



Forest Vegetation Monitoring at Indiana Dunes National Lakeshore

Natural Resource Technical Report NPS/GLKN/NRTR—2013/779



ON THE COVER

View looking eastward through plot 3018 in black oak forest adjacent to the Cowles Bog area.
Photograph by: Hannah Wigginton, Great Lakes Inventory and Monitoring Network

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Suzanne Sanders and Jessica Grochowski

National Park Service
Great Lakes Inventory and Monitoring Network
2800 Lake Shore Dr. East
Ashland, Wisconsin 54806

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Executive Summary

Long-term forest health monitoring programs are a valuable means to assess impacts of invasive species, disturbance regimes, and climate change. Monitoring programs can detect subtle changes not necessarily realized otherwise, and provide scientifically valid information on which management decisions can be based. A comprehensive, long-term forest monitoring program was established at Indiana Dunes National Lakeshore (INDU) in 2007, when 20 plots were installed. In 2012, we resampled these 20 plots and installed an additional 30, bringing the total to 50. Collectively, these plots spanned five forest types: black oak, upland oak, mesic, wet mesic, and modified successional.

In general, black oak forests (29 plots) were healthy, largely due to prescribed burns in this forest type. Although 8.1% of the species located in black oak forest plots were non-native, these were largely naturalized and non-invasive species. The main exceptions to this were exotic honeysuckles (*Lonicera* spp.) that were colonizing along railroad rights-of-way. In modified successional forests (6 plots), a mean of 11.9 species per plot were not native. These plots were largely located near the Calumet Bike Trail and other areas of disturbance. The non-native species also reflect land use history, as many plots in this forest type are located on previously farmed land, or former homesteads. Upland oak forests (5 plots), like black oak forests, were generally healthy. Also similar to black oak forests, 7.7% of species located in the plots were non-native, but these were not highly invasive. A notable exception was multiflora rose (*Rosa multiflora*). This species reproduces clonally and, in many plots, we observed multiflora rose clumps spreading outward into otherwise healthy forests. Mesic forests (6 plots) had the lowest percentage of invasive species (4.5%), although this forest type seems to be the most threatened. Many of the plots were highly invaded by bittersweet (*Celastrus* sp.). While we did not distinguish between the native and the non-native species of this genus, the highly invasive growth form, as well as the habitat, suggests that we typically observed the Asian (non-native) species. Mesic forests are further threatened by the emerald ash borer (EAB, *Agilus planipennis* Fairmaire), since green ash (*Fraxinus pensylvanica*) was, and still is, a large component of this forest type. Infestation by EAB, which feeds on the phloem and kills the tree within three to four years of initial attack, results in large amounts of coarse woody material and large canopy gaps. This facilitates further colonization by bittersweet, and other invasive species preferentially located in areas of high light.

The browse index, defined as the percentage of 1-m-radius circles (n=68/plot) that have at least one shrub, woody vine, or sapling browsed during the current growing season, was high for all forest types. This was highest (34.8%) in modified successional forests, where deer preferentially fed on black cherry (*Prunus serotina*). This index was also high (27.2%) in black oak forests where black cherry as well as sassafras (*Sassafras albidum*) were preferred species. The browse index was 20.8%, 12.5%, and 11.3% for wet mesic, upland oak, and mesic forests, respectively. It is possible that the lower browse intensity on upland oak and mesic forest shrubs and saplings may be due to the sparse understory in these forests. Deer may be venturing into forest types with a greater amount of herbaceous species.

Forest change between time periods (2007-2012) was largely explained by stand aging. In black oak forests, change was largely related to time-since-burn. The density of live trees decreased by 166 trees/ha, while standing dead tree density increased by 170 trees/ha. Basal area of living trees differed little between years, although basal area of standing dead trees doubled between the two sampling periods. In mesic forests, the dynamics of ash are an important component of change. Although ash is more common in mesic forests than any of the other types, collectively ash species

represent only 11.7% of the density and 6.12% of the basal area within this forest type. It does not appear that changes in mesic forests are entirely a reflection of ash demographics in response to EAB. The drop in density coupled with increased basal area is a pattern commonly observed when stands become composed of multiple cohorts, as is happening in mesic forests. The demographic patterns observed in modified successional forests reflect the relatively young age of these stands. Senescence of large trees will leave gaps that lead to recruitment of new cohorts. Our results may indicate the transition of this new cohort from the seedling and sapling stages into small trees.

Park managers at INDU face tough challenges as the problems posing the greatest threats are generally beyond their control. Large expanses of the park will be impacted by the loss of ash. We recommend that managers identify these areas and prioritize a limited number for intensive exotic species monitoring and management. In particular, we feel that monitoring should be in the form of scouting rather than a structured system of transects or quadrats. With the impending loss of ash, early detection of exotic species attempting to occupy the vacant niche will be paramount. The green ash-dominated forests at INDU support a number of native plant species only uncommonly observed within the eastern deciduous forest as a whole. This is especially true in many of the wet mesic forests immediately north of Highway 12.

The 50 permanent monitoring plots will be revisited in 2021. Because this will be the third visit to these plots, an assessment of trends can be made at that time.

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Introduction

Forest health monitoring programs are a valuable means to assess current and potential impacts such as invasive plant and insect species (Blossey 1999, Auclair 2005), disturbance regimes (Key and Benson 2006, Tanentzap et al. 2011), and climate change (Soldberg et al. 2009, Woodall et al. 2010). Monitoring programs can detect subtle changes not necessarily realized otherwise, and provide scientifically valid information on which management decisions can be based (Carignan and Villard 2002, Duchesne et al. 2005, Day and Puric-Mladenovic 2012). A comprehensive, long-term forest monitoring program was established at Indiana Dunes National Lakeshore (INDU) in 2007. This program, initiated by the Great Lakes Inventory and Monitoring Network (GLKN) includes goals of detecting and quantifying changes in overstory structure and composition and, ultimately, relating these changes to drivers and stressors.

Indiana Dunes National Lakeshore is situated along the southern edge of Lake Michigan, lying just east of the southernmost extremity of the lake near Gary, Indiana (Figure 1). This location promotes a great deal of habitat heterogeneity; an extensive dune and swale complex spans the length of the lakeshore resulting in a matrix of black ash-dominated swales and upland areas abundant with black oak and sassafras. In addition, dune orientation, prevailing westerly winds, and alignment with the lake promote fire-dependent woodland, savanna, and prairie communities toward the western side of the park, while mesophytic forests dominate the eastern side. Coarse-textured soils are common throughout the park, especially in the 3-5 km nearest the shoreline. The lakeshore supports 139 state-listed rare, threatened, or endangered plants, representing 36% of Indiana's total, and with 1,134 confirmed native species present, INDU ranks third in floristic diversity among NPS units (Weyenberg 2010).

The integrity of INDU's forests varies widely. The national lakeshore lands are fragmented islands, bisected by roads and railroads and interspersed with houses and private property, all within a larger urban and industrial complex. As such, there are numerous pressures on the lakeshore's forests. Locally abundant exotic plant species include *Celastrus orbiculatus* Thunb. (Asian bittersweet), *Rosa multiflora* Thunb. (multiflora rose), and *Alliaria petiolata* [M. Bieb.] Cavara & Grande (garlic mustard). The exotic beetle, emerald ash borer (*Agrilus planipennis* Fairmaire) has been present at the lakeshore for approximately five years. As a result, ash mortality is high and will remain so, until all three species largely become extirpated. Nonetheless, large tracts of intact, high quality forest and woodland remain. Park efforts to promote forest health are ongoing. The park regularly employs full-time workers in the summer to remove exotic plant species, and also maintains a fire crew whose members regularly burn selected tracts.

At the inception of the long-term forest monitoring program at INDU in 2007, 20 permanent plots were established within the park. Since that time, GLKN has also initiated this monitoring program at eight other National Park Service units. The summer of 2012 marked the first revisit of the program to INDU. In addition to resampling the original 20 plots, 30 additional plots were established, bringing the total at the park to 50. Here, we report on the current (2012) status of INDU forests based on all 50 plots, and on select changes detected in the 20 resampled plots.

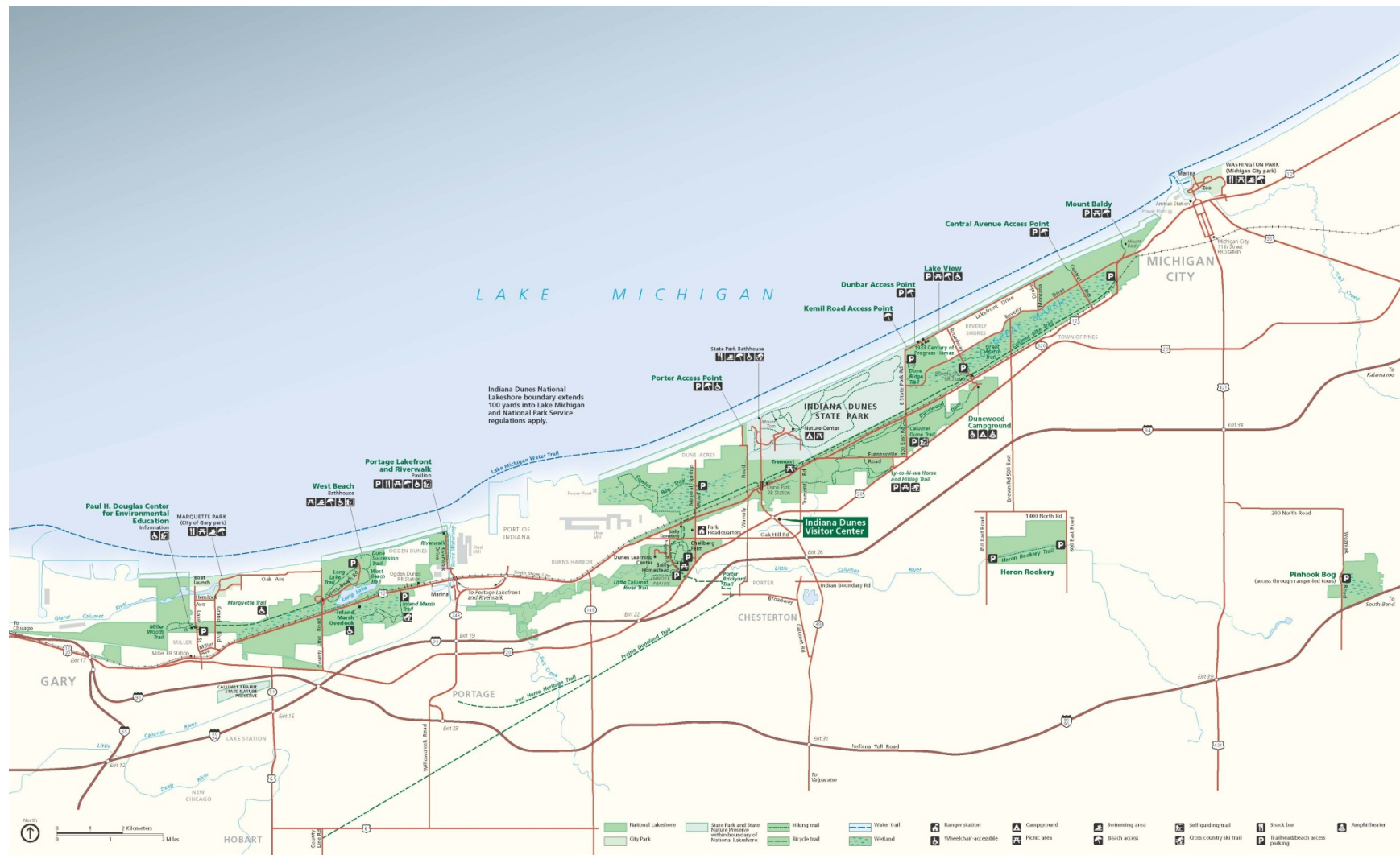


Figure 1. Indiana Dunes National Lakeshore (shown in green). Note the location of the Pinhook Bog in the lower right with the Heron Rookery tract almost immediately west of there. The Hobart Grove Prairie tract is just outside of the southwest corner of the image. Note also the large industrial complex separating the east and west units as well as the roads and railways that bisect both of these.

Methods

Sampling was conducted at INDU from 22 June-21 August 2012. Sites were selected prior to the 2007 sampling season using a generalized random-tessellation stratified design (Stevens and Olsen 2004), ensuring that sites were both randomly located and spatially balanced throughout the park. All sites were required to have a minimum of 10% forest cover. We checked all potential new sites against an aerial photography layer in GIS prior to visiting them in the field. Potential new sites that did not initially meet the minimum 10% forest cover requirement were moved the shortest distance possible, to a maximum of 100 m, so that they fell within the desired amount of cover. If a potential site could not be moved ≤ 100 m to meet the criteria, it was not sampled. Maps of individual sites are presented in Appendix A.

Field Methods

Basic Measurements

Sites were sampled using the Hybrid plot (Figure 2) developed specifically to meet the needs of the GLKN long-term monitoring program (Johnson et al. 2006, Johnson et al. 2008). The plot is composed of three 50-m parallel transects oriented east-west. Tree data were collected in a 6-m wide band along the length of each transect. Tree data collected included species, diameter at breast height (DBH), whether the tree was alive or dead, and select characteristics indicating damage and/or disease. Trees were defined as having a DBH ≥ 2.5 cm. Groundlayer vegetation was collected in 1 m² quadrats placed every 5 m along each transect (n = 30 per plot). Within each quadrat, we recorded all herbaceous, vine, and shrub species present, and counted and recorded seedlings. Seedlings were defined as tree species < 2.5 cm DBH, but at least 15 cm in height and showing evidence of growth from the previous year. Many species we commonly encountered reproduce vegetatively (e.g., black oak, sassafras). Individual sprouts (i.e., both ramets and genets) were deemed “seedlings” if no aboveground connections between them, or a parent tree, were visible. We measured coarse woody materials (CWM) along each of the three transects using the planar intercept method (Brown 1974, Woodall and Williams 2007). We recorded diameters at the point of intercept, the small end, and the large end; the length; the decay class (Woodall and Williams 2007); and, if possible, the species. Because we defined CWM as having a diameter ≥ 7.5 cm, the length of a piece was measured only along the section where the diameter exceeded this amount. This differed somewhat from the 2007 methods where we only recorded diameter at the transect intercept and the length. Finally, we performed a half-hour time-delimited search of the entire 50 m $\times$ 100 m plot area to locate any additional species not previously recorded in any of the sampling.

Browse Assessments

We examined white-tailed deer (*Odocoileus virginianus* Zimm.) winter and summer browse pressure using two distinct measures. Direct browse is an assessment of visible browse, i.e., bites, directly evident on the plant. The direct browse measure is assessed on woody species. The indirect browse assessment is conducted on herbaceous species and does not focus on obvious, visible browse, but rather changes in herbs, only indirectly observed over time (Webster et al. 2001, Kirschbaum and Anacker 2005). These changes are typically manifested as fewer and smaller individuals of preferred herbaceous browse species.

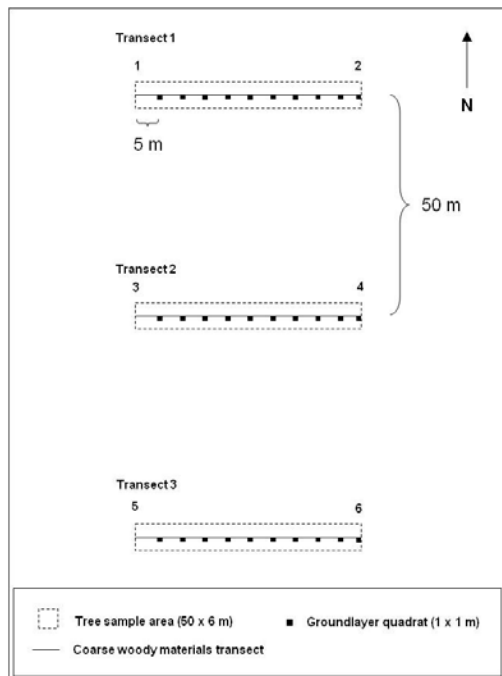


Figure 2. The hybrid plot configuration consisted of three parallel transects, each 50 m long and oriented east-to-west.

Direct browse was measured along each of the three 50-m transects, and along four additional transects flanking the east and west sides of the plot (Figure 3). Direct browse measurements were conducted in 3.14 m^2 (1 m radius) circular sampling areas. These browse sampling circles were centered every 5 meters along each transect, for a total of 68 per plot, equal to a total sampling area of 213 m^2 . For each direct browse sampling circle, all woody species present in the browse zone, defined as the space between ground level and 1.8 m in height, were recorded. In addition to species presence, evidence of any deer browse on that species in the sampling circle was recorded. Typically, winter browse surveys are conducted in the spring, prior to the new season's growth. Because we were not able to sample in the spring, we only considered a plant browsed when it was apparent that the browse occurred before the start of the current season's growth. This was evidenced by new growth arising from the bud immediately below the point of browse.

Direct browse data were used to calculate the proportion of browse. At the 1 m radius browse circle level, the proportion of browse is the number of species browsed to the number of species present. The proportion of browse values range from 0 to 1, where 0 represents a browse circle where no species present are browsed, and 1 represents a browse circle where all species present are browsed (Frerker and Waller 2013). The proportion of browse calculation can then be summed across all browse circles for each plot, each forest type, and the entire park. The proportion of browse calculation can also be used to determine which species are being browsed more frequently relative to others.

Direct browse data were also used to calculate the Morellet browse index, which uses a Bayesian approach (Morellet et al. 2001, Morellet et al. 2003). This browsing index was developed as a surrogate to costly, time consuming, and often inaccurate field counts of deer density. The idea is that deer abundance can be estimated by assessing their impacts, and that changes in these impacts over

time approximate changes in deer abundance. This browse index does not take the species present in a browse circle into consideration. If any woody stem within the browse circle shows evidence of browse, the circle is considered ‘browsed’ for this index. Therefore, this is a less precise calculation to estimate how common any incidence of browse is encountered in the forest. With a large number of browse circles, the Morellet browse index can be interpreted as a percentage of browse circles with at least one woody stem with evident browse.

The direct browse methods employed in 2012 differed considerably from those of 2007 where we simply noted the three closest woody plants to each of the thirty herbaceous quadrats and recorded whether browse was present. Because of the different methodology, no comparisons between time periods can be drawn.

The data collected for the direct browse assessments was also used to calculate frequency of occurrence of shrub and woody vine species in each plot. Frequency of occurrence was calculated based on the number of browse circles in which a shrub or woody vine species was present. We then calculated the mean frequency of occurrence across all plots in a forest type.

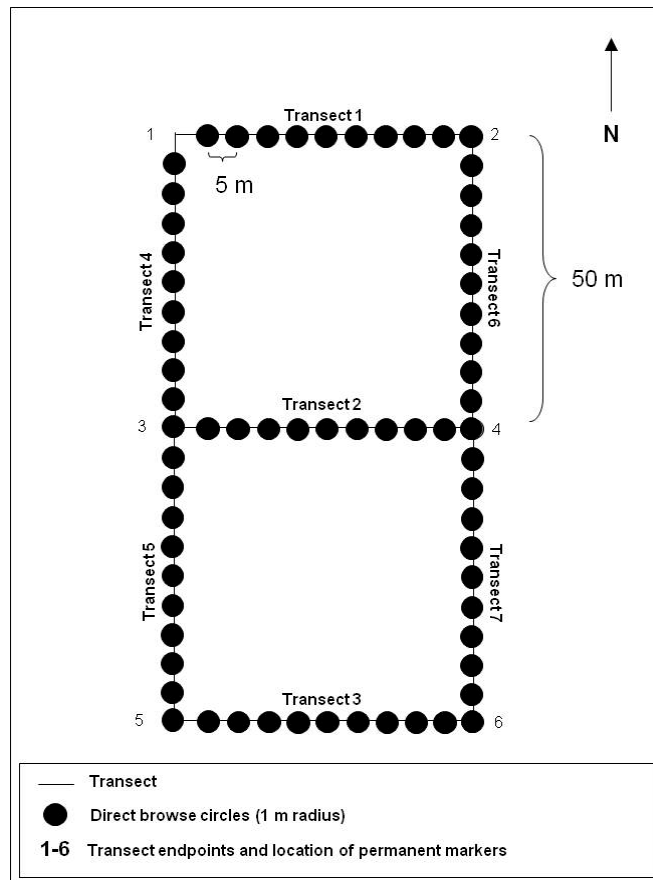


Figure 3. Location of the direct browse sampling circles in a plot.

To assess the indirect impacts of summer browse on understory species, we selected three target taxa that are known to be browsed by white-tailed deer in the region: *Osmorhiza* sp. Raf. (sweet cicely), *Maianthemum racemosum* ssp. *racemosum* (L.) Link (false Solomon’s seal), and *Lupinus perennis* L.

(wild lupine). For each target taxa present within each 1 m² herbaceous quadrat (see Figure 2), we measured the height of the tallest individual, and noted whether there was any evidence of browse within the quadrat. As with the direct browse measure, indirect browse methods of 2012 differed from those of 2007 (see Sanders [2008] for detailed methods). Because of the differing methodology, we will not make comparisons between the two time periods.

Tree Health

To assess tree health, we used an evidence-based approach whereby we examined each tree for the presence of broad classes of disease, damage, or injury (U.S. Department of Agriculture 2010). These classes included dieback, epicormic sprouting, wilted foliage, defoliation, discolored foliage, insect sign, and human induced stress. If a tree exhibited symptoms of one of these primary classes, a further classification of the damage or disease was made, based on predefined characteristics within each of the primary classes. For example, if a tree was classified as having discolored foliage, we would note whether this damage was in the form of (among other choices) marginal browning of the leaves, interveinal browning of the leaves, the leaves possessing a white coating, or a general yellowing of the leaves. This symptom-based assessment of damage and disease allows us to easily classify tree health issues, from which a diagnosis of the root cause can possibly be assigned upon further investigation. We feel that this symptom-based approach is more accurate than directly assigning a root cause to problems observed when at the field site. For some symptoms, there are dozens of possible causes and a pathologist or entomologist with specialization in the region would be needed to accurately assess the problem. Large-scale or persistent symptoms noted with this method can inform the park staff to potential disease or insect outbreaks, which would require further investigation by the park to identify the exact disease or pest. In 2007, we attempted to assign actual diseases or causal agents to diseased or injured trees, rather than focus on identification of the symptoms. Because of the differences in methods, no comparisons will be made between the two time periods.

Earthworm Assessments

Earthworm assessments were conducted at vegetation monitoring plots to determine the extent of invasive earthworm presence at INDU. Earthworm presence was determined using a simple visual assessment of the forest floor combined with a soil core assessment that followed methods developed for the Invasive Earthworm Rapid Assessment Tool (Loss et al. 2013). The forest floor assessment involved determining if the forest floor was composed of fresh litter, duff, and organic matter. In addition, the presence of earthworm casts, or excretions, were noted. We also noted the presence of middens, which are piles of cast material created by the nightcrawler (*Lumbricus terrestris* L.) (Hale and Host 2005). The soil core allows for a visual inspection of the depth of the organic layer, as well as an inspection of the A and E soil horizons, to determine their presence and thickness. Forests experiencing an earthworm invasion show a decrease in organic matter, and a thickening of the A soil horizon (Hale et al. 2005, Hale et al. 2008). From this, samples can be ranked as earthworm-free, minimally invaded, moderately invaded, substantially invaded, or heavily invaded. For example, an earthworm-free sample has fresh litter, duff, and organic matter present; no evidence of earthworm casts or middens; and the presence of an E soil horizon. A moderately invaded sample has both fresh and decayed litter, but no organic matter present; earthworm casts are present but not abundant; and earthworm middens may be present or absent. A heavily invaded sample would have fresh litter, but no decayed litter and no organic matter, and earthworm casts and middens would be abundant (Loss et al. 2013). Four earthworm assessments were conducted at each monitoring plot, in areas that were estimated to be representative of the plot overall. No earthworm assessments were carried out in 2007, so comparisons in earthworm impacts between the two time periods will not be made.

Assigning Forest Types

Because we may wish to stratify by forest type during later analyses (i.e., post-sampling stratification), we used the National Vegetation Classification System (Grossman et al. 1998) to assign a forest type for each plot, while we were at the plot. Under this system, we assigned the current forest type, from a choice of identified types, using a dichotomous key.

Visual Assessment/Photo Points

Documenting visual assessments of site change will be as important as statistical documentation, and potentially more informative. Therefore, we took six photographs at each plot. The six photo points were located at each of the six transect endpoints, with the photo taken facing into the plot (i.e., due east at points 1, 3, and 5 and due west at points 2, 4, and 6; see Figure 1).

Plant Identification

We attempted to identify all plants to the species level while in the field. When this was not possible, we typically collected specimens for later identification. In some instances, it was not possible to distinguish between multiple species present in a park, unless they were flowering or fruiting, which often was not the case. In these instances, we identified only to the genus or family level. Examples include *Carex* sp. L., *Sanicula* sp. L., Asteraceae, and Poaceae. One genus for which it was particularly challenging to positively identify to the species level was *Celastrus* (bittersweet). The native *C. scandens* L. and the exotic *C. orbiculatus* Thunb. are extremely difficult to distinguish when in vegetative states; characteristics to do this include leaf length to width ratio and leaf apex length, although these methods are not completely diagnostic (Leicht-Young et al. 2007). In addition, they are time consuming and not always possible in the field as many leaves are not reachable. By convention, we noted *Celastrus* sp. for all occurrences that did not have flowers or fruit present. For *Amelanchier*, another genus that presented identification challenges, we assigned individual plants to one of three groups of species complexes, with Group 1 containing *A. bartramiana* (Tausch) M. Roem.; Group 2 containing *A. arborea* (F. Michx.) Fernald, *A. laevis* Wiegand, and *A. interior* E.L. Nielsen; and Group 3 containing an uncertain number of species (Smith 2008). Finally, if a grass was not in flower or fruit, it was typically only possible to identify to the family (Poaceae) level.

Analysis and Classification Methods

Forest Type Classification

We used the National Vegetation Classification System developed for INDU (Hop et al. 2009) to assign specific vegetation types for each plot, while in the field. These were then subjectively assigned to one of five general forest types, defined by dominant tree species, moisture requirements, and degree of disturbance. We used non-metric multidimensional scaling (NMS) to verify the legitimacy of these groups. We limited inclusion in the NMS to those species that were present in at least 10% (5 of 50) of the plots. Collectively, the plots supported 28 taxa meeting these criteria. The NMS was based on the importance value, determined by the sum of the relative density and relative basal area of each species-plot combination (Dyer 2006, Elliott and Swank 2008). We used PC-ORD software for this analysis (McCune and Grace 2002).

Functional Groups

All taxa were assigned to classes within each of four functional groups. Within the *life history group*, taxa were assigned to either the annual, biennial, or perennial class. For taxa that are known to exhibit a range of life history strategies, we assigned the shortest strategy. For example, if a taxon is known to be either biennial or perennial, we assigned it to the biennial class. Within the *growth form group*, taxa were considered to be either woody (trees, shrubs, woody vines), graminoid (grasses,

sedges, and rushes), or forbs (herbaceous vines and broadleaved herbs). For this report, the latter class included ferns and fern allies. For the *pollination group*, taxa were considered to be abiotically pollinated if the flowers are non-existent (conifers) or not showy, and not known to produce any sensory attractants. These are typically wind pollinated. Otherwise, taxa which flower were considered to be biotically pollinated. Ferns and fern allies were assigned to the “not pollinated” class within this functional group. Within the *nativity group*, taxa were assigned to native, non-native, or native/non-native. Naturalized taxa (e.g., *Taraxacum officinale* F.H. Wigg. [common dandelion]) were considered non-native. In some instances taxa were identified only to the genus level and could not be assigned to a nativity group, as species within these genera are both native and non-native. Examples include *Poa* sp. L. (bluegrass) and *Hieraceum* sp. L. (hawkweed).

Coefficients of Conservatism

Coefficient of conservatism (COC) values describe the affinity of species to non-degraded habitats (Swink and Wilhelm 1994). Values range from 0 (either non-native species or generalists with no faithfulness to any particular habitat) to 10 (conservative species found only in high-quality, non-degraded habitats). Since a given species may be conservative in one area of its distribution but a generalist in the center of its range, COC values vary by region. Typically, values are assigned at the state level by experienced botanists and ecologists. For this report, we used COC values defined for the Chicago Region (Swink and Wilhelm 1994). Mean COC values were calculated for each of the five forest types.

Change Calculations

For forest types where at least three plots were resampled, we calculated the mean stem density and basal area for both live and standing dead trees in both 2007 and 2012. Due to the small sample sizes, we did not statistically test for differences, but plotted each in graph format. We also calculated and graphed density and basal area of key species or groups in these forest types. For black oak forests, black oak itself was the key species graphed. For mesic forests, we summed density and basal area for all ash species and graphed this; for modified successional forests, we summed density and basal area for both of the non-native tree species and presented it in graph form.

Results

A total of 50 plots were sampled in 2012; 20 of these were plots initially sampled in 2007 and resampled in 2012, and 30 were newly established plots. Maps of each plot are presented in Appendix A. From among all 50 plots, we identified 57 tree species, 79 shrub and woody vine taxa, and 367 taxa of herbs (Appendix B). Plots were assigned to one of five forest types: black oak, upland oak, mesic, wet mesic, and modified successional (Table 1, Figure 4).

Table 1. The five forest types sampled and the plots classified in each. Plots in red are those that were sampled in 2007 as well as 2012.

Forest type	Plots
Black oak	3003, 3011, 3012, 3013, 3014, 3015, 3018, 3022, 3028, 3029, 3031, 3033, 3036, 3038, 3044, 3051, 3053, 3059, 3065, 3078, 3082, 3084, 3093, 3095, 3096, 3103, 3104, 3105, 3106
Upland oak	3047, 3049, 3064, 3074, 3092
Mesic	3019, 3023, 3030, 3039, 3085, 3090
Wet mesic	3009, 3021, 3041, 3050
Modified successional	3017, 3026, 3034, 3042, 3069, 3102

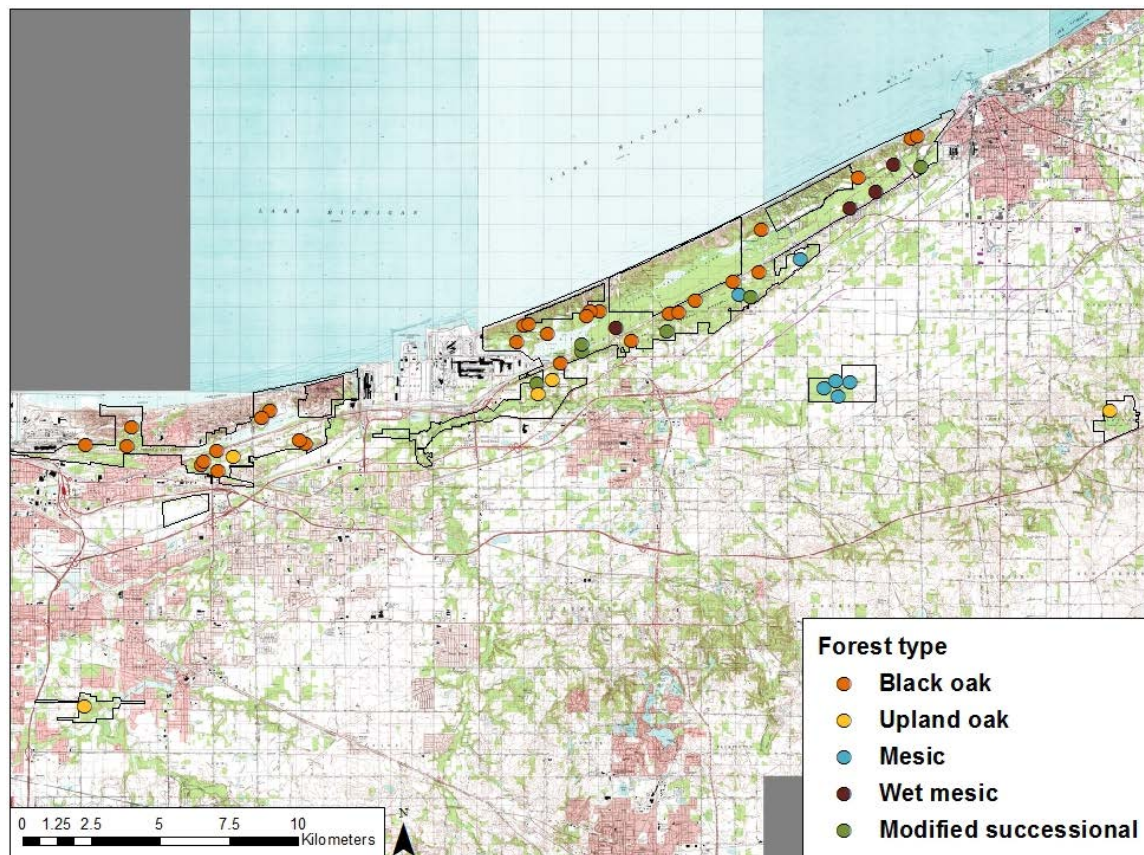


Figure 4. Distribution of forest types at Indiana Dunes National Lakeshore, 2012.

Black Oak Forest

Black oak forest was the most common type sampled (29 of the 50 plots). Of these, 24 plots were classified as the Black Oak-Pennsylvania Sedge NVCS vegetation type, while five were Black Oak (Northern Pin Oak)-White Oak/Wavyhair Grass. These were located throughout the park, but represented a greater proportion of the plots within the central and western areas of the park (Figure 4). Plots near the western border of the park, such as those in Miller Woods, were more savanna-like with low tree cover, while those further to the east tended to have more cover, and are often described as “oak woodlands.” In addition, several plots classified as black oak forest had nearly complete overstory cover. Hence, we used the more inclusive term, “Black Oak Forest” to apply to the whole continuum of savanna-woodland-forest. Overall plant richness was fairly high in black oak forest plots (mean = 65.97 species/plot), largely due to the groundlayer. A total of 30 overstory taxa were observed within the plots in black oak forest (Table 2), though only about six species were common (Figure 5). The stand structure varied considerably between plots within this forest type, dependent largely on the length of time since the last fire. Both *Quercus velutina* Lam. (black oak) and *Sassafras albidum* (Nutt.) Nees (sassafras) resprout readily following fire; one result of this was the presence of dense thickets of these species in many plots that have been burned within the previous 10 years. In plots that have not burned recently, larger diameter *Q. velutina* were the dominant trees present. Other common associates were *Prunus serotina* Ehrh. (black cherry) and *Q. alba* L. (white oak). Typical tree cover in black oak forests was ca. 30-60%.

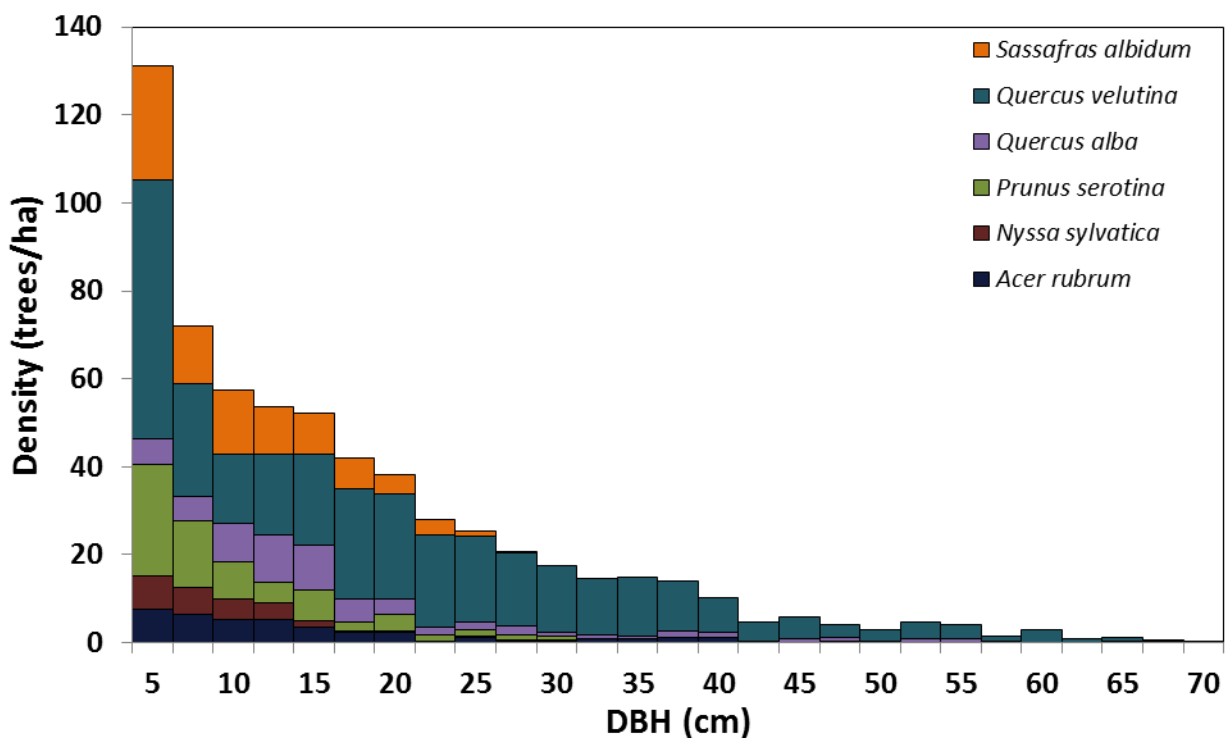


Figure 5. Density-diameter relationship for the six most important tree species in black oak forests.

Table 2. Basal area and density of live trees in black oak forests.

Latin name	Common name	Basal area (m ² /ha)	Density (trees/ha)
Hardwoods			
<i>Acer negundo</i>	boxelder	<0.01	0.38
<i>Acer rubrum</i>	red maple	0.82	39.46
<i>Amelanchier arborea</i>	serviceberry	0.01	3.07
<i>Betula alleghaniensis</i>	yellow birch	0.03	3.45
<i>Carpinus caroliniana</i>	American hornbeam	0.02	8.05
<i>Catalpa speciosa</i>	catalpa	0.03	3.07
<i>Cornus florida</i>	flowering dogwood	0.02	7.28
<i>Crataegus</i> sp.	hawthorn	<0.01	1.15
<i>Fraxinus americana</i>	white ash	<0.01	1.15
<i>Fraxinus pennsylvanica</i>	green ash	0.12	6.51
<i>Liriodendron tulipifera</i>	tulip poplar	0.01	0.38
<i>Morus alba</i> *	white mulberry	<0.01	0.38
<i>Nyssa sylvatica</i>	black gum	0.19	25.67
<i>Populus deltoides</i> ssp. <i>monilifera</i>	cottonwood	0.09	1.92
<i>Populus grandidentata</i>	bigtooth aspen	0.05	1.92
<i>Populus tremuloides</i>	trembling aspen	0.02	2.30
<i>Prunus serotina</i>	black cherry	0.65	70.88
<i>Prunus virginiana</i>	chokecherry	0.01	2.68
<i>Quercus alba</i>	white oak	2.46	65.90
<i>Quercus palustris</i>	pin oak	0.04	0.38
<i>Quercus rubra</i>	red oak	0.03	1.53
<i>Quercus velutina</i>	black oak	15.85	335.63
<i>Robinia pseudoacacia</i> *	black locust	0.04	4.21
<i>Salix</i> sp.	willow	0.00	0.38
<i>Sassafras albidum</i>	sassafras	0.86	90.04
<i>Tilia americana</i>	basswood	0.10	2.68
<i>Ulmus americana</i>	American elm	0.01	3.07
Conifers			
<i>Juniperus virginiana</i>	eastern red cedar	0.03	0.38
<i>Picea glauca</i> *	white spruce	0.02	0.77
<i>Pinus strobus</i>	white pine	0.04	1.53
Total		21.55	686.20

* non-native

Seedling density in the black oak forests (24,080 seedlings/hectare) was the highest of all forest types at the park. Seedlings of 18 taxa were identified, with the most abundant being *Sassafras albidum*, *Quercus velutina*, and *Prunus serotina* (Table 3). In general, the species with high densities at the seedling level were the same species with high densities as mature trees in the black oak forests.

Table 3. Seedling density in black oak forests.

Latin name	Common name	Density (seedlings/ha)
<i>Acer rubrum</i>	red maple	574.71
<i>Amelanchier arborea</i>	downy serviceberry	45.98
<i>Carpinus caroliniana</i>	American hornbeam	68.97
<i>Carya ovata</i>	shagbark hickory	80.46
<i>Catalpa speciosa</i>	catalpa	11.49
<i>Celtis occidentalis</i>	northern hackberry	11.49
<i>Cornus florida</i>	flowering dogwood	298.85
<i>Fraxinus americana</i>	white ash	45.98
<i>Fraxinus pennsylvanica</i>	green ash	344.83
<i>Liriodendron tulipifera</i>	tulip poplar	34.48
<i>Morus</i> sp.*	mulberry	11.49
<i>Nyssa sylvatica</i>	black gum	310.34
<i>Populus tremuloides</i>	trembling aspen	22.98
<i>Prunus serotina</i>	black cherry	3,574.71
<i>Prunus virginiana</i>	chokecherry	1,011.49
<i>Quercus alba</i>	white oak	2,000.00
<i>Quercus velutina</i>	black oak	5,988.51
<i>Sassafras albidum</i>	Sassafras	9,643.68
Total		24,080.44

*non-native

Black oak forests had the highest shrub and woody vine richness of all forest types, with 64 species identified. The most common species in black oak forests were *Celastrus* sp. (bittersweet), *Hamamelis virginiana* L. (witch hazel), *Parthenocissus* sp. Planch. (Virginia creeper), *Rubus allegheniensis* Porter (common blackberry), *Rubus flagellaris* Willd. (northern dewberry), *Rubus pensilvanicus* Poir. (Pennsylvania blackberry), *Toxicodendron* sp. Mill. (poison ivy), *Vaccinium angustifolium* Aiton (lowbush blueberry), and *Vaccinium pallidum* Aiton (Blueridge blueberry) (Table 4, species with mean frequency <0.01 are not shown).

Characteristic herbaceous species in the black oak forest type included *Carex pensylvanica* Lam. (Pennsylvania sedge), *Circaea canadensis* ssp. *canadensis* (L.) Hill (enchanter's nightshade), *Fragaria virginiana* Duchesne (wild strawberry), *Galium pilosum* Aiton (hairy bedstraw), *Helianthus divaricatus* L. (woodland sunflower), *Maianthemum racemosum* ssp. *racemosum* (L.) Link (false lily-of-the-valley), *Pteridium aquilinum* ssp. *latiusculum* (Desv.) Hultén (bracken fern), and *Solidago* sp. L. (goldenrod).

Table 4. Mean frequency of occurrence for shrubs and woody vines in black oak forests.

Latin name	Common name	Mean frequency
<i>Amelanchier</i> sp. (group 2)	serviceberry	0.09
<i>Aronia melanocarpa</i>	black chokeberry	0.01
<i>Berberis thunbergii</i> *	Japanese barberry	0.02
<i>Ceanothus americanus</i>	New Jersey tea	0.03
<i>Celastrus</i> sp.**	bittersweet	0.15
<i>Cephalanthus occidentalis</i>	common buttonbush	0.03
<i>Cornus racemosa</i>	gray dogwood	0.03
<i>Crataegus</i> sp.	hawthorn	0.01
<i>Diervilla lonicera</i>	northern bush-honeysuckle	0.01
<i>Elaeagnus umbellata</i> *	autumn olive	0.01
<i>Gaylussacia baccata</i>	black huckleberry	0.05
<i>Hamamelis virginiana</i>	witchhazel	0.16
<i>Ilex verticillata</i>	common winterberry	0.01
<i>Lindera benzoin</i>	spicebush	0.02
<i>Lonicera</i> sp. (exotic)*	exotic honeysuckle	0.05
<i>Parthenocissus</i> sp.	Virginia creeper	0.20
<i>Rhus aromatica</i>	fragrant sumac	0.01
<i>Rhus copallina</i>	flameleaf sumac	0.03
<i>Ribes cynosbati</i>	pasture currant	0.01
<i>Rosa blanda</i>	smooth rose	0.07
<i>Rosa carolina</i>	Carolina rose	0.09
<i>Rosa multiflora</i> *	multiflora rose	0.04
<i>Rubus allegheniensis</i>	Allegheny blackberry	0.16
<i>Rubus flagellaris</i>	whiplash dewberry	0.17
<i>Rubus hispidus</i>	bristly dewberry	0.06
<i>Rubus occidentalis</i>	black raspberry	0.07
<i>Rubus pensilvanicus</i>	Pennsylvania blackberry	0.11
<i>Rubus sachalinensis</i> var. <i>sachalinensis</i>	red raspberry	0.02
<i>Salix</i> sp.	Willow	0.01
<i>Smilax rotundifolia</i>	roundleaf greenbrier	0.05
<i>Smilax tamnoides</i>	bristly greenbrier	0.01
<i>Spiraea alba</i>	white meadowsweet	0.01
<i>Spiraea tomentosa</i>	steeplebush	0.01
<i>Toxicodendron</i> sp.	poison ivy	0.13
<i>Vaccinium angustifolium</i>	lowbush blueberry	0.22
<i>Vaccinium pallidum</i>	Blueridge blueberry	0.20
<i>Viburnum acerifolium</i>	mapleleaf viburnum	0.06
<i>Viburnum opulus</i> var. <i>americanum</i>	American cranberrybush	0.01
<i>Vitis aestivalis</i>	summer grape	0.02
<i>Vitis labrusca</i>	fox grape	0.02
<i>Vitis riparia</i>	riverbank grape	0.08

*non-native; **genus with both native and non-native species

Upland Oak Forest

We classified five plots as the Upland Oak forest type. Three of these were the NVCS type Red Oak–(Sugar Maple, White Oak) forest, while two were classified as White Oak–Red Oak–Shagbark Hickory glaciated forest. One plot each was located in the Hobart Prairie Grove and Pinhook Bog tracts. Two were located relatively close to park headquarters, and one just across the Lake County line from Porter County. Both *Quercus rubra* (red oak) and *Q. alba* (white oak), as well as *Carya ovata* (Mill.) K. Koch (shagbark hickory), were present throughout the range of size classes in these forests, although, in smaller size classes, both *Acer saccharum* Marsh. (sugar maple) and *A. rubrum* (red maple), as well as black cherry were common (Figure 6, Table 5).

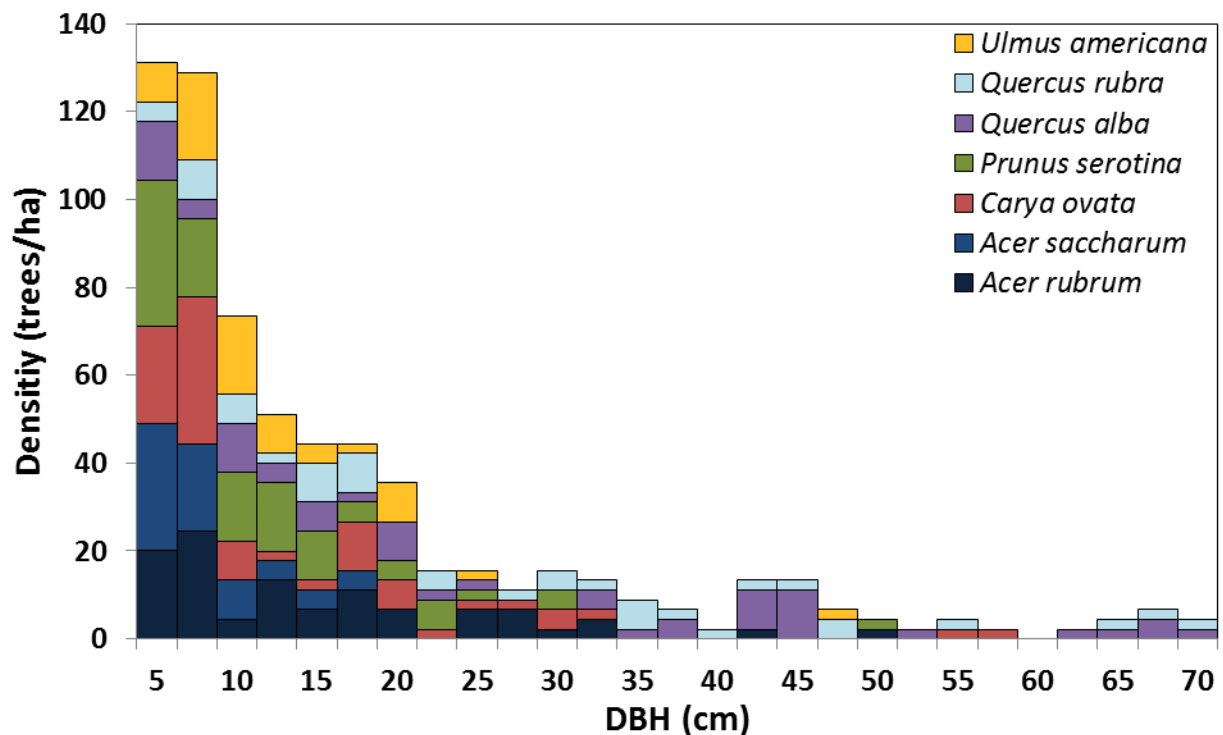


Figure 6. Density-diameter relationship for the seven most important tree species in upland oak forests.

Table 5. Basal area and density of live trees in upland oak forests.

Latin name	Common name	Basal area (m ² /ha)	Density (trees/ha)
<i>Acer rubrum</i>	red maple	2.63	111.11
<i>Acer saccharum</i>	sugar maple	0.34	71.11
<i>Carya ovata</i>	shagbark hickory	2.47	104.44
<i>Cornus florida</i>	flowering dogwood	0.03	13.33
<i>Crataegus</i> sp.	Hawthorn	0.13	24.44
<i>Fagus grandifolia</i>	Beech	0.01	8.89
<i>Fraxinus pennsylvanica</i>	green ash	0.02	8.89
<i>Fraxinus</i> sp.	Ash	0.03	2.22
<i>Morus alba</i> *	white mulberry	<0.01	2.22
<i>Nyssa sylvatica</i>	black gum	0.12	13.33
<i>Populus deltoides</i> ssp. <i>monilifera</i>	Cottonwood	0.35	2.22
<i>Prunus serotina</i>	black cherry	1.76	117.78
<i>Prunus virginiana</i>	Chokecherry	0.02	4.44
<i>Quercus alba</i>	white oak	8.69	100.00
<i>Quercus palustris</i>	pin oak	0.04	2.22
<i>Quercus rubra</i>	red oak	10.60	88.89
<i>Quercus velutina</i>	black oak	3.09	35.56
<i>Robinia pseudoacacia</i> *	black locust	0.10	2.22
<i>Sassafras albidum</i>	Sassafras	0.11	26.67
<i>Tilia americana</i>	Basswood	0.04	11.11
<i>Ulmus americana</i>	American elm	1.11	75.56
<i>Ulmus rubra</i>	slippery elm	0.12	8.89
Total		31.79	835.54

*non-native

Upland oak forests had the second highest seedling density of all forest types at the park (22,066 seedlings/hectare). Dominant seedling species included *Fraxinus pennsylvanica* Marsh. (green ash), *Sassafras albidum*, and *Cornus florida* L. (flowering dogwood) (Table 6). In general, the dominant species at the seedling layer differed from those that dominated as mature trees.

Table 6. Seedling density in upland oak forests.

Latin name	Common name	Density (seedlings/ha)
<i>Acer rubrum</i>	red maple	66.67
<i>Carya cordiformis</i>	bitternut hickory	66.67
<i>Carya ovata</i>	shagbark hickory	1,533.33
<i>Cornus florida</i>	flowering dogwood	2,800.00
<i>Fraxinus pennsylvanica</i>	green ash	8,866.67
<i>Populus tremuloides</i>	trembling aspen	466.67
<i>Prunus serotina</i>	black cherry	1,133.33
<i>Quercus alba</i>	white oak	866.67
<i>Quercus rubra</i>	red oak	200.00
<i>Quercus velutina</i>	black oak	1,000.00
<i>Sassafras albidum</i>	sassafras	5,000.00
<i>Ulmus americana</i>	American elm	66.67
Total		22,066.67

A total of 41 shrub and woody vine species were identified in upland oak forests. The most common species were *Celastrus* sp., *Lindera benzoin* (L.) Blume, *Parthenocissus* sp., *Rosa multiflora*, and *Toxicodendron* sp. (Table 7, species with mean frequency < 0.01 are not shown).

Common herbaceous species in the upland oak forest type were *Ageratina altissima* (L.) King & H. Rob. (white snakeroot), *Circaea canadensis* ssp. *canadensis*, *Galium triflorum* Michx. (fragrant bedstraw), *Geum canadense* Jacq. (white avens), *Hackelia virginiana* (L.) I.M. Johnst. (beggarticks), *Persicaria virginiana* (L.) Gaertn. (jumpseed), *Potentilla simplex* Michx. (cinquefoil), *Solidago* sp., *Symphyotrichum lateriflorum* (L.) Å. Löve & D. Löve var. *lateriflorum* (calico aster) and *Viola* sp. L.

Table 7. Mean frequency of occurrence for shrubs and woody vines in upland oak forests.

Latin Name	Common name	Mean frequency
<i>Amelanchier</i> sp. (group 2)	Serviceberry	0.03
<i>Amelanchier</i> sp. (group 3)	Serviceberry	0.01
<i>Berberis thunbergii</i> *	Japanese barberry	0.02
<i>Celastrus</i> sp.*	Bittersweet	0.31
<i>Cephalanthus occidentalis</i>	common buttonbush	0.01
<i>Cornus racemosa</i>	gray dogwood	0.01
<i>Corylus americana</i>	American hazelnut	0.03
<i>Crataegus</i> sp.	Hawthorn	0.10
<i>Euonymus atropurpureus</i>	burning bush	0.01
<i>Hamamelis virginiana</i>	Witchhazel	0.01
<i>Lindera benzoin</i>	Spicebush	0.29
<i>Lonicera</i> sp. (exotic)*	exotic honeysuckle	0.02
<i>Parthenocissus</i> sp.	Virginia creeper	0.35
<i>Rhamnus frangula</i> *	glossy buckthorn	0.01
<i>Ribes cynosbati</i>	pasture currant	0.01
<i>Ribes hirtellum</i>	hairystem gooseberry	0.01
<i>Rosa carolina</i>	Carolina rose	0.01
<i>Rosa multiflora</i> *	multiflora rose	0.23
<i>Rubus allegheniensis</i>	Allegheny blackberry	0.17
<i>Rubus flagellaris</i>	whiplash dewberry	0.09
<i>Rubus hispidus</i>	bristly dewberry	0.02
<i>Rubus occidentalis</i>	black raspberry	0.06
<i>Rubus pensilvanicus</i>	Pennsylvania blackberry	0.03
<i>Rubus pubescens</i>	dwarf red raspberry	0.01
<i>Sambucus racemosa</i> var. <i>racemosa</i>	red elderberry	0.01
<i>Smilax rotundifolia</i>	roundleaf greenbrier	0.01
<i>Smilax tamnoides</i>	bristly greenbrier	0.01
<i>Spiraea alba</i>	white meadowsweet	0.01
<i>Spiraea tomentosa</i>	Steeplebush	0.01
<i>Toxicodendron</i> sp.	poison ivy	0.10
<i>Vaccinium angustifolium</i>	lowbush blueberry	0.06
<i>Vaccinium pallidum</i>	Blueridge blueberry	0.04
<i>Viburnum lentago</i>	Nannyberry	0.04
<i>Viburnum opulus</i> var. <i>americanum</i>	American cranberrybush	0.04
<i>Viburnum rafinesqueanum</i>	downy arrowwood	0.01
<i>Vitis riparia</i>	riverbank grape	0.04

*non-native

Mesic Forest

Six plots were placed in the mesic forest type, which included all four plots in the Heron Rookery tract and one each near Kemil Rd. and the Dunewood Campground. The dominant tree species included *Fraxinus pennsylvanica* and both *Acer rubrum* and *A. saccharum* (Figure 7, Table 8). Throughout all size classes in this forest type, the relative proportions of key species were similar (Figure 7).

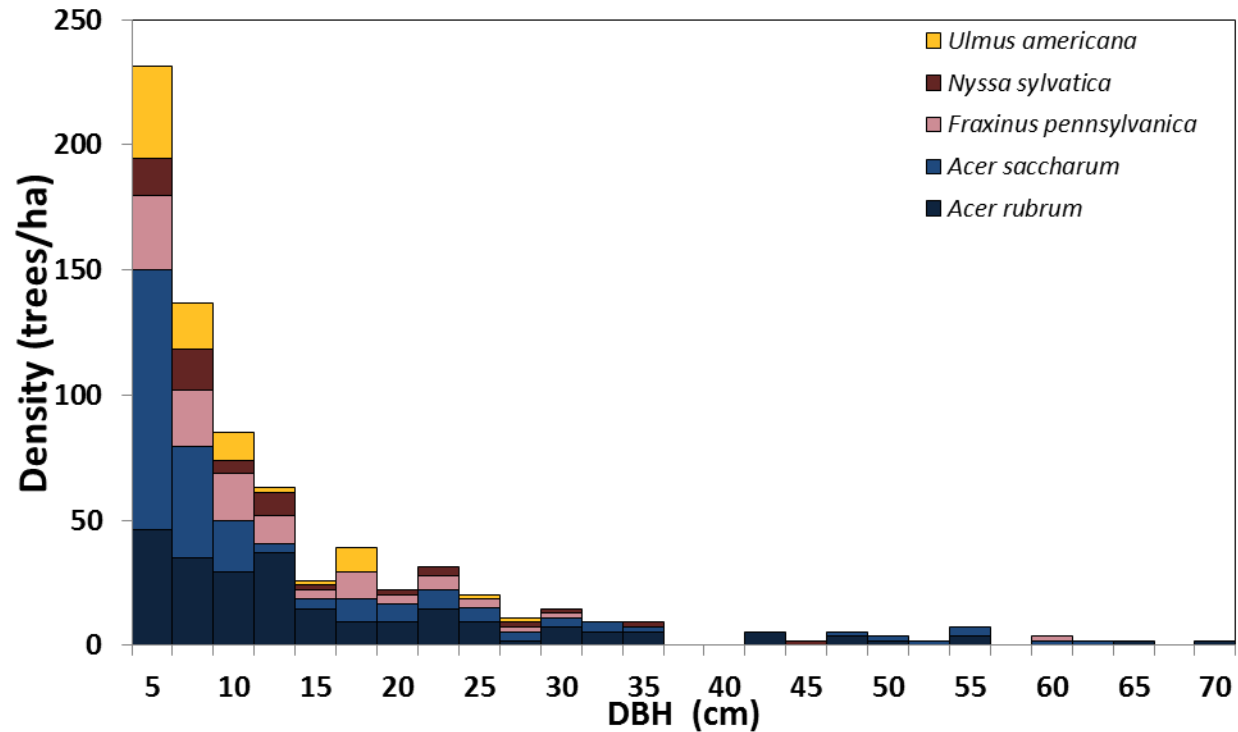


Figure 7. Density-diameter relationship for the five most important tree species in mesic forests.

Table 8. Basal area and density of live trees in mesic forests.

Latin name	Common name	Basal area (m ² /ha)	Density (trees/ha)
<i>Acer rubrum</i>	red maple	9.09	246.30
<i>Acer saccharinum</i>	silver maple	1.09	27.78
<i>Acer saccharum</i>	sugar maple	7.77	237.04
<i>Amelanchier arborea</i>	Serviceberry	0.02	9.26
<i>Asimina triloba</i>	Pawpaw	<0.01	1.85
<i>Carpinus caroliniana</i>	Musclewood	0.03	9.26
<i>Carya cordiformis</i>	bitternut hickory	0.83	7.41
<i>Carya ovata</i>	shagbark hickory	0.16	3.70
<i>Cornus florida</i>	flowering dogwood	0.01	3.70
<i>Crataegus</i> sp.	hawthorn	0.05	20.37
<i>Fagus grandifolia</i>	beech	0.14	11.11
<i>Fraxinus nigra</i>	black ash	0.21	3.70
<i>Fraxinus pennsylvanica</i>	green ash	1.74	114.81
<i>Liriodendron tulipifera</i>	tulip poplar	3.07	31.48
<i>Nyssa sylvatica</i>	black gum	1.07	61.11
<i>Ostrya virginiana</i>	ironwood	0.05	9.26
<i>Platanus occidentalis</i>	sycamore	0.02	5.56
<i>Populus deltoides</i> ssp. <i>monilifera</i>	cottonwood	0.96	5.56
<i>Populus grandidentata</i>	bigtooth aspen	0.21	1.85
<i>Prunus serotina</i>	black cherry	2.07	42.59
<i>Prunus virginiana</i>	chokecherry	<0.01	3.70
<i>Quercus alba</i>	white oak	0.62	9.26
<i>Quercus rubra</i>	red oak	0.89	14.81
<i>Quercus velutina</i>	black oak	0.82	11.11
<i>Robinia pseudoacacia</i> *	black locust	<0.01	1.85
<i>Sassafras albidum</i>	sassafras	0.31	25.93
<i>Ulmus americana</i>	American elm	0.56	83.33
<i>Ulmus rubra</i>	slippery elm	0.03	7.41
<i>Ulmus</i> sp.	elm	0.04	1.85
Total		31.84	1,012.95

*non-native

The dominant species in the seedling layer in mesic forests are *Prunus serotina* and *Sassafras albidum* (Table 9). The species composition in the seedling layer was rich, with 17 species identified.

Table 9. Seedling density in mesic forests.

Latin name	Common name	Density (seedlings/ha)
<i>Acer rubrum</i>	red maple	277.78
<i>Acer saccharum</i>	sugar maple	388.89
<i>Asimina triloba</i>	Pawpaw	666.67
<i>Carya cordiformis</i>	bitternut hickory	611.11
<i>Carya ovata</i>	shagbark hickory	222.22
<i>Fagus grandifolia</i>	Beech	55.56
<i>Fraxinus nigra</i>	black ash	888.89
<i>Fraxinus pennsylvanica</i>	green ash	222.22
<i>Liriodendron tulipifera</i>	tulip poplar	944.44
<i>Nyssa sylvatica</i>	black gum	333.33
<i>Ostrya virginiana</i>	Ironwood	55.56
<i>Prunus serotina</i>	black cherry	1,944.44
<i>Prunus virginiana</i>	Chokecherry	333.33
<i>Quercus rubra</i>	red oak	166.67
<i>Quercus velutina</i>	black oak	55.56
<i>Sassafras albidum</i>	Sassafras	1,388.89
<i>Ulmus americana</i>	American elm	333.33
Total		8,888.89

A total of 39 species of shrubs and woody vines were identified in mesic forest. The most frequent species were *Lindera benzoin*, *Parthenocissus* sp., *Rosa multiflora*, *Rubus allegheniensis*, *Rubus hispidus* L. (bristly dewberry), and *Toxicodendron* sp. (Table 10, species with mean frequency <0.01 are not shown).

Common herbaceous species in the mesic forest type were *Amphicarpaea bracteata* (L.) Fernald (hogpeanut), *Asarum canadense* L. (wild ginger), *Circaea canadensis* ssp. *canadensis*, *Cryptotaenia canadensis* (L.) DC. (honestwort), *Geranium maculatum* L. (crane's bill), *Laportea canadensis* (L.) Wedd. (woodland nettle), *Polygonum virginianum*, *Pilea* sp. Lindl. (clearweed), *Ranunculus* sp. (L.), *Solidago* sp., and *Viola* sp.

Table 10. Mean frequency of occurrence for shrubs and woody vines in mesic forests.

Latin name	Common name	Mean frequency
<i>Alnus incana</i> ssp. <i>rugosa</i>	speckled alder	0.01
<i>Amelanchier</i> sp. (group 2)	serviceberry	0.04
<i>Berberis thunbergii</i> *	Japanese barberry	0.01
<i>Celastrus</i> sp.	bittersweet	0.08
<i>Cephalanthus occidentalis</i>	common buttonbush	0.01
<i>Cornus racemosa</i>	gray dogwood	0.03
<i>Crataegus</i> sp.	hawthorn	0.02
<i>Elaeagnus umbellata</i> *	autumn olive	0.04
<i>Hamamelis virginiana</i>	witchhazel	0.08
<i>Ilex verticillata</i>	common winterberry	0.01
<i>Lindera benzoin</i>	spicebush	0.75
<i>Parthenocissus</i> sp.	Virginia creeper	0.45
<i>Rhamnus frangula</i> *	glossy buckthorn	0.03
<i>Ribes cynosbati</i>	pasture currant	0.03
<i>Ribes hirtellum</i>	hairystem gooseberry	0.01
<i>Rosa multiflora</i> *	multiflora rose	0.12
<i>Rubus allegheniensis</i>	Allegheny blackberry	0.12
<i>Rubus flagellaris</i>	whiplash dewberry	0.03
<i>Rubus hispidus</i>	bristly dewberry	0.12
<i>Rubus pensilvanicus</i>	Pennsylvania blackberry	0.09
<i>Smilax rotundifolia</i>	roundleaf greenbrier	0.01
<i>Smilax</i> sp.	greenbrier	0.01
<i>Smilax tamnoides</i>	bristly greenbrier	0.03
<i>Solanum dulcamara</i> *	woody nightshade	0.00
<i>Spiraea tomentosa</i>	steeplebush	0.07
<i>Toxicodendron</i> sp.	poison ivy	0.17
<i>Viburnum acerifolium</i>	mapleleaf viburnum	0.02
<i>Viburnum opulus</i> var. <i>americanum</i>	American cranberrybush	0.02
<i>Viburnum recognitum</i>	northern arrowwood	0.01
<i>Vitis aestivalis</i>	summer grape	0.03
<i>Vitis labrusca</i>	fox grape	0.03
<i>Vitis riparia</i>	riverbank grape	0.07

*non-native

Wet Mesic Forest

Four plots were grouped in the wet mesic forest type, though these exhibited a range of vegetation types and hydrology. One of these was centrally located and three were near the eastern end of the lakeshore. Common overstory species included *Populus deltoides* ssp. *monilifera* (Aiton) Eckenw. (eastern cottonwood), *Fraxinus pennsylvanica*, *Quercus palustris* Münchh. (pin oak), and *Q. bicolor* Willd. (swamp white oak) (Figure 8, Table 11).

The seedling layer of wet mesic forests was sparse (6,583 seedlings/hectare), with the fewest number of species of any of the five forest types sampled. The most abundant seedling species were *Fraxinus pennsylvanica* and *Acer saccharinum* L. (silver maple) (Table 12).

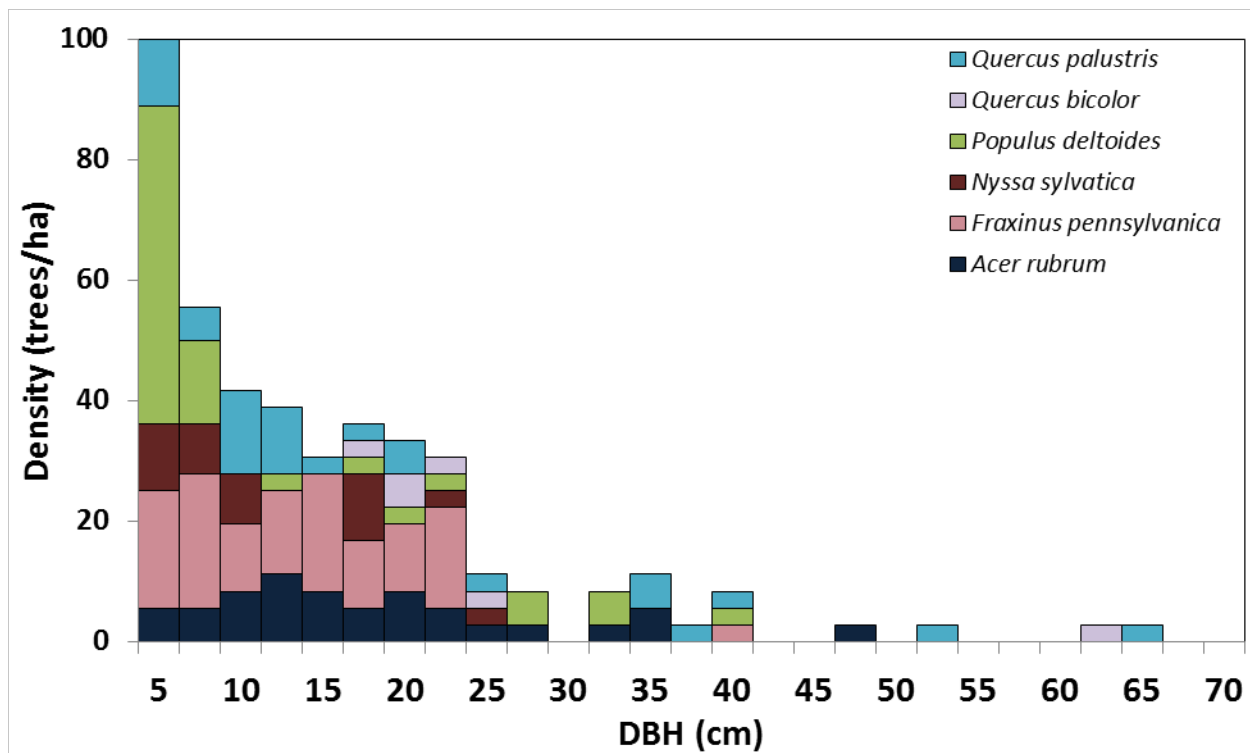


Figure 8. Density-diameter relationship for the six most important tree species in wet mesic forests.

Table 11. Basal area and density of live trees in wet mesic forests.

Latin name	Common name	Basal area (m ² /ha)	Density (trees/ha)
<i>Acer rubrum</i>	red maple	2.28	75.00
<i>Acer saccharinum</i>	silver maple	1.00	27.78
<i>Carya ovata</i>	shagbark hickory	0.01	2.78
<i>Fraxinus nigra</i>	black ash	0.06	2.78
<i>Fraxinus pennsylvanica</i>	green ash	2.00	127.78
<i>Morus alba</i> *	white mulberry	0.05	2.78
<i>Nyssa sylvatica</i>	black gum	0.54	44.44
<i>Populus deltoides</i> ssp. <i>monilifera</i>	cottonwood	1.40	91.67
<i>Populus tremuloides</i>	trembling aspen	0.10	2.78
<i>Prunus serotina</i>	black cherry	0.72	22.22
<i>Quercus bicolor</i>	swamp white oak	1.22	16.67
<i>Quercus palustris</i>	pin oak	3.12	72.22
<i>Quercus rubra</i>	red oak	3.05	8.33
<i>Robinia pseudoacacia</i> *	black locust	0.04	2.78
<i>Salix fragilis</i>	crack willow	2.72	13.89
<i>Sassafras albidum</i>	sassafras	0.03	2.78
<i>Ulmus americana</i>	American elm	0.18	16.67
Total		18.51	533.35

*non-native

Table 12. Seedling density in wet mesic forests.

Latin name	Common name	Density (seedlings/ha)
<i>Acer saccharinum</i>	silver maple	1,333.33
<i>Fraxinus nigra</i>	black ash	83.33
<i>Fraxinus pennsylvanica</i>	green ash	2,166.67
<i>Liriodendron tulipifera</i>	tulip poplar	83.33
<i>Nyssa sylvatica</i>	black gum	833.33
<i>Populus deltoides</i> ssp. <i>monilifera</i>	cottonwood	833.33
<i>Prunus serotina</i>	black cherry	583.33
<i>Prunus virginiana</i>	chokecherry	83.33
<i>Quercus palustris</i>	pin oak	166.67
<i>Ulmus americana</i>	American elm	416.67
Total		6,583.33

Shrub and woody vine species richness in wet mesic forests was the lowest of the five forest types, with 34 species identified. The most common species in wet mesic forests were *Lindera benzoin*, exotic species of the genus *Lonicera*, *Parthenocissus* sp., *Rosa multiflora*, and *Rubus allegheniensis* (Table 13, species with mean frequency < 0.01 are not shown).

Table 13. Mean frequency of occurrence for shrubs and woody vines in wet mesic forests.

Latin name	Common name	Mean frequency
<i>Alnus incana</i> ssp. <i>rugosa</i>	speckled alder	0.01
<i>Amelanchier</i> sp. (group 2)	serviceberry	0.02
<i>Celastrus</i> sp.	bittersweet	0.02
<i>Cornus racemosa</i>	gray dogwood	0.04
<i>Cornus sericea</i>	redosier dogwood	0.03
<i>Euonymus atropurpureus</i>	burning bush	0.01
<i>Ilex verticillata</i>	common winterberry	0.04
<i>Lindera benzoin</i>	spicebush	0.48
<i>Lonicera</i> sp. (exotic)*	exotic honeysuckle	0.20
<i>Parthenocissus</i> sp.	Virginia creeper	0.15
<i>Rhamnus frangula</i> *	glossy buckthorn	0.01
<i>Ribes americanum</i>	wild black currant	0.01
<i>Rosa multiflora</i> *	multiflora rose	0.31
<i>Rubus allegheniensis</i>	Allegheny blackberry	0.29
<i>Rubus flagellaris</i>	whiplash dewberry	0.03
<i>Rubus hispidus</i>	bristly dewberry	0.05
<i>Rubus occidentalis</i>	black raspberry	0.02
<i>Rubus pensilvanicus</i>	Pennsylvania blackberry	0.05
<i>Rubus sachalinensis</i> var. <i>sachalinensis</i>	red raspberry	0.03
<i>Salix</i> sp.	Willow	0.03
<i>Sambucus nigra</i> ssp. <i>canadensis</i>	Mexican elderberry	0.01
<i>Solanum dulcamara</i> *	woody nightshade	0.04
<i>Toxicodendron</i> sp.	poison ivy	0.07
<i>Viburnum lentago</i>	nannyberry	0.03
<i>Viburnum opulus</i> var. <i>americanum</i>	American cranberrybush	0.07
<i>Viburnum recognitum</i>	northern arrow-wood	0.08
<i>Vitis aestivalis</i>	summer grape	0.10
<i>Vitis labrusca</i>	fox grape	0.09
<i>Vitis riparia</i>	riverbank grape	0.07

*non-native

Common herbaceous species in wet mesic forests were *Boehmeria cylindrica* (L.) Sw. (falsenettle), *Carex tribuloides* Wahlenb. (blunt broom sedge), *Cinna arundinacea* L. (sweet woodreed), *Circaea canadensis* ssp. *canadensis*, *Geum canadense*, *Impatiens capensis* Meerb. (jewelweed), *Leersia oryzoides* (L.) Sw. (rice cutgrass), *Onoclea sensibilis* L. (sensitive fern), *Persicaria sagittata* (L.) H. Gross (arrowleaf tearthumb), *P. virginiana*, *Pilea* sp., and *Solidago* sp.

Modified Successional Forest

Six plots were classified as modified successional forest, and these were all located in disturbed areas, generally in the vicinity of either railroad tracks or the Calumet Bike Trail, or both. These generally contained a large amount of *Prunus serotina*, *Sassafras albidum*, and *Acer rubrum*, though *Fraxinus pennsylvanica* and *Ailanthus altissima* (Mill.) Swingle (tree-of-heaven) were present in the smaller size classes as well. Many of these plots are located in areas that were once farmed, or were old homesteads that are now in the early- to mid- stages of succession following the abandonment of farming practices.

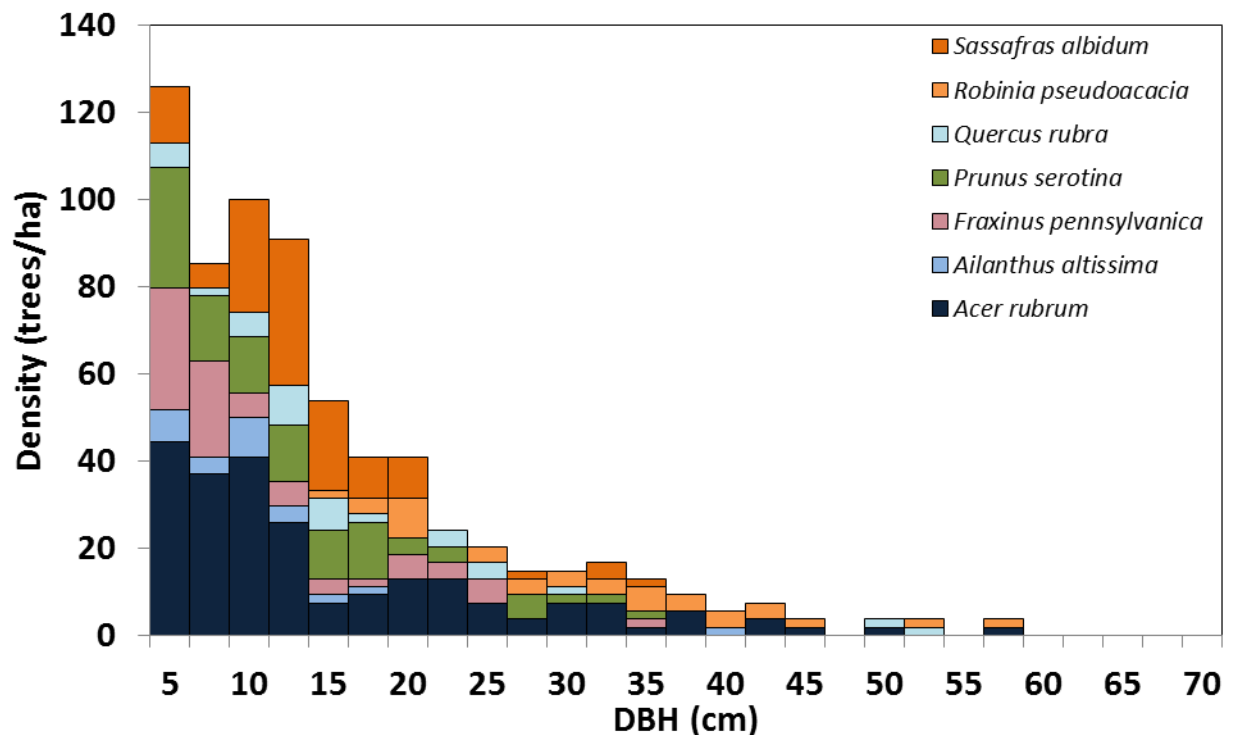


Figure 9. Density-diameter relationship for the seven most important tree species in modified successional forests.

Table 14. Basal area and density of live trees in modified successional forests.

Latin name	Common name	Basal area (m ² /ha)	Density (trees/ha)
Hardwood			
<i>Acer negundo</i>	boxelder	0.19	11.11
<i>Acer rubrum</i>	red maple	5.74	233.33
<i>Acer saccharinum</i>	silver maple	1.64	25.93
<i>Ailanthus altissima</i> *	tree-of-heaven	0.39	29.63
<i>Amelanchier arborea</i>	serviceberry	0.09	20.37
<i>Carya cordiformis</i>	bitternut hickory	0.02	11.11
<i>Cornus florida</i>	flowering dogwood	0.01	5.56
<i>Fraxinus americana</i>	white ash	1.03	20.37
<i>Fraxinus pennsylvanica</i>	green ash	0.97	83.33
<i>Liriodendron tulipifera</i>	tulip poplar	4.05	16.67
<i>Nyssa sylvatica</i>	black gum	0.14	5.56
<i>Populus tremuloides</i>	trembling aspen	0.31	20.37
<i>Prunus serotina</i>	black cherry	1.64	111.11
<i>Prunus virginiana</i>	chokecherry	0.08	20.37
<i>Quercus alba</i>	white oak	0.03	9.26
<i>Quercus rubra</i>	red oak	1.41	44.44
<i>Quercus velutina</i>	black oak	0.70	7.41
<i>Robinia pseudoacacia</i> *	black locust	4.99	53.70
<i>Salix</i> sp.	willow	0.22	5.56
<i>Sassafras albidum</i>	sassafras	1.81	124.07
<i>Ulmus americana</i>	American elm	0.77	50.00
Conifer			
<i>Pinus strobus</i>	white pine	0.50	7.41
Total		26.71	916.67

*non-native

Seedling composition in modified successional forests was rich, with 18 species identified. Dominant species in the seedling layer were *Fraxinus pennsylvanica*, *Sassafras albidum*, *F. americana* L. (white ash), and *Prunus serotina* (Table 15).

Table 15. Seedling density in modified successional forests.

Latin name	Common name	Density (seedlings/ha)
<i>Acer negundo</i>	Boxelder	55.56
<i>Acer rubrum</i>	red maple	611.11
<i>Carya ovata</i>	shagbark hickory	111.11
<i>Cornus florida</i>	flowering dogwood	277.78
<i>Fraxinus americana</i>	white ash	2,055.56
<i>Fraxinus pennsylvanica</i>	green ash	3,166.67
<i>Gleditsia triacanthos</i>	honey locust	444.44
<i>Liriodendron tulipifera</i>	tulip poplar	55.56
<i>Populus tremuloides</i>	trembling aspen	166.67
<i>Prunus pensylvanica</i>	pin cherry	166.67
<i>Prunus serotina</i>	black cherry	1,666.67
<i>Prunus virginiana</i>	Chokecherry	277.78
<i>Quercus alba</i>	white oak	111.11
<i>Quercus rubra</i>	red oak	444.44
<i>Quercus velutina</i>	black oak	55.56
<i>Robinia pseudoacacia</i> *	black locust	55.56
<i>Sassafras albidum</i>	Sassafras	2,777.78
<i>Ulmus americana</i>	American elm	222.22
Total		12,777.78

*non-native

Eight of the 43 total shrub and woody vine taxa identified in modified successional forests were non-native, the highest incidence of the five forest types. The most common taxa in this forest type were *Berberis thunbergii* DC. (Japanese barberry), *Celastrus* sp., *Lonicera benzoin*, exotic species of the genus *Lonicera*, *Parthenocissus* sp., *Rosa multiflora*, *Rubus hispidus*, *Toxicodendron* sp., and *Viburnum recognitum* Fernald (southern arrowwood) (Table 16; species with mean frequency <0.01 are not shown, including one other non-native species, *Syringa vulgaris* L.).

Table 16. Mean frequency of occurrence for shrubs and woody vines in modified successional forests.

Latin name	Common name	Mean frequency
<i>Alnus incana</i> ssp. <i>rugosa</i>	speckled alder	0.01
<i>Amelanchier</i> sp. (group 2)	Serviceberry	0.03
<i>Amelanchier</i> sp. (group 3)	Serviceberry	0.01
<i>Berberis thunbergii</i> *	Japanese barberry	0.12
<i>Celastrus</i> sp.**	Bittersweet	0.37
<i>Cornus racemosa</i>	gray dogwood	0.04
<i>Crataegus</i> sp.	Hawthorn	0.02
<i>Elaeagnus umbellata</i> *	autumn olive	0.02
<i>Euonymus alatus</i> *	winged burning bush	0.02
<i>Euonymus atropurpureus</i>	burning bush	0.05
<i>Lindera benzoin</i>	Spicebush	0.32
<i>Lonicera</i> sp. (exotic) *	exotic honeysuckle	0.13
<i>Parthenocissus</i> sp.	Virginia creeper	0.42
<i>Rhamnus frangula</i> *	glossy buckthorn	0.05
<i>Ribes cynosbati</i>	pasture currant	0.01
<i>Rosa carolina</i>	Carolina rose	0.01
<i>Rosa multiflora</i> *	multiflora rose	0.54
<i>Rubus allegheniensis</i>	Allegheny blackberry	0.15
<i>Rubus flagellaris</i>	whiplash dewberry	0.11
<i>Rubus hispidus</i>	bristly dewberry	0.14
<i>Rubus occidentalis</i>	black raspberry	0.06
<i>Rubus pensilvanicus</i>	Pennsylvania blackberry	0.08
<i>Rubus pubescens</i>	dwarf red raspberry	0.01
<i>Smilax rotundifolia</i>	roundleaf greenbrier	0.05
<i>Smilax tamnoides</i>	bristly greenbrier	0.01
<i>Toxicodendron</i> sp.	poison ivy	0.23
<i>Viburnum acerifolium</i>	mapleleaf viburnum	0.04
<i>Viburnum recognitum</i>	northern arrowwood	0.11
<i>Vitis aestivalis</i>	summer grape	0.08
<i>Vitis labrusca</i>	fox grape	0.06
<i>Vitis riparia</i>	riverbank grape	0.01

*non-native; **genus with both native and non-native species

Common herbaceous taxa in the modified successional forests were *Alliaria petiolata* (M. Bieb.) Cavara & Grande (garlic mustard), *Circaea canadensis* ssp. *canadensis*, *Geum canadense*, *Glechoma hederacea* L. (ground ivy), *Hackelia virginiana*, *Onoclea sensibilis*, *Prunus virginiana*, *Geum canadense*, *Potentilla simplex*, and *Solidago* sp.

Coarse Woody Material

The amount of coarse woody material varied greatly between forest types. The greatest biomass and density was in wet mesic forests (Tables 17, 18), but large amounts were also recorded in mesic and modified successional forests.

Table 17. Coarse woody material volume and biomass for each forest type.

Forest type	Number of plots in forest type	Volume (m ³ /ha)	Biomass (kg/ha)	Biomass (tons/ac)
Black oak	29	19.54	7,416.34	3.31
Upland oak	5	20.88	7,239.64	3.23
Mesic	6	44.42	13,906.35	6.20
Wet mesic	4	95.43	30,378.50	13.55
Modified successional	6	34.52	12,020.45	5.36
Mean	50	30.53	10,566.94	4.71

Table 18. Density of coarse woody material by diameter class in each forest type.

Forest type	Density (pieces/ha) for each diameter class (cm)				Total pieces/ha
	7.5-19.9	20.0-32.9	33.0-45.9	≥46.0	
Black oak	266.10	14.19	1.84	0.73	282.87
Upland oak	267.96	16.73	1.70	0.00	286.39
Mesic	242.04	37.41	9.35	2.82	291.62
Wet mesic	448.42	31.67	9.95	6.96	497.00
Modified successional	346.17	44.24	1.36	0.00	391.77
Mean	287.59	22.23	3.32	1.32	314.47

Browse and Disease

Browse pressure was observed in all forest types at INDU in 2012. Across the whole park, the proportion of browse was relatively low, with only 6.73% of the woody species assessed for bite marks in the direct browse circles showing recent browse by deer. The incidence of browse was highest in the modified successional forests, with 8.63% of the species assessed showing evidence of browse. Black oak forests and wet mesic forests also had a proportion of browse that was higher than the whole park value (Table 19). The species with the highest incidence of browse, across all forest types, were *Aronia melanocarpa* (Michx.) Elliott (black chokeberry), *Cornus florida*, *C. racemosa* Lam., *Nyssa sylvatica* Marshall (black gum), *Populus tremuloides* Michx. (trembling aspen), *Prunus serotina*, *P. virginiana* L. (chokecherry), *Ribes cynosbati* L. (prickly gooseberry), *R. multiflora*, *Smilax rotundifolia* L. (roundleaf greenbrier), *Viburnum acerifolium*, L. (mapleleaf viburnum), and *V. recognitum* (data not shown).

Table 19. Proportion of browse calculation in the 3.14 m² (1 m radius) circles. Results are shown by forest type and for the whole park.

Forest type	Number of plots	Proportion of browse
Black oak	29	0.0748
Upland oak	5	0.0384
Mesic	6	0.0291
Wet mesic	4	0.0713
Modified successional	6	0.0863
Whole park	50	0.0673

The Morellet browse index value for the whole park was 0.241. Of the 3,294 browse circles with any woody species present, browse was evident in 24.1% of them. The browse index was highest in modified successional forests and black oak forests, suggesting that a larger deer population occurs in these forest types (Table 20). This is the first year the Morellet browse index was calculated for vegetation plots at INDU.

Table 20. Morellet browse indices at the 3.14 m² (1 m radius) browse circles, by forest type and for the whole park.

Forest type	Number of plots	Browse circles with ≥ 1 woody stem with evident browse	Browse circles with species present	Morellet browse index
Black oak	29	519	1,912	0.272
Upland oak	5	40	325	0.125
Mesic	6	45	407	0.113
Wet mesic	4	53	258	0.208
Modified successional	6	136	392	0.348
Whole park	50	793	3,294	0.241

Deer browse was not regularly observed on our three herbaceous species in 2012; only 20 quadrats contained a target species showing evidence of browse out of the 145 quadrats where target species were observed (Table 21). One forest type, wet mesic, did not have any of the target species present. Of the 20 observations of browse, 19 were on *Maianthemum racemosum* ssp. *racemosum*.

Although direct evidence of browse on herbaceous species was only infrequently observed, our primary concern with browse impacts on herbs is their size and abundance. Over time, we will use the indirect browse data to assess long-term impacts on herbs by testing for changes in both frequency and height.

Table 21. Summary of indirect browse documented at Indiana Dunes NL in 2012.

Forest type	Species	Number of quadrats where present	Mean maximum height per quadrat	Number of quadrats with browse
Black oak	<i>Osmorhiza</i> sp.	9	15.8	0
	<i>Maianthemum racemosum</i> ssp. <i>racemosum</i>	92	18.0	19
	<i>Lupinus perennis</i>	18	20.2	0
Upland oak	<i>Maianthemum racemosum</i> ssp. <i>racemosum</i>	12	14.0	0
Mesic	<i>Osmorhiza</i> sp.	3	41.2	0
	<i>Maianthemum racemosum</i> ssp. <i>racemosum</i>	5	10.3	1
Modified successional	<i>Maianthemum racemosum</i> ssp. <i>racemosum</i>	6	12.8	0

A number of trees measured in our plots presented evidence of a pest, pathogen, or damage (Table 22). A total of 19.4% of the trees had some sort of indicator present, with most of these being in the black oak forests. Of these, the majority showed signs of fire damage. Also in black oak forests, six of the 19 total individuals of *Cornus florida* had evidence leaf damage, including mottling and/or splotches and dieback. These are characteristics of dogwood anthracnose, a fungal disease caused by *Discula destructiva*. While largely a problem in the southeastern United States, the disease has been documented in several northern Indiana counties, although its presence has not yet been confirmed within the park. Samples will be collected in spring of 2013 and sent to pathologists for confirmation. While fire and potential dogwood anthracnose issues were limited to black oak forests, other indicators were common across multiple forest types. These include the presence of discolored foliage, such as mottling, spots, or blotches on maple trees (members of the genus *Acer*).

Table 22. The number of trees in each of the five forest types with any sign or symptom of a pest, pathogen, or damage.

Forest type	Total number of live trees	Total number of trees with indicator
Black oak	1,711	453
Upland oak	181	12
Mesic	433	31
Wet mesic	56	14
Modified successional	392	27
Whole park	2,773	537

Ash trees (*Fraxinus* sp.) are of special concern due to the outbreak of emerald ash borer (EAB). Across all forest types, 29 of the 192 total living ash trees measured showed signs of damage or disease (Table 23). Besides the trees with D-shaped exit holes (the diagnostic indicator for EAB) other symptoms affecting ash trees were dieback, discolored and/or wilted foliage, and epicormic sprouting. These other indicators, while characteristic of EAB presence, are also indicative of a number of other diseases and disease complexes impacting ash.

Table 23. The number of live ash trees (*Fraxinus* sp.) in each of the five forest types with any sign or symptom of a pest or pathogen present.

Forest type	Number of ash trees in forest type	Indicator on ash trees	Number of ash trees with indicator
Black oak	20	Foliage affected	2
		D-shaped exit holes	1
Upland oak	5	Dieback	1
		Wilted foliage	3
Mesic	64	Dieback	3
		D-shaped exit holes	1
Wet mesic	47	Defoliation	6
		D-shaped exit holes	2
		Wilted foliage	1
Modified successional	56	Defoliation	4
		Discolored foliage	3
		Epicormic sprouting	2

Community Indices

A total of 503 taxa were located in the 50 plots, with a park-wide mean of 66.46 taxa per plot. Across all forest types, the majority of taxa were perennial and native (Table 24). Herbaceous species (forbs and graminoids) represented 53.68% of the total and, within the pollination group, 69% of species were biotically pollinated.

Table 24. Mean plot species richness within classes of each functional group for all five forest types.

Functional group	Class	Forest type				
		<i>Black oak</i>	<i>Upland oak</i>	<i>Mesic</i>	<i>Wet mesic</i>	<i>Modified successional</i>
Life history	annual	4.55	5.00	4.83	6.50	4.66
	biennial	1.21	0.80	1.00	1.25	0.67
	perennial	60.21	58.80	61.5	66.25	59.17
Growth form	forb	32.66	28.20	27.83	30.75	25.50
	graminoid	4.90	3.60	8.50	12.50	5.50
	woody	28.41	32.80	31.0	30.75	33.50
Pollination	abiotic	11.48	15.40	20.67	23.50	16.50
	biotic	52.83	49.00	42.00	46.50	46.17
	N/A	1.66	0.20	4.66	4.00	1.83
Nativity	native	58.00	58.20	61.50	61.75	54.33
	non-native	5.35	5.00	3.00	7.25	7.67
	native/non-native	2.62	1.40	2.83	5.00	2.50

The coefficient of conservatism (COC) values ranged from 3.9 (wet mesic forest) to 4.8 (mesic forests) (Figure 10). The mean COC value across all forest types was 4.54.

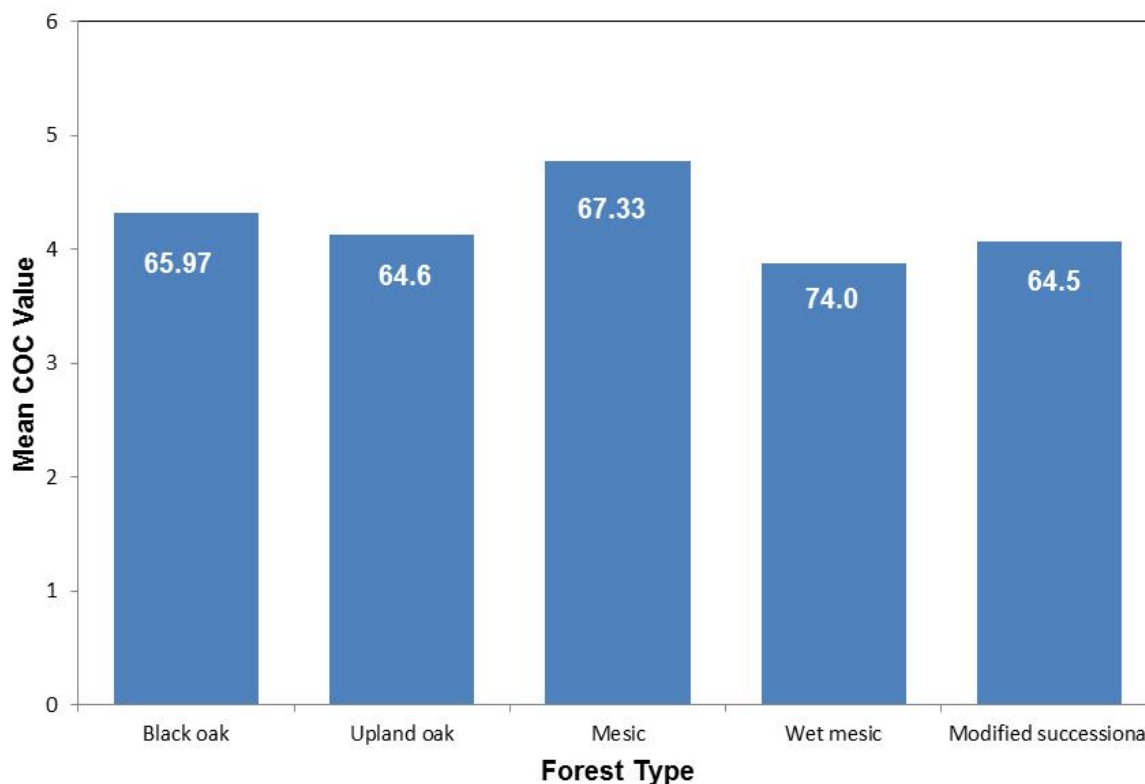


Figure 10. Mean Coefficient of Conservatism (COC) values for the five forest types. Numbers on the blue bars are the mean plot species richness values in the respective forest types.

Earthworm Assessments

We collected 184 earthworm assessment samples from plots in 2012 (Table 25). Three plots were not assessed for earthworms due to time constraints, and three plots did not have the full complement of four replicate samples. A large percentage of the earthworm assessment samples were either earthworm-free (45.6%) or minimally invaded (41.3%). Seven samples, representing 3.8% of the earthworm assessment samples taken at INDU, were classified as either substantially invaded or heavily invaded. These samples were taken from three separate plots: two were located in the Heron Rookery, and one was located in Pinhook Bog. The predominant soil types at plots with samples classified as substantially or heavily invaded were loams or sandy loams.

A total of 12 plots throughout the park were classified as earthworm free, based on our assessments. Eleven of these 12 plots are located in black oak forests, and the predominant soil type at all 12 plots was either fine sand or loamy sand.

Table 25. Earthworm assessment rankings by forest type at Indiana Dunes National Lakeshore, 2012.

Forest type	Total samples	Number of samples that are:				
		<i>Earthworm free</i>	<i>Minimally invaded</i>	<i>Moderately invaded</i>	<i>Substantially invaded</i>	<i>Heavily invaded</i>
Black oak	108	60	45	3	0	0
Upland oak	19	2	9	4	3	1
Mesic	22	1	12	6	3	0
Wet mesic	15	8	4	3	0	0
Modified successional	20	13	6	1	0	0
Whole park	184	84	76	17	6	1

Forest Change, 2007-2012

Twelve plots were resampled in black oak forests, but a transect was moved in one of these plots so data from this plot were not included in any change calculations.

The density of live trees decreased by 166 trees/ha between 2007 and 2012 (Figure 11a), while standing dead tree density increased by 170 trees/ha (Figure 11b). Basal area of living trees differed little between years (Figure 11c), while basal area of standing dead trees doubled (2.29 to 4.50 m²/ha) between the two sampling periods (Figure 11d). The density of living black oak (Figure 11a) was similar between the two sampling periods while the density of standing dead black oak trees more than tripled (Figure 11b). Values for indices of dead trees must be interpreted cautiously because not all individuals could be identified to species; a large percentage of individuals in Figure 11b were simply identified as “unknown hardwood.” Basal area of living black oak increased from 10.9 m²/ha to 14.8 m²/ha (Figure 11c).

Three plots in mesic forests were resampled, with a slight drop in density of living trees (52 trees/ha) (Figure 12a) between the two sampling periods, and a slight increase (96 trees/ha) in standing dead tree density (Figure 12b). Basal area of live trees increased 3.315 m²/ha during the time period (Figure 12c), while basal area of standing dead trees more than doubled, increasing 2.203 m²/ha (Figure 12d).

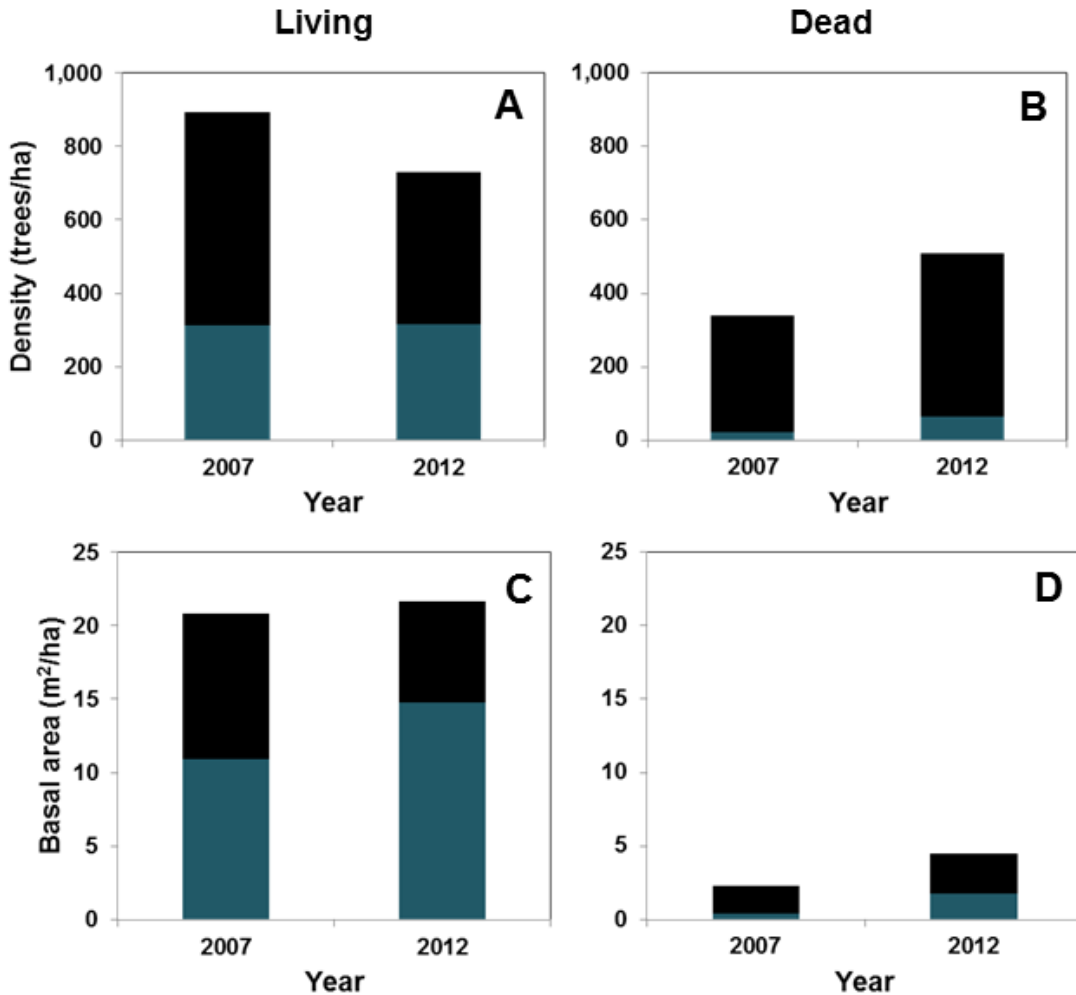


Figure 11. Tree density and basal area in black oak forests in 2007 and 2012. The plots on the left (A, C) reflect live trees and those on the right (B, D) reflect standing dead trees. Teal (■) represents black oak while black (■) represents all other species.

Density of living ash species, largely represented by green ash, decreased 74 trees/ha (Figure 12a), while density of standing dead ash increased 9 trees/ha (Figure 12b). As with all forest types sampled, a large number of standing dead trees could not be identified to species; it is probable that many, or even most of these, were ash. Basal area of living ash increased slightly (0.5 m²/ha) (Figure 1c), while basal area of standing dead trees positively identified as ash more than doubled to 0.063 (Figure 12d).

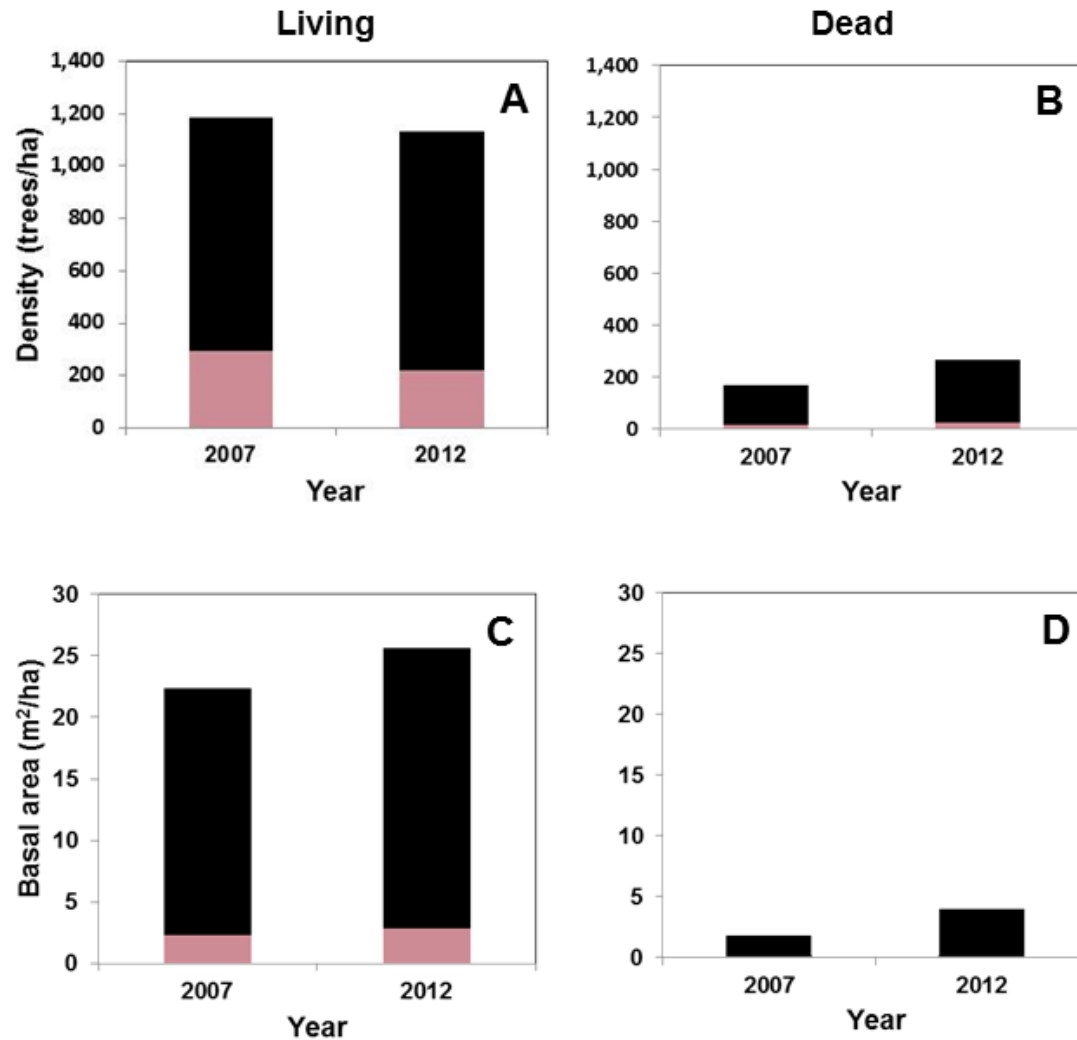


Figure 12. Tree density and basal area in mesic forests in 2007 and 2012. The plots on the left (A, C) reflect live trees and those on the right (B, D) reflect standing dead trees. Pink (■) represents ash species (predominantly green ash) while black (■) represents all other species.

In the three modified successional plots that were resampled, density and basal area of both living and standing dead trees increased slightly between the two sampling periods (Figure 13a-d). Two non-native tree species, black locust and tree-of-heaven, were present in modified successional plots, with the former, much more abundant than the latter. Together, non-native species comprised ca. 20% of the total living density and ca. 36% of the total living basal area in both years.

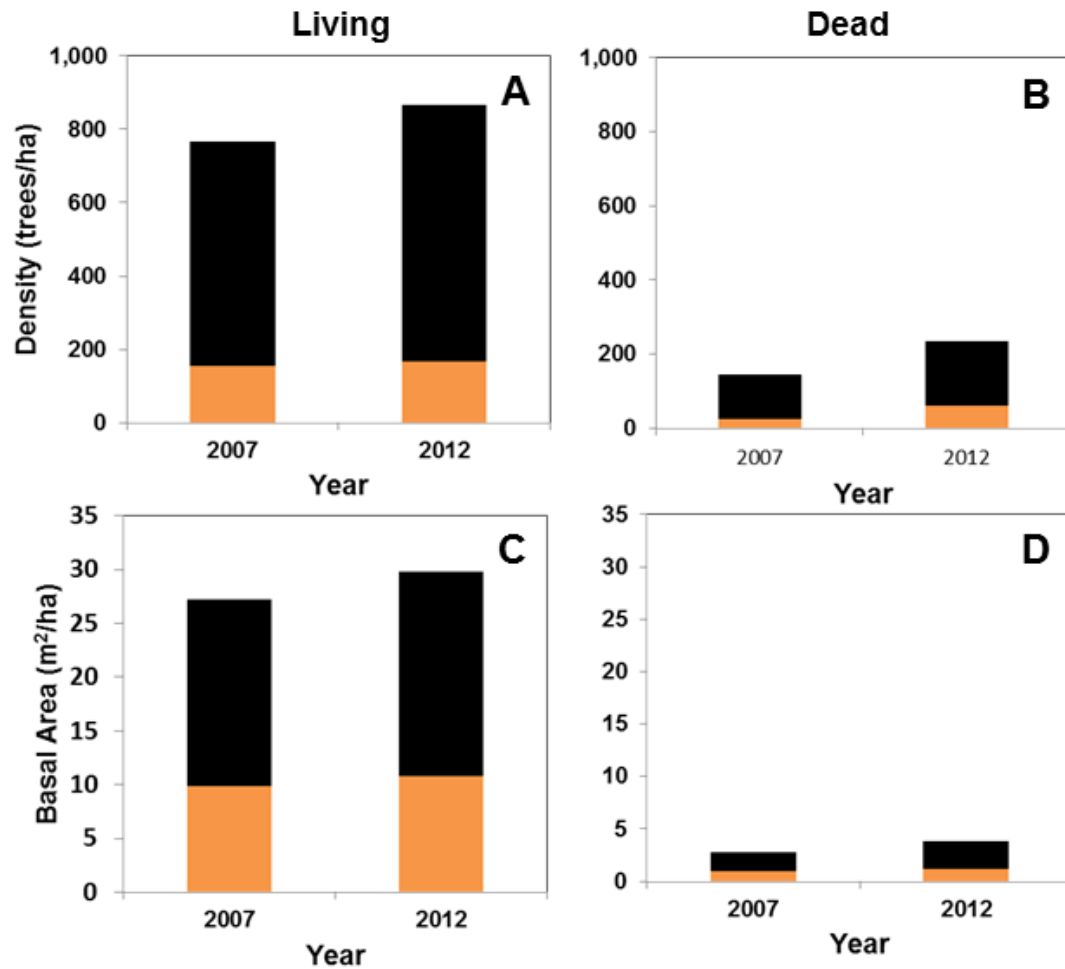


Figure 13. Tree density and basal area in modified successional forests in 2007 and 2012. The plots on the left (A, C) reflect live trees and those on the right (B, D) reflect standing dead trees. Orange (■) represents non-native species (predominantly black locust but with some tree-of-heaven) while black (■) represents all other species.

Discussion

The largest threat to the forests of INDU is continued pressure of invasive plant species. Perhaps the species posing the largest problem is Asian bittersweet, a non-native woody vine introduced in the mid-1700s for horticultural purposes (Miller 2003). In North America, density is greatest in the southeast United States (centered around Ashville, North Carolina) and in New England. Although many forests at INDU are substantially invaded by Asian bittersweet, INDU is near the northwest extent of the contiguous part of its range in North America. There are also scattered populations in lower Michigan, northern Illinois, southern Wisconsin, Minnesota and Iowa.

Asian bittersweet seedlings and young plants are highly shade tolerant, persisting in the understory for long periods of time until light becomes abundant (Greenberg et al. 2001, Leight-Young et al. 2013). When this happens, rapid vegetative growth occurs, resulting in overtopping of the native woody vegetation, which is killed largely by girdling and light attenuation. This strategy allows Asian bittersweet to opportunistically colonize forest edges, gaps, and other disturbed areas. While the Asian bittersweet species is more commonly located in mesic forest sites, its native congener, American bittersweet (*Celastrus scandens*) is more commonly observed in dryer habitats with more coarse textured soils (Pavlovic and Leicht-Young 2011). In areas where mesic forests and dune forests abut one another, both species grow together and do hybridize (Pooler et al. 2002), making identification and control even more difficult. Limited efforts to control the Asian species at INDU have been ongoing since 2005, but were especially intense during the 2012 growing season. At this time, efforts were concentrated at Portage Lakefront, West Beach, and Mt. Baldy which support both native and non-native *Celastrus* species, as well as Cowles Bog, Tolleston Dunes, Marquette Trail, and Glenwood Dune where the native species was not found. Larger vines were cut and stump treated with herbicide while smaller vines that carpeted the forest floor were sprayed with herbicide. The competitive ability of the Asian species is facilitated by burning, further complicating its control (Pavlovic and Leicht-Young, unpublished data). Prescribed burns are routinely carried out in the black oak forests and woodlands at INDU. Because the non-native species exhibits vigorous growth following burning, vines growing in areas scheduled for autumn, 2012 burns were also treated with herbicide.

While Asian bittersweet is perhaps the invasive plant species posing the greatest problem in INDU forests, three other species are also major threats. Multiflora rose colonizes a range of habitats, with introduction into previously uninvaded areas often occurring via avian dispersal. Once established, it may spread both by seed and clonally, via roots and layering (Jesse et al. 2010). We are especially concerned with its presence in a number of otherwise healthy oak-hickory forests, where open understories assure there is little competition at the groundlayer and shrub layer. At both the Pinhook Bog tract, and in forests within the vicinity of park headquarters, we observed sharp demarcations between dense clumps of multiflora rose and the otherwise healthy forests. Multiflora rose is the most frequent invasive plant at INDU (Noel Pavlovic, USGS Ecological Research Station, personal communication).

Tree-of-heaven (*Ailanthus altissima*) is a fast-growing, shade intolerant species (Knapp and Canham 2000) native to Asia that produces copious amounts of seeds in a season (Kaproth 2008).

Collectively, these traits facilitate its growth in disturbed areas, as well as in naturally occurring gaps in the forest. Although tree-of-heaven is common in the park, particularly along roadsides and railroad rights-of-way, we only noted its presence in two plots. The park's treatment strategy for this species is to control it in select areas and where it occurs within high priority management areas.

Garlic mustard (*Alliaria petiolata*) is a biennial herb capable of spreading by both seed and rhizomes. Where observed, garlic mustard is more commonly found in moist, low-lying sites. At INDU, this species was located in 13 of the 50 plots; these were distributed between all five forest types. Prior to 2006, treatments consisted primarily of hand pulling. Herbicide treatments were started in 2006 and became the primary treatment in 2007. The herbaceous nature of *A. petiolata* presents a challenge with herbicidal control as non-target native species are often killed in the process.

While invasive species present a serious problem for park managers, the impending impacts from emerald ash borer (EAB) are also a major concern for INDU forests. As of 2007, our initial sampling season at INDU, EAB had not yet been confirmed within the park, though its diagnostic D-shaped exit holes had been documented on the boles of ash trees immediately outside of the park. In 2012, D-shaped exit holes were only noted on a small percentage of ash trees in the monitoring plots, but characteristic symptoms of EAB presence (defoliation, wilt, discolored foliage, dieback, and epicormic sprouting) were commonly observed in plots. Across all forest types, 15% of ash trees exhibited at least one of these symptoms. We now have a better understanding of EAB attack and the progression of symptoms. We now know that symptoms are typically first observed in the upper canopy, usually as yellow foliage or general defoliation (Peters and Iverson 2009). The D-shaped holes are generally not evident on the lower boles until the infestation is fairly advanced. This information suggests that EAB was actually present in the park during our original visit in 2007.

During our summer 2012 sampling, we observed several stands that exhibited a continuum of apparent EAB impacts. Within these stands, there was a range of coarse woody material (Figure 14), a significant amount of standing dead ash, a number of live ash trees that exhibited a range of injury severities, and some individual trees not exhibiting any injury. In these stands, we closely examined numerous living trees, both with and without signs of injury, and only rarely observed the classic D-shaped exit hole. Further, when observed, the hole was not necessarily clearly D-shaped; at times, the side of the hole expected to be straight (the vertical line of the D) had a slight arc to it. This gave the hole a slightly more circular shape.

EAB was first detected in the Detroit, Michigan/Windsor, Canada area in 2002, but may have been in the area since the mid-1990s (Siegert et al. 2007, McCullough et al. 2008). It is believed to have been transported in the larval stage in ash wood pallets or crating material (Stone et al. 2005). Females generally lay 50-80 eggs in cracks or crevices of ash trees. Upon hatching, the larvae burrow into the tree, establishing themselves within the cambial layer. Here, they feed on the phloem and outer layer of sapwood, establishing extensive galleries. This disrupts both the xylem and phloem, inhibiting the flow of water and nutrients between the roots and canopy. Most trees typically die within two to four years of infestation (Herms et al. 2004). Prepupal larvae overwinter and adults emerge in May or June and feed on ash leaves for 3-6 weeks (Cappaert et al. 2005). Because adults generally feed on host trees within a few meters of their larval host tree, EAB spread is generally slow, except when assisted by humans, via firewood transport.



Figure 14. Typical appearance of a plot with a relatively large amount of coarse woody material.

Most of the ash located in sampling plots at INDU was green ash, and was present in mesic sites within the east unit. White ash was more frequently encountered farther from the Lake Michigan shoreline, and was more common in the smaller park units including the Pinhook Bog and the Heron Rookery tracts. Black ash (*F. nigra* Marsh.) was common in swamps, although these areas were not typically included in our monitoring as they generally did not have enough (10%) forest cover. Because EAB attacks and kills all native ash species, its impacts may actually be greater in the swamps dominated by black ash because there are often few-to-no other tree species.

Although we can make predictions about forests in the aftermath of EAB, it is impossible to understand the full extent of the impacts until later. Undoubtedly, these impacts will cascade throughout all levels of the ecosystem. Initially, the gaps created by the loss of ash will increase light both in the understory and subcanopy. This may promote the establishment of early successional species such as red maple, trembling aspen, tulip poplar, or black cherry. Similarly, it may allow the release of shade tolerant mid-successional species such as sugar maple or beech (*Fagus grandifolia* Ehrh.). Unfortunately, loss of ash will also result in temporarily vacant niches that opportunistic non-native species may occupy. Multiflora rose, tree-of-heaven, and Asian bittersweet all respond to light and the loss of ash could provide favorable conditions for these species.

Death of ash trees may initially be favorable for wildlife. Increased woodpecker feeding activity occurs on infested trees (Lindell et al. 2008), and it is likely that other insectivorous birds will also benefit from the abundance of saprophytic insects. Further, extensive down woody material will provide habitat for rodents, shrews, turtles, snakes, and salamanders. Ultimately, however, the loss of

mature ash trees will likely decrease habitat. The loss of seeds will impact the food supply of granivorous birds and mammals, and once snags fall, there will be increased competition among birds for nesting sites.

Besides impacts to wildlife, altered forest structure will be one of the cascading effects. This will occur directly by impacting the size classes in which ash was previously common. Indirect effects will also occur as a result of wind events. Papaik et al. (2005) found that stands attacked by beech bark disease were more susceptible to windthrow, as a direct result of openings in the canopy. This would likely also occur at INDU in response to ash loss, especially because of the prevalence of coarse textured soils.

Other impacts will be less obvious, and the reverberating effects will be hard to predict. Gandhi and Harms (2010) identified 43 native arthropod species that are associated exclusively with North American ash species for either breeding or feeding. Collectively, these species either form galls or feed on foliage, xylem and phloem, sap, or seeds. They represent eight major taxonomic groups: Arachnida (spiders), Coleoptera (beetles), Diptera (flies), Hemiptera (true bugs), Hymenoptera (bees and wasps), Lepidoptera (butterflies and moths), Orthoptera (crickets and grasshoppers), and Thysanoptera (thrips). The fate of these species remains unclear.

While most forest types are threatened, either by EAB or invasive plant species, black oak forests were generally healthy. This is largely due to the prescribed burning conducted in these communities. Historically, natural fire frequency within the lakeshore was high. Cole and Taylor (1995) examined the fire history of Howes Prairie, a 30 hectare tract of oak savanna. They used stand structure and fire scars to infer that fires were frequent from the early twentieth century until 1972, estimating that between 11 and 17 fires occurred within the prairie during this time with a mean fire return interval of 4.6 – 6.9 years. Unfortunately this method is not effective at determining fire history beyond 100 years prior to the time of study so they could not reliably estimate burn frequency prior to 1900.

A total of 54 separate burn units have been designated within the park. Savanna-like black oak communities (canopy cover generally <40%) are targeted for burning no more often than once every five to six years, although typically the interval is slightly longer than this. Black oak forests with more cover have a longer burn interval still, typically on the order of 15-20 years. In total, the park annually burns about 263 hectares within the burn units. This likely represents a more intensive burn pattern than occurred via historic, natural processes. Nonetheless, the park is still in the “restoration” phase of fire use and not the “maintenance” phase.

Haney et al. (2008) examined vegetation response to both initial burn intensity and to repeated burning over a twenty year period in a northwestern Indiana sand savanna. They found that, in the short term (<20 years), high intensity fires more effectively reduced oak cover. However, beyond this initial timeframe, repeated low intensity burns occurring three times per decade reduced oak cover as effectively as less frequent high intensity burns. Nonetheless, they found that four fires per decade were needed to reduce the ingrowth of shrubs and non-oak tree species.

A number of the plots in black oak forests showed evidence of burns. Plot 3013 near Teale Rd. was burned in 2006 and is now supporting a forest of small, dense black oak and sassafras. Plot 3028, located along the Harbor Belt in Miller Woods was unintentionally burned in spring 2012, a result of sparking from a railroad car. We also observed fire scars on large black oaks in numerous other plots.

Despite the relative health of black oak forests, one persistent threat on this, and all forest types at INDU, is that from deer browse. The ability of deer to impact ecosystems by altering forest structure through inhibiting growth and regeneration is well-documented (Augustine and de Calista 2003, Côte et al. 2004). Besides impacts to woody species, deer reduce the abundance, height, and reproductive effort of a number of herbaceous species (McGraw 2001). This is especially disconcerting at INDU because of the high species richness, abundance of unique habitats, and the large number of listed species. Deer management efforts at INDU are multi-faceted and focus on assessments both of deer abundance and impacts, as well as the identification of trigger points for targeted management.

Efforts to assess deer densities include spotlight surveys, conducted annually since 1991, as well as occasional aerial infrared surveys. The latter effort has estimated deer densities as high as 37.8 deer km² (98 deer/mi²) (INDU 2012). In response to the escalating adverse impacts from these high densities, the park has identified herbaceous indicator species to assess browse impacts. They have also developed thresholds for impacts; when these are reached, courses of action to alleviate the problem should be taken.

Webster and Parker (2000) and Webster et al. (2001), identified three herbaceous indicator species, of which plant height is related to browse impacts. Based on this work, INDU established threshold heights for each of the three species. Where mean heights are below these thresholds, browse impacts are determined to be moderate to severe; where plants are taller than these thresholds, browse impacts are assumed to be light. These target indicator species (and their threshold heights) are: *Osmorhiza* sp. Raf. (sweet cicely, 42 cm), *Actaea pachypoda* Elliott (white baneberry, 25 cm), and *Arisaema triphyllum* (L.) Schott (jack-in-the-pulpit, 37 cm).

INDU staff measure the height of these three indicator species in transects within three 20 × 20 m exclosures. These are located near the Howes Prairie area (in black oak savanna), within the Heron Rookery (in a maple-dominated mesophytic stand), and west of Beverly Shores. Based on measurements made in 1997 and 2000, they found clear differences in stem height between the plants within the exclosures and those in the controls, for all three species (INDU 2012). For the current (2012) GLKN monitoring, we elected not to include *A. pachypoda* or *A. triphyllum* in the list of three targeted indirect browse species because of the infrequency with which we encountered them in our 2007 monitoring (Sanders 2008). We did encounter in *Actaea* sp. in four plots, although it was only present in herbaceous quadrats in two of these; in the other two, it was only sighted in the whole-plot walkthrough. *Arisaema triphyllum* was found in quadrats in four of the 11 total plots where it was located, present only in the walkthrough in the other seven plots.

Osmorhiza sp., one of our three target browse indicator species, was present in fourteen of the 50 plots park-wide. Of those, it was only found in the whole-plot walkthrough in five plots, but present within herbaceous quadrats in the other nine. In black oak forests, where it was located in nine quadrats total, the mean height was 15.8 cm. In mesic forests, it was located in three quadrats with a mean height of 41.2 cm. Thus, in both forest types the mean height was below the threshold for action identified by the park.

Another herbaceous browse indicator identified by the park is the genus trillium (*Trillium* spp.). Augustine and Frelich (1998) found that deer densities of greater than 3.9 – 7.7/km² (10-20/mi²) reduced the density of flowering *Trillium* spp. plants by 50%. Their work also showed that browsing pressure must be reduced for at least two growing seasons, before any appreciable recovery in flowering will occur. Slow recovery, requiring multiple growing seasons has been documented by others. Collard et al. (2010) tested *Trillium erectum* L. recovery in exclosures following nearly 30

years of heavy deer browse. They found no difference in *T. erectum* abundance between exclosed and non-exclosed areas seven and eight years following the installation of exclosures. They did, however, note that exclosed plants were taller with greater leaf area. Webster looked at long-term recovery of various herbs in the understory near the Cades Cove area of the Great Smokey Mountains National Park. Here, deer densities reached 43/km² 1978-1979, before slowly declining. Exclosures were installed in 1996 and abundance and flowering rates in both the exclosures and adjacent control plots were assessed in 2004. They found that recovery was largely limited to those species that were able to persist during the period of high browse pressure.

Beside the large 20 m² exclosures, 28 1 m² exclosures have been established in selected populations of preferred browse species throughout five deer management zones identified by the park. These allow park managers to compare growth of individuals exposed to browsing with those protected. Targeted species for exclosures include *Trillium cernuum*, *T. grandiflorum*, *T. flexipes*, and *T. recurvatum*, with at least one of these species present in all of the 28 exclosures. Anderson (1994) recommended a height of 13 cm for *Trillium grandiflorum* (Michx.) Salisb. (large-flowered trillium) as a trigger point for deer management in Lake County, Illinois. This stem height occurred where deer densities were 3.9 – 6.1/km² (10-16/mi²). Based on this recommendation, the park adopted 13 cm for all species of trillium as a threshold for management action.

Monitoring in 2009 in the 1 m² quadrats showed plant heights in the control plots were below the action threshold in Dune Wood, Cowles Dunes, Dune Ridge, and Little Calumet deer management zones. In our monitoring in the park in 2012, GLKN did not note the presence of *Trillium* spp. in any of the 50 plots. Although the strong browse preference for trillium suggests it is a good indicator of deer abundance, paradoxically, this preference has led to its rarity at INDU, effectively reducing its value in this role.

Browse on multiple lupine species (*Lupinus* spp. L.) by ungulates has been well documented. These impacts are of special concern because of the dependence of many listed butterflies of the genus *Lycaeides* on lupines for egg and larval development. Frye (2012) studied white-tailed deer browse impacts in on sundial lupine (*Lupinus perennis* L.) in coastal Maryland. This species is also characteristic of the black oak savannas at INDU. Frye found a reduced likelihood of pod production, and fewer pods per inflorescence on plants within control plots compared with those protected by exclosures. Kuntz (2009) measured browse on both *L. perennis* and *Quercus* spp. (oaks) in northwestern Ohio oak woodlands. Her work found a ten-fold increase in browse on nearby oaks compared with lupine, suggesting that the browse on lupine was more incidental to the fact that it co-occurred with the oaks. Black oak forest was the only type where we located lupine within the herbaceous indirect browse quadrats. Here, it was present in 18 quadrats with a mean maximum height of 20.2 cm, well below the 30 cm threshold, established by the park.

Three additional taxa, closely related to one another, have been selected by INDU staff as indicator species of deer browse impacts: *Mainanthemum canadense* Desf., (Canada mayflower), *Maianthemum racemosum* (L.) Link (false Solomon's seal), and *Polygonatum* sp. Mill (Solomon's seal). These species, which were formerly placed in the lily family (Liliaceae), are now regarded as within the asparagus family (Asparagaceae). Browse on these, and closely-related lily and orchid family species are well documented. Based on height measurements of these three species both within and immediately outside of the three large exclosures from 1997 until 2000, INDU staff identified 10 cm as for *Polygonatum* sp., 16 cm for *M. racemosum*, and 8 cm for *M. canadense* as thresholds for action.

GLKN identified *Maianthemum racemosum* as one of the three indirect browse species for monitoring. This species is, perhaps, more of a generalist than the other two herbaceous indirect browse target species. As such, it was located in four of the five forest types and present in more quadrats than the other two. In black oak and upland oak forests, it was present in 92 and 12 quadrats with mean maximum heights of 18.0 and 14.0, respectively. In mesic forests, it was present in five quadrats with a mean maximum height in quadrats of 10.3 cm, and present in six quadrats in modified successional plots, with a mean maximum height of 12.8 cm. Thus, plant heights were below the threshold for management action in all but black oak forests.

INDU staff will continue to collect height data on an annual basis, so that current data is available for short-term decisions on deer control. The data collected as part of the Great Lakes I&M Program will only be collected every nine years. Nonetheless, our data will provide valuable information in many ways that the park surveys will not. First, park biologists have placed deer exclosures in select areas, typically within existing populations of target species. They have not, however, specifically targeted any of these in areas of extirpated populations. Our random but balanced spatial arrangement of plots makes no assumptions of species distributions and can tell us information about species recovery, park-wide, in response to herd management. For example, Lyon (1927) detailed flowering plants and ferns present in the Dunes State Park and surrounding vicinity. *Trillium grandiflorum* and *Uvularia grandiflora* are the first two species listed in as occurring in “rich wooded dunes.” While we did not locate either species in the 2012 sampling, should these areas become repopulated, via surviving propagules or deposit of seed, we will be able to quantify recovery.

The second way GLKN data will be useful is that our methods for quantifying browse impacts are robust, with respect to species. Although we do have target species, not all species will be found in all forest types. Frerker and Waller (2013) showed a positive correlation between frequency of species occurrences in sampling quadrats and species abundance, suggesting frequency can be a surrogate for actual density. For our sampling methods, we record all species present in each of 30 1m² quadrats per plot. We can then examine how these species frequencies change over time. For example, *Maianthemum stellatum* was not selected as a target species in black oak forest, but it is closely related to a number of other preferred browse species. In black oak forests, this was present at a frequency of 0.033 or, on average, one out of every 30 quadrats. Similarly, *Polygonatum biflorum* frequency in herbaceous quadrats was 0.022 or, on average once per 45 quadrats. Our methods will allow us to assess change in these, and other browsed species. This method can also be used to monitor change in species known to be avoided by deer. We feel that this information will provide longer-term value of judging how well herd control is working.

Forest Change

Changes in the structure of black oak forests (Figure 12) largely reflect their response to fire and the length of time since the last burn. Burns generally remove many small trees of all species, but also promote vegetative growth of both black oak and sassafras, leading to a dense thicket of “grubs” of both species. These grubs are similar in appearance to large seedlings or small saplings, and thin out over time due to competition. In addition to removing small trees, burning will also kill larger individuals, especially trees of species other than black oak. Within a given stand, succession will occur, but the reoccurrence of fire will continually reset the system. A given black oak forest, as a whole, will exhibit a range of structural classes and densities that reflect the successional state of all of the stands that comprise the forest. These processes help to explain the changes recorded between the two time intervals. The sharp drop in density of live trees, corresponding to an increase in the

density of dead trees likely reflects many smaller (<5 cm DBH) grubs dying in plots where it has been a period of time since the last burn. The increase in basal area of standing dead trees likely reflects the death of a small number of larger individuals. These changes are offset in living trees by the growth of survivors.

In mesic forests, the dynamics of ash are an important component of change. Although ash is more common in mesic forests than any of the other types, collectively ash species represent only 11.7% of the density and 6.12% of the basal area within this forest type (Table 8). It does not appear that changes in mesic forests (Figure 13) are strictly a reflection of ash demographics in response to EAB, particularly as the basal area increased. Our results are likely more a reflection of general stand aging. Oliver (1981) identified four stages of forest development following major disturbance. Following Initiation (stage 1) and Stem Exclusion (stage 2), Demographic Transition (stage 3) occurs by which time, the trees in the canopy are composed of more than one cohort. Self-thinning is generally density independent, largely a result of senescence and blowdown, although in mesic forests, ash loss due to EAB is contributing to this, as well. Although there may be fewer trees than in earlier stages, these may be larger, resulting in more stand basal area. The increased basal area and decreased density of living trees between the two time periods supports this idea (Figure 12a, c). It does appear, however, that increases in dead ash are reflected in both the density and basal area indices (Figure 12b, d). Because there are far fewer dead trees, overall, than living, small changes in demographics of dead trees result in larger proportional changes, when compared with living trees.

The demographic patterns observed in modified successional forests reflect the relatively young age of the stand. Senescence of large trees from the initial cohort will leave gaps that lead to recruitment of new cohorts. Our results may indicate the transition of this new cohort from the seedling and sapling stages into small trees. This is shown by Figure 9 (compare with Figures 5 and 7) where there are only small decreases in density in successively larger size classes.

Climate Change and INDU Forests

Impacts to INDU's forests resulting from climate change are difficult to detect at this point. Currently, the impacts of emerald ash borer and invasive species will largely override any, as yet subtle, impacts of climate change. Climate induced shifts in vegetation will likely become evident by the next sampling round in 2021.

Vegetation change at INDU will be especially pronounced in the black oak woodland and savanna-like tracts, but also in the oak-hickory stands. Vegetation shifts in response to climate change are expected to be more rapid and pronounced at ecotone boundaries (Gosz 1992, Case and Taper 2000). At these boundaries, steep gradients exist between disparate vegetation types (Risser 1995). This includes the forest-prairie border which separates dry, generally oak-hickory forests and woodlands from savannas and prairies. In the United States, this border extends southward from Minnesota to Texas with an eastward reach along the southern limits of the Great Lakes (Bailey 1995) (Figure 16), where it is in close proximity to INDU.

In the western reaches of the park, including the Hobart Prairie Grove tract, the understories have many classic prairie species. These include a number of grasses such as big bluestem (*Andropogon gerardii* Vitman), Canada wild rye (*Elymus canadensis* L.), little bluestem (*Schizachyrium scoparium* [Michx.] Nash), Junegrass (*Koeleria macrantha* [Ledeb.] Schult.), and Indian grass (*Sorghastrum nutans* [L.] Nash). Two shrub species, New Jersey tea (*Ceanothus americanus* L.) and Carolina rose (*Rosa carolina* L.) were commonly encountered, as were a number of forbs often found in prairies and savannas: downy phlox (*Phlox pilosa* L.), bastard toadflax (*Comandra umbellata* [L.]

Nutt.), Canadian lousewort (*Pedicularis canadensis* L.), bird's foot violet (*Viola pedata* L.), starflower (*Maianthemum stellatum* L.), leadplant (*Amorpha canescens* Pursh), flowering spurge (*Euphorbia corollata* L.), eastern prickly pear (*Opuntia humifusa* [Raf.] Raf.), hoary puccoon (*Lithospermum caroliniense* [Walter ex J.J. Gmel.] MacMill.), blazing star (*Liatris aspera* Michx.), dwarf dandelion (*Krigia biflora* [Walter] S.F. Blake), and butterflyweed (*Asclepius tuberosa* L.). Because understory species have shorter lifespans than trees, species turnover rates are quicker and the understory assemblages may closely reflect the current environment. In contrast, tree composition is often a reflection of conditions during the time of establishment and early growth. As climate change continues, the rate of overstory change will lag somewhat behind the changing climate.

In central North America, summer temperatures are projected to increase 3-9° C (Wuebbles and Hayhoe 2004, Christensen et al. 2007) but the precipitation response to climate change is unclear. Projections generally suggest it will be similar to the 30-year-period from 1970 to 1999 or decline slightly (Wuebbles and Hayhoe 2004, Christensen et al. 2007). At INDU in 2012, maximum daily temperatures, averaged on a monthly basis, were 1.7-3.9° warmer from May through July than the 1981-2010 averages. Precipitation for all of 2012 was 22.9 cm less than the 23-year mean and 27.9 cm below the 64-year mean (www.climateanalyzer.org).

A general northeastward migration of tree species, ranging in distance from 100-500 km, is expected (Walker et al. 2002, Prasad et al. 2009). A number of the 57 tree species located in plots at INDU in 2012 are near the western and/or southern limits of their ranges, likely a reflection of moisture limitations and temperature. These species, which are apt to move out of the park in the coming decades, include beech, black gum (*Nyssa sylvatica* Marshall), jack pine (*Pinus banksiana* Lamb.), tulip poplar (*Liriodendron tulipifera* L.), and trembling aspen (*Populus tremuloides* Michx.).

Within the anticipated 100-500 km climate shift range, and to the south and west of INDU, are a number of tree species that will likely migrate northeastward. These include a number of oaks— post oak (*Quercus stellata* Wangenh.), blackjack oak (*Quercus marilandica* Münchh.), chinkapin oak, (*Quercus muehlenbergii* Engelm.), chestnut oak (*Quercus prinus* L.), and Shumard's oak (*Quercus shumardii* Buckley) as well as black hickory (*Carya texana* Buckley), winged elm (*Ulmus alata* Michx.), and shortleaf pine (*Pinus echinata* Mill.). All of these species tolerate slightly dryer, warmer conditions than currently exist at INDU.

Immigration of tree species will be largely dependent on dispersal. Dispersal of oaks by gravity and caching by small mammals will be slow and may not keep pace with climate change-induced tree migration. However, dispersal rates of oaks by blue jays (*Cyanocitta cristata* L.) have been estimated to be 6-8 km annually. This may be sufficient to keep pace with the projected 50 km/decade shift in climatic zones (Kirilenko and Sedjo 2007). Migration of wind-dispersed species (e.g., elms, pines) may be able to keep pace with shifting climatic zones. For all tree species, habitat fragmentation, resulting in large gaps between suitable forest tracts, will still pose barriers for dispersal.

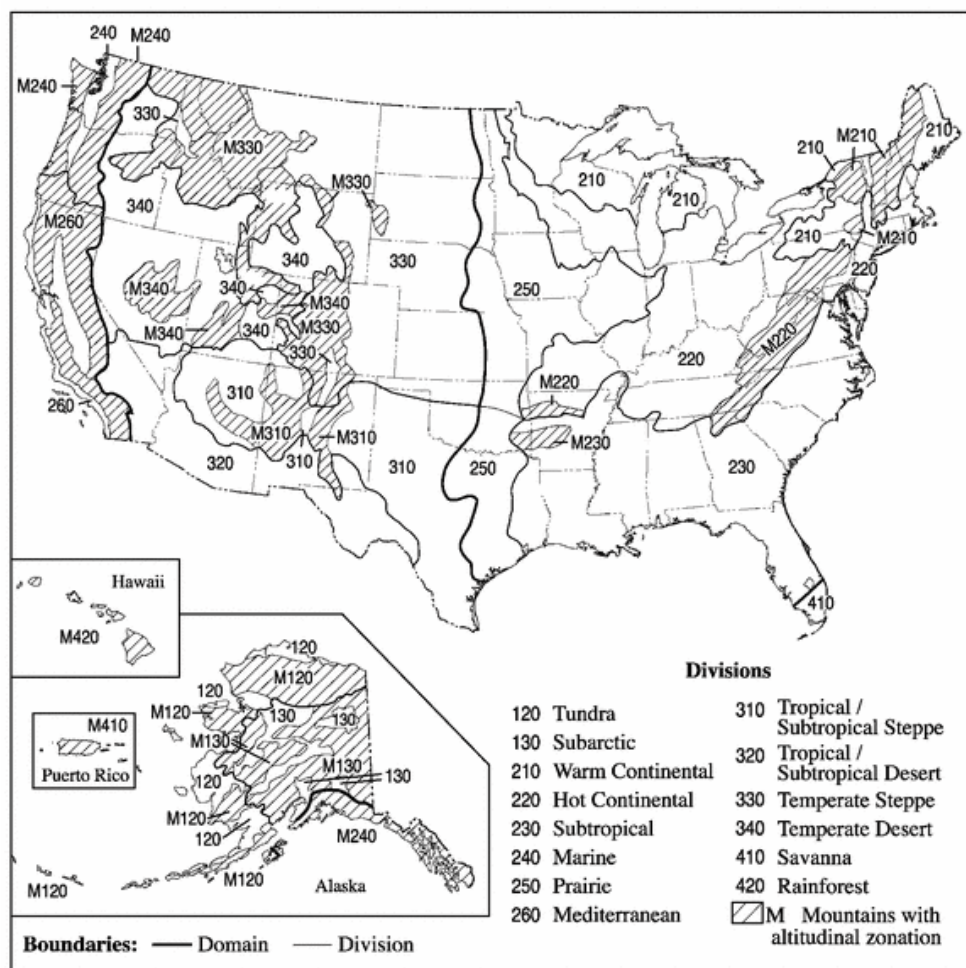


Figure 15. Vegetative ecoregions of the United States. Note the border between Divisions 220 and 250, which we refer to as eastern deciduous forest and prairie, respectively. Taken from Bailey 1995.

Management Directions

Park managers at INDU face tough challenges as the problems posing the greatest threats are generally beyond their control. Large expanses of the park will be impacted by the loss of ash. We feel that managers should identify these areas and prioritize a limited number of them for intensive exotic species monitoring and management. In particular, we feel that monitoring should be in the form of scouting rather than a structured system of transects or quadrats. With the impending loss of ash, early detection of exotic species, particularly *Celastrus orbiculatus*, attempting to occupy the vacant niche will be paramount. The green ash-dominated forests at INDU support a number of native plant species only uncommonly observed within the eastern deciduous forest as a whole. For example, the land immediately east of East State Park Rd. and north of Highway 12 supports high quality forest with minimal numbers of invasive species and many uncommon species. These include *Arisaema dracontium* (green dragon), *Saururus cernuus* L. (lizard's tail), and *Oxypolis rigidior* (L.) Raf. (stiff cowbane). Intensive monitoring (via scouting) for invasives, and their removal when found, will help promote the integrity of this area.

Deer browse has been, and remains, a concern for park managers. Traditional methods of assessing this may not be effective. For example, direct counts of deer do not necessarily provide enough detail about their impacts. Assessing browse impacts directly, by looking at what has been bitten will provide a more precise estimate of impacts; examining changes in height and abundance will be better yet. A number of effects interact to make deer impact monitoring even more challenging. Deer preference varies regionally, and in response to available food. Rather than assessing preferred browse species, Frerker et al. (2013) suggest monitoring the abundances of species preferentially avoided, as these will have less susceptibility to the variables above. Potential species include several grasses and ferns.

Although exotic plant species are a large problem at INDU, there are at least opportunities for their control. The highly dissected and fragmented nature of the park leaves it vulnerable to invasion, but managers have identified target areas for restoration and target species for treatment. Continued budget tightening within the National Park Service will challenge these efforts; hopefully, at least the current levels of treatment can be maintained.

Implementation: Problems, Logistics, and Future Plans

Sampling at INDU in 2012 went relatively smoothly, with no major problems. Current plans are to revisit INDU in 2021 and every nine years thereafter.

We recommend that future sampling crews use T-posts for marking those permanent endpoints that are located on active dunes, or in areas where there are no witness trees within eight meters from the endpoint. In many areas dominated by ash, there will soon be distances considerably greater than ten meters for many endpoints. Unless these are marked with T-posts, it will not always be possible to relocate the endpoint, resulting in a loss of data quality.

Current plans are to revisit INDU in 2021 and every nine years thereafter.

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Appendix A: Field Season Maps

Due to their large file size, the maps have been removed from the digital version of this report. If you would like to view these maps, please contact the Great Lakes Network Office.

Appendix B: Complete List of Species Sampled

Species Encountered during Site Visits - by Park

Park: INDU Year: 2012

This information is from certified and uncertified data from standard sampling of active alternating plots at this park.

Species

HERBACEOUS - Fern / Fern Allies

Aspleniaceae

Asplenium platyneuron

Dennstaedtiaceae

Pteridium aquilinum ssp. latiusculum

Dryopteridaceae

Dryopteris carthusiana

Dryopteris cristata

Polystichum acrostichoides

Equisetaceae

Equisetum arvense

Equisetum hyemale

Lycopodiaceae

Lycopodium digitatum

Onocleaceae

Matteuccia struthiopteris

Onoclea sensibilis

Ophioglossaceae

Botrychium dissectum

Botrychium sp.

Botrychium virginianum

Osmundaceae

Osmunda claytoniana

Osmunda regalis var. spectabilis

Osmundastrum cinnamomea

Thelypteridaceae

Thelypteris noveboracensis

Thelypteris palustris var. pubescens

Woodsiaceae

Athyrium filix-femina var. angustum

HERBACEOUS - Forb

Alismataceae

Alisma subcordatum

Alisma triviale

Amaranthaceae

Chenopodium album

Chenopodium leptophyllum

Chenopodium sp.

Amaryllidaceae

Allium tricoccum

Apiaceae

Cicuta bulbifera

Cicuta maculata

Cryptotaenia canadensis

Daucus carota

Osmorhiza sp.

Sanicula canadensis

Sanicula marilandica

Sanicula sp.

Apiaceae

Sium suave

Apocynaceae

Apocynum androsaemifolium

Apocynum cannabinum

Asclepias exaltata

Asclepias incarnata

Asclepias sp.

Asclepias syriaca

Asclepias tuberosa

Asclepias verticillata

Araceae

Arisaema dracontium

Arisaema triphyllum

Symplocarpus foetidus

Araliaceae

Aralia nudicaulis

Hydrocotyle umbellata

Aristolochiaceae

Asarum canadense

Asparagaceae

Asparagus officinalis

Convallaria majalis

Maianthemum canadense

Maianthemum racemosum ssp. racemosum

Maianthemum stellatum

Polygonatum biflorum

Polygonatum pubescens

Asteraceae

Achillea millefolium

Ageratina altissima

Ambrosia artemisiifolia

Antennaria plantaginifolia

Artemisia campestris ssp. caudata

Asteraceae fam.

Bidens connata

Bidens frondosa

Cirsium discolor

Cirsium sp.

Cirsium vulgare

Conyza canadensis

Coreopsis lanceolata

Coreopsis palmata

Coreopsis tripteris

Doellingeria umbellata var. umbellata

Erechtites hieraciifolius

Erigeron annuus

Erigeron philadelphicus

Erigeron strigosus

Eupatorium altissimum

Eupatorium perfoliatum

Eupatorium serotinum

Eupatorium sessilifolium

Eurybia macrophylla

Euthamia graminifolia

Eutrochium maculatum

Eutrochium purpureum

Species Encountered during Site Visits - by Park

Asteraceae

Helenium autumnale
Helianthus divaricatus
Hieracium caespitosum
Hieracium scabrum
Hieracium sp.
Ionactis linariifolia
Krigia virginica
Lactuca canadensis
Lactuca sp.
Liatris aspera
Liatris cylindracea
Liatris sp.
Prenanthes alba
Prenanthes sp.
Pseudognaphalium obtusifolium
Rudbeckia hirta
Solidago caesia
Solidago flexicaulis
Solidago sp.
Solidago speciosa
Sonchus asper
Symphyotrichum lateriflorum var. lateriflorum
Symphyotrichum oolentangiense
Symphyotrichum sp.
Taraxacum officinale
Taraxacum sp.
Verbesina alternifolia
Vernonia fasciculata
Vernonia missurica

Balsaminaceae

Impatiens capensis
Impatiens sp.

Berberidaceae

Caulophyllum thalictroides
Podophyllum peltatum

Boraginaceae

Hackelia virginiana
Lithospermum canescens
Lithospermum carolinense var. croceum

Brassicaceae

Alliaria petiolata
Arabidopsis lyrata ssp. lyrata
Cardamine sp.
Hesperis matronalis
Lepidium campestre
Lepidium virginicum

Buxaceae

Pachysandra terminalis

Cactaceae

Opuntia humifusa

Campanulaceae

Campanula americana
Campanula rotundifolia
Lobelia cardinalis
Lobelia siphilitica
Lobelia spicata

Cistaceae

Helianthemum canadense

Commelinaceae

Commelina communis
Tradescantia ohienensis
Tradescantia virginiana

Ericaceae

Gaultheria procumbens
Monotropa uniflora
Pyrola elliptica
Pyrola sp.

Euphorbiaceae

Euphorbia corollata

Fabaceae

Amorpha canescens
Desmodium illinoense
Desmodium nudiflorum
Desmodium paniculatum
Desmodium sessilifolium
Desmodium sp.
Lespedeza capitata
Lespedeza hirta
Lespedeza sp.
Lupinus perennis
Medicago lupulina
Melilotus albus
Tephrosia virginiana
Trifolium aureum
Trifolium sp.

Geraniaceae

Geranium maculatum

Haloragaceae

Proserpinaca palustris var. crebra

Hypericaceae

Hypericum ascyron
Hypericum majus
Hypericum mutilum
Hypericum perforatum
Hypericum prolificum
Hypericum punctatum
Hypericum sp.

Iridaceae

Iridaceae fam.
Iris sp.
Iris versicolor

Lamiaceae

Clinopodium vulgare
Glechoma hederacea
Lamiaceae fam.
Leonurus cardiaca
Lycopus americanus
Lycopus sp.
Lycopus uniflorus
Mentha arvensis
Monarda fistulosa
Monarda punctata

Species Encountered during Site Visits - by Park

Lamiaceae

Monarda sp.
Nepeta cataria
Prunella vulgaris
Pycnanthemum sp.
Pycnanthemum virginianum
Scutellaria galericulata
Scutellaria lateriflora
Scutellaria sp.
Stachys hyssopifolia
Stachys sp.
Stachys tenuifolia

Lentibulariaceae

Utricularia sp.

Liliaceae

Medeola virginiana

Linaceae

Linum virginianum

Lythraceae

Lythrum alatum

Melastomataceae

Rhexia virginica

Onagraceae

Circaea canadensis ssp. canadensis
Epilobium ciliatum ssp. ciliatum
Epilobium coloratum
Epilobium sp.
Ludwigia alternifolia
Oenothera biennis
Oenothera sp.

Orchidaceae

Epipactis helleborine
Gymnadeniopsis clavellata
Spiranthes sp.

Orobanchaceae

Aureolaria flava
Aureolaria pedicularia
Conopholis americana
Pedicularis canadensis
Pedicularis lanceolata

Oxalidaceae

Oxalis sp.
Oxalis stricta
Oxalis violacea

Papaveraceae

Chelidonium majus

Phrymaceae

Mimulus alatus
Mimulus ringens
Phryma leptostachya

Phytolaccaceae

Phytolacca americana

Plantaginaceae

Linaria vulgaris
Plantago major

Plantaginaceae

Plantago rugelii
Veronica officinalis
Veronica serpyllifolia

Polemoniaceae

Phlox pilosa

Polygonaceae

Fallopia convolvulus
Persicaria arifolia
Persicaria careyi
Persicaria hydropiper
Persicaria hydropiperoides
Persicaria maculosa
Persicaria punctata
Persicaria sagittata
Persicaria sp.
Persicaria virginiana
Rumex acetosella
Rumex crispus
Rumex obtusifolius
Rumex verticillatus

Primulaceae

Lysimachia ciliata
Lysimachia nummularia
Trientalis borealis

Ranunculaceae

Actaea pachypoda
Actaea sp.
Anemone acutiloba
Anemone americana
Anemone canadensis
Anemone cylindrica
Anemone virginiana
Aquilegia canadensis
Caltha palustris
Clematis virginiana
Ranunculus acris
Ranunculus hispidus
Ranunculus recurvatus
Ranunculus sceleratus
Ranunculus sp.
Thalictrum dasycarpum
Thalictrum dioicum
Thalictrum sp.

Rosaceae

Agrimonia gryposepala
Agrimonia parviflora
Agrimonia sp.
Fragaria virginiana
Geum canadense
Geum sp.
Potentilla simplex
Potentilla sp.

Rubiaceae

Galium aparine
Galium asprellum
Galium circaeans var. circaeans

Species Encountered during Site Visits - by Park

Rubiaceae

Galium concinnum
Galium lanceolatum
Galium obtusum
Galium pilosum
Galium trifidum
Galium triflorum
Mitchella repens

Santalaceae

Comandra umbellata

Scrophulariaceae

Scrophularia lanceolata
Scrophularia marilandica
Verbascum thapsus

Urticaceae

Boehmeria cylindrica
Laportea canadensis
Parietaria pensylvanica
Pilea sp.
Urtica dioica ssp. gracilis

Verbenaceae

Verbena hastata
Verbena sp.
Verbena stricta
Verbena urticifolia

Violaceae

Viola pedata
Viola sagittata
Viola sp.

HERBACEOUS - Forb (vine)

Apocynaceae

Vinca minor

Convolvulaceae

Calystegia sepium
Cuscuta gronovii
Ipomoea sp.

Dioscoreaceae

Dioscorea villosa

Fabaceae

Amphicarpea bracteata
Apos americana

Smilacaceae

Smilax ecirrhata

HERBACEOUS - Graminoid

Cyperaceae

Carex albursina
Carex bebbii
Carex blanda
Carex comosa
Carex crinita
Carex digitalis
Carex folliculata
Carex gracillima
Carex grayi
Carex hystericina

Cyperaceae

Carex intumescens
Carex lacustris
Carex normalis
Carex pensylvanica
Carex retrorsa
Carex scoparia
Carex sp.
Carex stipata
Carex swanii
Carex tribuloides
Carex vesicaria
Carex vulpinoidea
Cyperus strigosus
Dulichium arundinaceum
Schoenoplectus pungens var. pungens
Scirpus atrovirens
Scirpus cyperinus

Juncaceae

Juncus canadensis
Juncus effusus
Juncus sp.
Juncus tenuis

Poaceae

Agrostis gigantea
Andropogon gerardii
Brachyelytrum erectum
Bromus ciliatus
Bromus inermis
Bromus pubescens
Calamagrostis canadensis
Calamovilfa longifolia var. magna
Cinna arundinacea
Danthonia spicata
Dichanthelium acuminatum var. acuminatum
Dichanthelium clandestinum
Dichanthelium depauperatum
Dichanthelium dichotomum var. dichotomum
Dichanthelium latifolium
Dichanthelium sp.
Elymus canadensis
Elymus hystrix
Elymus sp.
Elymus trachycaulus
Elymus virginicus
Glyceria canadensis
Glyceria striata
Koeleria macrantha
Leersia oryzoides
Leersia sp.
Leersia virginica
Panicum virgatum
Phalaris arundinacea
Phragmites australis
Poa compressa
Poa palustris
Poa pratensis
Poa sp.
Poaceae fam.

Species Encountered during Site Visits - by Park

Poaceae

Schizachyrium scoparium
Sorghastrum nutans
Tridens flavus

Typhaceae

Typha latifolia
Typha sp.

OTHER1 - Shrub / Herbaceous

Smilacaceae

Smilax sp.

OTHER1 - Tree / Shrub

Rosaceae

Amelanchier sp.
Crataegus sp.

Salicaceae

Salix sp.

SHRUB

Adoxaceae

Sambucus nigra ssp. canadensis
Sambucus racemosa var. racemosa
Sambucus sp.
Viburnum acerifolium
Viburnum lentago
Viburnum opulus var. americanum
Viburnum rafinesqueanum
Viburnum recognitum

Anacardiaceae

Rhus aromatica
Rhus copallinum
Rhus glabra
Rhus sp.
Rhus typhina

Aquifoliaceae

Ilex verticillata

Asteraceae

Artemisia vulgaris

Berberidaceae

Berberis thunbergii

Betulaceae

Alnus incana ssp. rugosa
Corylus americana

Caprifoliaceae

Lonicera (exotic) sp.

Celastraceae

Euonymus alatus
Euonymus atropurpureus
Euonymus sp.

Cornaceae

Cornus alternifolia
Cornus racemosa
Cornus rugosa
Cornus sericea

Diervillaceae

Diervilla lonicera

Elaeagnaceae

Elaeagnus umbellata

Ericaceae

Gaylussacia baccata
Vaccinium angustifolium
Vaccinium pallidum

Fabaceae

Robinia hispida

Grossulariaceae

Ribes americanum
Ribes cynosbati
Ribes hirtellum

Hamamelidaceae

Hamamelis virginiana

Lauraceae

Lindera benzoin

Oleaceae

Syringa vulgaris

Rhamnaceae

Ceanothus americanus
Rhamnus cathartica
Rhamnus frangula

Rosaceae

Amelanchier Group 2 sp.
Amelanchier Group 3 sp.
Aronia melanocarpa
Physocarpus opulifolius
Rosa blanda
Rosa carolina
Rosa multiflora
Rubus allegheniensis
Rubus flagellaris
Rubus hispidus
Rubus occidentalis
Rubus pensilvanicus
Rubus pubescens
Rubus sachalinensis var. sachalinensis
Rubus sp.
Spiraea alba
Spiraea tomentosa

Rubiaceae

Cephalanthus occidentalis

Rutaceae

Ptelea trifoliata
Zanthoxylum americanum

Staphyleaceae

Staphylea trifolia

SHRUB - Woody Vine

Anacardiaceae

Toxicodendron radicans
Toxicodendron sp.

Species Encountered during Site Visits - by Park

Bignoniaceae

Campsis radicans

Cannabaceae

Humulus lupulus

Celastraceae

Celastrus sp.

Menispermaceae

Menispermum canadense

Smilacaceae

Smilax rotundifolia

Smilax tamnoides

Solanaceae

Solanum dulcamara

Vitaceae

Parthenocissus sp.

Vitis aestivalis

Vitis labrusca

Vitis riparia

TREE

Annonaceae

Asimina triloba

Betulaceae

Betula alleghaniensis

Carpinus caroliniana

Ostrya virginiana

Bignoniaceae

Catalpa speciosa

Cannabaceae

Celtis occidentalis

Cornaceae

Cornus florida

Cupressaceae

Juniperus virginiana

Fabaceae

Gleditsia triacanthos

Gymnocladus dioica

Robinia pseudoacacia

Fagaceae

Fagus grandifolia

Quercus alba

Quercus bicolor

Quercus palustris

Quercus rubra

Quercus sp.

Quercus velutina

Juglandaceae

Carya cordiformis

Carya ovata

Juglans cinerea

Juglans nigra

Lauraceae

Sassafras albidum

Magnoliaceae

Liriodendron tulipifera

Malvaceae

Tilia americana

Moraceae

Morus alba

Morus sp.

Nyssaceae

Nyssa sylvatica

Oleaceae

Fraxinus americana

Fraxinus nigra

Fraxinus pennsylvanica

Fraxinus sp.

Pinaceae

Picea glauca

Pinus banksiana

Pinus strobus

Platanaceae

Platanus occidentalis

Rosaceae

Amelanchier arborea

Prunus americana

Prunus pensylvanica

Prunus serotina

Prunus sp.

Prunus virginiana

Salicaceae

Populus deltoides ssp. monilifera

Populus grandidentata

Populus sp.

Populus tremuloides

Salix fragilis

Salix nigra

Sapindaceae

Acer negundo

Acer rubrum

Acer saccharinum

Acer saccharum

Acer sp.

Simaroubaceae

Ailanthus altissima

Ulmaceae

Ulmus americana

Ulmus rubra

Ulmus sp.

Appendix C: Individual Plot Data

Density and Basal Area of Tree Species (Live trees)

Plot: 3003	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer negundo</i>	11.1	0.0
<i>Acer rubrum</i>	188.9	1.2
<i>Fraxinus americana</i>	22.2	0.1
<i>Liriodendron tulipifera</i>	11.1	0.2
<i>Nyssa sylvatica</i>	11.1	0.0
<i>Populus deltoides ssp. monilifera</i>	33.3	1.6
<i>Populus tremuloides</i>	11.1	0.1
<i>Prunus serotina</i>	44.4	0.3
<i>Quercus alba</i>	166.7	10.3
<i>Quercus velutina</i>	188.9	18.2
<i>Sassafras albidum</i>	355.6	1.8
softwood		
<i>Juniperus virginiana</i>	11.1	0.9
TOTAL	1,055.6	34.7

Plot: 3009	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	11.1	0.3
<i>Acer saccharinum</i>	44.4	0.5
<i>Fraxinus nigra</i>	11.1	0.2
<i>Fraxinus pennsylvanica</i>	55.6	0.5
<i>Morus alba</i>	11.1	0.2
<i>Nyssa sylvatica</i>	11.1	0.0
<i>Populus deltoides ssp. monilifera</i>	100.0	3.0
<i>Prunus serotina</i>	44.4	2.4
<i>Quercus palustris</i>	111.1	1.8
<i>Robinia pseudoacacia</i>	11.1	0.2
<i>Salix fragilis</i>	55.6	10.9
<i>Sassafras albidum</i>	11.1	0.1
TOTAL	477.8	20.2

Plot: 3011	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	177.8	15.6
TOTAL	177.8	15.6

Plot: 3012	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Cornus florida</i>	177.8	0.6
<i>Fraxinus pennsylvanica</i>	11.1	0.1
<i>Prunus serotina</i>	11.1	0.0
<i>Quercus alba</i>	111.1	6.0
<i>Quercus rubra</i>	22.2	0.7
<i>Quercus velutina</i>	166.7	21.8
<i>Tilia americana</i>	66.7	2.7
TOTAL	566.7	31.8

Plot: 3013	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	66.7	1.1
<i>Quercus alba</i>	33.3	0.9
<i>Quercus velutina</i>	155.6	9.8
<i>Sassafras albidum</i>	377.8	4.6
TOTAL	633.3	16.4

Plot: 3014	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	311.1	7.2
<i>Cornus florida</i>	33.3	0.0
<i>Nyssa sylvatica</i>	11.1	0.0
<i>Prunus serotina</i>	211.1	0.7
<i>Quercus alba</i>	100.0	2.9
<i>Quercus velutina</i>	422.2	20.5
<i>Sassafras albidum</i>	122.2	0.6
<i>Ulmus americana</i>	77.8	0.1
TOTAL	1,288.9	32.1

Plot: 3015	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Nyssa sylvatica</i>	22.2	0.1
<i>Populus grandidentata</i>	55.6	1.5
<i>Prunus serotina</i>	155.6	3.7
<i>Quercus alba</i>	33.3	0.6
<i>Quercus rubra</i>	22.2	0.2
<i>Quercus velutina</i>	166.7	11.1
<i>Robinia pseudoacacia</i>	22.2	0.2
<i>Sassafras albidum</i>	166.7	1.4
TOTAL	644.4	18.6

Plot: 3017	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	177.8	5.5
<i>Amelanchier arborea</i>	122.2	0.5
<i>Fraxinus americana</i>	66.7	1.9
<i>Populus tremuloides</i>	122.2	1.9
<i>Prunus serotina</i>	233.3	3.7
<i>Prunus virginiana</i>	122.2	0.5
<i>Quercus rubra</i>	88.9	3.4
<i>Sassafras albidum</i>	133.3	1.7
<i>Ulmus americana</i>	33.3	0.2
TOTAL	1,100.0	19.3

Plot: 3018	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	188.9	8.7
TOTAL	188.9	8.7

Plot: 3019	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	133.3	6.6
<i>Cornus florida</i>	22.2	0.1
<i>Fraxinus nigra</i>	22.2	1.3
<i>Liriodendron tulipifera</i>	66.7	3.6
<i>Nyssa sylvatica</i>	111.1	2.9
<i>Prunus serotina</i>	44.4	3.4
<i>Quercus alba</i>	55.6	3.7
<i>Quercus rubra</i>	33.3	3.0
<i>Quercus velutina</i>	22.2	4.9
<i>Sassafras albidum</i>	111.1	1.2
<i>Ulmus americana</i>	33.3	0.1
TOTAL	655.6	30.6

Plot: 3021	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	100.0	4.8
<i>Populus tremuloides</i>	11.1	0.4
<i>Prunus serotina</i>	44.4	0.5
<i>Quercus rubra</i>	33.3	12.2
TOTAL	188.9	17.8

Plot: 3022	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	233.3	4.3
<i>Betula alleghaniensis</i>	100.0	0.9
<i>Fraxinus pennsylvanica</i>	11.1	0.9
<i>Prunus serotina</i>	22.2	0.7
<i>Quercus velutina</i>	311.1	19.0
<i>Sassafras albidum</i>	44.4	0.9
TOTAL	722.2	26.8

Plot: 3023	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	700.0	11.4
<i>Acer saccharum</i>	33.3	1.1
<i>Fraxinus pennsylvanica</i>	611.1	7.0
<i>Liriodendron tulipifera</i>	55.6	2.7
<i>Platanus occidentalis</i>	33.3	0.1
<i>Populus deltoides ssp. monilifera</i>	11.1	0.4
<i>Prunus serotina</i>	22.2	0.7
<i>Quercus velutina</i>	44.4	0.0
<i>Robinia pseudoacacia</i>	11.1	0.0
<i>Ulmus americana</i>	100.0	0.3
TOTAL	1,622.2	23.8

Plot: 3026	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer negundo</i>	11.1	0.3
<i>Acer rubrum</i>	11.1	0.1
<i>Acer saccharinum</i>	144.4	9.4
<i>Fraxinus americana</i>	55.6	4.2
<i>Prunus serotina</i>	11.1	0.0
<i>Quercus rubra</i>	11.1	0.1
<i>Robinia pseudoacacia</i>	233.3	22.3
<i>Ulmus americana</i>	211.1	4.2
TOTAL	688.9	40.6

Plot: 3028	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	188.9	18.2
TOTAL	188.9	18.2

Plot: 3029	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	111.1	5.1
<i>Catalpa speciosa</i>	55.6	0.5
<i>Fraxinus pennsylvanica</i>	11.1	0.4
<i>Prunus serotina</i>	200.0	2.9
<i>Quercus velutina</i>	911.1	13.7
<i>Robinia pseudoacacia</i>	88.9	1.1
<i>Sassafras albidum</i>	11.1	0.0
TOTAL	1,388.9	23.6

Plot: 3030	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	322.2	4.2
<i>Acer saccharinum</i>	155.6	6.5
<i>Amelanchier arborea</i>	55.6	0.1
<i>Fraxinus pennsylvanica</i>	22.2	0.2
<i>Nyssa sylvatica</i>	255.6	3.5
<i>Prunus serotina</i>	144.4	6.3
<i>Prunus virginiana</i>	22.2	0.0
<i>Quercus rubra</i>	44.4	0.3
<i>Sassafras albidum</i>	44.4	0.7
<i>Ulmus americana</i>	55.6	0.8
TOTAL	1,122.2	22.7

Plot: 3031	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Nyssa sylvatica</i>	166.7	0.7
<i>Populus tremuloides</i>	44.4	0.5
<i>Prunus serotina</i>	22.2	0.2
<i>Quercus alba</i>	433.3	3.9
<i>Quercus velutina</i>	488.9	12.4
<i>Sassafras albidum</i>	200.0	1.0
TOTAL	1,355.6	18.6

Plot: 3033	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Fraxinus americana</i>	11.1	0.0
<i>Prunus serotina</i>	44.4	0.4
<i>Quercus alba</i>	77.8	6.2
<i>Quercus velutina</i>	211.1	16.9
<i>Sassafras albidum</i>	22.2	0.0
softwood		
<i>Picea glauca</i>	11.1	0.3
TOTAL	377.8	23.9

Plot: 3034	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer negundo</i>	55.6	0.8
<i>Acer rubrum</i>	222.2	8.7
<i>Ailanthus altissima</i>	177.8	2.3
<i>Fraxinus pennsylvanica</i>	22.2	0.0
<i>Prunus serotina</i>	155.6	3.1
<i>Quercus rubra</i>	33.3	2.4
<i>Quercus velutina</i>	44.4	4.2
<i>Robinia pseudoacacia</i>	88.9	7.6
<i>Sassafras albidum</i>	11.1	0.2
TOTAL	811.1	29.5

Plot: 3036	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Amelanchier arborea</i>	55.6	0.2
<i>Nyssa sylvatica</i>	88.9	0.6
<i>Prunus serotina</i>	22.2	0.1
<i>Quercus alba</i>	133.3	5.5
<i>Quercus velutina</i>	300.0	11.0
TOTAL	600.0	17.4

Plot: 3038	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	33.3	0.2
<i>Quercus velutina</i>	377.8	15.4
<i>Sassafras albidum</i>	33.3	0.4
<i>Tilia americana</i>	11.1	0.2
TOTAL	455.6	16.2

Plot: 3039	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	33.3	0.4
<i>Acer saccharinum</i>	11.1	0.0
<i>Acer saccharum</i>	188.9	12.6
<i>Asimina triloba</i>	11.1	0.0
<i>Carya cordiformis</i>	33.3	1.2
<i>Crataegus sp.</i>	122.2	0.3
<i>Fagus grandifolia</i>	55.6	0.8
<i>Fraxinus pennsylvanica</i>	33.3	2.9
<i>Prunus serotina</i>	22.2	0.2
<i>Quercus rubra</i>	11.1	2.0
<i>Ulmus americana</i>	66.7	0.5
<i>Ulmus rubra</i>	44.4	0.2
<i>Ulmus sp.</i>	11.1	0.2
TOTAL	644.4	21.3

Plot: 3041	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer saccharinum</i>	66.7	3.5
<i>Fraxinus pennsylvanica</i>	11.1	0.0
<i>Populus deltoides ssp. monilifera</i>	266.7	2.6
TOTAL	344.4	6.1

Plot: 3042	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	600.0	6.5
<i>Carya cordiformis</i>	66.7	0.1
<i>Cornus florida</i>	33.3	0.0
<i>Liriodendron tulipifera</i>	11.1	0.8
<i>Prunus serotina</i>	144.4	1.3
<i>Quercus alba</i>	44.4	0.1
<i>Quercus rubra</i>	122.2	2.5
<i>Sassafras albidum</i>	466.7	7.3
TOTAL	1,488.9	18.5

Plot: 3044	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus virginiana</i>	33.3	0.0
<i>Quercus alba</i>	33.3	0.0
<i>Quercus velutina</i>	1477.8	15.4
<i>Sassafras albidum</i>	33.3	0.0
TOTAL	1,577.8	15.5

Plot: 3047	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Morus alba</i>	11.1	0.0
<i>Nyssa sylvatica</i>	66.7	0.6
<i>Prunus serotina</i>	266.7	2.8
<i>Quercus alba</i>	211.1	7.0
<i>Quercus velutina</i>	155.6	14.6
<i>Sassafras albidum</i>	77.8	0.2
TOTAL	788.9	25.2

Plot: 3049	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	211.1	2.9
<i>Acer saccharum</i>	144.4	0.8
<i>Carya ovata</i>	77.8	1.5
<i>Cornus florida</i>	66.7	0.2
<i>Crataegus sp.</i>	22.2	0.0
<i>Fagus grandifolia</i>	33.3	0.0
<i>Fraxinus sp.</i>	11.1	0.2
<i>Prunus serotina</i>	166.7	1.6
<i>Prunus virginiana</i>	11.1	0.1
<i>Quercus rubra</i>	211.1	43.5
<i>Tilia americana</i>	44.4	0.2
<i>Ulmus americana</i>	11.1	0.0
TOTAL	1,011.1	51.0

Plot: 3050	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	188.9	4.0
<i>Carya ovata</i>	11.1	0.0
<i>Fraxinus pennsylvanica</i>	444.4	7.4
<i>Nyssa sylvatica</i>	166.7	2.1
<i>Quercus bicolor</i>	66.7	4.9
<i>Quercus palustris</i>	177.8	10.7
<i>Ulmus americana</i>	66.7	0.7
TOTAL	1,122.2	29.9

Plot: 3051	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	11.1	0.2
<i>Quercus alba</i>	111.1	2.0
<i>Quercus velutina</i>	233.3	15.6
<i>Sassafras albidum</i>	133.3	2.0
softwood		
<i>Pinus strobus</i>	44.4	1.2
TOTAL	533.3	21.0

Plot: 3053	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	1.2
<i>Amelanchier arborea</i>	33.3	0.1
<i>Prunus serotina</i>	22.2	0.5
<i>Quercus alba</i>	66.7	1.8
<i>Quercus velutina</i>	511.1	12.3
<i>Sassafras albidum</i>	188.9	1.4
TOTAL	844.4	17.3

Plot: 3059	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Fraxinus pennsylvanica</i>	22.2	0.0
<i>Nyssa sylvatica</i>	177.8	1.0
<i>Prunus serotina</i>	733.3	3.0
<i>Quercus alba</i>	22.2	0.2
<i>Quercus velutina</i>	166.7	15.7
TOTAL	1,122.2	19.9

Plot: 3064	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Carya ovata</i>	233.3	5.5
<i>Prunus serotina</i>	44.4	0.5
<i>Quercus alba</i>	177.8	27.5
<i>Quercus rubra</i>	77.8	0.6
<i>Tilia americana</i>	11.1	0.0
<i>Ulmus americana</i>	144.4	1.5
TOTAL	688.9	35.7

Plot: 3065	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	33.3	0.4
<i>Crataegus sp.</i>	33.3	0.1
<i>Fraxinus pennsylvanica</i>	88.9	1.9
<i>Morus alba</i>	11.1	0.1
<i>Prunus serotina</i>	211.1	1.4
<i>Prunus virginiana</i>	44.4	0.1
<i>Quercus velutina</i>	133.3	18.5
<i>Robinia pseudoacacia</i>	11.1	0.0
<i>Sassafras albidum</i>	55.6	1.3
softwood		
<i>Picea glauca</i>	11.1	0.3
TOTAL	633.3	24.1

Plot: 3069	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	344.4	11.3
<i>Fraxinus pennsylvanica</i>	44.4	2.3
<i>Liriodendron tulipifera</i>	55.6	20.7
<i>Nyssa sylvatica</i>	22.2	0.1
<i>Prunus serotina</i>	66.7	1.1
<i>Sassafras albidum</i>	133.3	1.6
<i>Ulmus americana</i>	22.2	0.1
TOTAL	688.9	37.2

Plot: 3074	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	122.2	4.1
<i>Acer saccharum</i>	211.1	0.9
<i>Carya ovata</i>	88.9	3.8
<i>Crataegus sp.</i>	55.6	0.0
<i>Fagus grandifolia</i>	11.1	0.0
<i>Fraxinus pennsylvanica</i>	44.4	0.1
<i>Populus deltoides ssp. monilifera</i>	11.1	1.7
<i>Prunus virginiana</i>	11.1	0.0
<i>Quercus alba</i>	44.4	7.7
<i>Quercus rubra</i>	155.6	8.9
<i>Sassafras albidum</i>	11.1	0.1
<i>Ulmus rubra</i>	44.4	0.6
TOTAL	811.1	28.0

Plot: 3078	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	33.3	0.3
<i>Carpinus caroliniana</i>	233.3	0.6
<i>Nyssa sylvatica</i>	177.8	1.8
<i>Prunus serotina</i>	11.1	0.1
<i>Quercus alba</i>	44.4	6.5
<i>Quercus palustris</i>	11.1	1.1
<i>Quercus velutina</i>	133.3	15.3
TOTAL	644.4	25.7

Plot: 3082	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	44.4	0.1
<i>Quercus alba</i>	100.0	1.4
<i>Quercus velutina</i>	722.2	19.1
<i>Sassafras albidum</i>	111.1	1.2
TOTAL	977.8	21.7

Plot: 3084	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Catalpa speciosa</i>	33.3	0.4
<i>Populus deltoides ssp. monilifera</i>	22.2	1.1
<i>Populus tremuloides</i>	11.1	0.0
<i>Quercus velutina</i>	166.7	23.7
<i>Salix sp.</i>	11.1	0.1
<i>Sassafras albidum</i>	33.3	0.0
TOTAL	277.8	25.4

Plot: 3085	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	211.1	31.8
<i>Acer saccharum</i>	255.6	12.5
<i>Carpinus caroliniana</i>	33.3	0.1
<i>Carya ovata</i>	22.2	1.0
<i>Fraxinus pennsylvanica</i>	11.1	0.2
<i>Populus deltoides ssp. monilifera</i>	22.2	5.4
<i>Populus grandidentata</i>	11.1	1.3
<i>Prunus serotina</i>	11.1	0.7
<i>Ulmus americana</i>	211.1	1.7
TOTAL	788.9	54.6

Plot: 3090	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	77.8	0.2
<i>Acer saccharum</i>	944.4	20.4
<i>Carpinus caroliniana</i>	22.2	0.1
<i>Carya cordiformis</i>	11.1	3.8
<i>Fagus grandifolia</i>	11.1	0.0
<i>Fraxinus pennsylvanica</i>	11.1	0.1
<i>Liriodendron tulipifera</i>	66.7	12.1
<i>Ostrya virginiana</i>	55.6	0.3
<i>Prunus serotina</i>	11.1	1.1
<i>Ulmus americana</i>	33.3	0.1
TOTAL	1,244.4	38.1

Plot: 3092	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	222.2	6.1
<i>Carya ovata</i>	122.2	1.5
<i>Crataegus sp.</i>	44.4	0.6
<i>Prunus serotina</i>	111.1	3.9
<i>Quercus alba</i>	66.7	1.2
<i>Quercus palustris</i>	11.1	0.2
<i>Quercus velutina</i>	22.2	0.9
<i>Robinia pseudoacacia</i>	11.1	0.5
<i>Sassafras albidum</i>	44.4	0.2
<i>Ulmus americana</i>	222.2	4.0
TOTAL	877.8	19.1

Plot: 3093	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus alba</i>	33.3	0.3
<i>Quercus velutina</i>	411.1	19.9
TOTAL	444.4	20.2

Plot: 3095	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus alba</i>	11.1	0.0
<i>Quercus velutina</i>	411.1	20.1
TOTAL	422.2	20.1

Plot: 3096	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Nyssa sylvatica</i>	66.7	1.2
<i>Prunus serotina</i>	33.3	1.2
<i>Quercus alba</i>	88.9	1.5
<i>Quercus velutina</i>	111.1	11.2
<i>Sassafras albidum</i>	11.1	0.2
TOTAL	311.1	15.3

Plot: 3102	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	44.4	2.4
<i>Acer saccharinum</i>	11.1	0.4
<i>Fraxinus pennsylvanica</i>	433.3	3.4
<i>Liriodendron tulipifera</i>	33.3	2.8
<i>Nyssa sylvatica</i>	11.1	0.8
<i>Prunus serotina</i>	55.6	0.7
<i>Quercus alba</i>	11.1	0.0
<i>Quercus rubra</i>	11.1	0.1
<i>Salix sp.</i>	33.3	1.3
<i>Ulmus americana</i>	33.3	0.2
softwood		
<i>Pinus strobus</i>	44.4	3.0
TOTAL	722.2	15.1

Plot: 3103	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	144.4	2.9
<i>Fraxinus pennsylvanica</i>	44.4	0.1
<i>Nyssa sylvatica</i>	22.2	0.1
<i>Prunus serotina</i>	100.0	1.6
<i>Quercus alba</i>	155.6	11.4
<i>Quercus velutina</i>	111.1	11.6
<i>Sassafras albidum</i>	311.1	6.0
TOTAL	888.9	33.7

Plot: 3104	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	11.1	0.0
<i>Quercus alba</i>	22.2	0.4
<i>Quercus velutina</i>	244.4	20.4
<i>Sassafras albidum</i>	188.9	1.3
TOTAL	466.7	22.2

Plot: 3105	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	111.1	1.4
<i>Quercus alba</i>	77.8	8.6
<i>Quercus velutina</i>	233.3	9.1
<i>Sassafras albidum</i>	188.9	0.5
<i>Ulmus americana</i>	11.1	0.1
TOTAL	622.2	19.7

Plot: 3106	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus alba</i>	55.6	1.0
<i>Quercus velutina</i>	411.1	19.2
<i>Sassafras albidum</i>	22.2	0.3
TOTAL	488.9	20.5

Density and Basal Area of Tree Species (Dead trees)

Plot: 3003	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	22.2	0.0
<i>Quercus velutina</i>	11.1	0.0
<i>Sassafras albidum</i>	44.4	0.1
<i>unknown tree - hardwood</i>	133.3	1.5
TOTAL	211.1	1.7

Plot: 3009	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>unknown tree - hardwood</i>	44.4	0.8
TOTAL	44.4	0.8

Plot: 3011	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	11.1	0.0
TOTAL	11.1	0.0

Plot: 3012	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Cornus florida</i>	55.6	0.2
<i>Fraxinus pennsylvanica</i>	11.1	0.2
<i>Quercus velutina</i>	55.6	4.7
<i>Sassafras albidum</i>	133.3	0.2
<i>unknown tree - hardwood</i>	122.2	1.5
TOTAL	377.8	6.8

Plot: 3013	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.2
<i>Quercus alba</i>	66.7	0.4
<i>Quercus velutina</i>	33.3	0.3
<i>Sassafras albidum</i>	1222.2	3.9
<i>unknown tree - hardwood</i>	166.7	0.7
TOTAL	1,511.1	5.5

Plot: 3014	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	22.2	0.1
<i>Quercus velutina</i>	44.4	0.2
<i>Sassafras albidum</i>	22.2	0.1
<i>unknown tree - hardwood</i>	55.6	0.7
TOTAL	144.4	1.1

Plot: 3015	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Nyssa sylvatica</i>	22.2	0.0
<i>Populus grandidentata</i>	22.2	0.4
<i>Prunus serotina</i>	111.1	0.7
<i>Quercus velutina</i>	44.4	6.3
<i>Sassafras albidum</i>	666.7	1.0
<i>unknown tree - hardwood</i>	155.6	0.5
TOTAL	1,022.2	8.8

Plot: 3017	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.1
<i>Prunus serotina</i>	11.1	0.1
<i>Sassafras albidum</i>	11.1	0.0
<i>unknown tree - hardwood</i>	155.6	0.4
TOTAL	200.0	0.6

Plot: 3018	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	100.0	0.5
<i>Sassafras albidum</i>	11.1	0.1
TOTAL	111.1	0.6

Plot: 3019	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.7
<i>Liriodendron tulipifera</i>	22.2	2.0
<i>Prunus serotina</i>	22.2	1.0
<i>unknown tree - hardwood</i>	88.9	0.5
TOTAL	155.6	4.2

Plot: 3021	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	11.1	0.0
<i>unknown tree - hardwood</i>	11.1	1.1
TOTAL	22.2	1.2

Plot: 3022	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Betula alleghaniensis</i>	22.2	0.3
<i>Quercus velutina</i>	11.1	0.2
<i>Sassafras albidum</i>	66.7	0.5
<i>unknown tree - hardwood</i>	66.7	0.4
TOTAL	166.7	1.4

Plot: 3023	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.1
<i>Fraxinus pennsylvanica</i>	77.8	0.2
<i>Ulmus americana</i>	11.1	0.0
<i>unknown tree - hardwood</i>	177.8	0.2
TOTAL	288.9	0.5

Plot: 3026	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer saccharinum</i>	11.1	0.0
<i>Robinia pseudoacacia</i>	55.6	0.6
<i>Ulmus americana</i>	66.7	4.8
<i>unknown tree - hardwood</i>	144.4	1.9
TOTAL	277.8	7.4

Plot: 3028	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	44.4	3.4
TOTAL	44.4	3.4

Plot: 3029	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	88.9	0.8
<i>Quercus velutina</i>	22.2	0.0
<i>Robinia pseudoacacia</i>	100.0	1.0
<i>Sassafras albidum</i>	88.9	0.7
<i>unknown tree - hardwood</i>	1100.0	5.3
TOTAL	1,400.0	7.7

Plot: 3030	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer saccharinum</i>	33.3	0.1
<i>Nyssa sylvatica</i>	44.4	0.4
<i>Prunus serotina</i>	155.6	4.2
<i>Sassafras albidum</i>	11.1	0.1
<i>unknown tree - hardwood</i>	111.1	2.5
TOTAL	355.6	7.3

Plot: 3031	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Populus grandidentata</i>	11.1	0.1
<i>Populus tremuloides</i>	33.3	0.3
<i>Quercus alba</i>	122.2	0.3
<i>Quercus velutina</i>	222.2	0.8
<i>Sassafras albidum</i>	188.9	0.4
<i>unknown tree - hardwood</i>	44.4	0.1
TOTAL	622.2	1.9

Plot: 3033	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	11.1	0.1
<i>Quercus alba</i>	22.2	0.2
<i>Sassafras albidum</i>	77.8	0.2
<i>unknown tree - hardwood</i>	44.4	0.1
TOTAL	155.6	0.5

Plot: 3034	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	11.1	0.1
<i>Prunus serotina</i>	55.6	0.5
<i>Quercus rubra</i>	11.1	0.1
<i>Robinia pseudoacacia</i>	122.2	2.8
<i>unknown tree - hardwood</i>	22.2	0.2
TOTAL	222.2	3.6

Plot: 3036	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.2
<i>Nyssa sylvatica</i>	11.1	0.1
<i>Prunus serotina</i>	33.3	0.3
<i>Quercus alba</i>	22.2	2.5
<i>Quercus velutina</i>	133.3	3.6
<i>unknown tree - hardwood</i>	155.6	5.1
TOTAL	377.8	11.7

Plot: 3038	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus alba</i>	11.1	0.1
<i>Quercus velutina</i>	66.7	1.3
<i>unknown tree - hardwood</i>	66.7	2.8
TOTAL	144.4	4.2

Plot: 3039	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Ulmus sp.</i>	22.2	0.3
<i>unknown tree - hardwood</i>	66.7	4.0
TOTAL	88.9	4.2

Plot: 3041	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Populus deltoides ssp. monilifera</i>	11.1	0.0
<i>unknown tree - hardwood</i>	22.2	1.3
TOTAL	33.3	1.3

Plot: 3042	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	11.1	0.0
<i>Prunus serotina</i>	11.1	0.0
<i>Quercus sp.</i>	22.2	0.0
<i>Sassafras albidum</i>	622.2	7.6
<i>unknown tree - hardwood</i>	266.7	5.2
TOTAL	933.3	12.8

Plot: 3044	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	444.4	0.4
<i>Sassafras albidum</i>	22.2	0.0
TOTAL	466.7	0.4

Plot: 3047	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	22.2	0.0
<i>Quercus alba</i>	11.1	0.0
<i>Quercus velutina</i>	22.2	2.4
TOTAL	55.6	2.4

Plot: 3049	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.2
<i>Prunus serotina</i>	11.1	0.0
<i>Quercus rubra</i>	11.1	3.4
<i>unknown tree - hardwood</i>	144.4	0.4
TOTAL	188.9	4.0

Plot: 3050	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.4
<i>Fraxinus pennsylvanica</i>	255.6	2.1
<i>Ulmus americana</i>	11.1	0.2
<i>unknown tree - hardwood</i>	55.6	1.5
TOTAL	344.4	4.3

Plot: 3051	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	11.1	0.2
<i>Quercus alba</i>	11.1	0.0
<i>Quercus velutina</i>	33.3	1.1
<i>Sassafras albidum</i>	377.8	2.0
<i>unknown tree - hardwood</i>	200.0	0.6
TOTAL	633.3	4.1

Plot: 3053	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	11.1	0.0
<i>Quercus velutina</i>	133.3	0.5
<i>Sassafras albidum</i>	255.6	0.5
<i>unknown tree - hardwood</i>	22.2	0.1
TOTAL	422.2	1.1

Plot: 3059	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	88.9	1.9
<i>unknown tree - hardwood</i>	55.6	4.7
TOTAL	144.4	6.6

Plot: 3064	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Ulmus americana</i>	22.2	0.2
<i>unknown tree - hardwood</i>	133.3	2.0
TOTAL	155.6	2.2

Plot: 3065	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Crataegus sp.</i>	11.1	0.0
<i>Fraxinus pennsylvanica</i>	44.4	1.3
<i>Morus alba</i>	33.3	2.5
<i>Prunus serotina</i>	22.2	0.0
<i>Quercus velutina</i>	11.1	0.2
<i>Sassafras albidum</i>	11.1	0.2
<i>unknown tree - hardwood</i>	22.2	0.0
softwood		
<i>Pinus strobus</i>	11.1	0.7
TOTAL	166.7	4.9

Plot: 3069	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.7
<i>Liriodendron tulipifera</i>	11.1	0.6
<i>Prunus serotina</i>	55.6	3.1
<i>Sassafras albidum</i>	122.2	1.4
<i>unknown tree - hardwood</i>	88.9	1.3
TOTAL	300.0	7.1

Plot: 3074	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Crataegus sp.</i>	144.4	0.1
<i>Quercus rubra</i>	11.1	0.2
<i>unknown tree - hardwood</i>	322.2	1.6
TOTAL	477.8	1.9

Plot: 3078	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	22.2	0.1
<i>Quercus alba</i>	11.1	0.1
<i>Quercus velutina</i>	11.1	0.5
<i>unknown tree - hardwood</i>	22.2	0.0
TOTAL	66.7	0.7

Plot: 3082	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	66.7	0.2
<i>Quercus alba</i>	77.8	0.3
<i>Quercus velutina</i>	300.0	1.7
<i>Sassafras albidum</i>	400.0	2.1
<i>unknown tree - hardwood</i>	144.4	0.3
TOTAL	988.9	4.5

Plot: 3084	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	11.1	0.5
<i>Sassafras albidum</i>	155.6	0.1
<i>unknown tree - hardwood</i>	11.1	0.1
TOTAL	177.8	0.8

Plot: 3085	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	22.2	0.4
<i>Ulmus americana</i>	11.1	0.0
TOTAL	33.3	0.4

Plot: 3090	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer saccharum</i>	11.1	0.1
<i>unknown tree - hardwood</i>	33.3	1.5
TOTAL	44.4	1.5

Plot: 3092	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Acer rubrum</i>	55.6	0.5
<i>Crataegus sp.</i>	22.2	0.1
<i>Prunus serotina</i>	33.3	0.4
<i>Sassafras albidum</i>	44.4	0.2
<i>Ulmus americana</i>	55.6	0.6
<i>unknown tree - hardwood</i>	188.9	4.1
TOTAL	400.0	6.0

Plot: 3093	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Prunus serotina</i>	33.3	0.1
<i>Quercus alba</i>	22.2	0.2
<i>Quercus velutina</i>	266.7	4.1
<i>Sassafras albidum</i>	11.1	0.0
TOTAL	333.3	4.4

Plot: 3095	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	100.0	3.6
<i>Sassafras albidum</i>	77.8	0.1
TOTAL	177.8	3.7

Plot: 3096	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus alba</i>	44.4	0.2
<i>Quercus velutina</i>	22.2	2.5
<i>Sassafras albidum</i>	11.1	0.1
TOTAL	77.8	2.8

Plot: 3102	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Fraxinus pennsylvanica</i>	33.3	1.3
<i>Prunus serotina</i>	211.1	3.5
<i>unknown tree - hardwood</i>	188.9	1.1
softwood		
<i>Pinus strobus</i>	33.3	1.1
TOTAL	466.7	7.0

Plot: 3103	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	33.3	1.5
<i>Sassafras albidum</i>	77.8	1.0
<i>unknown tree - hardwood</i>	77.8	3.4
TOTAL	188.9	5.9

Plot: 3104	Density (individuals / ha)	Basal Area (m ² / ha)
Species		
hardwood		
<i>Quercus velutina</i>	11.1	0.0
<i>unknown tree - hardwood</i>	11.1	0.1
TOTAL	22.2	0.1

Plot: 3105		
Species	Density (individuals / ha)	Basal Area (m ² / ha)
hardwood		
<i>Prunus americana</i>	11.1	0.1
<i>Prunus serotina</i>	11.1	0.0
<i>Quercus velutina</i>	33.3	0.1
<i>Sassafras albidum</i>	11.1	0.0
<i>unknown tree - hardwood</i>	55.6	2.5
TOTAL	122.2	2.7

Plot: 3106		
Species	Density (individuals / ha)	Basal Area (m ² / ha)
hardwood		
<i>Quercus alba</i>	11.1	0.0
<i>Quercus velutina</i>	144.4	1.8
<i>Sassafras albidum</i>	122.2	0.5
<i>unknown tree - hardwood</i>	11.1	0.0
TOTAL	288.9	2.3

Frequency of Species in Groundlayer Quadrats

Plot: 3003

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.0	0.2	0.07
Alliaria petiolata	0.0	0.1	0.0	0.03
Amelanchier Group 2 sp.	0.0	0.0	0.2	0.07
Amphicarpaea bracteata	0.1	0.3	0.0	0.13
Aralia nudicaulis	0.0	0.0	0.1	0.03
Asclepias syriaca	0.0	0.0	0.1	0.03
Berberis thunbergii	0.0	0.3	0.0	0.10
Boehmeria cylindrica	0.0	0.4	0.0	0.13
Carex sp.	0.2	0.1	0.5	0.27
Celastrus sp.	0.8	0.7	0.1	0.53
Circaea canadensis ssp. canadensis	0.0	0.2	0.1	0.10
Convallaria majalis	0.4	0.0	0.0	0.13
Desmodium paniculatum	0.1	0.0	0.1	0.07
Dichanthelium sp.	0.1	0.0	0.1	0.07
Equisetum arvense	0.2	0.0	0.0	0.07
Euonymus atropurpureus	0.0	0.1	0.0	0.03
Fraxinus americana	0.3	0.0	0.1	0.13
Galium pilosum	0.0	0.1	0.1	0.07
Geum canadense	0.3	0.0	0.0	0.10
Hamamelis virginiana	0.0	0.1	0.4	0.17
Helianthus divaricatus	0.0	0.1	0.0	0.03
Iridaceae fam.	0.1	0.0	0.0	0.03
Juncus tenuis	0.1	0.0	0.0	0.03
Lonicera (exotic) sp.	0.3	0.0	0.0	0.10
Maianthemum racemosum ssp. racemosum	0.2	0.1	0.0	0.10
Medicago lupulina	0.0	0.1	0.0	0.03
Osmorhiza sp.	0.0	0.0	0.1	0.03
Oxalis sp.	0.0	0.1	0.1	0.07
Parthenocissus sp.	0.5	0.5	0.2	0.40
Poa sp.	0.0	0.3	0.0	0.10
Poaceae fam.	0.4	0.3	0.1	0.27
Polygonatum pubescens	0.1	0.0	0.2	0.10
Populus tremuloides	0.1	0.0	0.0	0.03
Prunus serotina	0.2	0.1	0.0	0.10
Pteridium aquilinum ssp. latiusculum	0.2	0.0	0.6	0.27
Quercus alba	0.2	0.5	0.0	0.23
Quercus velutina	0.3	0.0	0.1	0.13
Rhamnus cathartica	0.0	0.0	0.1	0.03
Rubus flagellaris	0.0	0.2	0.1	0.10
Sassafras albidum	0.1	0.0	0.4	0.17
Smilax rotundifolia	0.0	0.2	0.2	0.13
Solidago sp.	0.4	0.3	0.1	0.27
Taraxacum officinale	0.0	0.2	0.1	0.10
Toxicodendron sp.	0.2	0.3	0.0	0.17
Trifolium sp.	0.0	0.2	0.0	0.07
Vaccinium angustifolium	0.0	0.2	0.6	0.27
Vinca minor	0.7	0.0	0.0	0.23
Viola sp.	0.1	0.0	0.0	0.03
Vitis riparia	0.2	0.3	0.0	0.17

Plot: 3009

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Agrimonia parviflora	0.0	0.1	0.0	0.03
Agrimonia sp.	0.1	0.0	0.0	0.03
Alliaria petiolata	0.1	0.0	0.0	0.03
Alnus incana ssp. rugosa	0.1	0.0	0.0	0.03
Apocynum androsaemifolium	0.0	0.4	0.0	0.13
Athyrium filix-femina var. angustum	0.0	0.0	0.1	0.03
Caltha palustris	0.1	0.0	0.1	0.07
Carex normalis	0.1	0.0	0.0	0.03
Carex sp.	0.1	0.0	0.0	0.03
Circaea canadensis ssp. canadensis	0.2	0.3	0.0	0.17
Clematis virginiana	0.1	0.2	0.4	0.23
Cornus racemosa	0.2	0.2	0.2	0.20
Dichanthelium latifolium	0.0	0.0	0.1	0.03
Doellingeria umbellata var. umbellata	0.0	0.1	0.0	0.03
Dryopteris carthusiana	0.0	0.0	0.1	0.03
Eutrochium maculatum	0.0	0.1	0.1	0.07
Fraxinus nigra	0.0	0.1	0.0	0.03
Fraxinus pennsylvanica	0.0	0.2	0.0	0.07
Galium aparine	0.1	0.0	0.0	0.03
Geum canadense	1	0.3	0.7	0.67
Glyceria striata	0.4	0.0	0.0	0.13
Ilex verticillata	0.2	0.0	0.0	0.07
Impatiens capensis	0.6	0.0	0.6	0.40
Impatiens sp.	0.0	0.9	0.0	0.30
Juncus effusus	0.0	0.1	0.0	0.03
Juncus sp.	0.1	0.1	0.0	0.07
Lindera benzoin	0.6	0.2	0.3	0.37
Lonicera (exotic) sp.	0.0	0.0	0.1	0.03
Matteuccia struthiopteris	0.0	0.0	0.1	0.03
Onoclea sensibilis	0.3	0.4	0.4	0.37
Parthenocissus sp.	0.1	0.3	0.1	0.17
Persicaria sagittata	0.0	0.3	0.1	0.13
Persicaria sp.	0.0	0.1	0.0	0.03
Persicaria virginiana	0.1	0.0	0.0	0.03
Phalaris arundinacea	0.2	0.0	0.0	0.07
Poa compressa	0.0	0.0	0.1	0.03
Poa palustris	0.2	0.0	0.0	0.07
Poa pratensis	0.0	0.1	0.1	0.07
Poa sp.	0.0	0.3	0.2	0.17
Populus deltoides ssp. monilifera	0.0	0.1	0.0	0.03
Potentilla simplex	0.0	0.0	0.5	0.17
Ribes americanum	0.1	0.0	0.0	0.03
Rosa multiflora	0.4	0.1	0.5	0.33
Rubus allegheniensis	0.1	0.2	0.8	0.37
Rubus hispidus	0.1	0.0	0.2	0.10
Rubus occidentalis	0.0	0.1	0.0	0.03
Rubus pensilvanicus	0.0	0.0	0.2	0.07
Rubus sachalinensis var. sachalinensis	0.1	0.0	0.3	0.13
Salix sp.	0.0	0.0	0.1	0.03
Solanum dulcamara	0.0	0.0	0.2	0.07
Solidago sp.	0.5	0.5	0.9	0.63
Stachys tenuifolia	0.0	0.3	0.0	0.10

Plot: 3009

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Symphyotrichum sp.	0.0	0.3	0.0	0.10
Toxicodendron sp.	0.0	0.1	0.0	0.03
Ulmus americana	0.2	0.0	0.0	0.07
Viburnum lentago	0.2	0.0	0.0	0.07
Viburnum opulus var. americanum	0.1	0.0	0.0	0.03
Viburnum recognitum	0.2	0.0	0.2	0.13
Vitis aestivalis	0.2	0.0	0.3	0.17

Plot: 3011

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Achillea millefolium	0.1	0.0	0.1	0.07
Anemone virginiana	0.2	0.0	0.0	0.07
Antennaria plantaginifolia	0.2	0.0	0.0	0.07
Apocynum androsaemifolium	0.0	0.0	0.1	0.03
Asclepias syriaca	0.3	0.1	0.2	0.20
Asclepias verticillata	0.0	0.0	0.1	0.03
Asparagus officinalis	0.0	0.1	0.0	0.03
Asteraceae fam.	0.1	0.2	0.1	0.13
Carex sp.	0.0	0.0	0.1	0.03
Celastrus sp.	0.0	0.0	0.2	0.07
Circaea canadensis ssp. canadensis	0.0	0.0	0.2	0.07
Comandra umbellata	0.1	0.0	0.0	0.03
Coreopsis tripteris	0.2	0.0	0.0	0.07
Dichanthelium depauperatum	0.0	0.1	0.0	0.03
Dichanthelium sp.	0.2	0.0	0.0	0.07
Euphorbia corollata	0.3	0.0	0.0	0.10
Fragaria virginiana	0.8	0.4	0.3	0.50
Galium pilosum	0.4	0.7	0.5	0.53
Helianthus divaricatus	0.9	0.6	1	0.83
Hieracium sp.	0.1	0.0	0.0	0.03
Ionactis linariifolia	0.4	0.5	0.3	0.40
Koeleria macrantha	0.4	0.2	0.0	0.20
Lamiaceae fam.	0.1	0.0	0.0	0.03
Liatris sp.	0.0	0.1	0.0	0.03
Lithospermum canescens	0.3	0.0	0.0	0.10
Lonicera (exotic) sp.	0.0	0.0	0.2	0.07
Lupinus perennis	0.3	0.0	0.0	0.10
Maianthemum canadense	0.3	0.0	0.0	0.10
Maianthemum racemosum ssp. racemosum	0.0	0.1	0.0	0.03
Maianthemum stellatum	0.3	0.6	0.1	0.33
Monarda fistulosa	0.2	0.0	0.4	0.20
Parthenocissus sp.	0.0	0.0	0.1	0.03
Phlox pilosa	0.7	0.0	0.0	0.23
Poa compressa	0.4	0.0	0.0	0.13
Poaceae fam.	0.4	0.8	0.7	0.63
Potentilla simplex	0.0	0.0	0.6	0.20
Prunus serotina	0.1	0.1	0.4	0.20
Pteridium aquilinum ssp. latiusculum	0.0	0.0	0.4	0.13
Quercus alba	0.1	0.1	0.0	0.07
Quercus velutina	0.6	0.7	0.9	0.73
Rosa carolina	0.9	0.1	0.0	0.33
Rubus flagellaris	0.5	0.3	0.9	0.57
Rubus occidentalis	0.0	0.3	0.1	0.13
Rubus sachalinensis var. sachalinensis	0.5	0.0	0.0	0.17
Sassafras albidum	0.1	0.9	0.7	0.57
Schizachyrium scoparium	0.6	0.1	0.0	0.23
Solidago sp.	0.1	0.6	0.4	0.37
Symphyotrichum oolentangiense	0.1	0.1	0.0	0.07
Tradescantia ohiensis	0.1	0.1	0.0	0.07
Tradescantia virginiana	0.2	0.2	0.2	0.20
Vaccinium angustifolium	0.5	0.0	0.0	0.17
Vaccinium pallidum	0.9	0.0	0.0	0.30

Plot: 3012

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.1	0.0	0.0	0.03
Amelanchier Group 2 sp.	0.0	0.0	0.1	0.03
Aquilegia canadensis	0.1	0.0	0.0	0.03
Aralia nudicaulis	0.6	0.5	0.0	0.37
Boehmeria cylindrica	0.0	0.1	0.0	0.03
Carex sp.	0.5	0.5	0.9	0.63
Celastrus sp.	0.1	0.1	0.1	0.10
Dichanthelium latifolium	0.6	0.5	0.2	0.43
Diervilla lonicera	0.0	0.0	0.1	0.03
Fraxinus pennsylvanica	0.1	0.2	0.0	0.10
Galium asprellum	0.0	0.1	0.0	0.03
Galium circaeans var. circaeans	0.3	0.2	0.1	0.20
Galium lanceolatum	0.1	0.0	0.0	0.03
Geum canadense	0.0	0.0	0.1	0.03
Hamamelis virginiana	0.4	0.1	0.5	0.33
Helianthus divaricatus	0.1	0.1	0.5	0.23
Lonicera (exotic) sp.	0.0	0.1	0.0	0.03
Maianthemum canadense	0.1	0.0	0.0	0.03
Maianthemum racemosum ssp. racemosum	0.2	0.0	0.0	0.07
Osmorhiza sp.	0.1	0.3	0.0	0.13
Parthenocissus sp.	0.4	0.4	0.3	0.37
Poaceae fam.	0.0	0.1	0.0	0.03
Polygonatum biflorum	0.1	0.1	0.0	0.07
Potentilla simplex	0.1	0.0	0.0	0.03
Prenanthes sp.	0.2	0.0	0.0	0.07
Prunus serotina	0.2	0.0	0.1	0.10
Quercus alba	0.1	0.0	0.0	0.03
Quercus velutina	0.2	0.2	0.0	0.13
Rubus allegheniensis	0.0	0.0	0.1	0.03
Rubus flagellaris	0.1	0.1	0.4	0.20
Rudbeckia hirta	0.0	0.0	0.1	0.03
Sanicula sp.	0.0	0.2	0.0	0.07
Sassafras albidum	0.5	0.4	0.7	0.53
Smilax ecirrhata	0.0	0.0	0.2	0.07
Smilax rotundifolia	0.1	0.0	0.0	0.03
Smilax tamnoides	0.0	0.0	0.1	0.03
Solidago sp.	0.8	0.6	0.4	0.60
Toxicodendron sp.	0.0	0.0	0.2	0.07
Vaccinium angustifolium	0.2	0.2	0.1	0.17
Verbascum thapsus	0.0	0.0	0.1	0.03
Viburnum acerifolium	0.3	0.0	0.1	0.13
Viola sp.	0.1	0.3	0.0	0.13
Vitis aestivalis	0.0	0.2	0.0	0.07
Vitis riparia	0.3	0.2	0.2	0.23

Plot: 3013

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.3	0.0	0.0	0.10
Amelanchier Group 2 sp.	0.2	0.1	0.0	0.10
Amphicarpaea bracteata	0.1	0.0	0.0	0.03
Carex sp.	0.5	0.3	0.0	0.27
Celastrus sp.	0.1	0.0	0.0	0.03
Cephalanthus occidentalis	0.3	0.0	0.1	0.13
Galium pilosum	0.0	0.0	0.1	0.03
Hamamelis virginiana	0.1	0.0	0.0	0.03
Helianthus divaricatus	0.1	0.0	0.0	0.03
Liriodendron tulipifera	0.1	0.1	0.0	0.07
Maianthemum canadense	0.1	0.0	0.0	0.03
Maianthemum racemosum ssp. racemosum	0.5	0.3	0.1	0.30
Parthenocissus sp.	0.3	0.0	0.0	0.10
Poa compressa	0.1	0.0	0.0	0.03
Poaceae fam.	0.0	0.1	0.0	0.03
Prunus serotina	0.3	0.2	0.1	0.20
Pteridium aquilinum ssp. latiusculum	0.8	0.6	0.6	0.67
Pyrola elliptica	0.1	0.0	0.0	0.03
Quercus alba	0.3	0.1	0.0	0.13
Quercus velutina	0.3	0.7	0.1	0.37
Rhus copallinum	0.0	0.2	0.1	0.10
Rosa blanda	0.0	0.1	0.0	0.03
Rubus allegheniensis	0.0	0.2	0.0	0.07
Rubus flagellaris	0.2	0.5	0.2	0.30
Rubus sachalinensis var. sachalinensis	0.1	0.0	0.0	0.03
Sassafras albidum	0.7	0.6	0.7	0.67
Smilax rotundifolia	0.1	0.0	0.0	0.03
Solidago sp.	0.5	0.0	0.0	0.17
Toxicodendron sp.	0.0	0.0	0.1	0.03
Vaccinium angustifolium	0.0	0.2	0.0	0.07

Plot: 3014

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.3	0.0	0.2	0.17
Amelanchier Group 2 sp.	0.3	0.4	0.2	0.30
Amphicarpaea bracteata	0.1	0.0	0.0	0.03
Carex digitalis	0.0	0.1	0.0	0.03
Carya ovata	0.0	0.1	0.0	0.03
Celastrus sp.	0.0	0.2	0.4	0.20
Circaea canadensis ssp. canadensis	0.0	0.4	0.0	0.13
Cornus florida	0.0	0.2	0.1	0.10
Cornus racemosa	0.5	0.6	0.0	0.37
Crataegus sp.	0.0	0.1	0.1	0.07
Euonymus atropurpureus	0.0	0.0	0.1	0.03
Euonymus sp.	0.1	0.0	0.0	0.03
Fraxinus pennsylvanica	0.1	0.2	0.3	0.20
Geum canadense	0.0	0.1	0.0	0.03
Hamamelis virginiana	0.0	0.2	0.0	0.07
Hieracium sp.	0.1	0.0	0.0	0.03
Lindera benzoin	0.0	0.0	0.3	0.10
Lonicera (exotic) sp.	0.1	0.1	0.0	0.07
Maianthemum racemosum ssp. racemosum	0.1	0.2	0.2	0.17
Parthenocissus sp.	0.6	0.5	0.5	0.53
Poa compressa	0.3	0.0	0.0	0.10
Poa pratensis	0.2	0.0	0.0	0.07
Polygonatum pubescens	0.0	0.1	0.0	0.03
Potentilla simplex	0.1	0.0	0.1	0.07
Prunus serotina	0.3	0.6	0.6	0.50
Pteridium aquilinum ssp. latiusculum	0.1	0.0	0.0	0.03
Quercus alba	0.1	0.0	0.0	0.03
Quercus velutina	0.2	0.0	0.1	0.10
Ranunculus sp.	0.0	0.1	0.0	0.03
Ribes hirtellum	0.0	0.2	0.0	0.07
Rosa blanda	0.1	0.0	0.0	0.03
Rosa multiflora	0.0	0.1	0.0	0.03
Rubus allegheniensis	0.3	0.1	0.0	0.13
Rubus flagellaris	0.0	0.2	0.1	0.10
Rubus occidentalis	0.0	0.1	0.0	0.03
Rubus pensilvanicus	0.7	0.0	0.5	0.40
Rumex acetosella	0.1	0.0	0.0	0.03
Sassafras albidum	0.2	0.3	0.2	0.23
Solidago sp.	0.0	0.0	0.1	0.03
Taraxacum officinale	0.1	0.0	0.0	0.03
Toxicodendron sp.	0.4	0.1	0.2	0.23
Viburnum opulus var. americanum	0.0	0.2	0.0	0.07
Vitis riparia	0.1	0.1	0.0	0.07

Plot: 3015

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Alliaria petiolata	0.0	0.1	0.1	0.07
Amphicarpaea bracteata	0.3	0.0	0.0	0.10
Aralia nudicaulis	0.3	0.0	0.1	0.13
Boehmeria cylindrica	0.2	0.0	0.0	0.07
Carex sp.	0.9	0.2	0.0	0.37
Celtis occidentalis	0.0	0.0	0.1	0.03
Circaea canadensis ssp. canadensis	0.2	0.7	0.8	0.57
Dichanthelium latifolium	0.0	0.1	0.0	0.03
Erechtites hieraciifolius	0.1	0.0	0.0	0.03
Fragaria virginiana	0.3	0.0	0.0	0.10
Galium circaezans var. circaezans	0.3	0.4	0.2	0.30
Galium triflorum	0.0	0.2	0.0	0.07
Gaylussacia baccata	0.1	0.1	0.0	0.07
Geum canadense	0.3	0.1	0.1	0.17
Geum sp.	0.1	0.0	0.0	0.03
Glechoma hederacea	0.0	0.5	0.0	0.17
Helianthus divaricatus	0.2	0.0	0.0	0.07
Laportea canadensis	0.3	0.5	0.1	0.30
Maianthemum canadense	0.1	0.0	0.0	0.03
Nyssa sylvatica	0.0	0.2	0.0	0.07
Osmorhiza sp.	0.0	0.1	0.0	0.03
Osmunda regalis var. spectabilis	0.0	0.2	0.0	0.07
Parthenocissus sp.	0.1	0.2	0.1	0.13
Phytolacca americana	0.0	0.5	0.5	0.33
Poaceae fam.	0.1	0.0	0.0	0.03
Polygonatum pubescens	0.1	0.0	0.0	0.03
Potentilla simplex	0.4	0.0	0.0	0.13
Pteridium aquilinum ssp. latiusculum	0.1	0.0	0.0	0.03
Rosa blanda	0.2	0.0	0.0	0.07
Rosa carolina	0.1	0.0	0.0	0.03
Rubus allegheniensis	0.1	0.0	0.1	0.07
Rubus flagellaris	0.7	0.3	0.1	0.37
Rubus hispidus	0.4	0.1	0.0	0.17
Rubus occidentalis	0.1	0.1	0.5	0.23
Rubus sachalinensis var. sachalinensis	0.0	0.0	0.1	0.03
Sanicula canadensis	0.0	0.1	0.0	0.03
Sassafras albidum	0.9	0.9	0.5	0.77
Solidago caesia	0.0	0.0	0.1	0.03
Solidago sp.	0.7	0.3	0.1	0.37
Toxicodendron sp.	0.1	0.0	0.1	0.07
Urtica dioica ssp. gracilis	0.0	0.1	0.2	0.10
Vaccinium angustifolium	1	0.1	0.0	0.37
Vaccinium pallidum	0.1	0.0	0.0	0.03
Verbena urticifolia	0.0	0.5	0.9	0.47
Vernonia missurica	0.1	0.0	0.0	0.03
Viola sp.	0.1	0.2	0.3	0.20

Plot: 3017

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.1	0.3	0.13
Apios americana	0.0	0.1	0.0	0.03
Asteraceae fam.	0.1	0.0	0.1	0.07
Carex folliculata	0.0	0.1	0.0	0.03
Carex intumescens	0.0	0.3	0.0	0.10
Carex swanii	0.0	0.0	0.3	0.10
Celastrus sp.	0.0	0.0	0.1	0.03
Circaea canadensis ssp. canadensis	0.0	0.0	0.6	0.20
Cornus racemosa	0.0	0.0	0.2	0.07
Fraxinus americana	0.5	0.2	0.9	0.53
Geum canadense	0.0	0.0	0.2	0.07
Lonicera (exotic) sp.	0.1	0.0	0.5	0.20
Ludwigia alternifolia	0.1	0.0	0.0	0.03
Maianthemum canadense	0.0	0.2	0.1	0.10
Onoclea sensibilis	0.1	0.1	0.0	0.07
Osmunda regalis var. spectabilis	0.0	0.1	0.0	0.03
Parthenocissus sp.	0.1	0.0	0.4	0.17
Persicaria virginiana	0.1	0.0	0.0	0.03
Poa compressa	0.0	0.0	0.2	0.07
Poaceae fam.	0.3	0.1	0.1	0.17
Populus tremuloides	0.1	0.0	0.1	0.07
Potentilla simplex	0.2	0.3	0.0	0.17
Prunus serotina	0.3	0.1	0.3	0.23
Prunus virginiana	0.0	0.0	0.1	0.03
Quercus alba	0.0	0.0	0.1	0.03
Quercus velutina	0.1	0.0	0.0	0.03
Rhamnus frangula	0.2	0.3	0.3	0.27
Rosa carolina	0.1	0.0	0.0	0.03
Rosa multiflora	0.1	0.2	0.2	0.17
Rubus flagellaris	0.0	0.1	0.5	0.20
Rubus hispidus	0.8	0.9	0.0	0.57
Rubus pubescens	0.0	0.0	0.1	0.03
Sassafras albidum	0.0	0.0	0.5	0.17
Solidago sp.	0.3	0.6	0.6	0.50
Toxicodendron sp.	0.0	0.0	0.2	0.07
Vaccinium pallidum	0.0	0.0	0.1	0.03
Viburnum acerifolium	0.0	0.0	0.1	0.03
Viburnum recognitum	0.5	0.3	0.2	0.33
Vitis aestivalis	0.1	0.0	0.0	0.03

Plot: 3018

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.0	0.1	0.03
Aronia melanocarpa	0.0	0.2	0.2	0.13
Calamovilfa longifolia var. magna	0.6	0.0	0.1	0.23
Carex sp.	1	1	0.9	0.97
Comandra umbellata	0.0	0.1	0.2	0.10
Conyza canadensis	0.1	0.0	0.0	0.03
Coreopsis tripteris	0.1	0.0	0.0	0.03
Cornus racemosa	0.0	0.1	0.0	0.03
Danthonia spicata	0.1	0.0	0.0	0.03
Dichanthelium sp.	0.0	0.1	0.0	0.03
Euphorbia corollata	0.0	0.1	0.1	0.07
Fragaria virginiana	0.0	0.0	0.2	0.07
Galium pilosum	0.0	0.1	0.0	0.03
Gaylussacia baccata	0.0	0.2	0.0	0.07
Helianthemum canadense	0.4	0.0	0.0	0.13
Helianthus divaricatus	0.3	0.4	0.4	0.37
Hieracium sp.	0.2	0.0	0.0	0.07
Liatis cylindracea	0.3	0.0	0.0	0.10
Maianthemum racemosum ssp. racemosum	0.0	0.0	0.2	0.07
Monarda sp.	0.0	0.0	0.1	0.03
Oenothera sp.	0.1	0.0	0.0	0.03
Osmunda regalis var. spectabilis	0.0	0.0	0.1	0.03
Poaceae fam.	0.0	0.1	0.3	0.13
Polygonatum biflorum	0.0	0.2	0.4	0.20
Prunus serotina	0.0	0.2	0.3	0.17
Quercus alba	0.0	0.5	0.0	0.17
Quercus velutina	0.3	0.1	0.3	0.23
Rosa carolina	0.0	0.0	0.3	0.10
Rubus allegheniensis	0.0	0.3	0.1	0.13
Rubus hispidus	0.0	0.4	0.2	0.20
Rubus pensilvanicus	0.0	0.2	0.0	0.07
Salix sp.	0.0	0.0	0.2	0.07
Sassafras albidum	0.4	0.0	0.3	0.23
Solidago sp.	0.1	0.0	0.1	0.07
Tephrosia virginiana	0.6	0.1	0.0	0.23
Vaccinium angustifolium	0.2	0.6	0.5	0.43
Vaccinium pallidum	0.0	0.9	0.5	0.47
Vitis riparia	0.0	0.0	0.1	0.03

Plot: 3019

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Alliaria petiolata	0.0	0.0	0.2	0.07
Alnus incana ssp. rugosa	0.1	0.0	0.0	0.03
Amelanchier Group 2 sp.	0.2	0.1	0.0	0.10
Amphicarpaea bracteata	0.0	0.0	0.2	0.07
Arisaema triphyllum	0.0	0.3	0.0	0.10
Athyrium filix-femina var. angustum	0.0	0.2	0.0	0.07
Brachyelytrum erectum	0.2	0.1	0.1	0.13
Carex comosa	0.1	0.0	0.0	0.03
Carex crinita	0.4	0.0	0.0	0.13
Carex folliculata	0.2	0.0	0.0	0.07
Carex scoparia	0.1	0.0	0.0	0.03
Carex sp.	0.7	0.3	0.3	0.43
Celastrus sp.	0.0	0.0	0.4	0.13
Chenopodium sp.	0.0	0.0	0.1	0.03
Circaea canadensis ssp. canadensis	0.1	0.0	0.7	0.27
Dulichium arundinaceum	0.1	0.0	0.0	0.03
Fraxinus nigra	0.3	0.3	0.4	0.33
Galium obtusum	0.1	0.0	0.0	0.03
Geum canadense	0.0	0.0	0.1	0.03
Glyceria striata	0.1	0.0	0.0	0.03
Hackelia virginiana	0.0	0.0	0.1	0.03
Hamamelis virginiana	0.0	0.2	0.2	0.13
Laportea canadensis	0.1	0.0	0.0	0.03
Leersia sp.	0.4	0.0	0.0	0.13
Lindera benzoin	0.2	0.7	0.5	0.47
Liriodendron tulipifera	0.3	0.0	0.0	0.10
Lycopus sp.	0.3	0.0	0.0	0.10
Maianthemum canadense	0.2	0.1	0.0	0.10
Maianthemum racemosum ssp. racemosum	0.0	0.2	0.0	0.07
Medeola virginiana	0.0	0.1	0.0	0.03
Nyssa sylvatica	0.4	0.0	0.0	0.13
Osmorhiza sp.	0.0	0.0	0.2	0.07
Osmunda regalis var. spectabilis	0.1	0.0	0.0	0.03
Osmundastrum cinnamomea	0.0	0.5	0.0	0.17
Oxalis sp.	0.0	0.0	0.1	0.03
Parthenocissus sp.	0.1	0.2	0.7	0.33
Phragmites australis	0.1	0.0	0.0	0.03
Pilea sp.	0.1	0.0	0.0	0.03
Poaceae fam.	0.2	0.0	0.0	0.07
Podophyllum peltatum	0.2	0.5	0.0	0.23
Polygonatum biflorum	0.0	0.0	0.1	0.03
Prenanthes sp.	0.0	0.1	0.1	0.07
Prunus serotina	0.0	0.4	0.2	0.20
Rosa multiflora	0.0	0.0	0.1	0.03
Rubus allegheniensis	0.1	0.0	0.0	0.03
Rubus flagellaris	0.1	0.1	0.0	0.07
Rubus hispidus	0.0	0.2	0.0	0.07
Rubus pensilvanicus	0.0	0.1	0.3	0.13
Sassafras albidum	0.0	0.1	0.4	0.17
Scirpus cyperinus	0.2	0.0	0.0	0.07
Smilax ecirrhata	0.0	0.0	0.1	0.03
Smilax tamnoides	0.0	0.0	0.1	0.03
Symplocarpus foetidus	0.2	0.0	0.0	0.07
Viburnum acerifolium	0.0	0.1	0.0	0.03
Viola sp.	0.0	0.1	0.1	0.07

Plot: 3019

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Vitis labrusca	0.3	0.0	0.0	0.10
Vitis riparia	0.0	0.0	0.2	0.07

Plot: 3021

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
<i>Apios americana</i>	0.1	0.0	0.0	0.03
<i>Arisaema triphyllum</i>	0.0	0.1	0.0	0.03
<i>Boehmeria cylindrica</i>	0.1	0.0	0.0	0.03
<i>Calamagrostis canadensis</i>	0.2	0.0	0.0	0.07
<i>Caltha palustris</i>	0.1	0.0	0.0	0.03
<i>Carex blanda</i>	0.0	0.0	0.1	0.03
<i>Carex lacustris</i>	0.2	0.0	0.0	0.07
<i>Carex scoparia</i>	0.1	0.1	0.0	0.07
<i>Carex sp.</i>	0.0	0.2	0.1	0.10
<i>Carex vulpinoidea</i>	0.1	0.0	0.0	0.03
<i>Cicuta maculata</i>	0.1	0.0	0.0	0.03
<i>Cinna arundinacea</i>	0.3	0.0	0.0	0.10
<i>Circaea canadensis</i> ssp. <i>canadensis</i>	0.0	0.0	0.2	0.07
<i>Clematis virginiana</i>	0.2	0.0	0.0	0.07
<i>Erechtites hieraciifolius</i>	0.0	0.0	0.1	0.03
<i>Eutrochium maculatum</i>	0.3	0.1	0.0	0.13
<i>Eutrochium purpureum</i>	0.1	0.0	0.0	0.03
<i>Fraxinus pennsylvanica</i>	0.0	0.1	0.2	0.10
<i>Galium triflorum</i>	0.1	0.0	0.0	0.03
<i>Geum sp.</i>	0.2	0.1	0.0	0.10
<i>Glechoma hederacea</i>	0.0	0.1	0.0	0.03
<i>Glyceria canadensis</i>	0.4	0.0	0.0	0.13
<i>Impatiens capensis</i>	0.8	0.0	0.2	0.33
<i>Laportea canadensis</i>	0.1	0.0	0.0	0.03
<i>Leersia sp.</i>	0.6	0.0	0.0	0.20
<i>Lindera benzoin</i>	0.0	1	0.9	0.63
<i>Liriodendron tulipifera</i>	0.0	0.1	0.0	0.03
<i>Maianthemum canadense</i>	0.0	0.5	0.1	0.20
<i>Onoclea sensibilis</i>	0.6	0.0	0.0	0.20
<i>Parthenocissus sp.</i>	0.1	0.5	0.2	0.27
<i>Persicaria arifolia</i>	0.8	0.2	0.0	0.33
<i>Persicaria virginiana</i>	0.0	0.0	0.1	0.03
<i>Phalaris arundinacea</i>	0.3	0.0	0.0	0.10
<i>Phytolacca americana</i>	0.0	0.2	0.0	0.07
<i>Pilea sp.</i>	0.5	0.0	0.0	0.17
<i>Poaceae</i> fam.	0.2	0.0	0.0	0.07
<i>Polygonatum biflorum</i>	0.0	0.1	0.0	0.03
<i>Polygonatum pubescens</i>	0.0	0.2	0.0	0.07
<i>Prunus serotina</i>	0.0	0.0	0.3	0.10
<i>Prunus virginiana</i>	0.0	0.1	0.0	0.03
<i>Rosa multiflora</i>	0.1	0.0	0.0	0.03
<i>Rubus allegheniensis</i>	0.0	0.8	0.4	0.40
<i>Rubus pensilvanicus</i>	0.0	0.1	0.0	0.03
<i>Scutellaria sp.</i>	0.1	0.0	0.0	0.03
<i>Solanum dulcamara</i>	0.3	0.0	0.0	0.10
<i>Solidago sp.</i>	0.3	0.1	0.0	0.13
<i>Symphyotrichum lateriflorum</i> var. <i>lateriflorum</i>	0.0	0.0	0.1	0.03
<i>Symplocarpus foetidus</i>	0.1	0.0	0.2	0.10
<i>Viburnum recognitum</i>	0.0	0.3	0.0	0.10
<i>Viola sp.</i>	0.2	0.2	0.0	0.13
<i>Vitis aestivalis</i>	0.0	0.1	0.0	0.03

Plot: 3022

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
<i>Acer rubrum</i>	0.1	0.0	0.2	0.10
<i>Amelanchier</i> Group 2 sp.	0.1	0.1	0.0	0.07
<i>Amphicarpaea bracteata</i>	0.0	0.0	0.1	0.03
<i>Bidens connata</i>	0.0	0.0	0.5	0.17
<i>Carex sp.</i>	0.9	0.8	0.4	0.70
<i>Dichanthelium latifolium</i>	0.0	0.0	0.1	0.03
<i>Fraxinus pennsylvanica</i>	0.0	0.0	0.2	0.07
<i>Galium circaezans</i> var. <i>circaezans</i>	0.0	0.5	0.0	0.17
<i>Gaylussacia baccata</i>	0.1	0.0	0.2	0.10
<i>Geum canadense</i>	0.1	0.0	0.0	0.03
<i>Helianthemum canadense</i>	0.1	0.0	0.0	0.03
<i>Hieracium sp.</i>	0.1	0.0	0.0	0.03
<i>Impatiens capensis</i>	0.0	0.0	0.4	0.13
<i>Ionactis linariifolia</i>	0.1	0.1	0.0	0.07
<i>Leersia sp.</i>	0.0	0.0	0.2	0.07
<i>Lindera benzoin</i>	0.0	0.0	0.1	0.03
<i>Lonicera</i> (exotic) sp.	0.1	0.0	0.0	0.03
<i>Maianthemum canadense</i>	0.0	0.1	0.0	0.03
<i>Maianthemum racemosum</i> ssp. <i>racemosum</i>	0.0	0.3	0.0	0.10
<i>Onoclea sensibilis</i>	0.0	0.0	0.1	0.03
<i>Osmundastrum cinnamomea</i>	0.0	0.0	0.3	0.10
<i>Parthenocissus sp.</i>	0.4	0.2	0.0	0.20
<i>Persicaria arifolia</i>	0.0	0.0	0.1	0.03
<i>Poa sp.</i>	0.1	0.0	0.0	0.03
<i>Polygonatum biflorum</i>	0.1	0.1	0.2	0.13
<i>Polygonatum pubescens</i>	0.0	0.1	0.0	0.03
<i>Potentilla simplex</i>	0.0	0.0	0.1	0.03
<i>Prunus serotina</i>	0.2	0.3	0.0	0.17
<i>Prunus virginiana</i>	0.2	0.0	0.0	0.07
<i>Quercus alba</i>	0.0	0.1	0.0	0.03
<i>Quercus velutina</i>	0.2	0.1	0.2	0.17
<i>Ranunculus acris</i>	0.1	0.0	0.0	0.03
<i>Rubus allegheniensis</i>	0.5	0.6	0.0	0.37
<i>Rubus flagellaris</i>	0.0	0.0	0.1	0.03
<i>Rubus hispidus</i>	0.0	0.0	0.1	0.03
<i>Rubus occidentalis</i>	0.1	0.4	0.0	0.17
<i>Rubus pubescens</i>	0.0	0.0	0.1	0.03
<i>Rubus sachalinensis</i> var. <i>sachalinensis</i>	0.1	0.0	0.0	0.03
<i>Sassafras albidum</i>	0.6	0.7	0.3	0.53
<i>Smilax rotundifolia</i>	0.0	0.0	0.2	0.07
<i>Solanum dulcamara</i>	0.0	0.0	0.1	0.03
<i>Solidago caesia</i>	0.0	0.0	0.2	0.07
<i>Solidago sp.</i>	0.0	0.0	0.1	0.03
<i>Spiranthes sp.</i>	0.0	0.0	0.1	0.03
<i>Symplocarpus foetidus</i>	0.0	0.0	0.3	0.10
<i>Tephrosia virginiana</i>	0.1	0.0	0.0	0.03
<i>Toxicodendron sp.</i>	0.0	0.1	0.0	0.03
<i>Trientalis borealis</i>	0.0	0.0	0.3	0.10
<i>Vaccinium angustifolium</i>	0.5	0.3	0.1	0.30
<i>Vaccinium pallidum</i>	0.7	0.0	0.3	0.33

Plot: 3023

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.1	0.0	0.0	0.03
Agrimonia parviflora	0.1	0.0	0.1	0.07
Amphicarpaea bracteata	0.6	0.1	0.1	0.27
Caltha palustris	0.2	0.0	0.0	0.07
Cardamine sp.	0.0	0.0	0.1	0.03
Carex albursina	0.0	0.0	0.1	0.03
Carex intumescens	0.0	0.0	0.1	0.03
Carex pensylvanica	0.3	0.5	0.0	0.27
Carex sp.	0.6	0.2	0.7	0.50
Carya ovata	0.0	0.1	0.0	0.03
Celastrus sp.	0.0	0.0	0.1	0.03
Circaea canadensis ssp. canadensis	0.0	0.0	0.1	0.03
Cornus racemosa	0.0	0.1	0.1	0.07
Dichanthelium sp.	0.0	0.1	0.1	0.07
Elaeagnus umbellata	0.2	0.0	0.1	0.10
Elymus sp.	0.0	0.0	0.1	0.03
Fragaria virginiana	0.3	0.3	0.2	0.27
Fraxinus pennsylvanica	0.0	0.1	0.0	0.03
Geum canadense	0.3	0.0	0.2	0.17
Geum sp.	0.4	0.0	0.1	0.17
Hypericum punctatum	0.1	0.0	0.0	0.03
Hypericum sp.	0.0	0.1	0.0	0.03
Juncus sp.	0.2	0.1	0.1	0.13
Lindera benzoin	0.1	0.1	0.4	0.20
Lobelia spicata	0.0	0.1	0.0	0.03
Lycopodium digitatum	0.0	0.6	0.2	0.27
Onoclea sensibilis	0.1	0.0	0.0	0.03
Parthenocissus sp.	0.8	0.5	0.8	0.70
Persicaria sp.	0.5	0.0	0.3	0.27
Poa compressa	0.0	0.0	0.1	0.03
Poaceae fam.	0.6	0.1	0.3	0.33
Polystichum acrostichoides	0.0	0.1	0.0	0.03
Prunus serotina	0.0	0.2	0.2	0.13
Quercus rubra	0.0	0.0	0.1	0.03
Ribes cynosbati	0.1	0.0	0.1	0.07
Rosa multiflora	0.6	0.0	0.4	0.33
Rubus allegheniensis	0.4	0.1	0.2	0.23
Smilax tamnoides	0.0	0.0	0.3	0.10
Solidago sp.	0.9	0.6	0.7	0.73
Spiraea tomentosa	0.0	0.3	0.0	0.10
Symphyotrichum lateriflorum var. lateriflorum	0.2	0.1	0.0	0.10
Toxicodendron sp.	0.2	0.4	0.3	0.30
Ulmus americana	0.0	0.0	0.2	0.07
Viola sp.	0.0	0.0	0.3	0.10
Vitis riparia	0.1	0.4	0.1	0.20

Plot: 3026

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Alliaria petiolata	0.1	0.8	0.6	0.50
Amphicarpaea bracteata	0.0	0.1	0.0	0.03
Boehmeria cylindrica	0.2	0.3	0.0	0.17
Carex sp.	0.0	0.2	0.3	0.17
Celastrus sp.	0.1	0.1	0.1	0.10
Cicuta maculata	0.0	0.1	0.0	0.03
Circaea canadensis ssp. canadensis	0.0	0.0	0.2	0.07
Crataegus sp.	0.1	0.0	0.0	0.03
Elymus virginicus	0.0	0.0	0.4	0.13
Fraxinus americana	0.1	0.0	0.0	0.03
Fraxinus pennsylvanica	0.0	0.3	0.0	0.10
Fraxinus sp.	0.0	0.0	0.1	0.03
Galium triflorum	0.1	0.2	0.0	0.10
Geum canadense	0.7	0.9	0.9	0.83
Glechoma hederacea	0.0	0.3	0.4	0.23
Glyceria striata	0.1	0.0	0.0	0.03
Hackelia virginiana	0.1	0.3	0.3	0.23
Leersia sp.	0.2	0.0	0.0	0.07
Lindera benzoin	0.1	0.0	0.0	0.03
Mitchella repens	0.0	0.1	0.0	0.03
Oxalis stricta	0.0	0.0	0.1	0.03
Parthenocissus sp.	0.4	0.1	0.3	0.27
Persicaria sp.	0.8	1	0.8	0.87
Phalaris arundinacea	0.1	0.4	0.0	0.17
Pilea sp.	0.0	0.3	0.1	0.13
Poa compressa	0.4	0.0	0.0	0.13
Poaceae fam.	0.0	0.3	0.0	0.10
Ranunculus sp.	0.3	0.0	0.0	0.10
Robinia pseudoacacia	0.0	0.0	0.1	0.03
Rosa multiflora	0.6	0.5	0.9	0.67
Rubus occidentalis	0.0	0.0	0.1	0.03
Rubus sachalinensis var. sachalinensis	0.1	0.0	0.0	0.03
Sanicula marilandica	0.0	0.2	0.0	0.07
Smilax tamnoides	0.0	0.1	0.0	0.03
Solidago sp.	0.3	0.3	0.3	0.30
Symphyotrichum lateriflorum var. lateriflorum	0.0	0.1	0.1	0.07
Taraxacum officinale	0.0	0.1	0.0	0.03
Toxicodendron sp.	0.5	0.7	0.4	0.53
Vinca minor	0.0	0.0	0.1	0.03
Viola sp.	0.1	0.5	0.0	0.20
Vitis riparia	0.0	0.0	0.1	0.03

Plot: 3028

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Achillea millefolium	0.0	0.1	0.1	0.07
Anemone cylindrica	0.5	0.1	0.1	0.23
Antennaria plantaginifolia	0.0	0.2	0.2	0.13
Apocynum androsaemifolium	0.1	0.0	0.0	0.03
Aquilegia canadensis	0.1	0.0	0.0	0.03
Carex sp.	0.0	0.3	0.0	0.10
Ceanothus americanus	0.1	0.0	0.1	0.07
Clematis virginiana	0.1	0.0	0.0	0.03
Comandra umbellata	0.8	0.5	0.4	0.57
Coreopsis tripteris	0.0	0.0	0.2	0.07
Cornus racemosa	0.0	0.2	0.0	0.07
Dichanthelium sp.	0.1	0.1	0.1	0.10
Euphorbia corollata	0.3	0.5	0.9	0.57
Euthamia graminifolia	0.0	0.1	0.0	0.03
Fragaria virginiana	0.4	0.5	0.2	0.37
Helianthus divaricatus	1	1	1	1.00
Ionactis linariifolia	0.1	0.3	0.6	0.33
Liatis aspera	0.2	0.0	0.0	0.07
Lithospermum canescens	0.1	0.0	0.0	0.03
Lonicera (exotic) sp.	0.2	0.1	0.0	0.10
Lupinus perennis	0.0	0.4	0.3	0.23
Maianthemum canadense	0.0	0.0	0.2	0.07
Maianthemum stellatum	0.7	0.5	0.6	0.60
Monarda fistulosa	0.2	0.0	0.2	0.13
Phlox pilosa	0.9	1	1	0.97
Plantago rugelii	0.1	0.0	0.0	0.03
Poa compressa	0.7	0.2	0.0	0.30
Poaceae fam.	0.7	0.7	0.9	0.77
Polygonatum biflorum	0.1	0.1	0.2	0.13
Prunella vulgaris	0.0	0.0	0.1	0.03
Prunus virginiana	0.0	0.1	0.0	0.03
Quercus velutina	0.6	1	0.8	0.80
Rosa blanda	1	1	1	1.00
Rudbeckia hirta	0.0	0.1	0.0	0.03
Solidago sp.	0.1	0.5	0.1	0.23
Solidago speciosa	0.0	0.0	0.2	0.07
Symphyotrichum oolentangiense	0.8	0.6	0.2	0.53
Tephrosia virginiana	0.1	0.2	0.1	0.13
Toxicodendron sp.	0.8	0.6	0.3	0.57
Tradescantia ohiensis	0.0	0.1	0.0	0.03
Tradescantia virginiana	0.0	0.2	0.0	0.07
Vaccinium pallidum	0.0	0.3	0.0	0.10

Plot: 3029

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.2	0.2	0.0	0.13
Amelanchier Group 2 sp.	0.3	0.3	0.0	0.20
Carex normalis	0.0	0.0	0.1	0.03
Carex sp.	0.0	0.0	0.1	0.03
Catalpa speciosa	0.0	0.1	0.0	0.03
Celastrus sp.	0.0	0.1	0.0	0.03
Clinopodium vulgare	0.0	0.1	0.1	0.07
Dichanthelium dichotomum var. dichotomum	0.0	0.5	0.1	0.20
Fraxinus pennsylvanica	0.1	0.4	0.0	0.17
Helianthemum canadense	0.0	0.1	0.1	0.07
Lepidium virginicum	0.0	0.2	0.0	0.07
Lindera benzoin	0.1	0.1	0.0	0.07
Maianthemum racemosum ssp. racemosum	0.1	0.0	0.1	0.07
Parthenocissus sp.	0.1	0.0	0.0	0.03
Prunus serotina	0.3	0.2	0.1	0.20
Quercus velutina	0.4	0.4	0.0	0.27
Rosa blanda	0.1	0.0	0.0	0.03
Rubus flagellaris	0.6	0.6	0.1	0.43
Rumex acetosella	0.0	0.1	0.2	0.10
Sassafras albidum	0.1	0.1	0.1	0.10
Solidago sp.	0.2	0.0	0.1	0.10
Taraxacum sp.	0.0	0.0	0.1	0.03
Tradescantia virginiana	0.0	0.1	0.1	0.07

Plot: 3030

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Amelanchier Group 2 sp.	0.3	0.4	0.1	0.27
Arisaema triphyllum	0.1	0.0	0.0	0.03
Carex hystericina	0.0	0.0	0.2	0.07
Carex sp.	0.4	0.1	0.3	0.27
Celastrus sp.	0.4	0.1	0.3	0.27
Clematis virginiana	0.0	0.1	0.0	0.03
Cornus racemosa	0.0	0.1	0.0	0.03
Dichanthelium clandestinum	0.3	0.1	0.1	0.17
Dryopteris carthusiana	0.0	0.1	0.0	0.03
Dulichium arundinaceum	0.0	0.0	0.1	0.03
Fraxinus nigra	0.0	0.3	0.0	0.10
Glyceria striata	0.0	0.0	0.1	0.03
Impatiens sp.	0.0	0.0	0.1	0.03
Laportea canadensis	0.0	0.2	0.0	0.07
Lindera benzoin	1	0.9	0.6	0.83
Lycopus americanus	0.0	0.2	0.1	0.10
Maianthemum canadense	0.1	0.0	0.0	0.03
Maianthemum racemosum ssp. racemosum	0.0	0.1	0.0	0.03
Nyssa sylvatica	0.0	0.0	0.1	0.03
Onoclea sensibilis	0.0	0.1	0.0	0.03
Parthenocissus sp.	0.2	0.2	0.2	0.20
Persicaria sagittata	0.0	0.0	0.2	0.07
Phragmites australis	0.0	0.0	0.5	0.17
Polygonatum biflorum	0.1	0.1	0.0	0.07
Potentilla simplex	0.0	0.4	0.0	0.13
Prunus serotina	0.2	0.3	0.0	0.17
Prunus virginiana	0.0	0.1	0.0	0.03
Quercus velutina	0.0	0.1	0.0	0.03
Rhamnus frangula	0.0	0.5	0.5	0.33
Rosa multiflora	0.0	0.0	0.1	0.03
Rubus hispidus	0.3	0.9	0.4	0.53
Rubus pensilvanicus	0.2	0.3	0.2	0.23
Sassafras albidum	0.6	0.5	0.1	0.40
Scutellaria sp.	0.0	0.0	0.1	0.03
Smilax rotundifolia	0.0	0.0	0.1	0.03
Solidago sp.	0.1	0.4	0.6	0.37
Spiraea tomentosa	0.0	0.3	0.1	0.13
Symphytotrichum lateriflorum var. lateriflorum	0.0	0.1	0.0	0.03
Ulmus americana	0.0	0.1	0.1	0.07
Viola sp.	0.3	0.5	0.2	0.33
Vitis riparia	0.1	0.0	0.0	0.03

Plot: 3031

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Ambrosia artemisiifolia	0.0	0.0	0.1	0.03
Aronia melanocarpa	0.1	0.2	0.0	0.10
Boehmeria cylindrica	0.1	0.0	0.1	0.07
Carex sp.	0.7	0.5	0.9	0.70
Circaea canadensis ssp. canadensis	0.2	0.1	0.1	0.13
Dichanthelium sp.	0.0	0.0	0.1	0.03
Fragaria virginiana	0.0	0.0	0.2	0.07
Galium pilosum	0.5	0.1	0.2	0.27
Gaylussacia baccata	0.4	0.5	0.7	0.53
Helianthus divaricatus	0.1	0.2	0.5	0.27
Hypericum sp.	0.0	0.0	0.1	0.03
Lycopus uniflorus	0.1	0.0	0.0	0.03
Maianthemum racemosum ssp. racemosum	0.0	0.2	0.0	0.07
Nyssa sylvatica	0.1	0.0	0.0	0.03
Poa sp.	0.0	0.1	0.3	0.13
Potentilla simplex	0.2	0.7	0.4	0.43
Prunus serotina	0.0	0.1	0.0	0.03
Pteridium aquilinum ssp. latiusculum	0.0	0.2	0.0	0.07
Quercus alba	0.1	0.0	0.1	0.07
Quercus velutina	0.1	0.4	0.2	0.23
Rhus copallinum	0.1	0.0	0.0	0.03
Rosa blanda	0.0	0.0	0.3	0.10
Rubus flagellaris	0.0	0.1	0.0	0.03
Rubus hispidus	0.9	0.1	0.6	0.53
Sassafras albidum	0.7	0.5	0.6	0.60
Scrophularia lanceolata	0.1	0.0	0.0	0.03
Scutellaria sp.	0.0	0.0	0.1	0.03
Solidago sp.	0.5	0.7	0.1	0.43
Spiraea tomentosa	0.2	0.0	0.0	0.07
Toxicodendron sp.	0.0	0.0	0.1	0.03
Vaccinium angustifolium	0.7	0.9	0.7	0.77
Viola sagittata	0.0	0.1	0.0	0.03
Vitis riparia	0.0	0.0	0.1	0.03

Plot: 3033

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Ageratina altissima	0.1	0.0	0.0	0.03
Amelanchier Group 2 sp.	0.4	0.4	0.0	0.27
Aralia nudicaulis	0.0	0.1	0.0	0.03
Asteraceae fam.	0.1	0.0	0.0	0.03
Boehmeria cylindrica	0.0	0.0	0.1	0.03
Carex sp.	0.8	0.7	0.5	0.67
Carex swanii	0.0	0.0	0.1	0.03
Celastrus sp.	0.6	0.7	0.9	0.73
Circaea canadensis ssp. canadensis	0.1	0.1	0.0	0.07
Convallaria majalis	0.1	0.0	0.0	0.03
Danthonia spicata	0.0	0.0	0.2	0.07
Diervilla lonicera	0.1	0.0	0.0	0.03
Euonymus alatus	0.1	0.0	0.0	0.03
Fragaria virginiana	0.1	0.0	0.3	0.13
Galium pilosum	0.3	0.9	0.4	0.53
Hamamelis virginiana	0.6	0.4	0.0	0.33
Helianthus divaricatus	0.8	0.2	0.1	0.37
Hieracium sp.	0.0	0.0	0.1	0.03
Hypericum perforatum	0.0	0.1	0.0	0.03
Lespedeza hirta	0.1	0.0	0.0	0.03
Lonicera (exotic) sp.	0.0	0.0	0.1	0.03
Lysimachia ciliata	0.3	0.0	0.0	0.10
Maianthemum racemosum ssp. racemosum	0.1	0.1	0.0	0.07
Monarda fistulosa	0.1	0.2	0.0	0.10
Oxalis sp.	0.0	0.0	0.2	0.07
Parthenocissus sp.	0.1	0.2	0.1	0.13
Poa sp.	0.0	0.3	0.4	0.23
Poaceae fam.	0.0	0.0	0.2	0.07
Polygonatum biflorum	0.1	0.0	0.0	0.03
Prunus serotina	0.3	0.0	0.2	0.17
Prunus virginiana	0.0	0.0	0.1	0.03
Pteridium aquilinum ssp. latiusculum	0.0	0.3	0.0	0.10
Quercus alba	0.1	0.4	0.4	0.30
Quercus velutina	0.5	0.3	0.2	0.33
Rosa carolina	0.1	0.0	0.0	0.03
Rosa multiflora	0.1	0.0	0.0	0.03
Rubus allegheniensis	0.3	0.0	0.7	0.33
Rubus flagellaris	0.1	0.7	0.3	0.37
Rubus occidentalis	0.6	0.2	0.0	0.27
Sassafras albidum	0.9	0.1	0.6	0.53
Smilax ecirrhata	0.1	0.0	0.0	0.03
Smilax rotundifolia	0.6	0.5	0.0	0.37
Solidago caesia	0.7	0.1	0.7	0.50
Solidago sp.	0.0	0.0	0.3	0.10
Toxicodendron sp.	0.3	0.3	0.1	0.23
Vaccinium angustifolium	0.1	0.1	0.0	0.07
Vaccinium pallidum	0.5	0.1	0.0	0.20
Veronica officinalis	0.0	0.0	0.3	0.10
Viburnum acerifolium	0.1	0.4	0.0	0.17
Vitis aestivalis	0.2	0.0	0.0	0.07
Vitis riparia	0.0	0.0	0.1	0.03

Plot: 3034

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer negundo	0.0	0.1	0.0	0.03
Acer rubrum	0.0	0.1	0.0	0.03
Calamagrostis canadensis	0.2	0.0	0.0	0.07
Calystegia sepium	0.1	0.0	0.0	0.03
Celastrus sp.	0.1	0.1	0.6	0.27
Circaea canadensis ssp. canadensis	0.4	0.1	0.0	0.17
Cornus racemosa	0.0	0.0	0.2	0.07
Dichanthelium clandestinum	0.3	0.0	0.0	0.10
Fraxinus pennsylvanica	0.2	0.0	0.0	0.07
Geum canadense	0.3	0.2	0.3	0.27
Glechoma hederacea	0.0	0.5	0.3	0.27
Gleditsia triacanthos	0.0	0.1	0.4	0.17
Glyceria striata	0.2	0.0	0.0	0.07
Impatiens sp.	0.1	0.0	0.0	0.03
Juncus sp.	0.1	0.0	0.0	0.03
Lamiaceae fam.	0.0	0.0	0.1	0.03
Leersia sp.	0.1	0.1	0.0	0.07
Lindera benzoin	0.1	0.1	0.0	0.07
Lonicera (exotic) sp.	0.2	0.0	0.1	0.10
Parthenocissus sp.	0.3	0.7	0.3	0.43
Persicaria virginiana	0.3	0.9	0.5	0.57
Poaceae fam.	0.1	0.0	0.1	0.07
Potentilla simplex	0.1	0.0	0.0	0.03
Prunus serotina	0.2	0.1	0.0	0.10
Quercus rubra	0.0	0.1	0.0	0.03
Rhus sp.	0.0	0.0	0.2	0.07
Rosa multiflora	0.6	0.3	0.1	0.33
Rubus allegheniensis	0.6	0.2	0.0	0.27
Rubus flagellaris	0.0	0.5	0.0	0.17
Rubus hispidus	0.7	0.1	0.0	0.27
Rubus occidentalis	0.0	0.1	0.0	0.03
Rumex obtusifolius	0.2	0.0	0.0	0.07
Scutellaria lateriflora	0.2	0.0	0.0	0.07
Solidago sp.	0.3	0.0	0.2	0.17
Syringa vulgaris	0.0	0.0	0.2	0.07
Toxicodendron sp.	0.2	0.1	0.1	0.13
Urtica dioica ssp. gracilis	0.0	0.0	0.1	0.03
Vitis aestivalis	0.4	0.0	0.0	0.13

Plot: 3036

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.2	0.1	0.10
Amelanchier arborea	0.0	0.1	0.3	0.13
Aquilegia canadensis	0.1	0.0	0.0	0.03
Asteraceae fam.	0.1	0.0	0.0	0.03
Boehmeria cylindrica	0.7	0.5	0.3	0.50
Carex bebbii	0.3	0.0	0.1	0.13
Carex sp.	0.8	1	0.7	0.83
Carex vesicaria	0.4	0.0	0.0	0.13
Carex vulpinoidea	0.1	0.0	0.0	0.03
Celastrus sp.	0.3	0.6	0.3	0.40
Cephalanthus occidentalis	1	0.1	0.0	0.37
Circaea canadensis ssp. canadensis	0.0	0.4	0.1	0.17
Cirsium sp.	0.4	0.0	0.0	0.13
Conyza canadensis	0.2	0.1	0.0	0.10
Cornus racemosa	0.1	0.0	0.0	0.03
Crataegus sp.	0.1	0.0	0.0	0.03
Dichanthelium dichotomum var. dichotomum	0.0	0.2	0.0	0.07
Diervilla lonicera	0.0	0.1	0.0	0.03
Dulichium arundinaceum	0.8	0.0	0.0	0.27
Erechtites hieraciifolius	0.5	0.0	0.0	0.17
Eupatorium perfoliatum	0.2	0.1	0.1	0.13
Eupatorium sessilifolium	0.2	0.1	0.0	0.10
Fallopia convolvulus	0.4	0.0	0.0	0.13
Galium pilosum	0.0	0.4	0.7	0.37
Galium triflorum	0.1	0.2	0.0	0.10
Gaylussacia baccata	0.0	0.2	0.4	0.20
Hackelia virginiana	0.1	0.3	0.1	0.17
Helianthus divaricatus	0.0	0.2	0.1	0.10
Hieracium sp.	0.0	0.1	0.0	0.03
Hypericum sp.	0.2	0.0	0.0	0.07
Ilex verticillata	0.0	0.0	0.2	0.07
Iris sp.	0.2	0.0	0.0	0.07
Juncus sp.	0.4	0.0	0.0	0.13
Leersia sp.	0.7	0.0	0.2	0.30
Lonicera (exotic) sp.	0.2	0.0	0.0	0.07
Lycopus sp.	0.1	0.0	0.0	0.03
Lycopus uniflorus	0.2	0.0	0.2	0.13
Maianthemum canadense	0.0	0.2	0.0	0.07
Maianthemum racemosum ssp. racemosum	0.0	0.2	0.1	0.10
Mimulus alatus	0.2	0.0	0.0	0.07
Nyssa sylvatica	0.0	0.0	0.2	0.07
Parthenocissus sp.	0.1	0.5	0.7	0.43
Persicaria sp.	0.5	0.0	0.2	0.23
Phragmites australis	0.1	0.0	0.0	0.03
Phytolacca americana	0.0	0.1	0.0	0.03
Pilea sp.	0.4	0.1	0.0	0.17
Poa sp.	0.0	0.1	0.0	0.03
Poaceae fam.	0.5	0.2	0.2	0.30
Polygonatum biflorum	0.0	0.0	0.1	0.03
Potentilla sp.	0.0	0.1	0.0	0.03
Proserpinaca palustris var. crebra	0.1	0.0	0.0	0.03
Prunus serotina	0.0	0.3	0.2	0.17
Prunus virginiana	0.0	0.2	0.0	0.07
Quercus alba	0.0	0.0	0.1	0.03
Quercus velutina	0.0	0.3	0.2	0.17

Plot: 3036

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Rubus allegheniensis	0.0	0.1	0.3	0.13
Rubus hispidus	0.1	0.1	0.3	0.17
Rubus pensilvanicus	0.1	0.2	0.5	0.27
Rubus sachalinensis var. sachalinensis	0.0	0.0	0.2	0.07
Sambucus sp.	0.0	0.1	0.0	0.03
Sanicula marilandica	0.0	0.1	0.0	0.03
Sassafras albidum	0.0	0.1	0.0	0.03
Scutellaria galericulata	0.2	0.0	0.0	0.07
Scutellaria sp.	0.2	0.0	0.0	0.07
Smilax rotundifolia	0.0	0.2	0.0	0.07
Solanum dulcamara	0.2	0.0	0.0	0.07
Solidago sp.	0.3	0.1	0.1	0.17
Spiraea tomentosa	0.0	0.0	0.1	0.03
Symphyotrichum lateriflorum var. lateriflorum	0.0	0.0	0.1	0.03
Symphyotrichum sp.	0.1	0.0	0.0	0.03
Taraxacum officinale	0.0	0.2	0.0	0.07
Thelypteris palustris var. pubescens	0.1	0.0	0.0	0.03
Toxicodendron sp.	0.0	0.0	0.1	0.03
unknown Herbaceous species	0.1	0.0	0.0	0.03
Utricularia sp.	0.1	0.0	0.0	0.03
Vaccinium angustifolium	0.0	0.8	0.8	0.53
Vaccinium pallidum	0.0	0.4	0.4	0.27
Viola sp.	0.1	0.1	0.0	0.07
Vitis labrusca	0.0	0.5	0.2	0.23

Plot: 3038

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Alliaria petiolata	0.1	0.0	0.0	0.03
Amelanchier Group 2 sp.	0.0	0.2	0.2	0.13
Amphicarpaea bracteata	0.3	0.0	0.0	0.10
Anemone acutiloba	0.5	0.0	0.3	0.27
Aquilegia canadensis	0.2	0.0	0.1	0.10
Arabidopsis lyrata ssp. lyrata	0.0	0.0	0.1	0.03
Asclepias sp.	0.1	0.0	0.0	0.03
Asclepias syriaca	0.0	0.2	0.0	0.07
Asplenium platyneuron	0.1	0.0	0.0	0.03
Athyrium filix-femina var. angustum	0.1	0.0	0.0	0.03
Boehmeria cylindrica	0.8	0.0	0.4	0.40
Carex sp.	0.4	0.9	1	0.77
Celastrus sp.	0.3	0.0	0.0	0.10
Circaea canadensis ssp. canadensis	0.1	0.0	0.0	0.03
Comandra umbellata	0.0	0.2	0.1	0.10
Desmodium sp.	0.0	0.0	0.2	0.07
Dichanthelium latifolium	0.3	0.3	0.0	0.20
Dichanthelium sp.	0.0	0.0	0.4	0.13
Epipactis helleborine	0.1	0.0	0.0	0.03
Galium pilosum	0.4	0.7	0.8	0.63
Galium triflorum	0.5	0.0	0.0	0.17
Gaylussacia baccata	0.1	0.0	0.0	0.03
Hamamelis virginiana	0.5	0.0	0.0	0.17
Helianthus divaricatus	0.1	0.9	0.9	0.63
Lupinus perennis	0.0	0.2	0.0	0.07
Maianthemum canadense	0.0	0.2	0.0	0.07
Maianthemum racemosum ssp. racemosum	0.3	0.2	0.0	0.17
Parthenocissus sp.	0.1	0.0	0.3	0.13
Phlox pilosa	0.0	0.0	0.3	0.10
Poa compressa	0.1	0.0	0.0	0.03
Poa sp.	0.0	0.3	0.4	0.23
Polygonatum biflorum	0.0	0.1	0.1	0.07
Prunus serotina	0.5	0.2	0.1	0.27
Prunus virginiana	0.0	0.0	0.2	0.07
Pteridium aquilinum ssp. latiusculum	0.0	0.2	0.1	0.10
Quercus alba	0.1	0.0	0.0	0.03
Quercus velutina	0.4	0.6	0.3	0.43
Rosa blanda	0.0	0.6	0.6	0.40
Rubus allegheniensis	0.1	0.0	0.0	0.03
Rubus flagellaris	0.0	0.0	0.1	0.03
Rubus pensilvanicus	0.0	0.0	0.2	0.07
Sassafras albidum	0.1	0.7	0.7	0.50
Smilax ecirrhata	0.2	0.0	0.0	0.07
Solidago sp.	0.6	0.4	0.2	0.40
Taraxacum officinale	0.2	0.0	0.0	0.07
Thalictrum sp.	0.6	0.0	0.0	0.20
Tradescantia ohiensis	0.0	0.0	0.4	0.13
Tradescantia virginiana	0.0	0.7	0.3	0.33
Vaccinium angustifolium	0.1	0.4	0.6	0.37
Vaccinium pallidum	0.0	0.1	0.3	0.13
Viola sp.	0.4	0.0	0.0	0.13
Vitis labrusca	0.4	0.0	0.0	0.13
Vitis riparia	0.1	0.2	0.0	0.10

Plot: 3039

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer saccharum	0.2	0.0	0.0	0.07
Alliaria petiolata	0.0	0.2	0.0	0.07
Anemone acutiloba	0.2	0.0	0.0	0.07
Asarum canadense	0.4	0.7	0.3	0.47
Asimina triloba	0.1	0.0	0.0	0.03
Carex sp.	0.2	0.0	0.0	0.07
Carya cordiformis	0.3	0.0	0.0	0.10
Carya ovata	0.1	0.0	0.0	0.03
Caulophyllum thalictroides	0.0	0.0	0.1	0.03
Circaea canadensis ssp. canadensis	0.1	0.0	0.2	0.10
Cryptotaenia canadensis	0.1	0.8	0.0	0.30
Dioscorea villosa	0.0	0.0	0.2	0.07
Dryopteris carthusiana	0.1	0.0	0.0	0.03
Elymus sp.	0.0	0.0	0.1	0.03
Fagus grandifolia	0.1	0.0	0.0	0.03
Geranium maculatum	0.1	0.5	0.3	0.30
Geum canadense	0.0	0.0	0.1	0.03
Geum sp.	0.0	0.0	0.1	0.03
Impatiens sp.	0.0	0.0	0.1	0.03
Laportea canadensis	0.1	0.8	0.5	0.47
Lindera benzoin	0.3	0.5	0.7	0.50
Maianthemum racemosum ssp. racemosum	0.1	0.0	0.0	0.03
Osmorhiza sp.	0.0	0.1	0.0	0.03
Parthenocissus sp.	0.5	0.3	0.7	0.50
Persicaria virginiana	0.8	0.6	0.1	0.50
Pilea sp.	0.1	0.5	0.3	0.30
Podophyllum peltatum	0.0	0.1	0.0	0.03
Polygonatum biflorum	0.0	0.0	0.1	0.03
Polystichum acrostichoides	0.3	0.0	0.0	0.10
Prunus virginiana	0.0	0.0	0.1	0.03
Quercus rubra	0.1	0.0	0.0	0.03
Ranunculus recurvatus	0.1	0.0	0.1	0.07
Ranunculus sp.	0.0	0.5	0.6	0.37
Rosa multiflora	0.0	0.2	0.1	0.10
Rubus allegheniensis	0.1	0.0	0.0	0.03
Sanicula sp.	0.0	0.6	0.1	0.23
Smilax ecirrhata	0.0	0.0	0.1	0.03
Smilax tamnoides	0.0	0.1	0.0	0.03
Solidago flexicaulis	0.3	0.0	0.0	0.10
Thalictrum dasycarpum	0.0	0.4	0.0	0.13
Toxicodendron sp.	0.1	0.0	0.5	0.20
Viburnum recognitum	0.0	0.1	0.0	0.03
Vinca minor	0.1	0.0	0.0	0.03
Viola sp.	0.9	1	0.8	0.90

Plot: 3041

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer saccharinum	0.4	0.3	0.1	0.27
Apocynum cannabinum	0.0	0.0	0.4	0.13
Bidens connata	0.5	0.0	0.0	0.17
Bidens frondosa	0.5	0.0	0.0	0.17
Boehmeria cylindrica	0.9	0.9	0.2	0.67
Calamagrostis canadensis	0.0	0.4	0.2	0.20
Carex sp.	0.8	0.6	0.1	0.50
Carex tribuloides	0.6	0.3	0.1	0.33
Cinna arundinacea	0.2	0.1	0.0	0.10
Circaea canadensis ssp. canadensis	0.0	0.0	0.3	0.10
Cornus sericea	0.0	0.2	0.0	0.07
Cuscuta gronovii	0.2	0.2	0.0	0.13
Elymus virginicus	0.0	0.2	0.1	0.10
Equisetum arvense	0.0	0.1	0.2	0.10
Geum canadense	0.0	0.0	0.3	0.10
Impatiens capensis	0.6	0.3	0.8	0.57
Ipomoea sp.	0.0	0.0	0.4	0.13
Leersia oryzoides	0.5	0.6	0.0	0.37
Lycopus sp.	0.1	0.0	0.0	0.03
Onoclea sensibilis	0.4	0.4	0.1	0.30
Oxalis stricta	0.0	0.0	0.1	0.03
Persicaria hydropiper	0.3	0.5	0.0	0.27
Persicaria sagittata	0.1	0.4	0.1	0.20
Persicaria virginiana	0.1	0.0	0.2	0.10
Phragmites australis	0.2	0.0	0.2	0.13
Pilea sp.	0.7	0.8	0.5	0.67
Poa sp.	0.0	0.0	0.3	0.10
Poaceae fam.	0.0	0.1	0.0	0.03
Populus deltoides ssp. monilifera	0.0	0.0	0.5	0.17
Rhamnus frangula	0.0	0.0	0.1	0.03
Ribes hirtellum	0.0	0.0	0.1	0.03
Rosa multiflora	0.0	0.1	0.3	0.13
Rubus allegheniensis	0.0	0.0	0.4	0.13
Rubus flagellaris	0.0	0.0	0.1	0.03
Rubus hispidus	0.0	0.1	0.0	0.03
Rubus occidentalis	0.0	0.0	0.3	0.10
Salix sp.	0.0	0.2	0.0	0.07
Scutellaria lateriflora	0.2	0.3	0.1	0.20
Sium suave	0.1	0.1	0.0	0.07
Solidago sp.	0.0	0.2	0.7	0.30
Symphyotrichum lateriflorum var. lateriflorum	0.0	0.1	0.1	0.07
Toxicodendron sp.	0.0	0.0	0.5	0.17
Urtica dioica ssp. gracilis	0.0	0.1	0.3	0.13
Viola sp.	0.0	0.1	0.0	0.03
Vitis riparia	0.0	0.1	0.2	0.10

Plot: 3042

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.0	0.3	0.10
Actaea sp.	0.0	0.0	0.1	0.03
Agrimonia gryposepala	0.0	0.0	0.1	0.03
Amelanchier Group 2 sp.	0.0	0.1	0.1	0.07
Amphicarpaea bracteata	0.0	0.0	0.3	0.10
Berberis thunbergii	0.3	0.2	0.1	0.20
Carex sp.	0.0	0.0	0.1	0.03
Carex swanii	0.0	0.0	0.1	0.03
Carya ovata	0.1	0.1	0.0	0.07
Celastrus sp.	0.5	0.4	0.8	0.57
Circaea canadensis ssp. canadensis	0.6	0.4	0.3	0.43
Cornus florida	0.1	0.2	0.0	0.10
Cornus racemosa	0.0	0.3	0.1	0.13
Crataegus sp.	0.0	0.0	0.1	0.03
Desmodium paniculatum	0.0	0.0	0.1	0.03
Dioscorea villosa	0.1	0.0	0.0	0.03
Elaeagnus umbellata	0.0	0.0	0.2	0.07
Elymus hystrix	0.1	0.0	0.0	0.03
Euonymus alatus	0.2	0.1	0.2	0.17
Euonymus atropurpureus	0.1	0.3	0.1	0.17
Fraxinus pennsylvanica	0.2	0.2	0.3	0.23
Geum canadense	0.3	0.0	0.2	0.17
Geum sp.	0.0	0.1	0.2	0.10
Lindera benzoin	0.6	0.7	0.7	0.67
Liriodendron tulipifera	0.0	0.0	0.1	0.03
Lonicera (exotic) sp.	0.0	0.0	0.1	0.03
Maianthemum racemosum ssp. racemosum	0.2	0.2	0.2	0.20
Oxalis sp.	0.0	0.0	0.1	0.03
Parthenocissus sp.	0.6	0.9	0.9	0.80
Persicaria sp.	0.0	0.0	0.1	0.03
Persicaria virginiana	0.4	0.0	0.0	0.13
Poa compressa	0.0	0.0	0.2	0.07
Poaceae fam.	0.0	0.0	0.1	0.03
Polygonatum biflorum	0.2	0.0	0.0	0.07
Polygonatum pubescens	0.0	0.1	0.2	0.10
Potentilla sp.	0.0	0.0	0.1	0.03
Prunus serotina	0.4	0.2	0.5	0.37
Prunus virginiana	0.1	0.0	0.1	0.07
Quercus rubra	0.0	0.1	0.1	0.07
Ribes cynosbati	0.1	0.0	0.0	0.03
Rosa multiflora	0.2	0.5	0.2	0.30
Rubus allegheniensis	0.0	0.1	0.4	0.17
Rubus pensilvanicus	0.4	0.0	0.0	0.13
Sassafras albidum	0.2	0.4	0.7	0.43
Smilax rotundifolia	0.0	0.2	0.1	0.10
Solidago sp.	0.0	0.2	0.1	0.10
Toxicodendron sp.	0.3	0.3	0.5	0.37
Viburnum acerifolium	0.0	0.1	0.4	0.17
Viola sp.	0.0	0.0	0.1	0.03
Vitis aestivalis	0.0	0.1	0.0	0.03

Plot: 3044

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Amphicarpaea bracteata	0.2	0.0	0.0	0.07
Antennaria plantaginifolia	0.1	0.0	0.0	0.03
Aquilegia canadensis	0.2	0.0	0.0	0.07
Aralia nudicaulis	0.4	0.7	0.0	0.37
Carex sp.	0.5	0.3	0.7	0.50
Ceanothus americanus	0.3	0.3	0.0	0.20
Comandra umbellata	0.2	0.2	0.2	0.20
Conyza canadensis	0.0	0.1	0.0	0.03
Coreopsis tripteris	0.1	0.0	0.0	0.03
Desmodium paniculatum	0.0	0.0	0.1	0.03
Diervilla lonicera	0.3	0.0	0.0	0.10
Erechtites hieraciifolius	0.0	0.0	0.1	0.03
Euphorbia corollata	0.0	0.0	0.2	0.07
Fragaria virginiana	0.5	0.1	0.4	0.33
Helianthus divaricatus	0.3	0.3	0.8	0.47
Ionactis linariifolia	0.3	0.0	0.3	0.20
Lonicera (exotic) sp.	0.2	0.0	0.2	0.13
Lupinus perennis	0.0	0.1	0.5	0.20
Maianthemum canadense	0.2	0.0	0.0	0.07
Maianthemum racemosum ssp. racemosum	0.5	0.4	0.1	0.33
Maianthemum stellatum	0.0	0.0	0.1	0.03
Monarda fistulosa	0.0	0.1	0.2	0.10
Poaceae fam.	0.0	0.0	0.5	0.17
Polygonatum biflorum	0.1	0.0	0.0	0.03
Prunus virginiana	0.1	0.1	0.0	0.07
Pteridium aquilinum ssp. latiusculum	0.1	0.4	0.0	0.17
Quercus alba	0.1	0.0	0.0	0.03
Quercus velutina	0.7	0.7	0.7	0.70
Rhus copallinum	0.0	0.0	0.6	0.20
Rosa carolina	1	0.5	0.6	0.70
Rubus flagellaris	0.2	0.0	0.0	0.07
Rubus pensilvanicus	0.0	0.1	0.0	0.03
Sassafras albidum	0.0	0.2	0.0	0.07
Solidago caesia	0.2	0.0	0.0	0.07
Solidago sp.	0.2	0.2	0.4	0.27
Tephrosia virginiana	0.0	0.0	0.1	0.03
Toxicodendron sp.	0.0	0.5	0.2	0.23
Tradescantia ohiensis	0.1	0.0	0.2	0.10
Vaccinium angustifolium	0.4	0.2	0.0	0.20
Vaccinium pallidum	0.2	0.2	0.0	0.13
Viola sp.	0.0	0.0	0.1	0.03

Plot: 3047

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Achillea millefolium	0.0	0.0	0.1	0.03
Ageratina altissima	0.0	0.3	0.6	0.30
Alliaria petiolata	0.4	0.0	0.1	0.17
Ambrosia artemisiifolia	0.2	0.0	0.0	0.07
Aralia nudicaulis	0.0	0.4	0.0	0.13
Carex sp.	0.5	0.5	0.6	0.53
Celastrus sp.	0.7	0.6	0.2	0.50
Chelidonium majus	0.0	0.0	0.1	0.03
Chenopodium album	0.0	0.0	0.1	0.03
Circaea canadensis ssp. canadensis	0.1	0.1	0.5	0.23
Coreopsis tripteris	0.0	0.1	0.0	0.03
Diervilla lonicera	0.0	0.0	0.1	0.03
Erechtites hieraciifolius	0.0	0.0	0.1	0.03
Fragaria virginiana	0.1	0.0	0.0	0.03
Geum canadense	0.0	0.2	0.1	0.10
Helianthus divaricatus	0.1	0.1	0.3	0.17
Juncus tenuis	0.0	0.2	0.0	0.07
Maianthemum racemosum ssp. racemosum	0.0	0.0	0.1	0.03
Parthenocissus sp.	0.1	0.0	0.1	0.07
Persicaria hydropiper	0.0	0.1	0.0	0.03
Poaceae fam.	0.0	0.2	0.0	0.07
Populus tremuloides	0.0	0.0	0.1	0.03
Potentilla simplex	0.0	0.1	0.0	0.03
Prunus serotina	0.0	0.0	0.2	0.07
Pteridium aquilinum ssp. latiusculum	0.3	0.3	0.1	0.23
Quercus alba	0.1	0.2	0.0	0.10
Quercus velutina	0.3	0.3	0.4	0.33
Rhamnus frangula	0.0	0.0	0.1	0.03
Rhus copallinum	0.0	0.2	0.0	0.07
Rhus sp.	0.0	0.0	0.1	0.03
Rosa carolina	0.0	0.2	0.0	0.07
Rosa multiflora	0.0	0.0	0.1	0.03
Rubus allegheniensis	0.1	0.0	0.0	0.03
Rubus flagellaris	0.4	0.4	0.1	0.30
Rubus hispidus	0.0	0.4	0.0	0.13
Rubus occidentalis	0.0	0.1	0.2	0.10
Sanicula sp.	0.0	0.0	0.1	0.03
Sassafras albidum	0.3	1	0.3	0.53
Solidago sp.	0.0	0.2	0.2	0.13
Spiraea alba	0.0	0.2	0.0	0.07
Tradescantia ohiensis	0.0	0.1	0.0	0.03
Tridens flavus	0.3	0.0	0.0	0.10
Urtica dioica ssp. gracilis	0.0	0.2	0.0	0.07
Vaccinium angustifolium	0.0	0.3	0.5	0.27
Vaccinium pallidum	0.0	0.1	0.6	0.23
Verbena urticifolia	0.0	0.1	0.1	0.07
Viburnum acerifolium	0.0	0.0	0.1	0.03

Plot: 3049

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Amelanchier Group 3 sp.	0.0	0.1	0.1	0.07
Amphicarpaea bracteata	0.0	0.1	0.0	0.03
Carex sp.	0.0	0.1	0.5	0.20
Carya ovata	0.0	0.2	0.4	0.20
Circaea canadensis ssp. canadensis	0.2	0.1	0.0	0.10
Cornus florida	0.0	0.0	0.5	0.17
Crataegus sp.	0.0	0.2	0.1	0.10
Fraxinus pennsylvanica	0.5	0.8	0.6	0.63
Geum canadense	0.0	0.1	0.1	0.07
Hackelia virginiana	0.1	0.0	0.0	0.03
Lindera benzoin	0.3	0.0	0.1	0.13
Maianthemum racemosum ssp. racemosum	0.0	0.0	0.1	0.03
Parthenocissus sp.	0.0	0.2	0.1	0.10
Persicaria virginiana	0.1	0.0	0.0	0.03
Populus tremuloides	0.1	0.2	0.1	0.13
Potentilla simplex	0.0	0.0	0.3	0.10
Prenanthes sp.	0.0	0.1	0.0	0.03
Prunella vulgaris	0.0	0.0	0.1	0.03
Prunus serotina	0.1	0.3	0.2	0.20
Quercus rubra	0.0	0.2	0.1	0.10
Sassafras albidum	0.0	0.1	0.0	0.03
Smilax rotundifolia	0.0	0.1	0.2	0.10
Solidago sp.	0.0	0.1	0.0	0.03
Thalictrum dioicum	0.3	0.1	0.0	0.13
Toxicodendron sp.	0.0	0.2	0.1	0.10
Vaccinium angustifolium	0.0	0.0	0.2	0.07
Vaccinium pallidum	0.0	0.0	0.1	0.03
Viburnum opulus var. americanum	0.0	0.4	0.2	0.20
Vitis riparia	0.0	0.1	0.0	0.03

Plot: 3050

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Amelanchier Group 2 sp.	0.1	0.0	0.0	0.03
Carex blanda	0.0	0.1	0.0	0.03
Carex grayi	0.1	0.0	0.0	0.03
Carex sp.	0.3	0.2	0.7	0.40
Carex tribuloides	0.0	0.0	0.1	0.03
Celastrus sp.	0.0	0.0	0.2	0.07
Cinna arundinacea	0.2	0.1	0.1	0.13
Dichanthelium clandestinum	0.0	0.0	0.1	0.03
Elymus virginicus	0.0	0.1	0.0	0.03
Erechtites hieraciifolius	0.1	0.0	0.0	0.03
Fraxinus pennsylvanica	0.4	0.1	0.2	0.23
Galium trifidum	0.3	0.0	0.0	0.10
Geum canadense	0.0	0.1	0.0	0.03
Geum sp.	0.1	0.0	0.0	0.03
Glyceria striata	0.0	0.0	0.4	0.13
Ilex verticillata	0.0	0.1	0.2	0.10
Juncus effusus	0.1	0.1	0.0	0.07
Leersia virginica	0.1	0.1	0.4	0.20
Lindera benzoin	0.3	0.5	0.1	0.30
Lonicera (exotic) sp.	0.5	0.3	0.5	0.43
Nyssa sylvatica	0.2	0.1	0.0	0.10
Onoclea sensibilis	0.3	0.1	0.2	0.20
Parthenocissus sp.	0.3	0.2	0.3	0.27
Persicaria virginiana	0.3	0.5	0.0	0.27
Poa palustris	0.1	0.0	0.0	0.03
Poaceae fam.	0.1	0.0	0.0	0.03
Potentilla simplex	0.0	0.3	0.0	0.10
Prenanthes alba	0.2	0.1	0.0	0.10
Quercus palustris	0.1	0.0	0.1	0.07
Ranunculus sp.	0.1	0.0	0.0	0.03
Rosa multiflora	0.3	0.2	0.4	0.30
Rubus hispidus	0.1	0.1	0.2	0.13
Rubus pensilvanicus	0.1	0.1	0.0	0.07
Solidago sp.	0.6	0.2	0.6	0.47
Symphyotrichum lateriflorum var. lateriflorum	0.1	0.0	0.4	0.17
Toxicodendron sp.	0.2	0.0	0.1	0.10
Ulmus americana	0.0	0.1	0.1	0.07
Viburnum opulus var. americanum	0.1	0.1	0.1	0.10
Vitis labrusca	0.3	0.0	0.0	0.10
Vitis riparia	0.0	0.1	0.0	0.03

Plot: 3051

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Amelanchier Group 3 sp.	0.1	0.2	0.1	0.13
Apocynum cannabinum	0.0	0.0	0.1	0.03
Carex sp.	0.5	0.9	0.6	0.67
Hamamelis virginiana	0.2	0.0	0.0	0.07
Helianthus divaricatus	0.1	0.0	0.0	0.03
Maianthemum racemosum ssp. racemosum	0.1	0.0	0.0	0.03
Prunus serotina	0.2	0.1	0.0	0.10
Pteridium aquilinum ssp. latiusculum	0.0	0.1	0.0	0.03
Quercus alba	0.3	0.0	0.1	0.13
Quercus velutina	0.0	0.1	0.3	0.13
Rhus copallinum	0.0	0.0	0.1	0.03
Rubus allegheniensis	0.1	0.0	0.0	0.03
Rubus flagellaris	0.3	0.2	0.3	0.27
Sassafras albidum	0.5	0.9	0.6	0.67
Smilax rotundifolia	0.0	0.1	0.3	0.13
Vaccinium angustifolium	0.1	1	0.2	0.43
Vaccinium pallidum	0.9	0.5	0.0	0.47

Plot: 3053

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.1	0.1	0.07
Asteraceae fam.	0.0	0.6	0.3	0.30
Bidens connata	0.0	0.0	0.1	0.03
Carex lacustris	0.0	0.1	0.0	0.03
Carex sp.	0.7	0.6	0.8	0.70
Carex swanii	0.0	0.0	0.1	0.03
Cornus racemosa	0.0	0.1	0.0	0.03
Danthonia spicata	0.1	0.0	0.0	0.03
Dichanthelium sp.	0.0	0.1	0.1	0.07
Helianthemum canadense	0.0	0.1	0.0	0.03
Helianthus divaricatus	0.0	0.0	0.3	0.10
Maianthemum canadense	0.1	0.0	0.0	0.03
Maianthemum racemosum ssp. racemosum	0.1	0.0	0.0	0.03
Pedicularis canadensis	0.2	0.0	0.0	0.07
Poaceae fam.	0.2	0.5	0.1	0.27
Potentilla simplex	0.0	0.1	0.1	0.07
Prunus serotina	0.0	0.0	0.6	0.20
Pteridium aquilinum ssp. latiusculum	0.0	0.3	0.9	0.40
Quercus alba	0.0	0.1	0.4	0.17
Quercus velutina	0.8	0.1	0.6	0.50
Rosa carolina	0.1	0.0	0.0	0.03
Rubus allegheniensis	0.0	0.3	0.0	0.10
Rubus flagellaris	0.1	0.7	0.5	0.43
Rubus sachalinensis var. sachalinensis	0.0	0.2	0.0	0.07
Sassafras albidum	0.0	1	0.1	0.37
Smilax rotundifolia	0.0	0.5	0.1	0.20
Solidago sp.	0.0	0.1	0.1	0.07
Vaccinium angustifolium	0.9	0.1	0.6	0.53
Vaccinium pallidum	0.2	0.0	0.0	0.07
Vitis aestivalis	0.0	0.0	0.2	0.07

Plot: 3059

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.1	0.0	0.03
Ageratina altissima	0.4	0.0	0.1	0.17
Amelanchier Group 2 sp.	0.1	0.0	0.0	0.03
Bidens frondosa	0.1	0.4	0.0	0.17
Boehmeria cylindrica	0.3	0.2	0.0	0.17
Carex comosa	0.1	0.2	0.0	0.10
Carex sp.	0.3	0.0	0.4	0.23
Carex tribuloides	0.2	0.0	0.0	0.07
Celastrus sp.	0.2	0.2	0.6	0.33
Circaea canadensis ssp. canadensis	0.5	0.1	0.4	0.33
Cuscuta gronovii	0.1	0.5	0.0	0.20
Fallopia convolvulus	0.0	0.2	0.0	0.07
Fraxinus pennsylvanica	0.3	0.0	0.0	0.10
Galium pilosum	0.0	0.0	0.2	0.07
Geum sp.	0.1	0.0	0.0	0.03
Glyceria striata	0.0	0.2	0.0	0.07
Hydrocotyle umbellata	0.1	0.0	0.0	0.03
Leersia oryzoides	0.3	0.0	0.0	0.10
Leersia virginica	0.0	0.4	0.0	0.13
Lonicera (exotic) sp.	0.1	0.0	0.2	0.10
Maianthemum racemosum ssp. racemosum	0.1	0.0	0.0	0.03
Monarda fistulosa	0.0	0.0	0.1	0.03
Nyssa sylvatica	0.2	0.1	0.0	0.10
Oxalis stricta	0.2	0.0	0.0	0.07
Parthenocissus sp.	0.6	0.1	0.9	0.53
Persicaria maculosa	0.1	0.0	0.0	0.03
Persicaria punctata	0.1	0.6	0.0	0.23
Persicaria sagittata	0.2	0.2	0.0	0.13
Phragmites australis	0.0	0.7	0.0	0.23
Pilea sp.	0.0	0.7	0.0	0.23
Poaceae fam.	0.0	0.1	0.3	0.13
Prunus serotina	0.5	0.0	0.5	0.33
Prunus virginiana	0.1	0.0	0.0	0.03
Quercus velutina	0.1	0.1	0.1	0.10
Rosa multiflora	0.4	0.0	0.4	0.27
Rubus flagellaris	0.2	0.0	0.1	0.10
Rubus occidentalis	0.2	0.1	0.2	0.17
Rubus pensilvanicus	0.0	0.0	0.4	0.13
Rubus sachalinensis var. sachalinensis	0.1	0.0	0.0	0.03
Smilax ecirrhata	0.1	0.0	0.0	0.03
Solidago sp.	0.0	0.0	0.2	0.07
Toxicodendron sp.	0.1	0.0	0.1	0.07
Urtica dioica ssp. gracilis	0.1	0.0	0.0	0.03
Vaccinium angustifolium	0.0	0.0	0.1	0.03
Viburnum opulus var. americanum	0.1	0.0	0.0	0.03
Viburnum recognitum	0.1	0.0	0.0	0.03
Viola sp.	0.0	0.0	0.1	0.03
Vitis riparia	0.1	0.1	0.0	0.07

Plot: 3064

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Ageratina altissima	0.4	0.0	0.1	0.17
Agrimonia gryposepala	0.0	0.3	0.0	0.10
Amelanchier Group 2 sp.	0.1	0.0	0.0	0.03
Amphicarpaea bracteata	0.1	0.0	0.1	0.07
Bidens frondosa	0.1	0.1	0.3	0.17
Bromus ciliatus	0.0	0.1	0.0	0.03
Carex sp.	0.1	0.2	0.1	0.13
Carya ovata	0.3	0.1	0.1	0.17
Circaea canadensis ssp. canadensis	0.5	0.6	0.7	0.60
Cornus florida	0.0	0.0	0.1	0.03
Fraxinus pennsylvanica	0.2	0.1	0.3	0.20
Galium concinnum	0.0	0.0	0.2	0.07
Galium triflorum	0.1	0.4	0.0	0.17
Geranium maculatum	0.3	0.3	0.2	0.27
Geum canadense	0.5	0.4	0.7	0.53
Hackelia virginiana	0.2	0.1	0.2	0.17
Impatiens sp.	0.1	0.0	0.1	0.07
Lobelia cardinalis	0.0	0.0	0.1	0.03
Maianthemum canadense	0.0	0.0	0.2	0.07
Maianthemum racemosum ssp. racemosum	0.1	0.0	0.0	0.03
Oxalis stricta	0.5	0.3	0.1	0.30
Parthenocissus sp.	0.4	0.4	0.3	0.37
Persicaria virginiana	0.6	0.5	0.6	0.57
Poaceae fam.	0.3	0.8	0.3	0.47
Potentilla simplex	0.2	0.7	0.4	0.43
Prenanthes sp.	0.2	0.0	0.0	0.07
Prunus serotina	0.1	0.0	0.2	0.10
Quercus alba	0.0	0.1	0.1	0.07
Rubus allegheniensis	0.2	0.6	0.7	0.50
Solidago sp.	0.2	0.3	0.3	0.27
Symphotrichum lateriflorum var. lateriflorum	0.0	0.4	0.3	0.23
Taraxacum officinale	0.1	0.0	0.0	0.03
Toxicodendron sp.	0.2	0.2	0.1	0.17
Ulmus americana	0.0	0.1	0.0	0.03
unknown Herbaceous species	0.0	0.1	0.0	0.03
Viburnum lentago	0.2	0.1	0.0	0.10
Viburnum recognitum	0.1	0.0	0.0	0.03
Viola sp.	0.3	0.3	0.1	0.23
Vitis riparia	0.0	0.0	0.1	0.03

Plot: 3065

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.0	0.2	0.07
Amelanchier Group 2 sp.	0.1	0.0	0.0	0.03
Amphicarpaea bracteata	0.0	0.0	0.1	0.03
Berberis thunbergii	0.2	0.0	0.0	0.07
Boehmeria cylindrica	0.1	0.0	0.0	0.03
Carex pensylvanica	0.0	0.0	0.6	0.20
Carya ovata	0.0	0.1	0.4	0.17
Celastrus sp.	0.9	0.3	0.6	0.60
Chelidonium majus	0.0	0.1	0.0	0.03
Circaea canadensis ssp. canadensis	0.1	0.6	0.5	0.40
Convallaria majalis	0.1	0.3	0.0	0.13
Cornus racemosa	0.0	0.0	0.3	0.10
Crataegus sp.	0.0	0.0	0.4	0.13
Euonymus sp.	0.1	0.0	0.0	0.03
Fraxinus pennsylvanica	0.1	0.2	0.1	0.13
Geum canadense	0.3	0.0	0.0	0.10
Hamamelis virginiana	0.0	0.0	0.1	0.03
Lindera benzoin	0.0	0.0	0.3	0.10
Lonicera (exotic) sp.	0.0	0.1	0.1	0.07
Maianthemum racemosum ssp. racemosum	0.0	0.1	0.1	0.07
Osmorhiza sp.	0.1	0.0	0.0	0.03
Pachysandra terminalis	0.3	0.0	0.0	0.10
Parthenocissus sp.	0.7	0.4	0.9	0.67
Persicaria virginiana	0.7	0.3	0.4	0.47
Polygonatum pubescens	0.0	0.1	0.0	0.03
Prunus serotina	0.0	0.6	0.1	0.23
Prunus virginiana	0.0	0.3	0.3	0.20
Quercus alba	0.0	0.0	0.1	0.03
Ribes cynosbati	0.1	0.1	0.1	0.10
Rosa multiflora	0.2	0.0	0.2	0.13
Rubus flagellaris	0.0	0.2	0.1	0.10
Rubus occidentalis	0.1	0.1	0.0	0.07
Sanicula sp.	0.2	0.0	0.1	0.10
Sassafras albidum	0.1	0.0	0.6	0.23
Symphyotrichum lateriflorum var. lateriflorum	0.1	0.0	0.0	0.03
Toxicodendron sp.	0.3	0.1	0.1	0.17
Vernonia fasciculata	0.0	0.0	0.2	0.07
Viola sp.	0.2	0.0	0.0	0.07

Plot: 3069

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Amelanchier Group 3 sp.	0.1	0.1	0.1	0.10
Berberis thunbergii	0.1	0.0	0.1	0.07
Carex sp.	0.0	0.1	0.3	0.13
Celastrus sp.	0.9	1	0.6	0.83
Circaea canadensis ssp. canadensis	0.5	0.3	0.1	0.30
Cornus florida	0.0	0.1	0.0	0.03
Equisetum arvense	0.0	0.0	0.1	0.03
Eutrochium maculatum	0.0	0.1	0.0	0.03
Fraxinus pennsylvanica	0.4	0.2	0.4	0.33
Galium pilosum	0.1	0.0	0.0	0.03
Geum canadense	0.7	0.3	0.2	0.40
Hackelia virginiana	0.1	0.0	0.0	0.03
Lindera benzoin	0.1	0.2	0.5	0.27
Osmorhiza sp.	0.0	0.1	0.0	0.03
Parthenocissus sp.	1	0.4	0.5	0.63
Persicaria virginiana	1	0.0	0.1	0.37
Poaceae fam.	0.0	0.0	0.1	0.03
Potentilla simplex	0.2	0.1	0.1	0.13
Prenanthes sp.	0.0	0.2	0.0	0.07
Prunus serotina	0.0	0.0	0.3	0.10
Prunus virginiana	0.0	0.0	0.1	0.03
Quercus rubra	0.2	0.0	0.0	0.07
Rosa multiflora	0.2	0.3	0.2	0.23
Rubus allegheniensis	0.3	0.2	0.2	0.23
Rubus hispidus	0.0	0.1	0.0	0.03
Sassafras albidum	0.2	0.1	0.2	0.17
Smilax rotundifolia	0.1	0.5	0.2	0.27
Smilax tamnoides	0.0	0.0	0.1	0.03
Toxicodendron sp.	0.3	0.3	0.2	0.27
Ulmus americana	0.3	0.0	0.0	0.10
unknown Herbaceous species	0.0	0.0	0.2	0.07
Viburnum rafinesqueanum	0.0	0.1	0.0	0.03
Viola sp.	0.3	0.0	0.0	0.10

Plot: 3074

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Agrimonia gryposepala	0.0	0.1	0.0	0.03
Amelanchier Group 2 sp.	0.0	0.0	0.1	0.03
Amelanchier Group 3 sp.	0.0	0.0	0.1	0.03
Arisaema triphyllum	0.1	0.0	0.0	0.03
Berberis thunbergii	0.0	0.1	0.0	0.03
Carex sp.	0.0	0.1	0.1	0.07
Carya ovata	0.3	0.2	0.3	0.27
Celastrus sp.	0.1	0.2	0.4	0.23
Circaea canadensis ssp. canadensis	0.3	0.1	0.2	0.20
Cornus florida	0.3	0.2	0.4	0.30
Crataegus sp.	0.4	0.0	0.3	0.23
Fraxinus pennsylvanica	0.3	0.1	0.5	0.30
Geum canadense	0.0	0.1	0.1	0.07
Hackelia virginiana	0.0	0.0	0.2	0.07
Juncus tenuis	0.0	0.0	0.1	0.03
Lindera benzoin	0.0	0.1	0.1	0.07
Maianthemum canadense	0.0	0.0	0.1	0.03
Oxalis stricta	0.0	0.1	0.0	0.03
Parthenocissus sp.	0.6	0.7	0.5	0.60
Persicaria virginiana	0.1	0.0	0.2	0.10
Poaceae fam.	0.0	0.1	0.0	0.03
Potentilla simplex	0.3	0.1	0.3	0.23
Prunus serotina	0.0	0.0	0.2	0.07
Quercus alba	0.1	0.0	0.1	0.07
Rosa multiflora	0.2	0.1	0.4	0.23
Rubus allegheniensis	0.0	0.3	0.2	0.17
Rubus pubescens	0.2	0.0	0.0	0.07
Sanicula sp.	0.0	0.1	0.0	0.03
Solidago sp.	0.1	0.1	0.0	0.07
Symphyotrichum lateriflorum var. lateriflorum	0.0	0.1	0.1	0.07
Toxicodendron sp.	0.2	0.0	0.0	0.07
Viburnum lentago	0.1	0.1	0.3	0.17
Viola sp.	0.0	0.1	0.0	0.03

Plot: 3078

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.1	0.0	0.0	0.03
Aronia melanocarpa	0.0	0.0	0.2	0.07
Brachyelytrum erectum	0.0	0.0	0.1	0.03
Carex pensylvanica	1	1	0.0	0.67
Carex sp.	0.0	0.0	0.2	0.07
Carpinus caroliniana	0.0	0.0	0.4	0.13
Carya ovata	0.0	0.1	0.0	0.03
Circaea canadensis ssp. canadensis	0.0	0.3	0.0	0.10
Comandra umbellata	0.1	0.1	0.0	0.07
Cornus racemosa	0.2	0.1	0.0	0.10
Euphorbia corollata	0.1	0.0	0.0	0.03
Fragaria virginiana	0.0	0.1	0.0	0.03
Fraxinus pennsylvanica	0.0	0.0	0.1	0.03
Galium pilosum	0.1	0.5	0.0	0.20
Gaylussacia baccata	0.0	0.1	0.0	0.03
Hamamelis virginiana	0.0	0.0	0.5	0.17
Helianthus divaricatus	0.9	0.6	0.0	0.50
Lindera benzoin	0.0	0.0	0.7	0.23
Maianthemum racemosum ssp. racemosum	0.3	0.0	0.0	0.10
Monarda fistulosa	0.0	0.1	0.0	0.03
Monarda punctata	0.0	0.1	0.0	0.03
Nyssa sylvatica	0.0	0.0	0.2	0.07
Osmunda regalis var. spectabilis	0.0	0.0	0.3	0.10
Osmundastrum cinnamomea	0.0	0.0	0.8	0.27
Parthenocissus sp.	0.0	0.0	0.1	0.03
Podophyllum peltatum	0.0	0.0	0.1	0.03
Polygonatum pubescens	0.2	0.1	0.0	0.10
Potentilla simplex	0.0	0.5	0.0	0.17
Prunus serotina	0.3	0.2	0.0	0.17
Prunus virginiana	0.0	0.2	0.1	0.10
Pteridium aquilinum ssp. latiusculum	0.0	0.2	0.0	0.07
Quercus velutina	1	0.4	0.0	0.47
Rosa carolina	0.6	0.2	0.0	0.27
Rubus allegheniensis	0.7	1	0.0	0.57
Rubus hispidus	0.2	0.0	0.5	0.23
Rubus occidentalis	0.0	0.1	0.0	0.03
Rubus pensilvanicus	0.1	0.0	0.1	0.07
Sassafras albidum	0.5	0.7	0.2	0.47
Smilax ecirrhata	0.0	0.2	0.0	0.07
Smilax rotundifolia	0.0	0.0	0.2	0.07
Solidago caesia	0.0	0.2	0.0	0.07
Solidago sp.	0.1	0.0	0.1	0.07
Vaccinium pallidum	0.9	0.6	0.0	0.50
Viola sp.	0.0	0.0	0.2	0.07
Vitis labrusca	0.0	0.1	0.0	0.03

Plot: 3082

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.2	0.1	0.1	0.13
Amelanchier Group 2 sp.	0.1	0.1	0.2	0.13
Antennaria plantaginifolia	0.0	0.0	0.1	0.03
Carex pensylvanica	1	1	1	1.00
Celastrus sp.	0.0	0.0	0.1	0.03
Desmodium sessilifolium	0.0	0.0	0.1	0.03
Euonymus sp.	0.0	0.0	0.1	0.03
Euphorbia corollata	0.0	0.0	0.1	0.03
Gaylussacia baccata	0.3	0.1	0.0	0.13
Hamamelis virginiana	0.1	0.0	0.0	0.03
Helianthus divaricatus	0.2	0.0	0.1	0.10
Maianthemum racemosum ssp. racemosum	0.1	0.4	0.2	0.23
Nyssa sylvatica	0.0	0.1	0.0	0.03
Poa compressa	0.0	0.0	0.1	0.03
Polygonatum biflorum	0.0	0.1	0.0	0.03
Potentilla simplex	0.0	0.0	0.1	0.03
Prunus serotina	0.3	0.3	0.2	0.27
Pteridium aquilinum ssp. latiusculum	0.0	0.0	0.1	0.03
Quercus alba	0.0	0.0	0.2	0.07
Quercus velutina	0.1	0.4	0.4	0.30
Ribes cynosbati	0.0	0.1	0.0	0.03
Rosa carolina	0.2	0.3	0.2	0.23
Rubus allegheniensis	0.0	0.5	0.0	0.17
Rubus flagellaris	0.1	0.0	0.3	0.13
Sassafras albidum	0.5	0.5	0.5	0.50
Solidago sp.	0.2	0.0	0.0	0.07
Toxicodendron sp.	0.0	0.0	0.1	0.03
Vaccinium angustifolium	0.4	0.5	1	0.63
Vaccinium pallidum	0.8	0.6	0.0	0.47
Vitis riparia	0.0	0.1	0.0	0.03

Plot: 3084

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.1	0.0	0.0	0.03
Achillea millefolium	0.0	0.1	0.0	0.03
Ageratina altissima	0.0	0.1	0.0	0.03
Amelanchier Group 2 sp.	0.0	0.1	0.0	0.03
Amphicarpaea bracteata	0.5	0.0	0.0	0.17
Apios americana	0.2	0.0	0.0	0.07
Asclepias syriaca	0.3	0.1	0.0	0.13
Bidens connata	0.2	0.0	0.0	0.07
Carex sp.	0.4	0.0	0.0	0.13
Celastrus sp.	0.0	0.1	0.0	0.03
Chenopodium album	0.0	0.0	0.1	0.03
Cornus racemosa	0.2	0.1	0.0	0.10
Desmodium sessilifolium	0.0	0.0	0.1	0.03
Dichanthelium sp.	0.0	0.1	0.1	0.07
Diervilla lonicera	0.0	0.1	0.0	0.03
Epilobium sp.	0.2	0.0	0.0	0.07
Equisetum hyemale	0.4	0.0	0.0	0.13
Erechtites hieraciifolius	0.1	0.0	0.0	0.03
Eupatorium perfoliatum	0.2	0.0	0.0	0.07
Euphorbia corollata	0.1	0.1	0.5	0.23
Euthamia graminifolia	0.1	0.0	0.0	0.03
Fragaria virginiana	0.1	0.2	0.7	0.33
Galium pilosum	0.1	0.1	0.1	0.10
Gaylussacia baccata	0.0	0.1	0.0	0.03
Hackelia virginiana	0.0	0.2	0.0	0.07
Helianthemum canadense	0.1	0.0	0.0	0.03
Helianthus divaricatus	0.1	0.6	0.6	0.43
Hypericum sp.	0.1	0.0	0.0	0.03
Juncus canadensis	0.2	0.0	0.0	0.07
Leersia sp.	0.0	0.0	0.5	0.17
Lespedeza hirta	0.0	0.1	0.0	0.03
Lespedeza sp.	0.1	0.0	0.0	0.03
Liatis aspera	0.1	0.0	0.0	0.03
Linaria vulgaris	0.4	0.0	0.2	0.20
Lithospermum caroliniense var. croceum	0.0	0.0	0.1	0.03
Lycopus americanus	0.1	0.0	0.0	0.03
Maianthemum racemosum ssp. racemosum	0.0	0.1	0.0	0.03
Monarda fistulosa	0.3	0.1	0.1	0.17
Oenothera biennis	0.0	0.0	0.1	0.03
Parthenocissus sp.	0.0	0.0	0.1	0.03
Persicaria maculosa	0.1	0.0	0.0	0.03
Poaceae fam.	0.8	0.9	1	0.90
Polygonatum biflorum	0.0	0.1	0.1	0.07
Potentilla simplex	0.1	0.8	0.0	0.30
Prunus serotina	0.0	0.1	0.2	0.10
Prunus virginiana	0.0	0.0	0.1	0.03
Pteridium aquilinum ssp. latiusculum	0.0	0.6	0.2	0.27
Quercus velutina	0.2	0.1	0.9	0.40
Rosa blanda	0.0	0.3	0.3	0.20
Rubus pensilvanicus	0.0	0.7	1	0.57
Rubus sachalinensis var. sachalinensis	0.0	0.0	0.1	0.03
Salix sp.	0.6	0.0	0.0	0.20
Sassafras albidum	0.1	0.8	0.3	0.40

Plot: 3084

Species	Quadrat Frequency			Mean Quadrat Frequency
	Transect 1	Transect 2	Transect 3	
Schoenoplectus pungens var. pungens	0.3	0.0	0.0	0.10
Solidago sp.	0.8	0.6	0.8	0.73
Stachys sp.	0.1	0.0	0.0	0.03
Symphyotrichum oolentangiense	0.0	0.0	0.1	0.03
Toxicodendron sp.	0.2	0.0	0.0	0.07
Vaccinium angustifolium	0.0	0.8	0.0	0.27
Vaccinium pallidum	0.0	0.3	0.0	0.10
Vitis riparia	0.0	0.0	0.2	0.07

Plot: 3085

Species	Quadrat Frequency			Mean Quadrat Frequency
	Transect 1	Transect 2	Transect 3	
Athyrium filix-femina var. angustum	0.0	0.2	0.0	0.07
Boehmeria cylindrica	0.1	0.0	0.0	0.03
Carex sp.	0.1	0.1	0.2	0.13
Carya cordiformis	0.0	0.3	0.1	0.13
Carya ovata	0.1	0.0	0.0	0.03
Circaea canadensis ssp. canadensis	0.0	0.1	0.1	0.07
Dryopteris carthusiana	0.1	0.0	0.0	0.03
Geum canadense	0.1	0.0	0.0	0.03
Hamamelis virginiana	0.1	0.0	0.0	0.03
Lindera benzoin	1	1	0.9	0.97
Parthenocissus sp.	0.1	0.7	0.2	0.33
Persicaria virginiana	0.0	0.0	0.1	0.03
Poaceae fam.	0.1	0.0	0.0	0.03
Polygonatum pubescens	0.0	0.1	0.0	0.03
Ribes cynosbati	0.0	0.1	0.0	0.03
Rubus flagellaris	0.0	0.2	0.0	0.07
Sanicula sp.	0.1	0.0	0.0	0.03
Solidago flexicaulis	0.0	0.0	0.1	0.03
Toxicodendron sp.	0.2	0.2	0.1	0.17
Viburnum opulus var. americanum	0.0	0.0	0.1	0.03
Viola sp.	0.1	0.0	0.0	0.03

Plot: 3090

Species	Quadrat Frequency			Mean Quadrat Frequency
	Transect 1	Transect 2	Transect 3	
Acer rubrum	0.1	0.0	0.0	0.03
Acer saccharum	0.2	0.1	0.0	0.10
Allium tricoccum	0.1	0.0	0.0	0.03
Asarum canadense	0.4	0.0	0.0	0.13
Asimina triloba	0.0	0.0	0.2	0.07
Carex sp.	0.2	0.1	0.0	0.10
Carya cordiformis	0.1	0.2	0.0	0.10
Fraxinus pennsylvanica	0.1	0.0	0.0	0.03
Hamamelis virginiana	0.1	0.0	0.0	0.03
Laportea canadensis	0.1	0.0	0.0	0.03
Lindera benzoin	0.6	0.9	1	0.83
Liriodendron tulipifera	0.2	0.0	0.0	0.07
Maianthemum racemosum ssp. racemosum	0.1	0.0	0.0	0.03
Ostrya virginiana	0.0	0.1	0.0	0.03
Parthenocissus sp.	0.4	0.4	0.0	0.27
Persicaria virginiana	0.3	0.0	0.0	0.10
Phytolacca americana	0.1	0.0	0.0	0.03
Pilea sp.	0.1	0.0	0.0	0.03
Polystichum acrostichoides	0.1	0.0	0.0	0.03
Prunus serotina	0.4	0.0	0.0	0.13
Prunus virginiana	0.1	0.0	0.0	0.03
Quercus rubra	0.1	0.0	0.0	0.03
Ribes hirtellum	0.1	0.0	0.1	0.07
Rubus pensilvanicus	0.3	0.1	0.0	0.13
Toxicodendron sp.	0.2	0.0	0.1	0.10
Viola sp.	0.1	0.0	0.0	0.03
Vitis riparia	0.1	0.0	0.0	0.03

Plot: 3092

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.0	0.0	0.1	0.03
Alliaria petiolata	0.0	0.0	0.1	0.03
Berberis thunbergii	0.3	0.1	0.0	0.13
Carex sp.	0.5	0.1	0.4	0.33
Carya cordiformis	0.0	0.1	0.0	0.03
Celastrus sp.	0.7	0.7	0.0	0.47
Cephalanthus occidentalis	0.0	0.0	0.1	0.03
Cinna arundinacea	0.0	0.0	0.4	0.13
Circaea canadensis ssp. canadensis	0.1	0.1	0.0	0.07
Crataegus sp.	0.1	0.2	0.0	0.10
Cryptotaenia canadensis	0.0	0.0	0.1	0.03
Elymus sp.	0.1	0.0	0.0	0.03
Fraxinus pennsylvanica	0.4	0.7	0.0	0.37
Galium circaeans var. circaeans	0.1	0.0	0.0	0.03
Galium triflorum	0.4	0.4	0.0	0.27
Geum canadense	0.4	0.2	0.0	0.20
Hackelia virginiana	0.1	0.3	0.1	0.17
Impatiens sp.	0.0	0.0	0.1	0.03
Iris sp.	0.0	0.0	0.1	0.03
Lindera benzoin	0.8	0.9	0.4	0.70
Lonicera (exotic) sp.	0.1	0.0	0.0	0.03
Lysimachia ciliata	0.0	0.0	0.1	0.03
Lysimachia nummularia	0.0	0.0	0.3	0.10
Maianthemum racemosum ssp. racemosum	0.4	0.0	0.0	0.13
Parthenocissus sp.	0.4	0.9	0.0	0.43
Persicaria punctata	0.0	0.0	0.2	0.07
Persicaria virginiana	0.6	0.5	0.1	0.40
Pilea sp.	0.0	0.2	0.3	0.17
Poaceae fam.	0.1	0.4	0.0	0.17
Ranunculus hispidus	0.0	0.1	0.0	0.03
Ranunculus recurvatus	0.0	0.0	0.1	0.03
Ribes cynosbati	0.0	0.1	0.0	0.03
Rosa multiflora	0.3	0.2	0.0	0.17
Rubus pensilvanicus	0.1	0.3	0.0	0.13
Sanicula marilandica	0.1	0.0	0.0	0.03
Sanicula sp.	0.3	0.0	0.0	0.10
Smilax tamnoides	0.1	0.0	0.0	0.03
Solidago sp.	0.0	0.1	0.3	0.13
Symphytotrichum lateriflorum var. lateriflorum	0.2	0.2	0.4	0.27
Toxicodendron sp.	0.2	0.1	0.1	0.13
Verbesina alternifolia	0.0	0.0	0.1	0.03
Viola sp.	0.3	0.1	0.3	0.23

Plot: 3093

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Ageratina altissima	0.2	0.1	0.0	0.10
Ambrosia artemisiifolia	0.1	0.0	0.0	0.03
Amelanchier Group 2 sp.	0.2	0.3	0.0	0.17
Antennaria plantaginifolia	0.1	0.0	0.0	0.03
Aralia nudicaulis	0.4	0.0	0.0	0.13
Asclepias syriaca	0.1	0.0	0.0	0.03
Carex sp.	1	1	1	1.00
Celastrus sp.	0.2	0.1	0.2	0.17
Coryza canadensis	0.0	0.1	0.0	0.03
Coreopsis tripteris	0.0	0.1	0.0	0.03
Cornus florida	0.1	0.2	0.1	0.13
Cornus racemosa	0.2	0.0	0.0	0.07
Dichanthelium sp.	0.2	0.5	0.3	0.33
Diervilla lonicera	0.4	0.0	0.0	0.13
Doellingeria umbellata var. umbellata	0.0	0.1	0.0	0.03
Eupatorium altissimum	0.0	0.0	0.1	0.03
Eupatorium serotinum	0.0	0.1	0.0	0.03
Euphorbia corollata	0.2	0.0	0.0	0.07
Fragaria virginiana	0.0	0.1	0.0	0.03
Galium pilosum	0.1	0.2	0.3	0.20
Hamamelis virginiana	0.5	0.0	0.0	0.17
Helianthemum canadense	0.0	0.2	0.0	0.07
Helianthus divaricatus	0.8	0.8	0.7	0.77
Ionactis linariifolia	0.0	0.1	0.0	0.03
Lespedeza sp.	0.1	0.1	0.1	0.10
Maianthemum racemosum ssp. racemosum	0.0	0.1	0.0	0.03
Parthenocissus sp.	0.1	0.2	0.1	0.13
Phalaris arundinacea	0.0	0.1	0.0	0.03
Phlox pilosa	0.0	0.2	0.0	0.07
Poaceae fam.	0.0	0.1	0.2	0.10
Prunus serotina	0.2	0.5	0.5	0.40
Prunus virginiana	0.3	0.1	0.0	0.13
Pteridium aquilinum ssp. latiusculum	0.0	0.0	0.3	0.10
Quercus alba	0.2	0.0	0.1	0.10
Quercus velutina	0.3	0.2	0.4	0.30
Rhus copallinum	0.1	0.1	0.0	0.07
Rosa blanda	0.7	0.5	0.3	0.50
Rubus allegheniensis	0.0	0.1	0.0	0.03
Rubus occidentalis	0.2	0.1	0.0	0.10
Rubus pensilvanicus	0.4	0.4	0.7	0.50
Sassafras albidum	0.6	0.6	0.7	0.63
Smilax tamnoides	0.0	0.0	0.1	0.03
Solidago sp.	0.1	0.0	0.4	0.17
Toxicodendron sp.	0.2	0.0	0.1	0.10
Tradescantia ohiensis	0.0	0.1	0.1	0.07
Vaccinium angustifolium	0.1	0.1	0.0	0.07
Vaccinium pallidum	0.2	0.0	0.3	0.17
Verbascum thapsus	0.0	0.0	0.1	0.03
Viburnum rafinesqueanum	0.1	0.1	0.0	0.07
Vitis riparia	0.4	0.0	0.3	0.23

Plot: 3095

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
<i>Aquilegia canadensis</i>	0.4	0.2	0.3	0.30
<i>Aralia nudicaulis</i>	0.0	0.7	0.0	0.23
<i>Artemisia campestris</i> ssp. <i>caudata</i>	0.0	0.0	0.2	0.07
<i>Calamovilfa longifolia</i> var. <i>magna</i>	0.0	0.0	0.2	0.07
<i>Carex</i> sp.	0.9	0.4	0.9	0.73
<i>Ceanothus americanus</i>	0.2	0.3	0.1	0.20
<i>Comandra umbellata</i>	0.3	0.2	0.6	0.37
<i>Dichanthelium</i> sp.	0.1	0.0	0.3	0.13
<i>Euphorbia corollata</i>	0.9	0.1	0.7	0.57
<i>Fragaria virginiana</i>	0.4	0.1	0.1	0.20
<i>Galium circaeans</i> var. <i>circaeans</i>	0.6	0.0	0.0	0.20
<i>Galium pilosum</i>	0.2	0.2	0.0	0.13
<i>Geum</i> sp.	0.2	0.0	0.0	0.07
<i>Helianthus divaricatus</i>	1	0.8	0.9	0.90
<i>Ionactis linariifolia</i>	0.5	0.0	0.6	0.37
<i>Koeleria macrantha</i>	0.0	0.3	0.1	0.13
<i>Lithospermum carolinense</i> var. <i>croceum</i>	0.0	0.0	0.1	0.03
<i>Lonicera</i> (exotic) sp.	0.2	0.0	0.1	0.10
<i>Maianthemum canadense</i>	0.0	0.1	0.0	0.03
<i>Maianthemum racemosum</i> ssp. <i>racemosum</i>	0.1	0.0	0.1	0.07
<i>Monarda fistulosa</i>	0.9	0.6	0.1	0.53
<i>Oenothera biennis</i>	0.1	0.0	0.0	0.03
<i>Panicum virgatum</i>	0.0	0.0	0.3	0.10
<i>Plantago rugelii</i>	0.1	0.0	0.0	0.03
<i>Poa compressa</i>	0.4	0.0	0.0	0.13
<i>Poa</i> sp.	0.0	0.0	0.2	0.07
Poaceae fam.	0.0	0.1	0.0	0.03
<i>Prunus virginiana</i>	0.0	0.3	0.1	0.13
<i>Ptelea trifoliata</i>	0.1	0.0	0.0	0.03
<i>Quercus alba</i>	0.0	0.0	0.1	0.03
<i>Quercus velutina</i>	0.0	0.2	0.4	0.20
<i>Rhus aromatica</i>	0.2	0.3	0.1	0.20
<i>Rhus copallinum</i>	0.0	0.0	0.4	0.13
<i>Rosa carolina</i>	0.7	0.5	0.7	0.63
<i>Rubus allegheniensis</i>	0.6	0.0	0.0	0.20
<i>Rubus flagellaris</i>	0.1	0.0	0.0	0.03
<i>Sassafras albidum</i>	0.0	0.2	0.0	0.07
<i>Solidago caesia</i>	0.2	0.0	0.0	0.07
<i>Solidago</i> sp.	1	0.1	0.1	0.40
<i>Symphyotrichum oolentangiense</i>	0.1	0.0	0.0	0.03
<i>Toxicodendron</i> sp.	0.7	0.6	0.6	0.63
<i>Tradescantia ohiensis</i>	0.0	0.1	0.0	0.03
<i>Viburnum acerifolium</i>	0.0	0.3	0.0	0.10
<i>Vitis riparia</i>	0.1	0.0	0.0	0.03

Plot: 3096

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
<i>Acer rubrum</i>	0.0	0.0	0.3	0.10
<i>Agrimonia gryposepala</i>	0.0	0.0	0.1	0.03
<i>Apios americana</i>	0.0	0.0	0.4	0.13
<i>Aronia melanocarpa</i>	0.2	0.1	0.1	0.13
<i>Berberis thunbergii</i>	0.0	0.0	0.1	0.03
<i>Calamagrostis canadensis</i>	0.9	0.0	0.0	0.30
<i>Carex</i> sp.	0.1	0.2	0.9	0.40
<i>Carex swanii</i>	0.0	0.1	0.0	0.03
<i>Celastrus</i> sp.	0.0	0.1	0.1	0.07
<i>Cephalanthus occidentalis</i>	0.5	0.7	0.0	0.40
<i>Conyza canadensis</i>	0.1	0.0	0.0	0.03
<i>Cornus racemosa</i>	0.1	0.1	0.3	0.17
<i>Crataegus</i> sp.	0.0	0.0	0.2	0.07
<i>Desmodium</i> sp.	0.0	0.0	0.2	0.07
<i>Dichanthelium</i> sp.	0.2	0.1	0.0	0.10
<i>Diervilla lonicera</i>	0.0	0.0	0.1	0.03
<i>Dulichium arundinaceum</i>	0.1	0.0	0.0	0.03
<i>Erechtites hieraciifolius</i>	0.2	0.3	0.0	0.17
<i>Eupatorium perfoliatum</i>	0.1	0.0	0.0	0.03
<i>Eupatorium serotinum</i>	0.4	0.0	0.0	0.13
<i>Euthamia graminifolia</i>	0.1	0.0	0.0	0.03
<i>Eutrochium maculatum</i>	0.1	0.0	0.0	0.03
<i>Fallopia convolvulus</i>	0.1	0.0	0.0	0.03
<i>Fragaria virginiana</i>	0.1	0.0	0.0	0.03
<i>Galium triflorum</i>	0.1	0.1	0.0	0.07
<i>Gaylussacia baccata</i>	0.0	0.0	0.7	0.23
<i>Geranium maculatum</i>	0.0	0.0	0.2	0.07
<i>Hypericum majus</i>	0.2	0.0	0.0	0.07
<i>Ilex verticillata</i>	0.4	0.1	0.0	0.17
<i>Lycopus americanus</i>	0.1	0.0	0.0	0.03
<i>Lycopus uniflorus</i>	0.7	0.2	0.2	0.37
<i>Maianthemum racemosum</i> ssp. <i>racemosum</i>	0.0	0.0	0.8	0.27
<i>Nyssa sylvatica</i>	0.0	0.2	0.3	0.17
<i>Osmunda regalis</i> var. <i>spectabilis</i>	0.2	0.4	0.0	0.20
<i>Parthenocissus</i> sp.	0.0	0.0	0.6	0.20
<i>Persicaria</i> sp.	0.1	0.1	0.0	0.07
<i>Phytolacca americana</i>	0.1	0.0	0.0	0.03
<i>Pilea</i> sp.	0.4	0.0	0.0	0.13
Poaceae fam.	0.0	0.1	0.0	0.03
<i>Polygonatum biflorum</i>	0.0	0.0	0.1	0.03
<i>Potentilla</i> sp.	0.1	0.4	0.4	0.30
<i>Prunus virginiana</i>	0.0	0.0	0.2	0.07
<i>Pteridium aquilinum</i> ssp. <i>latiusculum</i>	0.0	0.0	0.7	0.23
<i>Quercus alba</i>	0.0	0.0	0.1	0.03
<i>Quercus velutina</i>	0.1	0.1	0.2	0.13
<i>Rosa blanda</i>	0.0	0.0	0.1	0.03
<i>Rosa multiflora</i>	0.0	0.0	0.1	0.03
<i>Rubus allegheniensis</i>	0.1	0.2	0.8	0.37
<i>Rubus hispidus</i>	0.8	0.5	0.8	0.70
<i>Rubus pensilvanicus</i>	0.2	0.1	0.0	0.10
<i>Rubus sachalinensis</i> var. <i>sachalinensis</i>	0.1	0.2	0.0	0.10
<i>Sassafras albidum</i>	0.0	0.1	1	0.37
<i>Scutellaria lateriflora</i>	0.0	0.2	0.0	0.07
<i>Solidago</i> sp.	0.4	0.3	0.1	0.27
<i>Spiraea alba</i>	0.0	0.0	0.1	0.03

Plot: 3096

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
<i>Spiraea tomentosa</i>	0.7	0.0	0.0	0.23
<i>Stachys hyssopifolia</i>	0.1	0.0	0.1	0.07
<i>Symphytotrichum</i> sp.	0.1	0.1	0.0	0.07
<i>Thelypteris palustris</i> var. <i>pubescens</i>	0.5	0.0	0.0	0.17
<i>Toxicodendron</i> sp.	0.0	0.0	0.1	0.03
<i>Urtica dioica</i> ssp. <i>gracilis</i>	0.1	0.3	0.0	0.13
<i>Vaccinium angustifolium</i>	0.0	0.1	1	0.37
<i>Vernonia fasciculata</i>	0.1	0.0	0.0	0.03
<i>Viburnum lentago</i>	0.1	0.0	0.0	0.03
<i>Viola</i> sp.	0.5	0.1	0.0	0.20
<i>Vitis aestivalis</i>	0.0	0.0	0.4	0.13
<i>Vitis riparia</i>	0.1	0.0	0.0	0.03

Plot: 3102

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
<i>Acer rubrum</i>	0.0	0.1	0.0	0.03
<i>Amphicarpaea bracteata</i>	0.0	0.3	0.0	0.10
<i>Apios americana</i>	0.0	0.0	0.2	0.07
<i>Carex blanda</i>	0.2	0.0	0.0	0.07
<i>Carex</i> sp.	0.0	0.1	0.0	0.03
<i>Celastrus</i> sp.	0.3	0.0	0.2	0.17
<i>Cicuta maculata</i>	0.0	0.0	0.1	0.03
<i>Cinna arundinacea</i>	0.0	0.0	0.4	0.13
<i>Circaea canadensis</i> ssp. <i>canadensis</i>	0.2	0.0	0.0	0.07
<i>Clematis virginiana</i>	0.1	0.0	0.1	0.07
<i>Cornus racemosa</i>	0.0	0.1	0.1	0.07
<i>Dichanthelium clandestinum</i>	0.0	0.0	0.2	0.07
<i>Equisetum arvense</i>	0.0	0.1	0.4	0.17
<i>Eupatorium perfoliatum</i>	0.0	0.0	0.1	0.03
<i>Eutrochium maculatum</i>	0.0	0.0	0.1	0.03
<i>Fragaria virginiana</i>	0.0	0.1	0.0	0.03
<i>Fraxinus pennsylvanica</i>	0.1	0.5	0.4	0.33
<i>Geum canadense</i>	0.1	0.4	0.3	0.27
<i>Glechoma hederacea</i>	0.0	0.0	0.1	0.03
<i>Glyceria striata</i>	0.0	0.2	0.2	0.13
<i>Hackelia virginiana</i>	0.1	0.0	0.2	0.10
<i>Impatiens capensis</i>	0.1	0.1	0.0	0.07
<i>Leersia virginica</i>	0.7	0.2	0.2	0.37
<i>Lindera benzoin</i>	0.6	0.3	0.3	0.40
<i>Lonicera</i> (exotic) sp.	0.1	0.3	0.4	0.27
<i>Onoclea sensibilis</i>	0.0	0.5	0.8	0.43
<i>Osmunda regalis</i> var. <i>spectabilis</i>	0.2	0.0	0.1	0.10
<i>Oxalis stricta</i>	0.1	0.0	0.0	0.03
<i>Parthenocissus</i> sp.	0.1	0.3	0.4	0.27
<i>Persicaria sagittata</i>	0.1	0.0	0.0	0.03
<i>Persicaria virginiana</i>	0.5	0.3	0.4	0.40
<i>Potentilla simplex</i>	0.2	0.1	0.0	0.10
<i>Prenanthes</i> sp.	0.4	0.0	0.0	0.13
<i>Prunus pennsylvanica</i>	0.3	0.0	0.0	0.10
<i>Quercus rubra</i>	0.0	0.1	0.2	0.10
<i>Rosa multiflora</i>	0.3	0.4	0.1	0.27
<i>Rubus flagellaris</i>	0.0	0.0	0.2	0.07
<i>Rubus hispidus</i>	0.9	0.4	0.0	0.43
<i>Rubus pensilvanicus</i>	0.0	0.6	0.0	0.20
<i>Rubus pubescens</i>	0.0	0.0	0.3	0.10
<i>Sambucus nigra</i> ssp. <i>canadensis</i>	0.0	0.0	0.1	0.03
<i>Solidago</i> sp.	0.4	0.8	0.6	0.60
<i>Symphytotrichum lateriflorum</i> var. <i>lateriflorum</i>	0.2	0.2	0.5	0.30
<i>Thalictrum dioicum</i>	0.1	0.0	0.0	0.03
<i>Toxicodendron</i> sp.	0.0	0.1	0.2	0.10
<i>Vernonia fasciculata</i>	0.1	0.0	0.0	0.03
<i>Vitis labrusca</i>	0.2	0.0	0.1	0.10

Plot: 3103

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Acer rubrum	0.2	0.1	0.0	0.10
Ageratina altissima	0.1	0.0	0.0	0.03
Alliaria petiolata	0.0	0.1	0.0	0.03
Amelanchier Group 2 sp.	0.1	0.2	0.5	0.27
Amphicarpaea bracteata	0.0	0.0	0.1	0.03
Bromus pubescens	0.2	0.0	0.0	0.07
Carex pensylvanica	0.5	0.0	0.3	0.27
Carex sp.	0.0	0.6	0.1	0.23
Cinna arundinacea	0.2	0.2	0.1	0.17
Circaea canadensis ssp. canadensis	0.2	0.3	0.0	0.17
Dichanthelium clandestinum	0.0	0.0	0.1	0.03
Dichanthelium latifolium	0.0	0.1	0.0	0.03
Doellingeria umbellata var. umbellata	0.0	0.0	0.2	0.07
Eurybia macrophylla	0.2	0.0	0.0	0.07
Galium triflorum	0.2	0.0	0.0	0.07
Gaultheria procumbens	0.1	0.0	0.0	0.03
Geum canadense	0.2	0.0	0.0	0.07
Hackelia virginiana	0.4	0.0	0.0	0.13
Hamamelis virginiana	0.9	0.5	0.6	0.67
Ilex verticillata	0.0	0.0	0.1	0.03
Liriodendron tulipifera	0.0	0.0	0.1	0.03
Lonicera (exotic) sp.	0.1	0.0	0.0	0.03
Maianthemum canadense	0.0	0.0	0.1	0.03
Maianthemum racemosum ssp. racemosum	0.3	0.0	0.2	0.17
Osmorhiza sp.	0.0	0.1	0.0	0.03
Oxalis sp.	0.0	0.1	0.0	0.03
Oxalis stricta	0.1	0.0	0.0	0.03
Parthenocissus sp.	0.5	0.6	0.1	0.40
Persicaria virginiana	0.0	0.3	0.1	0.13
Polygonatum biflorum	0.0	0.1	0.0	0.03
Prenanthes sp.	0.0	0.0	0.1	0.03
Prunus serotina	0.6	0.2	0.1	0.30
Quercus alba	0.6	0.1	0.0	0.23
Quercus velutina	0.3	0.1	0.3	0.23
Rosa multiflora	0.0	0.3	0.1	0.13
Rubus allegheniensis	0.1	0.2	0.1	0.13
Rubus pensilvanicus	0.1	0.0	0.0	0.03
Sassafras albidum	0.6	0.7	0.3	0.53
Smilax rotundifolia	0.0	0.0	0.2	0.07
Smilax tamnoides	0.0	0.0	0.2	0.07
Solidago sp.	0.0	0.1	0.0	0.03
Symplocarpus foetidus	0.0	0.0	0.1	0.03
Toxicodendron sp.	0.3	0.1	0.0	0.13
Vaccinium angustifolium	0.6	0.1	0.0	0.23
Vaccinium pallidum	0.3	0.2	0.0	0.17
Viburnum recognitum	0.0	0.0	0.2	0.07
Viola sp.	0.0	0.1	0.0	0.03
Vitis labrusca	0.0	0.0	0.1	0.03

Plot: 3104

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Apios americana	0.1	0.0	0.0	0.03
Apocynum androsaemifolium	0.0	0.1	0.0	0.03
Aralia nudicaulis	0.0	0.0	0.1	0.03
Asclepias syriaca	0.0	0.3	0.0	0.10
Bidens connata	0.8	0.0	0.0	0.27
Boehmeria cylindrica	0.8	0.0	0.0	0.27
Calamagrostis canadensis	0.3	0.0	0.0	0.10
Carex lacustris	0.2	0.0	0.0	0.07
Carex sp.	0.0	0.8	0.3	0.37
Celastrus sp.	0.0	0.0	0.4	0.13
Circaea canadensis ssp. canadensis	0.0	0.8	0.0	0.27
Coryza canadensis	0.0	0.1	0.0	0.03
Coreopsis palmata	0.0	0.0	0.2	0.07
Cornus racemosa	0.0	0.2	0.0	0.07
Doellingeria umbellata var. umbellata	0.1	0.0	0.0	0.03
Fallopia convolvulus	0.0	0.1	0.0	0.03
Hackelia virginiana	0.0	0.1	0.0	0.03
Helianthus divaricatus	0.0	0.6	0.2	0.27
Leersia oryzoides	0.4	0.0	0.0	0.13
Lycopus uniflorus	0.2	0.0	0.0	0.07
Maianthemum racemosum ssp. racemosum	0.1	0.0	0.1	0.07
Parthenocissus sp.	0.0	0.1	0.0	0.03
Persicaria punctata	0.3	0.0	0.0	0.10
Poa compressa	0.0	0.3	0.0	0.10
Poaceae fam.	0.0	0.1	0.3	0.13
Polygonatum biflorum	0.0	0.0	0.2	0.07
Potentilla sp.	0.0	0.1	0.0	0.03
Prunus serotina	0.2	0.7	0.1	0.33
Prunus virginiana	0.0	0.0	0.1	0.03
Pteridium aquilinum ssp. latiusculum	0.0	0.1	0.0	0.03
Quercus alba	0.0	0.1	0.0	0.03
Quercus velutina	0.0	0.3	0.2	0.17
Rosa carolina	0.0	0.1	0.3	0.13
Rubus allegheniensis	0.0	0.2	0.0	0.07
Rubus occidentalis	0.0	0.2	0.1	0.10
Rubus pensilvanicus	0.2	0.9	0.5	0.53
Rubus sachalinensis var. sachalinensis	0.0	0.2	0.0	0.07
Sassafras albidum	0.1	0.8	0.4	0.43
Scutellaria lateriflora	0.1	0.0	0.0	0.03
Solanum dulcamara	0.2	0.0	0.0	0.07
Solidago sp.	0.0	0.5	0.2	0.23
Symphyotrichum sp.	0.0	0.0	0.1	0.03
Tradescantia ohienensis	0.0	0.1	0.0	0.03
Vaccinium angustifolium	0.0	0.2	0.0	0.07
Vaccinium pallidum	0.2	0.0	0.0	0.07
Viburnum acerifolium	0.0	0.1	0.6	0.23
Vitis riparia	0.0	0.0	0.1	0.03

Plot: 3105

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Agrimonia gryposepala	0.0	0.3	0.1	0.13
Amelanchier Group 2 sp.	0.0	0.0	0.4	0.13
Berberis thunbergii	0.0	0.2	0.0	0.07
Carex sp.	0.0	0.3	0.0	0.10
Celastrus sp.	0.4	0.2	0.3	0.30
Fraxinus pennsylvanica	0.1	0.0	0.0	0.03
Galium circaeans var. circaeans	0.0	0.2	0.0	0.07
Galium triflorum	0.0	0.0	0.3	0.10
Hackelia virginiana	0.0	0.0	0.1	0.03
Hamamelis virginiana	0.0	0.6	0.8	0.47
Helianthus divaricatus	0.0	0.1	0.0	0.03
Maianthemum racemosum ssp. racemosum	0.0	0.3	0.0	0.10
Morus sp.	0.0	0.0	0.1	0.03
Osmorhiza sp.	0.0	0.0	0.1	0.03
Parthenocissus sp.	0.0	0.6	0.1	0.23
Poa sp.	0.0	0.1	0.0	0.03
Polygonatum biflorum	0.0	0.4	0.0	0.13
Prunus serotina	0.0	0.1	0.1	0.07
Prunus virginiana	0.0	0.3	0.0	0.10
Quercus alba	0.0	0.2	0.1	0.10
Quercus velutina	0.2	0.2	0.2	0.20
Rosa multiflora	0.0	0.2	0.0	0.07
Rubus allegheniensis	0.0	0.0	0.1	0.03
Rubus flagellaris	0.0	0.1	0.0	0.03
Rubus occidentalis	0.0	0.4	0.0	0.13
Sassafras albidum	0.0	1	0.7	0.57
Smilax tamnoides	0.0	0.1	0.1	0.07
Solidago caesia	0.0	0.4	0.1	0.17
Toxicodendron sp.	0.0	0.6	0.0	0.20
Vaccinium angustifolium	0.0	0.0	0.2	0.07
Vaccinium pallidum	0.0	0.2	0.5	0.23
Viburnum acerifolium	0.0	0.3	0.4	0.23
Vitis riparia	0.4	0.0	0.0	0.13

Plot: 3106

Species	Quadrat Frequency			Mean Quadrat Frequency
	1	2	3	
Ageratina altissima	0.9	0.5	0.1	0.50
Amphicarpaea bracteata	0.0	0.1	0.0	0.03
Apocynum androsaemifolium	0.0	0.4	0.0	0.13
Asclepias syriaca	0.0	0.3	0.1	0.13
Aureolaria flava	0.0	0.1	0.0	0.03
Berberis thunbergii	0.1	0.0	0.0	0.03
Boehmeria cylindrica	0.0	0.1	0.0	0.03
Carex sp.	0.9	1	1	0.97
Ceanothus americanus	0.0	0.1	0.0	0.03
Celastrus sp.	0.1	0.2	0.0	0.10
Convallaria majalis	0.0	0.0	0.2	0.07
Dichanthelium latifolium	0.0	0.2	0.0	0.07
Eupatorium serotinum	0.0	0.1	0.2	0.10
Galium pilosum	0.7	1	0.3	0.67
Galium triflorum	0.2	0.2	0.0	0.13
Gaylussacia baccata	0.1	0.0	0.0	0.03
Helianthus divaricatus	0.4	0.2	1	0.53
Maianthemum canadense	0.0	0.0	0.1	0.03
Maianthemum racemosum ssp. racemosum	0.2	0.2	0.1	0.17
Parthenocissus sp.	0.3	0.0	0.0	0.10
Phlox pilosa	0.0	0.2	0.0	0.07
Poa sp.	0.0	0.0	0.2	0.07
Polygonatum biflorum	0.0	0.1	0.3	0.13
Potentilla simplex	0.0	0.1	0.0	0.03
Prunus serotina	0.4	0.4	0.2	0.33
Prunus virginiana	0.0	0.1	0.0	0.03
Quercus alba	0.0	0.4	0.0	0.13
Quercus velutina	0.1	0.5	0.1	0.23
Rosa blanda	0.0	0.2	0.0	0.07
Rosa carolina	0.4	0.0	0.3	0.23
Rubus flagellaris	0.0	0.0	0.6	0.20
Rubus pensilvanicus	0.0	0.2	0.0	0.07
Rubus sachalinensis var. sachalinensis	0.0	0.0	0.2	0.07
Rudbeckia hirta	0.0	0.1	0.0	0.03
Sassafras albidum	0.6	0.4	0.1	0.37
Solidago sp.	0.0	0.2	0.2	0.13
Tradescantia ohienensis	0.0	0.3	0.0	0.10
Vaccinium angustifolium	0.3	0.3	0.1	0.23
Vaccinium pallidum	0.7	1	1	0.90
Viola sp.	0.0	0.1	0.0	0.03
Vitis aestivalis	0.0	0.1	0.0	0.03
Vitis riparia	0.3	0.1	0.0	0.13

Coarse Woody Materials Volume and Abundance in Each Plot

Park: INDU

Plot	Year	CWD volume (m³/ha)	Biomass (kg/ha)	Biomass	pieces/ha by size class (cm DTI)				Total
					7.5 -19.9	20.0 - 32.9	33.0-45.9	≥ 46.0	
3003	2012	5.76	1992.55	0.89	165.68	0.00	0.00	0.00	165.68
3009	2012	205.86	65081.68	29.03	452.88	33.00	0.00	27.84	513.71
3011	2012	9.81	5505.91	2.46	85.78	24.05	0.00	0.00	109.83
3012	2012	38.24	13064.70	5.83	172.59	46.93	0.00	8.18	227.70
3013	2012	30.40	14114.87	6.30	683.35	31.94	0.00	0.00	715.29
3014	2012	5.17	2247.59	1.00	181.13	0.00	0.00	0.00	181.13
3015	2012	9.30	3223.39	1.44	302.61	20.14	0.00	0.00	322.75
3017	2012	26.76	9538.19	4.25	62.76	11.57	8.18	0.00	82.51
3018	2012	14.92	7003.54	3.12	150.11	11.14	0.00	0.00	161.25
3019	2012	18.13	5035.43	2.25	186.76	11.77	0.00	0.00	198.52
3021	2012	74.53	24856.93	11.09	825.67	37.17	14.61	0.00	877.44
3022	2012	21.58	8416.41	3.75	224.00	0.00	5.11	0.00	229.11
3023	2012	0.96	313.08	0.14	28.30	0.00	0.00	0.00	28.30
3026	2012	78.02	27536.08	12.28	918.72	45.31	0.00	0.00	964.03
3028	2012	14.22	6842.64	3.05	85.25	0.00	12.04	0.00	97.28
3029	2012	2.67	1224.67	0.55	51.17	0.00	0.00	0.00	51.17
3030	2012	26.25	9876.34	4.41	342.46	26.21	12.62	0.00	381.28
3031	2012	5.50	2650.87	1.18	350.25	0.00	0.00	0.00	350.25
3033	2012	13.87	5986.08	2.67	449.36	8.38	0.00	0.00	457.73
3034	2012	56.94	18871.57	8.42	339.91	126.95	0.00	0.00	466.87
3036	2012	6.37	2264.24	1.01	212.74	10.58	0.00	0.00	223.32
3038	2012	78.96	30906.80	13.79	684.82	37.00	7.59	6.63	736.03
3039	2012	38.23	12423.38	5.54	259.14	93.16	0.00	0.00	352.30
3041	2012	97.46	30223.75	13.48	370.86	56.49	25.21	0.00	452.57
3042	2012	15.40	5686.92	2.54	307.59	21.65	0.00	0.00	329.25
3044	2012	5.39	2135.13	0.95	117.99	0.00	0.00	0.00	117.99
3049	2012	29.15	9560.74	4.26	210.97	32.47	8.51	0.00	251.95
3050	2012	3.85	1351.65	0.60	144.29	0.00	0.00	0.00	144.29
3051	2012	7.73	2513.15	1.12	177.08	0.00	0.00	0.00	177.08
3053	2012	3.40	1001.42	0.45	161.32	0.00	0.00	0.00	161.32
3059	2012	43.36	14985.02	6.68	170.12	25.16	0.00	6.31	201.59
3064	2012	19.91	6933.37	3.09	234.29	8.51	0.00	0.00	242.80
3065	2012	34.73	11601.54	5.18	209.70	29.93	6.54	0.00	246.17
3069	2012	18.34	6124.74	2.73	146.17	12.32	0.00	0.00	158.49
3074	2012	20.30	6286.98	2.80	466.76	11.90	0.00	0.00	478.66
3078	2012	20.89	8807.66	3.93	247.43	34.63	0.00	0.00	282.07
3082	2012	8.68	2125.73	0.95	320.15	0.00	0.00	0.00	320.15
3084	2012	15.48	5194.58	2.32	453.16	0.00	0.00	0.00	453.16
3085	2012	59.46	21148.37	9.43	238.57	57.54	0.00	0.00	296.12
3090	2012	123.49	34641.49	15.45	396.99	35.75	43.48	16.94	493.16
3092	2012	35.03	13417.10	5.99	427.77	30.75	0.00	0.00	458.53
3093	2012	14.85	5237.09	2.34	297.37	0.00	0.00	0.00	297.37
3095	2012	3.92	1706.21	0.76	75.82	0.00	0.00	0.00	75.82
3096	2012	13.61	5408.77	2.41	199.71	13.97	0.00	0.00	213.68
3102	2012	11.65	4365.21	1.95	301.87	47.60	0.00	0.00	349.47
3103	2012	60.22	22343.91	9.97	397.78	61.76	13.01	0.00	472.56
3104	2012	29.89	9848.97	4.39	534.72	22.54	0.00	0.00	557.26
3105	2012	33.91	12259.08	5.47	319.17	33.41	9.19	0.00	361.77
3106	2012	13.73	4461.37	1.99	236.58	0.00	0.00	0.00	236.58
2012	Mean	30.53	10,566.94	4.71	287.59	22.23	3.32	1.32	314.47

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

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