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14 February 1992

TO: John Schwegman
Illinois Dept. of Conservation
Division of Natural Heritage
600 North Grand Ave. West
Springfield, IL 62706

FROM: John Taft

RE: Final Report for Flatwoods Study

Dear John:

Enclosed is the final report for the flatwoods study that was partially funded with a grant from the Nongame Checkoff Conservation Fund. Please use Appendix I from the Draft Report to add to this Final Report. Appendix I is the print out of the raw soils data from A & L Labs. If you have any questions, just call. Thank you for the financial support.

Sincerely,

John

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F491-022

The Vegetational Ecology of Six Southern Flatwoods on the Illinoian Tillplain of Illinois

Final Report

by

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and

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10 February 1992

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Report to the Illinois Department of Conservation
Division of Natural Heritage

INTRODUCTION

Southern flatwoods (White 1978) dominated by post oaks, known as post oak flatwoods, are primarily restricted to the Midwest. Although intact remnants are among the least common plant communities in the region, they have received little study. The published studies have concentrated on only a few Indiana sites (Aldrich and Homoya 1984, Dolan and Menges 1989), a single Illinois site (Fralish 1988), and general accounts applying to Illinois flatwoods (Telford 1926, Vestal 1936). In addition, two other Illinois sites have been described in unpublished reports (Borger 1968, Coates 1990). In the Midwest, post oak flatwoods primarily are found on the Illinoian till plain in Illinois and Indiana. Nelson (1985) indicated that flatwoods occurred locally throughout Missouri. However, only a single site has been identified suggesting that flatwoods are not widespread in Missouri. Post oak (Quercus stellata) ranges throughout much of the eastern United States, from Massachusetts south to central Florida and west to southeastern Iowa and southwest to westcentral Texas (Harlow and Harrar 1969).

Flatwoods are woodlands growing on level surfaces, usually with widely spaced trees that at times form a savannalike structure, with slowly permeable and poorly drained soils that contain an argillic horizon, or claypan. Some sites occur on soils with a fragipanlike or fragic horizon usually below the B Horizon (claypan). The slow drainage characteristics of flatwoods soils result in seasonally saturated surface horizons. However, during the summer months after the surface-soil moisture has evapotranspired, subsurface moisture is largely impeded from restoring moisture to the primary rooting zones resulting in extremely dry conditions in the rhizosphere. As a consequence of seasonally wet and seasonally dry conditions, flatwoods are composed of floodplain terrace species together with species of dry upland forests and barrens.

Though similar ecological forces appear to influence the vegetational composition of remnant southern flatwoods, there are variations within and between sites in both composition and structure. Variations occur in stand structure, tree species composition and dominance, shrub density, and herbaceous species composition, richness, and density. While some sites retain an open aspect with an herbaceous understory and a poorly developed shrub layer, others show evidence of vegetational change characterized by the invasion of mesophytic woody plant taxa, poor oak regeneration, and a depauperate herbaceous understory. Although fire presumably had a role in maintaining the openness of most flatwoods, it is not clear why after several decades of fire suppression some sites are undergoing vegetational changes and others appear more stable.

The goals of this study were to determine the roles that selected edaphic factors such as texture, depth to argillic horizon, and soil fertility have on selected quantitative vegetational characteristics such as stand structure, and species dominance and diversity. This phase of the study evaluates the site-summary data. These results reveal aspects of flatwoods community ecology useful in guiding management strategies that will help maintain or enhance native species richness in flatwoods remnants. Future analysis will investigate the plot-specific data.

METHODS AND PROCEDURES

A total of six sites were examined on the Southern Till Plain Natural Division (Schwegman 1973) of Illinois. Five sites were recognized by the Illinois Natural Areas Inventory (White 1978) as statewide-significant natural features. In order to recognize as many plant species as possible (ie...early and late developing species) and to keep the data comparable, all sampling was conducted during July. Two sites were sampled in 1989 and the remaining four sites were sampled in 1990 (Table 1, Figure 1). This study attempted to include sites that represented the full range in vegetative characteristics associated with southern flatwoods of the Illinoian tillplain in Illinois. Time and project funding limitations permitted studies at only six rather than the originally proposed eight sites.

A total of 50 0.05 ha circular tree plots were sampled during this study. Each study site was quantitatively sampled with a stratified-random sampling regime using eight (ten at Lake Sara Flatwoods) 0.05 ha circular plots for trees. Tree densities and basal areas were determined by identifying and measuring the diameter at breast height (dbh) all woody plants $\geq$ 6 cm dbh. Density of shrubs (woody plants < 6 cm dbh but taller than 50 cm) was measured in a single nested 0.005 hectare circular plot within the tree plots. Importance values (IV 200) for trees were calculated by summing relative dominance and relative density.

Frequency and cover data for herbaceous species, seedlings (woody plants < 50 cm), and vines were collected from 25 0.25 meter-square quadrats in each tree plot totalling 200 0.25 meter-square plots per study site. Lake Sara Flatwoods was sampled with 13 0.25 meter-square quadrats per tree plot totalling 130 ground cover plots. These 0.25 meter-square plots were placed every meter along a line transect across the diameter of the tree plot that passed through the plot center. The direction of the transect was determined from a random numbers table and correlation to a compass degree (by multiplying by 3.6).

Cover of herbaceous species, seedlings, and vines was determined from cover estimates employing the Daubenmire cover-class system (Daubenmire 1968) and modified following Bailey and Poulton (1968). Only plants rooted within the frame of the quadrat were recorded. The modified Daubenmire cover scale is as follows: class 1 = 0-1%; class 2 = 1-5%; class 3 = 5-25%; class 4 = 25-50%; class 5 = 50-75%; class 6 = 75-95%; class 7 = 95-100%. Importance values (IV 200) for ground cover species was determined by summing relative cover and relative frequency.

Bare ground was measured using a point intercept method (Mueller-Dombois and Ellenberg 1974). The plot frame was modified by using five points. These five sample points were taken at one meter intervals along the transect passing through the center of the tree plot with a total of 100 point intercepts for each tree plot and 800 for each site. Lake Sara Flatwoods was sampled with 50 point intercepts per plot and 500 point intercepts for the site. Nomenclature follows Mohlenbrock (1986).

Taxonomic uncertainties for a few species that were often vegetative at the time of sampling required the recognition of a few species groups that may contain two different but closely related taxa. These inclusions are summarized in Table 2.

A total of 150 soil samples were collected during this study. Usually a single soil probe was taken at the center point of each tree plot. Each probe yielded three soil samples - one each from the A1 horizon, the E (or A2) horizon, and the B horizon (or claypan). Depth to "hardpan" was determined as the distance from the surface to a horizon that offered extreme resistance when inserting the soil probe. This relative distinction was readily apparent in many instances, but less apparent in others. Not all plots had a recognizable "hardpan".

The laboratory soil analyses were conducted by the Memphis office of A & L Analytical Laboratories, Inc. Both soil physical measurements (particle size analysis) and a basic nutrient analysis were performed on the 150 soil samples collected during the study. The basic nutrient analysis measured organic matter content, estimated nitrogen release, available phosphorus, exchangeable potassium, magnesium, and calcium, soil pH, buffer pH, cation exchange capacity, and percent base saturation of macronutrient cations. Soil samples were prepared for analysis by air drying and sifting through a 10-mesh screen before shipping to the A & L labs.

Similarity of vegetational composition between sites was compared by determining Sorenson's qualitative similarity index from the ground cover sampling data (Mueller-Dombois and Ellenberg 1974) and with quantitative modifications of Sorenson's similarity index by Motyka, Dobrzanski, and Zawadski as described in Mueller-Dombois and Ellenberg (pp. 219, 1974). Values for comparing species diversity between sites were species richness, or the number of species occurring within a sample area (Whittaker 1975), calculated from the ground cover sampling data, and species density, which is defined as the average number of species sampled in the 1/4 m^2 ground cover frequency/cover plots.

Correlation data were graphed using Cricket Graph software for the Macintosh personal computer. Coefficients of determination (R^2 values), or correlation indices, were calculated by the graphics program to fit the simple linear correlations.

Appendices, Tables, and Figures cited in the text are grouped at the end of the report.

RESULTS AND DISCUSSION

The data from the soil texture and nutrient analyses conducted by A & L Laboratories are presented in Appendix 1. Soils data for all samples taken at each site are summarized in Appendix 2. A summary of the mean values showing standard deviations for each site is in Table 3.

The quantitative tree and sapling data for each site are summarized in Appendix 3. Data summarizing selected quantitative aspects of all sites are shown in Table 4. Size class distribution data for trees at each site are graphed in Figures 2-7.

Data from the ground cover sampling for each site are summarized in Appendix 4. Data summarizing species richness, density, and percent bare ground for each site are shown in Table 5. Rank order of the most important species recorded in the herbaceous sampling procedure for all sites is shown in Table 6. Additional characteristic species are shown in Table 7. Similarity indices comparing all sites based on the ground cover sampling data are found in Tables 8 and 9.

A review of the site-summary data presented shows considerable variation within and between sites among the soils and quantitative vegetation data. Considering the within site variation, it is likely that, to an extent, the site-summary data discussed in this report dilutes variation and may conceal meaningful trends and correlations that occur between individual plots within a study site. The plot summary data will be examined in more detail during the second phase of this analysis. Nevertheless, general trends that will be useful in pursuing plot specific correlations are apparent from the site summary soils and vegetation data.

Several assumptions were established from field observations and vegetation sampling in flatwoods on the Illinoian tillplain regarding the relationships between edaphic properties, tree and sapling density, and herbaceous species richness and density. Foremost among these assumptions was the theory that certain edaphic properties such as percent clay content (particularly in the B horizon), percent increase in clay content between horizons, and depth to claypan and "hardpan" influenced tree density in southern flatwoods on the Southern Tillplain. Small openings in flatwoods are characteristic, and may be related to localized edaphic factors. In addition, it seemed probable that tree density was inversely related to herbaceous species richness and density. Finally, species composition was believed to be influenced by edaphic factors such as depth to "hardpan" with species favoring drier habitats such as glades and barrens confined to sites characterized by shallow depth to "hardpan". These assumptions are described and analyzed in the following sections.

Soils Data

A total of four soil series are mapped at the six study sites (Table 10). Flatwoods have formed on a variety of soil series derived from either alluvium, lacustrine, or loess materials. Okaw soils formed in thin layers of loess or silty sediments and underlying clayey alluvium and/or lacustrine deposits (Wallace 1978, Lineback 1979) while Ava, Bluford, and Wynoose soils formed in loess (Herman et al. 1979). Many soils of the southern tillplain formed in two layers of loess, the upper Peoria Loess, and the underlying Roxana Silt. Ava, Bluford, and presumably Wynoose soils (Wynoose is frequently associated with Bluford soils) formed where the Peoria Loess has weathered and the less permeable and more dense Roxana Silt is closer to the surface (Herman et al. 1979).

All soil samples from this study are characterized by low organic matter content (ranging from means of 1.44% to 2.69%), low pH values (ranging from means in the A1 horizon from pH 4.36 to 4.53, in the E from pH 4.49 to 4.85, and in the B horizon from pH 4.73 to 4.86), and low percentage base saturation (especially in the A1 horizons, ranging from 16% to 36%) (Appendix 1). However, there is considerable variation among other edaphic factors, including among soil samples collected from the same soil series.

Recker, Chip-O-Will, and Jackson Slough woods all occur on the Okaw soil series (Smith and Smith 1937, Wallace 1978). This soil is confined in this region to terraces along the Kaskaskia River (Wallace 1978). The A1 horizon soil samples at Jackson Slough Woods and three plots at Recker Woods are characterized by a silt loam texture, while Chip-O-Will Woods and four plots at Recker Woods are characterized by a sandy loam texture (Appendix 2). The coarseness of the A1 soil horizon at Chip-O-Will and partially Recker woods was unexpected and unusual among all sites. This sandy texture can probably be explained by the alluvial origins of the surface material and movement of clay particles into the B horizon. Percentage sand in the A1 ranges widely among and between these sites on the Okaw soil with individual plots ranging from 13 to 58% and site summary means of 38.6% at Recker Woods with standard deviation (SD) of 22.4, 50.6% at Chip-O-Will Woods with SD 15.74, and only 15.4% at Jackson Slough Woods with SD 2.97 (Appendix 2). Judging from the contour intervals on the Okawville (Recker Woods), Venedy (Chip-O-Will Woods), and Mascoutah (Jackson Slough Woods) 7.5' series United States Geological Survey topographic maps, Jackson Slough Woods appears to be about 4.5 m (15 ft) higher above the Kaskaskia River compared to Recker and Chip-O-Will woods. This may explain why soils at Recker and Chip-O-Will woods contain more sand compared to the more elevated, and thus less flood-prone, position at Jackson Slough Woods. If flooding does occur at Jackson Slough Woods, the heavier sand particles may have already dropped out of suspension as flow intensity decreases with greater elevation. Percentage clay content in the B horizon of individual plot samples ranges from 20 to 56%; the site summary data, compared with the sand percentages, are less varied with means of 26% at Recker Woods and SD 7.4, 24% and SD 5.4 at Chip-

O-Will Woods, and 45.5% and SD 5.8 at Jackson Slough (Appendix 2, Table 3). However, percentage increase in percent clay content from A1 to A2 and from A2 to B horizons widely varies among and between all sites (Table 11). Depth to B horizon also widely varies among and between these sites on the Okaw soil with individual plots ranging from 28 cm to 55 cm and site summary means of 42.5 cm and SD 9.8 at Recker Woods, 31.5 cm and SD 5.2 at Chip-O-Will Woods, and 44.38 cm and SD 7.76 at Jackson Slough Woods (Appendix 2, Table 3).

Variation occurs but, in general, is less pronounced among the other three soil types in this study (Appendix 2, Table 3). Wynoose soil series is mapped throughout Williams Creek Woods and a portion of Lake Sara Flatwoods (Smith and Smith 1937, USDA 1984); recent data indicate that Bluford soil occurs at Posen Woods (USDA 1988) rather than Wynoose (Fralish 1988); Bluford also occurs at a portion of Lake Sara Flatwoods (USDA 1984); and, Ava is mapped at a portion of Lake Sara Flatwoods (USDA 1984). Since three soil types are mapped at the flatwoods at Lake Sara it is not possible with these data to determine if variation occurs between soil samples taken from the same soil series at Lake Sara. The particle-size analyses for the A1 horizon indicates a silt loam texture for all plots at all three sites, excepting a single plot at Posen Woods determined to be sandy-loam texture. Percent sand in the A1 horizon ranges among individual plots, with a single exception, from 13 to 34% with site summary means of 22.5% and SD 15.2 at Posen Woods (the single sandy loam plot mentioned above with 59% sand), from 8 to 17% with SD of 2.8 at Williams Creek Woods, and from 20 to 34% and SD of 5 at Lake Sara Flatwoods. Percent clay content in the B horizon ranges among individual plots from 26 to 46% with site summary means of 38.5% and SD 6.2 at Posen Woods, 41.6% and SD 2.1 at Williams Creek Woods, and 43.1% and SD 2.1 at Lake Sara Flatwoods (Appendix 2). Percent increase in percent clay between horizons for all sites is summarized in Table 11. Depth to B horizon varies widely with individual plots ranging from 35 to 90 cm and site summary means of 56 cm and SD 17.7 at Posen Woods, 48 cm and SD 5.4 at Williams Creek Woods, and 46 cm and SD 12.5 at Lake Sara Flatwoods.

Though there is variation in the textural composition and depth of B horizon in these flatwoods soils, the edaphic characteristic unifying all flatwoods examined in this study and probably throughout the Illinoian tillplain is presence of an argillic horizon, or claypan. Argillic horizons (claypans) are illuvial subsurface zones where clay has accumulated from overlying eluvial zones (USDA 1975) and they impede the movement of water and air and the growth of roots (Soil Science Society of America 1975). The clay accumulation in the B horizon is usually abrupt and characterized by an increase of about 20% (though as little as 8% clay in a clayey soil) compared to the eluvial horizon (USDA 1975). All sites sampled in this study except Recker Woods showed increases of percent clay content greater than 20% in the site summary mean values between E and B horizons

(Table 11). All sites show increases in percent clay content greater than 20% between A1 and E horizons (Table 11). Soil samples from Recker Woods show wide variance in differences of percent clay content between E and B horizons (Table 11). Some of the plot values of percent clay content are lower in the B than the E (Appendix 2). This may be due to localized mixing of the soil horizons by burrowing animals, other disturbances, or possibly a more widespread consequence of the flooding history. Recker Woods is unique among the flatwoods studied in that it is, like an island, formed on a low terrace completely surrounded by floodplain forests of the Kaskaskia River.

Past efforts at flatwoods classification have emphasized edaphic factors with particular references to the presence of hardpans (White 1978, Nelson 1985), or fragipans (Aldrich and Homoya 1984, Nelson 1985). There appears to be some confusion regarding these terms with the two sometimes used interchangeably (Nelson 1985). Hardpan is a hard impervious often clayey layer of soil at or just below surface produced by cementation of soil particles by relatively insoluble materials such as silica, iron oxide, calcium carbonate, or organic matter. Because of wide popular use sometimes applied to any hard layer that is difficult to drill or excavate, the term has been avoided in modern soil taxonomy (Bates and Jackson 1980). Nevertheless, considering the low organic matter content, eluvial nature of the A1 and E horizons with clay particles leached into the B horizon, low to very low levels of calcium in the eluvial horizons, and low pH values (Appendix 1) limiting or preventing precipitation of calcium carbonate, actual cementation of soil particles in the E horizon may not occur. However, some other as yet unidentified cementation factor may be involved.

At all sites, depth to "hardpan" (popular usage) was recorded where present. When encountered the "hardpan" was always in the E horizon and was distinguished by the relatively difficult-to-penetrate character. For instance, the claypan was always far easier to penetrate with a soil probe than this overlying zone in the E horizon. This "hardpan" was not always present, and at most plots at Recker and Chip-O-Will woods, depth to this zone was described in only relative terms (Appendix 2). Where measured, site summary means for depth to "hardpan" range from 10 to 24.8 cm with all but a single plot measured between 17 and 28 cm (Appendix 2). This restrictive subsurface zone may be due to the relatively high bulk densities of soil horizons high in percent silt and/or sand when these horizons are very dry (Olsen, pers. comm.). These coarse-textured soils have low water-holding capacities and thus become extremely dry during the summer growing season when evapotranspiration is accelerated. These coarser materials are in contrast to the montmorillonitic clays typical of the soils in this study with their high lattice structure, high shrink-swell potential, and high water-holding capacity (Brady 1974). All soil samples show magnesium content of the B horizon to be very high and most samples from the E horizon are also very high (Appendix 1). Where combined with the high bulk density materials in the E horizon, this macronutrient may contribute to enhancing the bulk density (Olsen, pers. comm.) or in some way acting as a binding agent when precipitated. The nature of this zone, whether cemented or not, needs further analysis. Of particular interest is the strong positive correlation that exists between magnesium content and importance values for Quercus marilandica and all Eleocharis species (see discussion in following sections).

Soil descriptions of the Ava and Bluford soils, both found at Lake Sara Flatwoods, include a fragipan (USDA 1984). However, current soil taxonomic theories favor the term fragic horizon as many soil scientist believe that no true fragipans occur in Illinois (Lester Bushue, Dennis Keene, Ken Olsen, Leon Follmer, pers comm). This fragic horizon, however, is usually below the claypan or is a lens within the lower B horizon occurring between 40 and 80 cm depth. A fragipan is a loamy or occasionally fine sandy subsurface horizon that may, such as with the Bluford and Ava soils, underlie an argillic horizon. Fragipans are characterized by low organic matter, high bulk density compared to overlying horizons, and are seemingly cemented when dry. When moist, fragipans are somewhat brittle (USDA 1975). All of the B horizon samples from Lake Sara Flatwoods are in the particle-size class of silty clays and depth to B horizon ranges from 36 to 70 cm (Appendix 2). Fragic horizons do not form where clay content is high (USDA 1975). Where present at Lake Sara Flatwoods, the fragic horizon apparently occurs below the sampled area.

In summary, flatwoods soils are characterized by the presence of an argillic horizon or claypan that limits root penetration. This claypan severely limits water movement (USDA 1975), and thus seasonally supports a perched water table, particularly in the spring with the moisture of snow melt and rainfall before evapotransporation accelerates with warmer temperatures. Though true hardpans may not occur in the E horizon, the high bulk density and low water-holding capacity characteristics of these mostly silty and sandy loams, especially during the dry summer months, simulates edaphic conditions found in dry upland barrens and glade-like habitats where shallow soils over bedrock become droughty.

Vegetation Data

Variation in the edaphic characteristics between sites is matched by considerable variation in the vegetation data between sites (Appendices 3 and 4, Tables 4, 5, 8, 9).

Tree and Sapling Data - Particularly noteworthy among the tree and sapling summary data (Table 4) is the wide variation between study sites in tree species number, sapling species number, sapling stem densities, total stem densities, summed Quercus species sapling relative densities, and Q. marilandica tree IV 200.

The relationship between the sum of Quercus species sapling relative densities and total stem number indicates that, with the exception of Lake Sara Flatwoods, there would be a strong negative correlation between total stem number and Quercus species sapling relative density (Figure 8). The exceptionally low values for sapling density and total Quercus species sapling relative density, tree density, and probably sapling species number from Lake Sara Flatwoods are due to an established fire management program at the site. Fire has been used nearly annually at the Lake Sara Flatwoods for about 20 years. Note that although the tree densities are just over half those found at the other sites the tree dominance (basal area) values are comparable (Table 4). This indicates that much of the increased density at the unburned sites is among the smaller size classes that contribute little to site basal area values (Figures 2-7).

Size class distribution data (Figures 2-7) and tree summary data for each site (Appendix 3) clearly show that Q. stellata is the most important tree at all six study sites. In fact, of the eight flatwoods remnants on the Illinoian tillplain that were field reviewed for this study, all but one were dominated by Quercus stellata. This contrasts markedly with reports that Q. stellata is unimportant in flatwoods of the southern tillplain in Illinois (Menges, et al. 1987) and throughout the upper Midwest (Dolan and Menges 1989). However, field observations indicate that flatwoods dominated by other oak species are typical south of the Illinoian tillplain in Illinois (Taft, pers. obs.).

Quercus stellata appears to be replacing itself at Recker and Chip-O-Will woods (Figures 2 and 3). However, recruitment of Q. stellata appears to be restricted at Posen, Williams Creek, and Jackson Slough woods by the establishment of numerous additional tree species occupying the smaller size classes (Figures 4-6). The shade intolerant Q. stellata appears to be dependent at these sites on some form of stochastic event that maintains Quercus species dominance in the larger size classes. In the absence of an event that reduces the density of trees and saplings in the understory, these sites may be converting to a more mesophytic forest community. Posen Woods, with Sassafras albidum outranking Quercus stellata relative density, is particularly vulnerable to this compositional shift. Although Williams Creek and Jackson Slough woods also show a sharp decline in Q. stellata recruitment among the trees, Q. stellata ranks 8th among all species in the ground cover sampling at Williams Creek Woods indicating that oak seedlings are common (Table 6), and Q. stellata saplings are fairly well represented at Jackson Slough Woods (Appendix 3). The reason for the decline in Q. stellata stems among the smaller tree size classes at these two sites is unclear. Jackson Slough Woods ranks with the highest tree density of all sites, though Posen Woods has almost twice the total stem density per hectare. Williams Creek Woods, on the other hand, ranks fifth among tree densities and first in total basal area per hectare, while only Lake Sara Flatwoods, with frequent ground fire, ranks with fewer trees per hectare (Table 4).

Ground Cover Sampling Data - The quantitative data from the ground cover sampling at all sites are summarized in Appendix 4. Sorensen's similarity indices were calculated comparing both qualitative and quantitative relationships between the ground cover vegetation at all study sites (Tables 8 and 9). These data show that no two sites have greater than a 56% similarity based on ground cover species presence, and a maximum quantitative similarity of 53%. The two most similar sites, Williams Creek and Jackson Slough woods, occur on different soil series derived from different parent materials; the two least similar sites, Posen Woods and Lake Sara Flatwoods, both include areas mapped as Wynoose silt loam, though not a dominant series at Lake Sara. Since it has been demonstrated that the same soil series can vary in many quantitative aspects, lack of vegetational similarity is not especially surprising. These data also suggest that all flatwoods are compositionally distinct. Lake Sara Flatwoods shares the least commonality with the other five study sites, particularly when based on quantitative indices of similarity (Table 9). Certain species with creeping vine habits such as Parthenocissus quinquefolius, Toxicodendron radicans, and Rubus flagellaris that are common and often occur with high relative cover values at many flatwoods are much limited at Lake Sara by the frequent fire regime.

The most characteristic ground cover species of the flatwoods studied, those taxa that occurred among the 15 most important species at three or more sites, are grouped in rank order in Table 6. An additional list of characteristic species includes taxa that were recorded at three or more sites, but did not typically occur with high cover values (Table 7). Many of these species occurred at all sites but may not have appeared in sample plots at certain sites (eg. Gillenia stipulacea, Carex glaucoidea). Additional species that were characteristic of the flatwoods studied but were not sampled at more than two sites include: Tradescantia virginiana, Passiflora lutea, Aristolochia serpentaria, Penstemon digitalis, and Krigia biflora.

These ground cover data (Tables 6 and 7, Appendix 4) indicate that the flatwoods in this study are characterized by grasses of lowland and terrace forests (Agrostis scabra, Cinna arundinacea), sedges of both lowland and upland forests (Carex artitecta, C. festucacea, C. bushii, C. caroliniana, C. glaucoidea, Eleocharis verrucosa) and forbs of open woodlands, barrens, and prairies (Helianthus divaricatus, Pycnanthemum tenuifolium, Gillenia stipulacea, Parthenium integrifolium, Tradescantia ohiensis). Woody vines and small shrubs of open woodlands are common (Parthenocissus quinquefolius [ranking as the most important species overall], Rubus alleghaniense/R. pensylvanicus [ranking as the second most important species overall], R. flagellaris, Toxicodendron radicans, and Rosa carolina). Seedlings of trees are common with some ranking among the most important ground cover species (Quercus stellata, Q. imbricaria, Q. marilandica, Q. velutina, Carya ovata, and Fraxinus americanus).

Some prairie and open woodland species were occasionally observed, but rarely recorded: Helianthus mollis, Veronicastrum virginicum, Liatris pycnostachya, Baptisia lactea, B. leucophaea, Euphorbia corollata, Psoralea psoraleoides, and Euthamia graminifolia. No characteristic prairie grasses were sampled at any of the sites studied, and at only Lake Sara Flatwoods was a single clump of Andropogon gerardii observed. Dolan and Menges (1989) indicate that prairie grasses and forbs are described for oak-dominated flatwoods in Missouri (Nelson 1985), Illinois (White 1978), and Indiana (Jackson 1980). Though this strong prairie association may be part of the conventional thinking, none of these publications support this apparent misconception.

Species of barrens and glades that were associated with some of the flatwoods of this study, but not sampled at over two sites were: Danthonia spicata, Crotonopsis elliptica, Lechea tenuifolia, Paronychia fastigiata, Isoetes melanopoda, and Trifolium reflexum.

Trifolium reflexum, a species listed as Endangered by the Illinois Endangered Species Protection Board (Herkert 1991), was found at both Chip-O-Will and Jackson Slough woods. Trifolium reflexum was recorded in the ground cover sampling at Chip-O-Will Woods (Appendix 4) where it was closely associated with Quercus stellata (post oak). About 25 plants were observed in the forest interior and all were within about one meter from the base of a post oak. Other associates included: Quercus marilandica, Scutellaria parvula, Acalypha gracilens, and Parthenocissus quinquefolius. Trifolium reflexum was also observed in the mowed "lawn" of a cabin area on the edge of the woods. Trifolium reflexum was not limited to the base of post oaks in the lawn, but rather were occasional throughout the cabin "lawn" area. At Jackson Slough, buffalo clover was only seen in the mowed "lawn" of a cabin in the woods. There it associated with: Cinna arundinacea, Carex artitecta, Dichanthelium sp., Hedeoma pulegioides, Potentilla simplex, Acalypha gracilens, Paronychia fastigiata, Scutellaria parvula, Pycnanthemum tenuifolium, Rudbeckia hirta, Erigeron annuus, and Juncus tenuis. At both cabin sites, the lawns were composed primarily of native flatwoods species. These are the first records of Trifolium reflexum from flatwoods in Illinois. However, though possibly extirpated from Indiana, T. reflexum has been previously recorded from flatwoods in that state (Aldrich and Homoya 1984).

Trifolium reflexum apparently can have a biennial habitat (Schwegman, pers. comm.). However, in a recent greenhouse experiment, this species germinated, flowered, and died within a single growing season (Taft, unpublished data). This facultative annual habit may be adaptive in a fire prone environment and occasional mowing may simulate fire to the extent of enhancing habitat suitability for this species.

Correlation Analysis

In contrast to some of the primary assumptions regarding interactions between soils and vegetation, there are no clear, strong relationships in the site summary data between tree density and depth to "hardpan", depth to claypan, or percent clay content of subsurface soil horizons (Figures 9-11). Further, no correlation exists between total stem density and depth to "hardpan" (Figure 12). However, there is a moderate positive correlation between total stem density and depth to claypan (B horizon) (R^2 = 0.557) (Figure 13) and shrub/sapling density compared to depth to claypan (R^2 = 0.573) (Figure 14). This shows that with increasing depth to claypan there is an increase in total stem density. The lack of a relationship (R^2 = 0.003) between tree density and depth to claypan (Figure 10) suggests that depth to claypan has in the past had little influence on tree density, but increasing depth to claypan favors shrub and sapling establishment (Figure 14). Surprisingly, these site summary data suggest that importance (IV 200) of mesic tree species is only weakly correlated (R^2 = 0.439) to depth to claypan (Figure 15). There is a moderately strong (R^2 = 0.755) positive correlation between sapling density and combined mesic tree species importance values (Figure 16A). Finally, though clay content in subsurface horizons is not correlated with tree density (Figure 11), tree species richness is positively correlated (R^2 = 0.683) with finer textured soils (clay content in the E horizon) (Figure 16B).

The results from the ground cover sampling reveal that Posen Woods, with the greatest stem density of all sites, has the lowest total ground cover species richness value, while Lake Sara Flatwoods, with the lowest stem density, ranks with the greatest total ground cover species richness (Table 5). However, the expected negative correlation between tree density and total stem density compared with ground cover species richness for all six sites is less clear (Figures 17 and 18). The slightly greater correlation between tree density and ground cover species richness (R^2 = 0.556) compared to total stem density and ground cover species richness (R^2 = 0.480) suggests that there is a lag time between shrub and sapling establishment and reduction of species richness. This suggestion is supported by the ground cover species density data which show a strong negative correlation with tree density (R^2 = 0.870) but a weak correlation with total stem density (R^2 = 0.314) (Figure 19 and 20). A moderately strong positive correlation exists (R^2 = 0.774) between ground cover species richness and species density (Figure 21).

Lake Sara Flatwoods ranks first with over three times the ground cover species density compared with the other sites and ranks with the lowest percent bare ground (Table 5). The two sites with the greatest percent bare ground, Recker and Chip-O-Will woods, rank with the lowest herbaceous species densities (Table 5). When comparing all sites, a strong negative correlation (R^2 = 0.927) exists between percent bare ground and ground cover species density (Figure 22), though only a moderately negative correlation (R^2 = 0.600) exists when comparing percent bare ground and ground cover species richness

(Figure 23).

One of the more fascinating aspects of post oak flatwoods is the occurrence of Quercus marilandica. This oak species is the most adapted to xeric habitats in the Midwest and is primarily confined to elevated slope positions with south-to-southwest facing aspects on shallow soils. Q. marilandica is also found on deep sand deposits associated with the lower Illinois River. The occurrence in flatwoods suggests extremes in environmental conditions for the habitat. In this respect, it is at first surprising to realize the moderately strong negative correlation (R^2 = 0.761) between Q. marilandica site importance values and percent clay content in the claypan (Figure 24) and percent increase in clay content (R^2 = 0.711) between the E and B soil horizons (Figure 25). These data suggest that importance of Q. marilandica increases with coarser textured soils (eg., comparing Q. marilandica IV 200 to percent sand in A1 horizon, R^2 = 0.652). In fact, Q. marilandica reaches its greatest importance at two sites, Recker and Chip-O-Will woods, with soils derived, in part, from alluvium. These alluvial soils contain a higher percent sand content than the soils formed in loess (Appendix 2). Importance of Q. marilandica is only weakly negatively correlated (R^2 = 0.451) with depth to claypan (Figure 26). Though weak, this correlation suggests that as depth to claypan is reduced, the most available rooting zone is limited simulating edaphic conditions comparable to other Q. marilandica habitats.

Since the relationship between Q. marilandica and these edaphic factors is, at best, only moderately explained, it seemed likely that some other aspect of the eluvial E horizon was important in controlling Q. marilandica occurrence and abundance. Most of the soil samples have very high magnesium content in the E and B horizons (Appendix 1). Though most of these samples were very high in magnesium, there was considerable variation in the values from plot to plot and in the site to site mean values (Table 3). Site summary data show a very strong positive correlation (R^2 = 0.930) between magnesium content in the E horizon and Q. marilandica importance values (Figure 27). Magnesium availability is limited in soils with low pH (Brady 1974). In view of this limited availability, the influence of magnesium on importance of Q. marilandica may primarily be mechanical. Magnesium may act to bind the silty and sandy E horizon materials when the soil is very dry resulting in either higher bulk density and reduced water-holding capacity, or possibly a cementation of the E horizon. Either process may act to limit root penetration and further restrict upward capillary water movement from lower horizons.

Locally cemented E horizons may support a perched water table more effectively than the deeper and widespread claypans. Following this reasoning, ephemeral wetland species may also be associated with magnesium content in the subsoil. In fact, there is a strong positive correlation (R^2 = 0.911) between combined Eleocharis species and magnesium content in the E horizon (Figure 28). Only with this understanding is it no surprise that importance of *Eleocharis* species is very strongly correlated (R^2 = 0.995) to importance of *Quercus marilandica* (Figure 29).

Another possible explanation for this close association is that both *Quercus marilandica* and combined *Eleocharis* species occur most frequently in slight depressions where the water table is exposed during wet seasons. Differences in relief of a few inches may result in ponding in an otherwise level woodland. However, there appears to be no explanation as to why magnesium content would be elevated in depressions. No slope or relief measurements were made during this study. In any case, magnesium content in the subsoil either contributes to conditions favoring both *Eleocharis* species and *Q. marilandica*, or microelevational differences favoring these two species contribute to an increased magnesium content. As previously described, *Q. marilandica* is mostly associated with xeric upland habitats; it seems unlikely that microelevational depressions alone would contribute to habitat suitability for this species.

Microelevational differences were found to be significant in species composition in an Indiana flatwoods (Dolan and Menges 1989) with *Eleocharis verrucosa* found in the wetter soils. However, in that study, *Eleocharis verrucosa* was not closely associated with *Quercus marilandica*.

Fire History of Illinois Post Oak Flatwoods

About 63% of an area roughly corresponding to the Southern Tillplain Natural Division was forested in presettlement times (Telford 1926). Much of this was undoubtedly savanna and open woodland (Nuzzo 1986). Many characteristics of post oak flatwoods suggest they would be prone to frequent fires, including: seasonally dry conditions, level aspect in a relatively undissected landscape, open woodland character allowing wind movement, fuel load of oak leaves and a ground cover of graminoid and forb species, and association with a prairie patchwork. Fire was considered an important ecological force in flatwoods during presettlement times in Missouri (Nelson 1985), and possibly Indiana (Dolan and Menges 1989), and in post oak savannas of Texas (Dyksterhuis 1948). Fire scars were not observed on living trees anywhere during this study except Lake Sara Flatwoods. Fire scars were observed on one dead tree at Recker Woods and at a flatwoods remnant one mile south of Chip-O-Will Woods.

Considering size-class distribution data (Figures 2-7) and the shade intolerance of *Quercus stellata*, fire must have had an influence on the vegetational composition and structure of presettlement post oak flatwoods in Illinois, particularly in the recruitment of post oak. Lake Sara Flatwoods, with its nearly annual burn cycle, may represent the presettlement condition as close as any flatwoods remnant in Illinois. In this respect, fire suppression at the other five sites has resulted in a considerable reduction of species richness with a loss of species density to less than one third the presettlement condition (Table 5). Though annual fires were probably not common in presettlement flatwoods, and determining the presettlement fire frequency is largely speculative, fires probably occurred regularly. As a management strategy, fire should be periodically withheld from portions of Lake Sara Flatwoods in order to allow oak seedlings to become established to size classes that would survive subsequent fires. However, in order to initiate oak recruitment fire should be used in the management of other remnant post oak flatwoods. The reintroduction of fire may also restore greater species richness and density to the ground cover.

Fires appear to have been infrequent in recent years at the other five sites. A land owner at Chip-O-Will Woods indicated during this study that in the nearly 30 years he has visited that woodland, he has observed no evidence of fire. Despite the relatively uniform fire-free recent histories of these sites, shrub and sapling establishment varies widely (Table 4). Besides Lake Sara, the sites with the lowest total stem and sapling densities are Recker and Chip-O-Will woods (Table 4). These two sites were unique in the relative coarseness of the A1 and E soil horizons (Appendix 2, Table 3). Shrub and sapling density are moderately negatively associated ($R^2 = 0.607$) with percent sand content in the A1 and E soil horizons (Figure 30). Sapling and shrub development at these sites appears to be retarded at least partially by edaphic conditions including coarse texture.

<u>Summary</u>

Flatwoods soils are characterized by the presence of an argillic horizon (claypan) that limits root penetration and water movement. Thus, this claypan results in a seasonally saturated and seasonally very dry rhizosphere.

The range of variability found in the vegetational composition of post oak flatwoods is correlated with environmental gradients. Soil textural differences, depth to claypan, magnesium content of subsurface soil horizons, tree density, and fire history appear to be the most important factors in shaping the composition and diversity of flatwoods remnants. Compositional ranges for post oak flatwoods along these environmental gradients include sites with dominance of <u>Quercus stellata</u> with <u>Q. alba</u>, <u>Q. velutina</u>, <u>Carya tomentosa</u>, <u>C. ovata</u>, <u>C. glabra</u>, and <u>C. ovalis</u> also present, but with less importance, in the larger size classes. These sites have the greatest stem densities and are characterized by poor oak regeneration and an increase of woody mesophytic taxa in the smaller size classes. In general, stem density is greater with increasing depth to claypan and the Importance Values (IV 200) of mesophytic trees are positively correlated with shrub and sapling densities. Tree species number is higher on sites with soils characterized by finer-textured E horizons.

On the other extreme are sites with dominance of <u>Q. stellata</u> and strong representation of <u>Q. marilandica</u>. In general, these sites are characterized by good oak regeneration, have lower total stem density and lack an increase of woody mesophytic taxa in the smaller size classes. Importance of <u>Q. marilandica</u>

increases with coarser-textured soils and is positively correlated with magnesium content in the subsoil horizons.

Generally, the ground cover stratum in the flatwoods studied included graminoid species (grasses and sedges) of forested floodplains and terraces as well as sedges and forbs of dry upland forests, barrens, glades, and prairies. The two most important ground cover species were woody vines. Species density was over three times greater at a site with a 20-year history of prescribed fire compared with five sites without a recent fire history. Species richness at the site managed with prescribed fire was from about 50% higher to double the totals at the unburned sites.

A more detailed factor analysis based on the plot-specific data will be presented in the second phase of this study.

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Appendices 1 through 4

Appendix 1

Soils Data from A & L Labs

Itemized List of Soil Samples for John Taft
Illinois Natural History Survey
607 East Peabody Drive
Champaign, IL 61820

First letter refers to site, number refers to plot#, second letter refers to relative horizon of collection (A = A_1, B = A_2, C = B horizon).

R = Recker Flatwoods

#	Sample Code	A & L Reference Code
1.	R-1-A	R 1 A
2.	R-1-B	R 1 B
3.	R-1-C	R 1 C
4.	R-2-A	R 2 A
5.	R-2-B	R 2 B
6.	R-2-C	R 2 C
7.	R-3-A	R 3 A
8.	R-3-B	R 3 B
9.	R-3-C	R 3 C
10.	R-4-A	R 4 A
11.	R-4-B	R 4 B
12.	R-4-C	R 4 C
13.	R-5-A	R 5 A
14.	R-5-B	R 5 B
15.	R-5-C	R 5 C
16.	R-6-A	R 6 A
17.	R-6-B	R 6 B
18.	R-6-C	R 6 C
19.	R-7-A	R 7 A
20.	R-7-B	R 7 B
21.	R-7-C	R 7 C
22.	R-8-A	R 8 A
23.	R-8-B	R 8 B
24.	R-8-C	R 8 C

C/W = Chip-O-Will Flatwoods

#	Sample Code	A & L Reference Code
25.	C/W-1-A	C/W 1 A
26.	C/W-1-B	C/W 1 B
27.	C/W-1-C	C/W 1 C
28.	C/W-2-A	C/W 2 A
29.	C/W-2-B	C/W 2 B
30.	C/W-2-C	C/W 2 C
31.	C/W-3-A	C/W 3 A
32.	C/W-3-B	C/W 3 B
33.	C/W-3-C	C/W 3 C
34.	C/W-4-A	C/W 4 A
35.	C/W-4-B	C/W 4 B
36.	C/W-4-C	C/W 4 C
37.	C/W-5-A	C/W 5 A
38.	C/W-5-B	C/W 5 B

C/W = Chip-O-Will Flatwoods, continued...

#	Sample Code	A & L Reference Code
39.	C/W-5-C	C/W 5 C
40.	C/W-6-A	C/W 6 A
41.	C/W-6-B	C/W 6 B
42.	C/W-6-C	C/W 6 C
43.	C/W-7-A	C/W 7 A
44.	C/W-7-B	C/W 7 B
45.	C/W-7-C	C/W 7 C
46.	C/W-8-A	C/W 8 A
47.	C/W-8-B	C/W 8 B
48.	C/W-8-C	C/W 8 C

Posen = Posen Woods Nature Preserve

#	Sample Code	A & L Reference Code
49.	Posen 1 A	P 1 A
50.	Posen 1 B	P 1 B
51.	Posen 1 C	P 1 C
52.	Posen 2 A	P 2 A
53.	Posen 2 B	P 2 B
54.	Posen 2 C	P 2 C
55.	Posen 3 A	P 3 A
56.	Posen 3 B	P 3 B
57.	Posen 3 C	P 3 C
58.	Posen 4 A	P 4 A
59.	Posen 4 B	P 4 B
60.	Posen 4 C	P 4 C
61.	Posen 5 A	P 5 A
62.	Posen 5 B	P 5 B
63.	Posen 5 C	P 5 C
64.	Posen 6 A	P 6 A
65.	Posen 6 B	P 6 B
66.	Posen 6 C	P 6 C
67.	Posen 7 A	P 7 A
68.	Posen 7 B	P 7 B
69.	Posen 7 C	P 7 C
70.	Posen 8 A	P 8 A
71.	Posen 8 B	P 8 B
72.	Posen 8 C	P 8 C

WCW = Williams Creek Woods

#	Sample Code	A & L Reference Code (no change)
73.	WCW 1 A	WCW 1 A
74.	WCW 1 B	WCW 1 B
75.	WCW 1 C	WCW 1 C
76.	WCW 2 A	WCW 2 A
77.	WCW 2 B	WCW 2 B
78.	WCW 2 C	WCW 2 C
79.	WCW 3 A	WCW 3 A
80.	WCW 3 B	WCW 3 B
81.	WCW 3 C	WCW 3 C

WCW = Williams Creek Woods, continued...

# Sample Code	A & L Reference Code (no change)
82. WCW 4 A	WCW 4 A
83. WCW 4 B	WCW 4 B
84. WCW 4 C	WCW 4 C
85. WCW 5 A	WCW 5 A
86. WCW 5 B	WCW 5 B
87. WCW 5 C	WCW 5 C
88. WCW 6 A	WCW 6 A
89. WCW 6 B	WCW 6 B
90. WCW 6 C	WCW 6 C
91. WCW 7 A	WCW 7 A
92. WCW 7 B	WCW 7 B
93. WCW 7 C	WCW 7 C
94. WCW 8 A	WCW 8 A
95. WCW 8 B	WCW 8 B
96. WCW 8 C	WCW 8 C

JS = Jackson Slough Flatwoods

# Sample Code	A & L Reference Code (no change)
97. JS 1 A	JS 1 A
98. JS 1 B	JS 1 B
99. JS 1 C	JS 1 C
100. JS 2 A	JS 2 A
101. JS 2 B	JS 2 B
102. JS 2 C	JS 2 C
103. JS 3 A	JS 3 A
104. JS 3 B	JS 3 B
105. JS 3 C	JS 3 C
106. JS 4 A	JS 4 A
107. JS 4 B	JS 4 B
108. JS 4 C	JS 4 C
109. JS 5 A	JS 5 A
110. JS 5 B	JS 5 B
111. JS 5 C	JS 5 C
112. JS 6 A	JS 6 A
113. JS 6 B	JS 6 B
114. JS 6 C	JS 6 C
115. JS 7 A	JS 7 A
116. JS 7 B	JS 7 B
117. JS 7 C	JS 7 C
118. JS 8 A	JS 8 A
119. JS 8 B	JS 8 B
120. JS 8 C	JS 8 C

Sara = Lake Sara Flatwoods

# Sample Code	A & L Reference Code
121. Sara 1 A	S 1 A
122. Sara 1 B	S 1 B
123. Sara 1 C	S 1 C
124. Sara 2 A	S 2 A

Sara = Lake Sara Flatwoods, continued...

#	Sample Code	A & L Reference Code
125.	Sara 2 B	S 2 B
126.	Sara 2 C	S 2 C
127.	Sara 3 A	S 3 A
128.	Sara 3 B	S 3 B
129.	Sara 3 C	S 3 C
130.	Sara 4 A	S 4 A
131.	Sara 4 B	S 4 B
132.	Sara 4 C	S 4 C
133.	Sara 5 A	S 5 A
134.	Sara 5 B	S 5 B
135.	Sara 5 C	S 5 C
136.	Sara 6 A	S 6 A
137.	Sara 6 B	S 6 B
138.	Sara 6 C	S 6 C
139.	Sara 7 A	S 7 A
140.	Sara 7 B	S 7 B
141.	Sara 7 C	S 7 C
142.	Sara 8 A	S 8 A
143.	Sara 8 B	S 8 B
144.	Sara 8 C	S 8 C
145.	Sara 9 A	S 9 A
146.	Sara 9 B	S 9 B
147.	Sara 9 C	S 9 C
148.	Sara 10 A	S 10 A
149.	Sara 10 B	S 10 B
150.	Sara 10 C	S 10 C

Appendix 2

Appendix 2

Selected Soils Data for each Site Sorted by Plot

Tree Plot #	1	2	3	4	5	6	7	8		
SOIL ANALYSIS									Avg	Std Dev
% Organic Matter										
Horizon A1	1.7	1.2	1.5	1.4	1	1.7	1.5	1.6	1.45	0.24
A2	1	0.6	0.8	0.8	0.8	1.1	1.4	0.8	0.91	0.25
B	1.3	0.7	0.7	0.7	0.9	0.8	0.7	0.8	0.83	0.21
Phosphorus (ppm)										
Horizon A1	12	13	9	12	7	26	9	16	13.00	5.95
A2	17	21	15	14	10	50	6	10	17.88	13.79
B	25	29	18	16	10	20	16	16	18.75	5.92
Potassium (ppm)										
Horizon A1	55	54	73	52	61	51	57	65	58.50	7.48
A2	85	106	133	93	91	78	65	114	95.63	21.49
B	116	115	145	126	61	122	93	130	113.50	25.85
Magnesium (ppm)										
Horizon A1	35	31	111	235	264	54	113	162	125.63	88.72
A2	593	997	990	792	768	457	499	814	738.75	206.08
B	998	992	996	994	564	984	962	995	935.63	150.61
Calcium (ppm)										
Horizon A1	190	180	200	180	250	190	270	200	207.50	33.70
A2	220	260	310	200	250	270	230	180	240.00	41.40
B	280	340	350	200	280	350	260	230	286.25	56.55
Soil pH										
Horizon A1	4.3	4.2	4.3	4.8	4.7	4.4	4.4	4.3	4.43	0.21
A2	4.7	4.7	4.5	5	5	4.5	4.7	4.7	4.73	0.19
B	4.8	4.6	4.5	4.7	4.9	4.7	4.9	4.7	4.73	0.14
C.E.C. (meg/100g)										
Horizon A1	6.7	7.7	10.5	5.6	7.3	7.8	8.8	11.3	8.21	1.91
A2	12.6	20	22.8	13.3	13.4	18.1	11.1	16.1	15.93	4.07
B	18.9	22.3	22.8	19.4	11.2	20.7	17.1	19.7	19.01	3.65
BASE SATURATION										
% K - Horizon A1	2.1	1.8	1.8	2.4	2.1	1.7	1.7	1.5	1.89	0.29
A2	1.7	1.4	1.5	1.8	1.7	1.1	1.5	1.8	1.56	0.24
B	1.6	1.3	1.6	1.7	1.4	1.5	1.4	1.7	1.53	0.15
% Mg - Horizon A1	4.4	3.4	8.8	34.7	30.2	5.8	10.7	11.9	13.74	11.98
A2	39.1	41.6	36.2	49.7	47.9	21	37.6	42.1	39.40	8.80
B	44	37.1	36.4	42.7	42.1	39.6	47	42	41.36	3.53
% Ca - Horizon A1	14.4	11.7	9.4	15.9	17.2	11.7	14.9	8.7	12.99	3.08
A2	8.7	6.5	6.6	7.5	9.4	7.7	10.4	5.6	7.80	1.61
B	7.4	7.6	7.6	5.1	12.5	8.4	7.6	5.8	7.75	2.20
% H - Horizon A1	79.1	83.1	80	47	50.5	80.8	72.7	77.9	71.39	14.32
A2	50.5	50.5	55.7	41	41	70.2	50.5	50.5	51.24	9.19
B	47	54	54.4	50.5	44	50.5	44	50.5	49.36	4.03
SOIL TEXTURE										
Horizon A1										
% Sand	15	57	57		16	58	13	54	38.57	22.41
% Silt	69	34	30		58	34	63	32	45.71	16.84
% Clay	16	9	13		26	8	24	14	15.71	6.95
Texture Class	silt loam	sandy loam	sandy loam		silt loam	sandy loam	silt loam	sandy loam		
Thickness (cm)					18					
Horizon A2										
% Sand	11	58	77		52	12	54	55	45.57	24.72
% Silt	55	23	0		26	60	26	23	30.43	20.63
% Clay	34	19	23		22	28	20	22	24.00	5.26
Class	slty cl lm	sandy loam	sdy cl lm		sdy cl lm	slty cl lm	sdy cl lm	sdy cl lm		
Depth to A2 (cm)					18					
Thickness (cm)					22					
Horizon B										
% Sand	53	55	55	54	54	54	8	51	48.00	16.21
% Silt	21	22	22	22	26	22	48	23	25.75	9.11
% Clay	26	23	24	24	20	24	44	26	26.38	7.37
Texture Class	sdy cl lm	sdy cl lm	sdy cl lm	sdy cl lm	sdy cl lm	sdy cl lm	silty clay	sdy cl lm		
Depth to B (cm)	55	50	50	31	40	48	38	28	42.50	9.77
Depth to Hardpan (cm)	22	22	none	weak - near surface	none	near surface	near surface	near surface	22.00	0.00

Tree Plot #	1	2	3	4	5	6	7	8	Average	Std Dev
SOIL ANALYSIS										
% Organic Matter										
Horizon A1	0.8	1.6	1.5	1.4	1.2	1.7	1.3	2	1.44	0.36
A2	0.8	0.8	0.9	0.9	1.1	1.1	0.8	1.3	0.96	0.18
B	0.9	0.8	0.8	0.8	1.3	0.8	0.8	0.7	0.86	0.18
Phosphorus (ppm)										
Horizon A1	7	11	16	8	8	15	8	14	10.88	3.64
A2	14	8	5	17	8	11	7	7	9.63	4.07
B	29	26	29	46	29	18	15	125	39.63	35.71
Potassium (ppm)										
Horizon A1	51	59	64	53	48	56	61	69	57.63	7.01
A2	69	61	75	65	57	69	98	92	73.25	14.57
B	93	84	121	102	91	88	113	129	102.63	16.60
Magnesium (ppm)										
Horizon A1	123	50	44	70	63	146	331	245	134.00	103.98
A2	382	292	487	564	531	288	968	637	518.63	221.16
B	794	795	999	991	992	765	996	997	916.13	109.27
Calcium (ppm)										
Horizon A1	190	190	190	180	190	230	240	210	202.50	21.88
A2	200	180	180	200	220	250	330	310	233.75	58.05
B	240	240	250	230	210	230	450	480	291.25	108.16
Soil pH										
Horizon A1	4.7	4.5	4.4	4.5	4.4	4.4	4.9	4.4	4.53	0.18
A2	5	5	4.8	5	4.9	4.6	4.9	4.6	4.85	0.17
B	4.8	5	4.9	4.9	4.9	4.7	4.9	4.8	4.86	0.09
C.E.C. (meg/100g)										
Horizon A1	4.3	6.9	9	7.8	8.2	9.7	7.3	11.1	8.04	2.03
A2	7.4	5.9	9.7	9.9	10.1	8.3	17.8	15.4	10.56	4.04
B	15.2	13.6	17.7	17.1	17.1	15.7	19.4	20.8	17.08	2.30
% BASE SATURATION										
% K - Horizon A1	3.1	2.2	1.8	1.7	1.5	1.5	2.1	1.6	1.94	0.54
A2	2.4	2.6	2	1.7	1.4	2.1	1.4	1.5	1.89	0.46
B	1.6	1.6	1.8	1.5	1.4	1.4	1.5	1.6	1.55	0.13
% Mg - Horizon A1	24.1	6	4.1	7.5	6.4	12.5	37.5	18.4	14.56	11.56
A2	43.1	41.1	41.8	47.3	43.7	28.8	45.3	34.4	40.69	6.12
B	43.5	48.6	47.2	48.3	48.5	40.7	42.9	39.9	44.95	3.63
% Ca - Horizon A1	22.3	13.5	10.8	11.3	11.6	11.8	16.4	9.7	13.43	4.12
A2	13.5	15.3	9.2	10	10.9	15.1	9.3	10.1	11.68	2.56
B	7.9	8.8	7	6.2	6.1	7.4	11.6	11.5	8.31	2.18
% H - Horizon A1	50.5	78.3	83.3	79.5	80.5	74.2	44	70.3	70.08	14.74
A2	41	41	47	41	44	54	44	54	45.75	5.50
B	47	41	44	44	44	50.5	44	47	45.19	2.88
SOIL TEXTURE										
Horizon A1										
% Sand	15	56		57	55	59	56	56	50.57	15.74
% Silt	63	34		33	33	29	30	30	36.00	12.06
% Clay	22	10		10	12	12	14	14	13.43	4.12
Texture Class	silt loam	sandy loam		sandy loam	sandy loam	sandy loam	sandy loam	sandy loam		
Thickness										
Horizon A2										
% Sand		56		55	53	55	54	54	54.50	1.05
% Silt		30		29	33	27	24	26	28.17	3.19
% Clay		14		16	14	18	22	20	17.33	3.27
Texture Class		sandy loam		sandy loam	sandy loam	sandy loam	sndy cl lm	sndy cl lm		
Depth to A2 (cm)										
Thickness (cm)										
Horizon B										
% Sand	54	12	55	55	53		52	54	47.86	15.85
% Silt	24	52	23	23	27		26	22	28.14	10.67
% Clay	22	36	22	22	20		22	24	24.00	5.42
Texture Class	sndy cl lm	silty cl lm	sndy cl lm	sndy cl lm	sndy cl lm		sndy cl lm	sndy cl lm		
Depth to B (cm)	30	32	29	31	25	30	32	43	31.50	5.15
Depth to Hardpan (cm)	A-dstnct	A-dstnct	A-dstnct	A-dstnct	A-dstnct	A-dstnct	A-poorly	none		
							devlpd			

Tree Plot #	1	2	3	4	5	6	7	8	Average	Std Dev
SOIL ANALYSIS										
% Organic Matter										
Horizon A1	1.2	1.0	1.7	1.2	4.7	2.3	4.2	3.0	2.4	1.4
A2	0.6	0.8	0.9	1.3	1.0	0.8	0.9	0.9	0.9	0.2
B	0.6	0.5	0.6	0.5	0.4	0.7	0.7	0.5	0.6	0.1
Phosphorus (ppm)										
Horizon A1	18.0	10.0	9.0	18.0	46.0	17.0	34.0	21.0	21.6	12.5
A2	12.0	6.0	7.0	7.0	20.0	7.0	13.0	5.0	9.6	5.1
B	5.0	10.0	9.0	6.0	12.0	23.0	13.0	12.0	11.3	5.5
Potassium (ppm)										
Horizon A1	55.0	47.0	59.0	44.0	91.0	60.0	105.0	51.0	64.0	22.0
A2	43.0	42.0	48.0	46.0	57.0	54.0	52.0	48.0	48.8	5.3
B	40.0	41.0	49.0	45.0	41.0	45.0	46.0	51.0	44.8	4.0
Magnesium (ppm)										
Horizon A1	99.0	21.0	46.0	21.0	46.0	66.0	78.0	25.0	50.3	28.7
A2	145.0	118.0	152.0	239.0	158.0	102.0	51.0	146.0	138.9	53.7
B	199.0	396.0	497.0	486.0	434.0	374.0	301.0	416.0	387.9	98.5
Calcium (ppm)										
Horizon A1	340.0	200.0	250.0	180.0	330.0	380.0	570.0	200.0	306.3	130.0
A2	370.0	210.0	360.0	330.0	290.0	320.0	240.0	250.0	296.3	58.5
B	440.0	330.0	840.0	430.0	520.0	670.0	490.0	490.0	526.3	159.0
Soil pH										
Horizon A1	4.6	4.2	4.4	4.3	4.8	4.6	4.6	4.4	4.5	0.2
A2	4.6	4.7	4.7	4.4	4.5	4.5	4.4	4.8	4.6	0.1
B	4.8	4.8	4.6	4.5	4.7	5.1	4.6	5.0	4.8	0.2
C.E.C. (meg/100g)										
Horizon A1	5.8	6.0	8.7	6.4	4.3	5.7	8.2	7.9	6.6	1.5
A2	6.9	4.3	6.4	14.4	11.3	9.2	7.5	4.9	8.1	3.4
B	7.5	9.5	18.4	19.2	12.8	10.6	11.0	10.2	12.4	4.2
% Base Saturation										
% K - Horizon A1	2.4	2.0	1.7	1.8	5.5	2.7	3.3	1.7	2.6	1.3
A2	1.6	2.5	1.9	0.8	1.3	1.5	1.8	2.5	1.7	0.6
B	1.4	1.1	0.7	0.6	0.8	1.1	1.1	1.3	1.0	0.3
% Mg - Horizon A1	14.2	2.9	4.4	2.7	9.0	9.7	7.9	2.6	6.7	4.2
A2	17.5	22.7	19.7	13.8	11.7	9.2	5.7	24.9	15.7	6.7
B	22.2	34.6	22.5	21.1	28.3	29.4	22.7	33.8	26.8	5.4
% Ca - Horizon A1	29.4	16.8	14.6	14.2	38.5	33.6	34.8	12.2	24.3	10.8
A2	26.9	24.3	27.9	11.8	12.7	17.6	16.5	25.6	20.4	6.5
B	29.4	17.3	22.8	11.1	20.4	31.5	22.2	23.9	22.3	6.5
% H - Horizon A1	54.0	78.3	79.3	81.3	47.0	54.0	54.0	83.5	66.4	15.4
A2	54.0	50.5	50.5	73.6	74.3	71.7	76.0	47.0	62.2	12.7
B	47.0	47.0	54.0	67.2	50.5	38.0	54.0	41.0	49.8	9.0
SOIL TEXTURE										
Horizon A1										
% Sand	25.0	15.0	14.0	16.0	59.0	19.0	19.0	13.0	22.5	15.2
% Silt	55.0	71.0	70.0	66.0	31.0	61.0	65.0	71.0	61.3	13.4
% Clay	20.0	14.0	16.0	18.0	10.0	20.0	16.0	16.0	16.3	3.3
Texture Class	silt loam	silt loam	silt loam	silt loam	sndy loar	silt loam	silt loam	silt loam		
Thickness	20.0	22.0	23.0	23.0	10.0	19.0	10.0	15.0	17.8	5.4
Horizon A2										
% Sand	30.0	13.0	16.0	14.0	21.0	17.0	15.0	15.0	17.6	5.6
% Silt	48.0	63.0	62.0	54.0	55.0	59.0	63.0	57.0	57.6	5.2
% Clay	22.0	24.0	22.0	32.0	24.0	24.0	22.0	28.0	24.8	3.5
Texture Class	loam	silt loam	silt loam	slty cl lm	silt loam	silt loam	silt loam	slty cl lm		
Thickness (cm)	25.0	20.0	25.0	25.0	39.0	59.0	35.0	33.0	32.6	12.4
Horizon B										
% Sand	24.0	18.0	23.0	17.0	19.0	19.0	17.0	15.0	19.0	3.1
% Silt	50.0	38.0	33.0	41.0	41.0	47.0	47.0	43.0	42.5	5.5
% Clay	26.0	44.0	44.0	42.0	40.0	34.0	36.0	42.0	38.5	6.2
Texture Class	silt loam	clay	clay	silty clay	clay	slty cl lm	slty cl lm	silty clay		
Depth to B (cm)	90.0	42.0	48.0	48.0	49.0	78.0	45.0	48.0	56.0	17.7
Depth to Hardpan	none	22.0	28.0	28.0	20.0	none	24.0	27.0	24.8	3.4

Tree Plot #	1	2	3	4	5	6	7	8	Average	Std Dev
SOIL ANALYSIS										
% Organic Matter										
Horizon A1	1.1	3.6	1.2	1.8	1.2	1.3	2.1	1.9	1.78	0.83
A2	0.7	0.5	0.8	0.7	0.7	0.7	1.5	0.8	0.80	0.30
B	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.6	0.44	0.07
Phosphorus (ppm)										
Horizon A1	10	20	16	23	9	11	36	12	17.13	9.11
A2	6	11	15	7	10	7	43	14	14.13	12.12
B	24	21	19	16	12	22	31	20	20.63	5.60
Potassium (ppm)										
Horizon A1	47	72	53	56	52	52	50	62	55.50	8.00
A2	45	44	45	39	40	42	57	53	45.63	6.28
B	60	57	47	61	54	59	76	103	64.63	17.52
Magnesium (ppm)										
Horizon A1	72	47	21	27	34	21	22	25	33.63	17.82
A2	292	292	45	95	113	130	101	86	144.25	94.40
B	592	503	568	542	491	679	709	640	590.50	79.95
Calcium (ppm)										
Horizon A1	240	290	210	190	200	200	200	230	220.00	32.95
A2	540	510	180	220	230	260	310	230	310.00	137.94
B	1210	1020	780	720	620	730	1010	550	830.00	226.78
Soil pH										
Horizon A1	4.5	4.7	4.3	4.4	4.1	4.3	4.5	4.5	4.41	0.18
A2	4.9	4.8	4.5	4.7	4.5	4.8	4.6	4.5	4.66	0.16
B	4.9	4.9	4.7	4.8	4.9	4.8	4.5	4.8	4.79	0.14
C.E.C. (meg/100g)										
Horizon A1	8.4	4.1	4.8	6.3	9	7.4	5.2	5.7	6.36	1.75
A2	9.4	9.6	7.5	4	8.9	4.7	5.5	8.4	7.25	2.22
B	19.9	16.9	17.7	15.6	13.1	17.8	26.6	15.7	17.91	4.03
% Base Saturation										
% K - Horizon A1	1.4	4.5	2.8	2.3	1.5	1.8	2.5	2.8	2.45	0.99
A2	1.2	1.2	1.5	2.5	1.2	2.3	2.6	1.6	1.76	0.61
B	0.8	0.9	0.7	1	1.1	0.8	0.7	1.7	0.96	0.33
% Mg - Horizon A1	7.1	9.6	3.6	3.6	3.1	2.4	3.5	3.7	4.58	2.46
A2	26	25.3	5	19.7	10.6	23.1	15.3	8.5	16.69	8.05
B	24.8	24.9	26.8	28.9	31.3	31.7	22.2	33.9	28.06	4.05
% Ca - Horizon A1	14.1	35.4	22.8	14.7	11	13.4	19	19.8	18.78	7.76
A2	28.8	26.5	12.2	27.3	12.9	27.6	28.1	13.7	22.14	7.66
B	30.4	30.2	22	23.1	23.6	20.5	19.1	17.4	23.29	4.78
% H - Horizon A1	77.4	50.5	70.8	79.4	84.4	82.4	75	73.7	74.20	10.57
A2	44	47	81.3	50.5	75.3	47	54	76.2	59.41	15.44
B	44	44	50.5	47	44	47	58	47	47.69	4.73
SOIL TEXTURE										
Horizon A1										
% Sand	11	17	11	11	9	13	13	8	11.63	2.77
% Silt	67	69	75	75	67	69	71	75	71.00	3.55
% Clay	22	14	14	14	24	18	16	17	17.38	3.81
Texture Class	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam		
Thickness (cm)	15	15	15	15	15	15	15	15	15.00	0.00
Horizon A2										
% Sand	13	13	13	11	11	14	12	8	11.88	1.89
% Silt	55	53	69	67	63	64	68	71	63.75	6.56
% Clay	32	34	18	22	26	22	20	21	24.38	5.80
Texture Class	slty cl lm	slty cl lm	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam		
Thickness (cm)	25	35	28	31	40	38	35		33.14	5.40
Horizon B										
% Sand	15	13	13	12	11	14	4	12	11.75	3.37
% Silt	45	47	45	46	47	44	50	49	46.63	2.07
% Clay	40	40	42	42	42	42	46	39	41.63	2.13
Texture Class	clay	clay	silty clay	silty clay	silty clay	silty clay	silty clay	slty cl lm		
Depth to B (cm)	40	50	43	46	55	53	50		48.14	5.40
Depth to Hardpan (cm)	24	24	22	27	none	24	24	21	23.71	1.89

Tree Plot #	1	2	3	4	5	6	7	8	Average	Std Dev
SOIL ANALYSIS										
% Organic Matter										
Horizon A1	1.2	1.4	2.5	0.7	3.6	4.2	2.6	2.8	2.38	1.21
A2	0.5	0.6	0.8	0.6	1.4	0.9	0.4	0.7	0.74	0.31
B	0.4	0.5	0.6	0.4	0.5	0.5	0.3	0.3	0.44	0.11
Phosphorus (ppm)										
Horizon A1	14.0	33.0	24.0	5.0	37.0	38.0	35.0	23.0	26.13	11.91
A2	46.0	13.0	17.0	8.0	16.0	13.0	26.0	12.0	18.88	12.15
B	38.0	7.0	23.0	14.0	12.0	12.0	21.0	21.0	18.50	9.64
Potassium (ppm)										
Horizon A1	54.0	81.0	78.0	60.0	82.0	62.0	82.0	55.0	69.25	12.61
A2	69.0	57.0	83.0	60.0	50.0	39.0	46.0	45.0	56.13	14.45
B	55.0	47.0	75.0	60.0	67.0	78.0	92.0	54.0	66.00	14.95
Magnesium (ppm)										
Horizon A1	86.0	88.0	102.0	301.0	42.0	37.0	36.0	19.0	88.88	90.83
A2	321.0	34.0	412.0	698.0	99.0	52.0	48.0	59.0	215.38	241.53
B	543.0	497.0	830.0	974.0	467.0	591.0	477.0	532.0	613.88	186.17
Calcium (ppm)										
Horizon A1	490.0	460.0	470.0	330.0	330.0	310.0	280.0	220.0	361.25	99.49
A2	1020.0	230.0	490.0	380.0	430.0	180.0	220.0	180.0	391.25	280.63
B	1400.0	660.0	760.0	470.0	1880.0	380.0	460.0	500.0	813.75	539.44
Soil pH										
Horizon A1	4.5	4.3	4.2	4.7	4.0	4.6	4.3	4.3	4.36	0.23
A2	5.1	4.4	4.7	5.2	4.2	4.3	4.4	4.4	4.59	0.38
B	5.0	4.4	4.7	5.0	4.7	4.8	4.5	4.7	4.73	0.21
C.E.C. (meg/100g)										
Horizon A1	6.1	8.9	9.6	8.7	7.8	4.4	7.2	8.7	7.67	1.72
A2	12.8	7.9	12.3	12.0	10.8	8.5	7.9	7.5	9.96	2.24
B	19.8	19.3	22.0	18.0	27.2	13.3	15.5	14.3	18.68	4.53
% Base Saturation										
% K - Horizon A1	2.3	2.3	2.1	1.8	2.7	3.6	2.9	1.6	2.41	0.64
A2	1.4	1.9	1.7	1.3	1.2	1.2	1.5	1.5	1.46	0.24
B	0.7	0.6	0.9	0.9	0.6	1.5	1.5	1.0	0.96	0.36
% Mg - Horizon A1	11.7	8.2	8.9	28.8	4.5	7.0	4.2	1.8	9.39	8.43
A2	20.9	3.6	27.9	48.4	7.6	5.1	5.1	6.6	15.65	15.88
B	22.9	21.5	31.4	45.1	14.3	37.2	25.6	31.0	28.63	9.68
% Ca - Horizon A1	40.1	25.5	24.4	18.9	21.0	35.4	19.3	12.7	24.66	9.05
A2	39.7	14.8	19.9	15.8	19.9	10.2	13.7	11.9	18.24	9.33
B	35.4	17.3	17.2	13.0	34.6	14.3	14.9	17.5	20.53	9.08
% H - Horizon A1	45.9	64.0	64.6	50.5	71.8	54.0	73.6	83.9	63.54	12.86
A2	38.0	79.7	50.5	34.5	71.3	83.5	79.7	80.0	64.65	20.38
B	41.0	60.6	50.5	41.0	50.5	47.0	58.0	50.5	49.89	7.05
SOIL TEXTURE										
Horizon A1										
% Sand	10.0	12.0	18.0	15.0	18.0	16.0	18.0	16.0	15.38	2.97
% Silt	71.0	66.0	60.0	46.0	63.0	67.0	67.0	69.0	63.63	7.89
% Clay	19.0	22.0	22.0	39.0	19.0	17.0	15.0	15.0	21.00	7.76
Texture Class	silt loam	silt loam	silt loam	slty cl lm	silt loam	silt loam	silt loam	silt loam		
Thickness (cm)	23.0	20.0	12.0	20.0	15.0	15.0	11.0	13.0	16.13	4.36
Horizon A2										
% Sand	8.0	10.0	32.0	6.0	14.0	14.0	18.0	14.0	14.50	8.05
% Silt	59.0	64.0	24.0	44.0	57.0	61.0	57.0	63.0	53.63	13.48
% Clay	33.0	26.0	44.0	50.0	29.0	25.0	25.0	23.0	31.88	9.95
Texture Class	slty cl lm	silt loam	clay	silty clay	slty cl lm	silt loam	silt loam	silt loam		
Thickness (cm)	32.0	33.0	24.0	30.0	21.0	22.0	35.0	29.0	28.25	5.28
Horizon B										
% Sand	16.0	10.0	12.0	8.0	12.0	10.0	12.0	14.0	11.75	2.49
% Silt	48.0	42.0	36.0	50.0	39.0	39.0	49.0	39.0	42.75	5.44
% Clay	36.0	48.0	52.0	42.0	49.0	51.0	39.0	47.0	45.50	5.83
Texture Class	slty cl lm	silty clay	clay	silty clay	clay	clay	slty cl lm	clay		
Depth to B (cm)	55.0	53.0	36.0	50.0	36.0	37.0	46.0	42.0	44.38	7.76
Depth to Hardpan (cm)	none	none	none	none	none	10.0	none	none	10.00	0.00
				A1 soil has						
				eroded						

Tree Plot #	1	2	3	4	5	6	7	8	9	10	Average	Std Dev
SOIL ANALYSIS												
% Organic Matter												
Horizon A1	2.8	1.8	1.7	2.0	2.8	3.7	2.5	4.2	2.2	5.4	2.69	0.90
A2	0.4	0.5	0.5	0.6	0.5	0.8	0.4	1.0	0.6	0.9	0.59	0.21
B	0.2	0.3	0.6	0.5	0.4	0.3	0.4	0.4	0.5	0.4	0.39	0.12
Phosphorus (ppm)												
Horizon A1	22.0	17.0	20.0	14.0	13.0	8.0	16.0	32.0	9.0	20.0	17.75	7.19
A2	5.0	8.0	8.0	5.0	5.0	5.0	8.0	13.0	4.0	5.0	7.13	2.80
B	6.0	8.0	6.0	6.0	7.0	13.0	6.0	3.0	8.0	7.0	6.88	2.85
Potassium (ppm)												
Horizon A1	58.0	50.0	65.0	54.0	60.0	48.0	52.0	85.0	53.0	63.0	59.00	11.89
A2	43.0	45.0	34.0	33.0	42.0	49.0	34.0	50.0	49.0	49.0	41.25	6.84
B	49.0	50.0	45.0	50.0	42.0	50.0	105.0	41.0	58.0	50.0	54.00	20.94
Magnesium (ppm)												
Horizon A1	57.0	40.0	39.0	35.0	52.0	65.0	36.0	59.0	31.0	34.0	47.88	11.74
A2	121.0	83.0	82.0	128.0	114.0	153.0	61.0	94.0	159.0	65.0	104.50	29.85
B	537.0	718.0	580.0	629.0	692.0	577.0	594.0	799.0	997.0	688.0	640.75	88.22
Calcium (ppm)												
Horizon A1	400.0	270.0	270.0	230.0	300.0	430.0	260.0	330.0	250.0	260.0	311.25	70.80
A2	250.0	190.0	210.0	190.0	210.0	310.0	200.0	200.0	180.0	200.0	220.00	41.06
B	460.0	250.0	220.0	200.0	230.0	580.0	260.0	280.0	260.0	230.0	310.00	135.75
Soil pH												
Horizon A1	4.5	4.4	4.2	4.2	4.6	4.6	4.3	4.7	4.5	4.6	4.44	0.19
A2	4.5	4.6	4.5	4.7	4.4	4.4	4.4	4.4	5.0	4.6	4.49	0.11
B	4.6	4.8	5.0	4.9	4.7	4.6	4.6	4.9	4.3	4.9	4.76	0.16
C.E.C. (meg/100g)												
Horizon A1	6.8	6.1	6.3	6.5	4.5	6.1	7.1	4.8	6.1	3.8	6.03	0.92
A2	8.6	3.8	7.6	4.2	9.0	9.3	7.2	8.3	4.0	3.6	7.25	2.12
B	15.0	13.9	10.3	11.4	14.2	17.0	14.2	14.6	20.2	12.5	13.83	2.09
% Base Saturation												
% K - Horizon A1	2.2	2.1	2.6	2.1	3.4	2.0	1.9	4.6	2.2	4.3	2.61	0.94
A2	1.3	3.0	1.1	2.0	1.2	1.4	1.2	1.5	3.2	3.5	1.59	0.64
B	0.8	0.9	1.1	1.1	0.8	0.8	1.9	0.7	0.7	1.0	1.01	0.39
% Mg - Horizon A1	7.0	5.5	5.2	4.5	9.6	8.9	4.2	10.3	4.2	7.5	6.90	2.41
A2	11.7	18.1	9.0	25.1	10.6	13.7	7.1	9.4	33.3	14.9	13.09	5.90
B	29.8	43.1	47.1	46.1	40.6	28.2	34.9	45.7	41.1	45.8	39.44	7.53
% Ca - Horizon A1	29.0	21.9	20.8	18.0	33.0	35.1	17.8	34.6	19.8	34.2	26.28	7.46
A2	14.9	24.9	13.6	22.4	11.5	17.2	13.9	12.0	22.5	27.6	16.30	4.91
B	15.4	9.0	10.8	8.8	8.1	17.0	9.2	9.6	6.7	9.2	10.99	3.33
% H - Horizon A1	61.8	70.5	71.4	75.4	54.0	54.0	76.1	50.5	73.8	54.0	64.21	10.42
A2	72.1	54.0	76.3	50.5	76.7	67.7	77.8	77.1	41.0	54.0	69.03	10.92
B	54.0	47.0	41.0	44.0	50.5	54.0	54.0	44.0	51.5	44.0	48.56	5.26
SOIL TEXTURE												
Horizon A1												
% Sand	24.0	20.0	30.0	22.0	22.0	34.0	22.0	20.0	26.0	24.0	24.25	5.06
% Silt	57.0	59.0	52.0	60.0	62.0	54.0	56.0	64.0	60.0	66.0	58.00	4.04
% Clay	19.0	21.0	18.0	18.0	16.0	12.0	22.0	16.0	14.0	10.0	17.75	3.15
Texture Class	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam		
Thickness (cm)	7.0	7.0	12.0	12.0	10.0	10.0	11.0	5.0	8.0	4.0	9.25	2.60
Horizon A2												
% Sand	18.0	16.0	20.0	18.0	20.0	28.0	21.0	16.0	22.0	19.0	19.63	3.85
% Silt	55.0	57.0	58.0	56.0	56.0	47.0	55.0	60.0	56.0	57.0	55.50	3.82
% Clay	27.0	27.0	22.0	26.0	24.0	25.0	24.0	24.0	22.0	24.0	24.88	1.73
Texture Class	silt loam	silt loam	silt loam	silt loam	silt loam	loam	silt loam	silt loam	silt loam	silt loam		
Thickness (cm)	63.0	29.0	29.0	23.0	34.0	32.0		51.0	27.0	37.0	37.29	14.31
Horizon B												
% Sand	16.0	14.0	18.0	16.0	16.0	18.0	13.0	18.0	18.0	15.0	16.13	1.89
% Silt	41.0	40.0	42.0	40.0	42.0	40.0	41.0	40.0	40.0	41.0	40.75	0.89
% Clay	43.0	46.0	40.0	44.0	42.0	42.0	46.0	42.0	42.0	44.0	43.13	2.10
Texture Class	silty clay	silty clay	clay	silty clay	silty clay	silty clay	silty clay	silty clay	silty clay	silty clay		
Depth to B (cm)	70.0	36.0	41.0	35.0	44.0	42.0		56.0	35.0	41.0	46.29	12.53
Depth to Hardpan (cm)	none	weak	none	20.0	24.0	none		none	20.0	17.0	22.00	2.83

Appendix 3

Tree and Shrub/Sapling Summary Data

Summary Tree Data

CHIP-O-WILL WOODS Tree Species	Total ba sq m/ha	Density/ha	Relative BA per ha	Rel Density per ha	IV 200
Quercus stellata	20.08	297.50	85.73	62.63	148.36
Quercus marilandica	2.21	97.50	9.43	20.53	29.95
Carya ovata	0.34	45.00	1.45	9.47	10.92
Quercus velutina	0.18	25.00	0.76	5.26	6.02
Quercus bicolor	0.61	7.50	2.59	1.58	4.16
Quercus mar+velutina	0.01	2.50	0.06	0.53	0.58
Total - all spp	**23.42**	**475.00**	**100.00**	**100.00**	**200.00**

RECKER WOODS Tree Species	Total ba sq m/ha	Density/ha	Relative BA per ha	Rel Density per ha	IV 200
Quercus stellata	14.49	232.50	73.60	46.27	119.87
Quercus marilandica	2.53	142.50	12.88	28.36	41.23
Quercus palustris	1.34	20.00	6.79	3.98	10.77
Carya ovata	0.32	37.50	1.63	7.46	9.09
Quercus alba	0.21	15.00	1.07	2.99	4.05
Quercus imbricaria	0.25	12.50	1.25	2.49	3.74
Fraxinus americana	0.14	12.50	0.72	2.49	3.21
Carya glabra	0.10	10.00	0.53	1.99	2.52
Quercus rubra	0.15	5.00	0.75	1.00	1.75
Quercus velutina	0.10	5.00	0.50	1.00	1.49
Diospyros virginiana	0.03	5.00	0.17	1.00	1.17
Ulmus rubra	0.02	2.50	0.08	0.50	0.58
Prunus virginiana	0.01	2.50	0.04	0.50	0.53
Total	**19.68**	**502.50**	**100.00**	**100.00**	**200.00**

POSEN WOODS Tree Species	Total ba sq m/ha	Density/ha	Relative BA per ha	Rel Density per ha	IV 200
Quercus stellata	14.00	125.00	61.85	23.92	85.77
Sassafras albidum	0.77	142.50	3.39	27.27	30.66
Carya ovata	1.09	77.50	4.83	14.83	19.67
Quercus velutina	2.98	27.50	13.19	5.26	18.45
Quercus alba	1.24	32.50	5.49	6.22	11.71
Carya ovalis	0.97	30.00	4.29	5.74	10.03
Carya tomentosa	0.61	37.50	2.69	7.18	9.86
Prunus serotina	0.10	17.50	0.43	3.35	3.78
Quercus marilandica	0.57	5.00	2.53	0.96	3.48
Ulmus rubra	0.06	10.00	0.25	1.91	2.17
Quercus rubra	0.04	7.50	0.19	1.44	1.63
Carya glabra	0.15	2.50	0.68	0.48	1.16
Morus rubra	0.02	5.00	0.11	0.96	1.07
Fraxinus americana	0.02	2.50	0.08	0.48	0.55
Total	**22.63**	**522.50**	**100.00**	**100.00**	**200.00**

Summary Tree Data

WILLIAMS CREEK WOODS Tree Spp (>6cm)	Total ba sq m/ha	Density/ha	Relative BA per ha	Rel Density per ha	IV 200
Quercus stellata	28.3296	230.00	94.0053	49.4624	143.4676
Quercus velutina	0.3706	42.50	1.2298	9.1398	10.3696
Quercus imbricaria	0.2660	42.50	0.8828	9.1398	10.0226
Carya ovata	0.5601	37.50	1.8586	8.0645	9.9231
Quercus marilandica	0.2261	37.50	0.7504	8.0645	8.8149
Carya texana	0.1352	25.00	0.4487	5.3763	5.8250
Ulmus rubra	0.1013	20.00	0.3361	4.3011	4.6371
Sassafras albidum	0.0561	10.00	0.1860	2.1505	2.3366
Carya tomentosa	0.0238	5.00	0.0788	1.0753	1.1541
Carya ovalis	0.0181	5.00	0.0599	1.0753	1.1352
Quercus alba	0.0229	2.50	0.0760	0.5376	0.6136
Quercus palustris	0.0110	2.50	0.0366	0.5376	0.5743
Diospyros virginiana	0.0083	2.50	0.0275	0.5376	0.5652
Acer negundo	0.0071	2.50	0.0235	0.5376	0.5611
Totals	**30.1362**	**465.00**	**100.0000**	**100.0000**	**200.0000**

JACKSON SLOUGH WOODS Tree Sp (>6cm)	Total ba sq m/ha	Density/ha	Relative BA per ha	Rel Density per ha	IV 200
Quercus stellata	13.4547	125.00	60.4582	23.4742	83.9323
Quercus palustris	2.6849	45.00	12.0646	8.4507	20.5153
Quercus imbricaria	1.2424	62.50	5.5825	11.7371	17.3196
Quercus velutina	1.2278	37.50	5.5171	7.0423	12.5594
Prunus serotina	0.3518	47.50	1.5809	8.9202	10.5011
Carya ovata	0.8037	35.00	3.6115	6.5728	10.1843
Ulmus rubra	0.4428	40.00	1.9896	7.5117	9.5013
Quercus rubra	0.3425	40.00	1.5391	7.5117	9.0508
Quercus marilandica	1.0721	22.50	4.8174	4.2254	9.0428
Carya texana	0.3256	37.50	1.4632	7.0423	8.5054
Sassafras albidum	0.0739	17.50	0.3322	3.2864	3.6186
Carya tomentosa	0.0695	5.00	0.3121	0.9390	1.2511
Morus rubra	0.0381	5.00	0.1712	0.9390	1.1102
Quercus alba	0.0144	5.00	0.0646	0.9390	1.0036
Ulmus cf. americana	0.0622	2.50	0.2795	0.4695	0.7490
Fraxinus americana	0.0390	2.50	0.1754	0.4695	0.6449
Diospyros virginiana	0.0091	2.50	0.0408	0.4695	0.5103
Totals	**22.2546**	**532.50**	**100.0000**	**100.0000**	**200.0000**

LAKE SARA FLATWOODS Species	Total ba sq m/ha	Density/ha	Relative BA per ha	Rel Density per ha	IV 200
Quercus stellata	10.3611	168	51.2540	59.1549	110.4090
Quercus velutina	5.5035	44	27.2248	15.4930	42.7177
Quercus alba	2.1786	24	10.7773	8.4507	19.2280
Quercus marilandica	1.3144	18	6.5021	6.3380	12.8401
Carya tomentosa	0.3167	12	1.5666	4.2254	5.7919
Carya ovata	0.1554	10	0.7686	3.5211	4.2897
Quercus imbricaria	0.3777	6	1.8685	2.1127	3.9812
Prunus serotina	0.0077	2	0.0381	0.7042	0.7423
Total	**20.2152**	**284**	**100.0000**	**100.0000**	**200.0000**

Shrub/Sapling Data

Recker Woods Saplings (<6cm)	Frequency/ 8 plots	Relative Freq Shrubs/Saps	Total Sapling Density/ha	Relative Density Shrubs/Saps
Rubus allegh/pen	4	0.5000	1050	32.8125
Ilex decidua	2	0.2500	950	29.6875
Quercus marilandica	3	0.3750	275	8.5938
Diospyros virginiana	4	0.5000	225	7.0313
Quercus palustris	4	0.5000	200	6.2500
Quercus stellata	4	0.5000	200	6.2500
Quercus alba	1	0.1250	75	2.3438
Quercus rubra	3	0.3750	75	2.3438
Fraxinus americana	2	0.2500	50	1.5625
Quercus imbricaria	2	0.2500	50	1.5625
Cornus florida	1	0.1250	25	0.7813
Ulmus rubra	1	0.1250	25	0.7813
Total			**3200**	**100.0000**

Chip-O-Will Woods Saplings (<6cm)	Frequency/ 8 plots	Relative Freq Shrubs/Saps	Total Sapling Density/ha	Relative Density Shrubs/Saps
Quercus marilandica	4	50	250	17.5439
Quercus stellata	4	50	250	17.5439
Prunus virginica	2	25	200	14.0351
Carya ovata	4	50	175	12.2807
Quercus velutina	5	62.5	150	10.5263
Rubus alleg/pen	2	25	100	7.0175
Toxicodendron radicans	2	25	100	7.0175
Quercus palustris	2	25	75	5.2632
Ulmus rubra	1	12.5	50	3.5088
Diospyros virginiana	1	12.5	25	1.7544
Prunus serotina	1	12.5	25	1.7544
Quercus bicolor	1	12.5	25	1.7544
Totals	8		**1425**	**100.0000**

Shrub/Sapling Data

Posen Woods Saplings (<6cm)	Frequency/ 8 plots	Relative Freq Shrubs/Saps	Total Sapling Density/ha	Relative Density Shrubs/Saps
Rubus pen/allegh	6	75	2125	23.2240
Sassafras albidum	8	100	2100	22.9508
Toxicodendron radicans	5	62.5	950	10.3825
Carya ovalis	7	87.5	875	9.5628
Prunus serotina	8	100	725	7.9235
Carya tomentosa	6	75	675	7.3770
Carya ovata	7	87.5	625	6.8306
Quercus velutina	5	62.5	250	2.7322
Rosa multiflora	2	25	125	1.3661
Ulmus rubra	3	37.5	125	1.3661
Quercus alba	3	37.5	75	0.8197
Celastris scandens	1	12.5	50	0.5464
Celtis occidentalis	2	25	50	0.5464
Cornus racemosa	1	12.5	50	0.5464
Morus rubra	2	25	50	0.5464
Quercus marilandica	1	12.5	50	0.5464
Quercus rubra	1	12.5	50	0.5464
Rhus copallina	2	25	50	0.5464
Diospyros virginiana	1	12.5	25	0.2732
Eleagnus angustifolius	1	12.5	25	0.2732
Fraxinus americana	1	12.5	25	0.2732
Lonicera tatartica	1	12.5	25	0.2732
Ostrya virginiana	1	12.5	25	0.2732
Quercus imbricaria	1	12.5	25	0.2732
Total			**9150**	**100.0000**

Williams Cr Woods Saplings (<6cm)	Frequency/ 8 plots	Relative Freq Shrubs/Saps	Total Sapling Density/ha	Relative Density Shrubs/Saps
Rubus pen/allegh	3	0.375	2275	39.3939
Toxicodendron radicans	3	0.375	525	9.0909
Prunus serotina	7	0.875	475	8.2251
Sassafras albidum	5	0.625	450	7.7922
Quercus marilandica	6	0.75	350	6.0606
Quercus imbricaria	5	0.625	325	5.6277
Carya texana	5	0.625	300	5.1948
Carya ovata	5	0.625	275	4.7619
Ulmus rubra	1	0.125	150	2.5974
Carya ovalis	2	0.25	125	2.1645
Quercus palustris	3	0.375	100	1.7316
Quercus stellata	3	0.375	100	1.7316
Quercus velutina	3	0.375	75	1.2987
Acer negundo	2	0.25	50	0.8658
Celtis occidentalis	1	0.125	50	0.8658
Diospyros virginiana	2	0.25	50	0.8658
Rubus occidentalis	1	0.125	50	0.8658
Fraxinus americanus	1	0.125	25	0.4329
Rhus copallina	1	0.125	25	0.4329
TOTAL			**5775**	**100.0000**

Jackson Slough Wds Saplings (<6cm)	Frequency/ 8 plots	Relative Freq Shrubs/Saps	Total Sapling Density/ha	Relative Density Shrubs/Saps
Prunus serotina	6	75	625	13.0208
Carya texana	5	62.5	550	11.4583
Sassafras albidum	3	37.5	475	9.8958
Quercus velutina	6	75	425	8.8542
Ulmus rubra	5	62.5	375	7.8125
Quercus stellata	1	12.5	300	6.2500
Carya ovata	4	50	225	4.6875
Quercus imbricaria	4	50	175	3.6458
Cornus racemosus	1	12.5	150	3.1250
Diospyros americana	2	25	150	3.1250
Fraxinus americana	1	12.5	150	3.1250
Prunus americana lanata	1	12.5	150	3.1250
Quercus rubra	3	37.5	125	2.6042
Carya laciniosa	3	37.5	100	2.0833
Morus rubra	2	25	100	2.0833
Quercus macrocarpa	1	12.5	100	2.0833
Rhus aromatica	1	12.5	100	2.0833
Rosa multiflora	1	12.5	100	2.0833
Carya ovalis	1	12.5	50	1.0417
Celtis occidentalis	2	25	50	1.0417
Fraxinus pensylvanica	2	25	50	1.0417
Quercus alba	2	25	50	1.0417
Quercus marilandica	1	12.5	50	1.0417
Toxicodendron radicans	1	12.5	50	1.0417
Carya glabra	1	12.5	25	0.5208
Carya tomentosa	1	12.5	25	0.5208
Crataegus sp	1	12.5	25	0.5208
Quercus palustris	1	12.5	25	0.5208
Rubus alleg/pen	1	12.5	25	0.5208
Total			**4800**	**100.0000**

Lake Sara Flatwoods Saplings (<6cm)	Frequency/ 10 plots	Relative Freq Shrubs/Saps	Total Sapling Density/ha	Relative Density Shrubs/Saps
Sassafras albidum	2	0.2	320	59.2593
Carya ovata	1	0.1	60	11.1111
Rubus pen/allegh	3	0.3	60	11.1111
Carya tomentosa	2	0.2	40	7.4074
Ceanothus americanus	1	0.1	20	3.7037
Quercus velutina	1	0.1	20	3.7037
Rosa carolina	1	0.1	20	3.7037
Total			**540**	**100.0000**

Appendix 4

Ground Cover Sampling Data for each Site

Recker Woods Herb Data Site Summary - 200 plots Species	Total # Occurrences per 200 plots	Frequency %	Relative Frequency	% Cover per 200 plots (50 sq m)	Cover - sq m per sample area (50 sq m)	Relative Cover	IV 200 Rel Freq + Rel Cover
Acalypha gracilens	10	5	2.9586	0.0250	0.0125	0.0960	3.0545
Acer rubrum	6	3	1.7751	0.0150	0.0075	0.0576	1.8327
Agrostis scabra	11	5.5	3.2544	0.7375	0.36875	2.8308	6.0852
Amphicarpa bracteata	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Boltonia asteroides	1	0.5	0.2959	0.0750	0.0375	0.2879	0.5837
Carex artitecta	7	3.5	2.0710	0.3675	0.18375	1.4106	3.4816
Carex caroliniana	1	0.5	0.2959	0.0750	0.0375	0.2879	0.5837
Carex festucacea	4	2	1.1834	0.7625	0.38125	2.9267	4.1102
Carex glaucoidea	14	7	4.1420	0.3225	0.16125	1.2379	5.3799
Carex rosea	4	2	1.1834	0.1025	0.05125	0.3934	1.5769
Carex sp. (glabrous, short)	2	1	0.5917	0.0775	0.03875	0.2975	0.8892
Carya glabra	2	1	0.5917	0.3875	0.19375	1.4874	2.0791
Carya ovata	2	1	0.5917	0.0030	0.0015	0.0115	0.6032
Celtis occidentalis	3	1.5	0.8876	0.0175	0.00875	0.0672	0.9547
Chasmanthium latifolium	1	0.5	0.2959	0.0125	0.00625	0.0480	0.3438
Cinna arundinacea	63	31.5	18.6391	6.2075	3.10375	23.8264	42.4655
Danthonia spicata	2	1	0.5917	0.6125	0.30625	2.3510	2.9427
Dichanthelium villosiss/acum	24	12	7.1006	1.2550	0.6275	4.8171	11.9177
Diospyros virginiana	3	1.5	0.8876	0.1925	0.09625	0.7389	1.6265
Eleocharis compressa/wolfii	9	4.5	2.6627	1.0625	0.53125	4.0782	6.7409
Eleocharis verrucosa	21	10.5	6.2130	3.0525	1.52625	11.7165	17.9295
Elymus villosus	1	0.5	0.2959	0.0125	0.00625	0.0480	0.3438
Euthamia graminifolia	3	1.5	0.8876	0.4625	0.23125	1.7752	2.6628
Fraxinus americanus	11	5.5	3.2544	0.0375	0.01875	0.1439	3.3984
Geum canadense	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Helianthus divaricatus	9	4.5	2.6627	0.3325	0.16625	1.2762	3.9390
Helianthus hirsutus	2	1	0.5917	0.1500	0.075	0.5757	1.1675
Hypericum mutilum	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Ilex decidua	5	2.5	1.4793	0.7250	0.3625	2.7828	4.2621
Isoetes melanopoda	1	0.5	0.2959	0.0750	0.0375	0.2879	0.5837
Juncus brachycarpus	1	0.5	0.2959	0.1875	0.09375	0.7197	1.0155
Liatris pycnostachya	1	0.5	0.2959	0.0125	0.00625	0.0480	0.3438
Paronychia fastigiata	2	1	0.5917	0.0050	0.0025	0.0192	0.6109
Parthenium integrifolium	5	2.5	1.4793	0.5375	0.26875	2.0631	3.5424
Parthenocissus quinquefolius	23	11.5	6.8047	2.0600	1.03	7.9070	14.7117
Podophyllum peltatum	2	1	0.5917	0.0250	0.0125	0.0960	0.6877
Psoralea psoraleoides	2	1	0.5917	0.0775	0.03875	0.2975	0.8892
Pycnanthemum tenuifolium	4	2	1.1834	0.1650	0.0825	0.6333	1.8168
Quercus alba	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Quercus imbricaria	1	0.5	0.2959	0.0750	0.0375	0.2879	0.5837
Quercus lyrata	1	0.5	0.2959	0.4250	0.2125	1.6313	1.9271
Quercus marilandica	4	2	1.1834	0.0500	0.025	0.1919	1.3753
Quercus palustris	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Quercus rubra	1	0.5	0.2959	0.0125	0.00625	0.0480	0.3438
Quercus stellata	13	6.5	3.8462	1.5375	0.76875	5.9014	9.7476
Quercus velutina	3	1.5	0.8876	0.0375	0.01875	0.1439	1.0315
Rubus allegh/pen	31	15.5	9.1716	2.9850	1.4925	11.4574	20.6290
Rubus flagellaris	2	1	0.5917	0.2000	0.1	0.7677	1.3594
Sanicula canadensis	2	1	0.5917	0.0050	0.0025	0.0192	0.6109
Solidago juncea	1	0.5	0.2959	0.0125	0.00625	0.0480	0.3438
Solidago nemoralis	2	1	0.5917	0.2625	0.13125	1.0076	1.5993
Toxicodendron radicans	1	0.5	0.2959	0.0750	0.0375	0.2879	0.5837
Tradescantia ohiensis	5	2.5	1.4793	0.1250	0.0625	0.4798	1.9591
Unknown Dicot	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Unknown Dicot 2	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Vitis aestivalis	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Vitis riparia	1	0.5	0.2959	0.0025	0.00125	0.0096	0.3055
Total Freq - all species	338	169	100.0000		13.0265	100.0000	200.0000
Avg. # spp/0.25 sq m plot	1.69						
Total % herb cover				26.053			

CHIP-O-WILL WOODS HERB SUMMARY DATA Species	Total # Occurrences per 200 plots	Frequency %	Relative Frequency	% Cover per 200 plots (50 sq m)	Cover - sq m per sample area (50 sq m)	Relative Cover	IV 200 Rel Freq + Rel Cover
Acalypha gracilens	4	2	1.24	0.01	0.005	0.03	1.28
Acer negundo	1	0.5	0.31	0.0025	0.00125	0.01	0.32
Agrostis scabra	12	6	3.73	0.3075	0.15375	1.05	4.78
Allium canadense	2	1	0.62	0.015	0.0075	0.05	0.67
Amorpha fruticosa	1	0.5	0.31	0.0125	0.00625	0.04	0.35
Aster cf lateriflorus	1	0.5	0.31	0.0125	0.00625	0.04	0.35
Carex artitecta	10	5	3.11	0.4075	0.20375	1.40	4.50
Carex caroliniana	2	1	0.62	0.15	0.075	0.51	1.13
Carex festucacea	9	4.5	2.80	1.7125	0.85625	5.87	8.66
Carex glaucoidea	12	6	3.73	0.215	0.1075	0.74	4.46
Carex meadii	2	1	0.62	0.15	0.075	0.51	1.13
Carex sp (glab, white base)	2	1	0.62	0.15	0.075	0.51	1.13
Carex sp (red base, tall)	14	7	4.35	2.7025	1.35125	9.26	13.61
Cinna arundinacea	31	15.5	9.63	3.3325	1.66625	11.42	21.04
Crotonopsis elliptica	1	0.5	0.31	0.0025	0.00125	0.01	0.32
Dichanthelium villosiss/acu	13	6.5	4.04	0.3925	0.19625	1.34	5.38
Diospyros virginiana	2	1	0.62	0.0775	0.03875	0.27	0.89
Eleocharis compressa	2	1	0.62	0.0875	0.04375	0.30	0.92
Eleocharis verrucosa	26	13	8.07	2.21	1.105	7.57	15.65
Euthamia graminifolia	2	1	0.62	0.2625	0.13125	0.90	1.52
Fraxinus americanus	4	2	1.24	0.0925	0.04625	0.32	1.56
Galium obtusum	9	4.5	2.80	0.67	0.335	2.30	5.09
Gillenia stipulacea	11	5.5	3.42	1.565	0.7825	5.36	8.78
Hedeoma pulegiodes	0	0	0.00	0	0	0.00	0.00
Helianthus divaricatus	2	1	0.62	0.0875	0.04375	0.30	0.92
Helianthus mollis	2	1	0.62	0.0875	0.04375	0.30	0.92
Parthenium integrifolium	22	11	6.83	4.2525	2.12625	14.57	21.40
Parthenocissus quinquefoli	27	13.5	8.39	2.355	1.1775	8.07	16.45
Phlox glaberrima	3	1.5	0.93	0.225	0.1125	0.77	1.70
Podophyllum peltatum	1	0.5	0.31	0.075	0.0375	0.26	0.57
Polygonum hydropiperoide	2	1	0.62	0.015	0.0075	0.05	0.67
Potentilla simplex	1	0.5	0.31	0.1875	0.09375	0.64	0.95
Prunus serotina	4	2	1.24	0.33	0.165	1.13	2.37
Prunus virginiana	2	1	0.62	0.315	0.1575	1.08	1.70
Pycnanthemum tenuifoliun	2	1	0.62	0.375	0.1875	1.28	1.91
Quercus imbricaria	3	1.5	0.93	0.09	0.045	0.31	1.24
Quercus marilandica	10	5	3.11	0.8575	0.42875	2.94	6.04
Quercus palustris	3	1.5	0.93	0.5125	0.25625	1.76	2.69
Quercus stellata	17	8.5	5.28	1.96	0.98	6.71	11.99
Quercus velutina	1	0.5	0.31	0.075	0.0375	0.26	0.57
Rubus flagellaris	10	5	3.11	1.025	0.5125	3.51	6.62
Rubus pen/allegh/ostryifol	16	8	4.97	0.7325	0.36625	2.51	7.48
Sassafras albidum	1	0.5	0.31	0.1875	0.09375	0.64	0.95
Scutellaria parvula	1	0.5	0.31	0.0125	0.00625	0.04	0.35
Solidago nemoralis	2	1	0.62	0.15	0.075	0.51	1.13
Toxicodendron radicans	3	1.5	0.93	0.1625	0.08125	0.56	1.49
Trifolium reflexum	1	0.5	0.31	0.0125	0.00625	0.04	0.35
Ulmus rubra	3	1.5	0.93	0.0175	0.00875	0.06	0.99
Viola sp (cordate leaf)	2	1	0.62	0.005	0.0025	0.02	0.64
Vitis aestivalis	8	4	2.48	0.545	0.2725	1.87	4.35
TOTAL	322		100.00		14.595	100.00	200.00
total % cover					29.19		
total bare ground					70.81		

Species	Total # Occurrences per 200 plots	Frequency %	Relative Frequency	% Cover per 200 plots (50 sq m)	Cover - sq m per sample area (50 sq m)	Relative Cover	IV 200 Rel Freq + Rel Cover
Acalypha gracilens	3	1.5	0.8621	0.0175	0.0088	0.0526	0.9146
Agrimonia rostellata	1	0.5	0.2874	0.0750	0.0375	0.2252	0.5126
Agrostis scabra	3	1.5	0.8621	0.5750	0.2875	1.7267	2.5888
Arisaema dracontium	7	3.5	2.0115	0.3275	0.1638	0.9835	2.9950
Carex artitecta	2	1	0.5747	0.1900	0.0950	0.5706	1.1453
Carex bushii/hirsutella	3	1.5	0.8621	0.3375	0.1688	1.0135	1.8756
Carex muhlenbergii	1	0.5	0.2874	0.0750	0.0375	0.2252	0.5126
Carex pensylvanica	1	0.5	0.2874	0.0750	0.0375	0.2252	0.5126
Carya ovata	8	4	2.2989	0.3900	0.1950	1.1712	3.4700
Carya ovalis	3	1.5	0.8621	0.3375	0.1688	1.0135	1.8756
Carya tomentosa	1	0.5	0.2874	0.1875	0.0938	0.5631	0.8504
Celtis occidentalis	1	0.5	0.2874	0.0025	0.0013	0.0075	0.2949
Cornus racemosus	3	1.5	0.8621	0.2750	0.1375	0.8258	1.6879
Dichanthelium villosissimum	2	1	0.5747	0.0050	0.0025	0.0150	0.5897
Dicot, unknown (cotyledons)	1	0.5	0.2874	0.0125	0.0063	0.0375	0.3249
Dioscorea villosa	5	2.5	1.4368	0.5800	0.2900	1.7417	3.1785
Diospyros virginiana	2	1	0.5747	0.1500	0.0750	0.4505	1.0252
Fraxinus americana	2	1	0.5747	0.0775	0.0388	0.2327	0.8074
Gillenia stipulacea	1	0.5	0.2874	0.0025	0.0013	0.0075	0.2949
Helianthus divaricatus	2	1	0.5747	0.2000	0.1000	0.6006	1.1753
Juncus tenuis	1	0.5	0.2874	0.0125	0.0063	0.0375	0.3249
Lonicera cf tatartica	1	0.5	0.2874	0.0025	0.0013	0.0075	0.2949
Lonicera japonica	6	3	1.7241	1.0125	0.5063	3.0405	4.7647
Menispermum canadense	1	0.5	0.2874	0.1875	0.0938	0.5631	0.8504
Ostrya virginiana	1	0.5	0.2874	0.0025	0.0013	0.0075	0.2949
Parthenocissus quinquefolius	123	61.5	35.3448	12.5375	6.2688	37.6502	72.9950
Phryma leptostachya	2	1	0.5747	0.3875	0.1938	1.1637	1.7384
Prunus serotina	8	4	2.2989	0.2475	0.1238	0.7432	3.0421
Quercus alba	2	1	0.5747	0.0250	0.0125	0.0751	0.6498
Quercus imbricaria	6	3	1.7241	0.4900	0.2450	1.4715	3.1956
Quercus rubra	1	0.5	0.2874	0.0125	0.0063	0.0375	0.3249
Quercus stellata	2	1	0.5747	0.0150	0.0075	0.0450	0.6198
Quercus velutina	6	3	1.7241	0.4875	0.2438	1.4640	3.1881
Rosa carolina	3	1.5	0.8621	0.2250	0.1125	0.6757	1.5377
Rosa multiflora	1	0.5	0.2874	0.3125	0.1563	0.9384	1.2258
Rubus pen/alleg	57	28.5	16.3793	7.3725	3.6863	22.1396	38.5189
Sassafras albidum	20	10	5.7471	0.4925	0.2463	1.4790	7.2261
Smilax hispida	1	0.5	0.2874	0.0125	0.0063	0.0375	0.3249
Toxicodendron radicans	41	20.5	11.7816	4.1700	2.0850	12.5225	24.3041
Vitis aestivalis	6	3	1.7241	0.7375	0.3688	2.2147	3.9389
Vitis riparia	7	3.5	2.0115	0.6650	0.3325	1.9970	4.0085
TOTAL	348		100.0000		16.6500		200.0000
Spp density/1/4 m sq	1.74						

Species	Total # Occurrences per 200 plots	Frequency %	Relative Frequency	% Cover per 200 plots (50 sq m)	Cover - sq m per sample area (50 sq m)	Relative Cover	IV 200 Rel Freq + Rel Cover
Acalypha gracilens	4	2	1.08	0.0100	0.0050	0.02	1.11
Acer negundo	1	0.5	0.27	0.0750	0.0375	0.16	0.43
Agrostis scabra	9	4.5	2.44	1.4550	0.7275	3.17	5.61
Amphicarpa bracteata	2	1	0.54	0.1500	0.0750	0.33	0.87
Apocynum androsaemifolium	1	0.5	0.27	0.0125	0.0063	0.03	0.30
Aster lateriflorus	8	4	2.17	1.4025	0.7013	3.05	5.22
Aster sp	1	0.5	0.27	0.0125	0.0063	0.03	0.30
Botrychium virginianum	1	0.5	0.27	0.0125	0.0063	0.03	0.30
Carex artitecta	1	0.5	0.27	0.3125	0.1563	0.68	0.95
Carex caroliniana	1	0.5	0.27	0.3125	0.1563	0.68	0.95
Carex festucacea	15	7.5	4.07	3.5750	1.7875	7.78	11.85
Carex bushii/hirsutella	2	1	0.54	0.0875	0.0438	0.19	0.73
Carya ovata	3	1.5	0.81	0.5125	0.2563	1.12	1.93
Carya texana	1	0.5	0.27	0.0125	0.0063	0.03	0.30
Celtis occidentalis	2	1	0.54	0.0150	0.0075	0.03	0.57
Cinna arundinacea	25	12.5	6.78	3.0750	1.5375	6.69	13.47
Desmodium cf canadense	1	0.5	0.27	0.1875	0.0938	0.41	0.68
Dichanthelium villosissimum	4	2	1.08	0.2250	0.1125	0.49	1.57
Diospyros virginiana	1	0.5	0.27	0.0750	0.0375	0.16	0.43
Eleocharis verrucosa	5	2.5	1.36	1.1875	0.5938	2.58	3.94
Elymus villosus	1	0.5	0.27	0.0750	0.0375	0.16	0.43
Fraxinus americana	0	0	0.00	0.0000	0.0000	0.00	0.00
Galium circaezans	1	0.5	0.27	0.0750	0.0375	0.16	0.43
Helianthus divaricatus	12	6	3.25	1.7125	0.8563	3.73	6.98
Helianthus hirsutus	10	5	2.71	1.4375	0.7188	3.13	5.84
Leersia virginica	1	0.5	0.27	0.0750	0.0375	0.16	0.43
Liparis lilifolia	1	0.5	0.27	0.0750	0.0375	0.16	0.43
Parthenocissus quinquefolius	96	48	26.02	11.6850	5.8425	25.43	51.45
Podophyllum peltatum	2	1	0.54	0.1500	0.0750	0.33	0.87
Potentilla simplex	2	1	0.54	0.2000	0.1000	0.44	0.98
Prunus serotina	7	3.5	1.90	0.1200	0.0600	0.26	2.16
Pycnanthemym tenuifolium	7	3.5	1.90	1.1750	0.5875	2.56	4.45
Quercus imbricaria	9	4.5	2.44	0.4150	0.2075	0.90	3.34
Quercus marilandica	2	1	0.54	0.2000	0.1000	0.44	0.98
Quercus palustris	2	1	0.54	0.1500	0.0750	0.33	0.87
Quercus stellata	16	8	4.34	1.0300	0.5150	2.24	6.58
Quercus velutina	1	0.5	0.27	0.0125	0.0063	0.03	0.30
Rosa carolina	2	1	0.54	0.0775	0.0388	0.17	0.71
Rubus flagellaris	49	24.5	13.28	8.1000	4.0500	17.63	30.91
Rubus occidentalis	0	0	0.00	0.0000	0.0000	0.00	0.00
Rubus penn/alleghanie	23	11.5	6.23	3.4275	1.7138	7.46	13.69
Sassafras albidum	9	4.5	2.44	0.2600	0.1300	0.57	3.00
Smilacina racemosa	1	0.5	0.27	0.0750	0.0375	0.16	0.43
Solidago ulmifolia	0	0	0.00	0.0000	0.0000	0.00	0.00
Toxicodendron radicans	15	7.5	4.07	1.3875	0.6938	3.02	7.09
Tradescantia ohiensis	1	0.5	0.27	0.0750	0.0375	0.16	0.43
Ulmus rubra	4	2	1.08	0.2675	0.1338	0.58	1.67
Viola sagittifolia	2	1	0.54	0.0875	0.0438	0.19	0.73
Vitis aestivalis	2	1	0.54	0.2625	0.1313	0.57	1.11
Vitis riparia	3	1.5	0.81	0.6275	0.3138	1.37	2.18
Totals	369		100.00		22.9713	100.00	200.00
% Cover					45.9425		
% Bare Ground					54.0575		
Spp density/.25 sq m	1.845						

Species	Total # Occurrences per 200 plots	Frequency %	Relative Frequency	% Cover per 200 plots (50 sq m)	Cover - sq m per sample area (50 sq m)	Relative Cover	IV 200 Rel Freq + Rel Cover
Acalypha gracilens	10	5	2.1008	0.035	0.0175	0.0814	2.1822
Acer negundo	3	1.5	0.6303	0.3375	0.16875	0.7847	1.4150
Agrostis scabra	17	8.5	3.5714	3.0125	1.50625	7.0046	10.5760
Apocynum androsaemifolium	2	1	0.4202	0.0875	0.04375	0.2035	0.6236
Aristolochia serpentaria	2	1	0.4202	0.005	0.0025	0.0116	0.4318
Asclepias variegata	1	0.5	0.2101	0.0125	0.00625	0.0291	0.2391
Aster sp	1	0.5	0.2101	0.0125	0.00625	0.0291	0.2391
Carex artitecta	15	7.5	3.1513	1.775	0.8875	4.1272	7.2784
Carex bushii/hirsutella	2	1	0.4202	0.15	0.075	0.3488	0.7689
Carex caroliniana	9	4.5	1.8908	1.1775	0.58875	2.7379	4.6287
Carex festucacea	9	4.5	1.8908	1.475	0.7375	3.4296	5.3204
Carex sp (veg. seedling)	1	0.5	0.2101	0.0125	0.00625	0.0291	0.2391
Carya ovata	0	0	0.0000	0	0	0.0000	0.0000
Carya texana	4	2	0.8403	0.35	0.175	0.8138	1.6541
Carya tomentosa	0	0	0.0000	0	0	0.0000	0.0000
Celastrus scandens	4	2	0.8403	0.1125	0.05625	0.2616	1.1019
Celtis occidentalis	1	0.5	0.2101	0.0125	0.00625	0.0291	0.2391
Cinna arundinacea	4	2	0.8403	0.1125	0.05625	0.2616	1.1019
Circaea quadriculcata	2	1	0.4202	0.005	0.0025	0.0116	0.4318
Cornus drummondii	8	4	1.6807	0.04	0.02	0.0930	1.7737
Crataegus sp	1	0.5	0.2101	0.075	0.0375	0.1744	0.3845
Crotonopsis elliptica	2	1	0.4202	0.005	0.0025	0.0116	0.4318
Desmodium glutinosum	1	0.5	0.2101	0.075	0.0375	0.1744	0.3845
Dichanthelium villosissimum	19	9.5	3.9916	1.345	0.6725	3.1274	7.1190
Dicot herb seedling - cordate	1	0.5	0.2101	0.0025	0.00125	0.0058	0.2159
Dicot herb seedling - ser/alt	1	0.5	0.2101	0.0025	0.00125	0.0058	0.2159
Dicot seedling - opp/ser	1	0.5	0.2101	0.0025	0.00125	0.0058	0.2159
Diospyros virginiana	3	1.5	0.6303	0.4	0.2	0.9301	1.5603
Eleocharis verrucossa	4	2	0.8403	0.6375	0.31875	1.4823	2.3226
Elymus villosus	1	0.5	0.2101	0.1875	0.09375	0.4360	0.6461
Eupatorium rugosum	7	3.5	1.4706	0.565	0.2825	1.3137	2.7843
Euphorbia corollata	4	2	0.8403	0.165	0.0825	0.3837	1.2240
Fraxinus americanus	2	1	0.4202	0.005	0.0025	0.0116	0.4318
Fraxinus pennsylvanicus	6	3	1.2605	0.24	0.12	0.5580	1.8185
Galium circaezans	13	6.5	2.7311	0.2475	0.12375	0.5755	3.3066
Geum laciniatum	4	2	0.8403	0.0825	0.04125	0.1918	1.0322
Gleditsia triacanthos	1	0.5	0.2101	0.0125	0.00625	0.0291	0.2391
Hedeoma pulegioides	2	1	0.4202	0.015	0.0075	0.0349	0.4550
Juncus interior	1	0.5	0.2101	0.0125	0.00625	0.0291	0.2391
Juncus tenuis	2	1	0.4202	0.15	0.075	0.3488	0.7689
Lonicera japonica	10	5	2.1008	0.9	0.45	2.0927	4.1935
Muhlenbergii sobolifera	6	3	1.2605	0.3875	0.19375	0.9010	2.1615
Parthenium integrifolium	8	4	1.6807	0.5375	0.26875	1.2498	2.9305
Parthenocissus quinquefolius	134	67	28.1513	17.655	8.8275	41.0510	69.2022
Passifloraa lutea	1	0.5	0.2101	0.0025	0.00125	0.0058	0.2159
Penstemon digitalis	1	0.5	0.2101	0.075	0.0375	0.1744	0.3845
Polygonum cristatum	2	1	0.4202	0.025	0.0125	0.0581	0.4783
Polygonum hydropiperoides	2	1	0.4202	0.025	0.0125	0.0581	0.4783
Potentilla simplex	7	3.5	1.4706	0.45	0.225	1.0463	2.5169
Prunus serotina	12	6	2.5210	0.72	0.36	1.6741	4.1951
Pycnanthemum tenuifolium	5	2.5	1.0504	0.3	0.15	0.6976	1.7480
Quercus imbricanria	2	1	0.4202	0.2	0.1	0.4650	0.8852
Quercus marilandica	1	0.5	0.2101	0.0125	0.00625	0.0291	0.2391
Quercus palustris	2	1	0.4202	0.15	0.075	0.3488	0.7689
Quercus rubra	2	1	0.4202	0.0875	0.04375	0.2035	0.6236
Quercus stellata	4	2	0.8403	0.215	0.1075	0.4999	1.3402
Quercus velutina	5	2.5	1.0504	0.725	0.3625	1.6858	2.7362
Rhus aromatica	1	0.5	0.2101	0.0125	0.00625	0.0291	0.2391
Rosa carolina	4	2	0.8403	0.175	0.0875	0.4069	1.2472
Rosa multiflora	0	0	0.0000	0	0	0.0000	0.0000
Rubus allegh/pensylvanica	10	5	2.1008	0.2925	0.14625	0.6801	2.7810
Rubus flagellaris	27	13.5	5.6723	3.2675	1.63375	7.5975	13.2698
Sanicula canadensis	1	0.5	0.2101	0.075	0.0375	0.1744	0.3845
Sassafras albidum	26	13	5.4622	1.1975	0.59875	2.7844	8.2466
Solidago canadensis	0	0	0.0000	0	0	0.0000	0.0000
Solidago juncea	2	1	0.4202	0.15	0.075	0.3488	0.7689
Toxicodendron radicans	12	6	2.5210	1.33	0.665	3.0925	5.6135
Ulmus rubra	4	2	0.8403	0.64	0.32	1.4881	2.3284
Viola sp- cordate leaf	3	1.5	0.6303	0.0275	0.01375	0.0639	0.6942
Vitis aestivalis	5	2.5	1.0504	0.3125	0.15625	0.7266	1.7770
Vitis riparius	6	3	1.2605	0.1075	0.05375	0.2500	1.5105
TOTALS	476		100.0000		21.50375	100.0000	200.0000

Lake Sara Herb Summary

Species	Total # Occurrences 130 Plots	Frequency %	Relative Frequency	Average Coverage	% Cover per 130 plots	Cover - sq m per sample	Relative Cover	IV 200 Rel Freq + Rel Cover
Acalypha gracilens	29	22.31	2.9835	0.1423		0.04625	0.0856	3.0692
Agalinis purpurea	1	0.77	0.1029	0.0192		0.00625	0.0116	0.1145
Agrostis scabra	54	41.54	5.5556	8.6923		2.825	5.2314	10.7869
Ambrosia artemisiifolia	8	6.15	0.8230	0.6654		0.21625	0.4005	1.2235
Amphicarpa/Stropho umb	20	15.38	2.0576	4.7115		1.53125	2.8356	4.8932
Aster shortii	3	2.31	0.3086	0.2346		0.07625	0.1412	0.4498
Aster sp (seedling)	4	3.08	0.4115	0.0308		0.01	0.0185	0.4300
Aster turbenellus	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Asteraceae (basal rosette)	6	4.62	0.6173	0.1346		0.04375	0.0810	0.6983
Asteraceae seedling	1	0.77	0.1029	0.0038		0.00125	0.0023	0.1052
Baptisia leucophaea	1	0.77	0.1029	0.4808		0.15625	0.2893	0.3922
Carex bushii/hirsutella	51	39.23	5.2469	12.0077		3.9025	7.2267	12.4736
Carex festucacea	27	20.77	2.7778	5.9808		1.94375	3.5995	6.3772
Carex glaucoidea	14	10.77	1.4403	0.7962		0.25875	0.4792	1.9195
Carex pensylvanica/artitecta	78	60.00	8.0247	20.0077		6.5025	12.0414	20.0661
Carex rosea/retroflexa	4	3.08	0.4115	0.1577		0.05125	0.0949	0.5064
Carex sp (seedling)	0	0.00	0.0000	0.0000		0	0.0000	0.0000
Carex sp. (glabrous)	6	4.62	0.6173	0.2923		0.095	0.1759	0.7932
Carya ovalis	0	0.00	0.0000	0.0000		0	0.0000	0.0000
Carya ovata	4	3.08	0.4115	0.5385		0.175	0.3241	0.7356
Cassia fasciculata	1	0.77	0.1029	0.0192		0.00625	0.0116	0.1145
Cinna arundinacea	10	7.69	1.0288	2.9231		0.95	1.7592	2.7880
Commandra richardsiana	10	7.69	1.0288	4.3846		1.425	2.6388	3.6676
Crotollaria sagittalis	1	0.77	0.1029	0.0192		0.00625	0.0116	0.1145
Cuscuta sp.	2	1.54	0.2058	0.2308		0.075	0.1389	0.3446
Danthonia spicata	17	13.08	1.7490	2.7154		0.8825	1.6342	3.3832
Desmodium dillenii	2	1.54	0.2058	0.4038		0.13125	0.2430	0.4488
Desmodium nudiflorum	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Desmodium paniculatum	1	0.77	0.1029	0.4808		0.15625	0.2893	0.3922
Dichanthelium cladestinum	7	5.38	0.7202	0.7385		0.24	0.4444	1.1646
Dichanthelium villosissimum	96	73.85	9.8765	4.9231		1.6	2.9629	12.8394
Dicot seedling (alt, simple)	1	0.77	0.1029	0.0038		0.00125	0.0023	0.1052
Dioscorea villosa	2	1.54	0.2058	0.1346		0.04375	0.0810	0.2868
Eleocharis verrucosa	19	14.62	1.9547	7.1346		2.31875	4.2939	6.2486
Elymus villosus	6	4.62	0.6173	0.5962		0.19375	0.3588	0.9761
Eupatorium perfoliatum	1	0.77	0.1029	0.0038		0.00125	0.0023	0.1052
Eupatorium rugosum	12	9.23	1.2346	0.4885		0.15875	0.2940	1.5285
Eupatorium sessilifolium	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Euphorbia corollata	6	4.62	0.6173	0.1154		0.0375	0.0694	0.6867
Galium circaezans	8	6.15	0.8230	0.1385		0.045	0.0833	0.9064
Galium concinnum	17	13.08	1.7490	0.7769		0.2525	0.4676	2.2166
Gillenia stipulacea	6	4.62	0.6173	0.7192		0.23375	0.4329	1.0501
Hedeoma pulegeoides	6	4.62	0.6173	0.0231		0.0075	0.0139	0.6312
Helianthus divaricatus	109	83.85	11.2140	56.3654		18.31875	33.9228	45.1368
Hieracium gronovii	1	0.77	0.1029	0.0192		0.00625	0.0116	0.1145
Hieracium scabrum	4	3.08	0.4115	0.2692		0.0875	0.1620	0.5736
Juncus interior	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Krigia biflora	2	1.54	0.2058	0.0077		0.0025	0.0046	0.2104
Lespedeza virginica	5	3.85	0.5144	0.0500		0.01625	0.0301	0.5445
Liatris scabra	2	1.54	0.2058	0.3077		0.1	0.1852	0.3909
Monarda bradburiana	10	7.69	1.0288	1.2577		0.40875	0.7569	1.7857
Muhlenbergia sobolifera	2	1.54	0.2058	0.1346		0.04375	0.0810	0.2868
Oxalis stricta	19	14.62	1.9547	0.1346		0.04375	0.0810	2.0357
Paronychia fastigiata	39	30.00	4.0123	0.6077		0.1975	0.3657	4.3781
Parthenocissus quinquefolius	3	2.31	0.3086	0.0577		0.01875	0.0347	0.3434
Poa compressa	2	1.54	0.2058	0.2308		0.075	0.1389	0.3446
Poaceae (hairy, memb lig.)	1	0.77	0.1029	0.0192		0.00625	0.0116	0.1145
Podophyllum peltatum	10	7.69	1.0288	1.1346		0.36875	0.6829	1.7117
Polygonum cristatum	5	3.85	0.5144	0.0346		0.01125	0.0208	0.5352
Potentilla simplex	11	8.46	1.1317	1.7538		0.57	1.0555	2.1872
Prunus serotina	3	2.31	0.3086	0.1538		0.05	0.0926	0.4012
Psoralea psoraleoides	1	0.77	0.1029	0.2885		0.09375	0.1736	0.2765
Pycnanthemum tenuifolium	3	2.31	0.3086	0.4231		0.1375	0.2546	0.5633
Quercus imbricaria	8	6.15	0.8230	0.4423		0.14375	0.2662	1.0892
Quercus marilandica	4	3.08	0.4115	0.7308		0.2375	0.4398	0.8513
Quercus rubra	2	1.54	0.2058	0.1346		0.04375	0.0810	0.2868
Quercus stellata	3	2.31	0.3086	0.1538		0.05	0.0926	0.4012
Quercus velutina	7	5.38	0.7202	0.2962		0.09625	0.1782	0.8984
Ranunculus hispidus	5	3.85	0.5144	0.3692		0.12	0.2222	0.7366
Rosa carolina	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Rubus occidentalis	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Rubus pensylvanicus/allegh	51	39.23	5.2469	7.6577		2.48875	4.6087	9.8556

Rudbeckia hirta	2	1.54	0.2058	0.0231		0.0075	0.0139	0.2196
Sassafras albidum	27	20.77	2.7778	3.3577		1.09125	2.0208	4.7986
Scutellaria cf incana	1	0.77	0.1029	0.0038		0.00125	0.0023	0.1052
[illegible]ilacina racemosa	1	0.77	0.1029	0.2885		0.09375	0.1736	0.2765
[illegible]ilax lasioneuron	0	0.00	0.0000	0.0000		0	0.0000	0.0000
Solidago canadensis	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Solidago cf juncea (basl rst)	5	3.85	0.5144	0.4615		0.15	0.2778	0.7922
Solidago nemoralis	9	6.92	0.9259	1.0192		0.33125	0.6134	1.5393
Solidago ulmifolia	11	8.46	1.1317	1.8654		0.60625	1.1227	2.2543
Tradescantia ohiensis	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Tradescantia virginiana	1	0.77	0.1029	0.1154		0.0375	0.0694	0.1723
Verbesina helianthoides	1	0.77	0.1029	0.2885		0.09375	0.1736	0.2765
Veronica cf peregrina	1	0.77	0.1029	0.0038		0.00125	0.0023	0.1052
Veronicastrum virginicum	2	1.54	0.2058	0.4038		0.13125	0.2430	0.4488
Viola sagittata	10	7.69	1.0288	0.4500		0.14625	0.2708	1.2996
Viola sp (cordate)	31	23.85	3.1893	0.3538		0.115	0.2130	3.4023
Vitis aestivalis	2	1.54	0.2058	0.5962		0.19375	0.3588	0.5645
Vitis cinerea	2	1.54	0.2058	0.5769		0.1875	0.3472	0.5530
Vitis riparia	4	3.08	0.4115	0.5231		0.17	0.3148	0.7263
TOTAL Species per plot	972		100.0000			54.00125	100.0000	200.0000
MEAN Species per plot	7.48							

Tables 1 through 11

POST OAK FLATWOODS SAMPLED DURING THIS STUDY

	Name	INAI #	County	Date Sampled
1.	Recker Woods (West End Sportsman's Club Woods)	865	Washington	10-11 July 1989
2.	Chip-O-Will Woods (Sipple Slough Woods)	886	Washington	12-13 July 1989
3.	Posen Woods Nature Preserve	867	Washington	16-17 July 1990
4.	Williams Creek Woods	869	Washington	18-19 July 1990
5.	Jackson Slough Woods	242	St. Clair	24-25 July 1990
6.	Lake Sara Flatwoods	none	Effingham	25-26 July and 3 August 1990

Table 1. Site name, INAI (Illinois Natural Areas Inventory) #, county of occurrence, and date of field sampling for the six post oak flatwoods sampled during this study.

Table 2. Summary of taxonomic difficulties from vegetation sampling data.

SPECIES LISTED[1]	POSSIBLY INCLUDES[2]	SITE(S)
Agrostis scabra*	Agrostis perennans	1-6
Agrostis scabra	Cinna arundinacea	6 (plots 4-8)
Amphicarpa bracteata	Strophostyles umbellata	6
Carex artitecta	Carex pensylvanica	1-5
Carex pensylvanica	Carex artitecta	6
Dichanthelium villosissimum var. praecocius	D. acuminatum var. fasciculatum and D. acuminatum var. linheimeri	1-6
Oxalis stricta	Oxalis dillenii	6
Rubus allegh/pen	Rubus alleghaniense Rubus pensylvanicus	1-6

Site 1 = Recker Woods
Site 2 = Chip-O-Will Woods
Site 3 = Posen Woods
Site 4 = Williams Creek Woods
Site 5 = Jackson Slough Woods
Site 6 = Lake Sara Flatwoods

[1] Refers to ground cover data summaries in Appendix.

[2] Due to vegetative condition at sampling time, material belonging to this species may have been included with the species listed. In all cases, these are closely related taxa.

* Note: All Agrostis scabra/perennans material found in flower during later visits to sampling sites is A. scabra. Other species pairs were recognized that are not included in this table because both species names appear unabreviated in the species lists. Example: though both Carex bushii and Carex hirsutella were present at Lake Sara Flatwoods, most material found with diagnostic pistillate spikelets was Carex bushii. However, most material of this species pair found throughout the study was vegetative and could not be determined to specific rank.

SOIL ANALYSIS	Recker Woods Summary Data		Chip-O-Will Woods Summary		Posen Woods Summary Data		Wms Cr Woods Summary Data		Jackson Slough Summary Data		Lake Sara Summary Data	
% Organic Matter	Avg	Std Dev	Avg	Std Dev	Avg	Std Dev	Avg	Std Dev	Avg	Std Dev	Avg	Std Dev
Horizon A1	1.45	0.24	1.44	0.36	2.4	1.4	1.78	0.83	2.38	1.21	2.69	0.90
A2	0.91	0.25	0.96	0.18	0.9	0.2	0.80	0.30	0.74	0.31	0.59	0.21
B	0.83	0.21	0.86	0.18	0.6	0.1	0.44	0.07	0.44	0.11	0.39	0.12
Phosphorus (ppm)												
Horizon A1	13.00	5.95	10.88	3.64	21.6	12.5	17.13	9.11	26.13	11.91	17.75	7.19
A2	17.88	13.79	9.63	4.07	9.6	5.1	14.13	12.12	18.88	12.15	7.13	2.80
B	18.75	5.92	39.63	35.71	11.3	5.5	20.63	5.60	18.50	9.64	6.88	2.85
Potassium (ppm)												
Horizon A1	58.50	7.48	57.63	7.01	64.0	22.0	55.50	8.00	69.25	12.61	59.00	11.89
A2	95.63	21.49	73.25	14.57	48.8	5.3	45.63	6.28	56.13	14.45	41.25	6.84
B	113.50	25.85	102.63	16.60	44.8	4.0	64.63	17.52	66.00	14.95	54.00	20.94
Magnesium (ppm)												
Horizon A1	125.63	88.72	134.00	103.98	50.3	28.7	33.63	17.82	88.88	90.83	47.88	11.74
A2	738.75	206.08	518.63	221.16	138.9	53.7	144.25	94.40	215.38	241.53	104.50	29.85
B	935.63	150.61	916.13	109.27	387.9	98.5	590.50	79.95	613.88	186.17	640.75	88.22
Calcium (ppm)												
Horizon A1	207.50	33.70	202.50	21.88	306.3	130.0	220.00	32.95	361.25	99.49	311.25	70.80
A2	240.00	41.40	233.75	58.05	296.3	58.5	310.00	137.94	391.25	280.63	220.00	41.06
B	286.25	56.55	291.25	108.16	526.3	159.0	830.00	226.78	813.75	539.44	310.00	135.75
Soil pH												
Horizon A1	4.43	0.21	4.53	0.18	4.5	0.2	4.41	0.18	4.36	0.23	4.44	0.19
A2	4.73	0.19	4.85	0.17	4.6	0.1	4.66	0.16	4.59	0.38	4.49	0.11
B	4.73	0.14	4.86	0.09	4.8	0.2	4.79	0.14	4.73	0.21	4.76	0.16
C.E.C. (meg/100g)												
Horizon A1	8.21	1.91	8.04	2.03	6.6	1.5	6.36	1.75	7.67	1.72	6.03	0.92
A2	15.93	4.07	10.56	4.04	8.1	3.4	7.25	2.22	9.96	2.24	7.25	2.12
B	19.01	3.65	17.08	2.30	12.4	4.2	17.91	4.03	18.68	4.53	13.83	2.09
BASE SATURATION												
% K - Horizon A1	1.89	0.29	1.94	0.54	2.6	1.3	2.45	0.99	2.41	0.64	2.61	0.94
A2	1.56	0.24	1.89	0.46	1.7	0.6	1.76	0.61	1.46	0.24	1.59	0.64
B	1.53	0.15	1.55	0.13	1.0	0.3	0.96	0.33	0.96	0.36	1.01	0.39
% Mg - Horizon A1	13.74	11.98	14.56	11.56	6.7	4.2	4.58	2.46	9.39	8.43	6.90	2.41
A2	39.40	8.80	40.69	6.12	15.7	6.7	16.69	8.05	15.65	15.88	13.09	5.90
B	41.36	3.53	44.95	3.63	26.8	5.4	28.06	4.05	28.63	9.68	39.44	7.53
% Ca - Horizon A1	12.99	3.08	13.43	4.12	24.3	10.8	18.78	7.76	24.66	9.05	26.28	7.46
A2	7.80	1.61	11.68	2.56	20.4	6.5	22.14	7.66	18.24	9.33	16.30	4.91
B	7.75	2.20	8.31	2.18	22.3	6.5	23.29	4.78	20.53	9.08	10.99	3.33
% H - Horizon A1	71.39	14.32	70.08	14.74	66.4	15.4	74.20	10.57	63.54	12.86	64.21	10.42
A2	51.24	9.19	45.75	5.50	62.2	12.7	59.41	15.44	64.65	20.38	69.03	10.92
B	49.36	4.03	45.19	2.88	49.8	9.0	47.69	4.73	49.89	7.05	48.56	5.26
SOIL TEXTURE												
Horizon A1												
% Sand	38.57	22.41	50.57	15.74	22.5	15.2	11.63	2.77	15.38	2.97	24.25	5.06
% Silt	45.71	16.84	36.00	12.06	61.3	13.4	71.00	3.55	63.63	7.89	58.00	4.04
% Clay	15.71	6.95	13.43	4.12	16.3	3.3	17.38	3.81	21.00	7.76	17.75	3.15
Texture Class												
Thickness (cm)					17.8	5.4	15.00	0.00	16.13	4.36	9.25	2.60
Horizon A2												
% Sand	45.57	24.72	54.50	1.05	17.6	5.6	11.88	1.89	14.50	8.05	19.63	3.85
% Silt	30.43	20.63	28.17	3.19	57.6	5.2	63.75	6.56	53.63	13.48	55.50	3.82
% Clay	24.00	5.26	17.33	3.27	24.8	3.5	24.38	5.80	31.88	9.95	24.88	1.73
Class												
Thickness (cm)					32.6	12.4	33.14	5.40	28.25	5.28	37.29	14.31
Horizon B												
% Sand	48.00	16.21	47.86	15.85	19.0	3.1	11.75	3.37	11.75	2.49	16.13	1.89
% Silt	25.75	9.11	28.14	10.67	42.5	5.5	46.63	2.07	42.75	5.44	40.75	0.89
% Clay	26.38	7.37	24.00	5.42	38.5	6.2	41.63	2.13	45.50	5.83	43.13	2.10
Texture Class												
Depth to B (cm)	42.50	9.77	31.50	5.15	56.0	17.7	48.14	5.40	44.38	7.76	46.29	12.53
Depth to Hardpan (cm)	22.00	0.00			24.8	3.4	23.71	1.89	10.00	0.00	22.00	2.83

Table 3. Selected summary soils data for the six flatwoods examined in this study.

Table 4. Selected tree and shrub/sapling summary data.

VARIABLE SITE	Basal Area sq m/ha	Quercus spp Rel Dom	Quercus spp Trees IV 200	Q marilandica IV 200	Q stellata IV 200	Tree Species #	Tree Density/ha	Sapling Density/ha	Quercus spp Saps Rel Den	Sapling Species #	Total Stem Density/ha
Recker Woods	19.68	96.8	183	41.2	119.9	13	503	3200	27.3	12	3703
Chip-O-Will	23.42	98.6	189	30	148.4	5	475	1425	52.6	12	1900
Posen Woods	22.63	83.2	121	3.5	85.8	14	523	9150	4.9	26	9673
Williams Creek	30.14	97	174	8.8	143.5	14	465	5775	16.45	19	6240
Jackson Slough	22.25	90	153	9	83.9	17	533	4800	26	29	5333
Lake Sara	20.22	97.6	189	12.8	110.4	8	284	540	3.7	7	824
AVERAGE	23.06	93.87	168.17	17.55	115.32	11.83	463.83	4148.33	21.83	17.50	4612.17
STD DEV	3.76	6.06	26.75	14.72	27.54	4.45	91.96	3143.99	18.10	8.69	3203.56

Table 5. Ground cover summary data for each site.

VARIABLE	Total Species Richness	Spp Density/ 0.25 m sq	% Bare Ground
SITE			
Recker Woods	59	1.69	83
Chip-O-Will	52	1.61	80
Posen Woods	41	1.71	76
Williams Cr Woods	50	1.85	67
Jackson Slough Woods	71	2.38	75
Lake Sara Flatwoods	92	7.48	32
AVERAGE	60.83	2.79	68.83
STD DEV	18.26	2.32	18.84

SITE SPECIES	Recker Woods	Chip-Will Woods	Posen Woods	Wms Creek Woods	Jackson Slough	Lake Sara Flatwoods	rank value
Parthenocissus quinquefolius	4	3	1	1	1	X	70
Rubus all/pen	2	9	2	3	15	6	59
Agrostis scabra	8	14	14	10	3	5	42
Dichanthelium villosiss/acum	5	12	X	X	6	3	38
Carex festucacea	11	8	A	5	8	7	36
Cinna arundinacea	1	2	A	4	X	X	36
Eleocharis verrucossa	3	4	A	13	X	8	31
Rubus flagellaris	X	10	A	2	2	X	29
Carex artitecta/pen	14	15	X	X	5	2	28
Quercus stellata	6	6	X	8	X	X	28
Toxicodendron radicans	X	X	3	6	7	A	27
Sassafras albidum	A	X	4	15	4	10	26
Helianthus divaricatus	12	X	X	7	A	1	23
Parthenium integrifolium	13	1	A	A*	13	A*	6
# Absent	1	0	5	1	1	2	

Table 6. Rank order of the most important ground cover species of the six flatwoods studied are listed based on quantitative data. This list includes species that were among the 15 most important species at three or more sites. Numbers indicate the rank at each site, based on importance values. The rank value is determined by summing the site ranks in inverse order so that the most important species at each site gets 15 points, second most important species gets 14 points, etc. Five points are subtracted for absent species (A). An asterisk (*) by "A" indicates the taxon was observed at the site but not recorded in sampling. An "X" indicates that the taxon was recorded in sampling but not among the 15 most important species. No value is added for these "X" species.

SITE / SPECIES	Recker Woods	Chip-Will Woods	Posen Woods	Wms Creek Woods	Jackson Slough	Lake Sara Flatwoods
Acalypha gracilens	X	X	X	X	X	15
Amphicarpa bracteata	X	A	A	X	A	9
Carex bushii/hirsutella	A	A	X	X	X	4
Carex caroliniana	X	X	A	X	9	A
Carex glaucoidea	9	X	A	A	A	X
Carya ovata	X	A	8	X	A	X
Fraxinus americanus	15	X	X	X	X	A
Gillenia stipulacea	A	7	X	A	A	X
Hedeoma pulegioides	A	X	A	A	X	X
Podophyllum peltatum	X	X	A*	X	A	X
Potentilla simplex	A	X	A	X	X	X
Prunus serotina	A	X	12	X	10	X
Pycnanthemum tenuifolium	X	X	A	12	X	X
Quercus imbricaria	X	X	9	14	X	X
Quercus marilandica	X	11	A	X	X	X
Quercus velutina	X	X	10	X	X	X
Rosa carolina	A	A	X	X	X	X
Tradescantia ohiensis	X	A	A	X	A	X
Vitis aestivalis	X	X	7	X	X	X
Vitis riparia	X	A	6	X	X	X
# Absent	6	6	9	3	6	1

Table 7. Additional characteristic ground cover species of the six flatwoods studied are listed in alphabetical order. These include taxa that were recorded at three or more sites, but did not typically occur with high cover values. Numbers indicate the rank at each site, determined from importance values. An "X" indicates the taxon was present but not among the 15 most important species. An "A" indicates absent species. An asterisk (*) by "A" indicates the taxon was observed but not recorded in sampling.

Sorensen's Similarity Index - Quantitative Modification

	L. Sara	Jack Sl	Wm Cr	Posen	C-O-W
Recker	15	23	37	22	51
C-O-W	13	27	40	17	
Posen	12	48	50		
Wms Cr	18	53			
Jack Sl	13				

Table 8. Sorensen's Similarity Indices comparing the six flatwoods studied are shown. These values represent an index of similarity for comparing the floristic similarity between all sites based on quantitative data. Site names are abreviated: L. Sara = Lake Sara Flatwoods, Jack Sl = Jackson Slough Woods, Wm Cr = Williams Creek Woods, Posen = Posen Woods, C-O-W = Chip-O-Will Woods, and Recker = Recker Woods.

Sorensen's Similarity Index - Qualitative

	L. Sara	Jack Sl	Wm Cr	Posen	C-O-W
Recker	41	43	53	38	52
C-O-W	35	49	55	37	
Posen	30	39	44		
Wms Cr	44	56			
Jack Sl	39				

Table 9. Sorensen's Similarity Indices comparing the six flatwoods studied are shown. These values represent an index of similarity for comparing the floristic similarity between all sites based on presence data. Site names are abreviated: L. Sara = Lake Sara Flatwoods, Jack Sl = Jackson Slough Woods, Wm Cr = Williams Creek Woods, Posen = Posen Woods, C-O-W = Chip-O-Will Woods, and Recker = Recker Woods.

FLATWOODS STUDY SITES AND CORRESPONDING SOIL TYPES

Site Name	Soil Name(s)	Taxonomic Class
Recker Woods	Okaw Silt Loam	Mesic Typic Albaqualf
Chip-O-Will Woods	Okaw Silt Loam	Mesic Typic Albaqualf
Posen Woods	Bluford Silt Loam	Mesic Aquic Hapludalf
Williams Cr Woods	Wynoose Silt Loam	Mesic Typic Albaqualf
Jackson Slough Woods	Okaw Silt Loam	Mesic Typic Albaqualf
Lake Sara Flatwoods	Bluford Silt Loam Wynoose Silt Loam Ava Silt Loam	Mesic Aquic Hapludalf, Mesic Typic Albaqualf, Mesic Typic Fragiudalf

Table 10. Flatwoods study sites and the corresponding soils. All contain fine montmorillonitic clays except the Ava silt loam which contains a mixed, fine-silty clay type.

PERCENT INCREASE OF CLAY BETWEEN SOIL HORIZONS

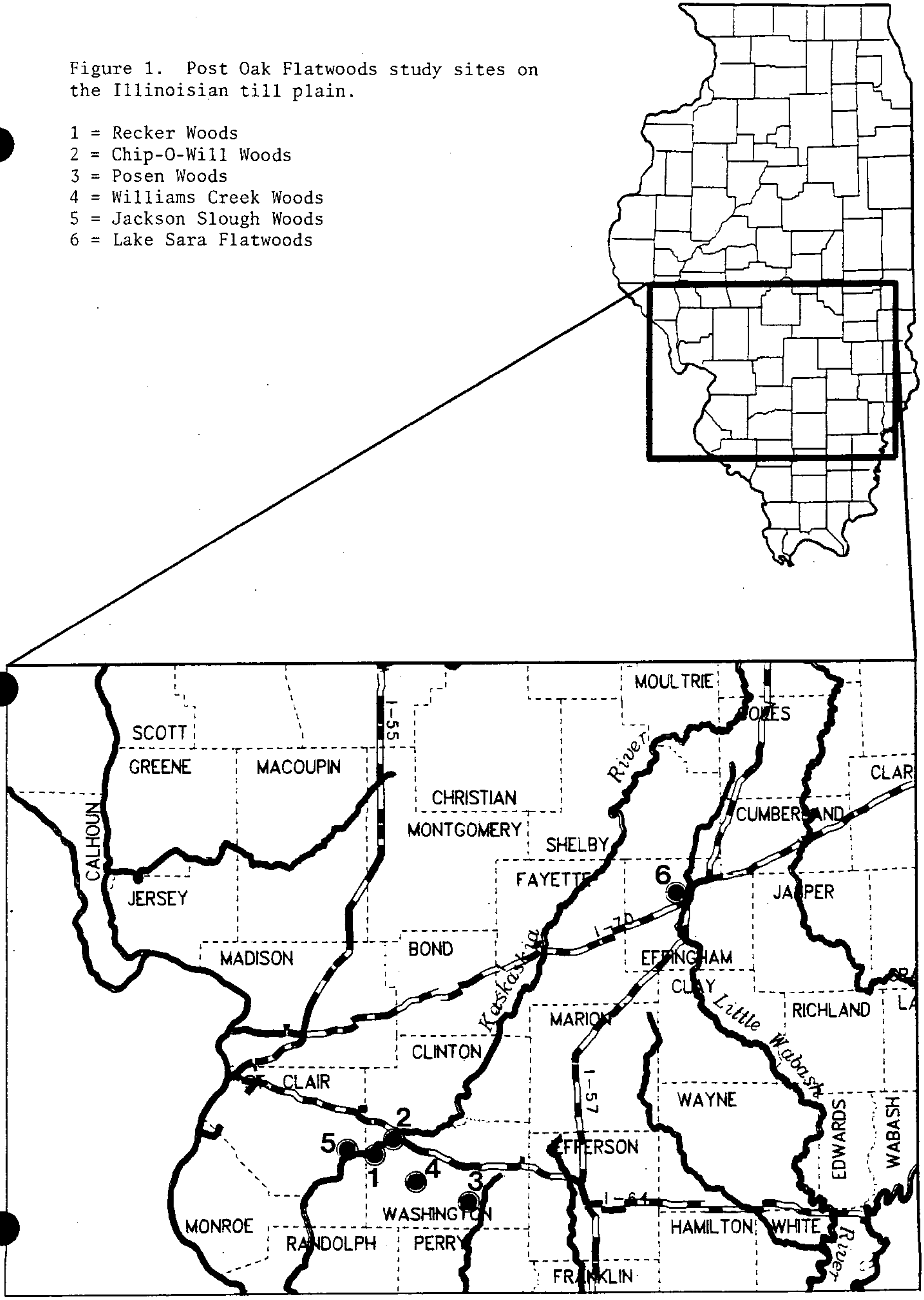
	HORIZONS A1-E		HORIZONS E-B	
Site	Range	Mean	Range	Mean
Recker	-20% to 250%	53%	-24% to 120%	10%
Chip-O-Will	17% to 57%	29%	0% to 171%	38%
Posen	10% to 140%	52%	18% to 100%	55%
Williams Creek	8% to 143%	40%	18% to 130%	71%
Jackson Slough	18% to 100%	52%	-16% to 104%	43%
Lake Sara	9% to 140%	40%	59% to 92%	73%

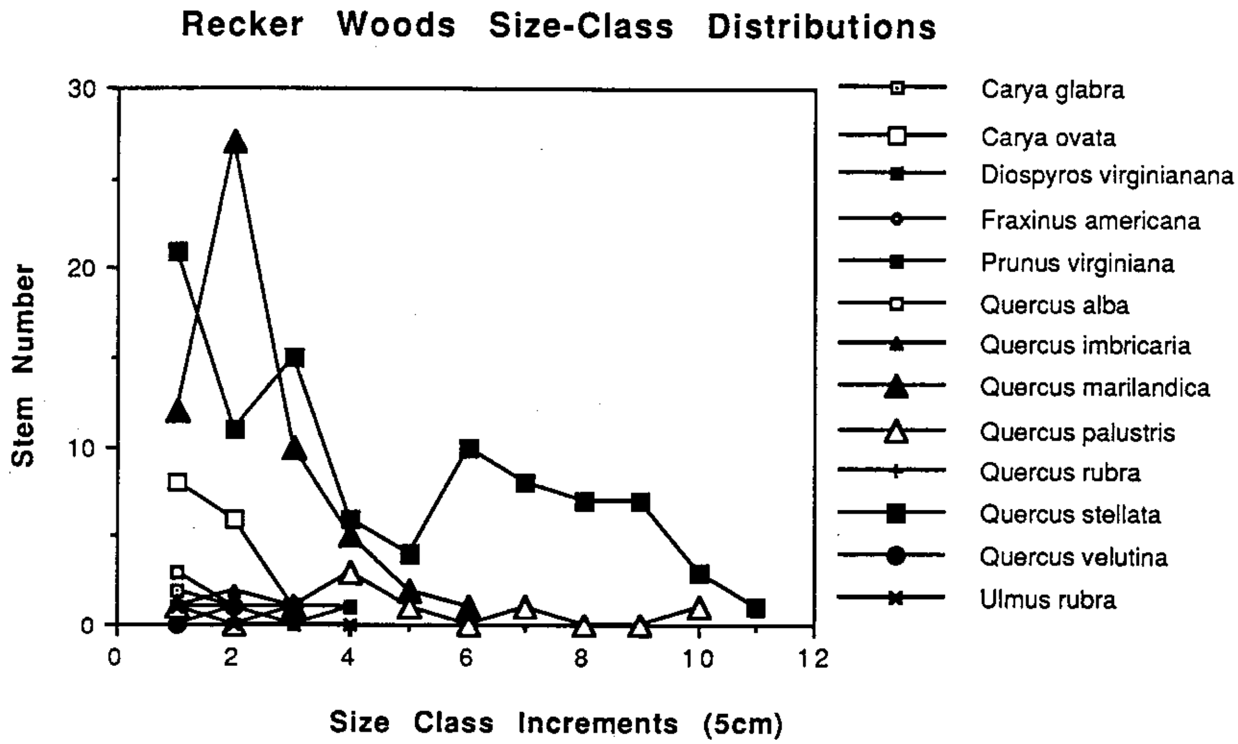
Table 11. Range and mean values of percent increase in percent clay between A1 soil horizon and the E horizon or claypan in six post oak flatwoods. Range indicates plots with the lowest and highest percent increase in clay; mean value reflects percent increase in clay in site summary means.

Figures 1 through 30

Figure 1. Post Oak Flatwoods study sites on the Illinoisian till plain.

1 = Recker Woods
2 = Chip-O-Will Woods
3 = Posen Woods
4 = Williams Creek Woods
5 = Jackson Slough Woods
6 = Lake Sara Flatwoods





Recker Woods Size-Class Distributions
Stem Number
30
20
10
0
0
2
4
6
8
10
12
Size Class Increments (5cm)
Carya glabra
Carya ovata
Diospyros virginianana
Fraxinus americana
Prunus virginiana
Quercus alba
Quercus imbricaria
Quercus marilandica
Quercus palustris
Quercus rubra
Quercus stellata
Quercus velutina
Ulmus rubra

Figure 2

Chip O' Will - Size-Class Distribution

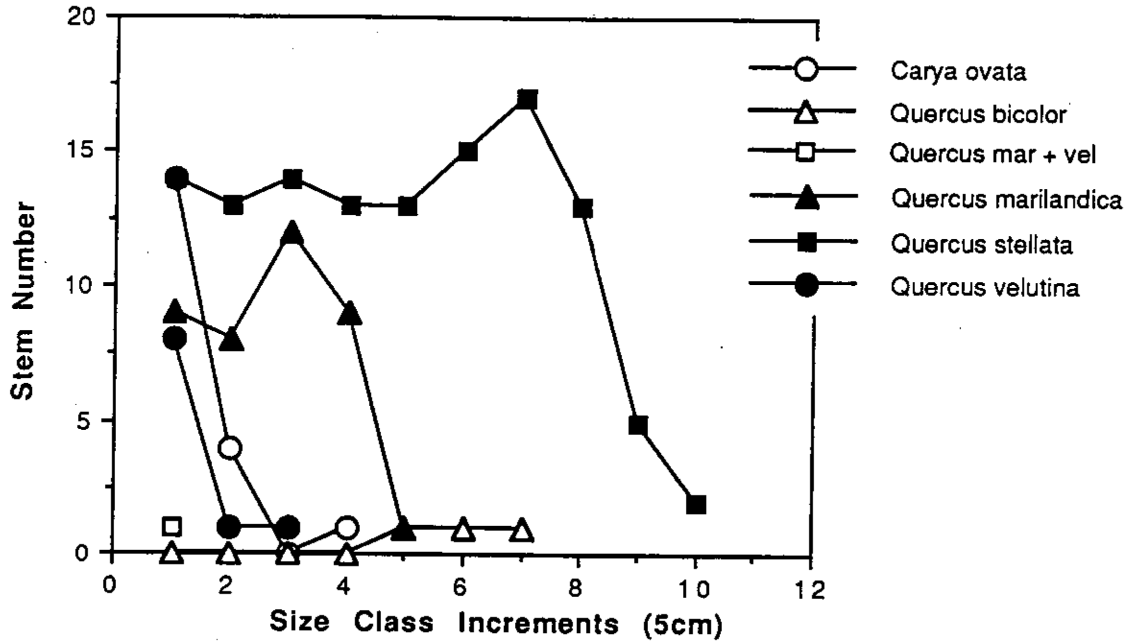


Figure 3

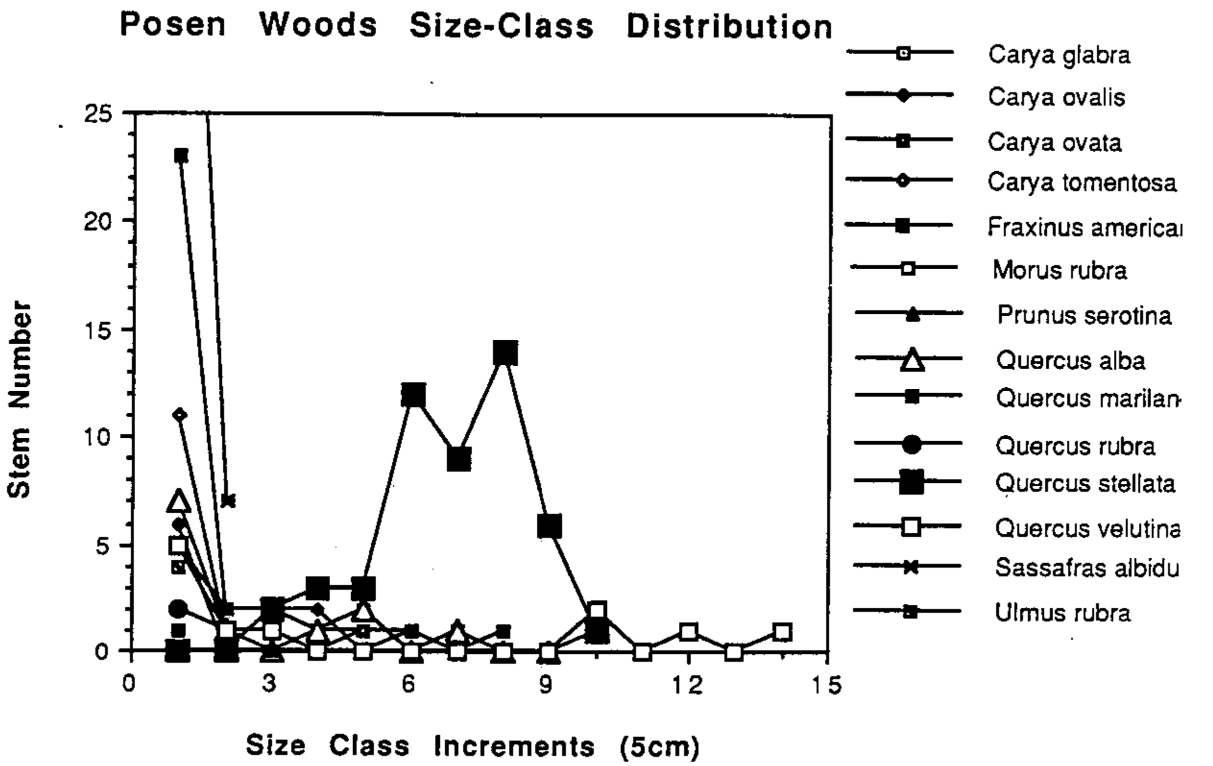

Posen Woods Size-Class Distribution
Stem Number
Size Class Increments (5cm)
0
5
10
15
20
25
0
3
6
9
12
15
Carya glabra
Carya ovalis
Carya ovata
Carya tomentosa
Fraxinus americai
Morus rubra
Prunus serotina
Quercus alba
Quercus marilan
Quercus rubra
Quercus stellata
Quercus velutina
Sassafras albidu
Ulmus rubra

Figure 4

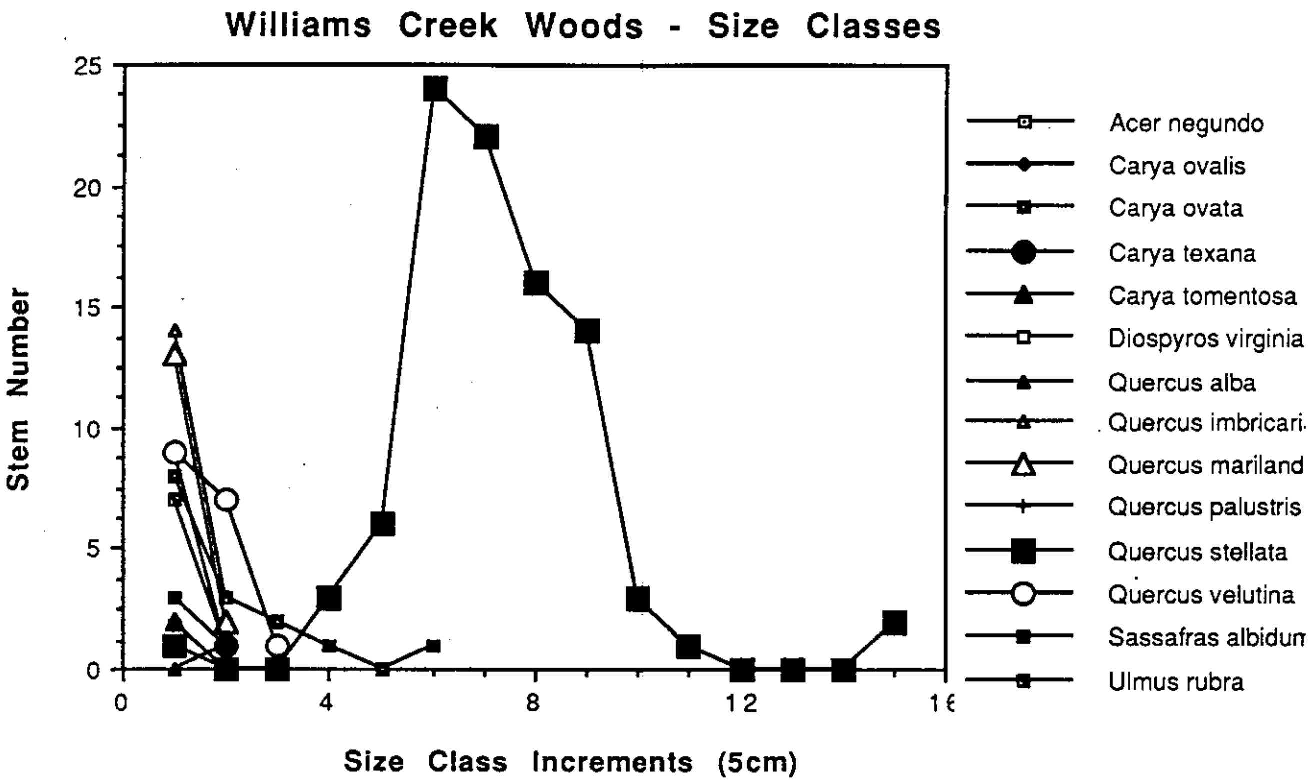

Williams Creek Woods - Size Classes
Stem Number
25
20
15
10
5
0
0
4
8
12
16
Size Class Increments (5cm)
Acer negundo
Carya ovalis
Carya ovata
Carya texana
Carya tomentosa
Diospyros virginia
Quercus alba
Quercus imbricari
Quercus mariland
Quercus palustris
Quercus stellata
Quercus velutina
Sassafras albidum
Ulmus rubra

Figure 5

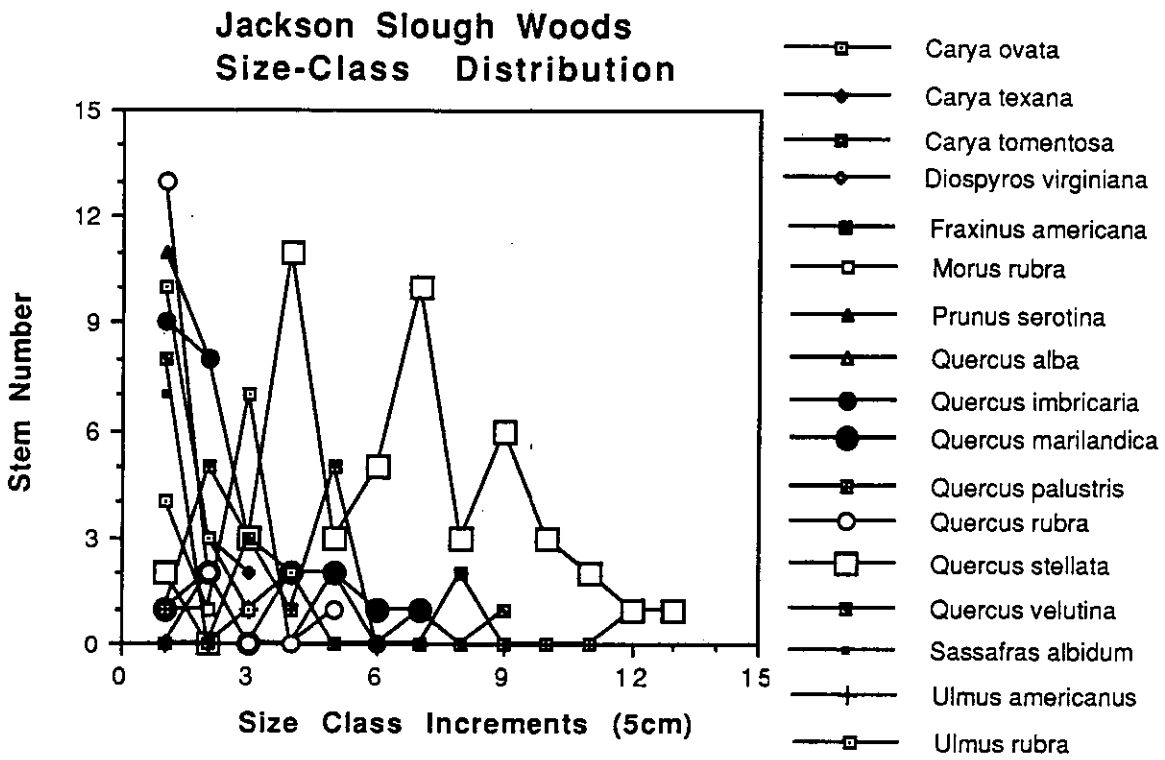
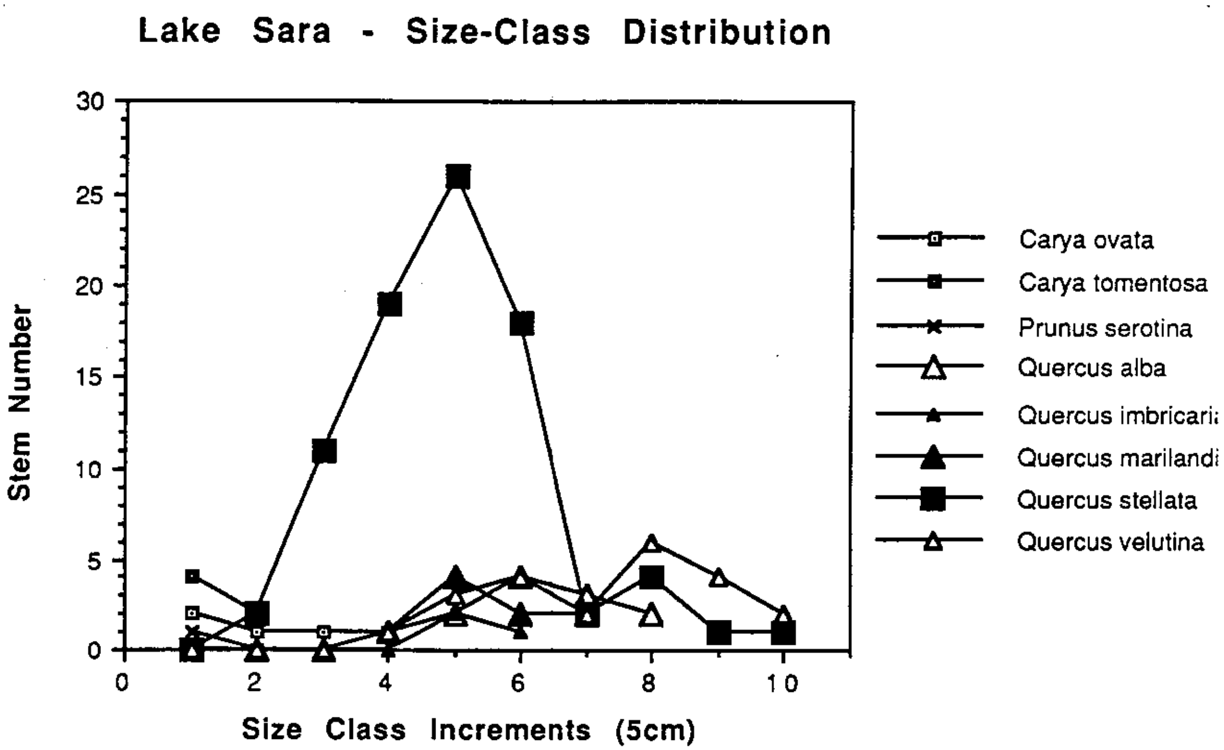

Jackson Slough Woods
Size-Class Distribution
Stem Number
Size Class Increments (5cm)
0
3
6
9
12
15
Carya ovata
Carya texana
Carya tomentosa
Diospyros virginiana
Fraxinus americana
Morus rubra
Prunus serotina
Quercus alba
Quercus imbricaria
Quercus marilandica
Quercus palustris
Quercus rubra
Quercus stellata
Quercus velutina
Sassafras albidum
Ulmus americanus
Ulmus rubra

Figure 6



Lake Sara - Size-Class Distribution
Stem Number
Size Class Increments (5cm)
30
25
20
15
10
5
0
0
2
4
6
8
10
Carya ovata
Carya tomentosa
Prunus serotina
Quercus alba
Quercus imbricari:
Quercus marilandi
Quercus stellata
Quercus velutina

Figure 7

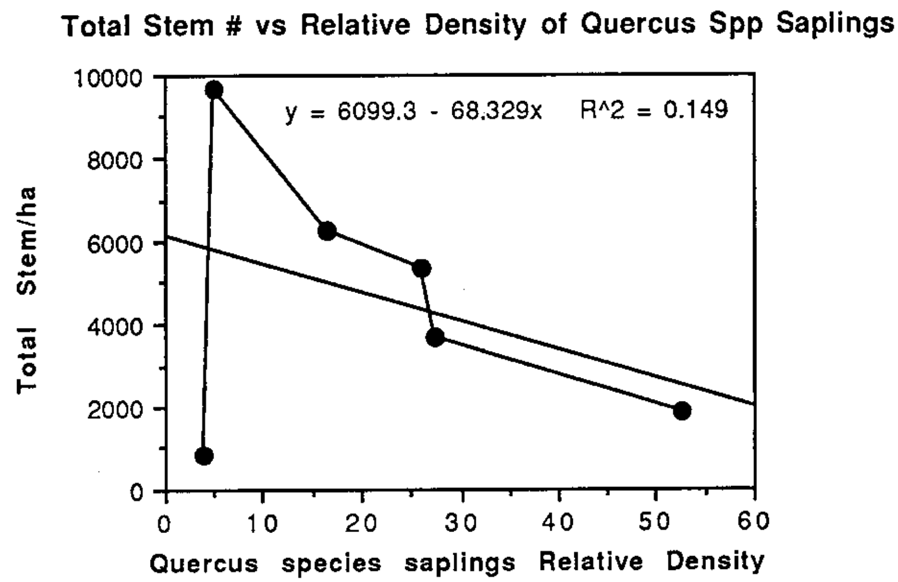

Total Stem # vs Relative Density of Quercus Spp Saplings
y = 6099.3 - 68.329x R^2 = 0.149
Total Stem/ha
10000
8000
6000
4000
2000
0
0
10
20
30
40
50
60
Quercus species saplings Relative Density

Figure 8.

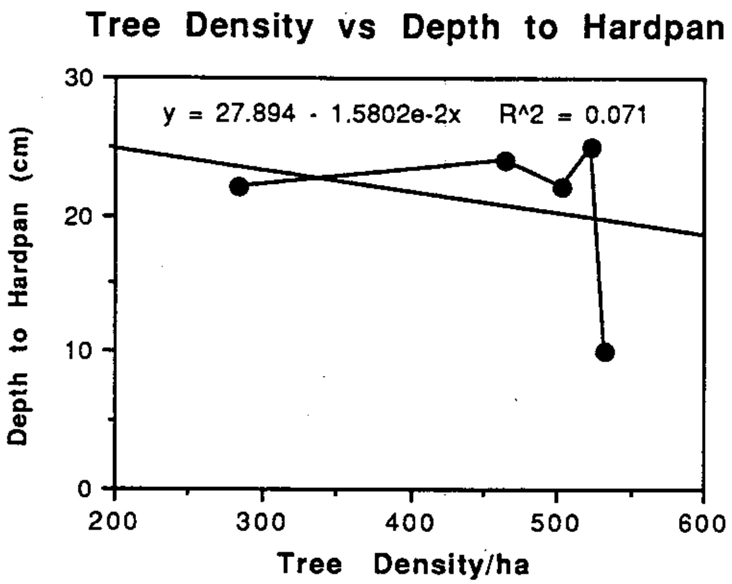

Tree Density vs Depth to Hardpan
y = 27.894 - 1.5802e-2x R^2 = 0.071
Depth to Hardpan (cm)
30
20
10
0
200
300
400
500
600
Tree Density/ha

Figure 9

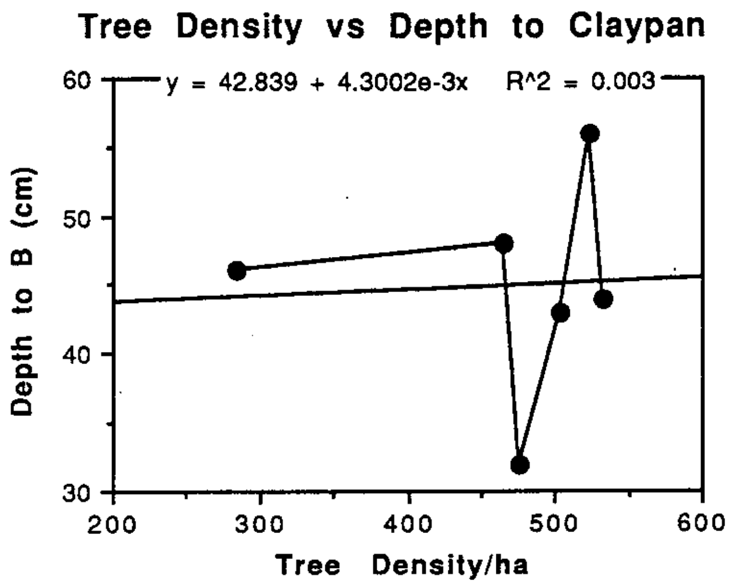

Tree Density vs Depth to Claypan
y = 42.839 + 4.3002e-3x R^2 = 0.003
Depth to B (cm)
60
50
40
30
200
300
400
500
600
Tree Density/ha

Figure 10

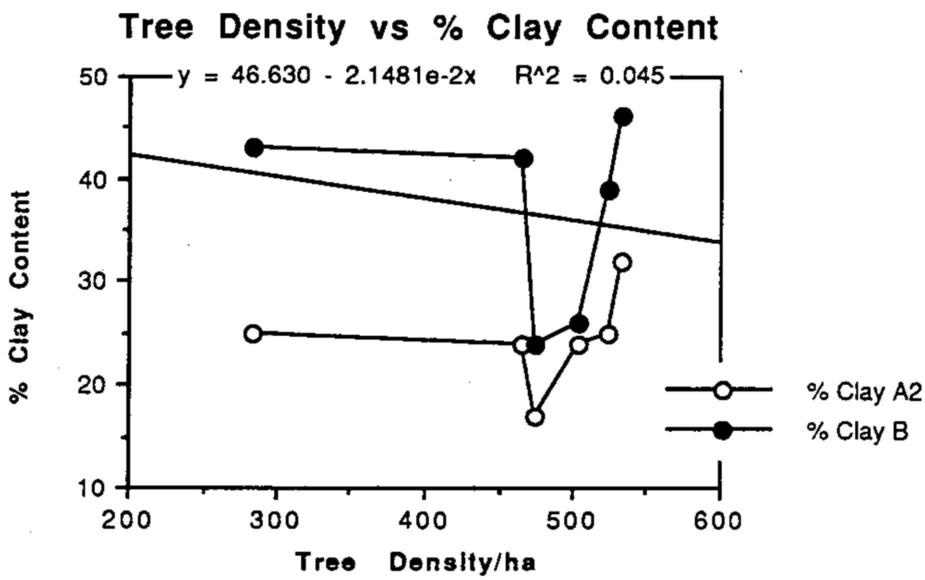

Tree Density vs % Clay Content
y = 46.630 - 2.1481e-2x R^2 = 0.045
% Clay Content
Tree Density/ha
50
40
30
20
10
200
300
400
500
600
% Clay A2
% Clay B

Figure 11

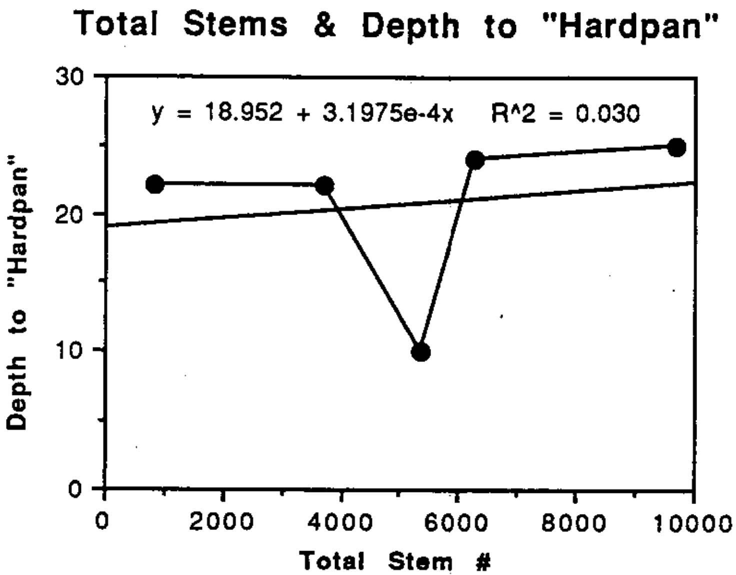

Total Stems & Depth to "Hardpan"
y = 18.952 + 3.1975e-4x R^2 = 0.030
Depth to "Hardpan"
30
20
10
0
0
2000
4000
6000
8000
10000
Total Stem #

Figure 12

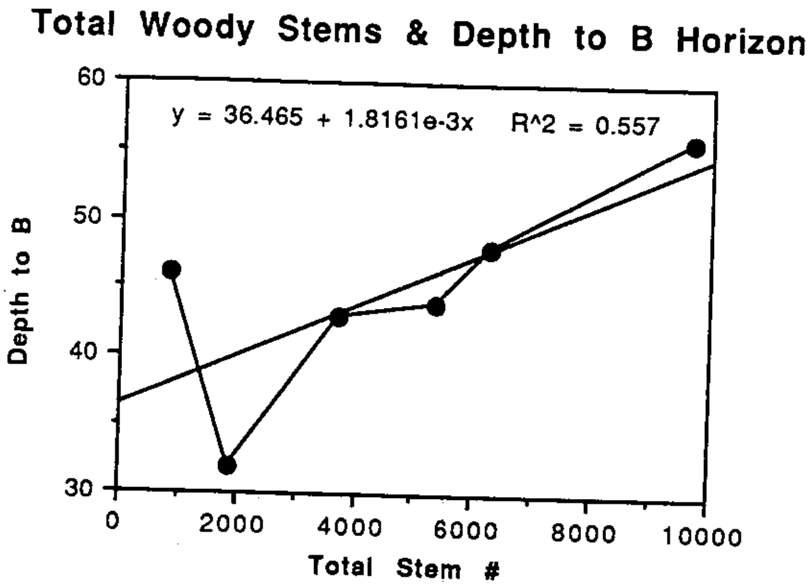

Total Woody Stems & Depth to B Horizon
y = 36.465 + 1.8161e-3x R^2 = 0.557
60
50
40
30
Depth to B
0
2000
4000
6000
8000
10000
Total Stem #

Figure 13

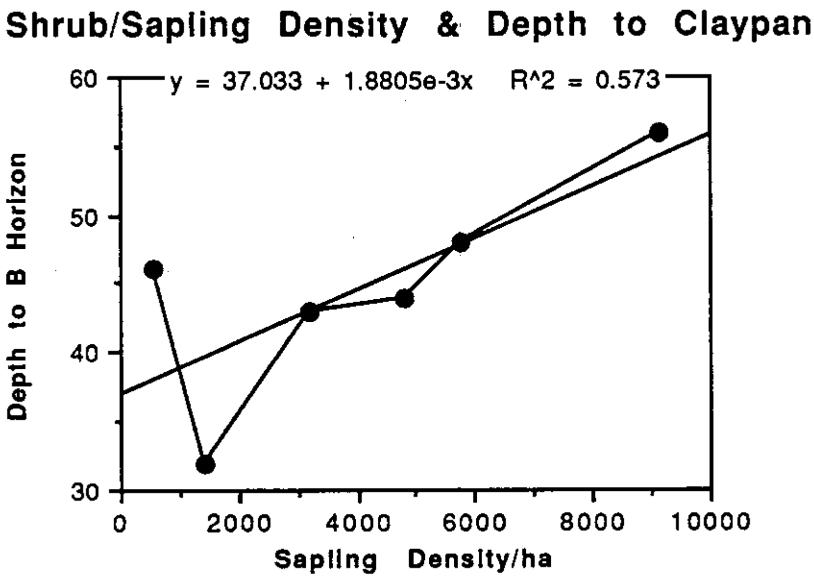
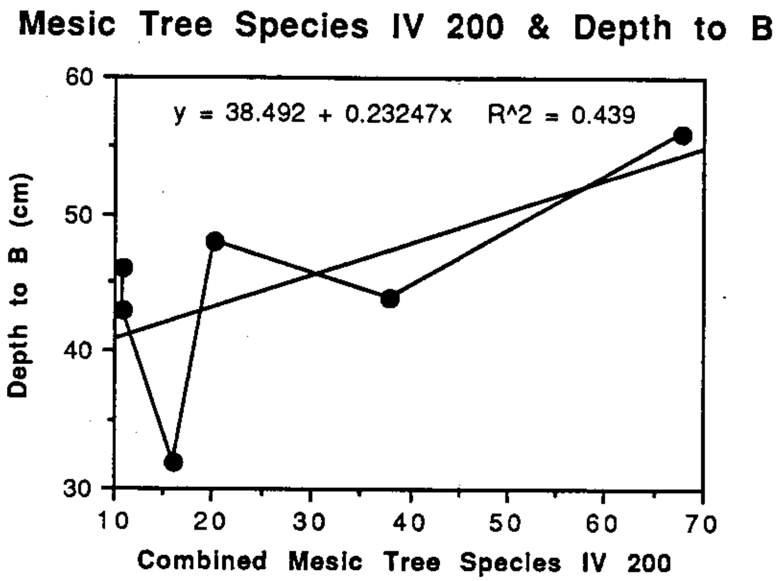

Shrub/Sapling Density & Depth to Claypan
y = 37.033 + 1.8805e-3x R^2 = 0.573
Depth to B Horizon
60
50
40
30
0
2000
4000
6000
8000
10000
Sapling Density/ha

Figure 14



Mesic Tree Species IV 200 & Depth to B
y = 38.492 + 0.23247x R^2 = 0.439
Depth to B (cm)
60
50
40
30
10
20
30
40
50
60
70
Combined Mesic Tree Species IV 200

Figure 15

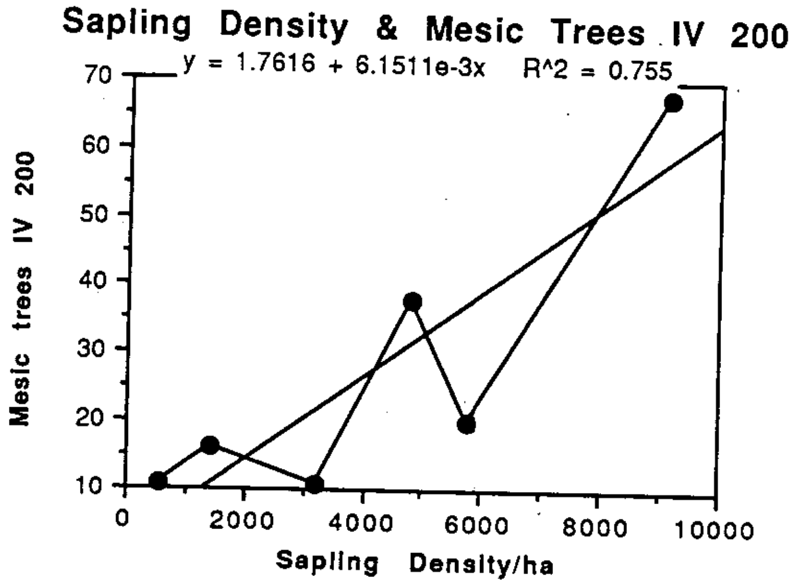

Sapling Density & Mesic Trees IV 200
y = 1.7616 + 6.1511e-3x R^2 = 0.755
Mesic trees IV 200
70
60
50
40
30
20
10
0
2000
4000
6000
8000
10000
Sapling Density/ha

Figure 16A.

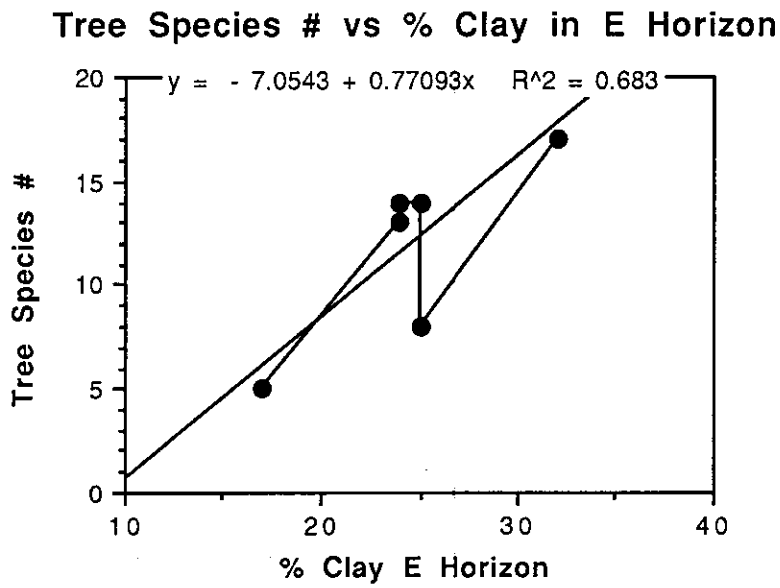
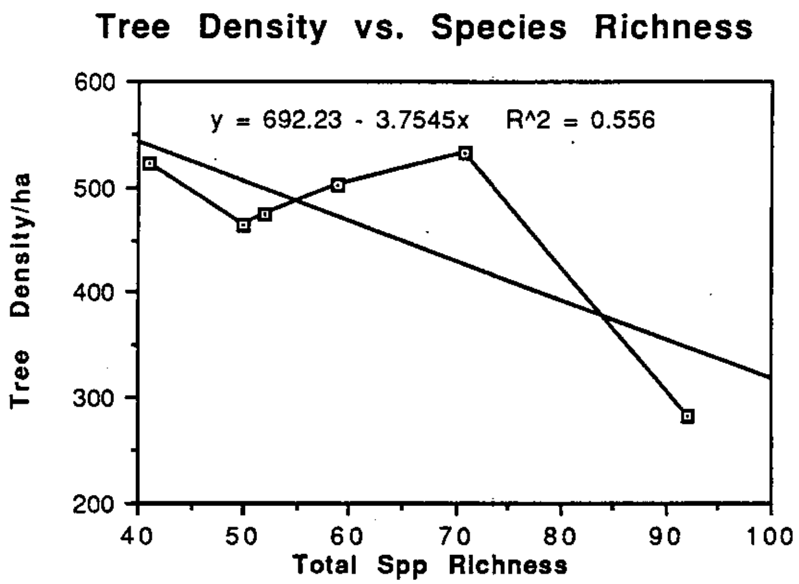
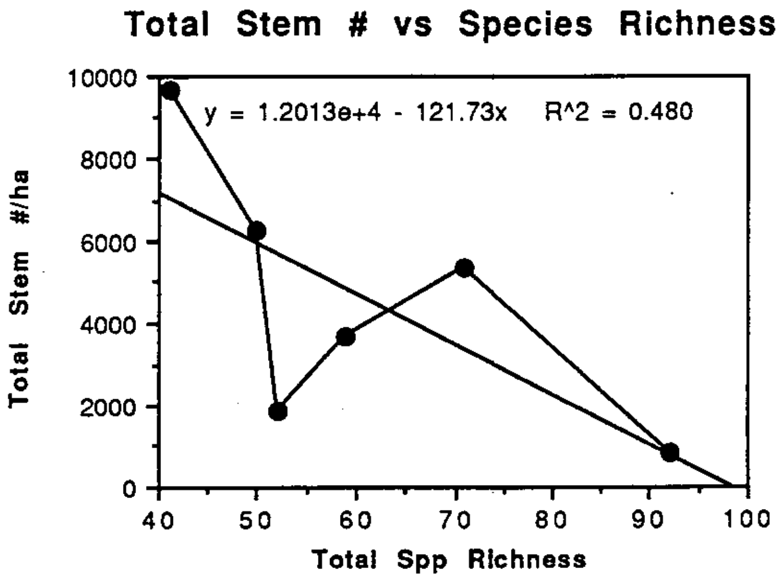

Tree Species # vs % Clay in E Horizon
y = - 7.0543 + 0.77093x R^2 = 0.683
Tree Species #
% Clay E Horizon
20
15
10
5
0
10
20
30
40

Figure 16B.



Tree Density vs. Species Richness
y = 692.23 - 3.7545x R^2 = 0.556
Tree Density/ha
600
500
400
300
200
40
50
60
70
80
90
100
Total Spp Richness

Figure 17



Total Stem # vs Species Richness
y = 1.2013e+4 - 121.73x R^2 = 0.480
Total Stem #/ha
Total Spp Richness
10000
8000
6000
4000
2000
0
40
50
60
70
80
90
100

Figure 18

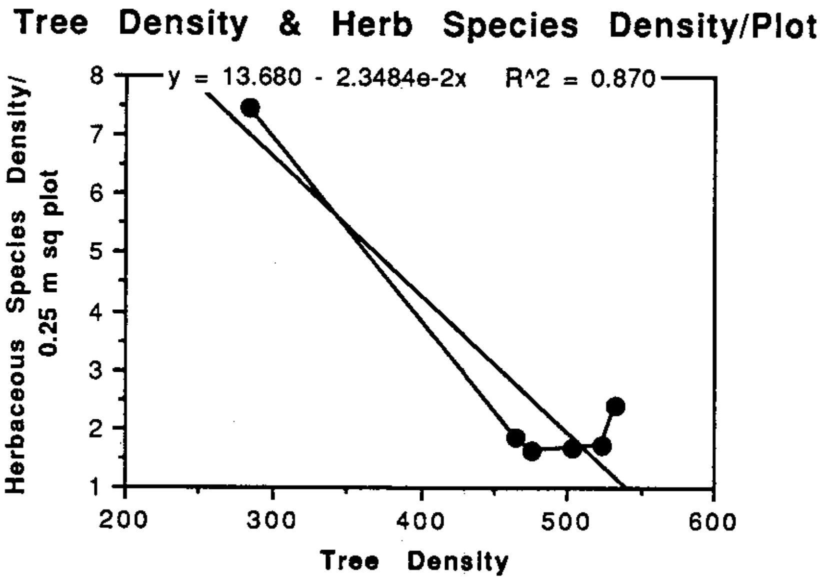

Tree Density & Herb Species Density/Plot
y = 13.680 - 2.3484e-2x R^2 = 0.870
Herbaceous Species Density/
0.25 m sq plot
8
7
6
5
4
3
2
1
200
300
400
500
600
Tree Density

Figure 19

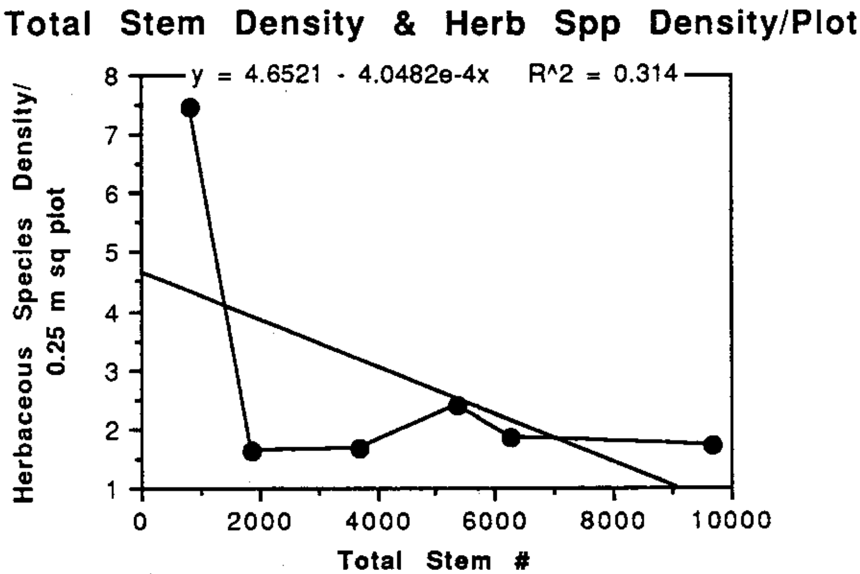

Total Stem Density & Herb Spp Density/Plot
y = 4.6521 - 4.0482e-4x R^2 = 0.314
Herbaceous Species Density/
0.25 m sq plot
8
7
6
5
4
3
2
1
0
2000
4000
6000
8000
10000
Total Stem #

Figure 20

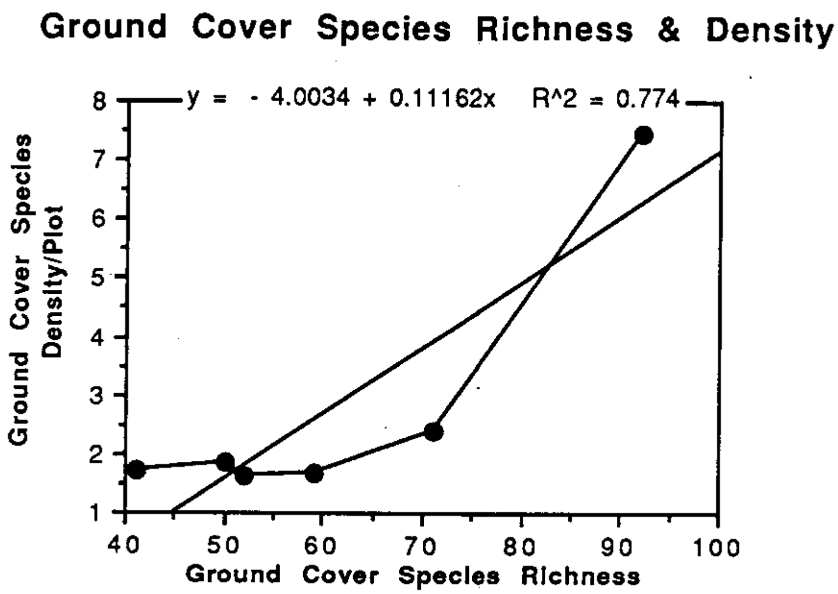
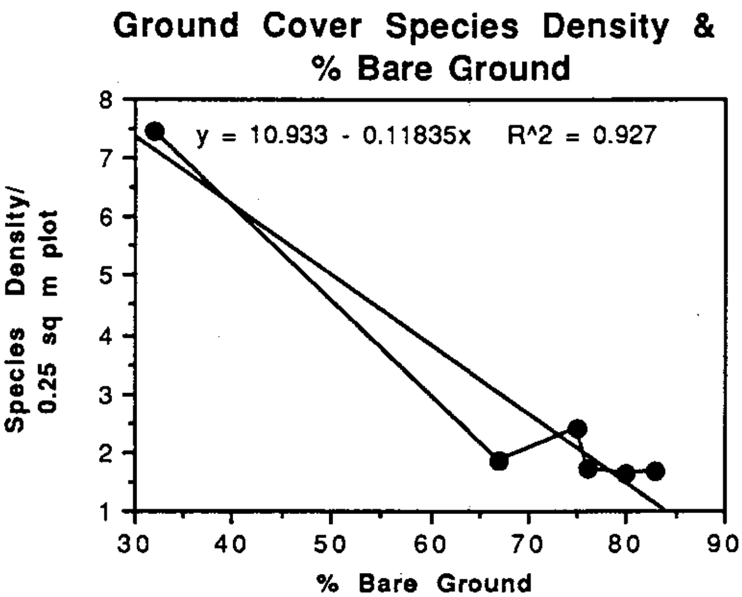

Ground Cover Species Richness & Density
y = - 4.0034 + 0.11162x R^2 = 0.774
Ground Cover Species Density/Plot
8
7
6
5
4
3
2
1
40
50
60
70
80
90
100
Ground Cover Species Richness

Figure 21



Ground Cover Species Density &
% Bare Ground
y = 10.933 - 0.11835x R^2 = 0.927
Species Density/
0.25 sq m plot
% Bare Ground
1
2
3
4
5
6
7
8
30
40
50
60
70
80
90

Figure 22

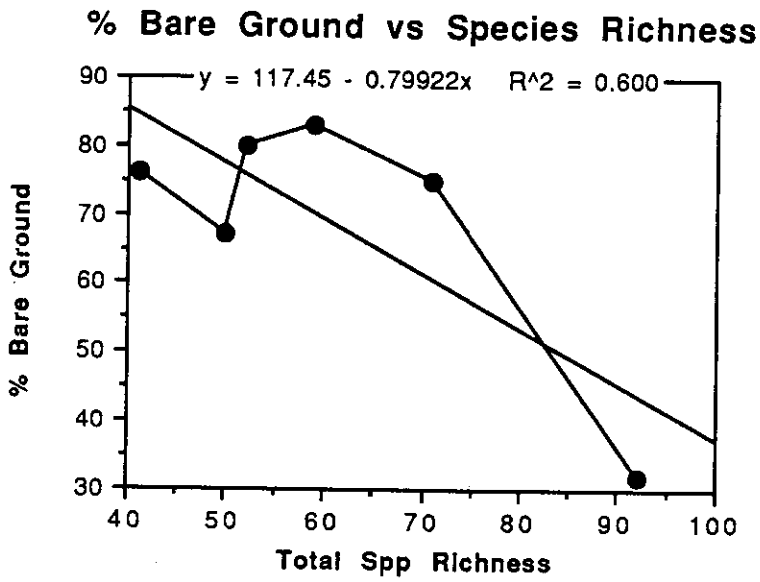
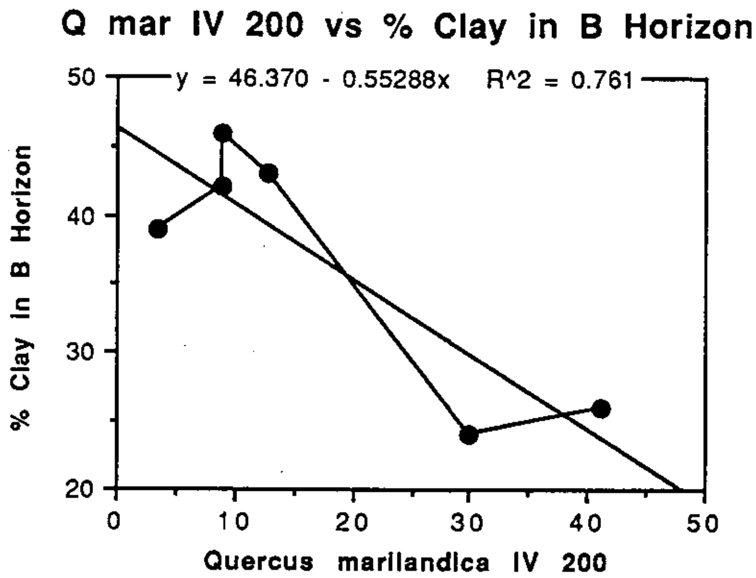

% Bare Ground vs Species Richness
y = 117.45 - 0.79922x R^2 = 0.600
90
80
70
60
50
40
30
% Bare Ground
40
50
60
70
80
90
100
Total Spp Richness

Figure 23



Q mar IV 200 vs % Clay in B Horizon
y = 46.370 - 0.55288x R^2 = 0.761
50
40
30
20
0
10
20
30
40
50
% Clay in B Horizon
Quercus marilandica IV 200

Figure 24

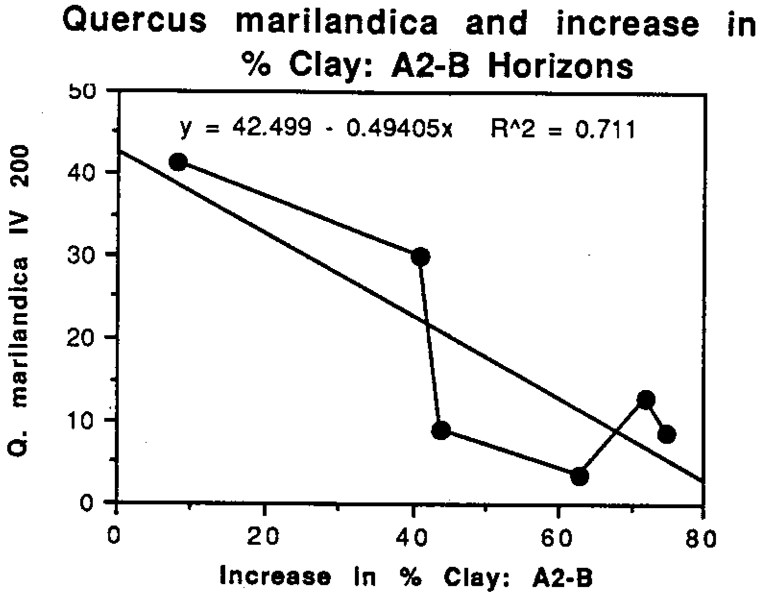
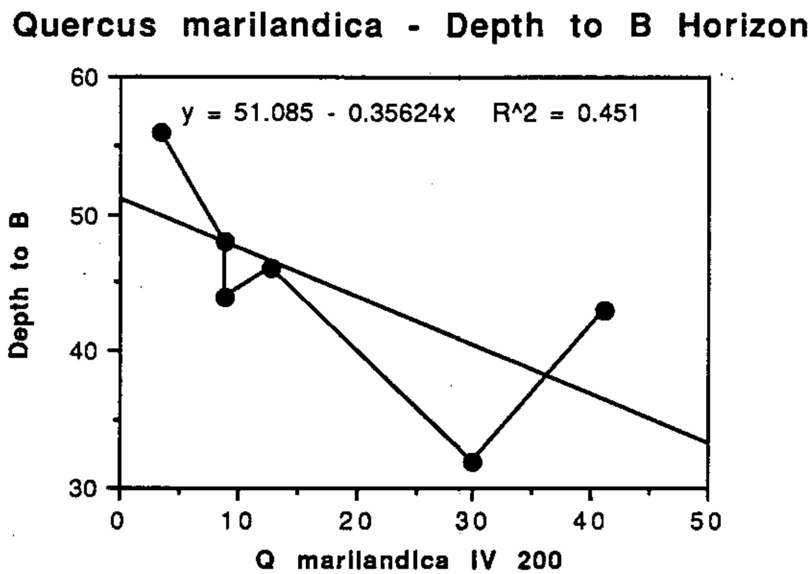

Quercus marilandica and increase in % Clay: A2-B Horizons
y = 42.499 - 0.49405x R^2 = 0.711
Q. marilandica IV 200
Increase in % Clay: A2-B
0
10
20
30
40
50
0
20
40
60
80

Figure 25



Quercus marilandica - Depth to B Horizon
y = 51.085 - 0.35624x R^2 = 0.451
Depth to B
60
50
40
30
0
10
20
30
40
50
Q marilandica IV 200

Figure 26

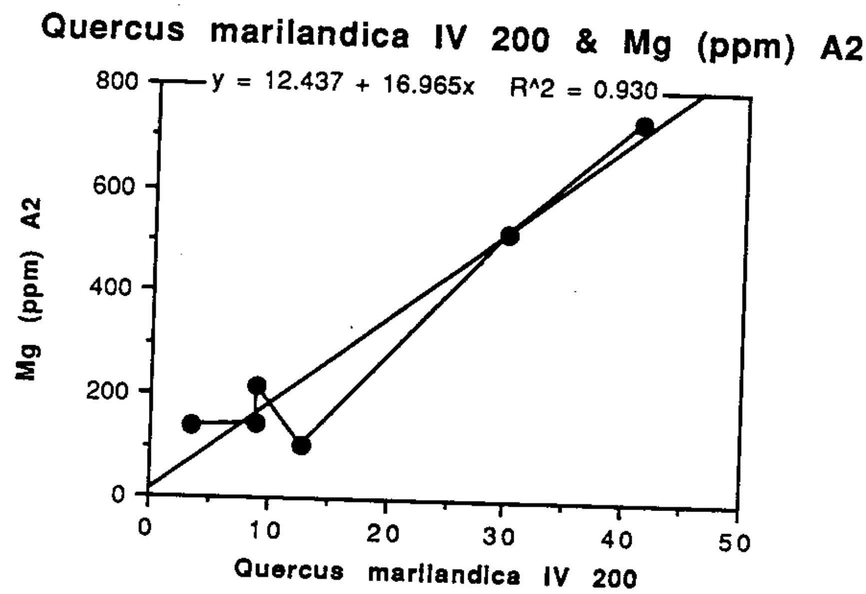
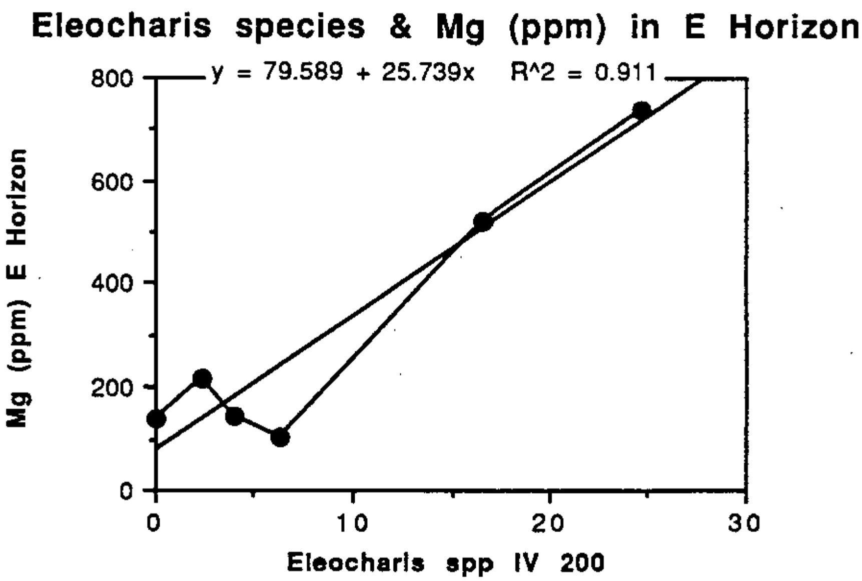

Quercus marilandica IV 200 & Mg (ppm) A2
y = 12.437 + 16.965x R^2 = 0.930
800
600
400
200
0
Mg (ppm) A2
0
10
20
30
40
50
Quercus marilandica IV 200

Figure 27



Eleocharis species & Mg (ppm) in E Horizon
y = 79.589 + 25.739x R^2 = 0.911
Mg (ppm) E Horizon
0
200
400
600
800
0
10
20
30
Eleocharis spp IV 200

Figure 28

Eleocharis spp IV 200/Q. marilandica IV 200

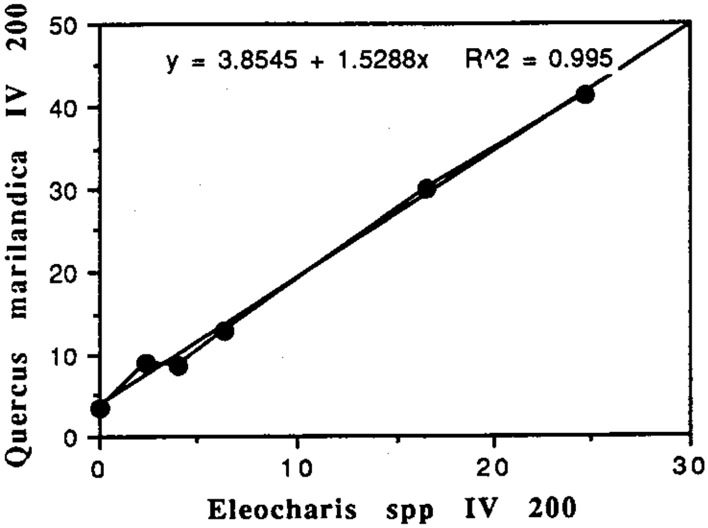
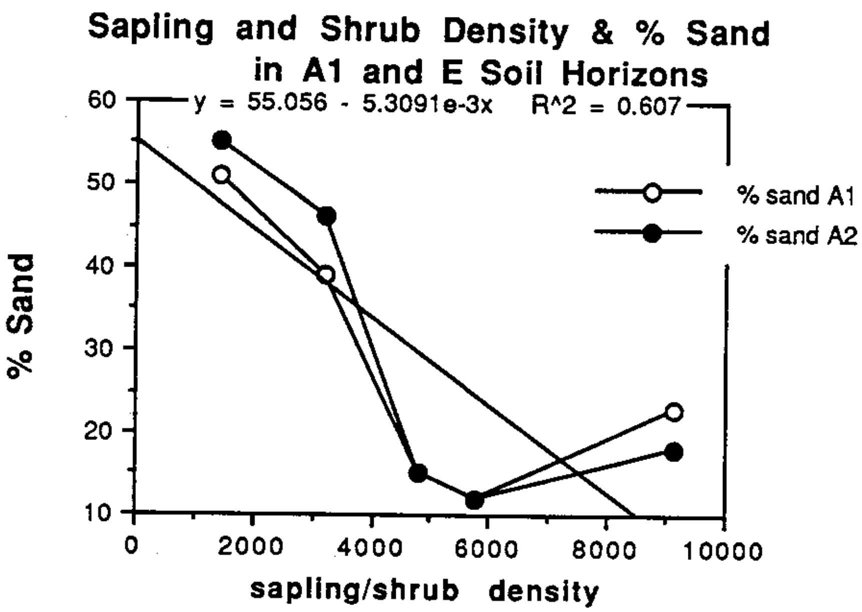


Figure 29



Sapling and Shrub Density & % Sand
in A1 and E Soil Horizons
y = 55.056 - 5.3091e-3x R^2 = 0.607
% sand A1
% sand A2
% Sand
60
50
40
30
20
10
0
2000
4000
6000
8000
10000
sapling/shrub density

Figure 30