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Vegetation Community Monitoring at Lincoln Boyhood National Memorial

2011–2019

Natural Resource Report NPS/HTLN/NRR—2021/2234

ON THE COVER
2011 photo of vegetation monitoring at site 4 at Lincoln Boyhood National Memorial
Photography by NPS/Heartland Network

Vegetation Community Monitoring at Lincoln Boyhood National Memorial

2011–2019

Natural Resource Report NPS/HTLN/NRR—2021/2234

Sherry A. Leis

National Park Service
Heartland Inventory and Monitoring Network
Republic, MO

Editing and Design by
Tani Hubbard

National Park Service &
Northern Rockies Conservation Cooperative
12661 E. Broadway Blvd.
Tucson, AZ 85748

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Contents

Page

Figures . . . iv
Tables . . . iv
Executive Summary . . . v
Acknowledgments . . . v
Introduction . . . 1
Methods . . . 2
    Study Site . . . 2
    Sampling Design . . . 2
    Data Summary . . . 3
        Climate . . . 3
        Overstory and Midstory . . . 3
        Understory . . . 3
        Vegetation . . . 4
        Ground Cover . . . 4
    Observer Error . . . 5
Results and Discussion . . . 6
    Climate . . . 6
    Canopy Closure . . . 6
    Midstory and Overstory Trees . . . 6
    Regeneration . . . 9
    Ground Flora Diversity . . . 9
        Species . . . 9
        Community . . . 12
        Guild . . . 12
    Ground Cover . . . 12
    Observer Error . . . 15
Conclusions . . . 16
Literature Cited . . . 17
Appendix A. Plant Species Observed in 2019 . . . 18

Figures

Page

Figure 1. Map of Heartland Inventory and Monitoring Network vegetation monitoring sites (N = 4) at Lincoln Boyhood National Memorial . . . 2

Figure 2. Mean Palmer Drought Severity Index values for the southcentral region of Indiana . . . 6

Figure 3. Midstory and overstory live tree basal area at Lincoln Boyhood National Memorial, 2011–2019 . . . 7

Figure 4. Cumulative mean basal area (m^2/ha) for all overstory tree species (> 5 cm DBH) in Lincoln Boyhood National Memorial, 2011–2019 . . . 8

Figure 5. Cumulative mean density (stems/ha) for the most abundant overstory tree species (> 5 cm DBH) in Lincoln Boyhood National Memorial, 2011–2019 . . . 8

Figure 6. Regeneration density by type at Lincoln Boyhood National Memorial, 2011–2019 . . . 9

Figure 7. Mean seedling (stems < 0.5 m tall) density (stems/ha) for three dominant tree species at Lincoln Boyhood National Memorial, 2011–2019. . . . 10

Figure 8. Mean small sapling (stems ≥ 0.5 m tall and < 2.5 cm DBH) density (stems/ha) for three dominant tree species at Lincoln Boyhood National Memorial, 2011–2019. . . . 10

Figure 9. Mean large sapling (stems ≥ 0.5 m tall and DBH > 2.5 cm and < 5.0 cm) density (stems/ha) for three dominant tree species at Lincoln Boyhood National Memorial, 2011–2019. . . . 11

Figure 10. Species diversity metrics, evenness (J') and Shannon diversity (H'), for vegetation monitoring sites in Lincoln Boyhood National Memorial, 2011–2019. . . . 11

Figure 11. Guild abundance of native and nonnative species at Lincoln Boyhood National Memorial, 2011–2019. . . . 13

Figure 12. Percent ground cover for three cover types (bare ground, bare rock, and grass litter) at Lincoln Boyhood National Memorial, 2011–2019. . . . 14

Figure 13. Percent ground cover for three cover types (leaf litter, unvegetated, and woody debris) at Lincoln Boyhood National Memorial, 2011–2019. . . . 14

Tables

Page

Table 1. Modified Daubenmire cover value scale used to determine ground flora species cover for the Heartland Network parks. . . . 3

Table 2. Diameter at breast height (DBH) measurement range (cm) and size class used to group midstory and overstory trees. . . . 3

Table 3. Overstory canopy closure at Lincoln Boyhood National Memorial, Indiana, 2011–2015. . . . 6

Table 4. Change in mean basal area and stem density of the most abundant midstory and overstory trees . . . 7

Table 5. Mean stem density of snags in Lincoln Boyhood National Memorial, Indiana, 2011–2019. . . . 7

Table 6. Native plant species richness and community diversity. . . . 9

Table 7. Exotic species abundance observed in vegetation monitoring sites at Lincoln Boyhood National Memorial, Indiana, 2011–2019. . . . 12

Table 8. Observer error rates for the 2019 sampling event . . . 15

Executive Summary

Lincoln Boyhood National Memorial celebrates the lives of the Lincoln family including the final resting place of Abraham's mother, Nancy Hanks Lincoln. Lincoln's childhood in Indiana was a formative time in the life our 16th president. When the Lincoln family arrived in Indiana, the property was covered in the oak-hickory forest type. They cleared land to create their homestead and farm. Later, designers of the memorial felt that it was important to restore woodlands to the site. The woodlands would help visitors visualize the challenges the Lincoln family faced in establishing and maintaining their homestead. Some stands of woodland may have remained, but significant restoration efforts included extensive tree planting.

The Heartland Inventory and Monitoring Network began monitoring the woodland in 2011 with repeat visits every four years. These monitoring efforts provide a window into the composition and structure of the woodlands. We measure both overstory trees and the ground flora within four permanently located plots. At these permanent plots, we record each species, foliar cover estimates of ground flora, diameter at breast height of midstory and overstory trees, and tree regeneration frequency (tree seedlings and saplings).

The forest species composition was relatively consistent over the three monitoring events. Climatic conditions measured by the Palmer Drought Severity Index indicated mild to wet conditions over the monitoring record. Canopy closure continued to indicate a forest structure with a closed canopy. Large trees (>45 cm DBH) comprised the greatest amount of tree basal area. Sugar maple was observed to have the greatest basal area and density of the 23 tree species observed. The oaks characteristic of the early woodlands were present, but less dominant. Although one hickory species was present, it was in very low abundance. Of the 17 tree species recorded in the regeneration layer, three species were most abundant through time: sugar maple (*Acer saccharum*), red bud (*Cercis canadensis*), and ash (*Fraxinus* sp.). Ash recruitment seemed to increase over prior years and maple saplings transitioned to larger size classes.

Ground flora diversity was similar through time, but alpha and gamma diversity were slightly greater in 2019. Percent cover by plant guild varied through time with native woody plants and forbs having the greatest abundance. Nonnative plants were also an important part of the ground flora composition. Common periwinkle (*Vinca minor*) and Japanese honeysuckle (*Lonicera japonica*) continued to be the most abundant nonnative species, but these two species were less abundant in 2019 than 2011. Unvegetated ground cover was high (mean = 95%) and increased by 17% since 2011. Bare ground increased from less than 1% in 2011 to 9% in 2019, but other ground cover elements were similar to prior years.

In 2019, we quantified observer error by double sampling two plots within three of the monitoring sites. We found total pseudoturnover to be about 29% (i.e., 29% of the species records differed between observers due to observer error). This 29% pseudoturnover rate was almost 50% greater than our goal of 20% pseudoturnover. The majority of the error was attributed to observers overlooking species. Plot frame relocation error likely contributed as well but we were unable to separate it from overlooking error with our design.

Acknowledgments

We appreciate the monitoring support from staff at Lincoln Boyhood National Memorial. Previous team members, K. James and K. Mlekush, collected and processed the first two years of data. Some basic language in the Introduction and Methods sections are from James (2011).

Introduction

Lincoln Boyhood National Memorial includes 200 acres of old fields and hardwood forest. Land surveys conducted in 1805 indicated the presence of oak-hickory forest including species sensitive to fire. Tree species included beech, black cherry, flowering dogwood, elm species, gum, shagbark hickory, ironwood, black locust, sugar maple, oak species, tulip poplar, pawpaw, redbud, sassafras, sycamore, and black walnut. When Lincoln's family arrived, they began to clear the land for agriculture (McEnaney 2001). Only small woodlots on the hilltop cemetery remained.

Later, as the memorial began to take shape, designers recommended recreating the forest to serve as a backdrop to the memorial features. The forest would provide visitors with a sense of what early settlers faced as they developed the land (McEnaney 2001). Nearly 40,000 native trees and shrubs were planted using the 1805 land survey as a guide for the project. However, it was difficult to recreate the dominance of oak and hickory species. A restoration plan included treatment of invasive species (especially Japanese honeysuckle), tree removal (sugar maple in particular), planting, and fire management (Pavlovic and White 1989). In this report, we assess changes to the forest monitoring sites since initial monitoring in 2011. We do not have details on management actions within the monitoring sites, so results are in the form of current and past status.

Forest at Lincoln Boyhood National Memorial. NPS/Paula Alexander

Methods

Study Site

Vegetation community monitoring sites were established in the forest of Lincoln Boyhood National Memorial in 2011. Four monitoring sites were installed within the southern area of the park and sampled in 2011, 2015, and 2019 (Figure 1). These four sites represent a mix of successional hardwood forest and the old homesite restoration (Pavlovic and Forste 2004).

Sampling Design

Monitoring methods followed the standard operating procedures outlined in the vegetation community monitoring protocol (James et al. 2009). Monitoring sites were 50 m x 20 m (0.1 ha) with two focal transects on the 50-m sides (Figure 1). Within the entire rectangular site, we collected overstory tree data: species, diameter at breast height (DBH), live or dead, and coppice (for trees >5.0 cm). Canopy

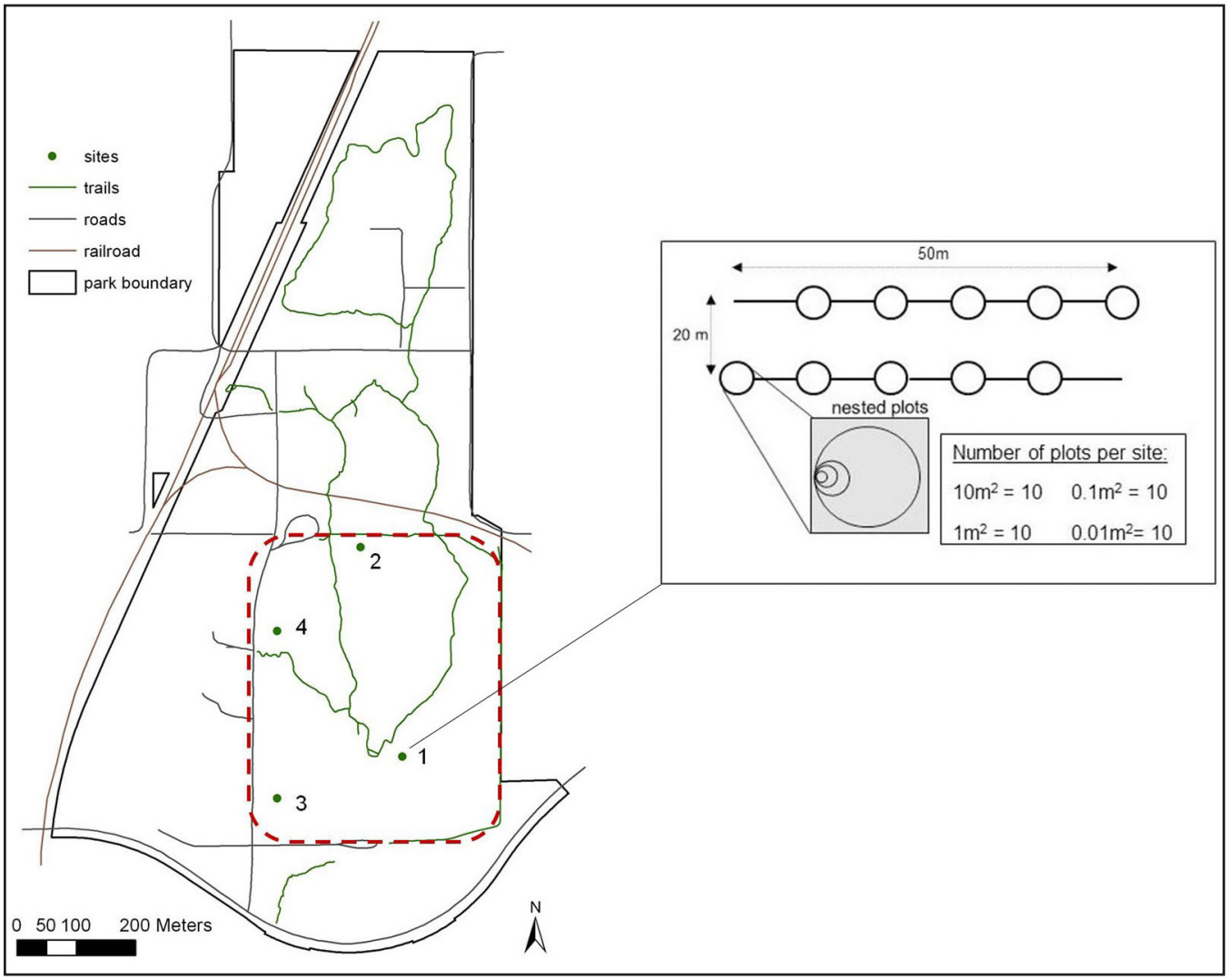

Figure 1. Map of Heartland Inventory and Monitoring Network vegetation monitoring sites (N = 4) at Lincoln Boyhood National Memorial, Indiana. The area within the dashed line (also in red) is the focus of plant community monitoring. Monitoring site configuration is shown on the right.

closure, percent cover for ground cover and species abundance, litter depth, and tree regeneration count were collected within subplots located along the two 50-m transects. 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 analysis. See James et al. (2009) for additional details on sampling design.

Data Summary

Foliar cover serves as an estimate of abundance for ground flora species. The cover class intervals are converted to midpoint values to estimate percent cover for each herbaceous and shrub species (Table 1). Mean percent cover was then calculated as the species percent cover for a sampling unit, averaged for all subplots. Sampling unit (site) means were then used to calculate community level means.

Table 1. 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

SPSS (Version 24; IBM 2016) and PC-ORD (McCune and Mefford 2016) were used for summary statistics. All site means were calculated from the included subplots (n = 10 per site). Confidence intervals (95%) were calculated and displayed.

Climate

The Palmer Drought Severity Index (PDSI) was used to describe the climate over the monitoring period at the Memorial (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 January 8, 2020). Monthly data were acquired for the south-central region of Indiana and averaged by year, but November and December index values were not available for 2019. Thirty-year normal precipitation data were obtained from National Centers for Environmental Information, NOAA (https://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#).

Overstory and Midstory

Snags were calculated separately from live trees. 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 to 5 (overstory trees) for interpretation. Diameter at breast height (DBH) and stem density were scaled to the hectare for analysis.

Table 2. Diameter at breast height (DBH) measurement range (cm) and size class used to group midstory and 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 closure data were collected using a densitometer. Densitometer readings were collected in the four cardinal directions in each of the 10-m^2 subplots and converted to canopy closure (multiplyed by 1.04). Plot level mean canopy cover (n = 4 per subplot) was used to calculate site-level mean canopy cover. A grand mean was then calculated for all sites (N = 4).

Understory

Woody regeneration and ground flora were measured within the 10 m^2-subplots at each site. The cover class intervals are converted to midpoint values to estimate percent cover for each herbaceous and shrub species (Table 1). Mean percent cover is then calculated as the species percent cover for a monitoring site by averaging all subplots. Monitoring site means were then used to calculate community level means.

Tree Regeneration

Tree regeneration stems were tallied by species in the 10-m^2 subplots and reported in three size classes: (1) seedlings = stems <0.5 m tall; (2) small saplings

= stems ≥0.5 m tall and <2.5 cm DBH; and (3) large saplings = stems ≥0.5 m tall and between 2.5 cm and < 5.0 cm DBH. Density (stems/ha) was calculated for all stems and by species. In both cases, site level densities were averaged across sites.

Vegetation

Species Diversity Indices

Based on foliar cover measurements, diversity indices describe the number of species and their abundances. Mean site cover for all non-tree species was calculated using all subplots within each site. For each site within the community, species richness (S), Shannon diversity index (H′) and evenness (J′) were calculated. Species richness, synonymous with alpha diversity, 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.

Plant diversity for each site was calculated using the Shannon diversity index:

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

where p_i is the relative cover of species i (Shannon and Weaver 1949).

Species distribution evenness (J′) is calculated by site according to Pielou (1969):

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

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). A value of 1 indicates even communities wereas 0 indicates a heterogeneous community.

Community Diversity Metrics

Community richness metrics evaluate how species richness differs across monitoring sites and the park. We limited these calculations to understory herbaceous species.

Beta Diversity=gamma/alpha-1

Alpha diversity is synonymous with species richness at the site scale (i.e., mean number of species per monitoring site). *Gamma* diversity is the community level richness (i.e., total number of species in the community) observed across all our monitoring sites. *Beta* diversity is a measure of heterogeneity in species distributions 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).

Guild Abundance

Understory plant 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 including 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.

The abundance of native verses nonnative (e.g. exotic) species was assessed using mean cover values. Mean cover values for species within a site were summed by origin (native or nonnative).

Ground Cover

Ground cover was assessed using cover classes (Table 1). A site mean was calculated by averaging the cover class midpoints for subplots in each site. We observed foliar cover of grass litter, leaf litter (deciduous plant leaves), exposed rock, bare ground, and the cover of woody debris (e.g. branches and sticks). Total unvegetated area reflects space unoccupied by stem basal area in the subplots (James et al. 2009). We also measured litter depth in each plot. Three measurements in each plot were averaged and the plot means were used to create a site level mean for litter depth.

Observer Error

We assessed our error in observing the ground flora with a double sampling method. At three of the four monitoring sites, after the transects were read, one plot from each of the two transects was randomly chosen for resampling. Sampling teams switched transects and sampled the ground flora in the randomly chosen plot. Pseudoturnover was calculated by comparing the two reads on each plot and identifying species that were overlooked (a species was recorded by one observer but not the other), misidentified (the same specimen was apparently recorded as different species by the two observers), or at different specificity levels (cautious errors, in which one observer identified a plant to species and the other identified it only to genus).

Pseudoturnover was calculated as in Nilsson and Nilsson (1985):

$$\frac{A + B}{S_A + S_B} \cdot 100$$

where A was the number of species recorded exclusively by observer-1, B was the number of species recorded exclusively by observer-2, S_A was the total number of species recorded by observer-1, and S_B was the total number of species recorded by observer -2. Pseudoturnover is expressed as a percentage.

Results and Discussion

Climate

Most years of the monitoring record ranged from normal to mild and moderately wet (Figure 2). The 30-year normal (1981–2010) for precipitation in nearby Evansville, Indiana, is 118.1 cm (46.5 in). Four of the nine years in the sampling record had above normal precipitation including the three years where sampling occurred.

Canopy Closure

Canopy closure measurements indicate a forest with a closed canopy across all four monitoring sites (Table 3). Pavlovic and Forste (2004) called for the creation of canopy gaps to facilitate oak and hickory regeneration. We did not see evidence of canopy openings within our monitoring sites.

Table 3. Overstory canopy closure at Lincoln Boyhood National Memorial, Indiana, 2011–2015. SE = standard error.

Year	N	Mean Canopy Closure (%)	SE
2011	4	95.6	1.23
2015	4	95.2	0.51
2019	4	92.8	0.79

Midstory and Overstory Trees

Large trees made up the greatest mean basal area (Figure 3). The pattern of the largest trees encompassing the greatest proportion of basal area is common in forests. Mean basal area of class 3 trees (25.0–34.9 DBH) declined by 2 m^2/ha in 2019.

Twenty tree species were observed among the four monitoring sites over the three visits (Figure 4). Sugar maple (*Acer saccharum*) continues to have the greatest basal area and density and has increased by 23% and 4%, respectively, from the initial monitoring event (Table 4). Between 2011 and 2019, red maple (*Acer rubrum*) declined by 59% and 68% for basal area and density, respectively. We suspect that red maple trees were also present in 2015 but were misidentified. Tulip poplar (*Liriodendron tulipifera*) basal area declined by 59% in 2019 and oaks remained an important part of the tree composition (Figure 4, Table 4). Shagbark hickory (*Carya ovata*) remains a minor component of the community.

Midstory and overstory tree density patterns reflect that of basal area (Figure 5). Sugar maple comprises most tree stems with contributions from sweet gum (*Liquidambar styraciflua*) and tulip poplar. Flowering

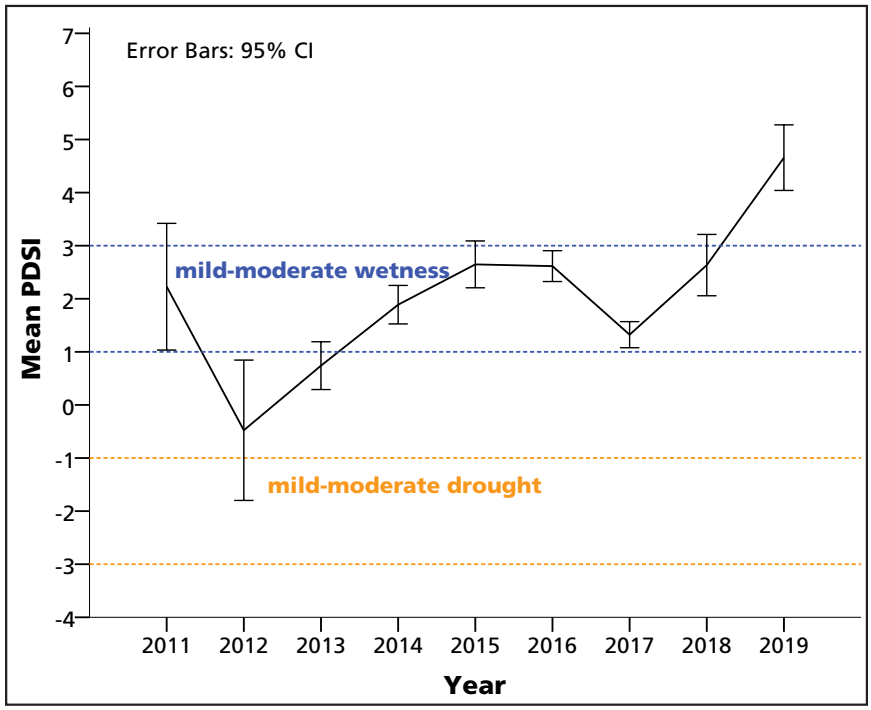

Figure 2. Mean Palmer Drought Severity Index values for the southcentral region of Indiana. 2019 data include January–October.

dogwood (*Cornus florida*) density appears to fluctuate between years but was 47% less in 2019 than 2011. Red oak (*Quercus rubra*) stems also declined from 2011 (Table 4).

Table 4. Change in mean basal area and stem density of the most abundant midstory and overstory tree (>5 cm DBH) species in Lincoln Boyhood National Memorial, Indiana, 2011–2019. 2019 abundance was compared to the baseline year (2011). Negative values for change indicate greater basal area in 2011 than 2019.

Species	Basal Area % Change	Density % Change
Acer rubrum	-59.2	-68
Acer saccharum	22.9	3.5
Cornus florida	-56.2	-47.1
Liquidambar styraciflua	-8.5	0
Platanus occidentalis	12.6	0
Quercus rubra	-6.9	-50
Quercus velutina	15.0	0

Snags are important for wildlife habitat; however, increases can be indicators of windstorms, disease, or insect outbreaks. The density of snags was similar across monitoring events (Table 5). Ash (*Fraxinus* sp.) is currently a minor component of the forest overstory at Lincoln Boyhood National Memorial, so the impact of the current regional infestations of emerald ash borer is unclear (Figures 4 and 5).

Table 5. Mean stem density of snags in Lincoln Boyhood National Memorial, Indiana, 2011–2019.

Year	Mean Stem Density (stems/ha)	95% Confidence Interval
2011	4.3	-1.3, 9.9
2015	4.8	-2.1, 11.6
2019	4.0	2.7, 5.3

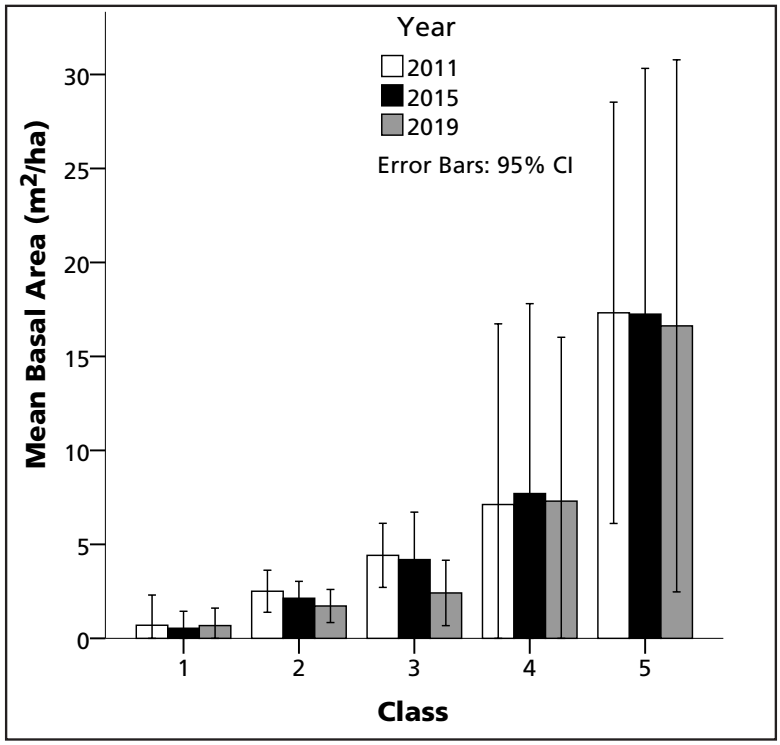

Figure 3. Midstory and overstory live tree basal area at Lincoln Boyhood National Memorial, Indiana, 2011–2019. Classes range from midstory (class 1: 5.0–14.9 cm DBH) to large overstory trees (class 5: ≥45 cm DBH).

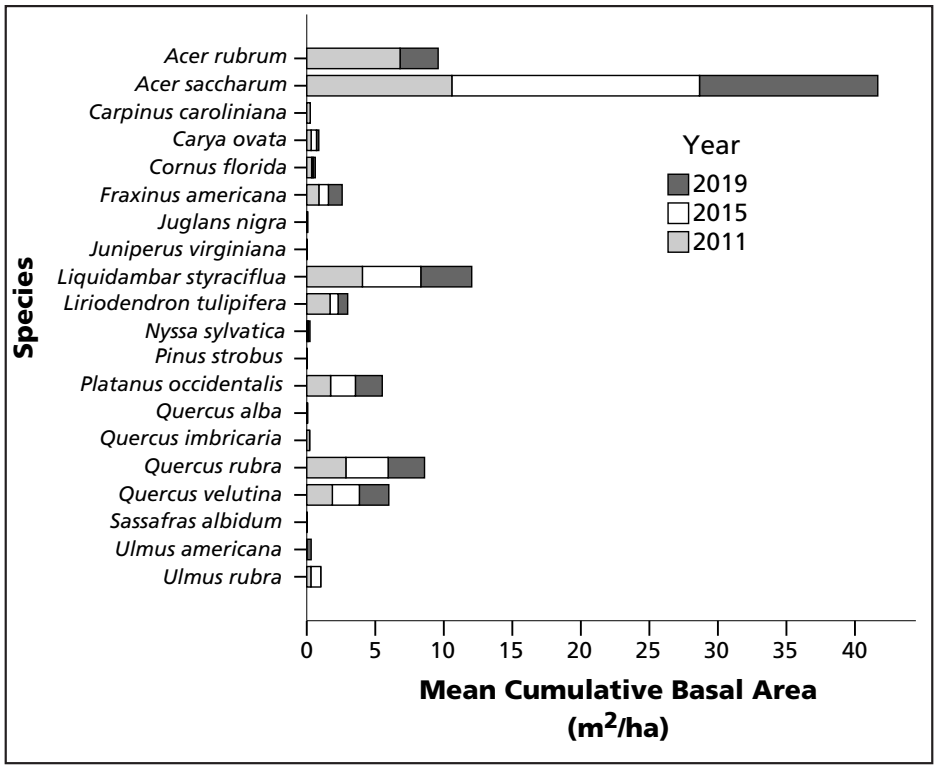

Figure 4. Cumulative mean basal area (m^2/ha) for all overstory tree species (>5 cm DBH) in Lincoln Boyhood National Memorial, Indiana, 2011–2019. Variably shaded bands represent mean basal area by year.

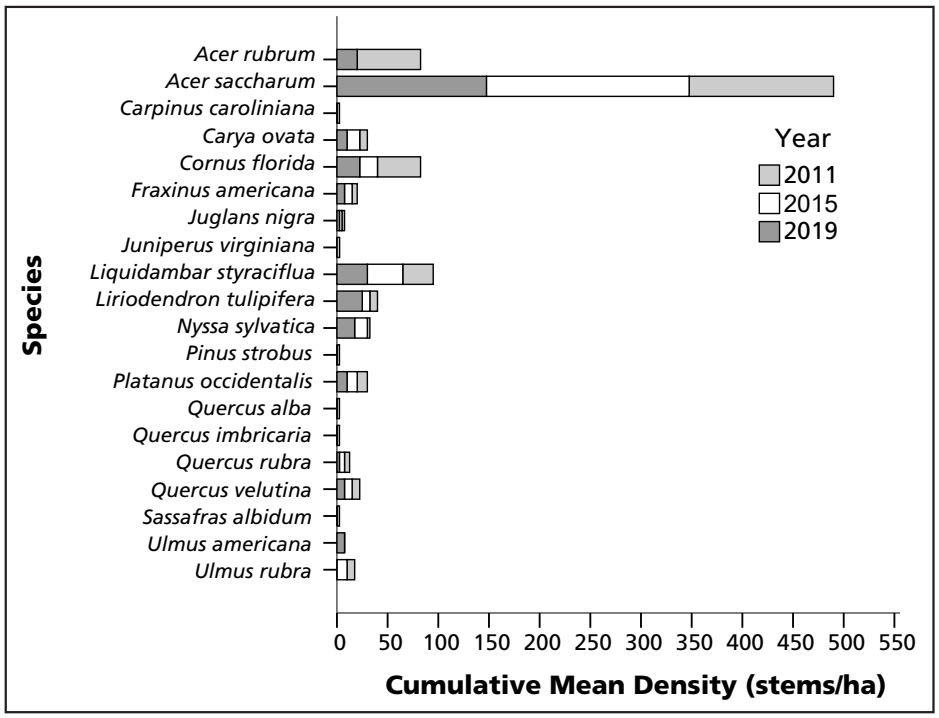

Figure 5. Cumulative mean density (stems/ha) for the most abundant overstory tree species (>5 cm DBH) in Lincoln Boyhood National Memorial, Indiana, 2011–2019. Variably shaded bands represent mean stem density by year.

Regeneration

Regeneration stem density is highly variable between monitoring sites and years (Figure 6). Mean stem density for seedlings and small saplings increased by 99% and 493%, respectively. Recruitment into the large sapling phase continues to be small.

Tree regeneration stems included 17 species. Only three tree species contributed more than 5% of stem density each to the community. Although ash was a minor component of the overstory, it is among the dominant species of the regeneration layer (Figures 7–9). Sugar maple saplings increased 260% between 2011 and 2019. This presents a challenge for restoration efforts that seek to reduce the influence of sugar maple in favor of more xeric species like oak and hickory.

Ground Flora Diversity

Species

Mean native plant species richness of the ground flora increased by 16% in 2019 (Table 6). Species were distributed somewhat homogenously with evenness values approaching 1 (Figure 10). Diversity was modest and similar through time (Figure 10).

Table 6. Native plant species richness and community diversity. CI = confidence interval.

Year	Species Richness	95% CI ±	Alpha	Gamma	Beta
2011	27.0	22.8, 31.2	27.0	48	0.8
2015	27.3	22.3, 32.3	27.3	48	0.8
2019	32.0	25.3, 38.7	32.0	58	0.8

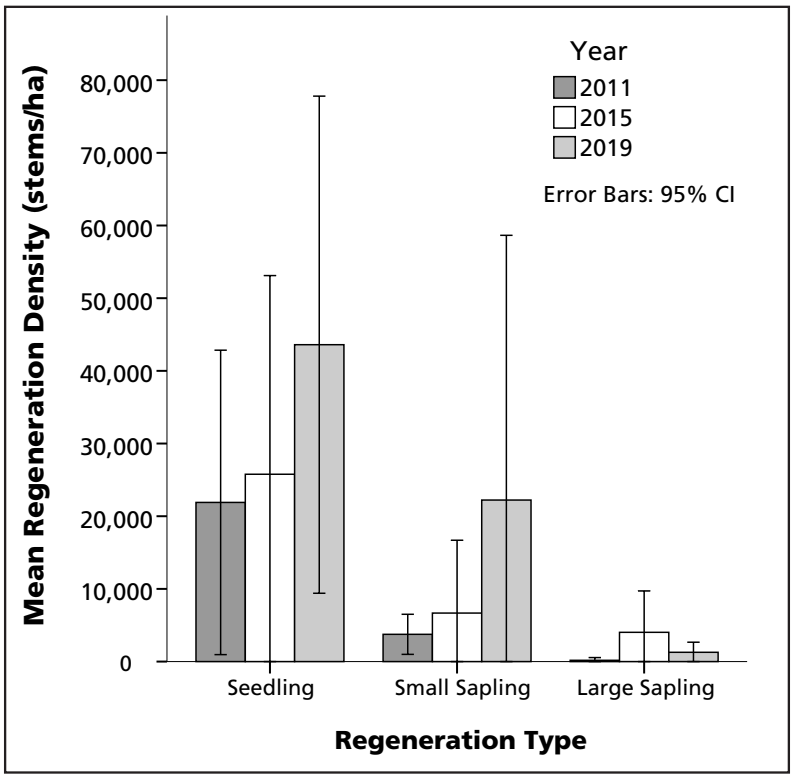

Figure 6. Regeneration density by type at Lincoln Boyhood National Memorial, Indiana, 2011–2019. Types are seedling (<0.5 m tall), small sapling (≥0.5 m tall and <2.5 cm DBH), and large sapling (≥0.5 m tall and between 2.5 cm and <5.0 cm DBH).

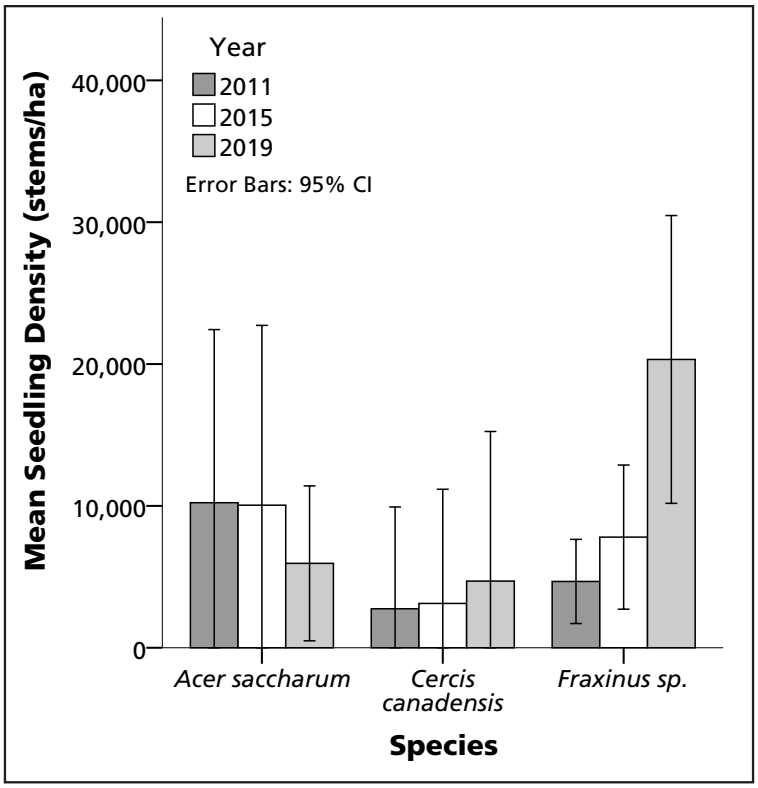

Figure 7. Mean seedling (stems <0.5 m tall) density (stems/ha) for three dominant tree species at Lincoln Boyhood National Memorial, Indiana, 2011–2019.

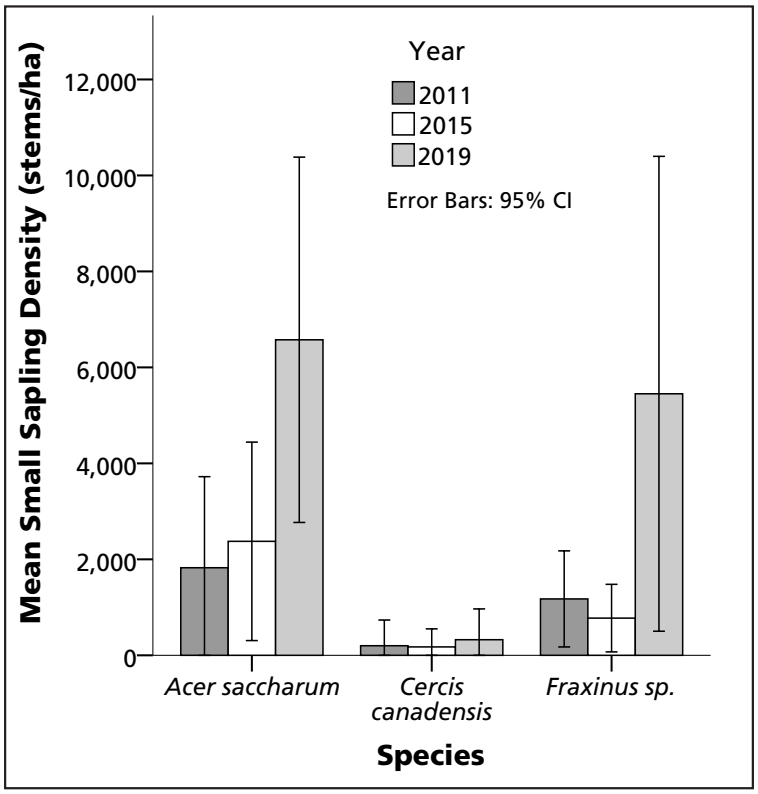

Figure 8. Mean small sapling (stems ≥0.5 m tall and <2.5 cm DBH) density (stems/ha) for three dominant tree species at Lincoln Boyhood National Memorial, Indiana, 2011–2019.

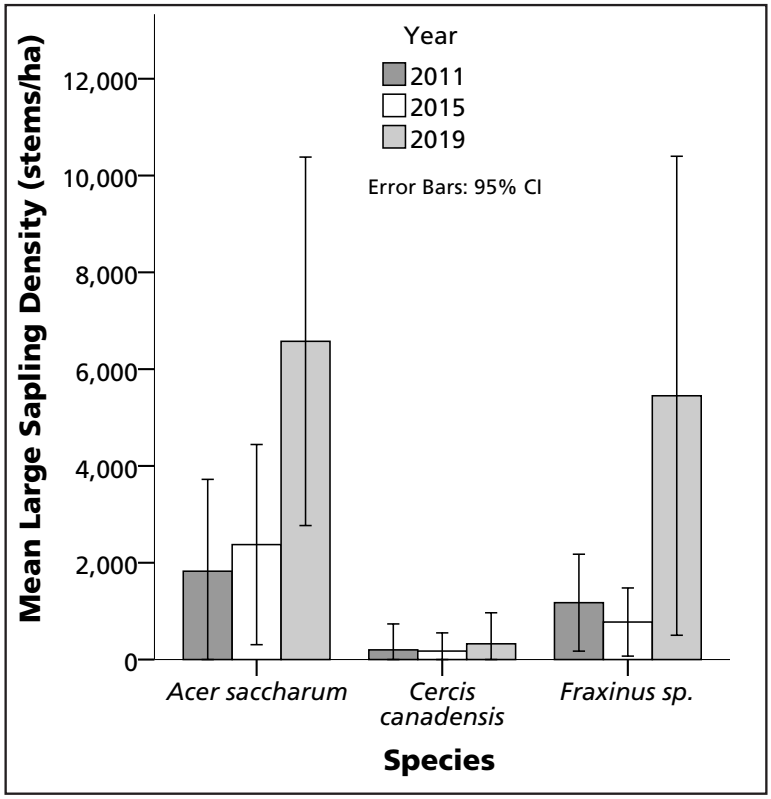

Figure 9. Mean large sapling (stems ≥0.5 m tall and DBH >2.5 cm and <5.0 cm) density (stems/ha) for three dominant tree species at Lincoln Boyhood National Memorial, Indiana, 2011–2019.

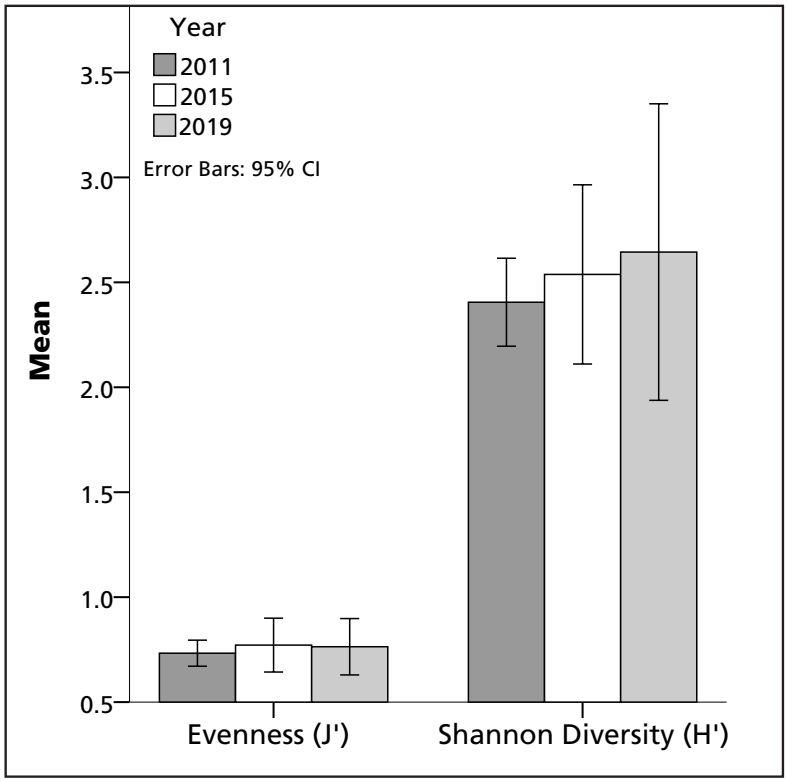

Figure 10. Species diversity metrics, evenness (J') and Shannon diversity (H'), for vegetation monitoring sites in Lincoln Boyhood National Memorial, Indiana, 2011–2019.

Community

Gamma diversity (park-wide richness) of native species increased by 10 species in 2019, but beta diversity remained low (Table 6). This indicates that sites are relatively homogenous. This is corroborated by the mean evenness values.

Guild

Abundance of dominant plant guilds was variable (Figure 11). For native plants, woody plants followed by forbs were most abundant. For nonnative species, woody plants and vining plants were greatest.

Exotic species were an important component of the ground flora with the number of exotic species recorded being greatest in 2019 (7 species in 2011, 6 species in 2015, 10 species in 2019). Common periwinkle (*Vinca minor*) declined by nearly half the 2011 abundance but continues to be the most abundant of the exotic species recorded in the plots (Table 7). Japanese honeysuckle (*Lonicera japonica*) persisted but declined by 74% over 2011 estimates.

Japanese honeysuckle was identified by Pavlovic and Forte for treatment (1989) because of the widespread distribution and negative effects on native flora. The Heartland invasive plant monitoring project (Young et.al. 2016) also recommended treatment.

Ground Cover

Grass litter and bare rocks were rare through time in vegetation monitoring sites. Bare ground increased from less than 1% in 2011 to 9% in 2019 (Figure 12). Ground cover was dominated by leaf litter with mean litter depths of 1.9 cm (SE ± 0.3). Sites were mostly unvegetated (mean cover 78–95 %) through time and woody debris was 18% less in 2019 (Figure 13).

Table 7. Exotic species abundance observed in vegetation monitoring sites at Lincoln Boyhood National Memorial, Indiana, 2011–2019.

Species	Common Name	Mean Cover (%) 2011	Mean Cover (%) 2015	Mean Cover (%) 2019
Berberis thunbergii	Japanese barberry	0.08	0	0
Celastrus orbiculatus	Oriental bittersweet	0	0	1.46
Euonymus alatus	burning bush	0	0	0.13
Euonymus fortunei	winter creeper	0	0	0.10
Ligustrum vulgare	European privet	0.26	0.40	0.01
Lonicera japonica	Japanese honeysuckle	9.13	6.94	2.41
Microstegium vimineum	Nepalese browntop	0.01	0	1.14
Perilla frutescens	beefsteakplant	0	0	0.01
Polygonum cespitosum	Oriental lady's thumb	0.41	0.08	0.55
Rosa multiflora	multiflora rose	0.38	0.03	0.14
Trifolium campestre	field clover	0	0.01	0
Vinca minor	common periwinkle	7.86	4.04	4.28

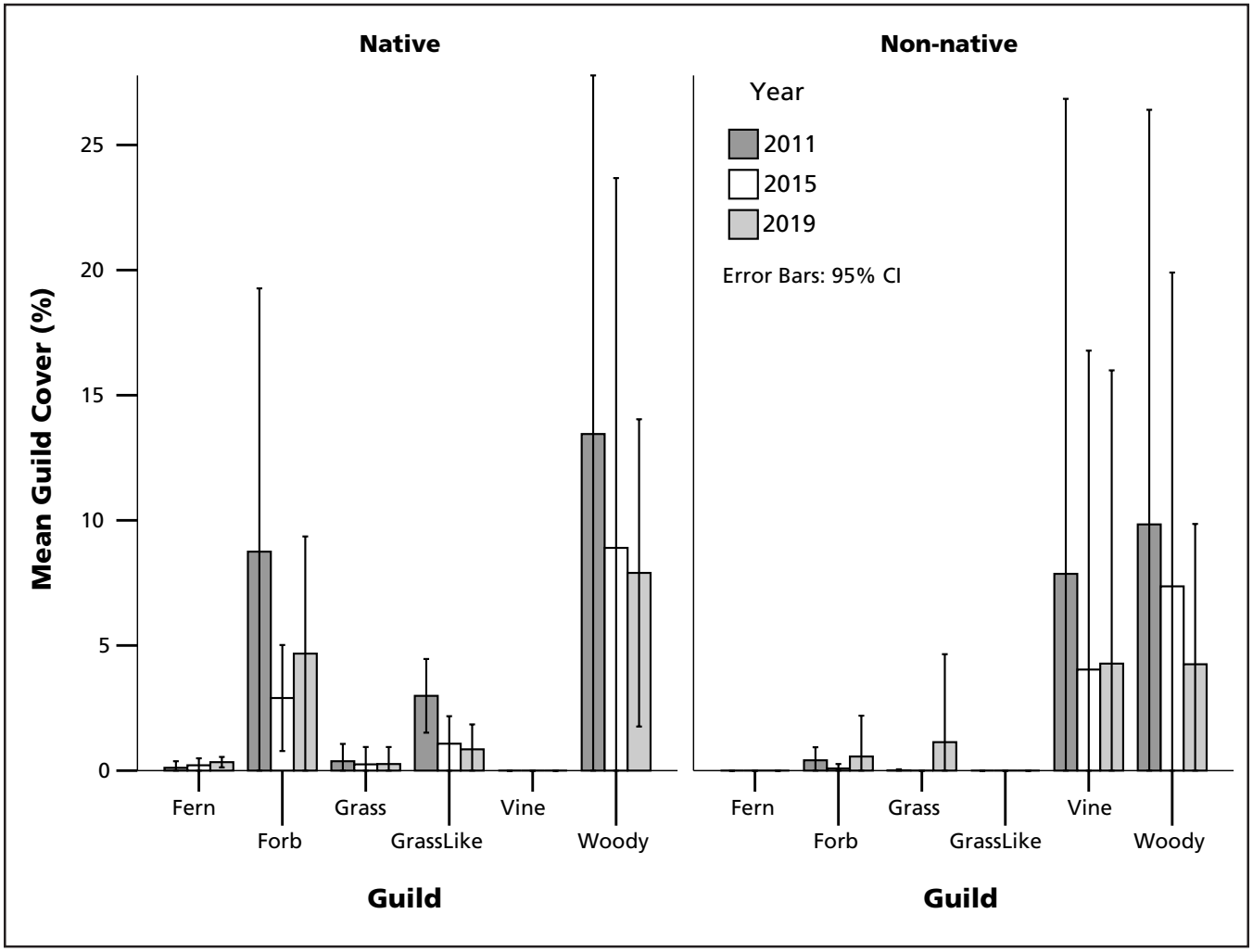

Figure 11. Guild abundance of native and nonnative species at Lincoln Boyhood National Memorial, Indiana, 2011–2019.

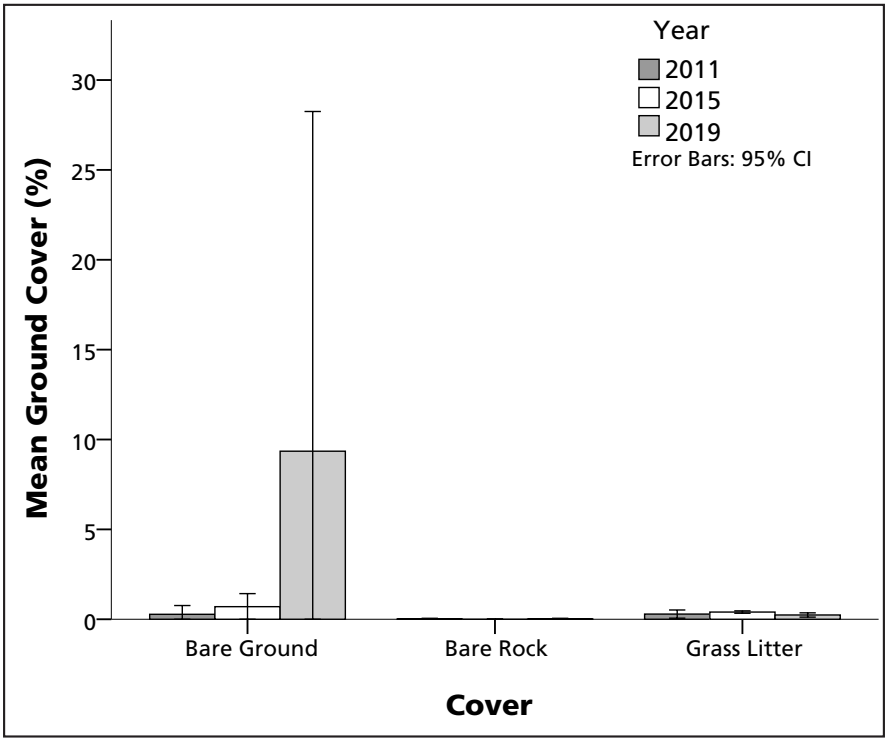

Figure 12. Percent ground cover for three cover types (bare ground, bare rock, and grass litter) at Lincoln Boyhood National Memorial, Indiana, 2011–2019.

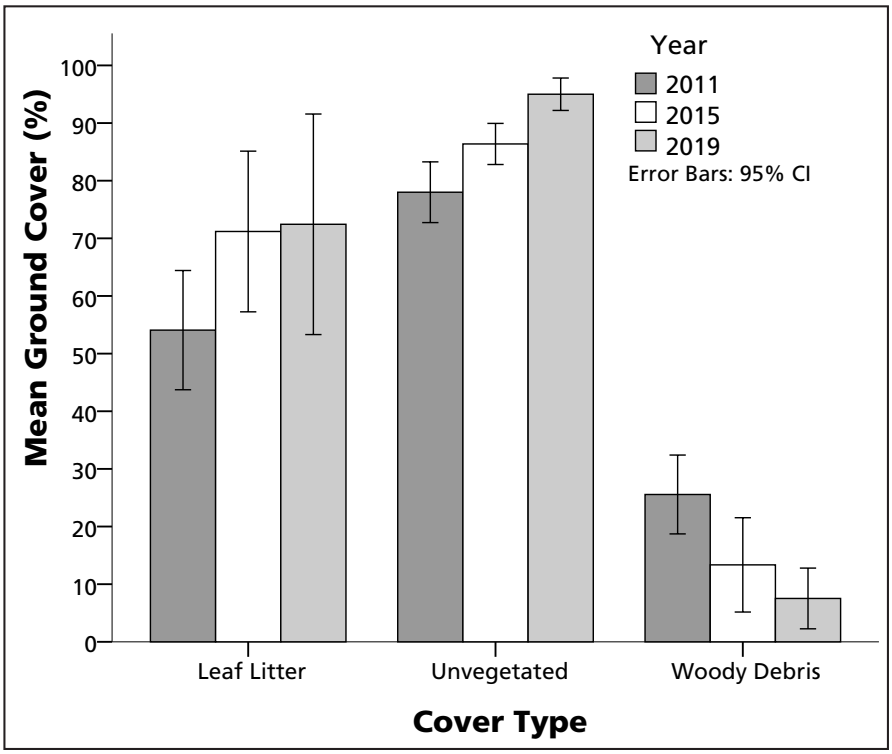

Figure 13. Percent ground cover for three cover types (leaf litter, unvegetated, and woody debris) at Lincoln Boyhood National Memorial, Indiana, 2011–2019.

Observer Error

Observer error is an unavoidable aspect of vegetation surveys. Pseudoturnover measures the discrepancy in species lists between observers and indicates the percentage of records that are erroneous (Table 8). Pseudoturnover has multiple components. Misidentification error appeared to be low (1.7%). Cautious error (where one observer lumped to a genus level and the other was more specific) was quite low as well (5.5%). The greatest source of error came from overlooking of species by one or the other of the observers (21.4%).

Total pseudoturnover is a function of all three types of error and averaged 28.6% for the sampling event. We aimed to keep our pseudoturnover around 20% as a benchmark based on prior research (Morrison 2016) and a previous sample event at the Tallgrass Prairie National Preserve (unpublished data). We suspect that sample frame relocation error between observations may have been an important source of error. However, our design did not allow us to distinguish this source of error from overlooking error. Changing plot delineation gear could reduce relocation error if the right materials could be found.

Table 8. Observer error rates for the 2019 sampling event (n = 6). SE = standard error

Error Component	Mean Error Rate (%)	SE
Overlooking	21.4	8.5
Misidentification	1.7	1.1
Cautious	5.5	2.9
Total Pseudoturnover	28.6	9.1

We also assessed the amount of agreement between observers on the species cover classes recorded. Overall there was 85% agreement on cover classes. All observations that were not in agreement were within one cover class.

Conclusions

The origin of plant communities within the monitoring sites may range from successional woodland to planted forest. However, vegetation communities at Lincoln Boyhood National Memorial were very similar across monitored years. Overstory tree composition reflects a mesic successional forest rather than an oak-hickory woodland. This is a persistent condition and management challenge for the park.

Regardless, the forest provides visitors a sense of the environment the Lincoln family faced as they worked to create a farm and homestead. The dense canopy cover may limit light for herbaceous species and oak tree development. Continued application of management to create canopy openings and treat problematic plant species may help the park reach the target plant communities.

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Appendix A. Plant Species Observed in 2019

Table A1. All species observed in 2019 at Lincoln Boyhood National Memorial, Indiana. Values for mean cover, standard deviation (SD) and occurrence are for 2019 only. N = native, I = nonnative, SE = standard error.

Species	Common Name	Guild	Origin	Mean Cover (%)	SE	Occurrence (% Sites Observed)
Acalypha virginica	Virginia threeseed mercury	forb	N	0.09	0.02	100
Ageratina altissima	white snakeroot	forb	N	0.55	0.41	75
Arisaema dracontium	green dragon	forb	N	0.01	0.01	25
Aristolochia serpentaria	Virginia snakeroot	forb	N	0.05	0.04	50
Arisaema triphyllum	Jack in the pulpit	forb	N	0.01	0.01	25
Asplenium platyneuron	ebony spleenwort	fern	N	0.03	0.01	50
Aster sp.	aster	forb	N	0.01	0.01	25
Bidens bipinnata	Spanish needles	forb	N	0.05	0.02	75
Boehmeria cylindrica	smallspike false nettle	forb	N	0.11	0.08	50
Botrychium multifidum	leathery grapefern	fern	N	0.01	0.01	25
Botrychium virginianum	rattlesnake fern	fern	N	0.29	0.05	100
Campsis radicans	trumpet creeper	woody	N	0.03	0.01	50
Carex sp.	sedge	grass-like	N	0.85	0.31	100
Cercis canadensis	eastern redbud	woody	N	0.08	0.08	25
Celastrus orbiculatus	Oriental bittersweet	woody	I	1.46	0.96	100
Cinna arundinacea	sweet woodreed	grass	N	0.18	0.18	25
Clematis virginiana	devil's darning needles	woody	N	0.10	0.08	50
Corylus americana	American hazelnut	woody	N	0.15	0.15	25
Dichanthelium sp.	rosette grass	grass	N	0.01	0.01	25
Dioscorea quaternata	fourleaf yam	forb	N	0.26	0.15	50
Elephantopus carolinianus	Carolina elephantsfoot	forb	N	0.03	0.03	25
Elymus virginicus	Virginia wildrye	grass	N	0.01	0.01	25
Erechtites hieraciifolia	American burnweed	forb	N	0.03	0.03	25
Euonymus alatus	burning bush	woody	I	0.13	0.11	50
Euonymus atropurpureus	Eastern burning bush	woody	N	0.01	0.01	25
Euonymus fortunei	winter creeper	woody	I	0.13	0.06	50
Eupatorium perfoliatum	common boneset	forb	N	0.01	0.01	25
Galium circaezans	licorice bedstraw	forb	N	0.29	0.09	100
Galium concinnum	shining bedstraw	forb	N	0.04	0.04	25
Galium triflorum	fragrant bedstraw	forb	N	0.03	0.01	50
Geum canadense	white avens	forb	N	0.13	0.08	75
Geum vernum	spring avens	forb	N	0.10	0.08	50
Hydrastis canadensis	goldenseal	forb	N	0.08	0.08	25
Impatiens capensis	jewelweed	forb	N	0.25	0.13	75
Leersia virginica	whitegrass	grass	N	0.06	0.05	50

Table A1 (continued). All species observed in 2019 at Lincoln Boyhood National Memorial, Indiana. Values for mean cover, standard deviation (SD) and occurrence are for 2019 only. N = native, I = nonnative, SE = standard error.

Species	Common Name	Guild	Origin	Mean Cover (%)	SE	Occurrence (% Sites Observed)
Lindera benzoin	northern spicebush	woody	N	1.69	1.26	75
Liparis liliifolia	brown widelip orchid	forb	N	0.01	0.01	25
Ligustrum vulgare	European privet	woody	I	0.01	0.01	25
Lonicera japonica	Japanese honeysuckle	woody	I	2.41	1.04	100
Microstegium vimineum	Nepalese browntop	grass	I	1.14	1.10	75
Oxalis sp.	woodsorrel	forb	N	0.08	0.04	50
Parthenocissus quinquefolia	Virginia creeper	woody	N	1.69	0.81	100
Perilla frutescens	beefsteakplant	forb	I	0.01	0.01	25
Phytolacca americana	American pokeweed	forb	N	0.01	0.01	25
Phryma leptostachya	American lopseed	forb	N	0.31	0.05	100
Pilea pumila	Canadian clearweed	forb	N	0.93	0.86	75
Polygonatum biflorum	smooth Solomon's seal	forb	N	0.01	0.01	25
Polygonum cespitosum	Oriental lady's thumb	forb	I	0.55	0.52	50
Podophyllum peltatum	mayapple	forb	N	0.03	0.01	50
Polygonum virginianum	jumpseed	forb	N	0.44	0.18	75
Rosa multiflora	multiflora rose	woody	I	0.14	0.09	75
Rubus sp.	blackberry	woody	N	0.65	0.44	100
Ruellia caroliniensis	Carolina wild petunia	forb	N	0.01	0.01	25
Ruellia sp.	wild petunia	forb	N	0.01	0.01	25
Sassafras albidum	sassafras	woody	N	0.75	0.75	25
Sanicula canadensis	Canadian blacksnakeroot	forb	N	0.25	0.07	100
Sanicula sp.	sanicle	forb	N	0.05	0.02	75
Smilax glauca	cat greenbrier	forb	N	0.14	0.02	100
Smilax tamnoides	bristly greenbrier	woody	N	0.09	0.07	50
Solidago sp.	goldenrod	forb	N	0.14	0.09	75
Staphylea trifolia	American bladdernut	woody	N	0.94	0.94	25
Symphoricarpos orbiculatus	coralberry	woody	N	0.06	0.02	75
Toxicodendron radicans	eastern poison ivy	woody	N	0.74	0.23	100
Viburnum dentatum	southern arrowwood	woody	N	0.09	0.09	25
Vinca minor	common periwinkle	vine	I	4.28	3.68	75
Viola sp.	violet	forb	N	0.16	0.05	100
Viburnum prunifolium	blackhaw	woody	N	0.48	0.36	75
Vitis sp.	grape	woody	N	0.38	0.10	100

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National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525