA4	<i>Antennaria parvifolia</i>	small-leaf pussytoes		
	ARCA13	<i>Artemisia cana</i>	silver sagebrush		
	ARLU	<i>Artemisia ludoviciana</i>	white sagebrush		
	BREU	<i>Brickellia eupatorioides</i>	false boneset		
	CIAR4	<i>Cirsium arvense</i>	Canada thistle	X	
	CIRSI	<i>Cirsium</i>	thistle	X	
	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle		
	COCA5	<i>Conyza canadensis</i>	Canadian horseweed		
	CORA4	<i>Conyza ramosissima</i>	dwarf horseweed		
	DYPA	<i>Dyssodia papposa</i>	fetid marigold		
	ERBE2	<i>Erigeron bellidiastrum</i>	western daisy fleabane		
	ERIGE2	<i>Erigeron</i>	fleabane		
	ERNA10	<i>Ericameria nauseosa</i>	rubber rabbitbrush		
	ERST3	<i>Erigeron strigosus</i>	prairie fleabane		
	GRSQ	<i>Grindelia squarrosa</i>	curlycup gumweed		
	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed		

Table 4 (continued). List of all plant species identified in BADL long-term plant community monitoring plots in 2016. The species are grouped by plant family. An “X” in the exotic column means that 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. Species that are on South Dakota’s list of noxious species are indicated with “SD” in the exotic column. Species of conservation concern in South Dakota are marked in the final column and the state conservation ranks are provided. Conservation rank definitions are in Table 3 of this report

Family	Code	Scientific Name	Common Name	Exotic	Rare
Asteraceae (continued)	HEAN3	<i>Helianthus annuus</i>	common sunflower		
	HELIA3	<i>Helianthus</i>	sunflower	X	
	HEPE	<i>Helianthus petiolaris</i>	prairie sunflower		
	LASE	<i>Lactuca serriola</i>	prickly lettuce	X	
	LIPU	<i>Liatris punctata</i>	dotted blazing star		
	LOAR5	<i>Logfia arvensis</i>	field cottonrose		
	MUOB99	<i>Mulgedium oblongifolium</i>	blue lettuce		
	RACO3	<i>Ratibida columnifera</i>	upright prairie coneflower		
	SOLID	<i>Solidago</i>	goldenrod		
	SOMI2	<i>Solidago missouriensis</i>	Missouri goldenrod		
	SYER	<i>Symphyotrichum ericoides</i>	white heath aster		
	SYMPH4	<i>Symphyotrichum</i>	aster		
	SYOB	<i>Symphyotrichum oblongifolium</i>	aromatic aster		
	TAOF	<i>Taraxacum officinale</i>	common dandelion	X	
	TRDU	<i>Tragopogon dubius</i>	yellow salsify	X	
	XASP99	<i>Xanthisma spinulosum</i>	lacy tansyaster		
	SORI2	<i>Solidago rigida</i>	stiff goldenrod		
Boraginaceae	CRCE	<i>Cryptantha celosioides</i>	buttecandle		
	HAFL2	<i>Hackelia floribunda</i>	manyflower stickseed		
	LAOC3	<i>Lappula occidentalis</i>	flatspine stickseed		
	LASQ	<i>Lappula squarrosa</i>	European stickseed	X	
Brassicaceae	ALDE	<i>Alyssum desertorum</i>	desert madwort	X	
	ARHI	<i>Arabis hirsuta</i>	hairy rockcress		

Table 4 (continued). List of all plant species identified in BADL long-term plant community monitoring plots in 2016. The species are grouped by plant family. An “X” in the exotic column means that 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. Species that are on South Dakota’s list of noxious species are indicated with “SD” in the exotic column. Species of conservation concern in South Dakota are marked in the final column and the state conservation ranks are provided. Conservation rank definitions are in Table 3 of this report

Family	Code	Scientific Name	Common Name	Exotic	Rare
Brassicaceae (continued)	CABU2	<i>Capsella bursa-pastoris</i>	shepherd's purse	X	
	CAMI2	<i>Camelina microcarpa</i>	littlepod false flax	X	
	DEPI	<i>Descurainia pinnata</i>	western tansymustard		
	DESO2	<i>Descurainia sophia</i>	herb sophia	X	
	DRRE2	<i>Draba reptans</i>	Carolina draba		
	ERRE4	<i>Erysimum repandum</i>	spreading wallflower	X	
	ERYSI	<i>Erysimum</i>	wallflower	X	
	LEDE	<i>Lepidium densiflorum</i>	common pepperweed		
	PHLU99	<i>Physaria ludoviciana</i>	foothill bladderpod		
	SIAL2	<i>Sisymbrium altissimum</i>	tall tumbledmustard	X	
	THAR5	<i>Thlaspi arvense</i>	field pennycress	X	
Cactaceae	ESMI3	<i>Escobaria missouriensis</i>	Missouri foxtail cactus		
	OPFR	<i>Opuntia fragilis</i>	brittle pricklypear		
	OPMA2	<i>Opuntia macrorhiza</i>	twistspine pricklypear		
	OPPO	<i>Opuntia polyacantha</i>	plains pricklypear		
Campanulaceae	TRLE3	<i>Triodanis leptocarpa</i>	slimpod Venus' looking-glass		
	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		
	SIAN2	<i>Silene antirrhina</i>	sleepy silene		
Chenopodiaceae	ATAR2	<i>Atriplex argentea</i>	silverscale saltbush		
	ATCA2	<i>Atriplex canescens</i>	fourwing saltbush		
	ATSU	<i>Atriplex suckleyi</i>	Suckley's endolepis		

Table 4 (continued). List of all plant species identified in BADL long-term plant community monitoring plots in 2016. The species are grouped by plant family. An “X” in the exotic column means that 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. Species that are on South Dakota’s list of noxious species are indicated with “SD” in the exotic column. Species of conservation concern in South Dakota are marked in the final column and the state conservation ranks are provided. Conservation rank definitions are in Table 3 of this report

Family	Code	Scientific Name	Common Name	Exotic	Rare
Chenopodiaceae (continued)	CHENO	<i>Chenopodium</i>	goosefoot	X	
	HAGL	<i>Halogeton glomeratus</i>	saltlover	X	
	KOSC	<i>Kochia scoparia</i>	burningbush, kochia	X	
	MONU	<i>Monolepis nuttalliana</i>	Nuttall's povertyweed		
	SATR12	<i>Salsola tragus</i>	prickly Russian thistle	X	
Commelinaceae	TRBR	<i>Tradescantia bracteata</i>	longbract spiderwort		
Convolvulaceae	COAR4	<i>Convolvulus arvensis</i>	field bindweed	SD	
Cupressaceae	JUSC2	<i>Juniperus scopulorum</i>	Rocky Mountain juniper		
Cyperaceae	CABR10	<i>Carex brevior</i>	shortbeak sedge		
	CADU6	<i>Carex duriuscula</i>	needleleaf sedge		
	CAFI	<i>Carex filifolia</i>	threadleaf sedge		
	CAPR5	<i>Carex praegracilis</i>	clustered field sedge		
	CAREX	<i>Carex</i>	sedge		
Euphorbiaceae	EUMA8	<i>Euphorbia marginata</i>	snow on the mountain		
	EUPHO	<i>Euphorbia</i>	spurge	X	
	EUSE4	<i>Euphorbia serpens</i>	matted sandmat		
	EUSP	<i>Euphorbia spathulata</i>	warty spurge		
Fabaceae	ASAG2	<i>Astragalus agrestis</i>	purple milkvetch		
	ASLO4	<i>Astragalus lotiflorus</i>	lotus milkvetch		
	ASMI10	<i>Astragalus missouriensis</i>	Missouri milkvetch		
	ASRA2	<i>Astragalus racemosus</i>	cream milkvetch		
	DAPU5	<i>Dalea purpurea</i>	purple prairie clover		
	LAPO2	<i>Lathyrus polymorphus</i>	manystem pea		

Table 4 (continued). List of all plant species identified in BADL long-term plant community monitoring plots in 2016. The species are grouped by plant family. An “X” in the exotic column means that 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. Species that are on South Dakota’s list of noxious species are indicated with “SD” in the exotic column. Species of conservation concern in South Dakota are marked in the final column and the state conservation ranks are provided. Conservation rank definitions are in Table 3 of this report

Family	Code	Scientific Name	Common Name	Exotic	Rare
Fabaceae (continued)	MELU	<i>Medicago lupulina</i>	black medick	X	
	MEOF	<i>Melilotus officinalis</i>	yellow sweetclover	X	
	PEAR6	<i>Pedimelum argophyllum</i>	silverleaf Indian breadroot		
	PSTE5	<i>Psoraleidum tenuiflorum</i>	slimflower scurfpea		
	VIAM	<i>Vicia americana</i>	American vetch		
Lamiaceae	HEHI	<i>Hedeoma hispida</i>	rough false pennyroyal		
	SARE3	<i>Salvia reflexa</i>	lanceleaf sage		
Liliaceae	ALTE	<i>Allium textile</i>	textile onion		
	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		
Onagraceae	OECE2	<i>Oenothera cespitosa</i>	tufted evening primrose		
	OESU99	<i>Oenothera suffrutescens</i>	scarlet beeblossom		
Oxalidaceae	OXST	<i>Oxalis stricta</i>	common yellow oxalis		
Plantaginaceae	PLPA2	<i>Plantago patagonica</i>	woolly plantain		
Poaceae	PIMI7	<i>Piptatherum micranthum</i>	littleseed ricegrass		
	ACHY	<i>Achnatherum hymenoides</i>	Indian ricegrass		
	ARPU9	<i>Aristida purpurea</i>	purple threeawn		
	BOCU	<i>Bouteloua curtipendula</i>	sideoats grama		
	BODA2	<i>Bouteloua dactyloides</i>	buffalograss		
	BOGR2	<i>Bouteloua gracilis</i>	blue grama		
	BRIN2	<i>Bromus inermis</i>	smooth brome	X	

Table 4 (continued). List of all plant species identified in BADL long-term plant community monitoring plots in 2016. The species are grouped by plant family. An “X” in the exotic column means that 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. Species that are on South Dakota’s list of noxious species are indicated with “SD” in the exotic column. Species of conservation concern in South Dakota are marked in the final column and the state conservation ranks are provided. Conservation rank definitions are in Table 3 of this report

Family	Code	Scientific Name	Common Name	Exotic	Rare
Poaceae (continued)	BRJA	<i>Bromus japonicus</i>	Japanese brome	X	
	BRTE	<i>Bromus tectorum</i>	cheatgrass	X	
	CALO	<i>Calamovilfa longifolia</i>	prairie sandreed		
	DISP	<i>Distichlis spicata</i>	saltgrass		
	ELCA4	<i>Elymus canadensis</i>	Canada wildrye		
	ELEL5	<i>Elymus elymoides</i>	squirreltail		
	ELRE4	<i>Elymus repens</i>	quackgrass	X	
	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass		
	HECO26	<i>Hesperostipa comata</i>	needle and thread		
	HOJU	<i>Hordeum jubatum</i>	foxtail barley		
	HOPU	<i>Hordeum pusillum</i>	little barley		
	KOMA	<i>Koeleria macrantha</i>	prairie Junegrass		
	MUCU3	<i>Muhlenbergia cuspidata</i>	plains muhly		
	MUPA99	<i>Muhlenbergia paniculata</i>	tumblegrass		
	MURA	<i>Muhlenbergia racemosa</i>	marsh muhly		
	MUSQ3	<i>Munroa squarrosa</i>	false buffalograss		
	NAVI4	<i>Nassella viridula</i>	green needlegrass		
	PACA6	<i>Panicum capillare</i>	witchgrass		
	PASM	<i>Pascopyrum smithii</i>	western wheatgrass		
	PAVI2	<i>Panicum virgatum</i>	switchgrass		
	POPR	<i>Poa pratensis</i>	Kentucky bluegrass	X	
	POSE	<i>Poa secunda</i>	Sandberg bluegrass		
	SCSC	<i>Schizachyrium scoparium</i>	little bluestem		

Table 4 (continued). List of all plant species identified in BADL long-term plant community monitoring plots in 2016. The species are grouped by plant family. An “X” in the exotic column means that 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. Species that are on South Dakota’s list of noxious species are indicated with “SD” in the exotic column. Species of conservation concern in South Dakota are marked in the final column and the state conservation ranks are provided. Conservation rank definitions are in Table 3 of this report

Family	Code	Scientific Name	Common Name	Exotic	Rare
Poaceae (continued)	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed		
	VUOC	<i>Vulpia octoflora</i>	sixweeks fescue		
Polemoniaceae	COLI2	<i>Collomia linearis</i>	tiny trumpet		
	PHAN4	<i>Phlox andicola</i>	prairie phlox		
	PHHO	<i>Phlox hoodii</i>	spiny phlox		
Polygalaceae	POAL4	<i>Polygala alba</i>	white milkwort		
	POVE	<i>Polygala verticillata</i>	whorled milkwort		
Polygonaceae	ERPA9	<i>Eriogonum pauciflorum</i>	fewflower buckwheat		
	POAV	<i>Polygonum aviculare</i>	prostrate knotweed	X	
	RUCR	<i>Rumex crispus</i>	curly dock	X	
Primulaceae	ANOC2	<i>Androsace occidentalis</i>	western rockjasmine		
Ranunculaceae	DECA3	<i>Delphinium carolinianum</i>	Carolina larkspur		
Rosaceae	PRVI	<i>Prunus virginiana</i>	chokecherry		
	ROAR3	<i>Rosa arkansana</i>	prairie rose		
	ROSA5	<i>Rosa</i>	rose		
Rubiaceae	GAAP2	<i>Galium aparine</i>	stickywilly		
Santalaceae	COUM	<i>Comandra umbellata</i>	bastard toadflax		
Scrophulariaceae	PEER	<i>Penstemon eriantherus</i>	fuzzytongue penstemon		
	VETH	<i>Verbascum thapsus</i>	common mullein	SD	
Solanaceae	PHLO4	<i>Physalis longifolia</i>	longleaf groundcherry		
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		

Total number of plant species observed in each plot at BADL was compiled using data from point-intercept, quadrat, and woody species survey methods (Table 5). The most diverse plot, with a total of 49 species identified, was BADL_PCM_0110. This plot, located in the northwest side of the park near Sage Creek Campground, was a combination of upland mixed-grass and juniper-dominated woody draw vegetation types. Plot BADL_PCM_0110 also contained the highest number of native plant species. Plot BADL_PCM_0050 was quite diverse with 48 total species, but also had the highest number of exotic species observed.

Table 5. Number of plant species per plot observed in across 32 plant community monitoring (PCM) and fire plant community monitoring (FPCM) plots at Badlands National Park in 2016. (*Plot read by NGPFire, therefore data only includes point-intercept data, and as a result, fewer species totals were observed.)

Plot Name	Native (number of plant species)	Invasive (number of plant species)	Total (number of species)
BADL_FPCM_0361*	11	4	15
BADL_FPCM_0428*	10	2	12
BADL_FPCM_0481*	7	4	11
BADL_FPCM_0553*	17	7	24
BADL_FPCM_0684*	14	4	18
BADL_FPCM_0921*	14	7	21
BADL_FPCM_1196*	8	1	9
BADL_FPCM_1452*	8	2	10
BADL_FPCM_1708*	6	2	8
BADL_FPCM_1724*	15	3	18
BADL_PCM_0002	13	7	20
BADL_PCM_0006	15	12	27
BADL_PCM_0007	20	7	27
BADL_PCM_0009	20	5	25
BADL_PCM_0021*	19	3	22
BADL_PCM_0041	26	5	31
BADL_PCM_0042	10	2	12
BADL_PCM_0043	10	1	11
BADL_PCM_0045	28	10	38
BADL_PCM_0046	30	4	34
BADL_PCM_0047	34	14	48
BADL_PCM_0048	12	4	16
BADL_PCM_0049	12	4	16
BADL_PCM_0050	30	18	48
BADL_PCM_0051	19	9	28
BADL_PCM_0058	22	8	30
BADL_PCM_0060	25	9	34

Table 5 (continued). Number of plant species per plot observed in across 32 plant community monitoring (PCM) and fire plant community monitoring (FPCM) plots at Badlands National Park in 2016. (*Plot read by NGPFire, therefore data only includes point-intercept data, and as a result, fewer species totals were observed.)

Plot Name	Native (number of plant species)	Invasive (number of plant species)	Total (number of species)
BADL_PCM_0101	11	5	16
BADL_PCM_0105*	11	4	15
BADL_PCM_0109	25	11	36
BADL_PCM_0110	39	10	49
BADL_PCM_0111	29	6	35

Calculations of both absolute cover and relative cover were done using only point-intercept data (Table 6). Three plots, BADL_PCM_0042, BADL_PCM_0043, and BADL_PCM_0046, were the most native by both absolute and relative percent cover. Plot BADL_PCM_0047, a plot located in the Badlands Wilderness Area that is used heavily by bison and prairie dog, had the greatest exotic species relative cover with 73%.

Table 6. Absolute and relative cover of native and exotic species in plots monitored at Badlands National Park in 2016. Absolute cover includes overlapping canopies and can be greater than 100%. (*NGPFire plot visits)

Plot Name	Absolute Cover (%)		Relative Cover (%)	
	Exotic	Native	Exotic	Native
BADL_FPCM_0361*	25.0	79.0	24.0	76.0
BADL_FPCM_0428*	103.0	95.0	52.0	48.0
BADL_FPCM_0481*	80.0	99.0	45.0	55.0
BADL_FPCM_0553*	54.0	101.0	35.0	65.0
BADL_FPCM_0684*	82.0	76.0	52.0	48.0
BADL_FPCM_0921*	50.0	99.0	34.0	66.0
BADL_FPCM_1196*	98.0	60.0	62.0	38.0
BADL_FPCM_1452*	98.0	68.0	59.0	41.0
BADL_FPCM_1708*	101.0	59.0	63.0	37.0
BADL_FPCM_1724*	22.0	159.0	12.0	88.0
BADL_PCM_0002	30.0	44.0	41.0	59.0
BADL_PCM_0006	66.0	82.0	45.0	55.0
BADL_PCM_0007	85.0	243.0	26.0	74.0
BADL_PCM_0009	49.0	122.0	29.0	71.0
BADL_PCM_0021*	11.0	103.0	10.0	90.0
BADL_PCM_0041	3.5	67.0	5.0	95.0
BADL_PCM_0042	0.0	14.0	0.0	100.0

Table 6 (continued). Absolute and relative cover of native and exotic species in plots monitored at Badlands National Park in 2016. Absolute cover includes overlapping canopies and can be greater than 100%. (*NGPFire plot visits)

Plot Name	Absolute Cover (%)		Relative Cover (%)	
	Exotic	Native	Exotic	Native
BADL_PCM_0043	0.0	17.0	0.0	100.0
BADL_PCM_0045	36.0	46.0	44.0	56.0
BADL_PCM_0046	0.0	51.0	0.0	100.0
BADL_PCM_0047	116.0	43.0	73.0	27.0
BADL_PCM_0048	2.0	6.0	25.0	75.0
BADL_PCM_0049	30.0	66.0	31.0	69.0
BADL_PCM_0050	78.0	127.0	38.0	62.0
BADL_PCM_0051	11.0	68.0	14.0	86.0
BADL_PCM_0058	3.0	76.0	4.0	96.0
BADL_PCM_0060	116.0	103.5	53.0	47.0
BADL_PCM_0101	9.0	106.5	8.0	92.0
BADL_PCM_0105*	61.0	101.0	38.0	62.0
BADL_PCM_0109	100.0	107.0	48.0	52.0
BADL_PCM_0110	24.0	95.0	20.0	80.0
BADL_PCM_0111	6.0	133.0	4.0	96.0

Live trees, poles and seedlings were present in only one of the thirty-two sites visited in 2016 (Table 7). Data collected included species name, size class based on diameter at breast height (DBH), status, total number of individuals, and density per hectare. DBH categories are tree (DBH>15 cm), pole (2.54 cm<DBH>15 cm), and seedling (DBH<2.54 cm). No tree regeneration was observed.

Table 7. Woody species data recorded from the only wooded plot visited at Badlands National Park in 2016, BADL_PCM_0110. DBH categories are tree (DBH>15 cm), pole (2.54 cm<DBH>15 cm), and seedling (DBH<2.54 cm).

Plot Name	Common Name	DBH	Status	Total Individuals	Density/ha.
BADL_PCM_0110	Rocky Mountain juniper	Tree	Alive	22	220.00
BADL_PCM_0110	Rocky Mountain juniper	Tree	Dead	1	10.00
BADL_PCM_0110	Rocky Mountain juniper	Pole	Alive	10	318.47
BADL_PCM_0110	Rocky Mountain juniper	Pole	Dead	1	31.85
BADL_PCM_0110	Rocky Mountain juniper	Seedling	Alive	19	604.70
BADL_PCM_0110	Chokecherry	Seedling	Alive	10	318.27

Dead and downed wood, and surface fuels, provide foraging habitat and refugia for small wildlife species, as well as substrate for mosses and fungi. Downed wood sometimes also provides “nursery” logs for vascular plant establishment. However, when surface fuels are too abundant in a forest they

can increase the risk of high intensity fires. Crews surveyed for and measured surface fuels in two plots, where there were juniper trees located either in or within 38 meters of plot center (Table 8). In BADL_PCM_0058, all fuels are zeros because this plot was a grassland plot and contained no measureable woody fuels.

Table 8. Surface fuels summary from two of 32 PCM and FPCM plots visited in 2016 at Badlands National Park.

MacroPlot	Average Tons per Acre										Avg. Depth (in.)		
	1-hr	10-hr	100-hr	1-100-hr	1000-hr sound	1000-hr rotten	1-1000-hr	Duff	Litter	Total	Duff	Litt	Total
BADL_PCM_0058	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
BADL_PCM_0110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.08	7.75	18.83	0.60	1.00	1.50

Disturbances occurred in nine out of thirty-two plant community monitoring plots at BADL during 2016 (Table 9). The two most common disturbance types observed were erosion and animal use, which includes trails, wallows, grazing, and trampled or missing vegetation.

Table 9. Disturbance types and area sizes recorded in nine plots visited within Badlands National Park during 2016. The size was approximated, and out of a total area of 1000 m².

MacroPlot	Disturbance Type	Size (m ²)	Comments
BADL_PCM_0002	Erosion	1000	
BADL_PCM_0007	Animal Trail	10	
	Erosion	10	
BADL_PCM_0043	Erosion	40	
BADL_PCM_0046	Animal Trail	100	Evidence of bison
BADL_PCM_0049	Flood	1000	Rained day before survey
BADL_PCM_0050	Prairie Dog	1000	Plot completely within colony
BADL_PCM_0058	Animal Trail	100	General area trampled
	Grazing	250	
	Wallow	10	Evidence of bison
	Flood	1000	Plot on floodplain
BADL_PCM_0109	Prairie Dog	500	Remnant colony
	Small Mammal	5	Not prairie dog
BADL_PCM_0110	Animal Trail	20	Evidence of bison
	Wallow	2	
	Small Mammal	2	
	Tree Removal	3	Old JUSC2 branch removal



Figure 4. Three distinct biomes exist in Badlands National Park: sparsely-vegetated badlands (top-left), as seen in BADL_PCM_043; mixed-grass prairie (top-right), as seen in BADL_PCM_0006; and juniper-dominated woody draws (bottom), as seen in BADL_PCM_0110.

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