



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

2019 Data Report

Natural Resource Data Series NPS/AGFO/NRDS—2019/1248



**ON THIS PAGE**

The Northern Great Plains Inventory and Monitoring Network visited an upland Plant Community Monitoring plot at Agate Fossil Beds National Monument, May 2019. 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, September 2019. Photograph courtesy of the National Park Service.

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Abstract

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

In 2019, 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 8 PCM and Fire Plant Community Monitoring (FPCM) plots in the North Carnegie, 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 13 riparian community monitoring (RCM) plots.

In 2019, the monitoring crews identified 123 unique plant species in 27 monitoring plots. Of these species, 22 are exotic species for the park. We observed one species, Canada thistle (*Cirsium arvense*), that is noxious in the state of Nebraska. Pale yellow iris (*Iris pseudacorus*), an exotic species of concern for the park, was observed at 5 of the 13 RCM plots monitored. Half of the upland plots had more native than exotic absolute cover, and the majority of riparian monitoring plots had more native than exotic absolute cover. The most commonly observed disturbances were soil disturbance and small mammal activity.

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 and A. Fowler. The 2019 NGPN vegetation field crew—S. Rockwood, I. Ashton, R. Manuel, M. Davis, T. Schaffner, E. Duda, 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 2019 from 14 upland plots and 13 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

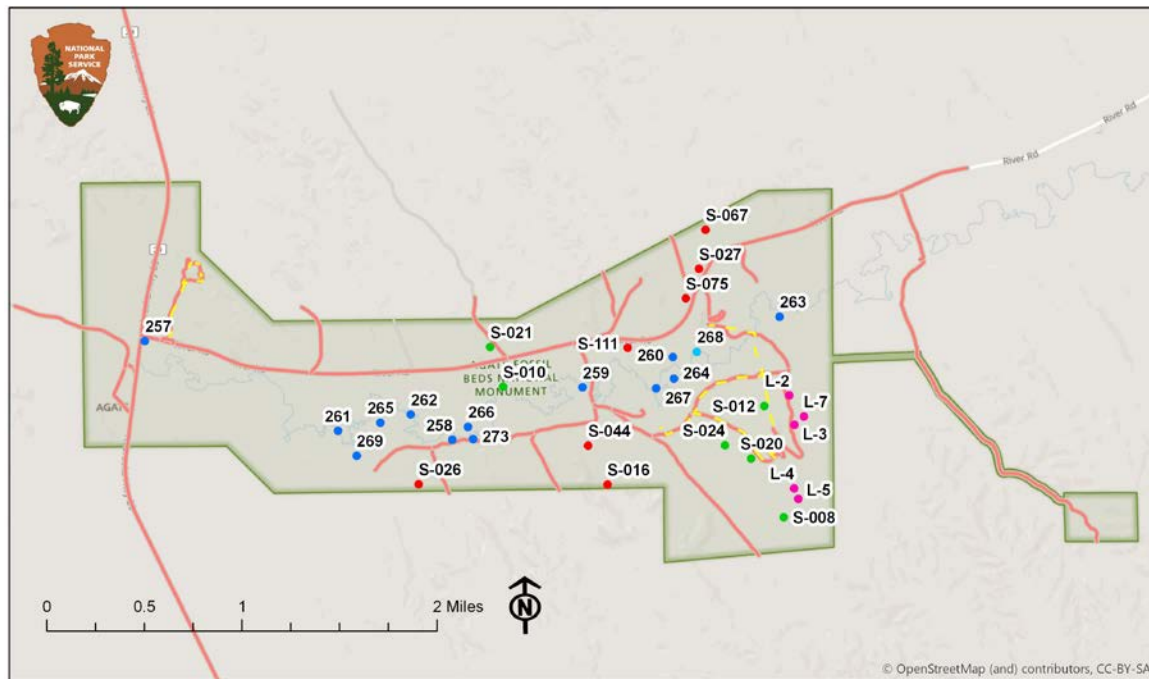
The NGPN Plant Community Composition and Structure Monitoring Protocol (Symstad et al. 2012b, a) describes in detail the methods used for sampling long-term plots. The general approach is briefly described below. For more detail, please see the monitoring protocol and standard operating procedures, available 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 May 2019, the NGPN crew visited a total of 6 sites in panels 3 and 4 (Figure 1). Sampling was completed by two NGPN crews over two days (Table 1). Late May storms covered the region in snow, making the monitoring season shorter than usual. As a result, NGPN did not visit any LPCM plots this year, nor were we able to collect quadrat data at one PCM plot (PCM_024). In early September, the NGPN crew made another visit to AGFO to collect data at 13 RCM plots (Figure 1). Data collection at one RCM plot was incomplete due to lightning storms, and a 14th plot was made dormant due to unsafe access conditions. RCM sampling was completed by three crews of two people over two days (Table 1). Monitoring crews lodged at the Cobblestone Hotel & Suites in Gering, NE while completing PCM plots, and at AGFO in park housing while completing 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 in active burn units. As part of the prescribed fire program at AGFO, the River-South and the River-Middle Units were burned September 15, 2014, and the Carnegie Unit was burned October 16, 2019. In 2019, the NGPFire crew visited 3 sites in the River-South Unit, 1 site in the River-Middle Unit, and 4 sites in the North Carnegie Unit.



Agate Fossil Beds National Monument Harrison, NE 69346

Northern Great Plains Inventory & Monitoring Network
National Park Service
11/5/2019

2019 Plant Community Monitoring

- Roads
- Trails
- NGPN Plot
- NGPFire Plot
- Riparian Plant Community Plot Visited
- Riparian Plant Community Plot Not Visited
- Legacy Plot (Not Visited)

Figure 1. Map of 14 Agate Fossil Beds National Monument plant community monitoring plots visited in 2019 by the Northern Great Plains Network Inventory & Monitoring Program (green) and the Northern Great Plains Fire Ecology Program (red). An additional 13 riparian plant community plots were read by the Northern Great Plains Network Inventory & Monitoring Program (dark blue), and one riparian plant community monitoring plot was made dormant due to unsafe access conditions (light blue). Five legacy plant community monitoring plots were not visited this year due to time and weather constraints (pink).

Table 1. Field journal for monitoring plot visits at Agate Fossil Beds National Monument in 2019. A total of 27 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 Visited	Plot Name	Field Notes
May 30, 2019	PCM_008	–
May 30, 2019	PCM_012	–
May 30, 2019	PCM_020	–
May 30, 2019	PCM_024	Quadrat data not collected due to time constraints
May 31, 2019	PCM_010	–
May 31, 2019	PCM_021	–
June 3, 2019	FPCM_044	River-South Burn Unit; visited by NGPFire
June 3, 2019	FPCM_067	North Carnegie Burn Unit; visited by NGPFire
June 3, 2019	PCM_016	River-South Burn Unit; visited by NGPFire
June 4, 2019	FPCM_075	North Carnegie Burn Unit; visited by NGPFire
June 5, 2019	FPCM_111	North Carnegie Burn Unit; visited by NGPFire
June 5, 2019	PCM_026	River-South Burn Unit; visited by NGPFire
June 7, 2019	FPCM_113	River-Middle Burn Unit; visited by NGPFire
June 7, 2019	PCM_027	North Carnegie Burn Unit; visited by NGPFire
September 10, 2019	RCM-257	–
September 10, 2019	RCM-258	–
September 10, 2019	RCM-261	Half of plot read due to lightning storms
September 10, 2019	RCM-263	–
September 10, 2019	RCM-273	–
September 11, 2019	RCM-259	–
September 11, 2019	RCM-260	–
September 11, 2019	RCM-262	–
September 11, 2019	RCM-264	–
September 11, 2019	RCM-265	–
September 11, 2019	RCM-266	–
September 11, 2019	RCM-267	–
September 11, 2019	RCM-268	Dormant. Access not safe, may be better next year.
September 11, 2019	RCM-269	–
N/A	LPCM_2	Plot not read due to time constraints
N/A	LPCM_3	Plot not read due to time constraints
N/A	LPCM_4	Plot not read due to time constraints
N/A	LPCM_5	Plot not read due to time constraints
N/A	LPCM_7	Plot not read due to time constraints

Plot Layout and Sampling

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

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.

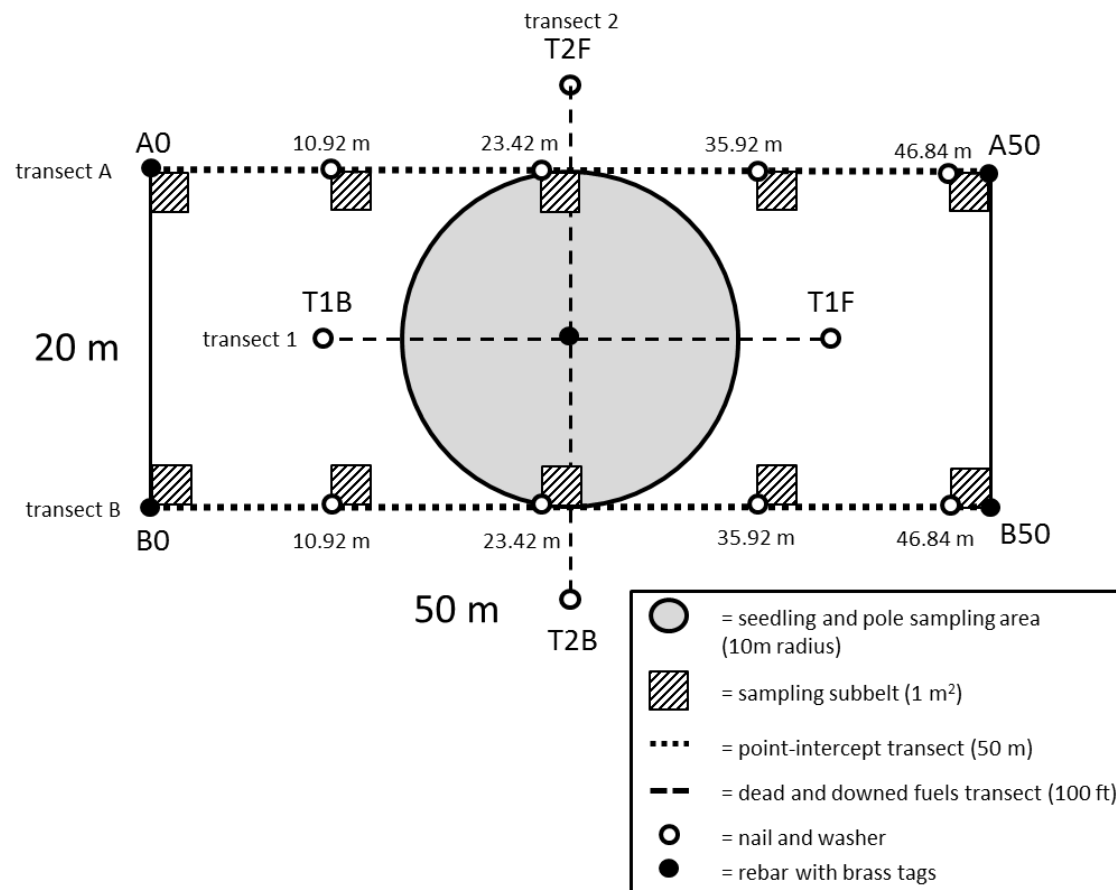


Figure 2. Long-term monitoring plot layout used for sampling vegetation used by the Northern Great Plains Inventory and Monitoring vegetation crew.

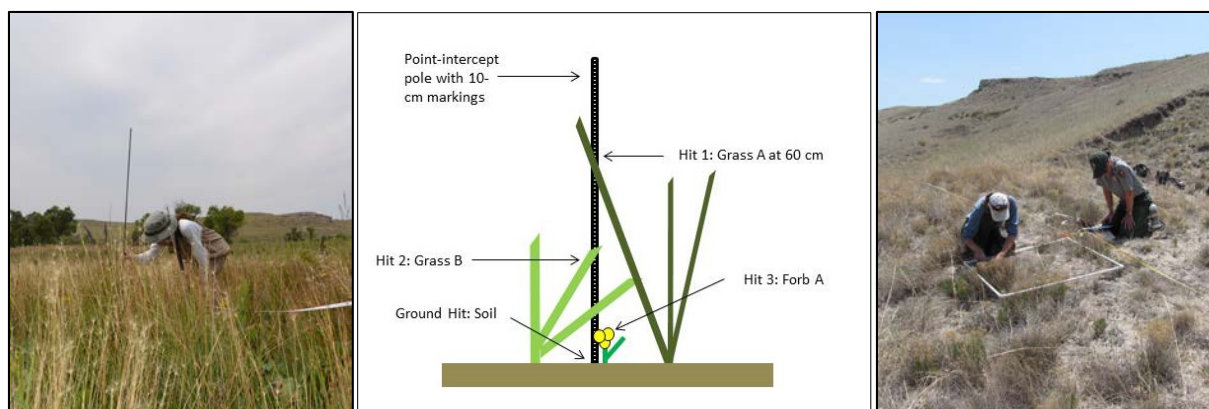


Figure 3. The Northern Great Plains Inventory & Monitoring vegetation crew used point-intercept (left and center panel) and quadrats (right panel) to document plant diversity and abundance.

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

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

Habitat	Scientific Name	Common Name
Riparian	<i>Alliaria petiolata</i>	garlic mustard
Riparian	<i>Polygonum cuspidatum</i> ; <i>P. sachalinense</i> ; <i>P. x bohemicum</i>	knotweeds
Riparian	<i>Pueraria montana</i> var. <i>lobata</i>	kudzu
Riparian	<i>Iris pseudacorus</i>	yellow iris
Riparian	<i>Ailanthus altissima</i>	tree of heaven
Riparian	<i>Lepidium latifolium</i>	perennial pepperweed
Riparian	<i>Arundo donax</i>	giant reed
Riparian	<i>Rhamnus cathartica</i>	common buckthorn
Riparian	<i>Heracleum mantegazzianum</i>	giant hogweed
Upland	<i>Centaurea solstitialis</i>	yellow star thistle
Upland	<i>Hieracium aurantiacum</i> ; <i>H. caespitosum</i>	orange and meadow hawkweed

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

Habitat	Scientific Name	Common Name
Upland	<i>Isatis tinctoria</i>	Dyer's woad
Upland	<i>Taeniatherum caput-medusae</i>	medusahead
Upland	<i>Chondrilla juncea</i>	rush skeletonweed
Upland	<i>Gypsophila paniculata</i>	baby's breath
Upland	<i>Centaurea virgata</i> ; <i>C. diffusa</i>	knapweeds
Upland	<i>Linaria dalmatica</i> ; <i>L. vulgaris</i>	toadflax
Upland	<i>Euphorbia myrsinites</i> & <i>E. cyparissias</i>	myrtle spurge
Upland	<i>Dipsacus fullonum</i> & <i>D. laciniatus</i>	common teasel
Upland	<i>Salvia aethiopis</i>	Mediterranean sage
Upland	<i>Ventenata dubia</i>	African wiregrass

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). We did not collect data at Legacy Plant Community Monitoring plots in 2019.

Data Management and Analysis

FFI (FEAT/FIREMON Integrated; <http://frames.gov/ffi/>) was the primary software environment used for managing our sampling data. FFI is used by a variety of agencies (e.g., NPS, USDA Forest Service, U.S. Fish and Wildlife Service), has a national-level support system, and generally conforms to the Natural Resource Database Template standards established by the Inventory and Monitoring Program. Species scientific names, codes, common names, and native status are from the USDA Plants Database (USDA-NRCS 2018). However, nomenclature follows the Integrated Taxonomic Information System (ITIS). In the few cases where ITIS recognized a new name that was not in the USDA PLANTS database, the new name was used, and a unique plant code was assigned.

After data were entered in the database, 100% of records were verified with the original data sheets to minimize transcription errors, followed by a 10% review of records to confirm accuracy. Automated queries were used to check for any remaining errors in the data. When errors were identified by the crew or the automated queries, corrections were made to the original datasheets and the FFI database.

Data summaries were produced using the FFI reporting and query tools and R software (R version 3.6.1). The number of species encountered in each plot was calculated using data from point-intercept, quadrat, 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 2019 was determined by cross-referencing with the [NatureServe](#) conservation status list, as well as the [Nebraska rare plant species lists](#). For the purpose of this report, a species is considered rare or of conservation concern if its global (G) or state (S) conservation status rank is classified as critically imperiled (G1/S1), imperiled (G2/S2), or vulnerable (G3/S3). The 2019 species list was also cross-referenced with the list of 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 123 species from 27 monitoring plots in 2019 (Table 3). Of these species, 22 are exotic species for the park. The 2019 species list was cross-referenced with state rare and noxious species lists. We observed one species, Canada thistle (*Cirsium arvense*), that is noxious in the state of Nebraska. In addition, we observed 1 plant species that is on the Nebraska rare species list. However, only certain subspecies or varieties of the species are rare. NGPN crews only identify plants to the species taxonomic level, so it is possible, though unlikely, that the plants we saw were rare.

Table 3. List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2019. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. Species described as “Possibly Rare” are species with subspecies or varieties that are rare. Because we only identify plants to the species level, we can’t know if the plants we saw were rare or not.

Family	Symbol	Scientific Name	Common Name	Notes
Agavaceae	YUGL	<i>Yucca glauca</i>	soapweed yucca	–
Alismataceae	ALTR7	<i>Alisma triviale</i>	northern water plantain	–
Alismataceae	SACU	<i>Sagittaria cuneata</i>	arumleaf arrowhead	–
Apiaceae	CIMA2	<i>Cicuta maculata</i>	spotted water hemlock	–
Apiaceae	LOOR	<i>Lomatium orientale</i>	Northern Idaho biscuitroot	–
Apiaceae	MUTE3	<i>Musineon tenuifolium</i>	slender wildparsley	–
Apiaceae	PASA2	<i>Pastinaca sativa</i>	wild parsnip	Exotic
Asclepiadaceae	ASSP	<i>Asclepias speciosa</i>	showy milkweed	–
Asteraceae	AMPS	<i>Ambrosia psilostachya</i>	Cuman ragweed	–
Asteraceae	ANPA4	<i>Antennaria parvifolia</i>	small-leaf pussytoes	–
Asteraceae	ARFR4	<i>Artemisia frigida</i>	fringed sagewort	–
Asteraceae	ARLU	<i>Artemisia ludoviciana</i>	white sagebrush	–
Asteraceae	BICE	<i>Bidens cernua</i>	nodding beggartick	–
Asteraceae	CIAR4	<i>Cirsium arvense</i>	Canada thistle	Exotic; NE State Noxious Weed
Asteraceae	CICA11	<i>Cirsium canescens</i>	prairie thistle	–
Asteraceae	CIFL	<i>Cirsium flodmanii</i>	Flodman's thistle	–
Asteraceae	COCA5	<i>Conyza canadensis</i>	horseweed	–
Asteraceae	CYXA	<i>Cyclachaena xanthifolia</i>	giant sumpweed	–
Asteraceae	DICA18	<i>Dieteria canescens</i>	hoary tansyaster	–

Table 3 (continued). List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2019. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. Species described as “Possibly Rare” are species with subspecies or varieties that are rare. Because we only identify plants to the species level, we can’t know if the plants we saw were rare or not.

Family	Symbol	Scientific Name	Common Name	Notes
Asteraceae	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed	–
Asteraceae	HELIA3	<i>Helianthus</i>	sunflower	–
Asteraceae	HEVI4	<i>Heterotheca villosa</i>	hairy false goldenaster	–
Asteraceae	LASE	<i>Lactuca serriola</i>	prickly lettuce	Exotic
Asteraceae	LYJU	<i>Lygodesmia juncea</i>	rush skeletonplant	–
Asteraceae	MATA2	<i>Machaeranthera tanacetifolia</i>	tanseyleaf tansyaster	–
Asteraceae	MUOB99	<i>Mulgedium oblongifolium</i>	blue lettuce	–
Asteraceae	SOAR2	<i>Sonchus arvensis</i>	field sowthistle	Exotic
Asteraceae	SOCA6	<i>Solidago canadensis</i>	Canada 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	TEAC	<i>Tetranneuris acaulis</i>	stemless four-nerve daisy	–
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	ERCA14	<i>Erysimum capitatum</i>	sanddune wallflower	–
Brassicaceae	LEDE	<i>Lepidium densiflorum</i>	common pepperweed	–
Brassicaceae	PHLU99	<i>Physaria ludoviciana</i>	foothill bladderpod	–
Brassicaceae	SIAL2	<i>Sisymbrium altissimum</i>	tall tumbledmustard	Exotic
Cactaceae	OPPO	<i>Opuntia polyacantha</i>	plains pricklypear	–
Caprifoliaceae	SYOC	<i>Symphoricarpos occidentalis</i>	western snowberry	–
Caryophyllaceae	ERHO13	<i>Eremogone hookeri</i>	Hooker's sandwort	–

Table 3 (continued). List of all plant species identified in Agate Fossil Beds National Monument plant community monitoring and riparian community monitoring plots in 2019. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. Species described as “Possibly Rare” are species with subspecies or varieties that are rare. Because we only identify plants to the species level, we can’t know if the plants we saw were rare or not.

Family	Symbol	Scientific Name	Common Name	Notes
Caryophyllaceae	SIDR	<i>Silene drummondii</i>	Drummond's campion	–
Chenopodiaceae	ATMI2	<i>Atriplex micrantha</i>	twoscale saltbush	Exotic
Chenopodiaceae	CHENO	<i>Chenopodium</i>	goosefoot	Exotic
Chenopodiaceae	KOSC	<i>Kochia scoparia</i>	burningbush; kochia	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	CAPE42	<i>Carex pellita</i>	woolly sedge	–
Cyperaceae	CAPR5	<i>Carex praegracilis</i>	clustered field 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	ASMI10	<i>Astragalus missouriensis</i>	Missouri milkvetch	–
Fabaceae	ASTRA	<i>Astragalus</i>	milkvetch	–
Fabaceae	DACA7	<i>Dalea candida</i>	white prairie clover	–
Fabaceae	DAPU5	<i>Dalea purpurea</i>	purple prairie clover	–
Fabaceae	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	–
Fabaceae	LAPO2	<i>Lathyrus polymorphus</i>	manystem pea	–
Fabaceae	LUAR3	<i>Lupinus argenteus</i>	silvery lupine	–
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	OXLA3	<i>Oxytropis lambertii</i>	purple locoweed	–
Fabaceae	PSLA3	<i>Psoralidium lanceolatum</i>	lemon scurfpea	–
Fabaceae	THRH	<i>Thermopsis rhombifolia</i>	golden pea	–
Iridaceae	IRPS	<i>Iris pseudacorus</i>	pale yellow iris	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 2019. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. Species described as “Possibly Rare” are species with subspecies or varieties that are rare. Because we only identify plants to the species level, we can’t know if the plants we saw were rare or not.

Family	Symbol	Scientific Name	Common Name	Notes
Juncaceae	JUBA	<i>Juncus balticus</i>	Baltic rush	–
Juncaceae	JUNCU	<i>Juncus</i>	rush	–
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	–
Linaceae	LIRI	<i>Linum rigidum</i>	stiffstem flax	–
Malvaceae	SPCO	<i>Sphaeralcea coccinea</i>	scarlet globemallow	–
Onagraceae	EPCI	<i>Epilobium ciliatum</i>	fringed willowherb	–
Onagraceae	OESE3	<i>Oenothera serrulata</i>	yellow sundrops	–
Onagraceae	OESU99	<i>Oenothera suffrutescens</i>	scarlet beeblossom	–
Plantaginaceae	PLPA2	<i>Plantago patagonica</i>	woolly plantain	–
Poaceae	AGGI2	<i>Agrostis gigantea</i>	redtop	Exotic
Poaceae	BOGR2	<i>Bouteloua gracilis</i>	blue grama	–
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	ELLA3	<i>Elymus lanceolatus</i>	thickspike wheatgrass	–
Poaceae	ELRE4	<i>Elymus repens</i>	quackgrass	Exotic
Poaceae	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	One variety is rare (G5T5/S1)
Poaceae	HECO26	<i>Hesperostipa comata</i>	needle and thread	–
Poaceae	HOJU	<i>Hordeum jubatum</i>	foxtail barley	–
Poaceae	KOMA	<i>Koeleria macrantha</i>	prairie Junegrass	–
Poaceae	LEOR	<i>Leersia oryzoides</i>	rice cutgrass	–
Poaceae	MUAS	<i>Muhlenbergia asperifolia</i>	scratchgrass; alkali muhly	–
Poaceae	MURA	<i>Muhlenbergia racemosa</i>	marsh muhly	–
Poaceae	PACA6	<i>Panicum capillare</i>	witchgrass	–
Poaceae	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	–
Poaceae	POCO	<i>Poa compressa</i>	Canada bluegrass	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 2019. In the Notes column, “Exotic” indicates that a species is not native to the park or, in the case where only the genus was identified, there are some species within that genus that are exotic. State noxious weed species are designated in the Notes column. Species described as “Possibly Rare” are species with subspecies or varieties that are rare. Because we only identify plants to the species level, we can’t know if the plants we saw were rare or not.

Family	Symbol	Scientific Name	Common Name	Notes
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	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	–
Polemoniaceae	PHHO	<i>Phlox hoodii</i>	spiny phlox	–
Polygonaceae	ERAN4	<i>Eriogonum annuum</i>	annual buckwheat	–
Polygonaceae	PORA3	<i>Polygonum ramosissimum</i>	bushy knotweed	–
Polygonaceae	RUMEX	<i>Rumex</i>	dock	Exotic
Polygonaceae	RUVE2	<i>Rumex venosus</i>	veiny dock	–
Rosaceae	ROWO	<i>Rosa woodsii</i>	Woods' rose	–
Salicaceae	SAIN3	<i>Salix interior</i>	sandbar willow	–
Salicaceae	SALIX	<i>Salix</i>	willow	–
Scrophulariaceae	PEAN4	<i>Penstemon angustifolius</i>	broadbeard beardtongue	–
Solanaceae	PHHI8	<i>Physalis hispida</i>	prairie groundcherry	–
Typhaceae	TYAN	<i>Typha angustifolia</i>	narrowleaf cattail	–
Typhaceae	TYLA	<i>Typha latifolia</i>	broadleaf cattail	–
Unknown family	UNKFORB	Unknown forb	unknown forb	Exotic
Unknown family	UNKGRAM	Unknown graminoid	unknown graminoid	Exotic
Urticaceae	URDI	<i>Urtica dioica</i>	stinging nettle	–
Violaceae	VINU2	<i>Viola nuttallii</i>	Nuttall's violet; yellow prairie violet	–

Based on the total count of unique species observed in each plot in 2019, PCM_021 had the highest number with 47 total species, 37 of which were native (Table 4; Figure 4). Absolute cover calculations (Table 5) showed that upland plots were evenly split between those dominated by native and those dominated by exotic species. Riparian plots were mostly dominated by native species. The plant cover was entirely native at two plots, PCM_020 and PCM_026. Plot PCM_026 had the highest absolute cover of native species (121%), and plot RCM_264 had the highest absolute cover of exotic species (80%). Pale yellow iris (*Iris pseudacorus*), an exotic species of concern for the park, was

observed at 5 of the 13 RCM plots monitored. It was most abundant in RCM_259 at 24% absolute cover (Table 5).

Table 4. Total number of plant species identified in each of the 27 plots monitored at Agate Fossil Beds National Monument in 2019. 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_044, FPCM_067, FPCM_075, FPCM_111, FPCM_113, PCM_016, PCM_026, PCM_027), plot PCM_024, or any of the RCM plots, resulting in a lower species count.

Plot	Exotic Species	Native Species	Total Species
AGFO_FPCM_044	3	6	9
AGFO_FPCM_067	2	13	15
AGFO_FPCM_075	4	8	12
AGFO_FPCM_111	3	8	11
AGFO_FPCM_113	3	7	10
AGFO_PCM_008	6	25	31
AGFO_PCM_010	8	22	30
AGFO_PCM_012	5	28	33
AGFO_PCM_016	1	7	8
AGFO_PCM_020	4	25	29
AGFO_PCM_021	10	37	47
AGFO_PCM_024	1	15	16
AGFO_PCM_026	0	15	15
AGFO_PCM_027	5	11	16
AGFO_RCM_257	1	6	7
AGFO_RCM_258	6	12	18
AGFO_RCM_259	3	15	18
AGFO_RCM_260	4	9	13
AGFO_RCM_261	7	7	14
AGFO_RCM_262	1	7	8
AGFO_RCM_263	3	5	8
AGFO_RCM_264	5	10	15
AGFO_RCM_265	5	9	14
AGFO_RCM_266	4	14	18
AGFO_RCM_267	5	14	19
AGFO_RCM_269	5	14	19
AGFO_RCM_273	4	11	15



Figure 4. Plot PCM_021 at Agate Fossil Beds National Monument had the highest count of unique native plant species in 2019. 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 2019. Absolute percent cover is calculated using the point-intercept data. This includes overlapping species canopies, which can result in values greater than 100%. Data was collected from only 25 points at plot RCM_261, resulting in smaller values for absolute percent cover.

Plot	Absolute % Exotic Cover	Absolute % Native Cover	Absolute % Cover of <i>Iris pseudacorus</i>
AGFO_FPCM_044	68	53	—
AGFO_FPCM_067	22	81	—
AGFO_FPCM_075	53	22	—
AGFO_FPCM_111	75	60	—
AGFO_FPCM_113	76	51	—
AGFO_PCM_008	4	80	—
AGFO_PCM_010	72	54	—
AGFO_PCM_012	24	65	—
AGFO_PCM_016	62	58	—
AGFO_PCM_020	0	85	—

Table 5 (continued). Absolute percent cover of native and exotic plant species in plots monitored at Agate Fossil Beds National Monument 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%. Data was collected from only 25 points at plot RCM_261, resulting in smaller values for absolute percent cover.

Plot	Absolute % Exotic Cover	Absolute % Native Cover	Absolute % Cover of <i>Iris pseudacorus</i>
AGFO_PCM_021	11	105	–
AGFO_PCM_024	1	85	–
AGFO_PCM_026	0	121	–
AGFO_PCM_027	59	52	–
AGFO_RCM_257	1	53	–
AGFO_RCM_258	22	51	–
AGFO_RCM_259	35	87	24
AGFO_RCM_260	72	73	1
AGFO_RCM_261	8	32	1
AGFO_RCM_262	6	73	6
AGFO_RCM_263	28	83	–
AGFO_RCM_264	80	42	–
AGFO_RCM_265	58	46	–
AGFO_RCM_266	37	80	–
AGFO_RCM_267	37	48	–
AGFO_RCM_269	46	86	–
AGFO_RCM_273	13	60	10

Disturbances were observed at 11 plots in 2019 (Table 6). The most commonly observed disturbances were soil disturbance and small mammal activity.

Table 6. Disturbance types and occurrence in plant community monitoring plots visited at Agate Fossil Beds National Monument in 2019.

Plot	Disturbance Type	Area (m ²)
AGFO_FPCM_044	Soil Disturbance	8
AGFO_FPCM_075	Soil Disturbance	24
AGFO_FPCM_113	Soil Disturbance	14.5
AGFO_PCM_008	Small Mammal	75
AGFO_PCM_008	Soil Disturbance	75
AGFO_PCM_010	Animal Trail	40
AGFO_PCM_010	Small Mammal	20
AGFO_PCM_010	Soil Disturbance	20
AGFO_PCM_012	Small Mammal	80
AGFO_PCM_012	Soil Disturbance	80
AGFO_PCM_016	Soil Disturbance	6.5
AGFO_PCM_020	Small Mammal	20
AGFO_PCM_020	Soil Disturbance	20
AGFO_PCM_021	Small Mammal	50
AGFO_PCM_021	Soil Disturbance	50
AGFO_PCM_024	Small Mammal	40
AGFO_PCM_024	Soil Disturbance	40
AGFO_PCM_027	Soil Disturbance	10.7

Further Analysis

This Data Report is intended to provide a basic review of the data collected during the NGPN and NGPFire monitoring team's 2019 visit to 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. 2019. 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. 2018. The PLANTS Database (<http://plants.usda.gov>, 24 January 2018). National Plant Data Team, Greensboro, NC 27401-4901 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.

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