



# Plant Community Composition and Structure Monitoring at Wind Cave National Park

## *2019 Data Report*

Natural Resource Data Series NPS/WICA/NRDS—2019/1247



**ON THIS PAGE**

Plant community composition and structure monitoring plot WICA\_PCM\_0023 at Wind Cave National Park, June 2019. Photograph courtesy of the National Park Service.

**ON THE COVER**

View of canyon looking east towards Boland Ridge, near plant community plot WICA\_PCM\_0027 at Wind Cave National Park, June 2019. Photograph courtesy of the National Park Service.

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# **Plant Community Composition and Structure Monitoring at Wind Cave National Park**

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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 the protocols.

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## **Abstract**

This report presents the results of the Northern Great Plains Inventory and Monitoring Network (NGPN) and Northern Great Plains Fire Ecology Program (NGPFire) vegetation monitoring at Wind Cave National Park (WICA) in 2019. This was the ninth year of combined monitoring efforts.

Crew members from NGPN visited 18 long-term monitoring plots to collect data representing the plant communities at WICA. The NGPFire program collected pre- and post-burn data from an additional 37 plant community and forest structure monitoring plots. This work is part of a long-term monitoring effort designed to evaluate the condition of the vegetation community and understand how it is changing over time. NGPN staff measured species richness, herb-layer height, native and non-native species abundance, ground cover, and site disturbance at each of the plots. In plots where woody species were present, tree regeneration, tall shrub density, tree density, and woody fuel loads were also measured. NGPFire conducted herb-layer height, native and non-native abundance, ground cover, disturbance, protocols at 18 plots, and where woody species were present, tree density, tree regeneration, tall shrub density, and woody fuel load protocols were completed at 35 plots.

In 2019, the NGPN and NGPFire monitoring crews identified 239 unique plant species from 55 plant community and forest structure monitoring plots. Of the 239 species observed in 2019, 203 were native and 34 were exotic.

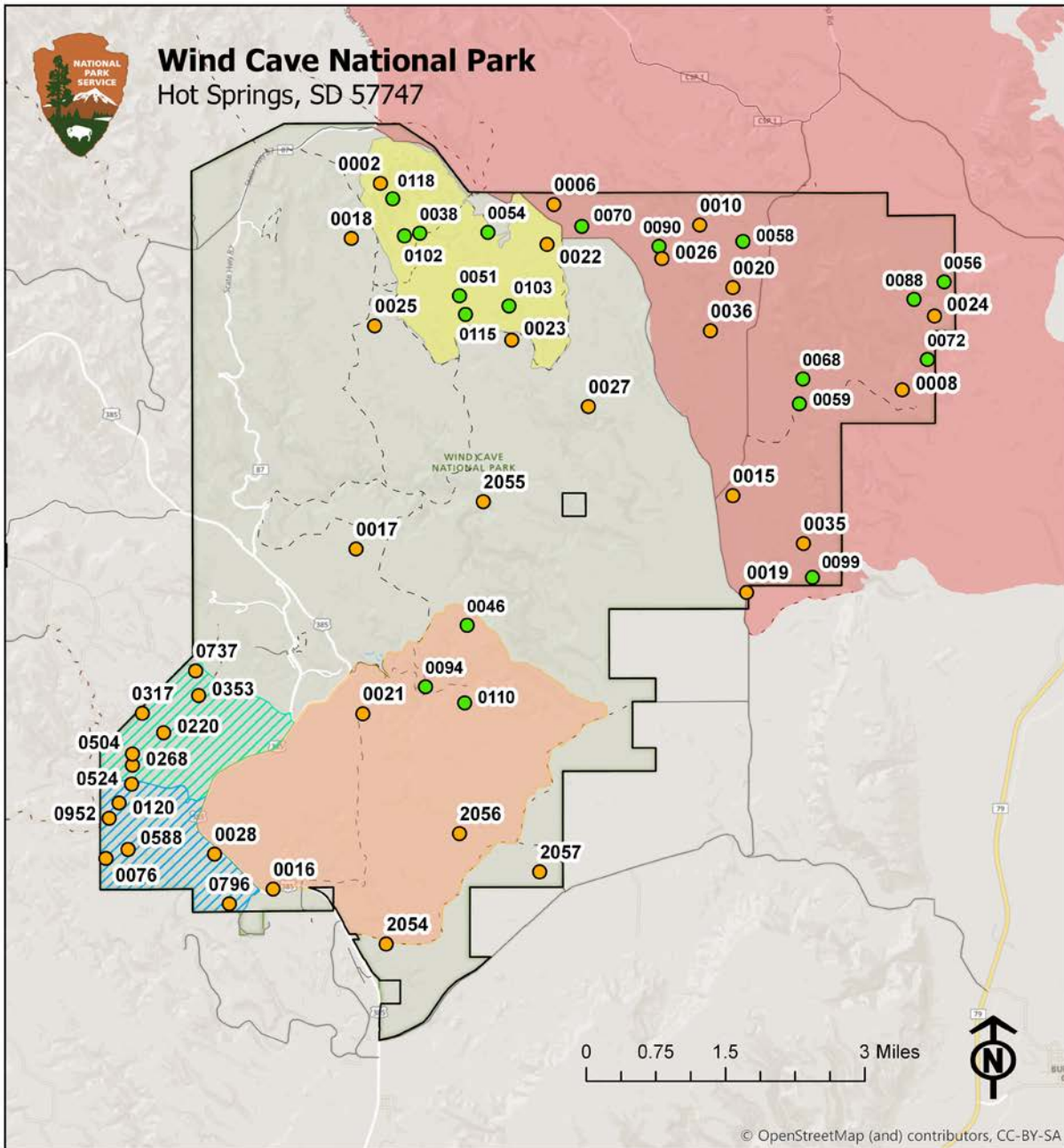
## **Acknowledgments**

We thank all the authors of the Northern Great Plains Plant Community Monitoring Protocol, particularly A. Symstad, for guidance on data collection and reporting. Thank you to the staff at WICA for providing logistical support. The 2019 NGPN vegetation field crew—C. Davis, M. Davis, S. Rockwood, R. Manuel, T. Schaffner, T. Bortz, and E. Duda, C. Knudtson, and A. Fowler— and 2019 NGPFire crew—D. Swanson, I. Muirhead, M. Pahler and L. Badertscher—collected the data included in this report.

## Introduction

Wind Cave National Park (WICA), established in 1903, is located in the southern Black Hills of South Dakota. The park purpose is to protect the unique Wind Cave resources and to preserve and enhance the mixed-grass prairie and native wildlife, while also providing for the enjoyment of the public. The 33,851 acres of WICA is a mosaic of ponderosa pine forest and mixed-grass prairie. While some areas have high exotic species cover, the native plant communities within the upland areas of WICA are considered to be in good condition ([Komp et al. 2011](#)).

The Northern Great Plains Fire Ecology Program (NGPFire) began vegetation monitoring at WICA in 1997 ([Wienk et al. 2011](#)). In 2011, the Northern Great Plains Inventory & Monitoring Program (NGPN) combined efforts with NGPFire ([Ashton et al. 2012](#)) to establish a coordinated vegetation monitoring protocol, and plot locations were shifted to better represent the entire park ([Symstad et al. 2012b](#)) based on the 2010 boundary. In 2011, WICA acquired the 5,550-acre Casey property, and ten upland plots were later installed to represent the addition to the park property. There is a separate effort to monitor streambank condition because riparian communities are an important resource for the park ([Burkhart and Kovacs 2013](#)). In this report, we provide summaries of the upland vegetation monitoring data collected at 55 plots visited in 2019 (Figure 1). For a more in-depth data report on long-term vegetation trends at WICA, refer to the 2011-2015 summary report (Ashton et al. 2016) or the most recent assessment of forest condition (Ashton et al. 2019).



### 2019 Plant Community Monitoring

- PCM Plot
- Forest Structure Plot
- Park Boundary
- Cold Brook Wildfire
- Legion Lake Wildfire
- Rankin Wildfire
- Cold Brook North Prescribed Fire
- Cold Brook South Prescribed Fire

Northern Great Plains Inventory & Monitoring Network  
National Park Service  
11/15/2019

**Figure 1.** Map of Wind Cave National Park (WICA) long-term monitoring plots visited in 2019. Plant Community (PCM) plots are represented in orange and Forest Structure plots are represented in green.

## 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>.

### Sample Design

The NGPN and NGPFire implemented a survey to monitor plant community structure and composition in WICA using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; [Stevens and Olsen 2003, 2004](#)). Using the GRTS design, NGPN selected 35 randomly located sites within WICA to install Plant Community Monitoring (PCM) plots. These 35 sites were split into five panels containing seven sites each. NGPN crews visit two panels (14 sites total) in June every year using a rotating sampling scheme that consists of seven plots visited the previous year and seven plots that have not been visited for four years. Data from these randomly selected sites can be used to estimate condition of vegetation communities for the whole park and can be used to discern trends in condition over time. Ten additional monitoring sites (2 per panel) were selected within the 2011 park addition and are on the same plot visit schedule as above. In 2019, NGPN crews visited sites in panel 3 and panel 4 during mid-June (Table 1). The NGPN crews commuted from Rapid City to WICA daily. Two NGPN crews, with help from NGPN program staff and volunteers, completed sampling in approximately 450 crew hours.

**Table 1.** Field journal for Northern Great Plains Network (NGPN) plant community monitoring (PCM) at Wind Cave National Park (WICA) in 2019. NGPN crews completed monitoring protocols at 18 plots.

| Date Visited | Plot     | Monitoring Type/ Panel | Field Notes                                                                               |
|--------------|----------|------------------------|-------------------------------------------------------------------------------------------|
| 6/13/2019    | PCM_0015 | PCM/ Panel 3           | 3 person crew                                                                             |
| 6/26/2019    | PCM_0016 | PCM/ Panel 3           | 3 person crew; quadrat protocol not performed due to high abundance of poison ivy in plot |
| 6/18/2019    | PCM_0017 | PCM/ Panel 3           | 3 person crew                                                                             |
| 6/20/2019    | PCM_0018 | PCM/ Panel 3           | 3 person crew                                                                             |
| 6/13/2019    | PCM_0019 | PCM/ Panel 3           | 3 person crew                                                                             |
| 6/24/2019    | PCM_0020 | PCM/ Panel 3           | 3 person crew                                                                             |
| 6/17/2019    | PCM_0021 | PCM/ Panel 3           | 4 person crew                                                                             |
| 6/17/2019    | PCM_0022 | PCM/ Panel 4           | 4 person crew                                                                             |
| 6/25/2019    | PCM_0023 | PCM/ Panel 4           | 4 person crew                                                                             |
| 6/19/2019    | PCM_0024 | PCM/ Panel 4           | 3 person crew                                                                             |
| 6/19/2019    | PCM_0025 | PCM/ Panel 4           | 3 person crew                                                                             |
| 6/24/2019    | PCM_0026 | PCM/ Panel 4           | 4 person crew                                                                             |
| 6/26/2019    | PCM_0027 | PCM/ Panel 4           | 3 person crew                                                                             |
| 6/13/2019    | PCM_0028 | PCM/ Panel 4           | 5 person crew                                                                             |

**Table 1 (continued).** Field journal for Northern Great Plains Network (NGPN) plant community monitoring (PCM) at Wind Cave National Park (WICA) in 2019. NGPN crews completed monitoring protocols at 18 plots.

| Date Visited | Plot     | Monitoring Type/ Panel | Field Notes   |
|--------------|----------|------------------------|---------------|
| 6/13/2019    | PCM_2054 | PCM/ Panel 3           | 5 person crew |
| 6/20/2019    | PCM_2055 | PCM/ Panel 3           | 4 person crew |
| 6/18/2019    | PCM_2056 | PCM/ Panel 4           | 3 person crew |
| 6/18/2019    | PCM_2057 | PCM/ Panel 4           | 6 person crew |

When a site was located within an active burn unit, NGPFire added additional visits based on a pre-burn, 1, 2, 5, and 10 year post-burn sampling schedule using the GRTS sampling schema, and established fire plant community monitoring (FPCM) plots. In 2019, monitoring by the NGPFire crew took place at 37 plots within three wildfire and two prescribed fire perimeters (Table 2). Seven forest structure monitoring plots and one plant community monitoring (PCM) plot were visited as year 2 reads within the September 11, 2017 Rankin wildfire perimeter. Nine forest structure and five PCM plots were year 2 reads within the Legion Lake wildfire perimeter, which burned December 11-15, 2017. Two PCM and four FPCM plots were year 5 reads within the Cold Brook South prescribed fire perimeter that occurred on April 13, 2015. Six FPCM plots were year 5 reads within the Cold Brook North fire perimeter that occurred on October 23, 2014. Three forest structure monitoring plots were year five reads within the Cold Brook wildfire, which occurred on April 13-14, 2015.

**Table 2.** Field journal for fire plant community monitoring at Wind Cave National Park (WICA) in 2019. The Northern Great Plains Fire Ecology Program (NGPFire) crew visited 37 plots.

| Date Visited | Plot      | Burn Unit        | Field Notes                        |
|--------------|-----------|------------------|------------------------------------|
| 8/9/2019     | FPCM_0220 | Cold Brook North | FPCM plot; year 5 read             |
| 6/24/2019    | FPCM_0268 | Cold Brook North | FPCM plot; year 5 read             |
| 6/27/2019    | FPCM_0317 | Cold Brook North | FPCM plot; year 5 read             |
| 6/18/2019    | FPCM_0353 | Cold Brook North | FPCM plot; year 5 read             |
| 6/24/2019    | FPCM_0504 | Cold Brook North | FPCM plot; year 5 read             |
| 6/20/2019    | FPCM_0524 | Cold Brook South | FPCM plot; year 5 read             |
| 6/26/2019    | FPCM_0588 | Cold Brook South | FPCM plot; year 5 read             |
| 6/18/2019    | FPCM_0737 | Cold Brook North | FPCM plot; year 5 read             |
| 6/19/2019    | FPCM_0796 | Cold Brook South | FPCM plot; year 5 read             |
| 6/25/2019    | FPCM_0952 | Cold Brook South | FPCM plot; year 5 read             |
| 8/7/2019     | PCM_0002  | Rankin wildfire  | FPCM plot; year 2 read             |
| 6/17/2019    | PCM_0006  | Boland wildfire  | PCM plot; year 2 read              |
| 8/8/2019     | PCM_0008  | Boland wildfire  | PCM plot; year 2 read              |
| 7/31/2019    | PCM_0010  | Boland wildfire  | PCM plot; year 2 read              |
| 8/6/2019     | PCM_0035  | Boland wildfire  | Forest structure plot; year 2 read |

**Table 2 (continued).** Field journal for fire plant community monitoring at Wind Cave National Park (WICA) in 2019. The Northern Great Plains Fire Ecology Program (NGPFire) crew visited 37 plots.

| Date Visited | Plot     | Burn Unit           | Field Notes                        |
|--------------|----------|---------------------|------------------------------------|
| 8/6/2019     | PCM_0036 | Boland wildfire     | PCM plot; year 2 read              |
| 8/16/2019    | PCM_0038 | Rankin wildfire     | Forest structure plot; year 2 read |
| 8/5/2019     | PCM_0046 | Cold Brook wildfire | Forest structure plot; year 5 read |
| 8/15/2019    | PCM_0051 | Rankin wildfire     | Forest structure plot; year 2 read |
| 8/16/2019    | PCM_0054 | Rankin wildfire     | Forest structure plot; year 2 read |
| 9/6/2019     | PCM_0056 | Boland wildfire     | Forest structure plot; year 2 read |
| 8/13/2019    | PCM_0058 | Boland wildfire     | Forest structure plot; year 2 read |
| 9/17/2019    | PCM_0059 | Boland wildfire     | Forest structure plot; year 2 read |
| 9/17/2019    | PCM_0068 | Boland wildfire     | Forest structure plot; year 2 read |
| 8/15/2019    | PCM_0070 | Boland wildfire     | Forest structure plot; year 2 read |
| 9/4/2019     | PCM_0072 | Boland wildfire     | Forest structure plot; year 2 read |
| 6/26/2019    | PCM_0076 | Cold Brook South    | PCM plot; year 5 read              |
| 9/6/2019     | PCM_0088 | Boland wildfire     | Forest structure plot; year 2 read |
| 8/13/2019    | PCM_0090 | Boland wildfire     | Forest structure plot; year 2 read |
| 8/21/2019    | PCM_0094 | Cold Brook wildfire | Forest structure plot; year 5 read |
| 9/13/2019    | PCM_0099 | Boland wildfire     | Forest structure plot; year 2 read |
| 8/16/2019    | PCM_0102 | Rankin wildfire     | Forest structure plot; year 2 read |
| 8/15/2019    | PCM_0103 | Rankin wildfire     | Forest structure plot; year 2 read |
| 8/20/2019    | PCM_0110 | Cold Brook wildfire | Forest structure plot; year 5 read |
| 8/15/2019    | PCM_0115 | Rankin wildfire     | Forest structure plot; year 2 read |
| 8/23/2019    | PCM_0118 | Rankin wildfire     | Forest structure plot; year 2 read |
| 6/20/2019    | PCM_0120 | Cold Brook South    | PCM plot; year 5 read              |

### Plot Layout and Sampling

At each site visited, the NGPN crew recorded plant species cover and frequency in a rectangular, 50 m x 20 m (0.1 ha), permanent plot (Figure 2). Data on ground cover, herb-layer height ( $\leq 2$  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 m<sup>2</sup> quadrats located systematically along each transect (Figure 3). The NGPN crew measured species presence at ten quadrats per plot. 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.

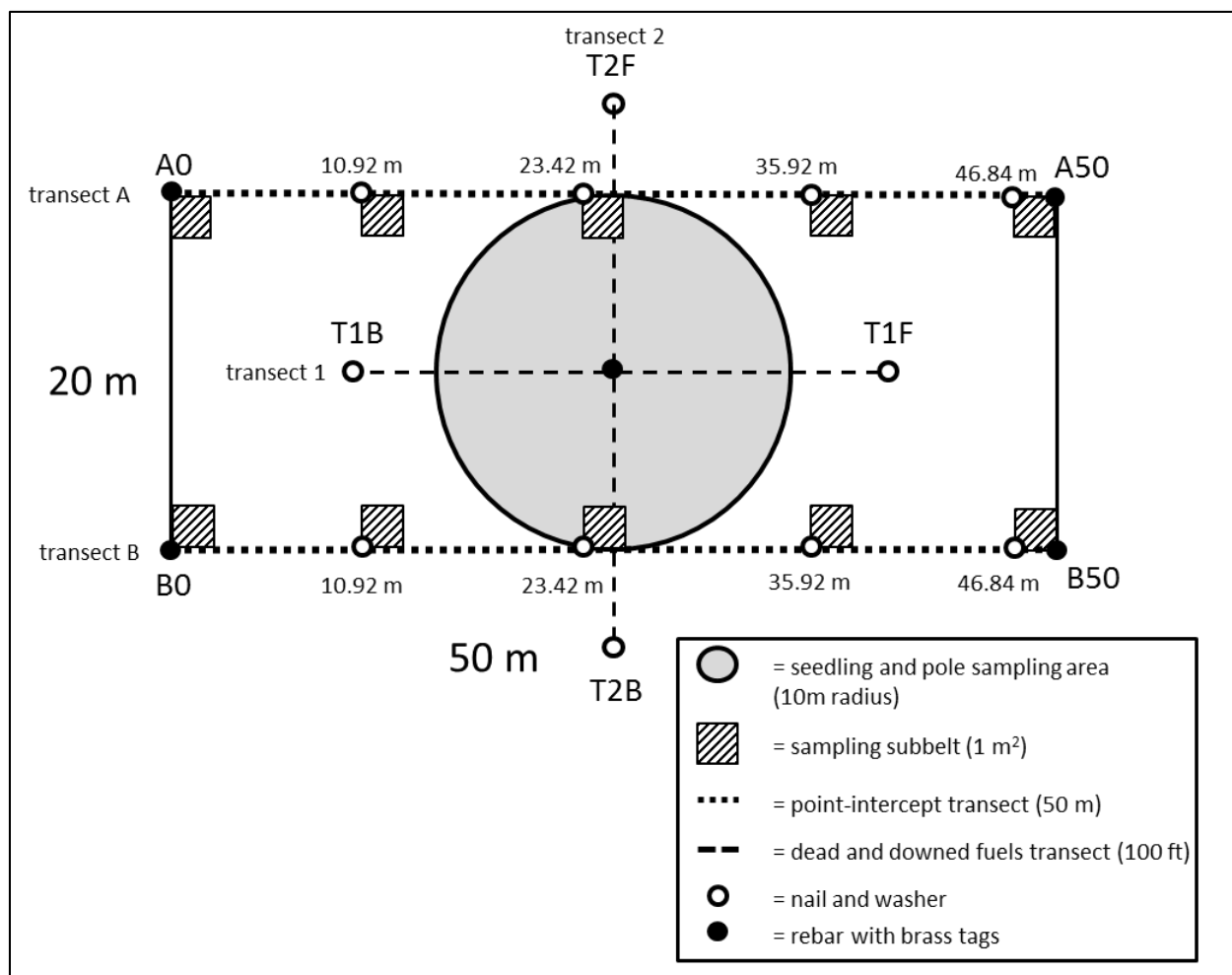


**Figure 2.** Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring and Fire Ecology programs.

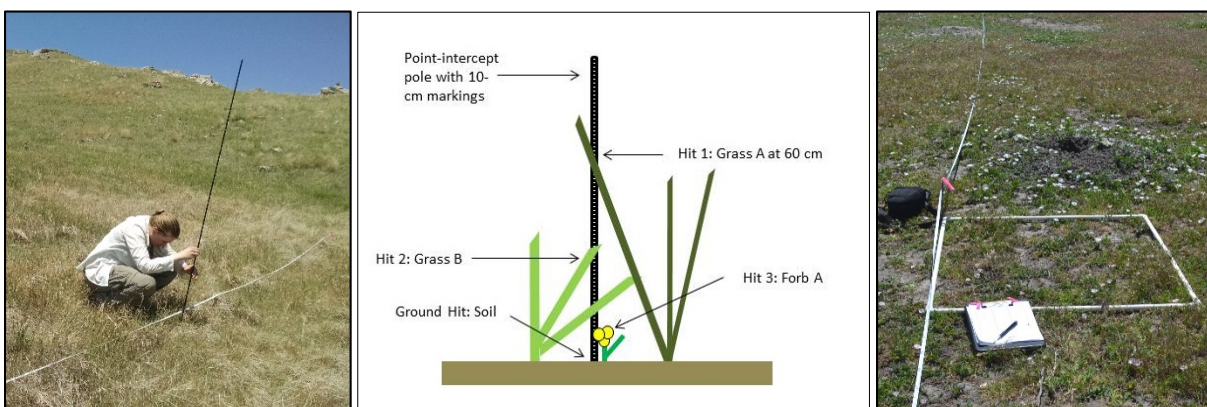


**Figure 3.** The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

When woody species were present within 38 m of plot center, monitoring crews collected tree regeneration and tall shrub density data within a 10 m radius subplot centered in the larger 50 m x 20 m (0.1 ha) plot. Trees with diameter at breast height (DBH) > 15 cm, present within the 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. 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 2019, NGPN changed the way these species counts were made. Stump sprouts (stems originating between ground level and 137 cm on the bole of trees that have died or been cut) were previously tallied individually, resulting in an over-representation of seedling recruitment. Now crews only count one sprout per dead tree stump based on the tallest height class present. If a sprout is attached to a live tree, it is not a seedling and therefore not counted. Dead and downed woody fuel load data were collected along two perpendicular, 100 ft (30.49 m) transects (fuel lines) with midpoints at the center of the plot (Figure 3), following Brown's Line methods (Brown 1974, Brown et al. 1982). Fuel load data were only collected if at least one piece of woody litter or fuel intersected a fuel line.

NGPN crews assessed and documented common disturbances at each plot. The type, which included animal mounds, animal trails, and fire, and the approximate area (m<sup>2</sup>) of each disturbance was recorded. Plots were also assessed for the presence and abundance of target exotic species (Table 3), 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 3.** 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                |

**Table 3 (continued).** Exotic species included in the Northern Great Plains Network's early detection and rapid response program.

| Habitat | Scientific Name                                     | Common Name        |
|---------|-----------------------------------------------------|--------------------|
| 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 2017). However, nomenclature follows the [Integrated Taxonomic Information System](#) (ITIS). 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. In the case where there is not enough evidence for genus and species identification, a special code for the unknown species was created. These are then designated as an exotic species in the total count, but omitted from the species list.

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. After all data were entered and verified, 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, as well as 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 WICA in 2019 was determined by cross-referencing with the [NatureServe](#) conservation status list, as well as the South Dakota rare plant species list. For the purpose of this report, a species was considered rare or of conservation concern if its state or global conservation status rank was critically imperiled (S1/G1), imperiled (S1/G2), or

vulnerable (S3/G3). The 2019 species list was also cross-referenced with the list of noxious weeds maintained by the [South Dakota Department of Agriculture](#).

## Results

There are 589 vascular plant species on the WICA species list, and monitoring crews found 238 of these species in 2019 (Table 4). Of these plant species, 34 are exotic species at WICA. A majority of exotic plants identified were either forbs or graminoids (grasses, sedges, and rushes). The 2019 species list was cross-referenced with state- and county-wide rare and noxious exotic species lists for South Dakota. Two species matched the South Dakota exotic species list: Canada thistle (*Cirsium arvense*) and leafy spurge (*Euphorbia esula*). Two additional species are designated as noxious in Custer County: common mullein (*Verbascum thapsus*) and horehound (*Marrubium vulgare*). One new species to the park, found by the NGPFire crew, was thymeleaf sandwort (*Arenaria serpyllifolia*). This species will need a voucher specimen collected in a future visit for verification and herbarium records. No monitoring crews identified rare plant species in any plot in 2019.

**Table 4.** A list of all plant species identified in Wind Cave National Park’s long-term plant community monitoring plots in 2019. In the Notes column, “Exotic” indicates 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. Also in the Notes column, plants are designated as: “Noxious” and “Early Detection Target” for state or county weed species; “Rare” for species on state, USFS regional, and global rare plant lists, along with their conservation rank; and “New” for species not on the NPSpecies list.

| Family         | Species Code | Scientific Name                 | Common Name               | Notes              |
|----------------|--------------|---------------------------------|---------------------------|--------------------|
| Agavaceae      | YUGL         | <i>Yucca glauca</i>             | soapweed yucca            | –                  |
| 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        | –                  |
| Asclepiadaceae | ASCLE        | <i>Asclepias</i> spp.           | milkweed                  | –                  |
| Asclepiadaceae | ASPU         | <i>Asclepias pumila</i>         | plains milkweed           | –                  |
| Asteraceae     | ACMI2        | <i>Achillea millefolium</i>     | common yarrow             | –                  |
| Asteraceae     | AMPS         | <i>Ambrosia psilostachya</i>    | Cuman ragweed             | –                  |
| Asteraceae     | ANNE         | <i>Antennaria neglecta</i>      | field pussytoes           | –                  |
| Asteraceae     | ANPA4        | <i>Antennaria parvifolia</i>    | small-leaf pussytoes      | –                  |
| Asteraceae     | ANTEN        | <i>Antennaria</i> spp.          | pussytoes                 | –                  |
| 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>           | nodding plumeless thistle | Exotic             |
| Asteraceae     | CIAR4        | <i>Cirsium arvense</i>          | Canada thistle            | Exotic; Noxious-SD |
| Asteraceae     | CIDR2        | <i>Cirsium drummondii</i>       | dwarf thistle             | –                  |
| Asteraceae     | CIUN         | <i>Cirsium undulatum</i>        | wavyleaf thistle          | –                  |
| Asteraceae     | COCA5        | <i>Conyza canadensis</i>        | horseweed                 | –                  |

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| Family     | Species Code | Scientific Name                     | Common Name                | Notes  |
|------------|--------------|-------------------------------------|----------------------------|--------|
| Asteraceae | CORA4        | <i>Conyza ramosissima</i>           | dwarf horseweed            | –      |
| Asteraceae | DYPA         | <i>Dyssodia papposa</i>             | fetid marigold             | –      |
| Asteraceae | ECAN2        | <i>Echinacea angustifolia</i>       | purple coneflower          | –      |
| Asteraceae | ERCA4        | <i>Erigeron canus</i>               | hoary fleabane             | –      |
| Asteraceae | ERFL         | <i>Erigeron flagellaris</i>         | trailing fleabane          | –      |
| Asteraceae | ERPH         | <i>Erigeron philadelphicus</i>      | Philadelphia fleabane      | –      |
| Asteraceae | GRSQ         | <i>Grindelia squarrosa</i>          | curlycup gumweed           | –      |
| Asteraceae | GUSA2        | <i>Gutierrezia sarothrae</i>        | broom snakeweed            | –      |
| Asteraceae | HELIA3       | <i>Helianthus</i> spp.              | 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 | LYJU         | <i>Lygodesmia juncea</i>            | rush skeletonplant         | –      |
| Asteraceae | MUOB99       | <i>Mulgedium oblongifolium</i>      | blue lettuce               | –      |
| Asteraceae | NOCU         | <i>Nothocalais cuspidata</i>        | prairie false dandelion    | –      |
| Asteraceae | PACA15       | <i>Packera cana</i>                 | woolly groundsel           | –      |
| Asteraceae | PAPL12       | <i>Packera plattensis</i>           | prairie groundsel          | –      |
| Asteraceae | RACO3        | <i>Ratibida columnifera</i>         | upright prairie coneflower | –      |
| Asteraceae | SOMI2        | <i>Solidago missouriensis</i>       | Missouri goldenrod         | –      |
| Asteraceae | SOMO         | <i>Solidago mollis</i>              | velvety goldenrod          | –      |
| Asteraceae | SONE         | <i>Solidago nemoralis</i>           | gray goldenrod             | –      |
| Asteraceae | SYER         | <i>Symphyotrichum ericoides</i>     | white heath aster          | –      |
| Asteraceae | SYLA3        | <i>Symphyotrichum laeve</i>         | smooth blue aster          | –      |
| Asteraceae | SYMPH4       | <i>Symphyotrichum</i> spp.          | aster                      | –      |
| Asteraceae | SYOB         | <i>Symphyotrichum oblongifolium</i> | aromatic aster             | –      |
| Asteraceae | TAOF         | <i>Taraxacum officinale</i>         | common dandelion           | Exotic |
| Asteraceae | TEAC         | <i>Tetraneuris acaulis</i>          | stemless four-nerve daisy  | –      |
| Asteraceae | TRDU         | <i>Tragopogon dubius</i>            | yellow salsify             | Exotic |
| Asteraceae | XASP99       | <i>Xanthisma spinulosum</i>         | lacy tansyaster            | –      |

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| Family          | Species Code | Scientific Name                    | Common Name                   | Notes       |
|-----------------|--------------|------------------------------------|-------------------------------|-------------|
| Boraginaceae    | CRCE         | <i>Cryptantha celosioides</i>      | buttecandle                   | –           |
| Boraginaceae    | CRTN         | <i>Cryptantha thyrsoiflora</i>     | calcareous cryptantha         | –           |
| Boraginaceae    | CYOF         | <i>Cynoglossum officinale</i>      | houndstongue                  | Exotic      |
| Boraginaceae    | LAOC3        | <i>Lappula occidentalis</i>        | flatspine stickseed           | –           |
| Boraginaceae    | LIIN2        | <i>Lithospermum incisum</i>        | narrowleaf stoneseed          | –           |
| Boraginaceae    | MELA3        | <i>Mertensia lanceolata</i>        | prairie bluebells             | –           |
| Boraginaceae    | ONBE         | <i>Onosmodium bejariense</i>       | soft-hair marbleseed          | –           |
| Brassicaceae    | ALDE         | <i>Alyssum desertorum</i>          | desert madwort                | Exotic      |
| Brassicaceae    | ARAB12       | <i>Arabis</i> spp.                 | rockcress                     | –           |
| Brassicaceae    | ARHI         | <i>Arabis hirsuta</i>              | hairy rockcress               | –           |
| Brassicaceae    | ARPY4        | <i>Arabis pycnocarpa</i>           | creamflower rockcress         | –           |
| 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    | ERAS2        | <i>Erysimum asperum</i>            | western wallflower            | –           |
| Brassicaceae    | ERCA14       | <i>Erysimum capitatum</i>          | sanddune wallflower           | –           |
| Brassicaceae    | ERYSI        | <i>Erysimum</i> spp.               | wallflower                    | Exotic      |
| Brassicaceae    | LEDE         | <i>Lepidium densiflorum</i>        | common pepperweed             | –           |
| Brassicaceae    | PHLU99       | <i>Physaria ludoviciana</i>        | foothill bladderpod           | –           |
| Cactaceae       | ESMI3        | <i>Escobaria missouriensis</i>     | Missouri foxtail cactus       | –           |
| Cactaceae       | OPFR         | <i>Opuntia fragilis</i>            | brittle pricklypear           | –           |
| Cactaceae       | OPMA2        | <i>Opuntia macrorhiza</i>          | twistspine pricklypear        | –           |
| Cactaceae       | OPUNT        | <i>Opuntia</i> spp.                | pricklypear                   | –           |
| Campanulaceae   | CARO2        | <i>Campanula rotundifolia</i>      | bluebell bellflower           | –           |
| Campanulaceae   | TRPE4        | <i>Triodanis perfoliata</i>        | clasping Venus' looking-glass | –           |
| Caprifoliaceae  | SYOC         | <i>Symphoricarpos occidentalis</i> | western snowberry             | –           |
| Caryophyllaceae | ARSE2        | <i>Arenaria serpyllifolia</i>      | thymeleaf sandwort            | Exotic; New |
| Caryophyllaceae | CEAR4        | <i>Cerastium arvense</i>           | field chickweed               | –           |
| Caryophyllaceae | PADE4        | <i>Paronychia depressa</i>         | spreading nailwort            | –           |
| Caryophyllaceae | PASE         | <i>Paronychia sessiliflora</i>     | creeping nailwort             | –           |

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| Family          | Species Code | Scientific Name                  | Common Name                | Notes              |
|-----------------|--------------|----------------------------------|----------------------------|--------------------|
| Caryophyllaceae | SIAN2        | <i>Silene antirrhina</i>         | sleepy silene              | –                  |
| Caryophyllaceae | SILA21       | <i>Silene latifolia</i>          | bladder campion            | Exotic             |
| Chenopodiaceae  | CHENO        | <i>Chenopodium</i> spp.          | goosefoot                  | –                  |
| 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  | EVNU         | <i>Evolvulus nuttallianus</i>    | shaggy dwarf 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      | CANE2        | <i>Carex nebrascensis</i>        | Nebraska sedge             | –                  |
| Cyperaceae      | CAREX        | <i>Carex</i> spp.                | sedge                      | –                  |
| Cyperaceae      | ELPA3        | <i>Eleocharis palustris</i>      | common spikerush           | –                  |
| Euphorbiaceae   | EUES         | <i>Euphorbia esula</i>           | leafy spurge               | Exotic; Noxious-SD |
| Euphorbiaceae   | EUGL3        | <i>Euphorbia glyptosperma</i>    | ribseed sandmat            | –                  |
| Euphorbiaceae   | EUPHO        | <i>Euphorbia</i> spp.            | spurge; sandmat            | –                  |
| Euphorbiaceae   | EUSP         | <i>Euphorbia spathulata</i>      | warty spurge               | –                  |
| Fabaceae        | AMCA6        | <i>Amorpha canescens</i>         | leadplant                  | –                  |
| Fabaceae        | ASAG2        | <i>Astragalus agrestis</i>       | purple milkvetch           | –                  |
| Fabaceae        | ASCR2        | <i>Astragalus crassicaarpus</i>  | groundplum milkvetch       | –                  |
| Fabaceae        | ASGI5        | <i>Astragalus gilviflorus</i>    | plains milkvetch           | –                  |
| Fabaceae        | ASGR3        | <i>Astragalus gracilis</i>       | slender milkvetch          | –                  |
| Fabaceae        | ASLA27       | <i>Astragalus laxmannii</i>      | Laxmann's milkvetch        | –                  |
| Fabaceae        | ASLO4        | <i>Astragalus lotiflorus</i>     | lotus milkvetch            | –                  |
| Fabaceae        | ASMI10       | <i>Astragalus missouriensis</i>  | Missouri milkvetch         | –                  |
| Fabaceae        | ASPL2        | <i>Astragalus plattensis</i>     | Platte River milkvetch     | –                  |
| Fabaceae        | ASTRA        | <i>Astragalus</i> spp.           | milkvetch                  | –                  |
| Fabaceae        | DAPU5        | <i>Dalea purpurea</i>            | purple prairie clover      | –                  |

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|-----------------|--------------|---------------------------------|---------------------------------|-------------------------------|
| Fabaceae        | GLLE3        | <i>Glycyrrhiza lepidota</i>     | American licorice               | –                             |
| Fabaceae        | LAOC2        | <i>Lathyrus ochroleucus</i>     | cream pea                       | –                             |
| 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        | OXCA4        | <i>Oxytropis campestris</i>     | field locoweed                  | –                             |
| Fabaceae        | PEAR6        | <i>Pedimelum argophyllum</i>    | silverleaf Indian breadroot     | –                             |
| Fabaceae        | PEES         | <i>Pedimelum esculentum</i>     | large Indian breadroot          | –                             |
| Fabaceae        | PSTE5        | <i>Psoralea tenuiflorum</i>     | slimflower scurfpea             | –                             |
| Fabaceae        | VIAM         | <i>Vicia americana</i>          | American vetch                  | –                             |
| Grossulariaceae | RIAU         | <i>Ribes aureum</i>             | golden currant                  | –                             |
| Grossulariaceae | RIOX         | <i>Ribes oxycanthoides</i>      | Canadian gooseberry             | –                             |
| Hydrophyllaceae | ELNY         | <i>Ellisia nyctelea</i>         | Aunt Lucy                       | –                             |
| Iridaceae       | SIMO2        | <i>Sisyrinchium montanum</i>    | strict blue-eyed grass          | –                             |
| Juncaceae       | JUIN2        | <i>Juncus interior</i>          | inland rush                     | –                             |
| Lamiaceae       | HEDR         | <i>Hedeoma drummondii</i>       | Drummond's false pennyroyal     | –                             |
| Lamiaceae       | HEHI         | <i>Hedeoma hispida</i>          | rough false pennyroyal          | –                             |
| Lamiaceae       | LECA2        | <i>Leonurus cardiaca</i>        | common motherwort               | Exotic                        |
| Lamiaceae       | MAVU         | <i>Marrubium vulgare</i>        | horehound                       | Exotic; Noxious-Custer County |
| Lamiaceae       | MEAR4        | <i>Mentha arvensis</i>          | wild mint                       | –                             |
| Lamiaceae       | MOFI         | <i>Monarda fistulosa</i>        | wild bergamot                   | –                             |
| Lamiaceae       | SARE3        | <i>Salvia reflexa</i>           | lanceleaf sage                  | –                             |
| Lamiaceae       | SCGA         | <i>Scutellaria galericulata</i> | marsh skullcap                  | –                             |
| Liliaceae       | ALTE         | <i>Allium textile</i>           | textile onion                   | –                             |
| Liliaceae       | CANU3        | <i>Calochortus nuttallii</i>    | sego lily                       | –                             |
| Liliaceae       | LEMO4        | <i>Leucocrinum montanum</i>     | common starlily                 | –                             |
| 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             | –                             |

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|----------------|--------------|------------------------------------|----------------------------|--------|
| Melanthiaceae  | TOVE2        | <i>Toxicoscordion venenosum</i>    | meadow deathcamas          | –      |
| Nyctaginaceae  | MILI3        | <i>Mirabilis linearis</i>          | narrowleaf four o'clock    | –      |
| Oleaceae       | FRPE         | <i>Fraxinus pennsylvanica</i>      | green ash                  | –      |
| Onagraceae     | OECO2        | <i>Oenothera coronopifolia</i>     | crownleaf evening primrose | –      |
| Onagraceae     | OESE3        | <i>Oenothera serrulata</i>         | yellow sundrops            | –      |
| Onagraceae     | OESU99       | <i>Oenothera suffrutescens</i>     | scarlet beeblossom         | –      |
| Onagraceae     | OEVI         | <i>Oenothera villosa</i>           | hairy evening primrose     | –      |
| Oxalidaceae    | OXST         | <i>Oxalis stricta</i>              | common yellow woodsorrel   | –      |
| Pinaceae       | PIPO         | <i>Pinus ponderosa</i>             | ponderosa pine             | –      |
| Plantaginaceae | PLPA2        | <i>Plantago patagonica</i>         | woolly plantain            | –      |
| Plantaginaceae | SYWY99       | <i>Synthyris wyomingensis</i>      | Wyoming kittentails        | –      |
| 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        | BOHI2        | <i>Bouteloua hirsuta</i>           | hairy grama                | –      |
| Poaceae        | BRIN2        | <i>Bromus inermis</i>              | smooth brome               | Exotic |
| Poaceae        | BRJA         | <i>Bromus japonicus</i>            | Japanese brome             | Exotic |
| Poaceae        | BROMU        | <i>Bromus</i> spp.                 | brome                      | Exotic |
| Poaceae        | BRTE         | <i>Bromus tectorum</i>             | cheatgrass                 | Exotic |
| Poaceae        | CALO         | <i>Calamovilfa longifolia</i>      | prairie sandreed           | –      |
| Poaceae        | DASP2        | <i>Danthonia spicata</i>           | poverty oatgrass           | –      |
| Poaceae        | DILI2        | <i>Dichanthelium linearifolium</i> | slimleaf panicgrass        | –      |
| Poaceae        | DIOL         | <i>Dichanthelium oligosanthos</i>  | Heller's rosette grass     | –      |
| Poaceae        | DIWI5        | <i>Dichanthelium wilcoxianum</i>   | fall rosette grass         | –      |
| Poaceae        | ECMU2        | <i>Echinochloa muricata</i>        | rough barnyardgrass        | –      |
| Poaceae        | ELCA4        | <i>Elymus canadensis</i>           | Canada wildrye             | –      |

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|---------------|--------------|--------------------------------|-------------------------|--------|
| 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> spp.             | wildrye                 | –      |
| Poaceae       | HECO26       | <i>Hesperostipa comata</i>     | needle and thread       | –      |
| Poaceae       | HESP11       | <i>Hesperostipa spartea</i>    | porcupinegrass          | –      |
| Poaceae       | KOMA         | <i>Koeleria macrantha</i>      | prairie Junegrass       | –      |
| Poaceae       | MUCU3        | <i>Muhlenbergia cuspidata</i>  | plains muhly            | –      |
| Poaceae       | MUPA99       | <i>Muhlenbergia paniculata</i> | tumblegrass             | –      |
| Poaceae       | MURA         | <i>Muhlenbergia racemosa</i>   | marsh muhly             | –      |
| Poaceae       | MUSQ3        | <i>Munroa squarrosa</i>        | false buffalograss      | –      |
| Poaceae       | NAVI4        | <i>Nassella viridula</i>       | green needlegrass       | –      |
| Poaceae       | PASM         | <i>Pascopyrum smithii</i>      | western wheatgrass      | –      |
| Poaceae       | PHAR3        | <i>Phalaris arundinacea</i>    | reed canarygrass        | Exotic |
| Poaceae       | PIMI7        | <i>Piptatherum micranthum</i>  | littleseed ricegrass    | –      |
| Poaceae       | POCO         | <i>Poa compressa</i>           | Canada bluegrass        | Exotic |
| Poaceae       | POPA2        | <i>Poa palustris</i>           | fowl bluegrass          | –      |
| Poaceae       | POPR         | <i>Poa pratensis</i>           | Kentucky bluegrass      | Exotic |
| Poaceae       | SCSC         | <i>Schizachyrium scoparium</i> | little bluestem         | –      |
| Poaceae       | SPCR         | <i>Sporobolus cryptandrus</i>  | sand dropseed           | –      |
| Poaceae       | SPHE         | <i>Sporobolus heterolepis</i>  | prairie dropseed        | –      |
| Poaceae       | VUOC         | <i>Vulpia octoflora</i>        | sixweeks fescue         | –      |
| Polemoniaceae | COLI2        | <i>Collomia linearis</i>       | tiny trumpet            | –      |
| 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  | 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 |

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|------------------|--------------|--------------------------------|--------------------------------|--------|
| Polygonaceae     | PORA3        | <i>Polygonum ramosissimum</i>  | bushy knotweed                 | –      |
| Polygonaceae     | RUCR         | <i>Rumex crispus</i>           | curly dock                     | Exotic |
| Portulacaceae    | POOL         | <i>Portulaca oleracea</i>      | little hogweed                 | Exotic |
| Primulaceae      | ANAR         | <i>Anagallis arvensis</i>      | scarlet pimpernel              | Exotic |
| Primulaceae      | ANOC2        | <i>Androsace occidentalis</i>  | western rockjasmine            | –      |
| Ranunculaceae    | ANCY         | <i>Anemone cylindrica</i>      | candle anemone                 | –      |
| Ranunculaceae    | ANEMO        | <i>Anemone</i> spp.            | anemone                        | –      |
| Ranunculaceae    | ANPA19       | <i>Anemone patens</i>          | eastern pasqueflower           | –      |
| Ranunculaceae    | DEBI         | <i>Delphinium bicolor</i>      | little larkspur                | –      |
| Ranunculaceae    | MYMI2        | <i>Myosurus minimus</i>        | tiny mousetail                 | –      |
| Rosaceae         | AMAL2        | <i>Amelanchier alnifolia</i>   | Saskatoon serviceberry         | –      |
| Rosaceae         | CEMO2        | <i>Cercocarpus montanus</i>    | mountain mahogany              | –      |
| Rosaceae         | FRVI         | <i>Fragaria virginiana</i>     | Virginia strawberry            | –      |
| Rosaceae         | POHI6        | <i>Potentilla hippiana</i>     | woolly cinquefoil              | –      |
| Rosaceae         | POPE8        | <i>Potentilla pensylvanica</i> | Pennsylvania cinquefoil        | –      |
| Rosaceae         | PRAM         | <i>Prunus americana</i>        | American plum                  | –      |
| Rosaceae         | PRVI         | <i>Prunus virginiana</i>       | chokecherry                    | –      |
| Rosaceae         | ROAC         | <i>Rosa acicularis</i>         | prickly rose                   | –      |
| Rosaceae         | ROAR3        | <i>Rosa arkansana</i>          | prairie rose                   | –      |
| Rubiaceae        | GAAP2        | <i>Galium aparine</i>          | stickywilly                    | –      |
| Rubiaceae        | GABO2        | <i>Galium boreale</i>          | northern bedstraw              | –      |
| Salicaceae       | POTR5        | <i>Populus tremuloides</i>     | quaking aspen                  | –      |
| Saxifragaceae    | HERI         | <i>Heuchera richardsonii</i>   | Richardson's alumroot          | –      |
| Scrophulariaceae | CASE5        | <i>Castilleja sessiliflora</i> | Great Plains Indian paintbrush | –      |
| Scrophulariaceae | PEAL2        | <i>Penstemon albidus</i>       | white penstemon                | –      |
| Scrophulariaceae | PEGR5        | <i>Penstemon gracilis</i>      | lilac penstemon                | –      |
| Scrophulariaceae | PEGR7        | <i>Penstemon grandiflorus</i>  | large beardtongue              | –      |

**Table 4 (continued).** A list of all plant species identified in Wind Cave National Park's long-term plant community monitoring plots in 2019. In the Notes column, "Exotic" indicates 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. Also in the Notes column, plants are designated as: "Noxious" and "Early Detection Target" for state or county weed species; "Rare" for species on state, USFS regional, and global rare plant lists, along with their conservation rank; and "New" for species not on the NPSpecies list.

| Family           | Species Code | Scientific Name                | Common Name            | Notes                         |
|------------------|--------------|--------------------------------|------------------------|-------------------------------|
| Scrophulariaceae | VEAR         | <i>Veronica arvensis</i>       | corn speedwell         | Exotic                        |
| Scrophulariaceae | VETH         | <i>Verbascum thapsus</i>       | common mullein         | Exotic; Noxious-Custer County |
| Selaginellaceae  | SEDE2        | <i>Selaginella densa</i>       | lesser spikemoss       | –                             |
| Solanaceae       | PHLO4        | <i>Physalis longifolia</i>     | longleaf groundcherry  | –                             |
| Solanaceae       | PHVI5        | <i>Physalis virginiana</i>     | Virginia groundcherry  | –                             |
| Solanaceae       | SORO         | <i>Solanum rostratum</i>       | buffalobur nightshade  | –                             |
| Ulmaceae         | ULAM         | <i>Ulmus americana</i>         | American elm           | –                             |
| 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       | –                             |

Table 5 shows the total count of unique species observed in all plots in 2019. The highest number of unique species is 83, observed in both PCM\_0018 and PCM\_2054. The highest number of unique native species observed is 76 observed in PCM\_2056, while the highest number of unique exotic species observed is 16 in PCM\_0017. The plots where density-quadrat protocols were conducted reveal a much higher number of unique species observed. Two plots show zero unique species present; only tree and seedling protocols were conducted for the plot, and no trees or seedlings were present. Absolute cover calculations (Table 6) showed that plots visited by NGPN and NGPFire were on average more native than exotic. PCM\_0026 (Figure 4) had the highest absolute cover of native species with 249%, and PCM\_0016 had the highest absolute cover of exotic species 113%.

**Table 5.** Total number of plant species identified in plots monitored at Wind Cave National Park in 2019. This is a count of all unique species identified in the plot using species data from point-intercept, quadrat, trees, seedlings, and target exotic species protocols.

| <b>Vegetation Protocols Completed</b>                                             | <b>Plot</b> | <b>Native Species</b> | <b>Exotic Species</b> | <b>Total Species</b> |
|-----------------------------------------------------------------------------------|-------------|-----------------------|-----------------------|----------------------|
| All Protocols: Point-Intercept, Density-Quadrat, Trees, Seedlings, Target Species | PCM_0016    | 22                    | 6                     | 28                   |
|                                                                                   | PCM_0018    | 68                    | 15                    | 83                   |
|                                                                                   | PCM_0021    | 64                    | 10                    | 74                   |
|                                                                                   | PCM_0023    | 46                    | 2                     | 48                   |
|                                                                                   | PCM_0024    | 54                    | 7                     | 61                   |
|                                                                                   | PCM_0025    | 59                    | 15                    | 74                   |
|                                                                                   | PCM_0027    | 48                    | 10                    | 58                   |
|                                                                                   | PCM_0028    | 69                    | 7                     | 76                   |
|                                                                                   | PCM_2054    | 74                    | 9                     | 83                   |
|                                                                                   | PCM_2055    | 63                    | 15                    | 78                   |
|                                                                                   | PCM_2056    | 76                    | 6                     | 82                   |
| Point-Intercept, Density-Quadrats, Target Species                                 | PCM_0015    | 40                    | 15                    | 55                   |
|                                                                                   | PCM_0017    | 55                    | 16                    | 71                   |
|                                                                                   | PCM_0019    | 52                    | 14                    | 66                   |
|                                                                                   | PCM_0020    | 56                    | 5                     | 61                   |
|                                                                                   | PCM_0022    | 52                    | 11                    | 63                   |
|                                                                                   | PCM_0026    | 66                    | 10                    | 76                   |
|                                                                                   | PCM_2057    | 68                    | 3                     | 71                   |
| Point-Intercept and Target Species                                                | PCM_0006    | 23                    | 1                     | 24                   |
|                                                                                   | PCM_0036    | 20                    | 3                     | 23                   |
| Point-Intercept, Trees, Seedlings, Target Species                                 | FPCM_0220   | 20                    | 3                     | 23                   |
|                                                                                   | FPCM_0268   | 19                    | 2                     | 21                   |
|                                                                                   | FPCM_0317   | 19                    | 4                     | 23                   |
|                                                                                   | FPCM_0353   | 18                    | 2                     | 20                   |
|                                                                                   | FPCM_0504   | 21                    | 2                     | 23                   |
|                                                                                   | FPCM_0524   | 25                    | 1                     | 26                   |
|                                                                                   | FPCM_0588   | 19                    | 4                     | 23                   |
|                                                                                   | FPCM_0737   | 13                    | 2                     | 15                   |
|                                                                                   | FPCM_0796   | 19                    | 5                     | 24                   |
|                                                                                   | FPCM_0952   | 19                    | 7                     | 26                   |
|                                                                                   | PCM_0002    | 17                    | 1                     | 18                   |
|                                                                                   | PCM_0008    | 15                    | 1                     | 16                   |
|                                                                                   | PCM_0010    | 22                    | 4                     | 26                   |
|                                                                                   | PCM_0035    | 27                    | 3                     | 30                   |

**Table 5 (continued).** Total number of plant species identified in plots monitored at Wind Cave National Park in 2019. This is a count of all unique species identified in the plot using species data from point-intercept, quadrat, trees, seedlings, and target exotic species protocols.

| <b>Vegetation Protocols Completed</b>                         | <b>Plot</b> | <b>Native Species</b> | <b>Exotic Species</b> | <b>Total Species</b> |
|---------------------------------------------------------------|-------------|-----------------------|-----------------------|----------------------|
| Point-Intercept, Trees, Seedlings, Target Species (continued) | PCM_0076    | 25                    | 8                     | 33                   |
|                                                               | PCM_0120    | 11                    | 6                     | 17                   |
| Trees, Seedlings, Target Species                              | PCM_0038    | 0                     | 0                     | 0                    |
|                                                               | PCM_0046    | 2                     | 0                     | 2                    |
|                                                               | PCM_0051    | 1                     | 0                     | 1                    |
|                                                               | PCM_0056    | 1                     | 0                     | 1                    |
|                                                               | PCM_0058    | 2                     | 0                     | 2                    |
|                                                               | PCM_0059    | 1                     | 0                     | 1                    |
|                                                               | PCM_0068    | 1                     | 0                     | 1                    |
|                                                               | PCM_0072    | 3                     | 0                     | 3                    |
|                                                               | PCM_0088    | 1                     | 0                     | 1                    |
|                                                               | PCM_0090    | 0                     | 0                     | 0                    |
|                                                               | PCM_0094    | 2                     | 0                     | 2                    |
|                                                               | PCM_0099    | 2                     | 0                     | 2                    |
|                                                               | PCM_0102    | 5                     | 0                     | 5                    |
|                                                               | PCM_0103    | 2                     | 0                     | 2                    |
|                                                               | PCM_0110    | 2                     | 0                     | 2                    |
|                                                               | PCM_0115    | 4                     | 0                     | 4                    |
|                                                               | PCM_0118    | 2                     | 0                     | 2                    |

**Table 6.** Absolute percent cover of native and exotic plant species in plots monitored at Wind Cave 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%.

| <b>Plot</b> | <b>Absolute % Exotic Cover</b> | <b>Absolute % Native Cover</b> |
|-------------|--------------------------------|--------------------------------|
| FPCM_0220   | 31                             | 157                            |
| FPCM_0268   | 35                             | 107                            |
| FPCM_0317   | 45                             | 69                             |
| FPCM_0353   | 22                             | 63                             |
| FPCM_0504   | 17                             | 78                             |
| FPCM_0524   | 49                             | 94                             |
| FPCM_0588   | 47                             | 84                             |
| FPCM_0737   | 49                             | 68                             |
| FPCM_0796   | 21                             | 92                             |
| FPCM_0952   | 50                             | 72                             |
| PCM_0002    | 2                              | 106                            |
| PCM_0006    | 31                             | 145                            |
| PCM_0008    | 14                             | 154                            |
| PCM_0010    | 94                             | 175                            |
| PCM_0015    | 78                             | 75                             |
| PCM_0016    | 113                            | 79                             |
| PCM_0017    | 28                             | 145                            |
| PCM_0018    | 37                             | 156                            |
| PCM_0019    | 55                             | 139                            |
| PCM_0020    | 0                              | 231                            |
| PCM_0021    | 50                             | 122                            |
| PCM_0022    | 87                             | 146                            |
| PCM_0023    | 1                              | 60                             |
| PCM_0024    | 75                             | 130                            |
| PCM_0025    | 37                             | 87                             |
| PCM_0026    | 17                             | 249                            |
| PCM_0027    | 59                             | 104                            |
| PCM_0028    | 2                              | 125                            |
| PCM_0035    | 31                             | 229                            |
| PCM_0036    | 42                             | 208                            |
| PCM_0076    | 76                             | 117                            |
| PCM_0120    | 30                             | 21                             |
| PCM_2054    | 32                             | 147                            |
| PCM_2055    | 68                             | 98                             |
| PCM_2056    | 8                              | 147                            |
| PCM_2057    | 2                              | 105                            |



**Figure 4.** PCM\_0026 had the highest absolute cover of native species observed from any plot in 2019 in Wind Cave National Park. Photograph courtesy of the National Park Service.

NGPN and NGPFire crews collected woody species data at 44 plots in 2019 (Table 7). Of those plots, two did not have any tree, pole, or seedling species present. Seven unique species of trees and shrubs were observed, with ponderosa pine (*Pinus ponderosa*) as the dominant cover. NGPFire counted 593 ponderosa pine seedlings at FPCM\_0353, the highest count from any plot visited in 2019. Most plots had fewer than 50 individual seedlings per species.

**Table 7.** Woody species densities from 42 long-term monitoring plots visited at Wind Cave National Park in 2019. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

| Plot Name | Common Name    | Status | DBH      | Count | Density/ha |
|-----------|----------------|--------|----------|-------|------------|
| FPCM_0220 | ponderosa pine | Live   | Seedling | 10    | 318.27     |
| FPCM_0220 | ponderosa pine | Live   | Pole     | 9     | 286.62     |
| FPCM_0220 | ponderosa pine | Dead   | Pole     | 2     | 63.69      |
| FPCM_0220 | ponderosa pine | Live   | Tree     | 6     | 191.08     |
| FPCM_0220 | ponderosa pine | Dead   | Tree     | 1     | 31.85      |

**Table 7 (continued).** Woody species densities from 42 long-term monitoring plots visited at Wind Cave National Park in 2019. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

| Plot Name | Common Name            | Status | DBH      | Count | Density/ha |
|-----------|------------------------|--------|----------|-------|------------|
| FPCM_0268 | chokecherry            | Live   | Seedling | 8     | 254.61     |
| FPCM_0268 | ponderosa pine         | Live   | Seedling | 7     | 222.79     |
| FPCM_0268 | ponderosa pine         | Live   | Pole     | 1     | 31.85      |
| FPCM_0268 | ponderosa pine         | Live   | Tree     | 9     | 286.62     |
| FPCM_0268 | ponderosa pine         | Dead   | Tree     | 1     | 31.85      |
| FPCM_0317 | ponderosa pine         | Live   | Seedling | 4     | 127.31     |
| FPCM_0317 | ponderosa pine         | Live   | Tree     | 9     | 286.62     |
| FPCM_0317 | ponderosa pine         | Dead   | Tree     | 1     | 31.85      |
| FPCM_0353 | ponderosa pine         | Live   | Seedling | 593   | 18873.33   |
| FPCM_0353 | Rocky Mountain juniper | Live   | Seedling | 1     | 31.83      |
| FPCM_0353 | chokecherry            | Live   | Seedling | 1     | 31.83      |
| FPCM_0353 | ponderosa pine         | Live   | Pole     | 3     | 95.54      |
| FPCM_0353 | ponderosa pine         | Dead   | Pole     | 2     | 63.69      |
| FPCM_0353 | ponderosa pine         | Live   | Tree     | 19    | 605.1      |
| FPCM_0353 | ponderosa pine         | Dead   | Tree     | 1     | 31.85      |
| FPCM_0504 | ponderosa pine         | Live   | Tree     | 10    | 318.47     |
| FPCM_0504 | ponderosa pine         | Dead   | Tree     | 1     | 31.85      |
| FPCM_0524 | chokecherry            | Live   | Seedling | 49    | 1559.52    |
| FPCM_0524 | American elm           | Live   | Seedling | 2     | 63.65      |
| FPCM_0524 | ponderosa pine         | Live   | Seedling | 1     | 31.83      |
| FPCM_0524 | ponderosa pine         | Dead   | Pole     | 8     | 254.78     |
| FPCM_0524 | ponderosa pine         | Live   | Pole     | 7     | 222.93     |
| FPCM_0524 | ponderosa pine         | Live   | Tree     | 19    | 605.1      |
| FPCM_0524 | ponderosa pine         | Dead   | Tree     | 1     | 31.85      |
| FPCM_0588 | chokecherry            | Live   | Seedling | 4     | 127.31     |
| FPCM_0588 | ponderosa pine         | Dead   | Pole     | 6     | 191.08     |
| FPCM_0588 | ponderosa pine         | Live   | Pole     | 6     | 191.08     |
| FPCM_0588 | ponderosa pine         | Live   | Tree     | 12    | 382.17     |
| FPCM_0588 | ponderosa pine         | Dead   | Tree     | 1     | 31.85      |
| FPCM_0737 | ponderosa pine         | Live   | Seedling | 95    | 3023.55    |
| FPCM_0737 | chokecherry            | Live   | Seedling | 22    | 700.19     |
| FPCM_0737 | ponderosa pine         | Live   | Pole     | 12    | 382.17     |
| FPCM_0737 | ponderosa pine         | Live   | Tree     | 12    | 382.17     |
| FPCM_0796 | chokecherry            | Live   | Seedling | 88    | 2800.76    |

**Table 7 (continued).** Woody species densities from 42 long-term monitoring plots visited at Wind Cave National Park in 2019. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

| Plot Name | Common Name            | Status | DBH      | Count | Density/ha |
|-----------|------------------------|--------|----------|-------|------------|
| FPCM_0796 | ponderosa pine         | Dead   | Pole     | 3     | 95.54      |
| FPCM_0796 | ponderosa pine         | Dead   | Tree     | 4     | 127.39     |
| FPCM_0952 | ponderosa pine         | Live   | Seedling | 20    | 636.54     |
| FPCM_0952 | ponderosa pine         | Dead   | Pole     | 37    | 1178.34    |
| FPCM_0952 | ponderosa pine         | Dead   | Tree     | 12    | 382.17     |
| PCM_0002  | ponderosa pine         | Live   | Seedling | 10    | 318.27     |
| PCM_0002  | ponderosa pine         | Live   | Tree     | 1     | 31.85      |
| PCM_0008  | ponderosa pine         | Dead   | Pole     | 1     | 31.85      |
| PCM_0008  | ponderosa pine         | Dead   | Tree     | 4     | 127.39     |
| PCM_0016  | ponderosa pine         | Live   | Tree     | 1     | 10         |
| PCM_0023  | ponderosa pine         | Live   | Seedling | 15    | 477.4      |
| PCM_0023  | ponderosa pine         | Live   | Pole     | 47    | 1496.82    |
| PCM_0023  | ponderosa pine         | Dead   | Pole     | 3     | 95.54      |
| PCM_0023  | ponderosa pine         | Live   | Tree     | 58    | 580        |
| PCM_0027  | ponderosa pine         | Live   | Seedling | 86    | 2737.11    |
| PCM_0027  | Rocky Mountain juniper | Live   | Seedling | 1     | 31.83      |
| PCM_0027  | ponderosa pine         | Live   | Pole     | 19    | 605.1      |
| PCM_0027  | ponderosa pine         | Dead   | Pole     | 4     | 127.39     |
| PCM_0027  | Rocky Mountain juniper | Live   | Pole     | 3     | 95.54      |
| PCM_0027  | ponderosa pine         | Live   | Tree     | 17    | 170        |
| PCM_0035  | ponderosa pine         | Live   | Seedling | 17    | 541.06     |
| PCM_0035  | ponderosa pine         | Live   | Pole     | 44    | 1401.27    |
| PCM_0035  | ponderosa pine         | Dead   | Pole     | 3     | 95.54      |
| PCM_0035  | ponderosa pine         | Live   | Tree     | 6     | 191.08     |
| PCM_0046  | ponderosa pine         | Live   | Seedling | 6     | 190.96     |
| PCM_0046  | ponderosa pine         | Live   | Pole     | 6     | 191.08     |
| PCM_0046  | ponderosa pine         | Dead   | Pole     | 2     | 63.69      |
| PCM_0046  | ponderosa pine         | Live   | Tree     | 10    | 318.47     |
| PCM_0046  | ponderosa pine         | Dead   | Tree     | 1     | 31.85      |
| PCM_0051  | ponderosa pine         | Live   | Tree     | 2     | 63.69      |
| PCM_0056  | chokecherry            | Live   | Seedling | 475   | 15117.76   |
| PCM_0058  | chokecherry            | Live   | Seedling | 249   | 7924.89    |
| PCM_0058  | American elm           | Live   | Seedling | 19    | 604.71     |
| PCM_0059  | ponderosa pine         | Dead   | Pole     | 47    | 1496.82    |

**Table 7 (continued).** Woody species densities from 42 long-term monitoring plots visited at Wind Cave National Park in 2019. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

| Plot Name | Common Name            | Status | DBH      | Count | Density/ha |
|-----------|------------------------|--------|----------|-------|------------|
| PCM_0059  | ponderosa pine         | Live   | Pole     | 9     | 286.62     |
| PCM_0059  | ponderosa pine         | Live   | Tree     | 1     | 31.85      |
| PCM_0068  | ponderosa pine         | Dead   | Pole     | 4     | 127.39     |
| PCM_0068  | ponderosa pine         | Dead   | Tree     | 8     | 254.78     |
| PCM_0072  | chokecherry            | Live   | Seedling | 15    | 477.4      |
| PCM_0072  | green ash              | Live   | Seedling | 7     | 222.79     |
| PCM_0072  | ponderosa pine         | Dead   | Pole     | 61    | 1942.68    |
| PCM_0072  | ponderosa pine         | Live   | Pole     | 1     | 31.85      |
| PCM_0072  | ponderosa pine         | Dead   | Tree     | 11    | 350.32     |
| PCM_0072  | ponderosa pine         | Live   | Tree     | 3     | 95.54      |
| PCM_0076  | ponderosa pine         | Live   | Seedling | 110   | 3500.95    |
| PCM_0076  | ponderosa pine         | Dead   | Pole     | 2     | 63.69      |
| PCM_0076  | ponderosa pine         | Live   | Tree     | 9     | 286.62     |
| PCM_0076  | ponderosa pine         | Dead   | Tree     | 7     | 222.93     |
| PCM_0088  | chokecherry            | Live   | Seedling | 65    | 2068.75    |
| PCM_0094  | chokecherry            | Live   | Seedling | 100   | 3182.69    |
| PCM_0094  | ponderosa pine         | Dead   | Pole     | 1     | 31.85      |
| PCM_0094  | ponderosa pine         | Dead   | Tree     | 1     | 31.85      |
| PCM_0094  | ponderosa pine         | Live   | Tree     | 1     | 31.85      |
| PCM_0099  | ponderosa pine         | Live   | Seedling | 15    | 477.4      |
| PCM_0099  | ponderosa pine         | Live   | Pole     | 36    | 1146.5     |
| PCM_0099  | ponderosa pine         | Live   | Tree     | 2     | 63.69      |
| PCM_0102  | chokecherry            | Live   | Seedling | 49    | 1559.52    |
| PCM_0102  | quaking aspen          | Live   | Seedling | 27    | 859.33     |
| PCM_0102  | Saskatoon serviceberry | Live   | Seedling | 7     | 222.79     |
| PCM_0102  | ponderosa pine         | Live   | Seedling | 4     | 127.31     |
| PCM_0102  | ponderosa pine         | Dead   | Pole     | 1     | 31.85      |
| PCM_0103  | ponderosa pine         | Live   | Seedling | 46    | 1464.04    |
| PCM_0103  | ponderosa pine         | Live   | Pole     | 6     | 191.08     |
| PCM_0103  | ponderosa pine         | Dead   | Pole     | 2     | 63.69      |
| PCM_0103  | ponderosa pine         | Live   | Tree     | 9     | 286.62     |
| PCM_0110  | chokecherry            | Live   | Seedling | 414   | 13176.32   |
| PCM_0110  | ponderosa pine         | Live   | Pole     | 6     | 191.08     |
| PCM_0110  | ponderosa pine         | Dead   | Pole     | 1     | 31.85      |

**Table 7 (continued).** Woody species densities from 42 long-term monitoring plots visited at Wind Cave National Park in 2019. DBH categories are tree (DBH > 15 cm), pole (2.54 cm ≤ DBH ≤ 15 cm), and seedling (DBH < 2.54 cm).

| Plot Name | Common Name            | Status | DBH      | Count | Density/ha |
|-----------|------------------------|--------|----------|-------|------------|
| PCM_0110  | ponderosa pine         | Live   | Tree     | 9     | 286.62     |
| PCM_0115  | ponderosa pine         | Live   | Seedling | 3     | 95.48      |
| PCM_0115  | quaking aspen          | Live   | Seedling | 1     | 31.83      |
| PCM_0115  | American elm           | Live   | Seedling | 1     | 31.83      |
| PCM_0115  | ponderosa pine         | Dead   | Pole     | 1     | 31.85      |
| PCM_0115  | ponderosa pine         | Live   | Tree     | 10    | 318.47     |
| PCM_0115  | ponderosa pine         | Dead   | Tree     | 2     | 63.69      |
| PCM_0118  | chokecherry            | Live   | Seedling | 7     | 222.79     |
| PCM_0118  | ponderosa pine         | Live   | Tree     | 6     | 191.08     |
| PCM_0120  | ponderosa pine         | Dead   | Pole     | 2     | 149.25     |
| PCM_0120  | ponderosa pine         | Live   | Pole     | 2     | 149.25     |
| PCM_0120  | ponderosa pine         | Live   | Tree     | 5     | 373.13     |
| PCM_2055  | American elm           | Live   | Seedling | 67    | 2132.4     |
| PCM_2055  | chokecherry            | Live   | Seedling | 50    | 1591.34    |
| PCM_2055  | ponderosa pine         | Live   | Seedling | 5     | 159.13     |
| PCM_2055  | Rocky Mountain juniper | Live   | Tree     | 5     | 50         |
| PCM_2055  | Rocky Mountain juniper | Dead   | Tree     | 1     | 10         |
| PCM_2055  | ponderosa pine         | Live   | Tree     | 1     | 10         |
| PCM_2056  | Rocky Mountain juniper | Live   | Pole     | 1     | 31.85      |

Surface fuels and dead and downed wood provide foraging habitat and refugia for small wildlife species, as well as substrate for mosses and fungi. Downed wood can also provide “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. NGPFire developed a management target to maintain surface fuel loads between 2 and 10 tons per acre (tpa) within the Black Hills parks. NGPN and NGPFire crews surveyed and measured surface fuels in 45 of the plots visited in JECA (Table 8). In 2019, total fuel loading within the Cold Brook South and Cold Brook North units averaged 17.15 and 13.32 tpa, five growing seasons after their March 2015 and October 2014 prescribed fires. Five growing seasons after the Cold Brook wildfire, total fuel loading for three plots averaged 8.99 tpa. Two years after the Rankin wildfire, total fuel loading averaged 4.13 tpa, whereas ten plots within the Legion Lake perimeter averaged 1.92 tpa.

**Table 8.** Surface fuels summary for 45 plots visited in 2019 at Wind Cave 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  | Litt | Total | Duff             | Litt | Total |
| FPCM_0220 | 0.06                  | 0.95  | 1.45   | 2.46     | 0.00          | 0.00           | 2.46      | 2.90  | 1.60 | 6.97  | 0.2              | 0.4  | 0.6   |
| FPCM_0268 | 0.00                  | 0.41  | 0.73   | 1.13     | 0.00          | 0.73           | 1.86      | 5.72  | 1.42 | 9.00  | 0.3              | 0.4  | 0.7   |
| FPCM_0317 | 0.00                  | 0.00  | 0.00   | 0.00     | 1.85          | 0.48           | 2.33      | 6.51  | 1.42 | 10.26 | 0.4              | 0.4  | 0.7   |
| FPCM_0353 | 0.00                  | 0.28  | 2.20   | 2.47     | 3.29          | 3.69           | 9.45      | 7.04  | 1.80 | 18.29 | 0.4              | 0.5  | 0.9   |
| FPCM_0504 | 0.00                  | 0.28  | 0.00   | 0.28     | 0.64          | 0.55           | 1.46      | 0.79  | 1.22 | 3.47  | 0.0              | 0.3  | 0.4   |
| FPCM_0524 | 0.10                  | 0.55  | 0.00   | 0.65     | 0.84          | 2.39           | 3.88      | 12.15 | 2.14 | 18.16 | 0.7              | 0.5  | 1.2   |
| FPCM_0588 | 0.18                  | 0.82  | 0.73   | 1.72     | 3.05          | 0.19           | 4.97      | 3.35  | 1.44 | 9.75  | 0.2              | 0.4  | 0.6   |
| FPCM_0737 | 0.08                  | 1.09  | 1.46   | 2.63     | 5.88          | 8.68           | 17.18     | 12.76 | 1.96 | 31.90 | 0.7              | 0.5  | 1.2   |
| FPCM_0796 | 0.16                  | 2.58  | 1.54   | 4.28     | 12.40         | 0.30           | 16.98     | 2.11  | 1.52 | 20.61 | 0.1              | 0.4  | 0.5   |
| FPCM_0952 | 0.06                  | 0.69  | 3.64   | 4.39     | 6.87          | 2.51           | 13.77     | 1.20  | 1.27 | 16.24 | 0.1              | 0.3  | 0.4   |
| PCM_0002  | 0.02                  | 0.31  | 0.00   | 0.33     | 0.00          | 0.00           | 0.33      | 2.87  | 0.76 | 3.95  | 0.2              | 0.2  | 0.4   |
| PCM_0008  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 0.26  | 0.60 | 0.86  | 0.0              | 0.2  | 0.2   |
| PCM_0010  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0016  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0018  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0021  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0023  | 0.02                  | 0.14  | 0.00   | 0.16     | 0.00          | 0.00           | 0.16      | 5.90  | 3.07 | 9.13  | 0.3              | 0.8  | 1.1   |
| PCM_0024  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0025  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0027  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 9.33  | 3.53 | 12.86 | 0.5              | 0.9  | 1.4   |
| PCM_0028  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00          | 0.00           | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0035  | 0.06                  | 0.00  | 0.00   | 0.06     | 0.00          | 0.00           | 0.06      | 2.20  | 0.94 | 3.20  | 0.1              | 0.2  | 0.4   |

**Table 8 (continued).** Surface fuels summary for 45 plots visited in 2019 at Wind Cave National Park.

| Macroplot | Average Tons per Acre |       |        |          |                  |                   |           |       |      |       | Avg. Depth (in.) |      |       |
|-----------|-----------------------|-------|--------|----------|------------------|-------------------|-----------|-------|------|-------|------------------|------|-------|
|           | 1-hr                  | 10-hr | 100-hr | 1-100-hr | 1000-hr<br>sound | 1000-hr<br>rotten | 1-1000-hr | Duff  | Litt | Total | Duff             | Litt | Total |
| PCM_0038  | 0.10                  | 0.41  | 1.45   | 1.96     | 0.00             | 0.00              | 1.96      | 0.35  | 0.40 | 2.71  | 0.0              | 0.1  | 0.1   |
| PCM_0046  | 0.24                  | 1.49  | 0.73   | 2.46     | 4.97             | 0.00              | 7.43      | 3.43  | 1.00 | 11.86 | 0.2              | 0.3  | 0.4   |
| PCM_0051  | 0.00                  | 0.14  | 0.00   | 0.14     | 0.00             | 0.00              | 0.14      | 1.32  | 0.26 | 1.72  | 0.1              | 0.1  | 0.1   |
| PCM_0054  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00             | 0.00              | 0.00      | 1.76  | 0.40 | 2.16  | 0.1              | 0.1  | 0.2   |
| PCM_0059  | 0.02                  | 0.00  | 0.00   | 0.02     | 0.00             | 0.00              | 0.02      | 0.53  | 0.42 | 0.97  | 0.0              | 0.1  | 0.1   |
| PCM_0068  | 0.06                  | 1.16  | 2.18   | 3.41     | 0.49             | 0.00              | 3.90      | 0.53  | 0.54 | 4.97  | 0.0              | 0.1  | 0.2   |
| PCM_0070  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00             | 0.00              | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0072  | 0.00                  | 0.32  | 0.00   | 0.32     | 0.00             | 0.00              | 0.32      | 0.62  | 0.36 | 1.30  | 0.0              | 0.1  | 0.1   |
| PCM_0076  | 0.00                  | 2.03  | 4.36   | 6.40     | 3.77             | 3.45              | 13.61     | 4.23  | 1.70 | 19.54 | 0.2              | 0.4  | 0.7   |
| PCM_0088  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00             | 0.00              | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0090  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00             | 0.00              | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_0094  | 0.02                  | 0.00  | 0.73   | 0.75     | 8.02             | 0.00              | 8.77      | 1.23  | 0.78 | 10.78 | 0.1              | 0.2  | 0.3   |
| PCM_0099  | 0.38                  | 0.87  | 0.00   | 1.24     | 0.00             | 0.00              | 1.24      | 0.44  | 0.46 | 2.14  | 0.0              | 0.1  | 0.1   |
| PCM_0102  | 0.04                  | 0.42  | 0.00   | 0.46     | 2.53             | 0.00              | 2.99      | 0.53  | 0.78 | 4.30  | 0.0              | 0.2  | 0.2   |
| PCM_0103  | 0.06                  | 0.28  | 0.73   | 1.06     | 3.81             | 0.00              | 4.87      | 2.64  | 1.28 | 8.79  | 0.2              | 0.3  | 0.5   |
| PCM_0107  | 0.14                  | 0.41  | 0.73   | 1.27     | 0.00             | 5.96              | 7.23      | 10.12 | 2.52 | 19.87 | 0.6              | 0.6  | 1.2   |
| PCM_0110  | 0.25                  | 0.44  | 0.00   | 0.69     | 0.00             | 0.00              | 0.69      | 2.99  | 0.66 | 4.34  | 0.2              | 0.2  | 0.3   |
| PCM_0115  | 0.06                  | 0.00  | 1.46   | 1.52     | 0.00             | 0.00              | 1.52      | 2.46  | 1.28 | 5.26  | 0.1              | 0.3  | 0.5   |
| PCM_0118  | 0.10                  | 0.14  | 0.73   | 0.96     | 0.00             | 0.00              | 0.96      | 2.02  | 1.16 | 4.14  | 0.1              | 0.3  | 0.4   |
| PCM_0120  | 0.12                  | 0.55  | 8.13   | 8.79     | 3.17             | 0.00              | 11.97     | 4.82  | 1.35 | 18.13 | 0.3              | 0.3  | 0.6   |
| PCM_2054  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00             | 0.00              | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |
| PCM_2055  | 0.00                  | 0.41  | 0.00   | 0.41     | 0.00             | 0.00              | 0.41      | 7.31  | 4.61 | 12.32 | 0.4              | 1.2  | 1.6   |
| PCM_2056  | 0.00                  | 0.00  | 0.00   | 0.00     | 0.00             | 0.00              | 0.00      | 0.00  | 0.00 | 0.00  | 0.0              | 0.0  | 0.0   |

Disturbances were observed in 21 of the 55 plots visited by NGPN and NGPFire in 2019 (Table 9). The most common disturbances were by related to animal use, such as grazing, animal trails, wallows, and prairie dog activity.

**Table 9.** Disturbance type and area observed in 21 plots visited at Wind Cave National Park by Northern Great Plains Network and Northern Great Plains Fire in 2019. The disturbance area was approximated out of a total area of 1000 m<sup>2</sup> for PCM plots and 730 m<sup>2</sup>. When disturbance was landscape-wide, only presence was recorded as “Yes” in the Area column.

| Plot      | Disturbance Type                      | Area (m2) |
|-----------|---------------------------------------|-----------|
| FPCM_0524 | Animal Trail                          | 10        |
| PCM_0015  | Animal Trail                          | 40        |
| PCM_0015  | Grazing                               | 50        |
| PCM_0015  | Wallow                                | 10        |
| PCM_0015  | Flood                                 | 500       |
| PCM_0015  | Soil Disturbance                      | 250       |
| PCM_0016  | Animal Trail                          | 50        |
| PCM_0016  | Grazing                               | 500       |
| PCM_0016  | Wallow                                | 20        |
| PCM_0016  | Prairie Dog                           | 110       |
| PCM_0016  | Soil Disturbance                      | 65        |
| PCM_0017  | Grazing                               | 1000      |
| PCM_0017  | Wallow                                | 3         |
| PCM_0017  | Prairie Dog                           | 1000      |
| PCM_0017  | Soil Disturbance                      | 35        |
| PCM_0018  | Grazing                               | 850       |
| PCM_0018  | Wallow                                | 6         |
| PCM_0018  | Prairie Dog                           | 25        |
| PCM_0018  | Soil Disturbance                      | 28        |
| PCM_0019  | Animal Trail                          | 3         |
| PCM_0019  | Wallow                                | 10        |
| PCM_0021  | Animal Trail                          | 2         |
| PCM_0021  | Grazing                               | 20        |
| PCM_0021  | Wallow                                | 3         |
| PCM_0021  | Soil Disturbance                      | 4         |
| PCM_0022  | Grazing                               | 1         |
| PCM_0023  | Wallow                                | 4         |
| PCM_0023  | Wind (downed live tree)               | Yes       |
| PCM_0024  | Wildfire (Legion Lake Fire, Dec 2017) | Yes       |

**Table 9 (continued).** Disturbance type and area observed in 21 plots visited at Wind Cave National Park by Northern Great Plains Network and Northern Great Plains Fire in 2019. The disturbance area was approximated out of a total area of 1000 m<sup>2</sup> for PCM plots and 730 m<sup>2</sup>. When disturbance was landscape-wide, only presence was recorded as “Yes” in the Area column.

| Plot     | Disturbance Type | Area (m <sup>2</sup> ) |
|----------|------------------|------------------------|
| PCM_0025 | Grazing          | 500                    |
| PCM_0025 | Prairie Dog      | 200                    |
| PCM_0025 | Soil Disturbance | 200                    |
| PCM_0026 | Animal Trail     | 50                     |
| PCM_0026 | Wallow           | 3                      |
| PCM_0026 | Soil Disturbance | 5                      |
| PCM_0028 | Prescribed Fire  | Yes                    |
| PCM_0036 | Animal Trail     | 7                      |
| PCM_0036 | Grazing          | 2                      |
| PCM_0038 | Animal Trail     | 17                     |
| PCM_0059 | Grazing          | 2                      |
| PCM_0059 | Other            | 12                     |
| PCM_0068 | Soil Disturbance | 0.25                   |
| PCM_0090 | Animal trail     | 17                     |
| PCM_0094 | Animal Trail     | 22                     |
| PCM_0110 | Animal Trail     | 24                     |
| PCM_2057 | Small Mammal     | 1                      |

## Further Analysis

This 2019 Data Report is intended to provide a basic review of the data collected during the 2019 vegetation monitoring visits by the NGPN and NGPFire crews at Wind Cave 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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