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Natural Resource Stewardship and Science

# Vegetation Monitoring at Homestead National Monument of America, Nebraska

*1998–2017*

Natural Resource Report NPS/HTLN/NRR—2019/1989

ON THE COVER
Sherry Leis traversing the prairie during vegetation monitoring at Homestead National Monument of America in 2017.
Photography by NPS/Heartland Network

# Vegetation Monitoring at Homestead National Monument of America, Nebraska

## *1998–2017*

Natural Resource Report NPS/HTLN/NRR—2019/1989

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# Executive Summary

The Heartland Inventory and Monitoring Network has sampled permanent monitoring sites in three vegetation community types (restored prairie, successional forest, and bur oak forest) at Homestead National Monument of America since 1998 (includes nine sample years). Network scientists record each species, aerial cover estimates of ground flora, diameter at breast height of midstory and overstory trees, and tree regeneration frequency (tree seedlings and saplings) within these permanent sites.

The park has experienced similar periods of drought and wetness through the monitoring record. Ground cover estimates indicate that prairie litter and bare ground are negatively related; prescribed fire cycles in the prairie are likely related to these trends in litter and bare ground. In the forests, bare ground is very low because deciduous leaf litter is high and variable. Ground flora vegetation is also sparse in the forests.

Basal area for the park forests appears to be very stable through time. The successional forest is dominated by hackberry (*Celtis occidentalis*) with prominent bur oaks (*Quercus macrocarpa*), but the bur oak forest is dominated by a small number of large bur oak trees, although there are more hackberry trees overall in both forest types. Both forest types have a developed midstory layer (class 1 trees). Canopy closure continues to be high in both forest types.

This closed canopy forest structure may limit oak regeneration because light is required on the forest floor for germination and recruitment. The most common species in the regeneration layer (seedlings and saplings) is hackberry. Bur oak regeneration was uncommon. Tree regeneration in the prairie was greatest in 2017 and dominated by elms (*Ulmus* spp.).

The prairie ground flora was most diverse (109 native species found in 2017), meeting prairie management goals. Composition within the prairie monitoring sites may be becoming more distinct over time. Diversity measures were variable across the successional forest sites in most years. Forbs were the primary plant guild in the ground flora layer of both forest communities. Grass and forb guilds appeared to decline over time in the prairie, but we attribute that in part to sampling error. The woody species guild remained similar through time; this guild is better understood through focused thicket monitoring. Exotic species are most common in the prairie, but two target species, Kentucky bluegrass (*Poa pratensis*) and smooth brome (*Bromus inermis*), were below management thresholds.

Plant communities at the park have remained relatively stable through the monitoring record. Trends in total plant cover and prairie forbs and grasses are unclear and likely due to sampling errors. Management actions that affect canopy cover have the potential to affect forest composition.

# Acknowledgments

We are grateful for the contributions of previous staff who helped to monitor vegetation at Homestead National Monument of America. S. Rolfsmeier provided botanical support in 2017. We also appreciate field support from the park. Some of the language of this report was taken from James et.al. (2009), particularly the methods. J. Haack-Gaynor provided maps. Mary Short provided forest expertise and analysis support.

# Introduction

Homestead National Monument of America celebrates the landscape the new settlers to the Great Plains would have encountered (NPS 2006). The park's natural communities play an important role in interpreting the history of the Homestead Act and the impact of homesteaders at Homestead National Monument of America. Park managers defined the desired condition of these resources (NPS 2006):

> "The monument's natural resources are managed in such a way as to maintain a heterogeneous landscape composed of a mosaic of high quality remnant and restored tallgrass prairie, lowland bur oak forest and associated ecotones, as well as prairie streams and their hydrologic processes; that reflect the value of the site as a homestead, represents as accurately as possible the environment encountered by early settlers, and preserves native biodiversity."

The tallgrass prairie and forests at the park have gone through extensive changes through time. The 100-acre prairie, restored in 1939, is the second oldest prairie restoration in the country and was the dominant vegetation type in the area at the time of settlement (Stubbendieck and Wilson 1987). The prairie has both upland and lowland components contributing to its diversity. Management includes prescribed fire, herbicide application, and mowing treatments to achieve goals focused on shrub, invasive cool season grass, and other invasive species management, in addition to supporting a diverse community of native species (NPS 2006, Beacham 2016).

Forested areas of the park extend from the floodplain of Cub Creek outward toward the prairie or crop fields. Although historically the forest could have represented a single community type, presently it is divided into two community types resulting from

Mike DeBacker measuring ground cover in the lowland forest during monitoring at Homestead National Monument of America in 2017.

differential anthropogenic activity (see Figure 1 in the Methods section). The northern portion of the forest, referred to as the bur oak woodland, is recognized as a rare community type in Nebraska (mesic bur oak forest; Steinauer and Rolfsmeier 2000). The southern portion of the forest, referred to as the successional forest, has a history of logging (Shevlin 1939; Mlekush and DeBacker 2003). Both forest communities have been excluded from prescribed fire since the monument was designated. Occasional flooding continues and deer herbivory is common in the forest.

The history of management recommendations for the forest is complex. Rolfsmeir's 2002 report (in Mlekush and DeBacker 2003) cautions against targeting a savanna structure. Rolfsmeir was concerned that using aggressive treatments to open the canopy could lead to expansion of invasive species rather than enhancement of a healthy forest. A 2007 report suggests that the canopy would have been relatively closed historically with gaps occurring within the woodland (Rolfsmeir 2007). A combination of careful thinning followed by fire was recommended for woodland restoration. Forest management has focused on invasive species removal and treatment in recent years.

Natural resource managers continue to develop strategies to maintain these communities, and long-term, reliable, scientific data can contribute to these planning efforts. Herein we present trend data for the prairie and two forest community types for the period of 1998 to 2017. These data provide a basis for park vegetation community management discussions.

# Methods

## Study Site

Sampling sites focus on three distinct plant community types at Homestead National Monument of America (Figure 1). Restored prairie includes seven sites. Forest sites include two successional forest (NVC identifier:CEGL002014) sites and one bur oak woodland (NVC identifier: CEGL002053; Kindscher et.al. 2011) site.

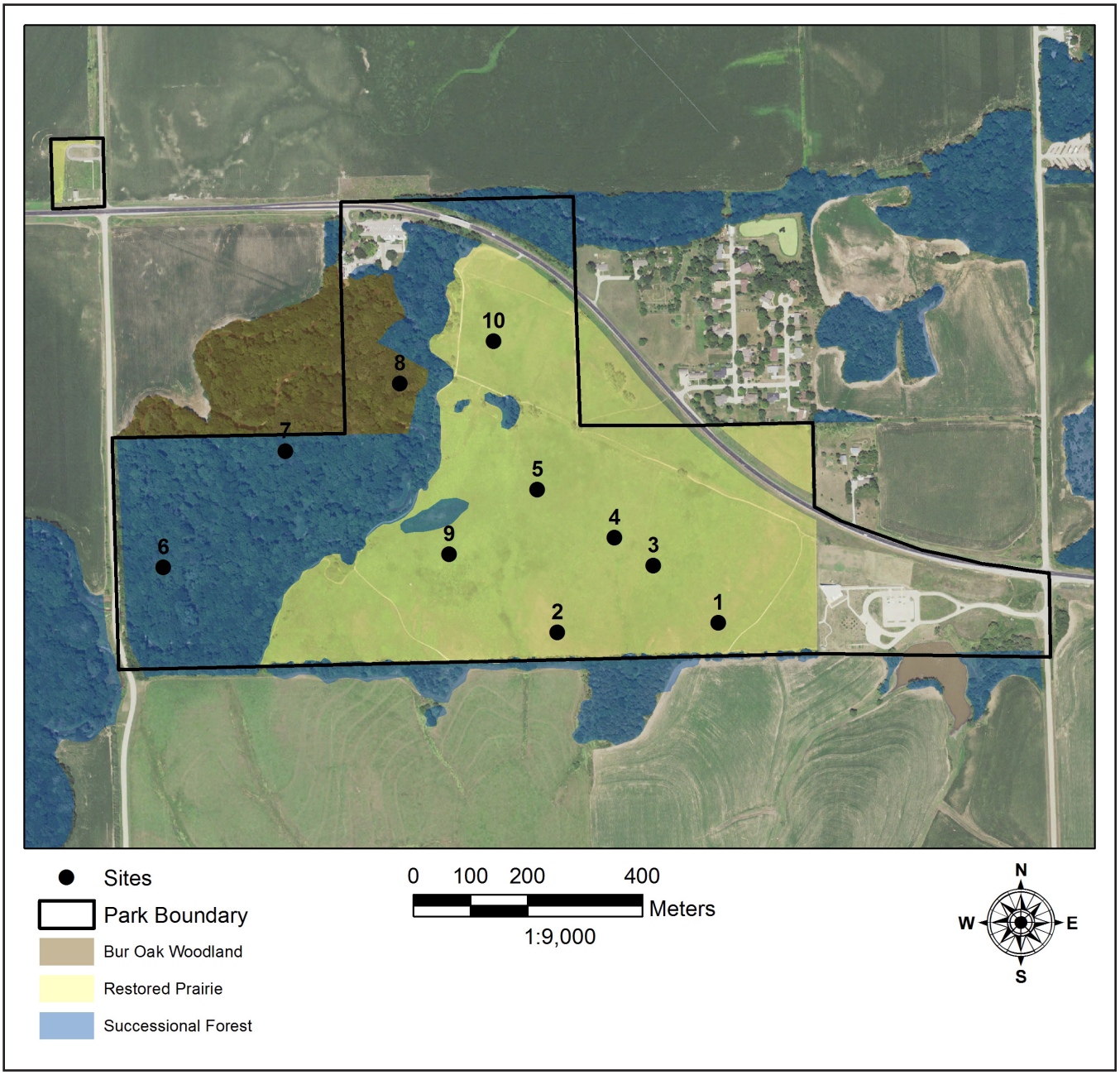


**Figure 1.** Map of Homestead National Monument of America monitoring sites with vegetation types based on Kindscher et al. (2011).

## Design

Monitoring methods followed the standard operating procedures outlined in the vegetation community monitoring protocol (James et al. 2009). Monitoring sites were 50 x 20 m (0.1 ha) in size with two focal transects bounding the site on the 50-m sides (Figure 2). For this protocol, overstory tree data were collected within the entire 0.1 ha area, while all other metrics were collected within 10 subplots located along the site boundaries. Each subplot consisted of a series of nested frames (0.01 $m^2$, 0.1 $m^2$, 1 $m^2$, and 10 $m^2$), but only observations at the 10-$m^2$ scale were summarized to the site scale (0.1 ha) for this study. Forest monitoring consisted of a suite of sampling methods for characterizing overstory tree composition, canopy cover, regeneration, understory herbaceous species composition, and ground cover. See James et al. (2009) for additional details on sampling design.

It is important to note that the monitoring protocol was changed in 2009 (James et. al. 2009 appendices). The revisit design changed from two-season sampling for monitored years to one-season sampling in monitored years. We expected a small decline in species richness (about 9 species) as a result.

## Data Summary

Monitoring sites were added at different times (Table 1). For forest sites, we started the analyses in 2002 when both successional forest sites were installed and sampled. We were unable to sample the one bur oak forest community site during the last monitoring event (2017) because of hazardous debris from a recent windstorm. For the prairie sites, we included all monitored years. However, sample sizes varied by year (N = 3 in 2002; N = 5 from 1998–2000 and 2005–2006; and N = 7 from 2009–2017).

SPSS (Version 24) (IBM 2016) and PCord (McCune and Mefford 2016) were used for summary statistics. All site means were calculated based on 10 subplots for each year (see Table 1 for number of sites).

### *Climate*

The Palmer drought severity index (PDSI) was used to describe the climate over the period of monitoring at the park (Heggen 1993; Vose et.al. 2014). Data were obtained from the NOAA/National Climatic Data Center (https://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#; accessed April 1, 2019). Monthly data were acquired for the southeastern region of Nebraska and averaged by year.

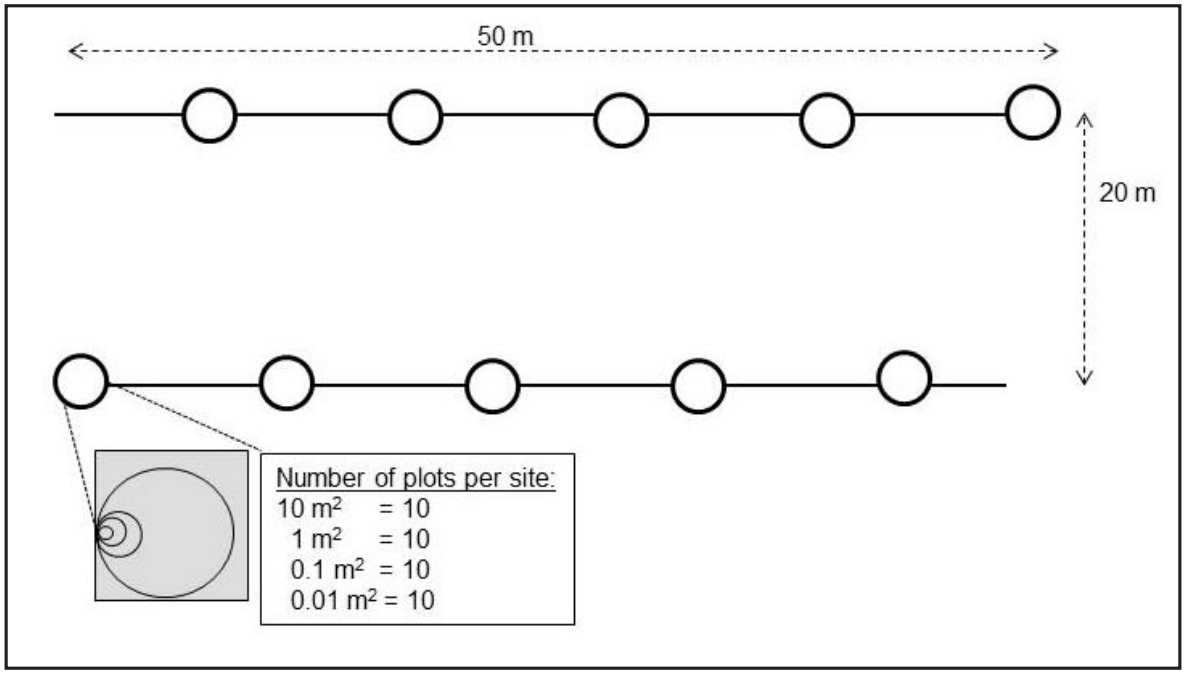


**Figure 2.** Plant community site monitoring design for Heartland Inventory and Monitoring Network parks.

**Table 1.** Site installation history and number of sites included in analyses.

| Year | New sites Installed | | | Sites Sampled | Sites in Analysis |
|---|---|---|---|---|---|
| | Prairie | Successional Forest | Bur Oak Forest | | |
| 1998 | 5 | – | – | 5 | 5 prairie only |
| 1999 | – | – | – | 5 | 5 prairie only |
| 2000 | – | 1 | – | 6 | 5 prairie only |
| 2002 | – | 1 | – | 5 | 5 (3 prairie, 2 successional forest) |
| 2005 | – | – | 1 | 8 | 8 (5 prairie, 3 forest) |
| 2006 | – | – | – | 8 | 8 (5 prairie, 3 forest) |
| 2009 | 2 | – | – | 10 | 10 (7 prairie, 3 forest) |
| 2013 | – | – | – | 10 | 10 (7 prairie, 3 forest) |
| 2017 | – | – | – | 9 | 9 (bur oak forest not sampled) |
| Total Sites | 7 | 2 | 1 | 10 | n/a |

### *Forest Overstory and Midstory*

Tree composition in the forest was based on individual tree counts for each species and diameter at breast height (DBH) for each tree greater than 5.0 cm in the 0.1-ha sites. Snags were calculated separately from live trees for overstory analysis. Basal area and stem density were calculated within size class categories (Table 2) as described in James et al. (2009). We distinguished class 1 (midstory trees) from classes 2 through 5 (overstory trees) for interpretation. In 2017, we measured a subplot (200 $m^2$) in three of the four sites because of the high volume of trees.

**Table 2.** Diameter at breast height (DBH) measurement range (cm) and size class used to group overstory trees.

| DBH (cm) | Size Class | Type |
|---|---|---|
| 5.0–14.9 | 1 | Midstory |
| 15.0–24.9 | 2 | Overstory |
| 25.0–34.9 | 3 | Overstory |
| 35.0–44.9 | 4 | Overstory |
| ≥ 45 | 5 | Overstory |

Canopy cover data were collected in the successional forest using a densitometer in 2002, 2005, 2013 and 2017. These data were collected in 2005 and 2013 for the bur oak forest. Densitometer readings were collected in the four cardinal directions in each of the ten 10-$m^2$ plots and converted to canopy cover (multiplying by 1.04). Plot level mean canopy cover (n = 4 per plot) was used to calculate site-level mean canopy cover. A grand mean was then calculated for all sites (N = 2 for successional forest and N = 1 for bur oak forest).

### *Forest Understory*

Woody regeneration and ground flora were measured within the ten 10-$m^2$ plots in each site.

Foliar cover serves as an estimate of abundance for ground flora species. The cover class intervals are converted to median values to estimate percent cover for each herbaceous and shrub species (Table 3). Mean percent cover is then calculated as the species percent cover for a sampling unit, averaged for all plots (n = 10). Sampling unit means were then used to calculate community level means.

**Table 3.** Modified Daubenmire cover value scale used to determine ground flora species cover for the Heartland Network parks.

| Cover Class Codes | Range of Cover (%) | Class Midpoints (%) |
|---|---|---|
| 7 | 95–100 | 97.5 |
| 6 | 75–95 | 85.0 |
| 5 | 50–75 | 62.5 |
| 4 | 25–50 | 37.5 |
| 3 | 5–25 | 15.0 |
| 2 | 1–5 | 2.5 |
| 1 | 0–0.99 | 0.5 |

### *Tree Regeneration*

Tree regeneration phase stems were tallied by species in the ten 10-$m^2$ subplots of each site and reported in three size classes: (1) seedlings = stems < 0.5 m tall; (2) small saplings = stems ≥ 0.5 m tall, but < 2.5 cm DBH; and (3) large saplings = stems ≥ 0.5 m tall and DBH > 2.5 cm and < 5.0 cm. Summary was done by pooling species to look at total stems/ha and by calculating stems/ha for each individual species. In both cases, stems were summed and averaged by the number of sites for each community (Table 2). We did not include measures of variability because sample sizes were either 1 or 2 for the forest and regeneration occurrence was relatively low and unevenly distributed among prairie sites.

### *Understory Species Diversity Indices*

Diversity indices describe the number of species and their abundances (based on foliar cover measurements) and can be compared across monitoring sites in the park. Mean site cover for all non-tree species was calculated using all plots within each site (n = 10). For each site within the community, species richness (S), Shannon diversity index (H′) and evenness (J′) were calculated. S represents the number of species observed. PC-ORD (version 7.02) was used to calculate these diversity indices (IBM 2016; McCune and Mefford 2016). A grand mean was then calculated for all sites in a community.

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

$$\text{Shannon Index: } H' = -\sum_{i=1}^{n} p_i \ln p_i$$

where $p_i$ is the relative cover of species i (Shannon 1948).

Species distribution evenness (J′) is calculated by site according to Pielou (1977):

$$\text{Evenness: } J' = \frac{H'}{\ln (S)}$$

where H′ is the Shannon index and ln(S) is the maximum possible Shannon diversity for a given number of species if all species were present in equal numbers. Evenness is a measure of distribution of species within a community as compared to equal distribution and maximum diversity (Pielou 1969).

### *Understory Community Diversity Metrics*

Community richness metrics evaluate how species richness differs across study sites and the park. We limited these calculations to understory herbaceous species. Alpha diversity is synonymous with species richness at the site scale (i.e., mean number of species per monitoring site). This is equivalent to species richness used to calculate the diversity measures described previously. Gamma diversity is the park richness (i.e., total number of species in the park) observed across all monitoring sites. Beta diversity is a measure of variation in species richness across monitoring sites such that small values (near 0) indicate a high degree of similarity in species occurrence across monitoring sites and greater values (>5) indicate a higher degree of variation in species between sites (more differentiated communities; McCune and Grace 2002).

$$\textit{Beta Diversity} = (\textit{gamma}/\textit{alpha}) - 1$$

### *Understory Guild Abundance*

Understory species were also summarized by guilds, also known as functional groups (designations per the USDA Plants database; James et al. 2009; USDA NRCS 2017). Guild assignments were grasses, forbs, grass-like species (sedges and rushes), and woody species. A complete species list along with guild assignment is provided in Appendix A. Mean cover values were calculated for each guild-site-year combination. A grand mean was then calculated across all sites in each community type.

Total site cover was assessed using the mean cover values for species separated by origin. Mean cover values for species within a site were totaled and then sites were averaged to calculate mean percent site cover.

Note: During peer review of this report, we discovered an error in the origin designation of *Cannabis sativa*. It was mistakenly designated as a native species. During revision we corrected the species richness analyses, alpha and gamma diversity, and analysis of origin by cover. We did not correct the other diversity measures or the guild analysis, as the abundance of 0.05 would not have influenced the results.

### *Ground Cover*

Ground cover was assessed using cover classes (Table 3). A site mean was calculated by averaging the cover class midpoints for plots (n = 10) in each site. We observed aerial cover of grass litter, leaf litter (deciduous plant leaves), rock (exposed rock), bare ground (soil), and the cover of woody debris (e.g. branches and sticks). Total unvegetated area reflects space unoccupied by stem basal area in the plots (James et al. 2009). Confidence intervals (95%) were calculated and displayed to illustrate trends relative to established goals.

# Results and Discussion

## Climate

Climate in the Great Plains is characteristically variable with drought occurring periodically (Anderson 2006). Over the vegetation monitoring record at Homestead National Monument of America, the number of years with mean Palmer Drought Severity Index (PDSI) greater than zero was equal to the number of years less than zero (Figure 3) indicating a balance of wet and dry years over time.

## Ground Cover

Woody debris and leaf litter were low, which is consistent with the limited number of tree stems present in the prairie (Figure 4; also see Figure 10 under Canopy Closure section below). Bare ground levels were opposite of grass litter, especially in 2006 and 2009. Prescribed fire cycles are likely related to the trends in litter and bare ground in the prairie, although moisture availability can contribute to biomass and litter production (Bragg 1995). Cover estimates in 1998 and 1999 may have been less standardized than in other years.

Ground cover metrics were similar across forest community types except for leaf litter, where forest types were more differentiated especially since 2009 (Figure 5). The forest monitoring sites are sparsely vegetated (unvegetated ground cover category) with a great deal of heterogeneity in most categories.

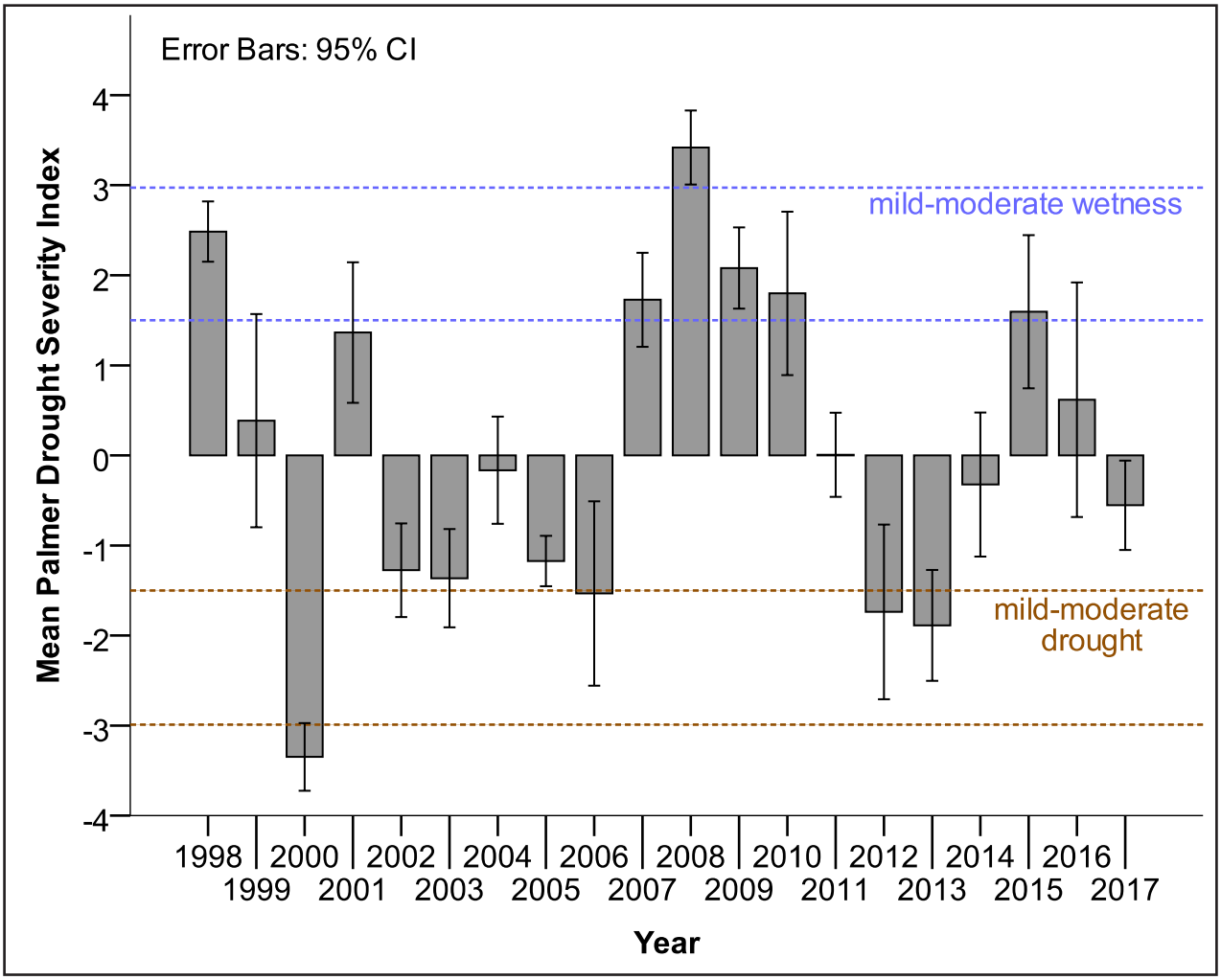


**Figure 3.** Mean Palmer Drought Severity Index for southeastern Nebraska, 1998–2017.

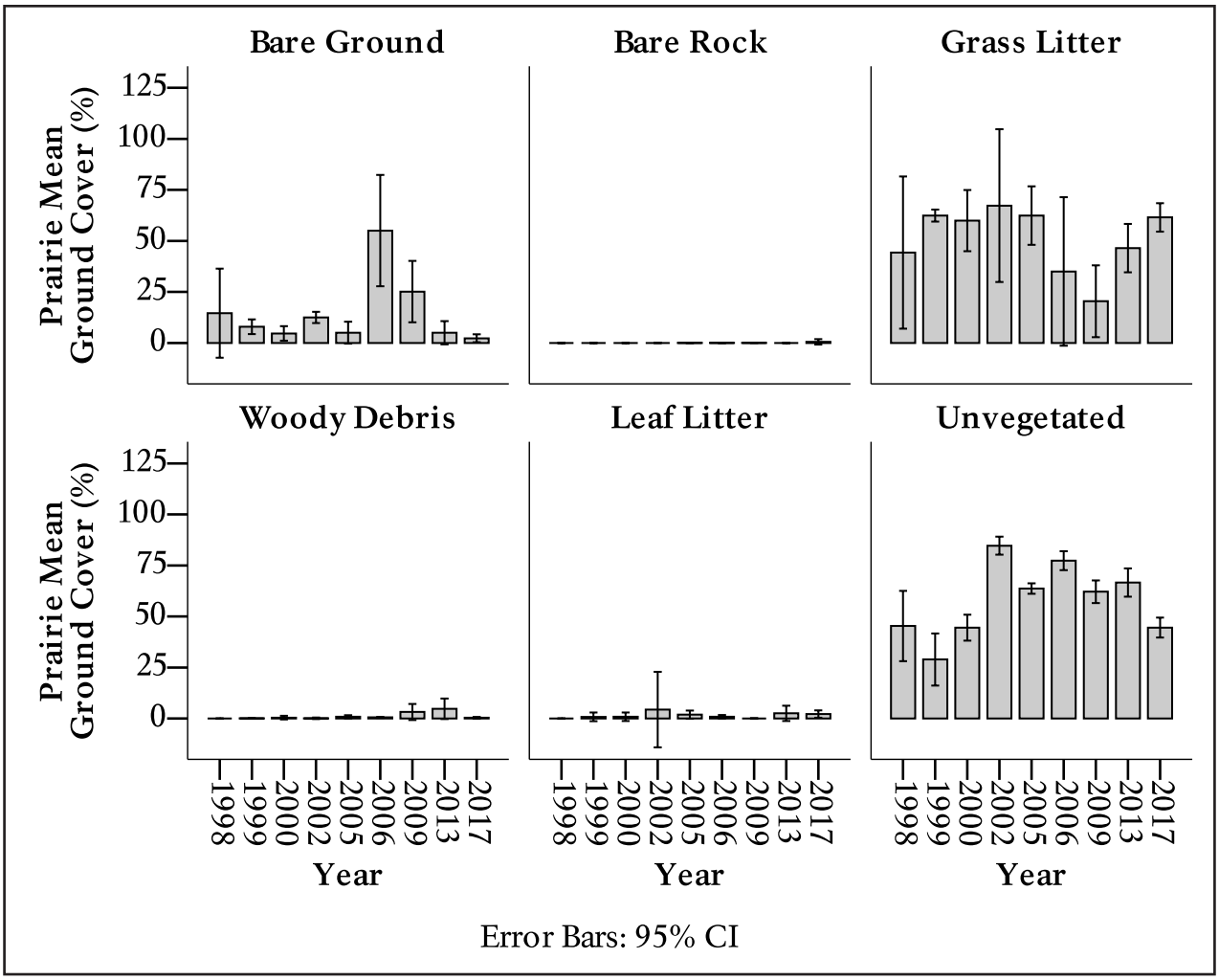


**Figure 4.** Ground cover for prairie monitoring sites at Homestead National Monument of America, 1998–2017. Number of samples differed through time: N = 3 in 2002, N = 5 from1998–2000 and 2005–2006, and N = 7 from 2009–2017.

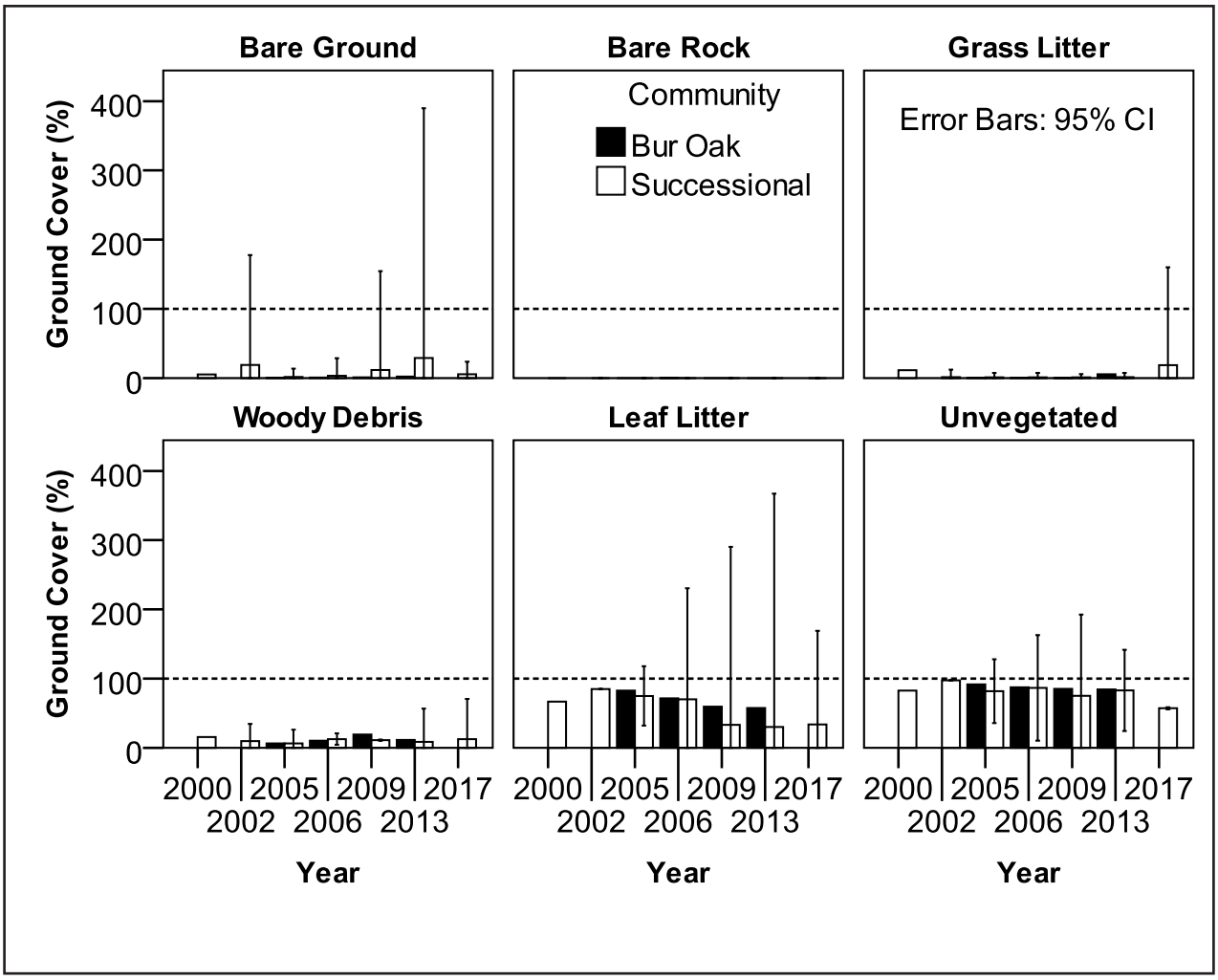


**Figure 5.** Mean percent ground cover for forest monitoring sites at Homestead National Monument of America, 2000–2017. N = 1 for bur oak forest type and N = 2 for successional forest type. A dashed line at 100% indicates the maximum possible value for a ground cover metric.

## Midstory and Overstory Trees

Total basal area of forested sites at Homestead National Monument of America indicates a forest structure (>30 $m^2$/ha) although the successional forest sites (Hanberry et. al. 2014) became more heterogeneous in recent years (Table 4). Rolfsmeier (2007) described an open woodland structure at the time of settlement in what is now bur oak forest and successional forest communities.

Basal area for individual species is similar within forest types through the monitoring record (Figure 6). Assessment of basal area with species aggregated by size class also indicates little change in the distribution through time (Figure 7). The species composition we observed is consistent with these forest types as defined by other sources (i.e., Kindscher et.al. 2011; Steinauer and Rolfsmeier 2000)

**Table 4.** Total basal area ($m^2$/ha) for forest types at Homestead National Monument of America. Confidence intervals for successional type based on N = 2 for successional forest and N = 1 for bur oak type. NA = not available.

| Year | Successional Forest | ± 95% CI | Bur Oak Forest |
|---|---|---|---|
| 2002 | 30.8 | 20.6 | NA |
| 2005 | 32.6 | 27.6 | 39.9 |
| 2009 | 30.8 | 11.9 | 41.9 |
| 2013 | 34.0 | 5.8 | 39.4 |
| 2017 | 34.7 | 6.1 | NA |

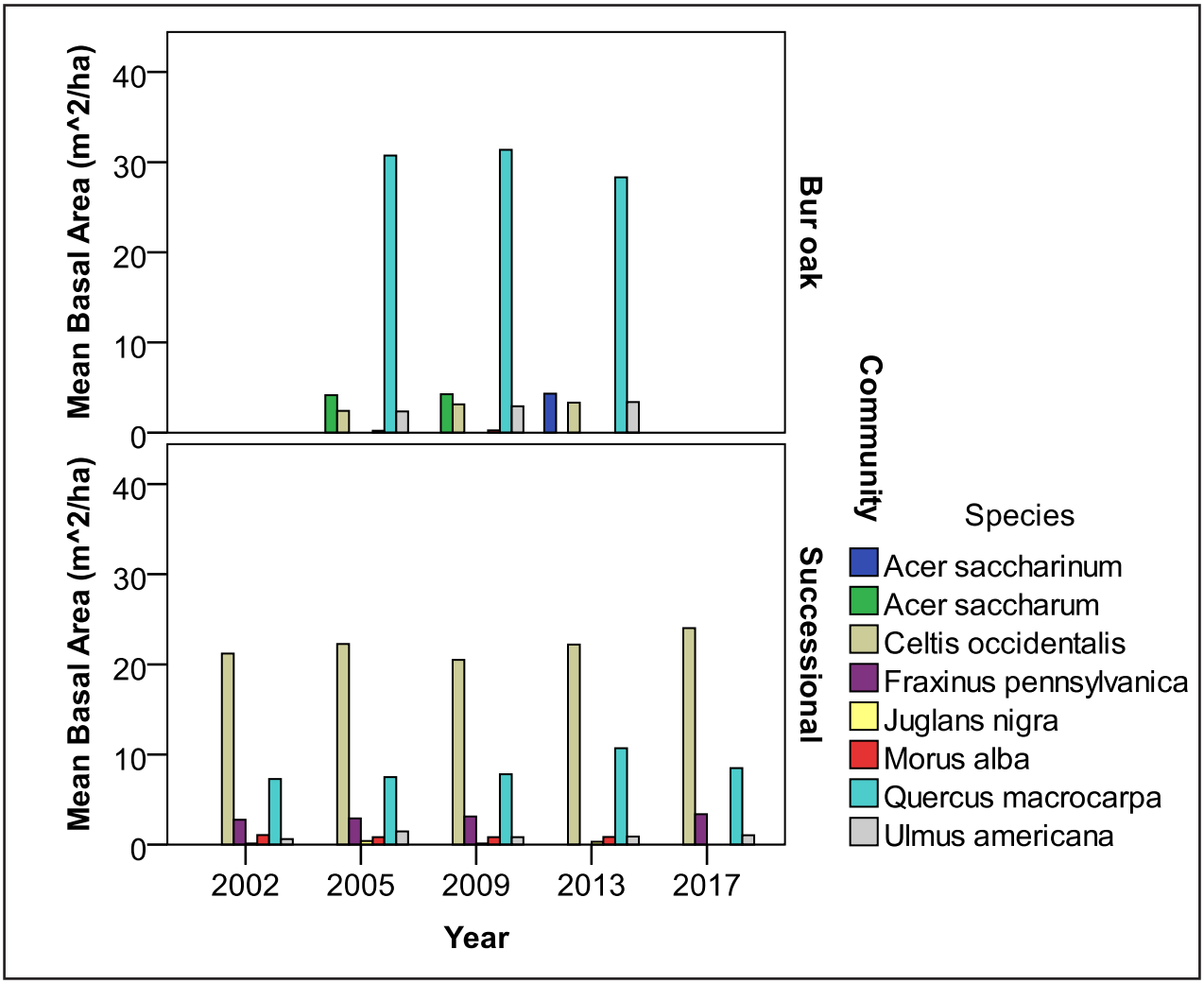


**Figure 6.** Mean basal area ($m^2$/ha) by species for forest vegetation types at Homestead National Monument of America, 2002–2017 (N = 1 for bur oak forest and N = 2 for successional forest).

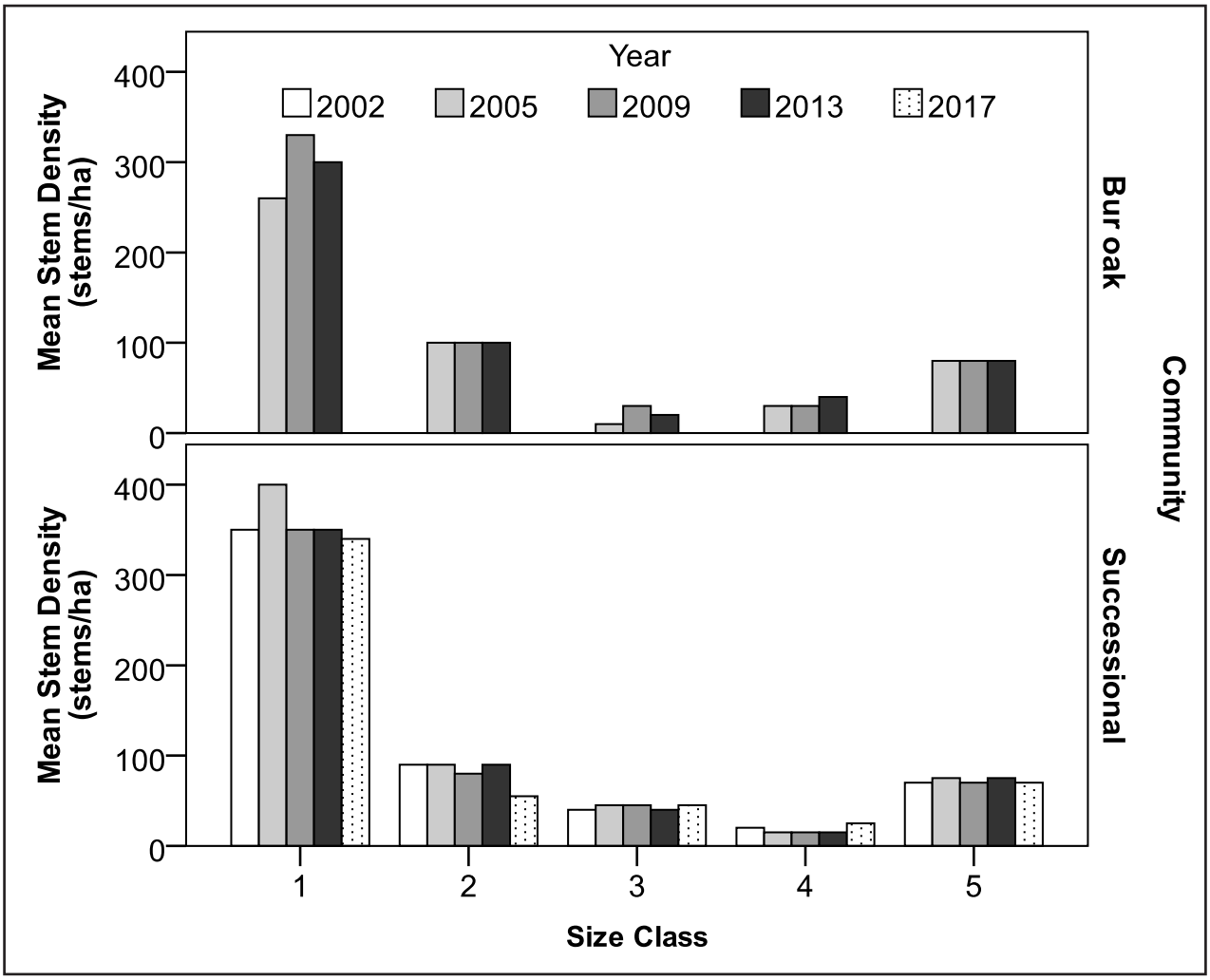


**Figure 7.** Mean stem density (stems/ha) for forest vegetation types at Homestead National Monument of America, 2002–2017 (N = 1 for bur oak forest and N = 2 for successional forest).

Total tree density for the two forest types (Table 5) is in the range of closed woodland-forest, consistent with the basal area estimates (Hanberry et. al. 2014). Distribution of stems within size classes has been consistent through time (Figure 7).

The forest is dominated by hackberry trees (*Celtis occidentalis*) in both community types. The density of each species was similar through time. The density of hackberry was three or more times greater than bur oak (*Quercus macrocarpa*) in the bur oak forest community type. Interestingly, in the bur oak forest community, the bur oak trees are large such that they dominate the forest by basal area (Figure 6), but they are few in number leaving the hackberry trees to dominate stem density (Figure 8).

**Table 5.** Tree density (stems/ha) for forest types at Homestead National Monument of America. Confidence intervals for successional forest type based on N = 2 for successional forest and N = 1 for bur oak forest. NA = not available.

| Year | Successional Forest | ± 95% CI | Bur Oak Forest |
|---|---|---|---|
| 2002 | 570 | 3049.4 | NA |
| 2005 | 625 | 2858.9 | 480 |
| 2009 | 560 | 2414.1 | 570 |
| 2013 | 570 | 2668.3 | 540 |
| 2017 | 535 | 2350.6 | NA |

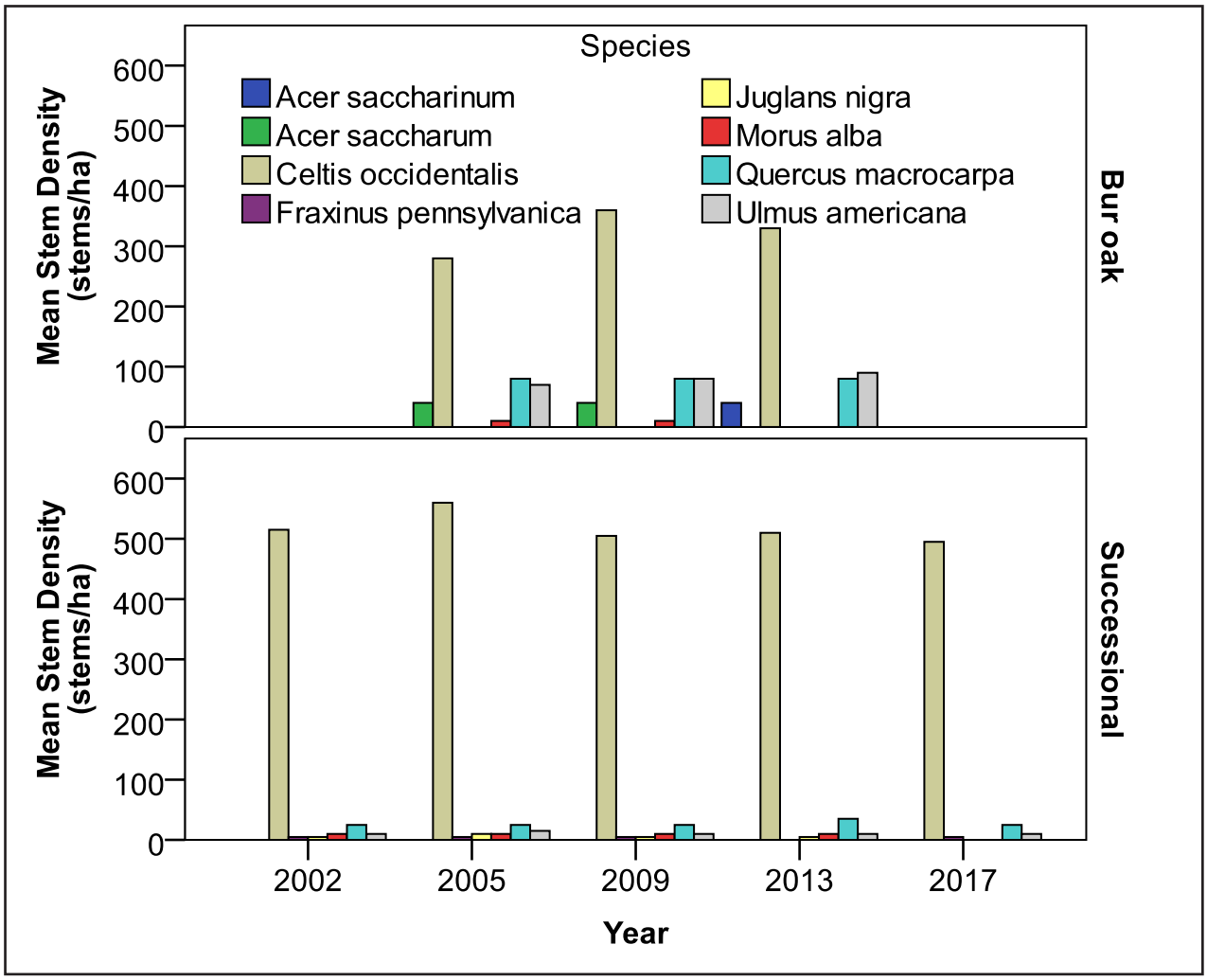


**Figure 8.** Density of midstory and overstory tree stems by species in the forest community types at Homestead National Monument of America, 2002–2017 (N = 2 for successional forest and N = 1 for bur oak forest).

### *Canopy Closure*

Canopy closure has been similar through the monitoring period, varying by only 9% in the successional forest (Figure 9). Canopy closure indicates the communities represented by our monitoring sites are at the boundary of closed woodland and forest types (Hanberry et. al. 2014). Consistent with the basal area and stem density measurements, we would characterize the structure as a forest type rather than an open woodland type.

Exclusion of fire has been suggested as a mechanism affecting the forests at Homestead National Monument of America (Rolfsmeier 2007). The Heartland Inventory and Monitoring Network's nearly 50-year record of fire history at the park shows that the forest communities have not been burned in that period of time. The role of fire in maintaining the forest has varied through time and remains unclear (Rolfsmeier 2002 *in* Mlekush and DeBacker 2003; Rolfsmeier 2007).

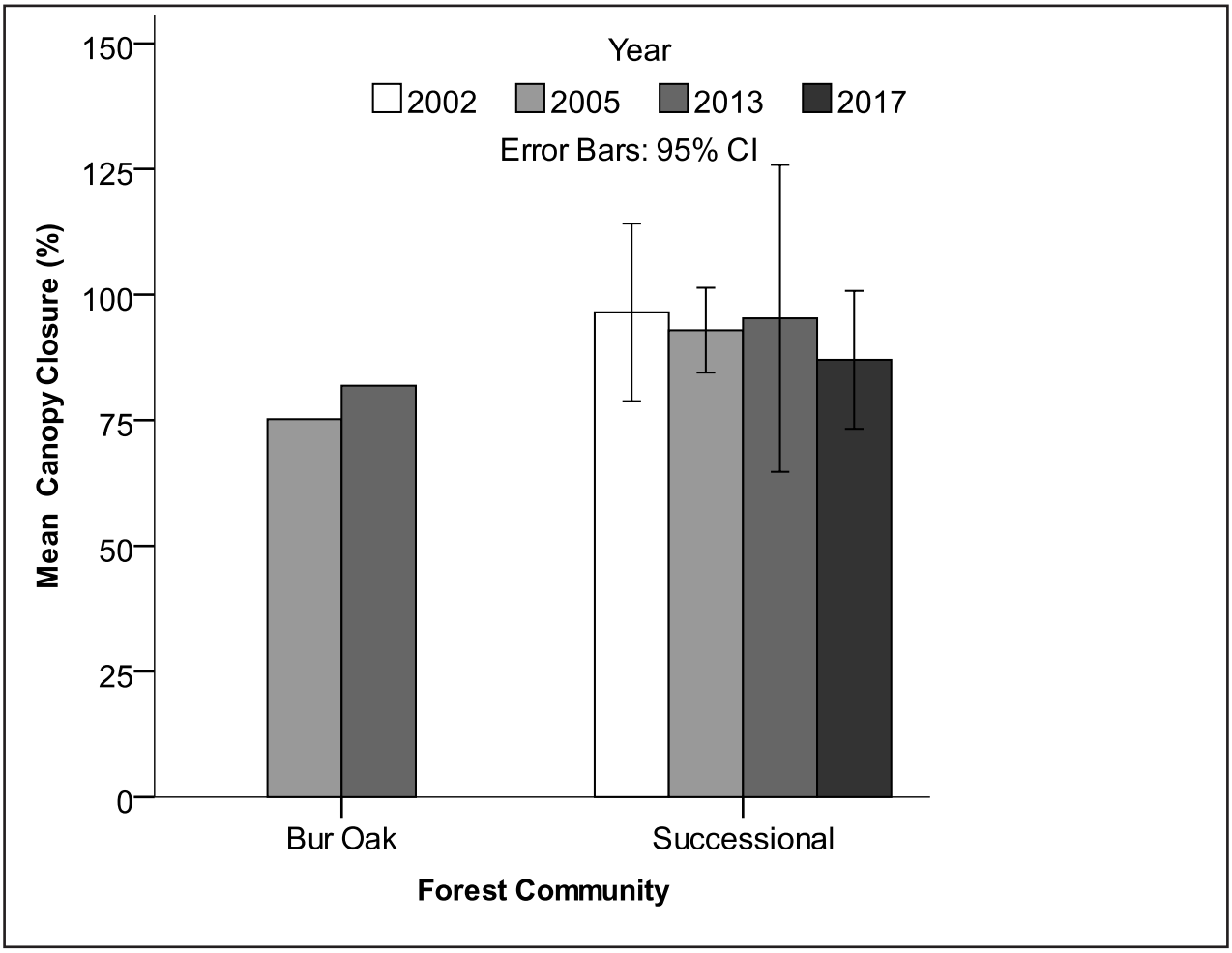


**Figure 9.** Percent canopy closure by forest community type at Homestead National Monument of America.

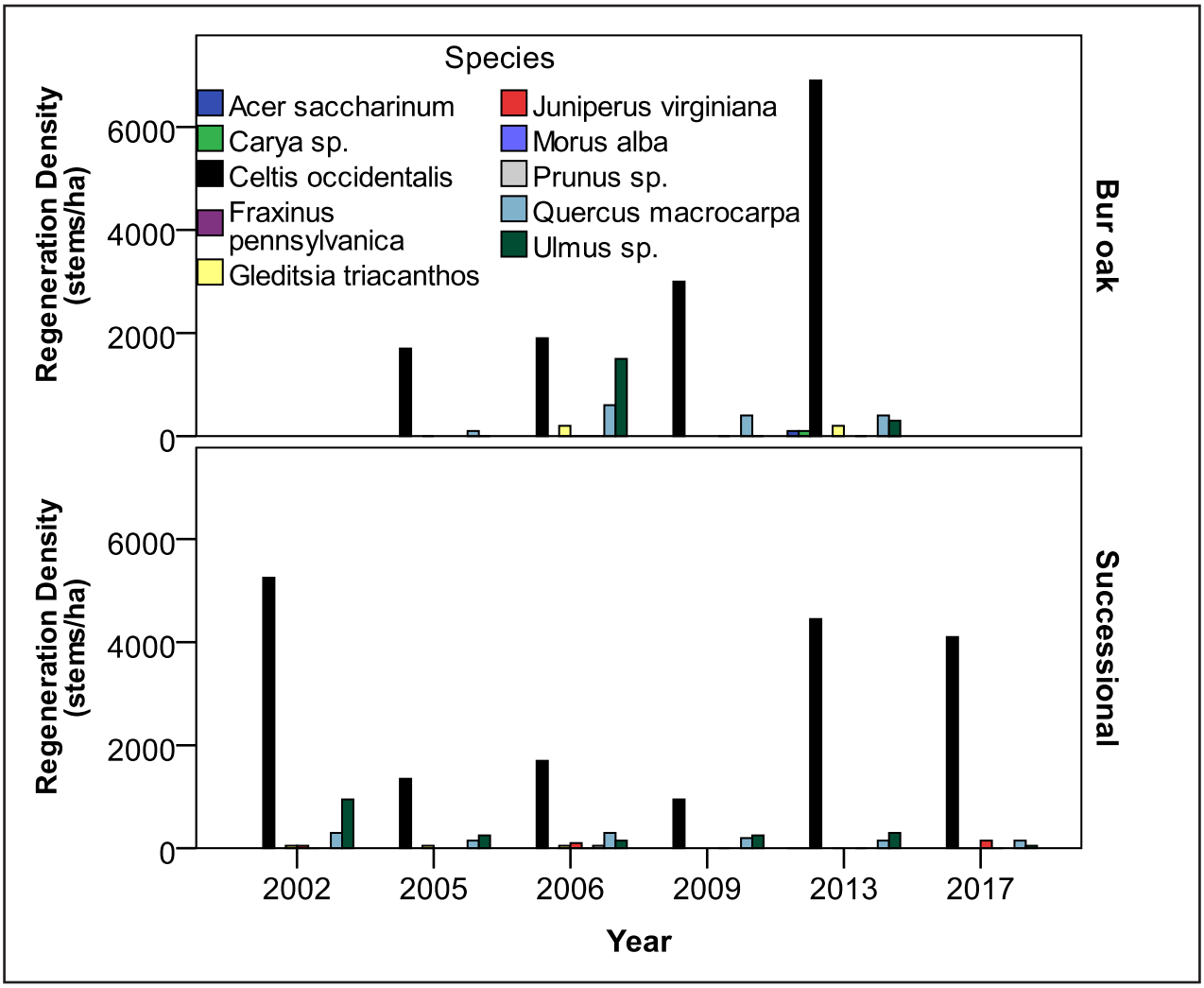


**Figure 10.** Tree regeneration density (stems/ha) for forest monitoring sites at Homestead National Monument of America, 2002–2017.

### *Regeneration*

Regeneration of tree species in the forests is similar to the overstory distribution in that hackberry is dominant and bur oak is present, but there is much less bur oak than hackberry. Stem density was greatest for the successional forest in 2002 (6600 stems/ha), but regeneration stem density was greatest in the bur oak forest in 2013 (8000 stems/ha; Figure 10). Distribution of seedlings and saplings is affected by a number of factors. Light to the forest floor (Johnson et.al. 2009) and herbivory (Rooney and Waller 2003; Dey 2014) are two factors that can limit oak regeneration. A variety of trees were replanted in the site of the successional forest. Rolfsmeier (2007) explained that hackberry, whether existing or planted, may have had a competitive advantage at that time, setting the stage for the forest vegetation we see today.

Tree seedlings and saplings were limited in the prairie through time although greatest in 2017 (171 stems/ha) and 2002 (166 stems/ha). Species richness of tree seedlings was also greatest in 2017. The dominant species shifted from white mulberry (*Morus alba*), an invasive species, to elm (*Ulmus* sp.), a native species (Figure 11). Prescribed fire can limit the establishment of tree species in prairie (Briggs et. al. 2002; Weir and Scasta 2017), but additional interventions are sometimes needed.

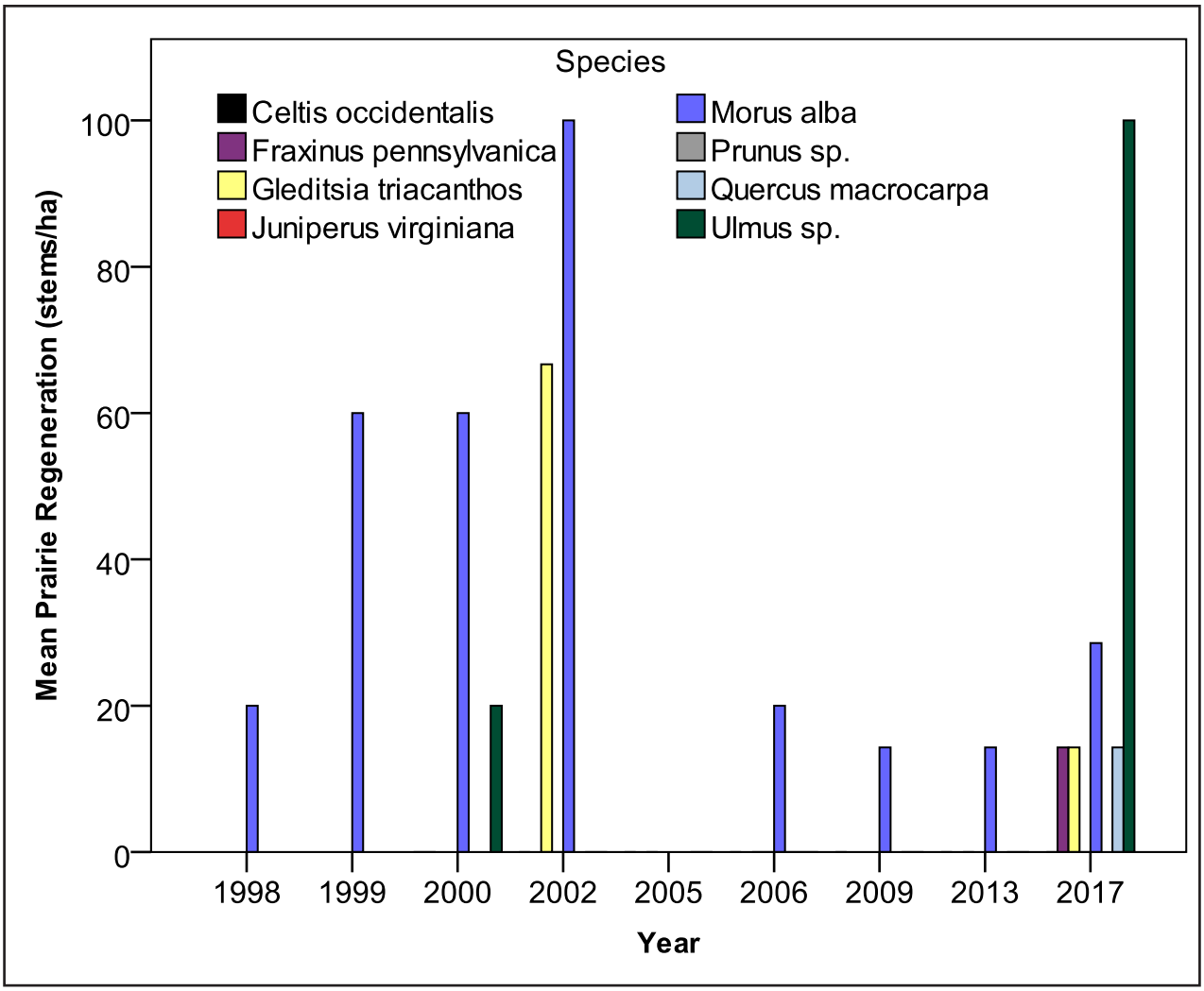


**Figure 11.** Tree regeneration observed in prairie monitoring sites at Homestead National Monument of America, 1998–2017. N = 3 in 2002, N = 5 from 1998–2000 and 2005–2006, and N = 7 from 2009–2017.

## Ground Flora Diversity

### *Community*

The park's goal of maintaining prairie gamma diversity above 83 species (Beacham 2016) has been met with gamma diversity of 109 native species recorded in 2017 (Figure 12). The prairie was the most diverse community type at all spatial scales. Prairie gamma diversity (prairie-wide number of species) was greatest in 2017 with 110 species recorded (Figure 12). Beta diversity values also indicated some differentiation among the monitoring sites, which resulted in prairie-wide diversity (Table 6). Forest sites had small numbers of species and sites were very similar (Figure 12 and Table 6).

**Table 6.** Beta diversity for two vegetation communities at Homestead National Monument of America. Greater values indicate greater diversity of plant assemblages. Bur oak is not represented because there was only one sample site. NA = not available.

| Year | Beta Prairie (N) | Beta Successional (N=2) |
|---|---|---|
| 1998 | 1.27 (5) | NA |
| 1999 | 1.05 (5) | NA |
| 2000 | 1.73 (5) | NA |
| 2002 | 0.84 (3) | 0.23 |
| 2005 | 1.19 (5) | 0.20 |
| 2006 | 1.22 (5) | 0.33 |
| 2009 | 1.58( 7) | 0.16 |
| 2013 | 1.56 (7) | 0.18 |
| 2017 | 1.75 (7) | 0.41 |

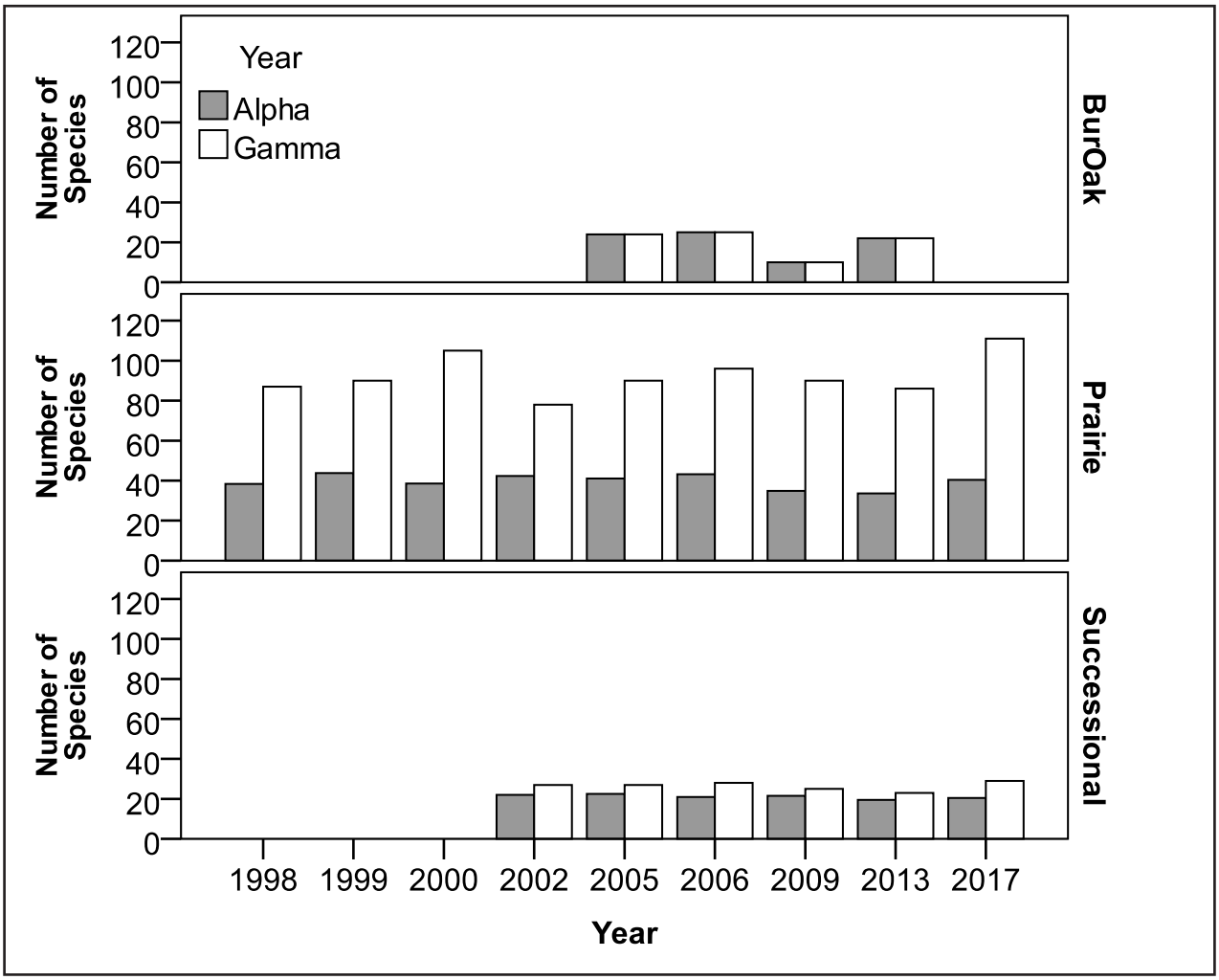


**Figure 12.** Mean community diversity metrics by vegetation community for the period of record (1998–2017 for prairie, 2002–2017 for successional forest, and 2005–2013 for bur oak forest) at Homestead National Monument of America.

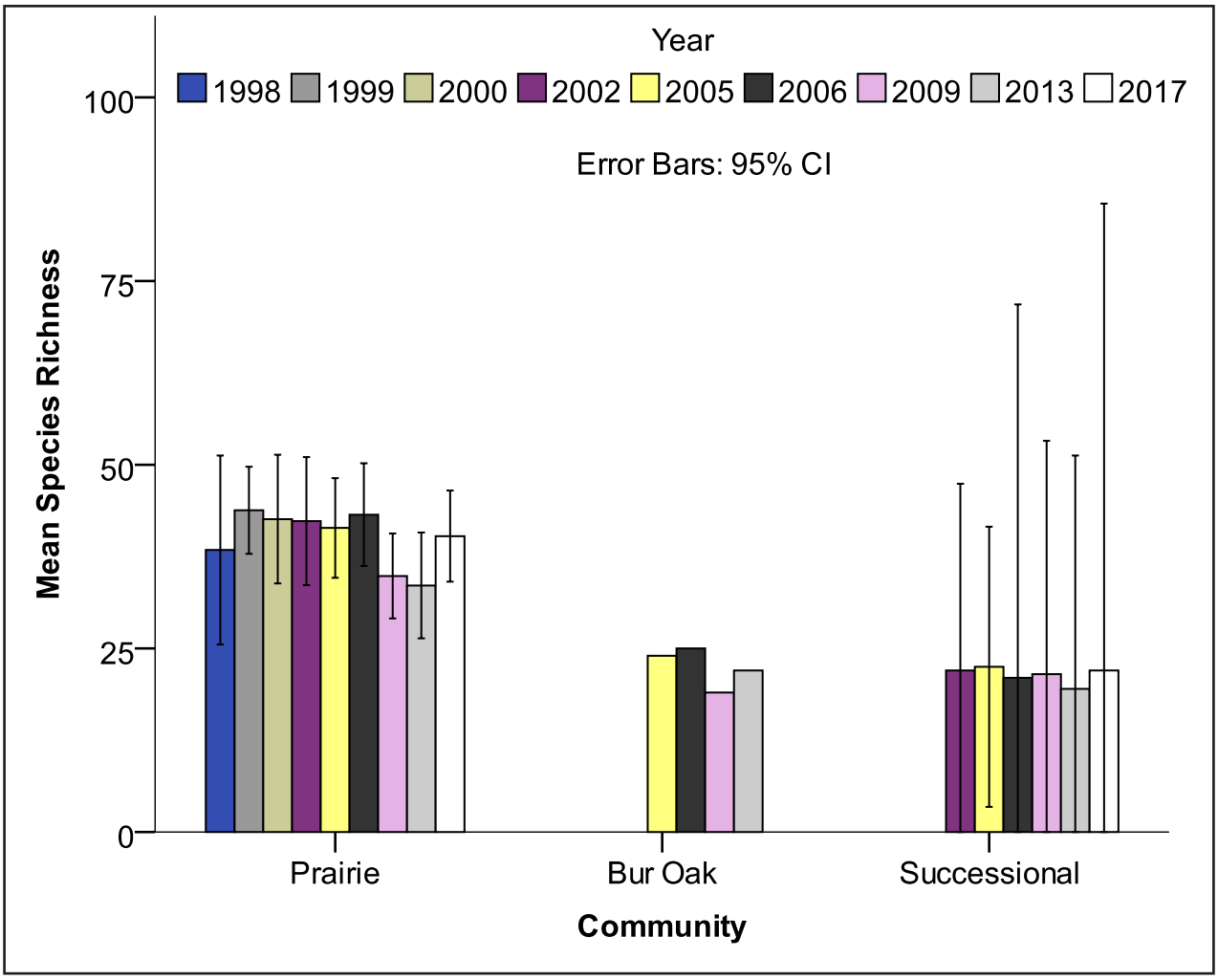


**Figure 13.** Mean site native species richness through time for vegetation communities at Homestead National Monument of America, 1998–2017.

### *Species*

Species richness was relatively stable across community types through time (Figure 13). Prairie richness estimates varied by 10 species. We anticipated a decline of around nine species based on the change in protocol in 2009, but mean species richness increased in 2017.

Prairie species composition is trending towards slightly less evenness (Figure 14) and diversity (H′; Figure 15). A prescribed fire in the prairie conducted four weeks prior to sampling could have affected the 2009 estimates. Decreasing evenness in prairie sites is consistent with the rising beta diversity (Table 6). Forest sites appear relatively stable (Figures 14 and 15). The bur oak forest species evenness and diversity increased in 2013, but we reserve interpretation of this until later monitoring events can identify a trend. The single site in the bur oak forest community provides for a cautious indicator. The successional forest includes a great deal of heterogeneity between the sites as evidenced by the large confidence intervals.

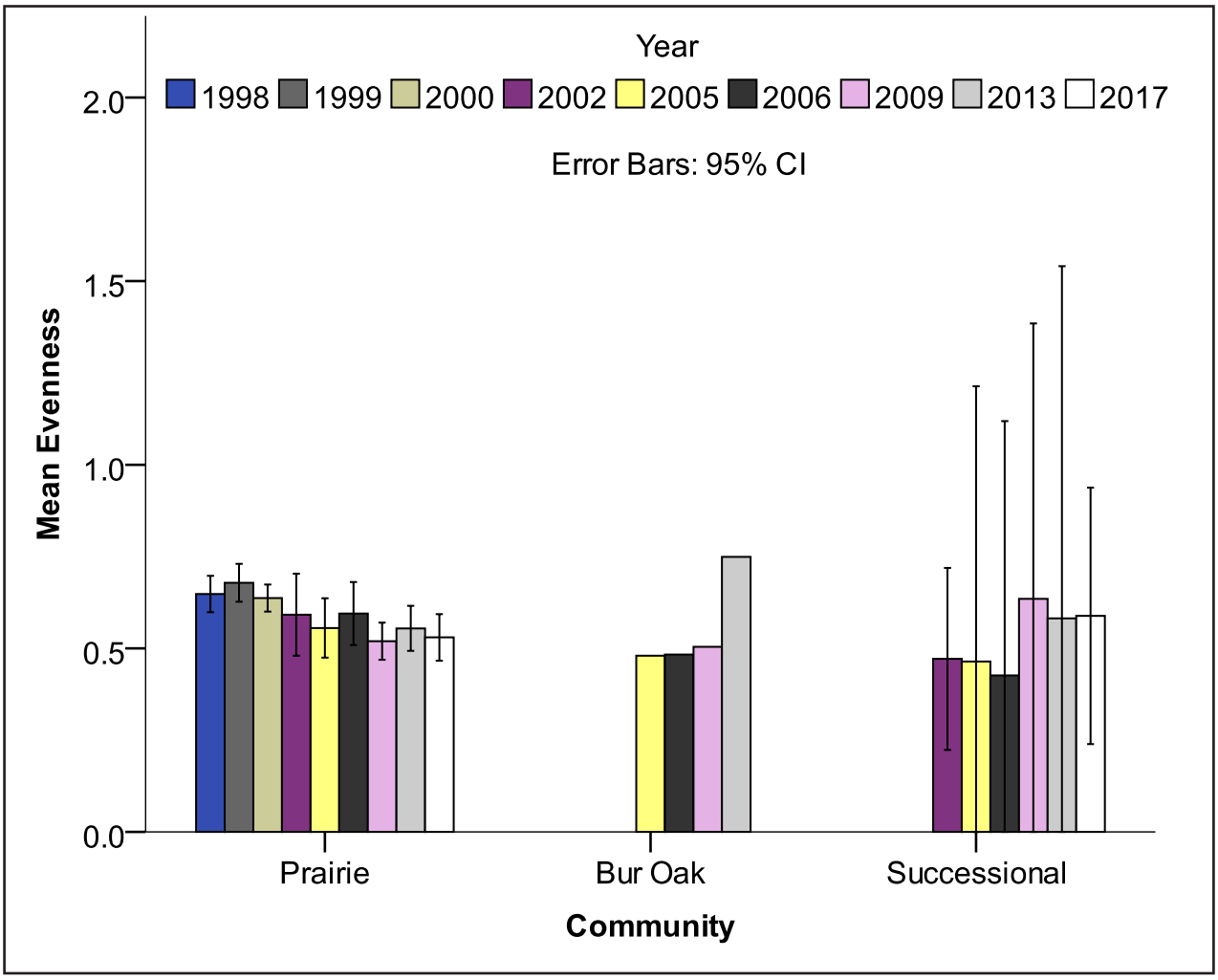


**Figure 14.** Mean native species evenness through time for vegetation communities at Homestead National Monument of America, 1998–2017.

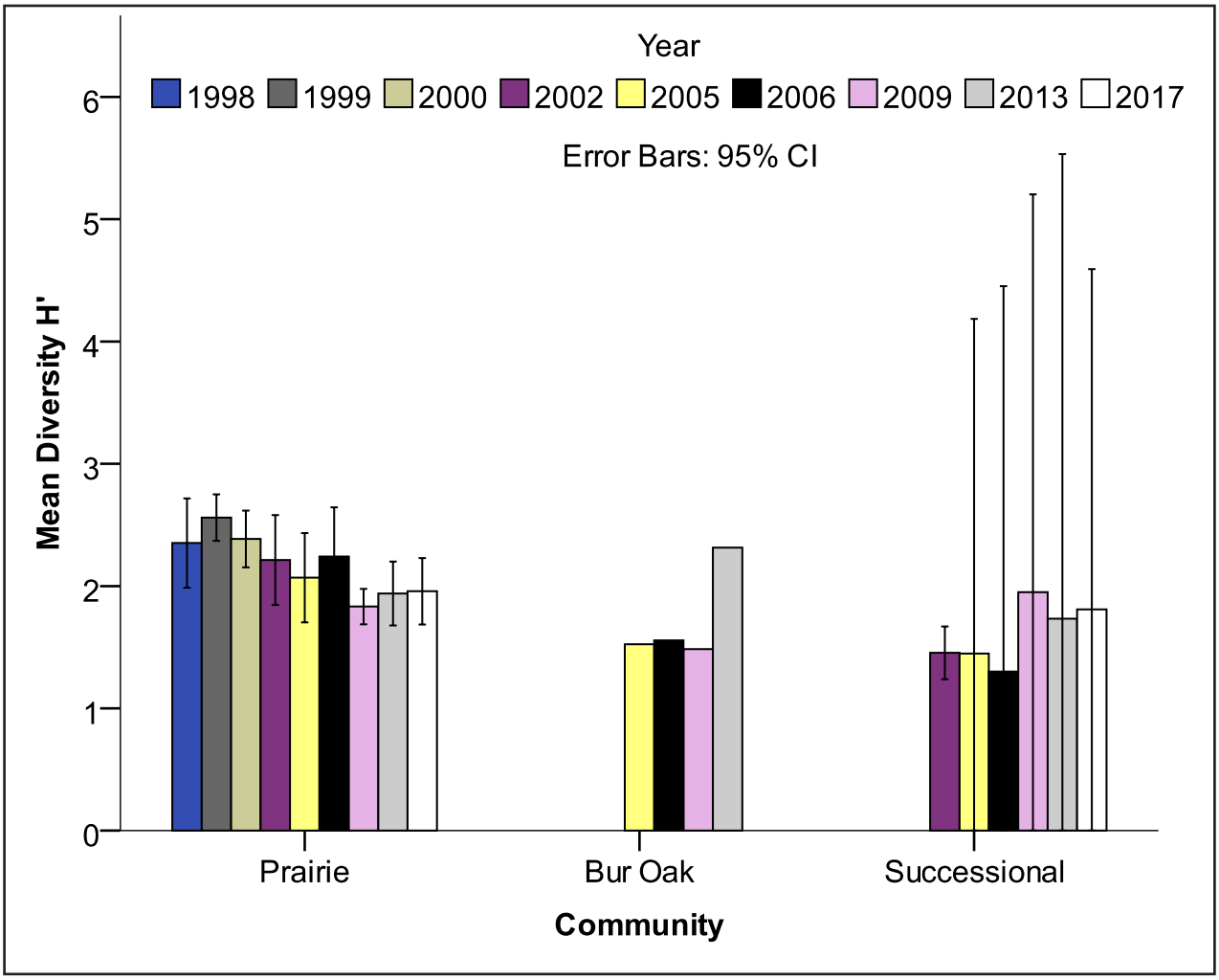


**Figure 15.** Mean native species diversity (Shannon Diversity) through time for vegetation communities at Homestead National Monument of America, 1998–2017.

### *Guild*

Distribution of species by guild varies between the prairie and forest community types in that the prairie includes a more robust suite of ground flora (Figure 16). Cover by guild for forest types reflects a sparse ground flora vegetation layer dominated by forbs. Guild cover within the two successional forest sites appears to be heterogeneous.

Grass and forb cover appeared be in declining in the prairie, but we suspect sampling error as the cause. During 1998 and 1999, cover estimates may have been more liberal than during subsequent sampling events, as the program was still working towards standardizing observations at that time (M. DeBacker, personal communication). Then, in 2009, a shift was made from two-season sampling to one-season sampling. We anticipated a reduction in the number of species sampled, but it appears there was a related reduction in cover associated with seasonality. No other factors reflected this trend (i.e. PDSI, ground cover metrics). Although the park worked to reduce woody species within the prairie (Beacham 2016), woody cover within the monitoring sites is variable and does not appear to be reduced as a whole and as such does not account for the trend. Targeted monitoring of the woody shrub thickets better addresses this goal (Haack-Gaynor 2015).

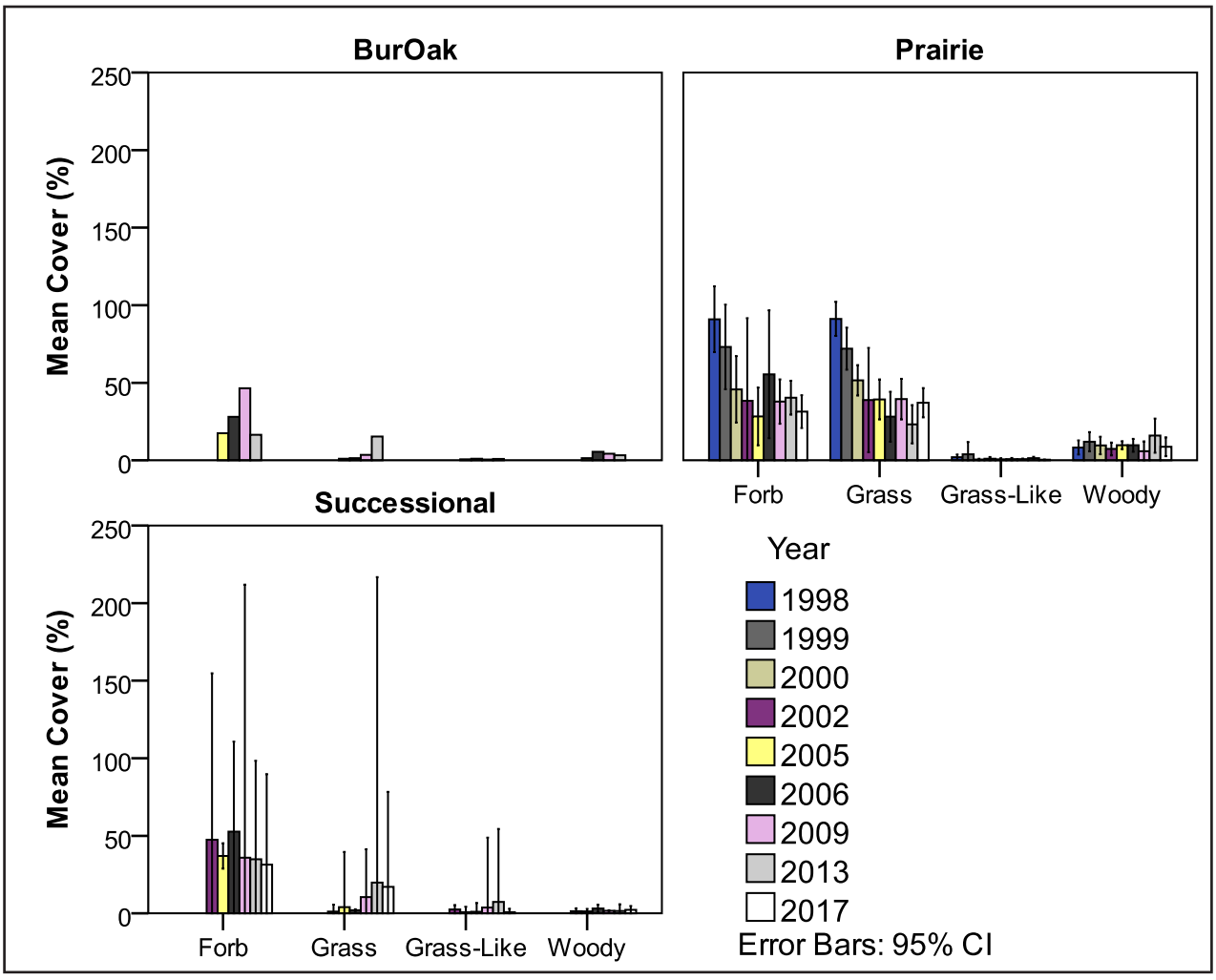


**Figure 16.** Cover of ground flora guilds by community type at Homestead National Monument of America, 1998–2017.

### *Exotics*

Only one observation of exotic species was recorded in the forest sites over the monitoring period (garlic mustard [*Alliaria petiolate*] in one plot in 2017). The prairie continues to be dominated by native species with a small contingent of introduced species (Figure 17; Table 7). The total cover of all species appears to be in decline similarly to grass cover noted in the guild section above. Although sampling error may be contributing to this trend, it is unclear if there are additional factors that are contributing to the decline of total prairie herbaceous cover.

**Table 7.** Nonnative species recorded in the prairie in 2017.

| Species | Common Name | Guild |
|---|---|---|
| *Bromus inermis* | smooth brome | grass |
| *Cannibis sativa* | marijuana | forb |
| *Phalaris arundinacea* | reed canarygrass | grass |
| *Poa pratensis* | Kentucky bluegrass | grass |
| *Rumex crispus* | curly dock | forb |
| *Thlaspi arvense* | field pennycress | forb |
| *Veronica arvensis* | corn speedwell | forb |

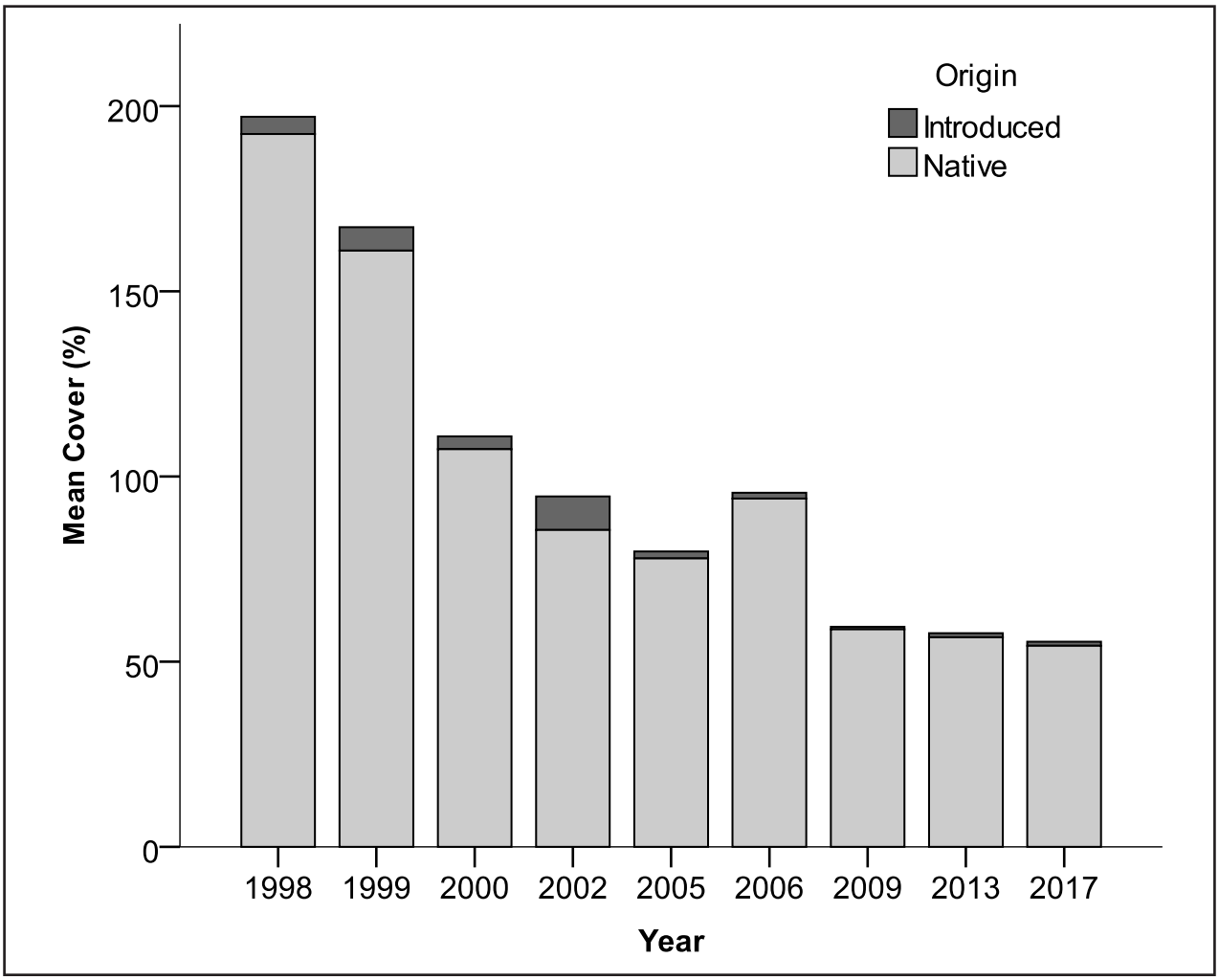


**Figure 17.** Mean total site cover (%) of native and introduced species in the prairie at Homestead National Monument of America 1998–2017. Cover is cumulative and can be greater than 100%.

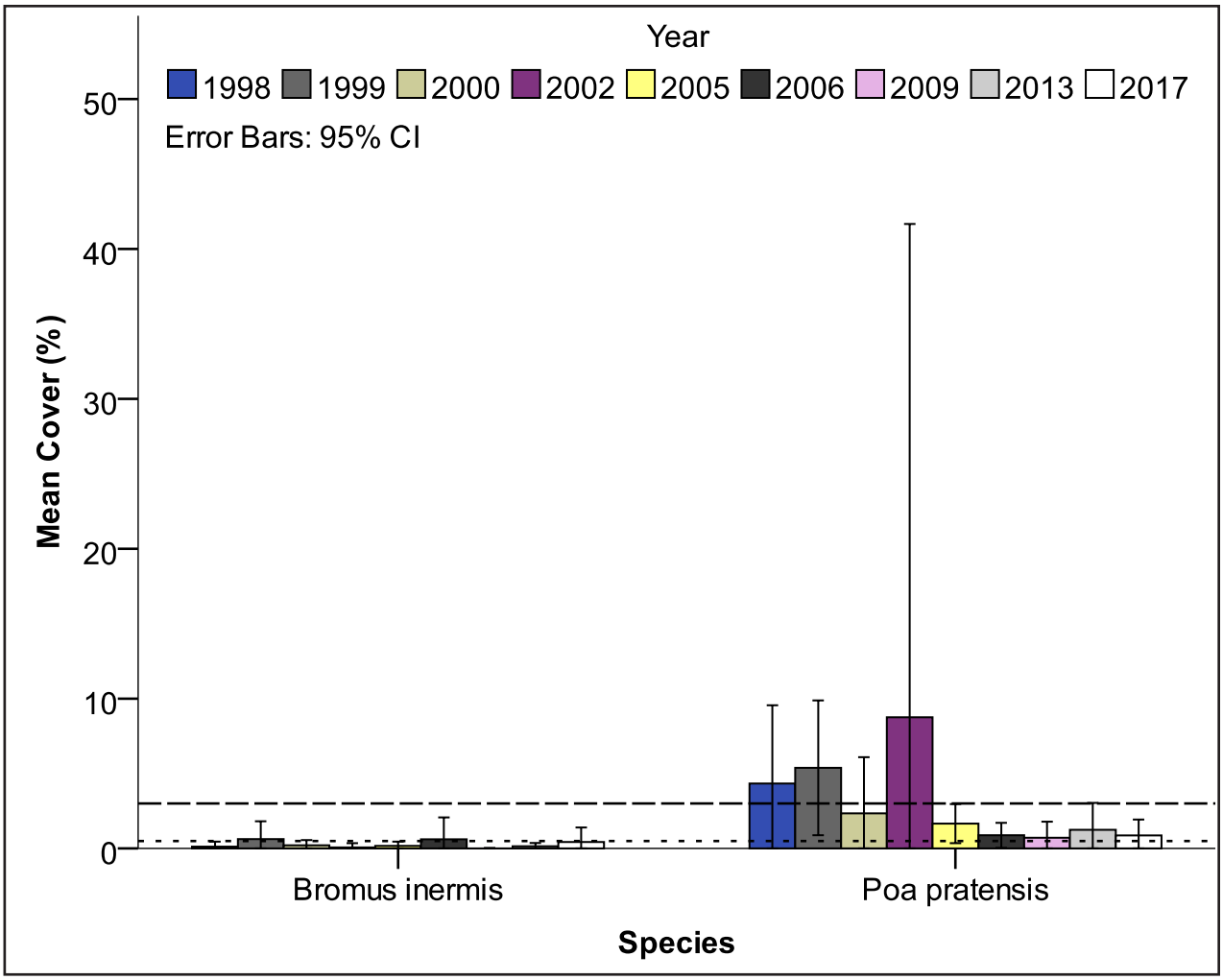


**Figure 18.** Mean cover of *Bromus inermis* (smooth brome) and *Poa pratensis* (Kentucky bluegrass) in prairie sites at Homestead National Monument of America from 1998 to 2017. Lines represent management thresholds: dotted line = management threshold for *Bromus inermis* (0.5%) and dashed line = management threshold for *Poa pratensis* (3.0%; Beacham 2016).

Introduced cool season grasses smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*) are a concern in the prairie. Both species remained below target thresholds (Figure 18; Beacham 2016). Kentucky bluegrass was listed as part of the original restoration seeding mix (1% of mix) Stubbendieck and Willson 1987) and remains close to 1% (0.9% ± 0.4 SE), but it was observed in all the prairie monitoring sites (Appendix A).

# Conclusions

The forest communities remained stable through the monitoring period. However, the overstory is more dense (stem density, basal area, canopy cover) than the target woodland structure (Rolfsmeier 2007). This dense overstory structure is consistent with the sparse ground flora layer within the forest. Exotic species were rare in the forest sites throughout the monitoring record, meeting the forest objective of keeping the exotic species at or near zero (NPS 2006). The targeted invasive species monitoring project (Young and Bell 2015) takes a more comprehensive approach to nonnative plant detection than we are able to do within the vegetation monitoring project.

Tree seedlings and saplings were sparse in the prairie. In the forest communities, regeneration was also limited for most species. Forest regeneration estimates reflected the overstory in species distribution. Intervention will be needed to increase regeneration and/or alter the species composition of the next generation of trees.

The prairie at Homestead National Monument of America continues to be species rich and dominated by native species. Our prairie monitoring sites yielded low numbers of tree regeneration stems and other woody plants. We did see a reduction in grass cover and plant cover as a whole that we suspect is to some degree a function of sampling error. Cover estimates have become more standardized through time especially after the first two years of monitoring (M. DeBacker, personal communication). As the network matured, field crews included calibration exercises to reduce differences in estimation among individuals. The change in protocol in 2009 (specifically the number of visits in a monitoring year) was predicted to reduce the number of species observed (James et. al. 2009). We did see the expected reduction in species richness from 2009 to 2013, but species richness recovered in 2017 making the cause for the pattern unclear. James et.al (2009) did not predict the concomitant decline in aerial cover we observed. It is possible that the change of seasonality contributed to the decline in vegetated cover in addition to possible overestimation of cover values in earlier years. Although we suspect that these sources of error contributed to the trends reported here, we are unable to specifically test for the cause of the trend.

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# Appendix A. Ground Flora Species Occurrence

Tables A-1 through A-3 list ground flora species in prairie, successional forest, and bur oak forest at Homestead National Monument of America, respectively. Table A-4 lists species observed at the park that were lumped into genera for analysis.

**Table A-1.** Ground flora species (excluding regeneration) found in the prairie of Homestead National Monument of America. Data on species abundance (% cover) and occurrence (percent of sites in which a species was observed) are from the most recent monitoring event (2017). SE = standard error. Origin codes: N = native, I = introduced.

| Species | Common Name | Guild | Origin | Mean Cover 2017 (%) | SE | Occurrence 2017 (%) |
|---|---|---|---|---|---|---|
| *Achillea millefolium* | common yarrow | forb | N | 0.01 | 0.01 | 28.57 |
| *Ageratina altissima* | white snakeroot | forb | N | 0.01 | 0.01 | 28.57 |
| *Agrostis hyemalis* | winter bentgrass | grass | N | 0.01 | 0.01 | 14.29 |
| *Ambrosia artemisiifolia* | annual ragweed | forb | N | 0.10 | 0.10 | 14.29 |
| *Ambrosia psilostachya* | Cuman ragweed | forb | N | 0.05 | 0.03 | 42.86 |
| *Amorpha canescens* | leadplant | forb | N | 5.59 | 4.68 | 71.43 |
| *Andropogon gerardii* | big bluestem | grass | N | 30.05 | 3.14 | 100.00 |
| *Anemone cylindrica* | candle anemone | forb | N | 0.01 | 0.01 | 14.29 |
| *Antennaria neglecta* | field pussytoes | forb | N | 0.01 | 0.01 | 14.29 |
| *Apocynum cannabinum* | Indianhemp | forb | N | 0.20 | 0.06 | 85.71 |
| *Artemisia ludoviciana* | white sagebrush | forb | N | 0.11 | 0.08 | 28.57 |
| *Asclepias stenophylla* | slimleaf milkweed | forb | N | 0.01 | 0.01 | 14.29 |
| *Asclepias sullivantii* | prairie milkweed | forb | N | 0.01 | 0.01 | 14.29 |
| *Asclepias syriaca* | common milkweed | forb | N | 0.09 | 0.06 | 57.14 |
| *Asclepias verticillata* | whorled milkweed | forb | N | 0.03 | 0.02 | 42.86 |
| *Astragalus canadensis* | Canadian milkvetch | forb | N | 0.04 | 0.03 | 28.57 |
| *Baptisia bracteata* var. *leucophaea* | longbract wild indigo | forb | N | 0.01 | 0.01 | 14.29 |
| *Bouteloua curtipendula* | sideoats grama | grass | N | 0.01 | 0.01 | 14.29 |
| *Brickellia eupatorioides* | false boneset | forb | N | 0.17 | 0.06 | 71.43 |
| *Bromus inermis* | smooth brome | grass | I | 0.43 | 0.40 | 57.14 |
| *Calylophus serrulatus* | yellow sundrops | forb | N | 0.01 | 0.01 | 14.29 |
| *Cannabis sativa* | marijuana | forb | I | 0.01 | 0.01 | 14.29 |
| *Carex* sp. | sedge | grass-like | N | 0.32 | 0.08 | 100.00 |
| *Chamaecrista fasciculata* | partridge pea | forb | N | 0.11 | 0.11 | 28.57 |
| *Chenopodium* sp. | goosefoot | forb | N | 0.03 | 0.02 | 42.86 |
| *Cirsium altissimum* | tall thistle | forb | N | 0.49 | 0.19 | 85.71 |
| *Conyza canadensis* | Canadian horseweed | forb | N | 0.23 | 0.11 | 57.14 |
| *Cornus drummondii* | roughleaf dogwood | woody | N | 4.57 | 2.12 | 85.71 |
| *Dalea candida* | white prairie clover | forb | N | 0.01 | 0.01 | 14.29 |
| *Dalea purpurea* | purple prairie clover | forb | N | 0.03 | 0.03 | 14.29 |

**Table A-1 (continued).** Ground flora species (excluding regeneration) found in the prairie of Homestead National Monument of America. Data on species abundance (% cover) and occurrence (percent of sites in which a species was observed) are from the most recent monitoring event (2017). SE = standard error. Origin codes: N = native, I = introduced.

| Species | Common Name | Guild | Origin | Mean Cover 2017 (%) | SE | Occurrence 2017 (%) |
|---|---|---|---|---|---|---|
| *Desmodium* sp. | ticktrefoil | forb | N | 0.01 | 0.01 | 14.29 |
| *Desmodium illinoense* | Illinois ticktrefoil | forb | N | 0.04 | 0.02 | 42.86 |
| *Dichanthelium* sp. | rosette grass | grass | N | 0.42 | 0.05 | 100.00 |
| *Elymus canadensis* | Canada wildrye | grass | N | 0.09 | 0.05 | 42.86 |
| *Eragrostis spectabilis* | purple lovegrass | grass | N | 0.01 | 0.01 | 14.29 |
| *Eupatorium altissimum* | tall thoroughwort | forb | N | 0.09 | 0.04 | 57.14 |
| *Euphorbia* sp. | spurge | forb | N | 0.01 | 0.01 | 14.29 |
| *Galium aparine* | stickywilly | forb | N | 0.14 | 0.12 | 28.57 |
| *Gentiana puberulenta* | downy gentian | forb | N | 0.04 | 0.04 | 14.29 |
| *Geum canadense* | white avens | forb | N | 0.01 | 0.01 | 14.29 |
| *Glycyrrhiza lepidota* | American licorice | forb | N | 0.74 | 0.48 | 28.57 |
| *Hackelia virginiana* | beggarslice | forb | N | 0.01 | 0.01 | 28.57 |
| *Helianthus grosseserratus* | sawtooth sunflower | forb | N | 0.21 | 0.21 | 14.29 |
| *Helianthus mollis* | ashy sunflower | forb | N | 0.21 | 0.21 | 14.29 |
| *Helianthus pauciflorus* ssp. *pauciflorus* | stiff sunflower | forb | N | 4.68 | 2.35 | 71.43 |
| *Helianthus tuberosus* | Jerusalem artichoke | forb | N | 0.53 | 0.51 | 28.57 |
| *Heliopsis helianthoides* | smooth oxeye | forb | N | 0.01 | 0.01 | 14.29 |
| *Hesperostipa spartea* | Porcupine-grass | grass | N | 0.01 | 0.01 | 28.57 |
| *Hieracium longipilum* | hairy hawkweed | forb | N | 0.09 | 0.08 | 28.57 |
| *Juncus interior* | inland rush | grass-like | N | 0.02 | 0.02 | 14.29 |
| *Koeleria macrantha* | prairie Junegrass | grass | N | 0.02 | 0.02 | 28.57 |
| *Lactuca* sp. | lettuce | forb | N | 0.01 | 0.01 | 14.29 |
| *Lactuca ludoviciana* | biannual lettuce | forb | N | 0.11 | 0.06 | 42.86 |
| *Leersia virginica* | whitegrass | grass | N | 0.01 | 0.01 | 14.29 |
| *Lespedeza capitata* | roundhead lespedeza | forb | N | 0.04 | 0.04 | 28.57 |
| *Liatris punctata* | dotted blazing star | forb | N | 0.01 | 0.01 | 14.29 |
| *Linum sulcatum* | grooved flax | forb | N | 0.02 | 0.02 | 14.29 |
| *Lotus unifoliolatus* var. *unifoliolatus* | American bird's-foot trefoil | forb | N | 0.07 | 0.03 | 71.43 |
| *Monarda fistulosa* | wild bergamot | forb | N | 0.16 | 0.16 | 28.57 |
| *Muhlenbergia* sp. | muhly | grass | N | 0.38 | 0.17 | 71.43 |
| *Oenothera* sp. | evening primrose | forb | N | 0.01 | 0.01 | 14.29 |
| *Oenothera biennis* | common evening primrose | forb | N | 0.01 | 0.01 | 14.29 |
| *Oligoneuron rigidum* var. *rigidum* | Stiff goldenrod | forb | N | 0.02 | 0.02 | 14.29 |
| *Oxalis* sp. | woodsorrel | forb | N | 0.13 | 0.01 | 100.00 |
| *Oxalis dillenii* | slender yellow woodsorrel | forb | N | 0.07 | 0.03 | 57.14 |
| *Oxalis violacea* | violet woodsorrel | forb | N | 0.01 | 0.01 | 14.29 |

**Table A-1 (continued).** Ground flora species (excluding regeneration) found in the prairie of Homestead National Monument of America. Data on species abundance (% cover) and occurrence (percent of sites in which a species was observed) are from the most recent monitoring event (2017). SE = standard error. Origin codes: N = native, I = introduced.

| Species | Common Name | Guild | Origin | Mean Cover 2017 (%) | SE | Occurrence 2017 (%) |
|---|---|---|---|---|---|---|
| *Packera plattensis* | Platte groundsel | forb | N | 0.01 | 0.01 | 14.29 |
| *Panicum virgatum* | switchgrass | grass | N | 0.40 | 0.25 | 71.43 |
| *Parietaria pensylvanica* | Pennsylvania pellitory | forb | N | 0.01 | 0.01 | 28.57 |
| *Phalaris arundinacea* | reed canarygrass | grass | I | 0.23 | 0.22 | 28.57 |
| *Physalis heterophylla* | clammy groundcherry | forb | N | 0.06 | 0.05 | 28.57 |
| *Physalis longifolia* | longleaf groundcherry | forb | N | 0.01 | 0.01 | 14.29 |
| *Physalis virginiana* | Virginia groundcherry | forb | N | 0.30 | 0.12 | 85.71 |
| *Pilea pumila* | Canadian clearweed | forb | N | 0.01 | 0.01 | 14.29 |
| *Plantago* sp. | plantain | forb | N | 0.01 | 0.01 | 14.29 |
| *Poa pratensis* | Kentucky bluegrass | grass | I | 0.87 | 0.44 | 100.00 |
| *Polygonum amphibium var. emersum* | longroot smartweed | forb | N | 0.49 | 0.31 | 57.14 |
| *Prunus americana* | American plum | woody | N | 0.39 | 0.39 | 14.29 |
| *Psoralidium tenuiflorum* | slimflower scurfpea | forb | N | 0.15 | 0.15 | 14.29 |
| *Rhus glabra* | smooth sumac | woody | N | 0.33 | 0.18 | 71.43 |
| *Rosa arkansana* | prairie rose | woody | N | 0.69 | 0.14 | 85.71 |
| *Rudbeckia hirta* | blackeyed Susan | forb | N | 0.02 | 0.02 | 14.29 |
| *Rumex crispus* | curly dock | forb | I | 0.01 | 0.01 | 14.29 |
| *Salvia azurea* | azure blue sage | forb | N | 0.03 | 0.02 | 28.57 |
| *Sanicula canadensis* | Canadian blacksnakeroot | forb | N | 0.01 | 0.01 | 14.29 |
| *Sanicula odorata* | clustered blacksnakeroot | forb | N | 0.01 | 0.01 | 14.29 |
| *Schizachyrium scoparium* | little bluestem | grass | N | 4.46 | 2.66 | 100.00 |
| *Silphium integrifolium* | wholeleaf rosinweed | forb | N | 0.21 | 0.21 | 14.29 |
| *Silphium perfoliatum* | cup plant | forb | N | 0.22 | 0.22 | 14.29 |
| *Sisyrinchium campestre* | prairie blue-eyed grass | forb | N | 0.01 | 0.01 | 28.57 |
| *Solidago canadensis* | Canada goldenrod | forb | N | 10.91 | 3.13 | 85.71 |
| *Solidago gigantea* | giant goldenrod | forb | N | 0.61 | 0.42 | 28.57 |
| *Solidago missouriensis* | Missouri goldenrod | forb | N | 1.04 | 1.00 | 28.57 |
| *Sorghastrum nutans* | Indiangrass | grass | N | 0.36 | 0.13 | 100.00 |
| *Sphenopholis obtusata* | prairie wedgescale | grass | N | 0.10 | 0.06 | 57.14 |
| *Sporobolus* sp. | dropseed | grass | N | 0.01 | 0.01 | 14.29 |
| *Sporobolus compositus* | composite dropseed | grass | N | 0.23 | 0.22 | 28.57 |
| *Sporobolus heterolepis* | prairie dropseed | grass | N | 0.47 | 0.47 | 14.29 |
| *Symphoricarpos orbiculatus* | coralberry | woody | N | 2.24 | 1.01 | 71.43 |
| *Symphyotrichum ericoides* var. *ericoides* | Squarrose white wild aster | forb | N | 0.24 | 0.17 | 57.14 |
| *Symphyotrichum lanceolatum* ssp. *lanceolatum* var. *lanceolatum* | white panicle aster | forb | N | 0.13 | 0.06 | 71.43 |

**Table A-1 (continued).** Ground flora species (excluding regeneration) found in the prairie of Homestead National Monument of America. Data on species abundance (% cover) and occurrence (percent of sites in which a species was observed) are from the most recent monitoring event (2017). SE = standard error. Origin codes: N = native, I = introduced.

| Species | Common Name | Guild | Origin | Mean Cover 2017 (%) | SE | Occurrence 2017 (%) |
|---|---|---|---|---|---|---|
| *Teucrium canadense* | Canada germander | forb | N | 0.01 | 0.01 | 14.29 |
| *Thlaspi arvense* | field pennycress | forb | I | 0.02 | 0.02 | 28.57 |
| *Toxicodendron radicans* | eastern poison ivy | woody | N | 0.52 | 0.47 | 42.86 |
| *Triosteum perfoliatum* | feverwort | forb | N | 0.01 | 0.01 | 14.29 |
| *Tripsacum dactyloides* | eastern gamagrass | grass | N | 0.04 | 0.04 | 14.29 |
| *Verbena stricta* | hoary verbena | forb | N | 0.02 | 0.02 | 28.57 |
| *Verbena urticifolia* | white vervain | forb | N | 0.16 | 0.08 | 42.86 |
| *Verbesina alternifolia* | wingstem | forb | N | 0.01 | 0.01 | 14.29 |
| *Vernonia baldwinii* | Baldwin's ironweed | forb | N | 1.26 | 0.60 | 100.00 |
| *Veronica arvensis* | corn speedwell | forb | I | 0.01 | 0.01 | 14.29 |
| *Viola* sp. | violet | forb | N | 0.05 | 0.04 | 28.57 |
| *Viola bicolor* | field pansy | forb | N | 0.01 | 0.01 | 14.29 |
| *Viola nephrophylla* | Violet | forb | N | 0.46 | 0.15 | 85.71 |
| *Viola pedatifida* | prairie violet | forb | N | 0.04 | 0.02 | 42.86 |
| *Viola sororia* | common blue violet | forb | N | 0.04 | 0.04 | 14.29 |
| *Vitis riparia* | riverbank grape | woody | N | 0.01 | 0.01 | 14.29 |

**Table A-2.** Ground flora species (excluding regeneration) found in the successional forest of Homestead National Monument of America. Data on species abundance (% cover) and occurrence (percent of sites in which a species was observed) are from the most recent monitoring event (2017). SE = standard error. Origin codes: N = native, I = introduced.

| Species | Common Name | Guild | Origin | Mean Cover 2017 (%) | SE 2017 | Occurrence 2017 (%) |
|---|---|---|---|---|---|---|
| *Ageratina altissima* | white snakeroot | forb | N | 0.075 | 0.025 | 100 |
| *Alliaria petiolata* | garlic mustard | forb | I | 0.025 | 0.025 | 50 |
| *Carex* sp. | sedge | grass-like | N | 0.825 | 0.175 | 100 |
| *Chenopodium* | goosefoot | forb | N | 0.025 | 0.025 | 50 |
| *Diarrhena obovata* | obovate beakgrain | grass | N | 1.1 | 1.1 | 50 |
| *Elymus macgregorii* | wildrye | grass | N | 15.15 | 6.45 | 100 |
| *Festuca subverticillata* | nodding fescue | grass | N | 0.525 | 0.325 | 100 |
| *Galium aparine* | stickywilly | forb | N | 1.875 | 1.875 | 50 |
| *Galium trifidum* | threepetal bedstraw | forb | N | 0.025 | 0.025 | 50 |
| *Hackelia virginiana* | beggarslice | forb | N | 1.4 | 1.3 | 100 |
| *Laportea canadensis* | Canadian woodnettle | forb | N | 12.2 | 4.9 | 100 |
| *Leersia virginica* | whitegrass | grass | N | 0.05 | 0.05 | 50 |
| *Maianthemum stellatum* | starry false lily of the valley | forb | N | 0.025 | 0.025 | 50 |
| *Muhlenbergia* sp. | muhly | grass | N | 0.2 | 0.15 | 100 |
| *Parietaria pensylvanica* | Pennsylvania pellitory | forb | N | 0.225 | 0.225 | 50 |
| *Parthenocissus quinquefolia* | Virginia creeper | woody | N | 1.2 | 0.25 | 100 |
| *Phryma leptostachya* | American lopseed | forb | N | 0.025 | 0.025 | 50 |
| *Phytolacca americana* | American pokeweed | forb | N | 0.025 | 0.025 | 50 |
| *Ribes missouriense* | Missouri gooseberry | woody | N | 0.075 | 0.025 | 100 |
| *Sanicula canadensis* | Canadian blacksnakeroot | forb | N | 0.25 | 0.15 | 100 |
| *Smilax tamnoides* | bristly greenbrier | woody | N | 0.475 | 0.175 | 100 |
| *Symphoricarpos orbiculatus* | coralberry | woody | N | 0.025 | 0.025 | 50 |
| *Teucrium canadense* | Canada germander | forb | N | 0.075 | 0.075 | 50 |
| *Toxicodendron radicans* | eastern poison ivy | woody | N | 0.45 | 0.2 | 100 |
| *Urtica dioica* ssp. *gracilis* | California nettle | forb | N | 0.25 | 0.1 | 100 |
| *Verbesina alternifolia* | wingstem | forb | N | 14.1 | 0.45 | 100 |
| *Viola nephrophylla* | Violet | forb | N | 0.55 | 0.4 | 100 |
| *Viola pubescens* | downy yellow violet | forb | N | 0.05 | 0.05 | 50 |
| *Viola sororia* | common blue violet | forb | N | 0.175 | 0.175 | 50 |
| *Vitis riparia* | riverbank grape | woody | N | 0.025 | 0.025 | 50 |

**Table A-3.** Ground flora species (excluding regeneration) found in the bur oak forest of Homestead National Monument of America. Species abundance (% cover) data are from the most recent monitoring event (2017). SE = standard error. Origin codes: N = native, I = introduced.

| Species | Common Name | Guild | Origin | Cover 2017 (%) |
|---|---|---|---|---|
| *Ageratina altissima* | white snakeroot | forb | N | 1.25 |
| *Boehmeria cylindrica* | smallspike false nettle | forb | N | 0.8 |
| *Carex* sp. | sedge | grass-like | N | 0.9 |
| *Diarrhena obovata* | obovate beakgrain | grass | N | 5.3 |
| *Ellisia nyctelea* | Aunt Lucy | forb | N | 0.95 |
| *Elymus hystrix* var. *hystrix* | eastern bottlebrush grass | grass | N | 3.75 |
| *Elymus virginicus* | Virginia wildrye | grass | N | 5.75 |
| *Festuca subverticillata* | nodding fescue | grass | N | 0.5 |
| *Galium aparine* | stickywilly | forb | N | 0.45 |
| *Geum canadense* | white avens | forb | N | 0.05 |
| *Laportea canadensis* | Canadian woodnettle | forb | N | 9 |
| *Parthenocissus quinquefolia* | Virginia creeper | woody | N | 1.95 |
| *Phryma leptostachya* | American lopseed | forb | N | 0.05 |
| *Polygonum virginianum* | jumpseed | forb | N | 0.1 |
| *Sanicula odorata* | clustered blacksnakeroot | forb | N | 0.15 |
| *Smilax tamnoides* | bristly greenbrier | woody | N | 0.45 |
| *Solidago canadensis* | Canada goldenrod | forb | N | 0.05 |
| *Symphoricarpos orbiculatus* | coralberry | woody | N | 0.05 |
| *Toxicodendron radicans* | eastern poison ivy | woody | N | 0.8 |
| *Urtica dioica ssp. gracilis* | California nettle | forb | N | 0.2 |
| *Verbesina alternifolia* | wingstem | forb | N | 3.15 |
| *Viola* sp. | violet | forb | N | 0.25 |

**Table A-4.** Additional species of ground flora observed in 2017 at Homestead National Monument of America that were lumped into genera for analysis. N = native.

| Species | Common Name | Guild | Origin | Number of Observations |
|---|---|---|---|---|
| *Carex blanda* | eastern woodland sedge | grass-like | N | 8 |
| *Carex davisii* | Davis' sedge | grass-like | N | 1 |
| *Carex gravida* | heavy sedge | grass-like | N | 1 |
| *Carex oligocarpa* | richwoods sedge | grass-like | N | 2 |
| *Carex grisca* | inflated narrow-leaf sedge | grass-like | N | 1 |
| *Dichanthelium oligosanthes* var. *scribnerianum* | Scribner's rosette grass | grass | N | 7 |

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