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Plant Community Composition and Structure Monitoring for Knife River Indian Villages National Historic Site

2014 Annual Report

Natural Resource Data Series NPS/NGPN/NRDS—2015/767

ON THE COVER
Long-term monitoring plot PCM-012 at Knife River Indian Villages National Historic Site, 2014
Photograph courtesy of the National Park Service

Plant Community Composition and Structure Monitoring for Knife River Indian Villages National Historic Site

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This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Abstract

This report presents the results of vegetation monitoring efforts in 2014 at Knife River Indian Villages National Historic Site (KNRI) by the Northern Great Plains Inventory and Monitoring Network (NGPN).

During the fourth full year of field work, crew members from NGPN visited seven plant community monitoring plots to collect data on the vegetation at KNRI. This is part of a long-term monitoring effort that aspires to sample eight of 20 randomly located upland plots every year, so that each plot is visited for two consecutive years and then rested for three years, on a five-year rotating basis. NGPN staff captured data relating to species richness, herb-layer height, abundance of individual native and non-native species, ground cover, and site disturbance on each of the seven plots.

Our 2014 findings can be summarized as follows: The crew observed 124 vascular plant species in upland plots, with an average of 4.0 native species occurring within any given 1 m^2 quadrat sampled. Grasses and sedges made up the bulk of the plant cover. While a couple of plots exhibited good native species richness, many sites struggled with non-native species, which represented about 60.6% of cover in the plots surveyed.

Acknowledgments

We thank all the authors of the NGPN Plant Community Monitoring Protocol, particularly A. Symstad, for outstanding guidance on data collection and reporting. Thank you to the staff at KNRI, particularly W. Ross and J. Schiferl for providing logistical support and safety checks. The 2014 NGPN vegetation field crew of K. Legner, R. Manuel, F. Sewell, D. Pinigis, M. Prowatzke, L. Mickelson, and S. Rockwood collected all of the data included in this report.

Introduction

During the last century, much of the prairie within the Northern Great Plains has been plowed for cropland, planted with non-natives to maximize livestock production, or otherwise developed, making it one of the most threatened ecosystems in the United States. Within North Dakota, greater than 71% of the area of native mixed-grass prairie has been lost since European settlement (Samson and Knopf 1994). The National Park Service (NPS) plays an important role in preserving and restoring some of the last pieces of intact prairies within its boundaries. The stewardship goal of the NPS is to "preserve ecological integrity and cultural and historical authenticity" (NPS 2012); however, resource managers struggle with the reality that there have been fundamental changes in the disturbance regimes, such as climate, fire, and large ungulate grazing, that have historically maintained prairies, and there is the continual pressure of exotic invasive species. Long-term monitoring in national parks is essential to sound management of prairie landscapes, because it can provide information on environmental quality and condition, benchmarks of ecological integrity, and early warning of declines in ecosystem health.

Knife River Indian Villages National Historic Site (KNRI) was established in 1974 with a mission to commemorate the culture and history of the Northern Great Plains Indian peoples and to preserve, study, and interpret the historic and archeological resources. KNRI sits on 1758 acres of upland mixed-grass prairie and riparian forests, much of which has a long history of human use. As a result, exotic species play a major role in the makeup of the park's current vegetation (DeKeyser and Krabbenhoft 2006). The Northern Great Plains Inventory & Monitoring Program (NGPN) began vegetation monitoring at KNRI in 2011 (Ashton et al. 2012). Vegetation monitoring protocols and plot locations were chosen to represent the park and to coordinate efforts with the Northern Great Plains Fire Ecology Program (FireEP). The long-term objectives of the NGPN plant community monitoring effort (Symstad et al. 2012b) in KNRI are to:

1. Determine park-wide status and long-term trends in vegetation species composition (e.g., exotic vs. native) and structure (e.g., cover, height) of herbaceous and shrub species.

2. Determine status (at 5-year intervals) and long-term trends of tree density by species, height class, and diameter class in the riparian forest.

3. Improve our understanding of the effects of external drivers and management actions on plant community species composition and structure by correlating changes in vegetation composition and structure with changes in climate, landscape patterns, atmospheric chemical composition, fire, and invasive plant control.

This report is intended to provide a timely release of basic data sets and data summaries from our sampling efforts at KNRI in 2014, our fourth year of sampling. We visited seven plots, and it will take one more year to visit every plot in the park twice (Figure 1). We expect to produce reports with more in-depth data analysis and interpretation when we complete five years of sampling. In the interim, reports, spatial data, and data summaries can be provided for park management and interpretation upon request.

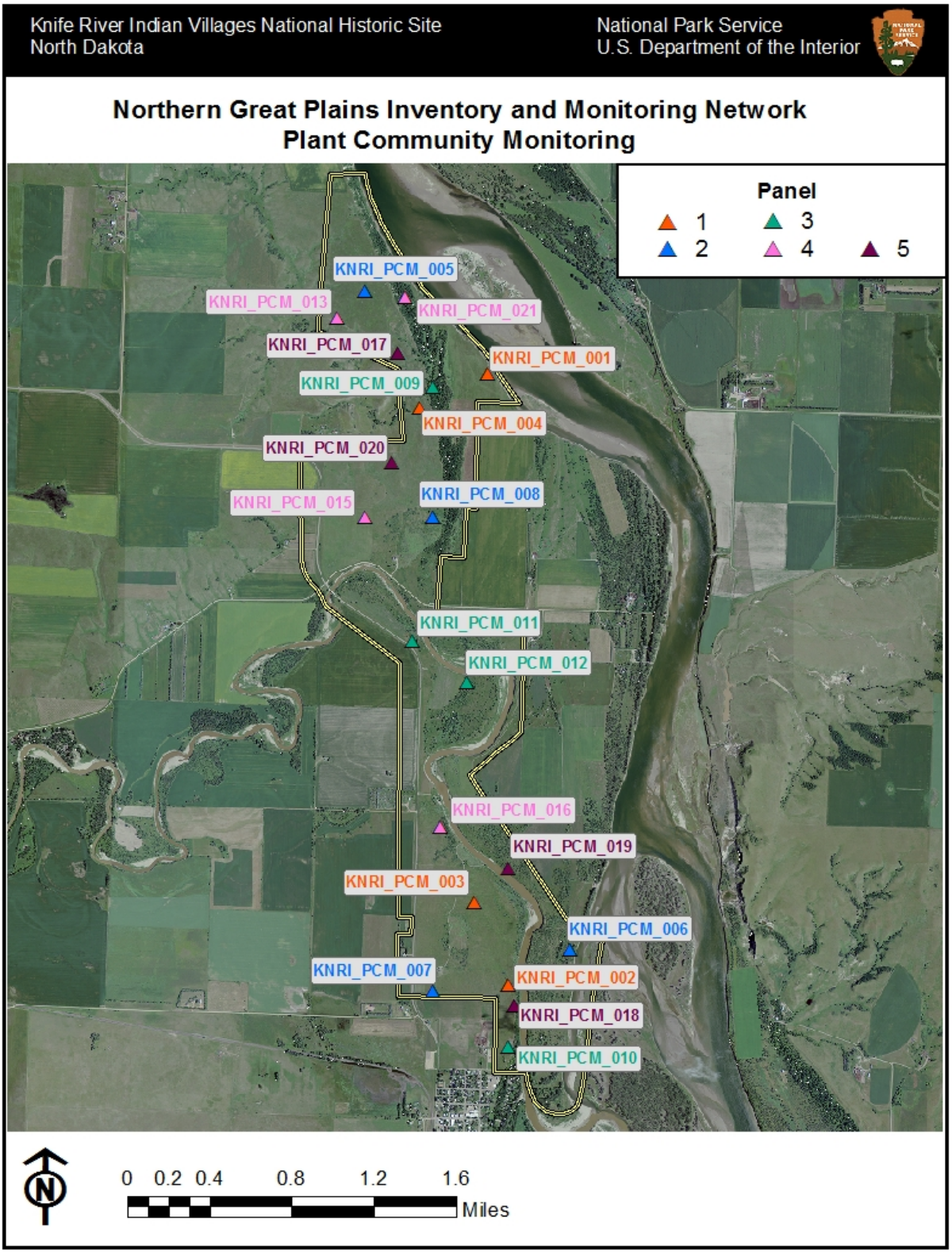


Figure 1. Map of plant community monitoring plots in Knife River Indian Villages National Historic Site (KNRI). Plots in panel 3 (green) and panel 4 (pink) were visited in 2014. Note that no herbaceous layer data was collected at PCM-021 due to time constraints.

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 Symstad et al. 2012a, available at http://science.nature.nps.gov/im/units/ngpn/monitor/plants.cfm.

Sample Design

We implemented a survey to monitor plant community structure and composition in KNRI using a spatially balanced probability design (Generalized Random Tessellation Stratified [GRTS]; Stevens and Olsen 2003, 2004). Using a GRTS design, we selected 20 randomly located sites within KNRI (Figure 1). We split these 20 sites into five panels with four sites each. We visit two panels (eight sites) every year, and after five years (2015) we will have visited all 20 sites twice. In 2011, we visited sites in panel 1 and panel 5, and in 2012 we visited sites in panel 1 and panel 2. In 2013, we visited sites in panel 2 and panel 3, and in 2014, we visited sites in panel 3 and panel 4 in the last week of July (Figure 1). Data from these randomly selected sites can be used to estimate condition of vegetation communities for the whole park and over time, can be used to discern trends in condition.

Plot Layout and Sampling

At each of the sites we visited, we 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. Species richness data from the point-intercept method were supplemented with species presence data collected in five sets of nested square quadrats (0.01 m^2, 0.1 m^2, 1 m^2, and 10 m^2) located systematically along each transect (Figure 2). In 2014, sampling at KNRI took the equivalent of a four-person crew five days with travel time (see Appendix A for a detail of activities each day).

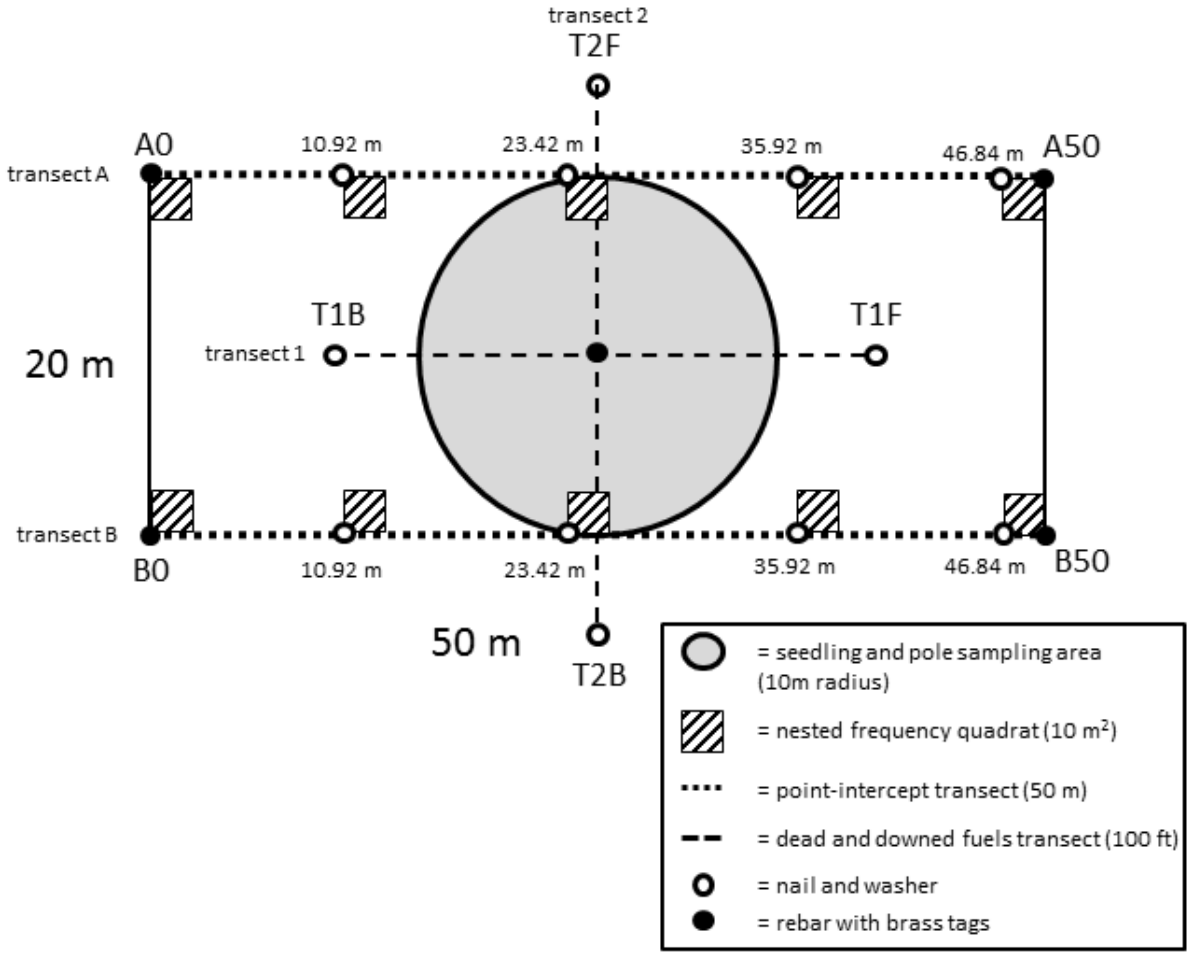


Figure 2. Long-term monitoring plot layout used for sampling vegetation in Knife River Indian Villages National Historic Site.

When woody species were present, tree regeneration and tall shrub density data were collected within a 10 m radius subplot centered in the larger 50 m x 20 m plot (Figure 2). Trees with diameter at breast height (DBH) > 15 cm, located within the entire 0.1 ha plot, are mapped and tagged. For each tree, the species, DBH, status, and condition (e.g., leaf-discoloration, insect-damaged, etc.) are recorded. In addition to upland plant community sampling, NGPN completed a survey of forests in KNRI in the second week of September 2014. Results of this effort will be published separately, and the forest survey is to be repeated every five years thereafter.

At all plots, we also surveyed the area for common disturbances and target species of interest to the park. Common disturbances included such things as roads, rodent mounds, animal trails, and fire. For all plots, the type and severity of the disturbances were recorded. We also surveyed the area for exotic species that have the potential to spread into the park and cause significant ecological impacts (Table 1). For each target species that was present at a site, an abundance class was given on a scale from 1-5 where 1 = one individual, 2 = few individuals, 3 = cover of 1-5%, 4 = cover of 5-25%, and 5 = cover > 25% of the plot. The information gathered from this procedure is critical for early

detection and rapid response to such threats. In addition, we noted the presence of plant species that are considered rare or vulnerable to loss in North Dakota, and which may potentially occur in KNRI (Table 2).

Table 1. Exotic species surveyed for at Knife River Indian Villages National Historic Site as part of the early detection and rapid response program within the Northern Great Plains Network.

Scientific Name	Common Name	Habitat
Alliaria petiolata	garlic mustard	Riparian
Polygonum cuspidatum; P. sachalinense; P. x bohemicum	knotweeds	Riparian
Pueraria montana var. *lobata*	kudzu	Riparian
Iris pseudacorus	yellow iris	Riparian
Ailanthus altissima	tree of heaven	Riparian
Lepidium latifolium	perennial pepperweed	Riparian
Arundo donax	giant reed	Riparian
Rhamnus cathartica	common buckthorn	Riparian
Heracleum mantegazzianum	giant hogweed	Riparian
Centaurea solstitialis	yellow star thistle	Upland
Hieracium aurantiacum; H. caespitosum	orange and meadow hawkweed	Upland
Isatis tinctoria	Dyer's woad	Upland
Taeniatherum caput-medusae	medusahead	Upland
Chondrilla juncea	rush skeletonweed	Upland
Gypsophila paniculata	baby's breath	Upland
Centaurea virgata; C.diffusa	knapweeds	Upland
Linaria dalmatica; L. vulgaris	toadflax	Upland
Euphorbia myrsinites & E. cyparissias	myrtle spurge	Upland
Dipsacus fullonum & D. laciniatus	common teasel	Upland
Salvia aethiopis	Mediterranean sage	Upland
Ventenata dubia	African wiregrass	Upland

Table 2. Rare species that was surveyed for during the 2014 field season at Knife River Indian Villages National Historic Site.

Scientific Name	Common Name
Carex gravida	heavy sedge

Data Management and Analysis

We used FFI (FEAT/FIREMON Integrated; http://frames.gov/ffi/) as the primary software environment 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, and common names are from the USDA Plants Database (USDA-NRCS 2012). However, nomenclature follows the Integrated Taxonomic Information System (ITIS) (http://www.itis.gov). In the few cases where ITIS recognizes a new name that was not in the USDA PLANTS database, the new name was used and a unique plant code was assigned.

After data for the sites were entered, 100% of records were verified to the original data sheet to minimize transcription errors. A further 10% of records were reviewed a second time. After all data were entered and verified, automated queries were developed to check for errors in the data. When

errors were caught by the crew or the automated queries, changes were made to the original datasheets and the FFI database as needed.

Plant life forms (e.g., shrub, forb) were based on definitions from the USDA Plants Database (USDA-NRCS 2012). Warm-season grasses were identified primarily using a guide by Skinner (2010). Summaries were produced using the FFI reporting and query tools and statistical summaries and graphics were generated using R software (version 3.1.2).

We measured diversity at the plots in three ways: species richness, the Shannon Index, and Pielou's Index of Evenness. Species richness is simply a count of the species recorded in an area. The Shannon Index, H', is a measure of the number of species in an area and how even abundances are across the community. It typically ranges between 0 (low richness and evenness) to 3.5 (high species richness and evenness). Pielou's Index of Evenness, J', measures how even abundances are across taxa. It ranges between 0 and 1; values near 0 indicate dominance by a single species, and values near 1 indicate nearly equal abundance of all species present.

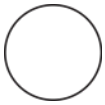
Disturbances were recorded in square meters and ranged from 0 (not present) to 2290 (the whole plot area) for each type of disturbance. We report the sum of all individual disturbances, so the value can be greater than 2290 m^2.

Reporting on Natural Resource Condition

Results were summarized in a Natural Resource Condition Table based on the templates from the State of the Park report series (http://www.nps.gov/stateoftheparks/). The goal is to improve park priority setting and to synthesize and communicate complex park condition information to the public in a clear and simple way. By focusing on specific indicators, such as exotic species cover, it will also be possible and straightforward to revisit the metric in subsequent years. The status and trend of each indicator is scored and assigned a corresponding symbol based on the key found in Table 3.

We chose a set of indicators and specific measures that can describe the condition of vegetation in the Northern Great Plains and the status of exotic plant invasions. The measures include: absolute herb-layer canopy cover, native species richness, evenness, relative cover of exotic species, and annual brome cover. Reference values were based on descriptions of historic condition and variation, past studies, and/or management targets. Current park condition was compared to a reference value, and status was scored as good condition, warrants moderate concern, or warrants significant concern based on this comparison (Table 3). Good condition was applied to values that fell within the range of the reference value, and significant concern was applied to conditions that fell outside the bounds of the reference value. In some case, reference conditions can be determined only after we have accumulated more years of data. When this is the case, we refer to these as "To be determined" and estimate condition based on our professional judgment.

Table 3. Key to the symbols used in the Natural Resource Condition Table. The background color represents the current status, the arrow summarizes the trend, and the thickness of the outside line represents the degree of confidence in the assessment. A symbol that does not contain an arrow indicates that there is insufficient information to assess a trend. Based on the State of the Park reports (http://www.nps.gov/stateoftheparks/).

Condition Status		Trend in Condition		Confidence in Assessment	
	Warrants Significant Concern		Condition is Improving		High
	Warrants Moderate Concern		Condition is Unchanging		Medium
	Resource is in Good Condition		Condition is Deteriorating		Low

Results and Discussion

Knife River Indian Villages National Historic Site experienced near normal precipitation in 2014 (http://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND: USC00323376/detail; Figure 3). When NGPN visited the park, cumulative precipitation was about one inch below average.

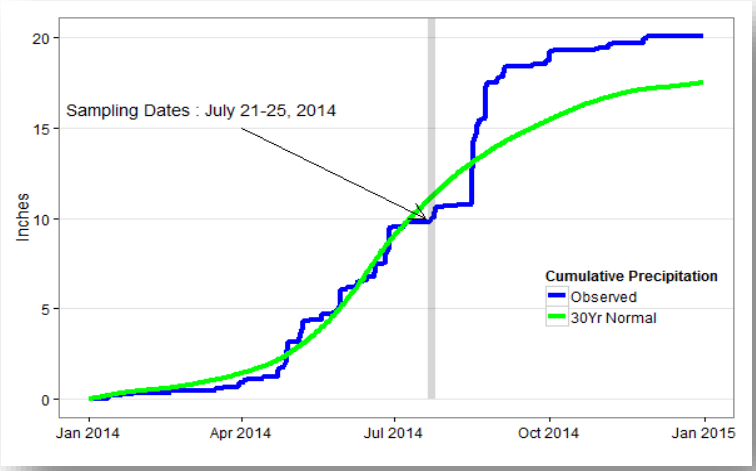


Figure 3. Observed and 30-year (1981-2010) normal precipitation near Knife River Indian Villages National Historic Site. Timing of NGPN visit is shown by vertical gray bar.

Average canopy cover was 180% (Table 4) in 2014, which was similar to the previous year (Ashton and Prowatzke 2014). There was a large amount of litter on the ground with ground cover at the sites averaging 97% plant litter.

We found 124 plant species in 2014 at KNRI (Appendix B). Graminoids, which includes grasses, sedges, and rushes, accounted for most of the vegetative cover at KNRI, but forbs, shrubs, trees, and vines were also present (Figure 4). We found 25 exotic species at the park, most of which were either forbs or graminoids; Siberian elm (*Ulmus pumila*) was the only exotic tree species found. The shrubs and vines were all native species.

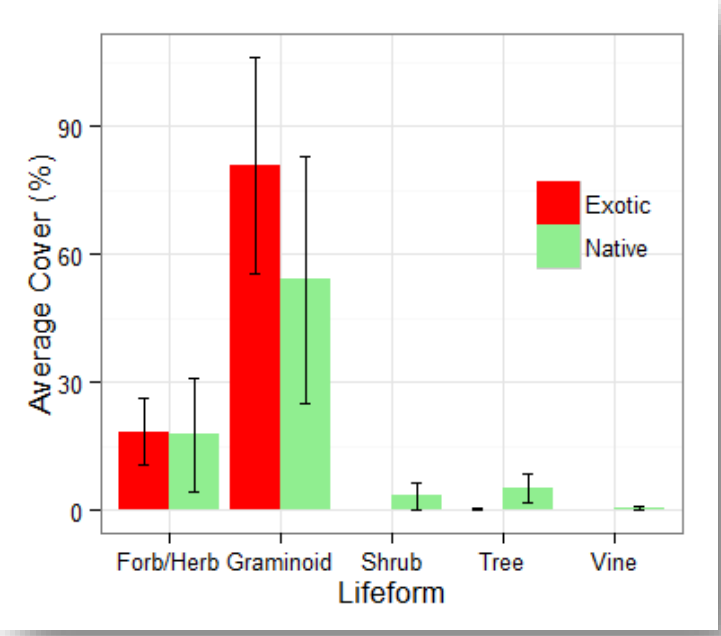


Figure 4. Average cover by lifeform in seven plant community monitoring plots in Knife River Indian Villages National Historic Site in 2014. Graminoids and shrubs were the most abundant lifeform found in the understory across the plots. Bars represent means ± standard errors.

Exotic graminoids accounted for the highest amount of the cover, with smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) being particularly abundant (Figure 5). We did not find any target exotic species or rare species.

Table 4. Natural resource condition summary table for upland plant communities in Knife River Indian Villages National Historic Site (KNRI).

Indicator of Condition	Specific Measures	2014 Value (mean ± SE)	Reference Condition and Data Source	Condition Status/Trend	Rationale for Resource Condition
Upland Plant Community Structure and Composition	Absolute herb-layer canopy cover	180 ± 15.0%	TBD (1)		KNRI protects and manages small remnants of northern mixed-grass prairie and supports an active prairie restoration program. A history of extensive human-use has led to low native species richness when compared to more intact mixed-grass prairies in the region. We do not have a reference condition or baseline for evenness or canopy cover, so we have low confidence in our estimate that current values indicate good condition. Future monitoring will help the park determine if the goal to maintain or increase native diversity is being met.
	Native species richness (based on average of 10 1m^2 quadrats per plot)	4.0 ± 1.4 species	8-18 species (2)		
	Evenness (based on point-intercept of 2-50m transects per plot)	0.68 ± 0.06	TBD (1)		
Exotic Plant Early Detection and Management	Relative cover of exotic species	60.6 ± 14.9%	A decreasing trend in exotic cover(3)		KNRI manages a landscape with a very high cover of exotic species. Smooth brome and Kentucky bluegrass are particularly abundant, and their cover should be reduced to retain native plant diversity. As NGPN collects more data, we will be able to determine whether the park is able to reduce the abundance of exotics.
	Relative percent cover of smooth brome	33.6 ± 13.0%	A decreasing trend in smooth brome cover(3)		

References, Notes, and Data Sources:

1. To be determined when more data are available 2. Symstad, A. J. and J. L. Jonas. 2014. Using natural range of variation to set decision thresholds: a case study for Great Plains grasslands.in G. R. Gutenspergen, editor. Application of threshold concepts in natural resource decision making. Springer Verlag. 3. Based on professional opinion.

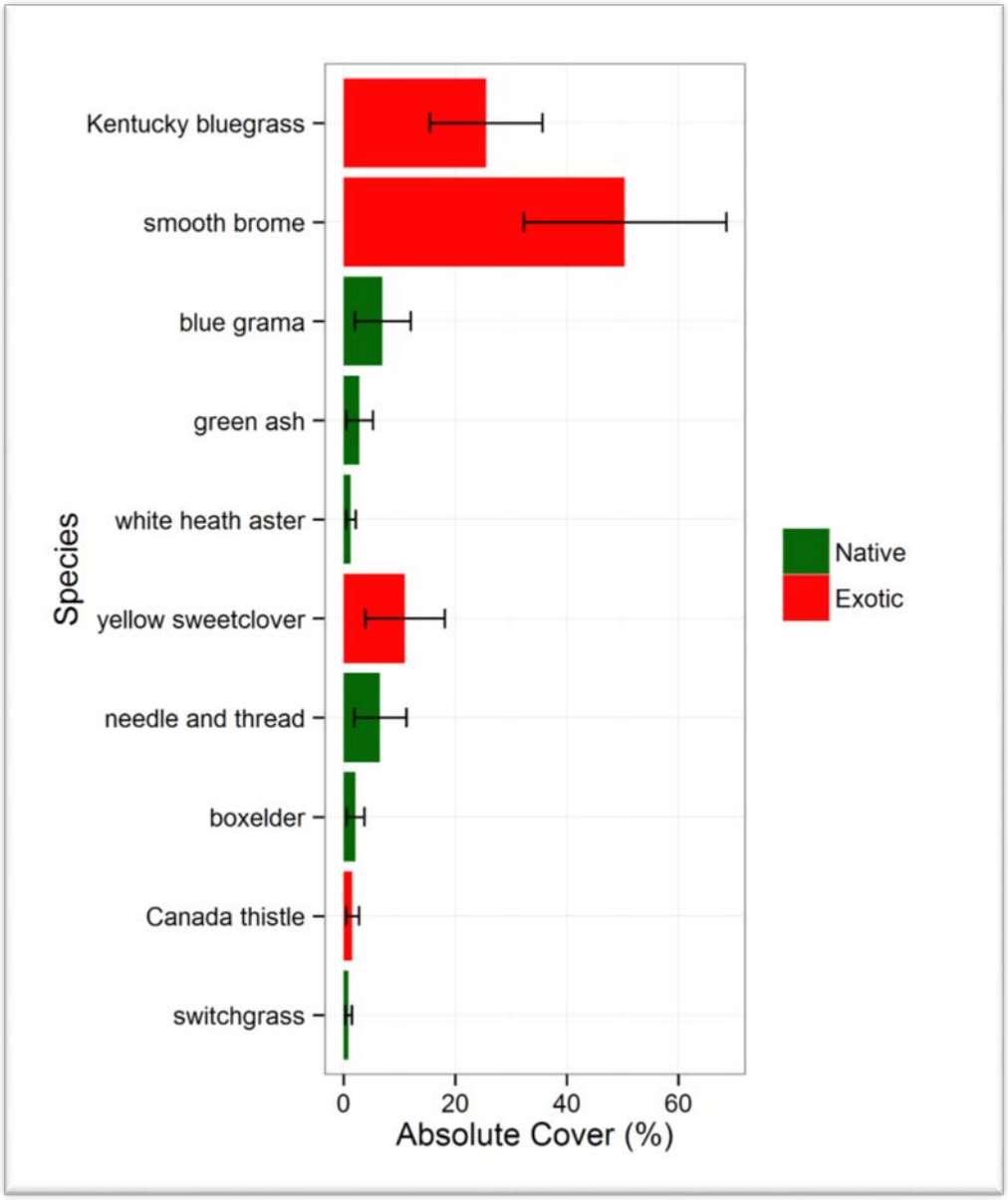


Figure 5. The average absolute cover of the 10 most common native (green) and exotic (red) plants recorded at Knife River Indian Villages National Historic Site in 2014. Bars represent means ± standard errors.

Average species richness at each of the seven plots was measured by point-intercept and in 1 m^2 and 10 m^2 quadrats. On average, there were about two exotic species within the 1 m^2 quadrat (Table 5). From the point-intersect data, we found average plot diversity, H', to be 1.5 ± 0.3. Evenness, J', averaged 0.68 ± 0.06 across the plots (Table 4). When including only native species, average diversity and evenness were 1.4 ± 0.3 and 0.70 ± 0.12, respectively. These low numbers are driven by two plots where we found less than two percent native species cover on the point-intercept transects.

Table 5. Average plant species richness in seven plots at Knife River Indian Villages National Historic Site in 2014. Values represent means ± standard errors, n=7.

	Point-intercept	1 m^2 quadrats	10 m^2 quadrats
Species richness	11 ± 3.2	6 ± 1.4	11 ± 2.4
Native species richness	8 ± 2.6	4 ± 1.4	8 ± 2.2
Exotic species richness	3 ± 0.7	2 ± 0.4	3 ± 0.6
Graminoid species richness	4 ± 0.6	3 ± 0.5	3 ± 0.6
Forb species richness	5 ± 2.4	3 ± 1.1	6 ± 1.9

While there was some variation across sites, the plots we visited in KNRI tended to have a low diversity of native plants compared to other mixed-grass prairies. Species richness in the mixed-grass prairie is determined by numerous factors including fire regime, grazing, prairie dog disturbance, and weather fluctuations (Symstad and Jonas 2011). While it is difficult to define a reference condition for species richness that can vary so much spatially and temporally, the natural range of variation over long-time periods may be a good starting point (Symstad and Jonas 2014). Long-term records of species diversity in mixed-grass prairie in a moderately grazed site in Montana ranged between 8 and 18 species per square meter (10-90th percentile range) between 1933-1945 (Symstad and Jonas 2014). The average native species richness falls below this natural range of variation for the park (Table 4), and it is below the range in five of the seven sites surveyed (Table 6). The highest diversity was seen in site PCM-013, in the northern prairie portion of the park.

Figure 6. Plot PCM-013, located in the northern prairie portion of the park, had high native species richness and relatively low exotic plant cover.

The average relative cover of exotic species at sites in KNRI was high (60.6 ± 14.9%). However, like species richness, cover of exotic species varied considerably among sites. Site PCM-013, in the northern prairie portion of the park, had a moderate cover of exotic species, while sites PCM-011 and PCM-012 had nearly 100% exotic cover and were dominated by smooth brome (Table 6).

Table 6. Characteristics of the plant community at seven plots in Knife River Indian Villages National Historic Site in 2014 including species richness, average cover of smooth brome, exotic plant cover, and area of disturbance.

Plot	Native species richness in 1 m^2	Exotic cover (%)	Smooth brome cover (%)	Disturbance within site (m^2)
PCM-009	9	25	0	0
PCM-010	2	88	38	0
PCM-011	0	100	70	100
PCM-012	1	98	82	2290
PCM-013	9	14	0	70
PCM-015	5	19	0	0
PCM-016	3	80	45	2
Park Average	*4.0 ± 1.4*	*60.6 ± 14.9*	*33.6 ± 13.1*	-

Disturbance from grazing, fire, and humans affects plant community structure and composition in mixed-grass prairie. For this reason, we measured the approximate area affected by natural and human disturbances at each site we visited. In 2014, the most common disturbance was off-road tracks, which was evident in two of the seven sites. Other disturbances noted included small mammal holes, fire, and human garbage.

Table 7. Seedling and sapling density at four long-term monitoring plots in Knife River Indian Villages National Historic Site. S=seedlings present, M=mature trees or shrubs present.

Plot	Box elder		Green ash		Cottonwood		Chokecherry		Serviceberry		Buffaloberry		Siberian elm	
	S	M	S	M	S	M	S	M	S	M	S	M	S	M
PCM-009	x	x	x	x									x	x
PCM-010	x	x	x			x	x		x				x	
PCM-012	x	x	x	x										
PCM-016	x	x	x	x			x	x			x			

Trees and seedlings were present in four of the seven sites we visited in 2014 (Table 7). Since we completed a more thorough assessment of forest structure and health in KNRI in early September, we will forego further discussion on the condition of the park's forests in this report. Rather, we will present the results of that assessment, involving 20 sites, in a separate report. However, for reference, Table 7 indicates the species and location of tree and tall shrub species found in the plots covered in this report.

Summary

KNRI protects and manages a small remnant of northern mixed-grass prairie. A history of extensive human use has led to low native species richness when compared to more intact mixed-grass prairies in the region. Exotic cover is high, and smooth brome and Kentucky bluegrass are particularly abundant. Reducing the cover of smooth brome will be critical to maintaining native diversity. Though challenging, it is important to continue efforts to reduce the cover of invasive plants to restore and retain ecological integrity. Allowing for natural disturbances such as fire may be critical to maintaining plant diversity in KNRI, but it should be balanced with the need to protect intact native communities and prevent further invasions of exotic species. Continued monitoring efforts will be critical to track changes in the condition of the vegetation communities in KNRI.

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Appendix A: Field journal for plant community monitoring in KNRI for the 2014 season

Plant community composition monitoring in Knife River Indian Villages National Historic Site was completed using a crew of four people working 4.5, 10-hour days, plus 8.25 hours of overtime. Herbaceous layer data were collected at seven of the scheduled eight plots, and tree data were collected at two of the plots during the forest health survey in September, taking two three-person crews approximately two hours. Severe weather hampered efforts on several days. Total hours worked were 200.25 hours.

Date	Day of week	Approximate Travel Time (hrs)	Housing	Sites Completed/Notes
July 21, 2014	Monday	5.5	Rough Rider Inn, Hazen, ND	PCM-010
July 22, 2014	Tuesday	1	Rough Rider Inn, Hazen, ND	PCM-009 (except trees)
July 23, 2014	Wednesday	1	Rough Rider Inn, Hazen, ND	PCM-011 PCM-013 PCM-015
July 24, 2014	Thursday	1	Rough Rider Inn, Hazen, ND	PCM-016
July 25, 2014	Friday	3	N/A	PCM-012 (half-day) Travel to Theodore Roosevelt NP
September 9, 2014	Tuesday	1	Rough Rider Inn, Hazen, ND	PCM-009 (trees) PCM-021 (trees, seedlings, & fuels)

Appendix B: List of plant species found in 2014 at KNRI

Family	Code	Scientific Name	Common Name	Exotic
Aceraceae	ACNE2	*Acer negundo*	boxelder	
Anacardiaceae	TORY	*Toxicodendron rydbergii*	western poison ivy	
Apiaceae	CIMA2	*Cicuta maculata*	spotted water hemlock	
	OSLO	*Osmorhiza longistylis*	longstyle sweetroot	
Asclepiadaceae	ASSY	*Asclepias syriaca*	common milkweed	
Asteraceae	ACMI2	*Achillea millefolium*	common yarrow	
	ANPA4	*Antennaria parvifolia*	small-leaf pussytoes	
	ARAB3	*Artemisia absinthium*	absinthium	*
	ARDR4	*Artemisia dracunculus*	tarragon	
	ARFR4	*Artemisia frigida*	prairie sagewort	
	ARLU	*Artemisia ludoviciana*	white sagebrush	
	ARMI2	*Arctium minus*	lesser burdock	*
	CIAR4	*Cirsium arvense*	Canada thistle	*
	CIRSI	*Cirsium* sp.	thistle	*
	COCA5	*Conyza canadensis*	Canadian horseweed	
	ECAN2	*Echinacea angustifolia*	blacksamson echinacea	
	HEVI4	*Heterotheca villosa*	hairy false goldenaster	
	LASE	*Lactuca serriola*	prickly lettuce	*
	LILI	*Liatris ligulistylis*	Rocky Mountain blazing star	
	LIPU	*Liatris punctata*	dotted blazing star	
	LYJU	*Lygodesmia juncea*	rush skeletonplant	
	MUOB99	*Mulgedium oblongifolium*	blue lettuce	
	RACO3	*Ratibida columnifera*	upright prairie coneflower	
	SOGI	*Solidago gigantea*	giant goldenrod	
	SOLID	*Solidago* sp.	goldenrod	
	SOMI2	*Solidago missouriensis*	Missouri goldenrod	
	SORI2	*Solidago rigida*	stiff goldenrod	
	SYER	*Symphyotrichum ericoides*	white heath aster	
	SYOB	*Symphyotrichum oblongifolium*	aromatic aster	
	TAOF	*Taraxacum officinale*	common dandelion	*
	TRDU	*Tragopogon dubius*	yellow salsify	*
Boraginaceae	CYOF	*Cynoglossum officinale*	gypsyflower	*
	HADE	*Hackelia deflexa*	nodding stickseed	
	LIIN2	*Lithospermum incisum*	narrowleaf stoneseed	
	ONBE	*Onosmodium bejariense*	soft-hair marbleseed	
Brassicaceae	BOECH99	*Boechera* sp.	rockcress	
	CAMI2	*Camelina microcarpa*	littlepod false flax	*
	ERCH9	*Erysimum cheiranthoides*	wormseed wallflower	*
	HEMA3	*Hesperis matronalis*	dames rocket	*
	LEDE	*Lepidium densiflorum*	common pepperweed	
	PHAR99	*Physaria arenosa*	Great Plains bladderpod	
Cactaceae	OPPO	*Opuntia polyacantha*	plains pricklypear	
Cannabaceae	HULU	*Humulus lupulus*	common hop	
Caprifoliaceae	SYOC	*Symphoricarpos occidentalis*	western snowberry	
Caryophyllaceae	MOLA6	*Moehringia lateriflora*	bluntleaf sandwort	
Chenopodiaceae	CHAL7	*Chenopodium album*	lambsquarters	*
	CHSI2	*Chenopodium simplex*	mapleleaf goosefoot	

Commelinaceae	TROC	*Tradescantia occidentalis*	prairie spiderwort	
Convolvulaceae	COAR4	*Convolvulus arvensis*	field bindweed	*
Cyperaceae	CABR10	*Carex brevior*	shortbeak sedge	
	CAFI	*Carex filifolia*	threadleaf sedge	
	CAREX	*Carex* sp.	sedge	
Elaeagnaceae	SHAR	*Shepherdia argentea*	silver buffaloberry	
Euphorbiaceae	EUES	*Euphorbia esula*	leafy spurge	*
	EUGL3	*Euphorbia glyptosperma*	ribseed sandmat	
Fabaceae	ACAM99	*Acmispon americanus*	American bird's-foot trefoil	
	ASLA27	*Astragalus laxmannii*	Laxmann's milkvetch	
	ASMI10	*Astragalus missouriensis*	Missouri milkvetch	
	DACA7	*Dalea candida*	white prairie clover	
	DAPU5	*Dalea purpurea*	purple prairie clover	
	MELU	*Medicago lupulina*	black medick	*
	MEOF	*Melilotus officinalis*	yellow sweetclover	*
	PEAR6	*Pediomelum argophyllum*	silverleaf Indian breadroot	
	VIAM	*Vicia americana*	American vetch	
Lamiaceae	HEHI	*Hedeoma hispida*	rough false pennyroyal	
	LECA2	*Leonurus cardiaca*	common motherwort	*
	LYAS	*Lycopus asper*	rough bugleweed	
	MOFI	*Monarda fistulosa*	wild bergamot	
	NECA2	*Nepeta cataria*	catnip	*
	SCLA2	*Scutellaria lateriflora*	blue skullcap	
	STPI6	*Stachys pilosa*	hairy hedgenettle	
Liliaceae	MAST4	*Maianthemum stellatum*	starry false lily of the valley	
Linaceae	LIRI	*Linum rigidum*	stiffstem flax	
Malvaceae	SPCO	*Sphaeralcea coccinea*	scarlet globemallow	
Nyctaginaceae	MILI3	*Mirabilis linearis*	narrowleaf four o'clock	
Oleaceae	FRPE	*Fraxinus pennsylvanica*	green ash	
Onagraceae	OECU2	*Oenothera curtiflora*	velvetweed	
	OESU99	*Oenothera suffrutescens*	scarlet beeblossom	
Oxalidaceae	OXST	*Oxalis stricta*	common yellow oxalis	
Poaceae	AGCR	*Agropyron cristatum*	crested wheatgrass	*
	ANGE	*Andropogon gerardii*	big bluestem	
	BOCU	*Bouteloua curtipendula*	sideoats grama	
	BOGR2	*Bouteloua gracilis*	blue grama	
	BRIN2	*Bromus inermis*	smooth brome	*
	ELVI3	*Elymus virginicus*	Virginia wildrye	
	HECO26	*Hesperostipa comata*	needle and thread	
	KOMA	*Koeleria macrantha*	prairie Junegrass	
	MUCU3	*Muhlenbergia cuspidata*	plains muhly	
	PASM	*Pascopyrum smithii*	western wheatgrass	
	PAVI2	*Panicum virgatum*	switchgrass	
	PHAR3	*Phalaris arundinacea*	reed canarygrass	
	POPR	*Poa pratensis*	Kentucky bluegrass	*
	SCSC	*Schizachyrium scoparium*	little bluestem	
	SONU2	*Sorghastrum nutans*	Indiangrass	
	SPCR	*Sporobolus cryptandrus*	sand dropseed	
	THIN6	*Thinopyrum intermedium*	intermediate wheatgrass	*
Polemoniaceae	PHHO	*Phlox hoodii*	spiny phlox	

Polygalaceae	POAL4	*Polygala alba*	white milkwort	
Primulaceae	ANOC2	*Androsace occidentalis*	western rockjasmine	
Ranunculaceae	ANCA8	*Anemone canadensis*	Canadian anemone	
	ANPA19	*Anemone patens*	eastern pasqueflower	
	THDA	*Thalictrum dasycarpum*	purple meadow-rue	
Rosaceae	AMAL2	*Amelanchier alnifolia*	Saskatoon serviceberry	
	GEAL3	*Geum aleppicum*	yellow avens	
	POPE8	*Potentilla pensylvanica*	Pennsylvania cinquefoil	
	PRAM	*Prunus americana*	American plum	
	PRVI	*Prunus virginiana*	chokecherry	
	ROAR3	*Rosa arkansana*	prairie rose	
Rubiaceae	GAAP2	*Galium aparine*	stickywilly	
	GABO2	*Galium boreale*	northern bedstraw	
	GATR3	*Galium triflorum*	fragrant bedstraw	
Salicaceae	PODE3	*Populus deltoides*	eastern cottonwood	
Scrophulariaceae	PEAL2	*Penstemon albidus*	white penstemon	
Smilacaceae	SMLA3	*Smilax lasioneura*	Blue Ridge carrionflower	
Ulmaceae	ULPU	*Ulmus pumila*	Siberian elm	*
Unknown family	UNKFORB	Unknown forb	unknown forb	*
	UNKFORBANN	Unknown annual forb	unknown annual forb	*
Urticaceae	PAPE5	*Parietaria pensylvanica*	Pennsylvania pellitory	
	URDI	*Urtica dioica*	stinging nettle	
Verbenaceae	PHLE5	*Phryma leptostachya*	American lopseed	
	VEBR	*Verbena bracteata*	bigbract verbena	
Violaceae	VICA4	*Viola canadensis*	Canadian white violet	
Vitaceae	PAVI5	*Parthenocissus vitacea*	woodbine	
	VIRI	*Vitis riparia*	riverbank grape	

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