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Vegetation Community Monitoring at Herbert Hoover National Historic Site, Iowa

2004 - 2009

Natural Resource Data Series NPS/HTLN/NRDS—2011/143

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Introduction

Vegetation inventory and monitoring has been ongoing in the park's tallgrass prairie since 1984. A few minor surveys occurred after reconstruction in 1971 before Dr. Paul Christiansen began annual surveys in 1984 (see Williams et al, 2007 for a summary of monitoring results from 1984 to 2005). Of the 81 acres designated as the natural zone at Herbert Hoover National Historic Site (HEHO), approximately 70 acres comprise the original reconstructed tallgrass prairie. The park added acreage through abandonment of previously mowed areas and through a conversion of three acres of mowed lawn to prairie. The entire area has been under active management to achieve the goals and objectives presented in the Prairie Management Plan (NPS 2003) and draft Resource Stewardship Strategy (NPS 2006). The vision for this area of the park is to create a system that serves as a facsimile of the tallgrass prairie that once dominated Iowa and with vegetation that pragmatically functions as a native prairie community. This report summarizes findings from three years of vegetation community monitoring efforts by the Heartland Inventory and Monitoring Network.

Methods

Data collection

The Heartland Inventory and Monitoring Network (HTLN) implemented monitoring at HEHO in 2004 to provide analysis and to assess future change in the prairie community (see James et al, 2009 for detailed information on monitoring protocol). Monitoring of the reconstructed tallgrass prairie sites occurred in 2004, 2005, and 2009. Six monitoring sites occur in five prairie management units (Fig. 1).

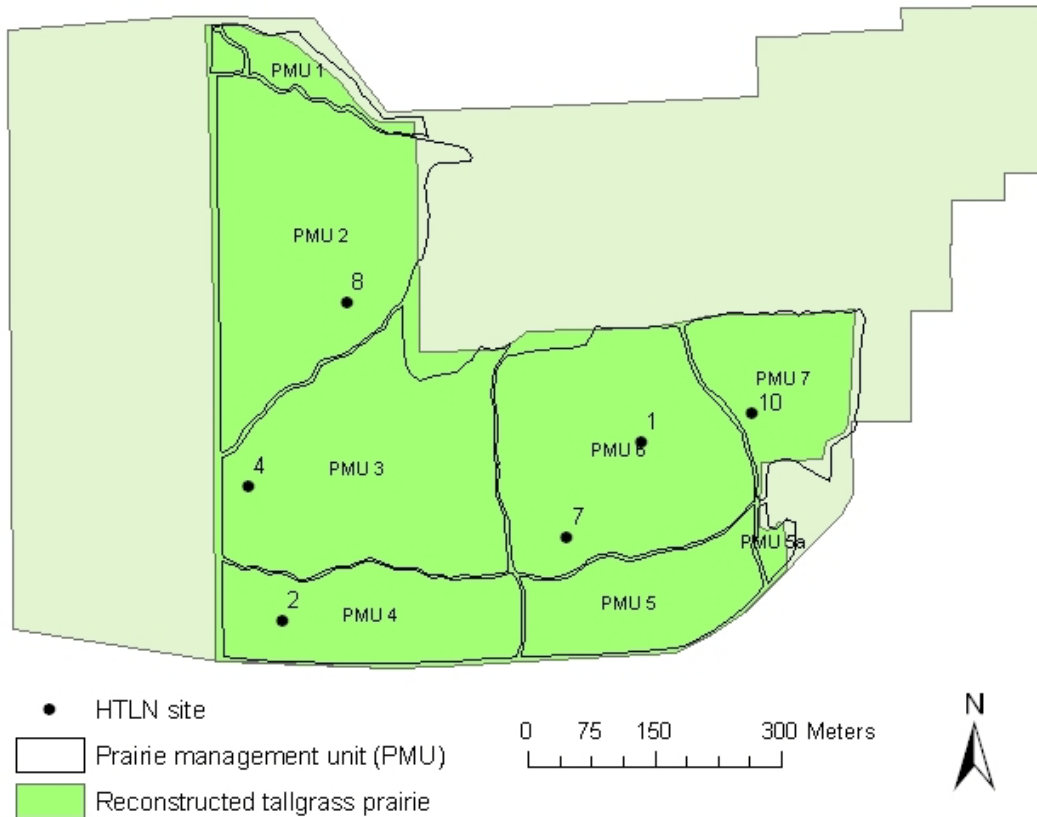


Figure 1. Location of Heartland Inventory and Monitoring Network vegetation monitoring sites (n=6) at Herbert Hoover National Historic Site, Iowa.

All sites are monitored according to the revised 2009 protocol and are comprised of two parallel transects each containing five nested sample plots (Fig. 2). Species composition and foliar cover estimates are collected from each plot and values are summarized to the individual site.

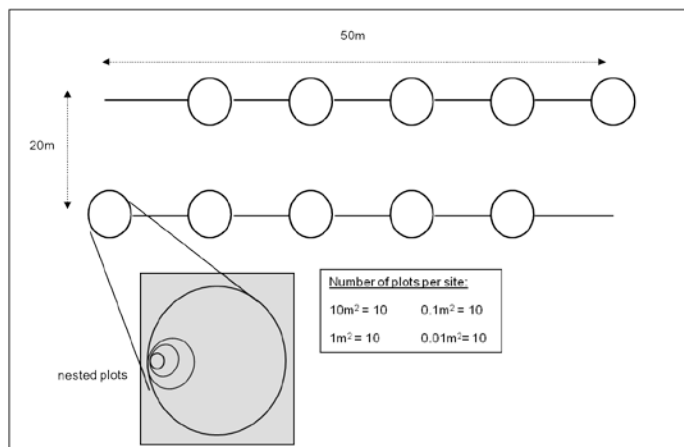


Figure 2. Heartland Inventory and Monitoring Network vegetation community sample design showing transects and plots including nested plots.

Individual species percent foliar cover is calculated for each site. Foliar cover serves as an estimate of abundance for herbaceous species. Cover class intervals are converted to median values to estimate percent cover for each herbaceous and shrub species. Mean percent cover is then calculated as the species percent cover for a site, averaged for all ten plots within the site.

Data Summary and Analysis

Data collected from all plots within a site are summarized by species to the site level. Mean site values along with a measure of among site variability (± 1 standard error of the mean) are presented for the community. Foliar cover estimates collected for each species within a plot are the basis of field data used in all subsequent analysis.

Prairie community diversity

Three measures of diversity were calculated among all sites within the reconstructed prairie. Alpha diversity (i.e., site level diversity) was calculated as the average species richness per site; gamma diversity (i.e., community level diversity) was estimated as the total number of species across all sites (McCune and Grace 2002). Each measure of diversity was summarized for the restored prairie. Beta diversity, as a measure of the heterogeneity in the data, was calculated as (Whittaker 1972):

$$\beta_w = (S_c / S) - 1$$

where:

$$\beta_w = \text{beta diversity,}$$

$$S_c = \text{the number of species in the prairie,}$$

$$S = \text{the average species richness in the sample sites.}$$

As a rule of thumb, values of $\beta_w < 1$ are rather low and $\beta_w > 5$ are considered high beta diversity (McCune and Grace 2002). If $\beta_w = 0$, then all species are found within each site. The one is subtracted to make zero beta diversity correspond to zero variation in species presence. While this measure does not have any formal units, the result could be thought of in approximate units as the “number of distinct communities” (McCune and Grace 2002).

Prairie species diversity

For each site within the community, species richness (S) along with the effective number of species derived from both Shannon diversity index (Shannon number or H_e) and Simpson's diversity index (Simpson's number or D_e) was calculated. Foliar cover estimates for each species in a site are used to determine each measure of species diversity in PC-ORD (McCune and Medford 1999).

Initial plant diversity for each site was calculated using the Shannon diversity index:

$$H' = - \sum_{i=1}^n p_i \ln p_i$$

where p_i is the relative cover of species i (Shannon 1948). Simpson's index of diversity for an infinite population (D) was calculated by site (McCune and Grace 2002). It is the likelihood that

two randomly chosen individuals from a site will be different species and emphasizes common species (McCune and Grace 2002). It is calculated by site using the complement of Simpson's original index of dominance:

$$\text{Simpson's index} = 1 - \sum_i^n p_i^2$$

Shannon and Simpson's index values were converted into effective number of species for each community (H_e and D_e , respectively). This allowed for both diversity measures to be compared directly to species richness of the sites (S) within and among sample years based on counts of distinct species in the community (Jost 2006). Shannon index was converted into effective number of species (H_e) using the following formula:

$$H_e = \exp^{(H)}$$

where H was the Shannon index value. The effective number of species based on Simpson's index (D_e) was the inverse of the index value or:

$$D_e = 1/(1-D)$$

where D was the Simpson's index value.

As S , H_e and D_e approach the same number, species begin to be equally abundant in the prairie while large differences in the number of species between each measure reflect an increasing number of less abundant species and decreasing number of more abundant species. See Jost (2006) and James and Rowell (2009) for a complete explanation and implementation of species diversity measures, respectively.

Prairie guild abundance

Species are grouped into functional guilds and foliar cover estimates are presented at the guild level for the prairie. For each guild, foliar cover is totaled for each plot and then a mean site value is calculated from all ten plots. Guilds are first divided among native and nonnative groups and then among grasses, forbs, sedges/rushes, ferns and woody species within each group. A complete species list along with guild assignment is provided in Appendix A.

Results

Total species richness in the reconstructed prairie differed by eleven species during the monitoring period (gamma diversity, Table 1). Alpha diversity (mean site species richness) fluctuated by six species among the three sample years. Although both alpha and gamma diversity measures were highest in 2005, beta diversity gradually increased through time.

Table 1. Alpha, beta and gamma diversity for the restored prairie by sample year. N is the number of monitoring sites sampled that year.

N	Year	Alpha	Beta	Gamma
4	2004	29.5	1.03	60
6	2005	32.5	1.18	71
6	2009	26.3	1.40	63

The HEHO prairie is characterized by a larger number of species that are represented by a few individuals and/or low foliar cover (species richness, Fig. 3), and a small number of species that occur frequently in large abundance (Shannon and Simpson number, Fig. 3). This is consistent with the distribution patterns of species within a native prairie (Collins and Glenn. 1991).

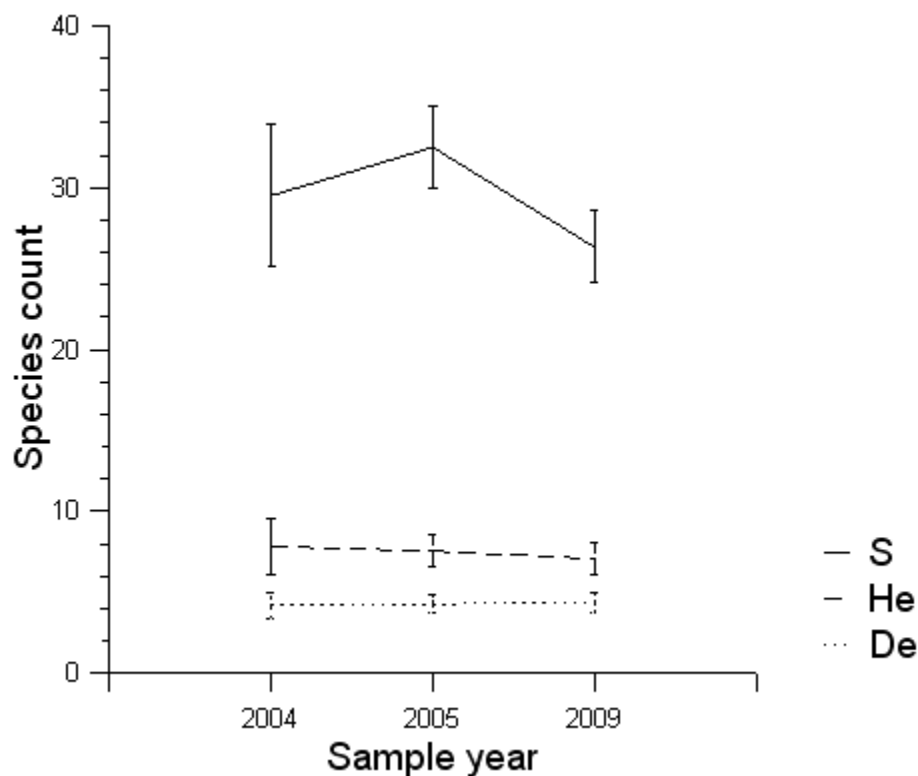


Figure 3. Mean number of species within a site as measured by species richness (S) and effective number of species for two diversity measures (Shannon number, He; and Simpson's number, De) for prairie sites. Error bars are ± 1 standard error of the mean.

Native forb and grass guilds occurred in greatest abundance during all three sample years (Fig. 4). Nonnative forb and grass guilds, although detectable, did not exceed ten percent foliar cover in any sample year.

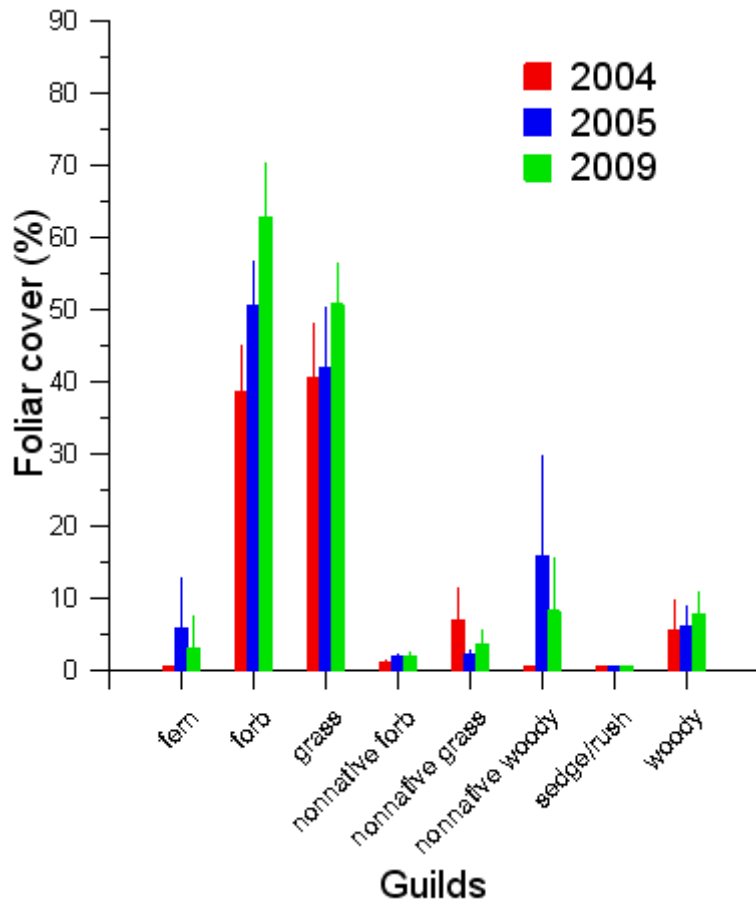


Figure 4. Mean foliar cover (± 1 standard error of the mean) for plant guilds in the reconstructed tallgrass prairie.

Discussion

Diversity measures and guild abundance derived from six HTLN monitoring sites over five years can be used to infer community function across the reconstructed tallgrass prairie area. Beta diversity values close to 1.0 indicate that all six sites are similar and belong to the same single community with nearly half of the total annual species richness being observed within a site. Functioning tallgrass prairies are typically composed of a few abundant native grass and forb species with numerous native species being infrequent or less abundant, as reflected in the difference between species richness and number of species derived from Shannon diversity and Simpson's diversity indices. Furthermore, the presence of diverse native guild groups throughout the sample period reflects the basic components required for a functioning prairie system. However, with any restoration effort, nonnative or invasive exotic species is always a concern.

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Appendix

Appendix A. Species list compiled from all HTLN vegetation monitoring sites sampled between 2004 and 2009.

Scientific name	Common name	Guild
<i>Acalypha virginica</i>	Virginia threeseed mercury	forb
<i>Ambrosia artemisiifolia</i>	annual ragweed	forb
<i>Ambrosia trifida</i>	great ragweed	forb
<i>Andropogon gerardii</i>	big bluestem	grass
<i>Anemone canadensis</i>	Canadian anemone	forb
<i>Antennaria neglecta</i>	field pussytoes	forb
<i>Apocynum cannabinum</i>	Indianhemp	forb
<i>Asclepias</i>	milkweed	forb
<i>Asclepias syriaca</i>	common milkweed	forb
<i>Aster</i>	aster	forb
<i>Aster lanceolatus</i>	white panicle aster	forb
<i>Aster novae-angliae</i>	New England wild aster	forb
<i>Aster pilosus</i>	Awl wild aster	forb
<i>Astragalus canadensis</i>	Canadian milkvetch	forb
<i>Baptisia alba</i> var. <i>macrophylla</i>	largeleaf wild indigo	forb
<i>Bouteloua curtipendula</i>	sideoats grama	grass
<i>Bromus inermis</i>	smooth brome	nonnative grass
<i>Calystegia sepium</i>	hedge false bindweed	forb
<i>Carex</i>	sedge	sedge/rush
<i>Cirsium discolor</i>	field thistle	forb
<i>Conyza canadensis</i>	Canadian horseweed	forb
<i>Cornus</i>	dogwood	woody
<i>Cornus racemosa</i>	gray dogwood	woody
<i>Desmodium canadense</i>	showy ticktrefoil	forb
<i>Echinacea pallida</i>	pale purple coneflower	forb
<i>Elaeagnus umbellata</i>	autumn olive	nonnative woody
<i>Elymus canadensis</i>	Canada wildrye	grass
<i>Equisetum arvense</i>	field horsetail	fern
<i>Erigeron strigosus</i>	prairie fleabane	forb
<i>Eryngium yuccifolium</i>	button eryngo	forb
<i>Helianthus grosseserratus</i>	sawtooth sunflower	forb
<i>Heliopsis helianthoides</i>	smooth oxeye	forb
<i>Heuchera richardsonii</i>	Richardson's alumroot	forb
<i>Hypericum ascyron</i>	great St. Johnswort	forb
<i>Juglans nigra</i>	black walnut	woody
<i>Lactuca canadensis</i>	Canada lettuce	forb
<i>Lactuca serriola</i>	prickly lettuce	nonnative forb

<i>Lespedeza capitata</i>	roundhead lespedeza	forb
<i>Lobelia spicata</i>	palespike lobelia	forb
<i>Lonicera</i>	honeysuckle	nonnative woody
<i>Medicago</i>	alfalfa	nonnative grass
<i>Melilotus officinalis</i>	yellow sweetclover	nonnative woody
<i>Monarda fistulosa</i>	wild bergamot	forb
<i>Morus alba</i>	white mulberry	nonnative woody
<i>Muhlenbergia</i>	muhly	grass
<i>Muhlenbergia racemosa</i>	marsh muhly	grass
<i>Oxalis</i>	woodsorrel	forb
<i>Panicum virgatum</i>	switchgrass	grass
<i>Pastinaca sativa</i>	wild parsnip	nonnative forb
<i>Phalaris arundinacea</i>	reed canarygrass	nonnative grass
<i>Physalis heterophylla</i>	clammy groundcherry	grass
<i>Physalis virginiana</i>	Virginia groundcherry	grass
<i>Poa compressa</i>	Canada bluegrass	nonnative grass
<i>Poa pratensis</i>	Kentucky bluegrass	nonnative grass
<i>Prunus virginiana</i>	chokecherry	woody
<i>Ratibida pinnata</i>	pinnate prairie coneflower	forb
<i>Rhus glabra</i>	smooth sumac	woody
<i>Rosa carolina</i>	Carolina rose	woody
<i>Rubus</i>	blackberry	woody
<i>Rudbeckia hirta</i>	blackeyed Susan	forb
<i>Rudbeckia laciniata</i>	cutleaf coneflower	forb
<i>Rumex crispus</i>	curly dock	nonnative forb
<i>Sambucus nigra</i> ssp. <i>canadensis</i>	American black elderberry	woody
<i>Schizachyrium scoparium</i>	little bluestem	grass
<i>Senecio plattensis</i>	Platte groundsel	forb
<i>Setaria viridis</i>	green bristlegrass	nonnative grass
<i>Silphium perfoliatum</i>	cup plant	forb
<i>Solanum carolinense</i>	Carolina horsenettle	forb
<i>Solidago canadensis</i>	Canada goldenrod	forb
<i>Solidago missouriensis</i>	Missouri goldenrod	forb
<i>Solidago rigida</i>	Stiff goldenrod	forb
<i>Sorghastrum nutans</i>	Indiangrass	grass
<i>Symphoricarpos occidentalis</i>	western snowberry	woody
<i>Taraxacum officinale</i>	common dandelion	nonnative forb
<i>Thalictrum dasycarpum</i>	purple meadow-rue	forb
<i>Tradescantia ohiensis</i>	bluejacket	forb
<i>Trifolium repens</i>	white clover	nonnative forb
<i>Ulmus rubra</i>	slippery elm	woody
<i>Veronicastrum virginicum</i>	Culver's root	forb
<i>Viburnum</i>	viburnum	woody

Viburnum lentago

Viola

Vitis

Zizia aurea

nannyberry

violet

grape

golden zizia

woody

forb

woody

forb