



Plant Community Composition and Structure Monitoring at Agate Fossil Beds National Monument *2022 Data Report*

Natural Resource Data Series NPS/AGFO/NRDS—2023/1392



**ON THIS PAGE**

The Northern Great Plains Inventory and Monitoring Network visited an upland Plant Community Monitoring plot at Agate Fossil Beds National Monument, June 2022. Photograph courtesy of the National Park Service.

ON THE COVER

The Northern Great Plains Inventory and Monitoring Network visited a Riparian Community Monitoring plot along the Niobrara River at Agate Fossil Beds National Monument, August 2022. Photograph courtesy of the National Park Service.

Plant Community Composition and Structure Monitoring at Agate Fossil Beds National Monument

2022 Data Report

Natural Resource Data Series NPS/AGFO/NRDS—2023/1392

Noah W. Haeefe, Louis E. Dupret

National Park Service
Northern Great Plains Inventory & Monitoring Network
820 Columbus St.
Rapid City, SD 57701

April 2023

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

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible and technically accurate.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the [Northern Great Plains Inventory & Monitoring website](#) and the [Natural Resource Publications Management website](#). If you have difficulty accessing information in this publication, particularly if using assistive technology, please email irma@nps.gov.

Please cite this publication as:

Haefele, N. W., Dupret L. E. 2023. Plant community composition and structure monitoring at Agate Fossil Beds National Monument: 2022 data report. Natural Resource Data Series NPS/AGFO/NRDS—2023/1392. National Park Service, Fort Collins, Colorado.
<https://doi.org/10.36967/2295520>

Contents

	Page
Figures.....	iv
Tables.....	iv
Abstract.....	v
Acknowledgments.....	vi
Introduction.....	1
Methods.....	2
Sample Design.....	2
Plot Layout and Sampling.....	5
Legacy Monitoring.....	7
Data Management and Analysis.....	7
Results.....	9
Further Analysis.....	20
Literature Cited.....	21

Figures

	Page
Figure 1. Map of 17 Agate Fossil Beds National Monument plant community monitoring plots visited in 2022 by the Northern Great Plains Network Inventory & Monitoring Program and the Northern Great Plains Fire Ecology Program.....	3
Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.....	5
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.....	6
Figure 4. Plot PCM_0004 at Agate Fossil Beds National Monument had one of the highest counts of unique native plant species in 2022. Photograph courtesy of the National Park Service.	17

Tables

	Page
Table 1. Field journal for monitoring plot visits at Agate Fossil Beds National Monument in 2022.	4
Table 2. Exotic species included in the Northern Great Plains Network’s early detection and rapid response program.	6
Table 2. Exotic species included in the Northern Great Plains Network’s early detection and rapid response program.	7
Table 3. List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2022.....	10
Table 4. Total number of plant species identified in each of the 29 plots monitored at Agate Fossil Beds National Monument in 2022.	16
Table 5. Absolute percent cover of native and exotic plant species in plots monitored at Agate Fossil Beds National Monument in 2022.	17
Table 6. Disturbance types and occurrence in plant community monitoring plots visited at Agate Fossil Beds National Monument in 2022.	19

Abstract

This report presents the results of vegetation monitoring efforts in 2022 at Agate Fossil Beds National Monument (AGFO) by the Northern Great Plains Inventory and Monitoring Network (NGPN) and the Northern Great Plains Fire Ecology Program (NGPFire). This was the tenth year of combined monitoring efforts.

In 2022, crew members from NGPN visited 6 long-term plant community monitoring (PCM) plots to collect data on the upland mixed-grass prairie plant communities at AGFO. This work is part of a long-term monitoring program established to better understand the condition of the vegetation community and how it changes over time. NGPN staff collected species richness, herb-layer height, native and non-native species abundance, ground cover, and site disturbance data at each plot. The NGPFire crew visited an additional 11 PCM and Fire Plant Community Monitoring (FPCM) plots in the North Carnegie, River-North, River-Middle, and River-South Burn Units to better understand the effects of prescribed fire on vegetation. In 2012, NGPN began monitoring plots within the riparian corridor of the Niobrara River. This year, NGPN evaluated 12 riparian community monitoring (RCM) plots.

In 2022, the monitoring crews identified 130 unique plant species in 29 monitoring plots. Of these species, 29 are exotic species for the park. We observed two species, Canada thistle (*Cirsium arvense*) and musk thistle (*Carduus nutans*), that are noxious in the state of Nebraska. Pale yellow iris (*Iris pseudacorus*), an exotic species of concern for the park, was observed at 8 of the 12 RCM plots monitored. The majority of upland and riparian plots had more native than exotic absolute cover. The most commonly observed disturbance was soil disturbance.

Acknowledgments

We thank the authors of the NGPN Plant Community Monitoring Protocol, particularly A. Symstad, for outstanding guidance on data collection and reporting. Thank you to the staff at NGPN and AGFO for providing help with field work and logistical support, especially AJ Legault, A. Fowler, and I. Notte. The 2022 NGPN vegetation field crew—L. Dupret, A. Thorstensen, M. Davis, A. Kuczera, N. Haeefe, A. Checchi, and T. Bortz—and NGPFire crew—D. Swanson, I. Muirhead, M. Pahler, and L. Badertscher—collected all the data included in this report.

Introduction

Agate Fossil Beds National Monument (AGFO) was established in 1965 to protect and preserve a large concentration of ancient mammal fossils. The monument contains 2,270 acres of mixed-grass prairie intersected by riparian vegetation along the Niobrara River. Vegetation monitoring began in AGFO in 1998 by the Heartland Inventory & Monitoring Program (James 2010) and the Northern Great Plains Fire Ecology Program (NGPFire; Wienk et al. 2011). In 2010, AGFO was absorbed into the Northern Great Plains Inventory & Monitoring Network (NGPN), and in 2011, NGPN began vegetation monitoring there (Ashton et al. 2011). At that time, vegetation monitoring protocols and plot locations were adjusted to represent the entire park and to coordinate efforts with NGPFire (Symstad et al. 2012b). In 2012, NGPN began monitoring additional plots within the riparian corridor of the Niobrara River system to assess riparian condition. In this report, we provide summaries of the data collected in 2022 from 17 upland plots and 12 riparian plots. For a more in-depth data report on long-term trends of vegetation at AGFO, refer to the 2011-2015 summary report (Ashton and Davis, 2016).

Methods

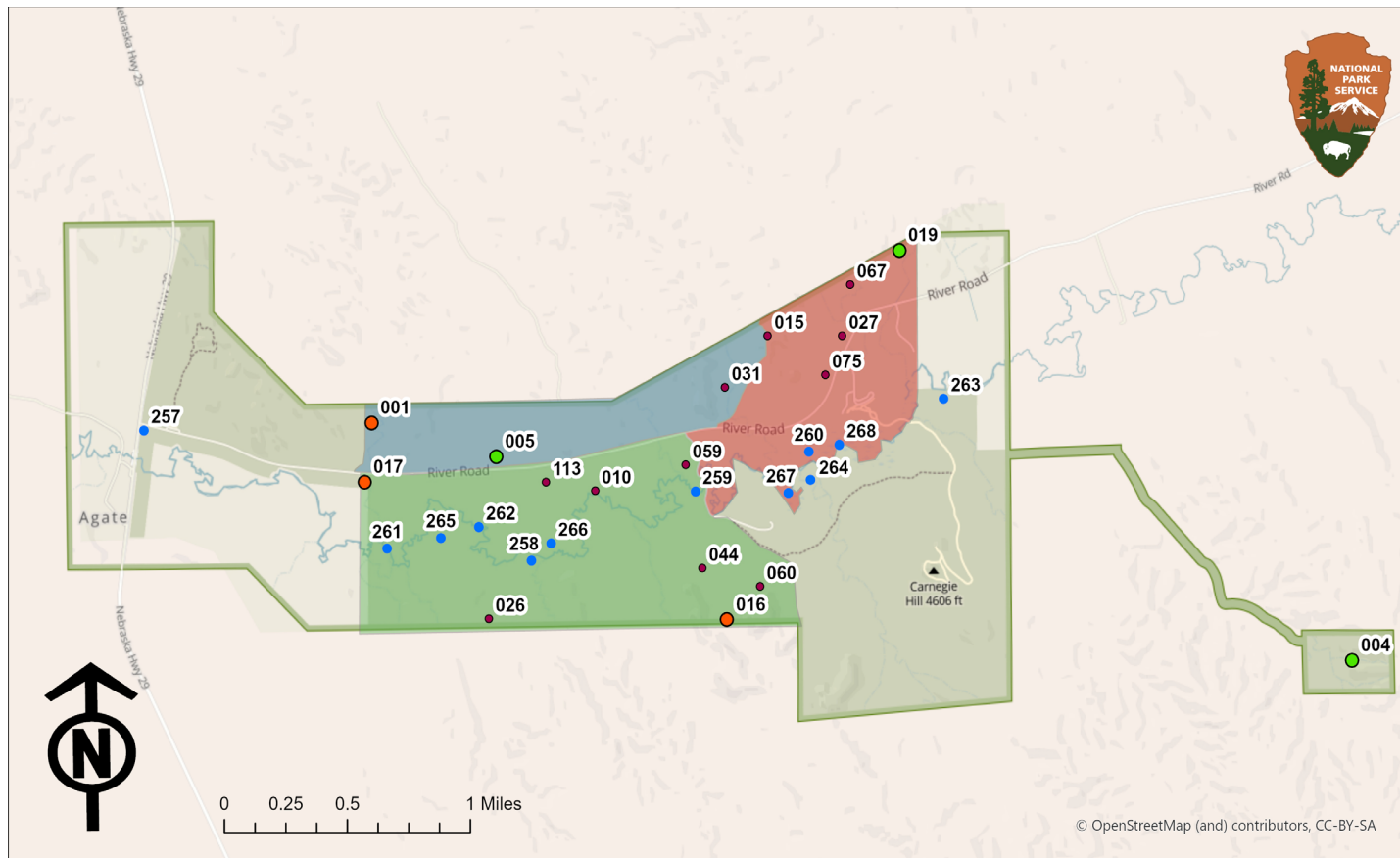
The NGPN Plant Community Composition and Structure Monitoring Protocol (Symstad et al. 2012b, a) describes in detail the methods used for sampling long-term plots. The general approach is briefly described below. For more detail, please see the monitoring protocol and standard operating procedures, available at <https://www.nps.gov/im/ngpn/plant-communities.htm>.

Sample Design

The NGPN team implemented a survey to monitor plant community structure and composition at AGFO using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003, 2004). Using a GRTS design, 15 randomly located sites were selected within the upland grasslands of AGFO to become Plant Community Monitoring plots (PCM plots). These sites were split into five panels, with three sites in each panel. An NGPN crew visits two panels in late May and early June every year, using a rotating sampling scheme that consists of half the plots visited the previous year, and the remaining plots having been visited five years prior. Data from these randomly selected sites can be used to estimate the condition of vegetation communities for the whole park and to discern trends in condition over time. A similar GRTS design was used to select 17 additional plots that fell within the riparian zone along the Niobrara River, called riparian community monitoring (RCM) plots. Additional data is collected at five legacy plant community monitoring (LPCM) sites using a protocol carried over from the Heartland Inventory and Monitoring Network. The five LPCM plots, installed in 1998, are concentrated in the southeast corner of the park and represent a portion of a long-term effort to monitor native grasslands after the installation of the Fossil Hills trail.

In late May/early June 2022, the NGPN crew visited a total of 6 sites in panels 1 and 2 (Figure 1). Sampling was completed by two NGPN crews over three days (Table 1). In August, the NGPN crew made another visit to AGFO to collect data at 12 RCM plots (Figure 1). RCM sampling was completed by two crews of three to four people over two days (Table 1). Monitoring crews lodged at AGFO in park housing while completing PCM and RCM plots.

The NGPFire crew has also established monitoring sites using the same GRTS design, but those plot locations are not randomly selected. Rather, they are focused on active burn units. As part of the prescribed fire program at AGFO, the River North Unit was burned April 26, 2022, the River-South and the River-Middle Units were burned April 29, 2019, and the Carnegie Unit was burned October 16, 2019. In 2022, the NGPFire crew visited 3 sites in the River-South Unit, 3 sites in the River-Middle Unit, 3 sites in the River-North Unit, and 4 sites in the North Carnegie Unit.



Agate Fossil Beds National Monument Harrison, NE 69346

Northern Great Plains Inventory and Monitoring Network
National Park Service
11/21/2022

2022 Plant Community Monitoring

- Plant Community Plot Panel 1
- Plant Community Plot Panel 2
- Riparian Plant Community Plot
- Fire Effects Monitoring Plot

Burn Unit

- Carnegie North
- River North
- River South Middle

Figure 1. Map of 17 Agate Fossil Beds National Monument plant community monitoring plots visited in 2022 by the Northern Great Plains Network Inventory & Monitoring Program and the Northern Great Plains Fire Ecology Program. An additional 12 riparian plant community plots were read by the Northern Great Plains Network Inventory & Monitoring Program (dark blue).

Table 1. Field journal for monitoring plot visits at Agate Fossil Beds National Monument in 2022. A total of 29 plots were visited by the Northern Great Plains Inventory & Monitoring (NGPN) and Fire Ecology (NGPFire) Programs. Plots were visited by NGPN unless otherwise noted.

Date(s) Visited	Plot Name	Field Notes
5/26/2022	PCM_0001	–
6/1/2022	PCM_0004	–
5/31/2022	PCM_0005	–
6/2/2022	PCM_0010	River Middle Burn Unit, visited by NGPFire
5/6/2022, 6/2/2022	PCM_0015	River North Burn Unit, visited by NGPFire
6/1/2022	PCM_0016	–
5/26/2022	PCM_0017	–
5/6/2022, 5/31/2022, 6/2/2022	PCM_0019	North Carnegie Burn Unit, visited by NGPFire (5/6, 6/2) and NGPN (5/31)
6/3/2022	PCM_0026	River South burn Unit, visited by NGPFire
5/6/2022, 6/2/2022	PCM_0027	North Carnegie Burn Unit, visited by NGPFire
5/6/2022, 6/2/2022	FPCM_0031	River North Burn Unit, visited by NGPFire
6/3/2022	FPCM_0044	River South burn Unit, visited by NGPFire
6/3/2022	FPCM_0059	River Middle Burn Unit, visited by NGPFire
6/3/2022	FPCM_0060	River South burn Unit, visited by NGPFire
5/6/2022, 6/2/2022	FPCM_0067	North Carnegie Burn Unit, visited by NGPFire
5/6/2022, 6/2/2022	FPCM_0075	North Carnegie Burn Unit, visited by NGPFire
6/2/2022	FPCM_0113	River Middle Burn Unit, visited by NGPFire
8/15/2022	RCM_0257	–
8/16/2022	RCM_0258	–
8/15/2022	RCM_0259	–
8/16/2022	RCM_0260	–
8/17/2022	RCM_0261	–
8/17/2022	RCM_0262	–
8/17/2022	RCM_0263	–
8/16/2022	RCM_0264	–
8/17/2022	RCM_0265	–
8/16/2022	RCM_0266	–
8/16/2022	RCM_0267	–
8/17/2022	RCM_0268	–

Plot Layout and Sampling

At each site visited, the NGPN crew recorded plant species cover and frequency in a rectangular, 50 m x 20 m (0.1 ha), permanent plot (Figure 2). Data on ground cover, herb-layer height (≤ 2 m), and plant cover were collected on two 50 m transects (the long sides of the plot) using a point-intercept method (Figure 3). Species richness data from the point-intercept method were supplemented with species presence data collected in five 1 m² quadrats located systematically along each transect (Figure 2). If a plant species was identified in the plot but was not included on the verified park species list, a voucher plant specimen was collected when possible and submitted to a botanist for independent verification. NGPFire collected point-intercept data at all plots they visited but did not collect species presence data from the quadrats.

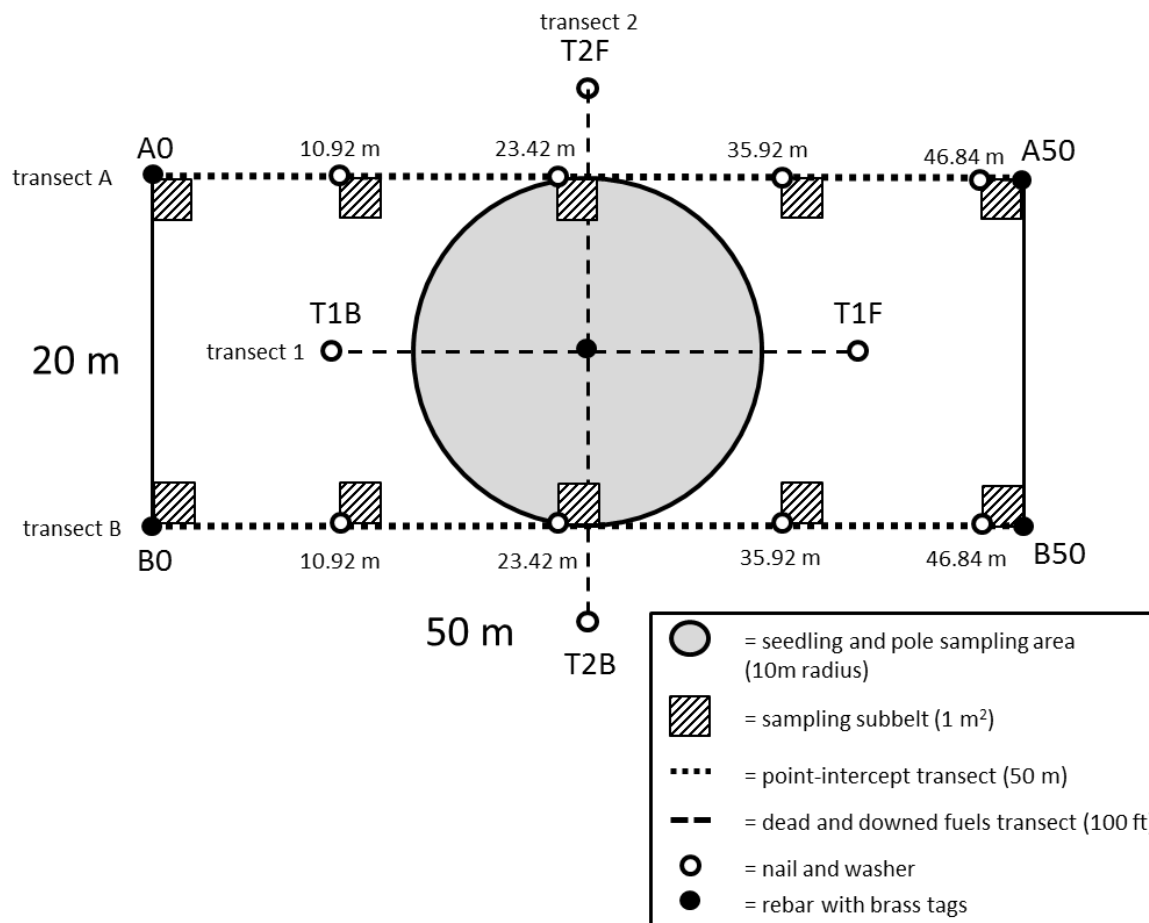


Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.

NGPN monitored riparian plant communities in AGFO in riparian plant community monitoring (RCM) plots. At RCM plots, vegetation was measured using the point-intercept method as described above, along a single 50 m transect that ran perpendicular to the river channel. These plots are not permanently marked and are relocated using GPS coordinates.

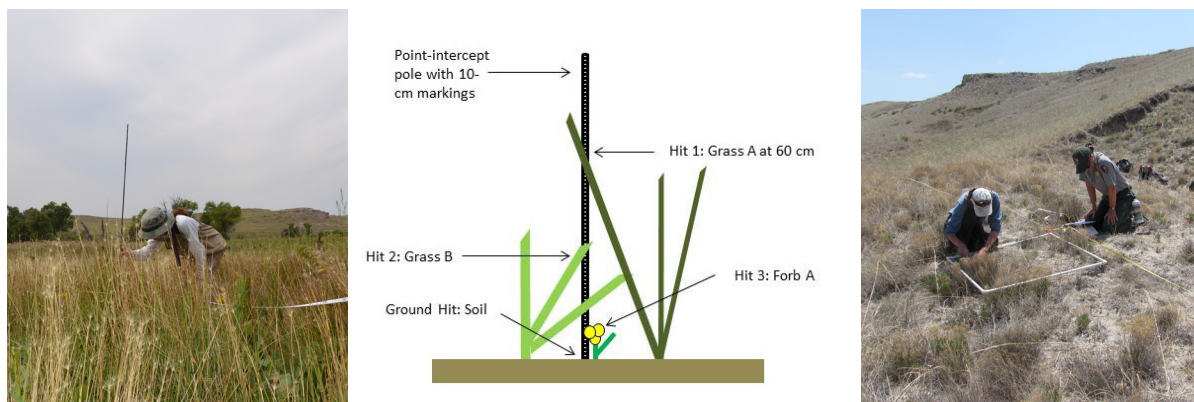


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

Common disturbances were assessed and documented at each plot. The type of disturbance, such as animal trails, erosion, or prairie dogs was recorded, and the area of the disturbance was estimated in m^2 . For some large-scale disturbances like fire, the disturbance was recorded as either present or absent. Plots were also assessed for the presence and abundance of target exotic species (Table 2), which is critical for early detection and rapid response to exotic species threats. These species were chosen in collaboration with the Midwest Invasive Plant Network, Northern Great Plains Invasive Plant Management Team, park managers, and local weed experts. Each target species was assigned an abundance class from 1–5, based on an ocular estimate of cover, where 1 = one individual, 2 = few individuals, 3 = cover of 1–5%, 4 = cover of 5–25%, and 5 = cover > 25% of the plot.

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

Habitat	Scientific Name	Common Name
Riparian	<i>Heracleum mantegazzianum</i>	giant hogweed
Riparian	<i>Alliaria petiolata</i>	garlic mustard
Riparian	<i>Lepidium latifolium</i>	perennial pepperweed
Riparian	<i>Pueraria montana</i> var. <i>lobata</i>	kudzu
Riparian	<i>Myriophyllum spicatum</i>	Eurasian Watermilfoil
Riparian	<i>Iris pseudacorus</i>	yellow iris
Riparian	<i>Arundo donax</i>	giant reed
Riparian	<i>Polygonum cuspidatum</i> ; <i>P. sachalinense</i> ; <i>P. x bohemicum</i>	knotweeds
Riparian	<i>Rhamnus cathartica</i>	common buckthorn
Riparian	<i>Ailanthus altissima</i>	tree of heaven
Upland	<i>Falcaria vulgaris</i>	Sickle Weed
Upland	<i>Pastinaca sativa</i>	Wild Parsnip
Upland	<i>Acroptilon repens</i>	Russian Knapweed

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

Habitat	Scientific Name	Common Name
Upland	<i>Centaurea solstitialis</i>	yellow star thistle
Upland	<i>Centaurea virgata</i> ; <i>C. diffusa</i> ; <i>C. jacea</i>	knapweeds
Upland	<i>Chondrilla juncea</i>	rush skeletonweed
Upland	<i>Hieracium aurantiacum</i> ; <i>H. caespitosum</i> ; <i>H. piloselloides</i>	orange, meadow, and tall hawkweed
Upland	<i>Senecio jacobaeae</i>	Tansy Ragwort
Upland	<i>Isatis tinctoria</i>	Dyer's woad
Upland	<i>Gypsophila paniculata</i>	baby's breath
Upland	<i>Dipsacus fullonum</i> & <i>D. laciniatus</i>	common teasel
Upland	<i>Euphorbia myrsinites</i> & <i>E. cyparissias</i>	myrtle spurge
Upland	<i>Salvia aethiopis</i> ; <i>S. pratensis</i>	Mediterranean and Meadow sage
Upland	<i>Lythrum salicaria</i>	Purple Loosestrife
Upland	<i>Taeniatherum caput-medusae</i>	medusahead
Upland	<i>Ventenata dubia</i>	African wiregrass
Upland	<i>Ranunculus acris</i>	Tall Buttercup
Upland	<i>Linaria dalmatica</i> ; <i>L. vulgaris</i>	toadflax
Upland	<i>Thymelaea passerina</i>	Spurge Flax

Legacy Monitoring

At each Legacy Plant Community Monitoring plot, point-intercept, disturbance, and target species data were collected as described above. The five plots chosen represent native mixed-grass prairie (LPCM_4 and 5) and an area within the same management unit impacted by construction of a paved trail (LPCM_2, 3 and 7). No data was collected at Legacy Plant Community Monitoring plots in 2022.

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 2022). However, nomenclature follows the [Integrated Taxonomic Information System](#) (ITIS). In the few cases where ITIS recognized a new name that was not in the USDA PLANTS database, the new name was used, and a unique plant code was assigned.

After data were entered in the database, 100% of records were verified with the original data sheets to minimize transcription errors, followed by a 10% review of records to confirm accuracy.

Automated queries were used to check for any remaining errors in the data. When errors were identified by the crew or the automated queries, corrections were made to the original datasheets and the FFI database.

Data summaries were produced using the FFI reporting and query tools and R software (R version 4.2.1). The number of species encountered in each plot was calculated using data from point-intercept, quadrat, 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 AGFO in 2022 was determined by cross-referencing with the [NatureServe](#) conservation status list, as well as the Nebraska rare plant species lists. For this report, a species is considered rare or of conservation concern if its global (G) or state (S) conservation status rank is classified as critically imperiled (G1/S1), imperiled (G2/S2), or vulnerable (G3/S3). The 2022 species list was also cross-referenced with the list of state noxious weeds maintained by the [Nebraska Department of Agriculture](#).

Results

There are 363 vascular plant species on the AGFO species list, and NGPN and NGPFire monitoring crews identified a total of 130 species from 29 monitoring plots in 2022 (Table 3). Of these species, 29 are exotic species for the park. The 2022 species list was cross-referenced with state rare and noxious species lists. We observed two species, Canada thistle (*Cirsium arvense*) and musk thistle (*Carduus nutans*), that are noxious in the state of Nebraska. We identified two rare plant species in AGFO monitoring plots in 2022 (Table 4). One of these, slender wheatgrass (*Elymus trachycaulus*) is critically imperiled (S1) in Nebraska; however, only one subspecies of slender wheatgrass (*Elymus trachycaulus* var. *andinus*) is considered rare. Since our monitoring protocols are to only identify plants to the species level, it is possible, but unlikely, that the rare subspecies occurs in SCBL. A second species, spotted fritillary (*Fritillaria atropurpurea*), is ranked as imperiled (S2). All rare species observed are classified as secure (G5) at the global scale but are rare in the state because they exist on the edge of their global range in Nebraska. All the species we detected are on the AGFO species list.

Table 3. List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2022. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. State rare species are designated in the notes column with their state and global classification.

Family	Symbol	Scientific Name	Common Name	Notes
Agavaceae	YUGL	<i>Yucca glauca</i>	soapweed yucca	–
Apiaceae	LOOR	<i>Lomatium orientale</i>	Northern Idaho biscuitroot	–
Apiaceae	MUTE3	<i>Musineon tenuifolium</i>	slender wildparsley	–
Asclepiadaceae	ASSP	<i>Asclepias speciosa</i>	showy milkweed	–
Asteraceae	AMPS	<i>Ambrosia psilostachya</i>	Cuman ragweed	–
Asteraceae	ARDR4	<i>Artemisia dracunculus</i>	tarragon	–
Asteraceae	ARFR4	<i>Artemisia frigida</i>	fringed sagewort	–
Asteraceae	BIFR	<i>Bidens frondosa</i>	devil's beggartick	–
Asteraceae	CANU4	<i>Carduus nutans</i>	nodding plumeless thistle	Exotic; Noxious
Asteraceae	CIAR4	<i>Cirsium arvense</i>	Canada thistle	Exotic; Noxious
Asteraceae	CIFL	<i>Cirsium flodmanii</i>	Flodman's thistle	–
Asteraceae	CIRSI	<i>Cirsium</i>	thistle	Exotic
Asteraceae	COCA5	<i>Conyza canadensis</i>	horseweed	–
Asteraceae	CYXA	<i>Cyclachaena xanthifolia</i>	giant sumpweed	–
Asteraceae	HEAN3	<i>Helianthus annuus</i>	common sunflower	–
Asteraceae	HELIA3	<i>Helianthus</i>	sunflower	–
Asteraceae	LASE	<i>Lactuca serriola</i>	prickly lettuce	Exotic
Asteraceae	LYJU	<i>Lygodesmia juncea</i>	rush skeletonplant	–
Asteraceae	MUOB99	<i>Mulgedium oblongifolium</i>	blue lettuce	–
Asteraceae	SERI2	<i>Senecio riddellii</i>	Riddell's ragwort	–
Asteraceae	SOAR2	<i>Sonchus arvensis</i>	field sowthistle	Exotic
Asteraceae	SOCA6	<i>Solidago canadensis</i>	Canada goldenrod	–
Asteraceae	SOGI	<i>Solidago gigantea</i>	giant goldenrod	–

Table 3 (continued). List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2022. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. State rare species are designated in the notes column with their state and global classification.

Family	Symbol	Scientific Name	Common Name	Notes
Asteraceae	SOMO	<i>Solidago mollis</i>	velvety goldenrod	–
Asteraceae	SYER	<i>Symphyotrichum ericoides</i>	white heath aster	–
Asteraceae	SYLA6	<i>Symphyotrichum lanceolatum</i>	white panicle aster	–
Asteraceae	SYMPH4	<i>Symphyotrichum</i>	aster	–
Asteraceae	TAOF	<i>Taraxacum officinale</i>	common dandelion	Exotic
Asteraceae	TRDU	<i>Tragopogon dubius</i>	yellow salsify	Exotic
Boraginaceae	LAOC3	<i>Lappula occidentalis</i>	flatspine stickseed	–
Boraginaceae	LIIN2	<i>Lithospermum incisum</i>	narrowleaf stoneseed	–
Brassicaceae	ALDE	<i>Alyssum desertorum</i>	desert madwort	Exotic
Brassicaceae	BOHO99	<i>Boechera holboellii</i>	Holboell's rockcress	–
Brassicaceae	CAMI2	<i>Camelina microcarpa</i>	littlepod false flax	Exotic
Brassicaceae	DEPI	<i>Descurainia pinnata</i>	western tansymustard	–
Brassicaceae	DESO2	<i>Descurainia sophia</i>	herb sophia	Exotic
Brassicaceae	DRRE2	<i>Draba reptans</i>	Carolina draba	–
Brassicaceae	LEDE	<i>Lepidium densiflorum</i>	common pepperweed	–
Brassicaceae	SIAL2	<i>Sisymbrium altissimum</i>	tall tumbled mustard	Exotic
Cactaceae	OPFR	<i>Opuntia fragilis</i>	brittle pricklypear	–
Caryophyllaceae	PADE4	<i>Paronychia depressa</i>	spreading nailwort	–
Chenopodiaceae	ATMI2	<i>Atriplex micrantha</i>	twoscale saltbush	Exotic
Chenopodiaceae	CHENO	<i>Chenopodium</i>	goosefoot	Exotic
Chenopodiaceae	CHPR5	<i>Chenopodium pratericola</i>	desert goosefoot	–
Chenopodiaceae	KOSC	<i>Kochia scoparia</i>	burningbush; kochia	Exotic
Chenopodiaceae	KRLA2	<i>Krascheninnikovia lanata</i>	winterfat	–

Table 3 (continued). List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2022. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. State rare species are designated in the notes column with their state and global classification.

Family	Symbol	Scientific Name	Common Name	Notes
Chenopodiaceae	SALSO	<i>Salsola</i>	Russian thistle	Exotic
Chenopodiaceae	SATR12	<i>Salsola tragus</i>	prickly Russian thistle	Exotic
Commelinaceae	TROC	<i>Tradescantia occidentalis</i>	prairie spiderwort	–
Cyperaceae	CADU6	<i>Carex duriuscula</i>	needleleaf sedge	–
Cyperaceae	CAFI	<i>Carex filifolia</i>	threadleaf sedge	–
Cyperaceae	CANE2	<i>Carex nebrascensis</i>	Nebraska sedge	–
Cyperaceae	CAPE42	<i>Carex pellita</i>	woolly sedge	–
Cyperaceae	CAPR5	<i>Carex praegracilis</i>	clustered field sedge	–
Cyperaceae	CAREX	<i>Carex</i>	sedge	–
Cyperaceae	ELER	<i>Eleocharis erythropoda</i>	bald spikerush	–
Cyperaceae	SCPU10	<i>Schoenoplectus pungens</i>	common threesquare	–
Cyperaceae	SCTA2	<i>Schoenoplectus tabernaemontani</i>	softstem bulrush	–
Equisetaceae	EQLA	<i>Equisetum laevigatum</i>	smooth horsetail	–
Euphorbiaceae	CRTE4	<i>Croton texensis</i>	Texas croton	–
Fabaceae	ASCE	<i>Astragalus ceramicus</i>	painted milkvetch	–
Fabaceae	DACA7	<i>Dalea candida</i>	white prairie clover	–
Fabaceae	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	–
Fabaceae	LAPO2	<i>Lathyrus polymorphus</i>	manystem pea	–
Fabaceae	LUPIN	<i>Lupinus</i>	lupine	–
Fabaceae	LUPL	<i>Lupinus plattensis</i>	Nebraska lupine	–
Fabaceae	LUPU	<i>Lupinus pusillus</i>	rusty lupine	–
Fabaceae	MEOF	<i>Melilotus officinalis</i>	yellow sweetclover	Exotic
Fabaceae	MESA	<i>Medicago sativa</i>	alfalfa	Exotic

Table 3 (continued). List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2022. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. State rare species are designated in the notes column with their state and global classification.

Family	Symbol	Scientific Name	Common Name	Notes
Fabaceae	THRH	<i>Thermopsis rhombifolia</i>	golden pea	–
Grossulariaceae	RIAM2	<i>Ribes americanum</i>	American black currant	–
Hydrophyllaceae	ELNY	<i>Ellisia nyctelea</i>	Aunt Lucy	–
Iridaceae	IRPS	<i>Iris pseudacorus</i>	pale yellow iris	Exotic
Juncaceae	JUBA	<i>Juncus balticus</i>	Baltic rush	–
Lamiaceae	LYAM	<i>Lycopus americanus</i>	American water horehound; American bugleweed	–
Lamiaceae	LYAS	<i>Lycopus asper</i>	rough bugleweed	–
Lamiaceae	MEAR4	<i>Mentha arvensis</i>	wild mint	–
Lemnaceae	LEMI3	<i>Lemna minor</i>	common duckweed	–
Liliaceae	ALTE	<i>Allium textile</i>	textile onion	–
Liliaceae	FRAT	<i>Fritillaria atropurpurea</i>	spotted fritillary	Rare: S2/G5
Loasaceae	MEDE2	<i>Mentzelia decapetala</i>	tenpetal blazingstar	–
Malvaceae	SPCO	<i>Sphaeralcea coccinea</i>	scarlet globemallow	–
Melanthiaceae	TOVE2	<i>Toxicoscordion venenosum</i>	meadow deathcamas	–
Onagraceae	OENOT	<i>Oenothera</i>	evening primrose	–
Onagraceae	OESU99	<i>Oenothera suffrutescens</i>	scarlet beeblossom	–
Papaveraceae	ARPO2	<i>Argemone polyanthemos</i>	crested pricklypoppy	–
Poaceae	ACHY	<i>Achnatherum hymenoides</i>	Indian ricegrass	–
Poaceae	AGCR	<i>Agropyron cristatum</i>	crested wheatgrass	Exotic
Poaceae	AGGI2	<i>Agrostis gigantea</i>	redtop	Exotic
Poaceae	BOGR2	<i>Bouteloua gracilis</i>	blue grama	–
Poaceae	BRJA	<i>Bromus japonicus</i>	Japanese brome	Exotic

Table 3 (continued). List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2022. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. State rare species are designated in the notes column with their state and global classification.

Family	Symbol	Scientific Name	Common Name	Notes
Poaceae	BRTE	<i>Bromus tectorum</i>	cheatgrass	Exotic
Poaceae	CALO	<i>Calamovilfa longifolia</i>	prairie sandreed	–
Poaceae	CAST36	<i>Calamagrostis stricta</i>	slimstem reedgrass	–
Poaceae	DISP	<i>Distichlis spicata</i>	saltgrass	–
Poaceae	ELLA3	<i>Elymus lanceolatus</i>	thickspike wheatgrass	–
Poaceae	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	S1
Poaceae	ELYMU	<i>Elymus</i>	wildrye	Exotic
Poaceae	HECO26	<i>Hesperostipa comata</i>	needle and thread	–
Poaceae	HOJU	<i>Hordeum jubatum</i>	foxtail barley	–
Poaceae	LEOR	<i>Leersia oryzoides</i>	rice cutgrass	–
Poaceae	MUAS	<i>Muhlenbergia asperifolia</i>	scratchgrass; alkali muhly	–
Poaceae	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	–
Poaceae	PHAR3	<i>Phalaris arundinacea</i>	reed canarygrass	–
Poaceae	POCO	<i>Poa compressa</i>	Canada bluegrass	Exotic
Poaceae	POPR	<i>Poa pratensis</i>	Kentucky bluegrass	Exotic
Poaceae	POSE	<i>Poa secunda</i>	Sandberg bluegrass	–
Poaceae	SCSC	<i>Schizachyrium scoparium</i>	little bluestem	–
Poaceae	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	–
Poaceae	SPGR	<i>Spartina gracilis</i>	alkali cordgrass	–
Poaceae	SPOB	<i>Sphenopholis obtusata</i>	prairie wedgescale	–
Poaceae	SPPE	<i>Spartina pectinata</i>	prairie cordgrass	–
Poaceae	VUOC	<i>Vulpia octoflora</i>	sixweeks fescue	–
Polemoniaceae	PHAN4	<i>Phlox andicola</i>	prairie phlox	–

Table 3 (continued). List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2022. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. State rare species are designated in the notes column with their state and global classification.

Family	Symbol	Scientific Name	Common Name	Notes
Polemoniaceae	PHHO	<i>Phlox hoodii</i>	spiny phlox	–
Polygonaceae	ERAN4	<i>Eriogonum annuum</i>	annual buckwheat	–
Polygonaceae	ERFL4	<i>Eriogonum flavum</i>	alpine golden buckwheat	–
Polygonaceae	PEAM8	<i>Persicaria amphibia</i>	longroot smartweed	–
Polygonaceae	RUVE2	<i>Rumex venosus</i>	veiny dock	–
Rosaceae	ROWO	<i>Rosa woodsii</i>	Woods' rose	–
Rubiaceae	GATI	<i>Galium tinctorium</i>	stiff marsh bedstraw	–
Salicaceae	SAIN3	<i>Salix interior</i>	sandbar willow	–
Solanaceae	PHH18	<i>Physalis hispida</i>	prairie groundcherry	–
Solanaceae	PHVI5	<i>Physalis virginiana</i>	Virginia groundcherry	–
Typhaceae	TYAN	<i>Typha angustifolia</i>	narrowleaf cattail	–
Typhaceae	TYLA	<i>Typha latifolia</i>	broadleaf cattail	–
Urticaceae	PAPE5	<i>Parietaria pensylvanica</i>	Pennsylvania pellitory	–
Urticaceae	URDI	<i>Urtica dioica</i>	stinging nettle	–
Verbenaceae	VEHA2	<i>Verbena hastata</i>	swamp verbena	–
Violaceae	VINU2	<i>Viola nuttallii</i>	Nuttall's violet; yellow prairie violet	–

Table 4. Total number of plant species identified in each of the 29 plots monitored at Agate Fossil Beds National Monument in 2022. This is a count of all unique species identified in the plot using species data from point-intercept, quadrat, and target species protocols. Note that quadrat data was not collected from the plots visited by NGPFire (FPCM plots), or any of the RCM plots, resulting in a lower species count.

Plot	Exotic Species	Native Species	Total Species
AGFO_PCM_0001	6	21	27
AGFO_PCM_0004	8	28	36
AGFO_PCM_0005	9	17	26
AGFO_PCM_0010	12	15	27
AGFO_PCM_0015	0	10	10
AGFO_PCM_0016	7	24	31
AGFO_PCM_0017	8	28	36
AGFO_PCM_0019	6	15	21
AGFO_PCM_0026	0	10	10
AGFO_PCM_0027	4	11	15
AGFO_RCM_0257	1	7	8
AGFO_RCM_0258	5	13	18
AGFO_RCM_0259	3	13	16
AGFO_RCM_0260	5	9	14
AGFO_RCM_0261	6	19	25
AGFO_RCM_0262	1	12	13
AGFO_RCM_0263	2	7	9
AGFO_RCM_0264	6	9	15
AGFO_RCM_0265	5	6	11
AGFO_RCM_0266	5	11	16
AGFO_RCM_0267	5	16	21
AGFO_RCM_0268	1	4	5
AGFO_FPCM_0031	0	7	7
AGFO_FPCM_0044	6	9	15
AGFO_FPCM_0059	7	11	18
AGFO_FPCM_0060	1	13	14
AGFO_FPCM_0067	2	10	12
AGFO_FPCM_0075	5	3	8
AGFO_FPCM_0113	6	11	17

Based on the total count of unique species observed in each plot in 2022, PCM_0004 and PCM_0017 had the highest number with 36 total species, 28 of which were native (Table 4; Figure 4). Absolute cover calculations (Table 5) showed that upland plots were mostly dominated by native species, with few plots being dominated by exotic species. Riparian plots were mostly dominated by native species. The plant cover was entirely native at three plots, PCM_0015, PCM_0026 and FPCM_0031.

Plot PCM_0016 had the highest absolute cover of native species (100%), and plot PCM_0005 had the highest absolute cover of exotic species (117%). Pale yellow iris (*Iris pseudacorus*), an exotic species of concern for the park, was observed at 8 of the 12 RCM plots monitored. It was most abundant in RCM_0259 at 27% absolute cover (Table 5).



Figure 4. Plot PCM_0004 at Agate Fossil Beds National Monument had one of the highest counts of unique native plant species in 2022. Photograph courtesy of the National Park Service.

Table 5. Absolute percent cover of native and exotic plant species in plots monitored at Agate Fossil Beds National Monument in 2022. Absolute percent cover is calculated using the point-intercept data. This includes overlapping species canopies, which can result in values greater than 100%.

Plot	Absolute % Exotic Cover	Absolute % Native Cover	Absolute % Cover of <i>Iris pseudacorus</i>
AGFO_FPCM_0031	0	71	—
AGFO_FPCM_0044	10	85	—
AGFO_FPCM_0059	55	56	—
AGFO_FPCM_0060	1	89	—

Table 5 (continued). Absolute percent cover of native and exotic plant species in plots monitored at Agate Fossil Beds National Monument in 2022. Absolute percent cover is calculated using the point-intercept data. This includes overlapping species canopies, which can result in values greater than 100%.

Plot	Absolute % Exotic Cover	Absolute % Native Cover	Absolute % Cover of <i>Iris pseudacorus</i>
AGFO_FPCM_0067	20	75	–
AGFO_FPCM_0075	78	12	–
AGFO_FPCM_0113	69	60	–
AGFO_PCM_0001	12	57	–
AGFO_PCM_0004	15	80	–
AGFO_PCM_0005	117	30	–
AGFO_PCM_0010	75	56	–
AGFO_PCM_0010	74	57	–
AGFO_PCM_0015	0	74	–
AGFO_PCM_0016	27	100	–
AGFO_PCM_0017	22	49	–
AGFO_PCM_0019	17	90	–
AGFO_PCM_0019	13	71	–
AGFO_PCM_0026	0	74	–
AGFO_PCM_0027	66	23	–
AGFO_RCM_0257	1	68	–
AGFO_RCM_0258	14	68	2
AGFO_RCM_0259	47	62	27
AGFO_RCM_0260	65	73	1
AGFO_RCM_0261	37	87	6
AGFO_RCM_0262	22	95	21
AGFO_RCM_0263	16	61	–
AGFO_RCM_0264	72	73	–
AGFO_RCM_0265	45	58	–
AGFO_RCM_0266	33	64	<1
AGFO_RCM_0267	39	67	2
AGFO_RCM_0268	10	57	9

Disturbances were observed at 15 plots in 2022 (Table 6). The most observed disturbance was soil disturbance.

Table 6. Disturbance types and occurrence in plant community monitoring plots visited at Agate Fossil Beds National Monument in 2022. Disturbances with a large area of effect may simply be marked as “Present”.

Plot	Disturbance Type	Comment	Area (m²)
AGFO_FPCM_0059	Soil Disturbance	Mounds	140
AGFO_PCM_0001	Soil Disturbance	–	250
AGFO_PCM_0019	Fire	–	Present
AGFO_PCM_0019	Small Mammal	–	40
AGFO_PCM_0019	Soil Disturbance	–	150
AGFO_PCM_0019	Soil Disturbance	Mounds	25.5
AGFO_FPCM_0075	Soil Disturbance	Mounds	45
AGFO_PCM_0027	Soil Disturbance	Mounds	26
AGFO_FPCM_0044	Soil Disturbance	mounds	45
AGFO_PCM_0004	Soil Disturbance	–	40
AGFO_FPCM_0060	Soil Disturbance	Mounds	7.5
AGFO_FPCM_0031	Small Mammal	animal excavation (not prairie dog)	100
AGFO_FPCM_0031	Soil Disturbance	–	250
AGFO_PCM_0026	Soil Disturbance	Mounds	15
AGFO_PCM_0016	Small Mammal	–	15
AGFO_PCM_0016	Soil Disturbance	–	20
AGFO_FPCM_0113	Soil Disturbance	Mounds	24
AGFO_PCM_0005	Small Mammal	–	10
AGFO_PCM_0005	Soil Disturbance	–	25
AGFO_PCM_0017	Small Mammal	–	25
AGFO_PCM_0017	Soil Disturbance	–	25
AGFO_PCM_0017	Other	Crew disturbance	2
AGFO_PCM_0015	Soil Disturbance	Mounds	10

Further Analysis

This Data Report is intended to provide a basic review of the data collected during the NGPN and NGPFire monitoring team's 2022 visits to Agate Fossil Beds National Monument. All data included in this report is available upon request from the Northern Great Plains Inventory and Monitoring Network, as well as in the archives found in the [IRMA Data Store](#).

Literature Cited

- Ashton, I. W. and C. J. Davis. 2016. Plant community composition and structure monitoring for Agate Fossil Beds National Monument: 2011-2015 summary report. Natural Resource Report NPS/NGPN/NRR—2016/1198. National Park Service, Fort Collins, Colorado.
- Ashton, I., M. Prowatzke, M. Bynum, T. Shepherd, S. K. Wilson, and K. Paintner-Green. 2011. Agate Fossil Beds National Monument plant community composition and structure monitoring: 2011 annual report. Natural Resource Technical Report NPS/NGPN/NRTR—2011/518. National Park Service, Fort Collins, Colorado.
- James, K. M. 2010. Vegetation community monitoring at Agate Fossil Beds National Monument, Nebraska: 1999-2009. Natural Resource Technical Report NPS/HTLN/NRTR—2010/351. National Park Service, Fort Collins, Colorado.
- R Core Team. 2022. R: A language and environment for statistical computing. Vienna, Austria. <https://www.R-project.org>
- Stevens, D. L. and A. R. Olsen. 2003. Variance estimation for spatially balanced samples of environmental resources. *Environmetrics* 14:593-610.
- Stevens, D. L. and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. *Journal Of The American Statistical Association* 99:262-278.
- Symstad, A. J., R.A. Gitzen, C. L. Wienk, M. R. Bynum, D. J. Swanson, A. D. Thorstenson, and K. J. Paintner. 2012a. Plant community composition and structure monitoring protocol for the Northern Great Plains I&M Network-Standard Operating Procedures: version 1.01. Natural Resource Report NPS/NGPN/ NRR-2012/489.1.
- Symstad, A. J., R.A. Gitzen, C. L. Wienk, M. R. Bynum, D. J. Swanson, A. D. Thorstenson, and K. J. Paintner. 2012b. Plant community composition and structure monitoring protocol for the Northern Great Plains I&M Network: version 1.01. Natural Resource Report NPS/NGPN/ NRR-2012/489.
- USDA-NRCS. 2022. The PLANTS Database (<http://plants.usda.gov>, 31 October 2022). National Plant Data Team, Greensboro, NC USA.
- Wienk, C., A. Thorstenson, J. Freeman, and D. Swanson. 2011. Northern Great Plains Fire Ecology Program review: 1997-2007. Natural Resource Report NPS/NRDS/NRDS—2010/112. National Park Service, Fort Collins, Colorado.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 165/188062, April 2023

National Park Service
U.S. Department of the Interior



[Natural Resource Stewardship and Science](#)

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525