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Vegetation Changes in Four Study Areas at Indiana Dunes National Lakeshore

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VEGETATION CHANGES IN FOUR STUDY AREAS AT

INDIANA DUNES NATIONAL LAKESHORE

(TITLE)

BY

Kathryn Ann Kerr

THESIS

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ABSTRACT

The sampling transects at Indiana Dunes were established to show the pre-burn condition of the vetetation and to monitor the long term effects of burning. However, one year of monitoring showed changes in vetetation that further substantiate the need for the burning program.

Miller Woods (Transect A) has burned frequently in recent years. The one year without fire showed little change in the herbaceous layer. The few notable herbaceous changes might indicate a transition to a more mesic community, but should be viewed skeptically because of the wet season in 1982.

Nearly half of the small shrub species at Miller Woods are low blueberries *(Vaccinium angustifolium* and *Vaccinium vacillans)*. Blueberries decrease rapidly in the absence of fire. In one year without fire the blueberries decreased 60,000 stems/ha at Transect A. This dramatic decrease of the dominant meant an over-all decrease of small shrubs even though there was an increase of other species.

Inland Marsh (Transect B) was chosen for its undisturbed condition. There was little change in herbaceous vegetation. An increase of cattails *(Thypha latifolia)* and purple loosestrife *(Lythrum salicaria)* would be expected in a marsh without burning. Significant increases were not shown along the transect in one year, probably because deep water along the transect limits the species. Buttonbush *(Cephalanthus occidentalis)*, the only woody species did increase by about 25% density.

Inland Savanna (Transect C), of the transects sampled showed the least change. The slight herbaceous changes reflect the

increasingly mesic conditions caused by the extending canopy. The slight decline of small shrubs further demonstrates the loss of light to the understory. The shrub species which did increase are commonly found in mesic woods, not sand savannas.

Dune Acres (Transect D) was once so open a savanna that it is variously called Lois Howe prairie, Lupine Lane Prairie, and Dune Acres Prairie. This area shows the greatest effects of fire suppression. There was an increase of woodland and wetland herbaceous species that might have been caused by the wet season, but which was probably caused by increasing shade. There was a corresponding decrease of prairie and dry-savanna species caused not only by the wet season, but also by the increased canopy and duff.

Small shrubs increased 43,000 stems/ha showing the rapid transition of the area. This overall increase encompassed a decline in such prariie or savanna species as low blueberries and black oak *(Quercus velutina)*.

The areas vary in their current need for fire. Miller Woods shows no immdeiate need for fire. Inland Marsh shows no herbaceous imbalance due to fire suppression. Inland Savanna has sufficient canopy that without burning soon it will begin to change rapidly. Dune Acres is now in danger of loosing floristic diversity. If fire does not soon remove shrubs and duff, it could become a dense community of shrubs with few surviving herbaceous species. The savanna species would be greatly reduced and the prairie flora lost.

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INTRODUCTION

Indiana Dunes National Lakeshore is a diverse 4,900-ha (12,000-acre) area at the south end of Lake Michigan. It has many natural communities, ranging from lakeshore and dune communities, to marshes and other wetlands, to savannas, prairies, and forests. These communities have been described and mapped by Wilhelm (1980).

Most of the communities developed with fire as a normal occurrence, and this influenced the frequency and distribution of native species and communities. Fires periodically burned across the Indiana Dunes area for centuries before the land was settled by European immigrants. The fires were started by native Americans and perhaps by lightning; once started, a fire could burn a very large area before being stopped by rain or a natural barrier such as a river or swamp.

Because of the mosiac of wet soil and broken topography at Indiana Dunes, some areas were more protected from fires than others. The protected areas burned less often and were colonized by plants that are sensitive to fire, such as American beech (*Fagus grandifolia*) and red maple (*Acer rubrum*). Other areas support communities that must be maintained by fire, and they have species such as prairie grasses and forbs that can tolerate fire. Many of these fire-tolerant plants actually require fire; in the absence of periodic fires, they cannot withstand competition from other plants and they are killed or fail to reproduce.

European settlers suppressed fires, so wild fires decreased as settlement increased. So many roads and farmsteads were

eventually established that fires were not allowed to spread far. The biggest changes at Indiana Dunes caused by the supression of fires have been a big increase in density of woody vegetation and an expansion of the area occupied by trees and shrubs. Aspen (*Populus tremuloides*) thickets have invaded wet prairies; cottonwoods (*Populus deltoides*) thickets have colonized open dunes; and black oak (*Quercus velutina*) forests have replaced savannas. Along with the increase in woody vegetation has been an expansion of herbs that were once restricted to small, protected, mesophytic enclaves. At the same time, species that require open, sunny areas have suffered from crowding and shading by overstory vegetation and deep accumulations of leaf litter.

The present study was undertaken to determine the present condition of vegetation at four areas at Indiana Dunes and to determine how quickly the vegetation changes in one year in the absence of fire. Baseline data was provided to the Indiana Dunes National Lakeshore so that a burning program might be established. Having data of the areas in pre-burn condition would allow documentation of the changes that would result if a burning program were instituted.

Description of Study Areas

Four study areas were chosen to represent different communities at Indiana Dunes National Lakeshore. Transects were placed in vegetation types whose response to fire needs study. Each transect covers one distinct natural community. Sample areas were where transects would be accessible, referenced to permanent landmarks, and straight. (See Figures 1-3.)

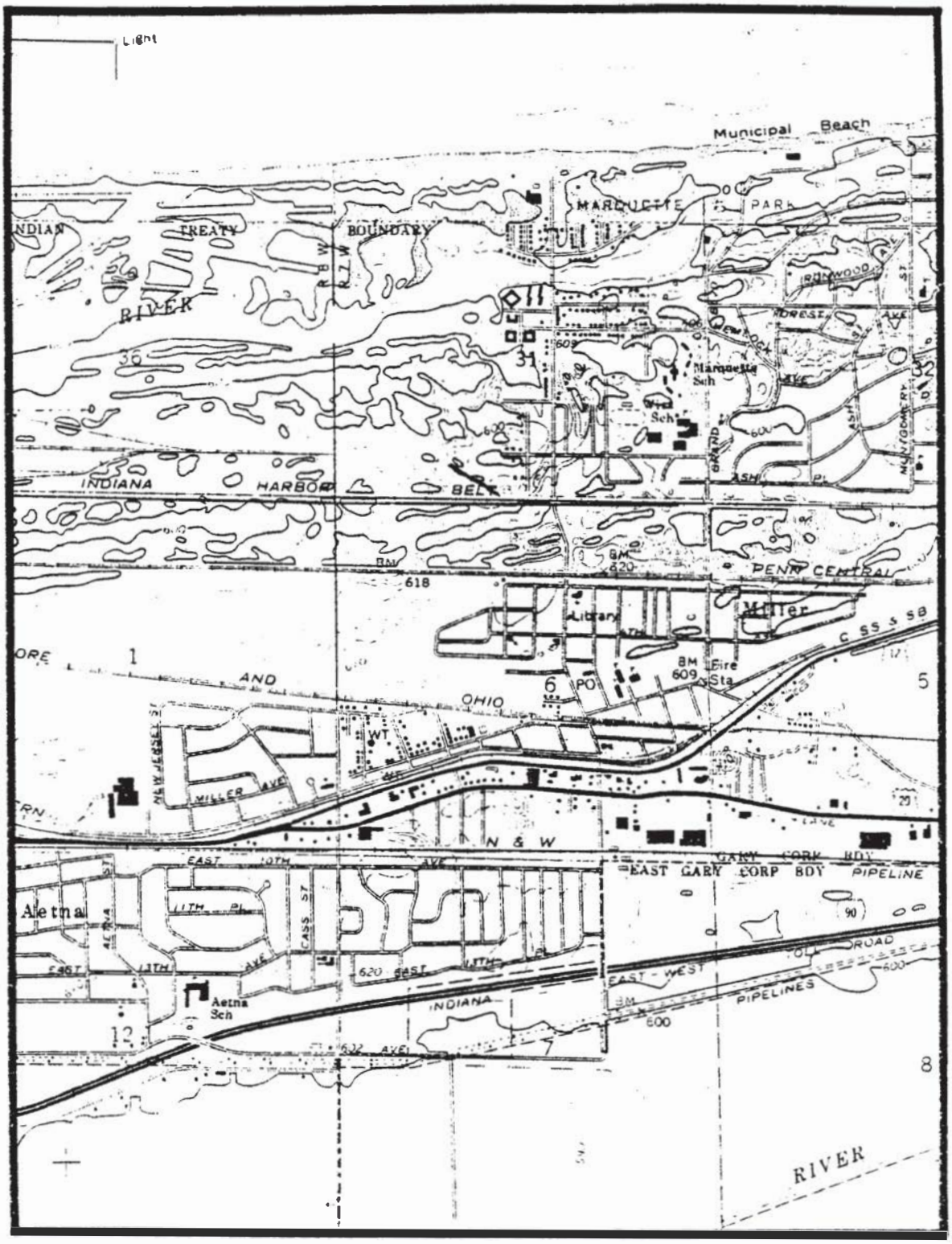


Figure 1. Topographic map of Transect A and vicinity. Gary 7.5' Quadrangle (1:24,000).

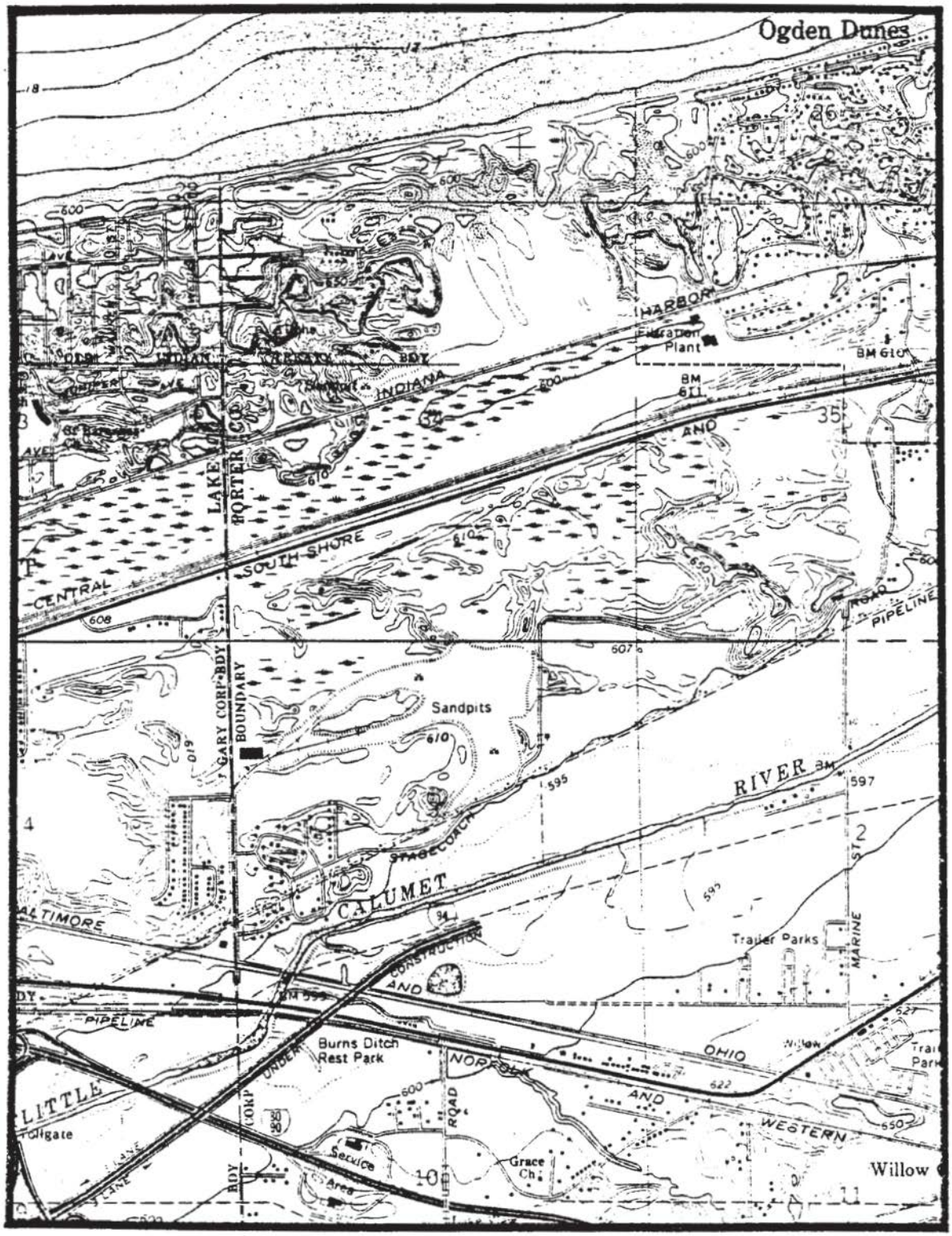


Figure 2. Topographic map of Transects B and C and vicinity. Portage 7.5' Quadrangle (1:24,000).

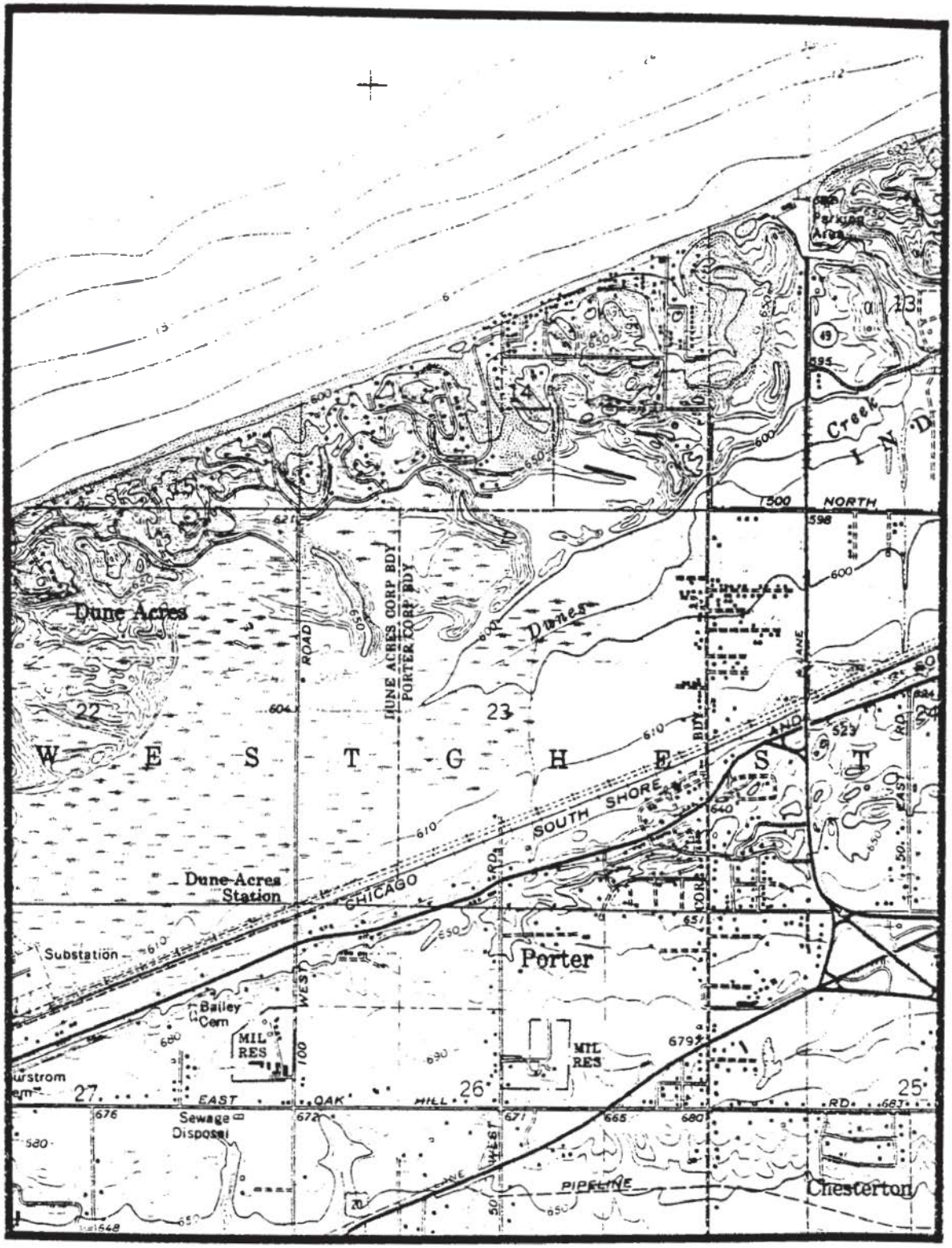


Figure 3. Topographic map of Transect D and vicinity. Dune Acres 7.5' Quadrangle (1:24,000).

Transect A: Miller Woods

Miller Woods was chosen because it is a savanna with a relatively continuous canopy formed by a dense, mature stand of black oaks (*Quercus velutina*). It has burned frequently but has had little unnatural disturbance. The permanent transect was placed in rolling dry-mesic savanna that had burned since the previous growing season.

Transect B: Inland Marsh

Two permanent transects were placed at the former Inland Steel property, Inland Dunes: one in a marsh, the other in a savanna. The northwestern-most marsh at the tract was chosen because it had not burned during the past several years and could be considered in unburned or pre-burned condition. Of the unburned marshes at the tract, it is the least invaded by cattails (*Typha latifolia*) and non-native plants. The transect was placed nearly the entire length of the marsh.

Transect C: Inland Savanna:

A savanna transect at Inland Dunes was placed on a low ridge in the northwestern part of the tract, between a long, narrow marsh and a series of smaller marshes. The ridge is not disturbed by trails and it has not burned for several years. This ridge was also chosen because its topography is more similar to the transect areas at Miller Woods than the higher, more distrubed, recently burned ridges in the rest of the tract. The transect was placed along the ridge to avoid low, wet swales so that the sampling would be in the dry-mesic, black oak savanna community.

Transect D: Dune Acres

Dune Acres is a complex area of open, prairie-like oak savanna and wetland that is being invaded by woody species because of fire suppression. The vegetation sampling transect includes the most open expanse of savanna.

MATERIALS AND METHODS

Summary of Procedures.--In each of the study areas, a transect with 20 permanently marked study points was established. Presence and frequency of herbaceous species were determined at these points during the growing season. Density of woody plants was determined by size class for each species at the end of the growing season. The vegetation study procedures are standard ones, described by authors such as Greig-Smith (1964), Kershaw (1964), and Mueller-Dombois and Ellenberg (1974). Plant nomenclature follows Swink and Wilhelm (1979).

VEGETATION MONITORING

Transects and Sampling Points

Establishment of Transects.--Each permanent vegetation sampling transect is a straight 200 m line that has 20 sampling points. The points are 10 m apart, and the transect extends 5 m beyond the first and last sampling points.

The transects and sampling points were established in the following manner. An azimuth for the transect was selected, and the location of the beginning of the transect was chosen. A stake was set at the beginning of the transect, then the alignment of the

transect was marked on the ground by setting a second stake with the aid of a Brunton Pocket Transit mounted on a tripod at the beginning stake. A plane table and alidade were mounted on a tripod at the beginning stake, then the alidade was aligned with the transect's azimuth by sighting through the alidade. The alidade was checked continually to ensure that it was aligned along the correct azimuth. The interval between sampling points was measured with a fiberglass tape, then the points were permanently marked with steel stakes. By using the alidade's telescope, it was possible to precisely align several sampling points before it was necessary to move the alidade farther down the transect because the view was obscured by brush. The transects were established in early spring, before the leaves had expanded on the understory trees and shrubs; it would have been impossible to sight through some of the thickets later in the season.

The stakes that mark the ends of the transects and sampling points are steel rods, about 1.2 m long and 8 mm in diameter. The lower end of each stake has a broad steel flange ("spade"), which helps anchor it. The stakes are concealed well enough to reduce the likelihood that they would be disturbed, but enough of the stake was exposed to aid in finding them. About 1.5 dm of many of the stakes is above the ground; but as much as 5 dm was left exposed in tall and dense groundcover.

Distribution of sampling points.--Sampling points for herbs, shrubs, and small trees were established 10 m apart along a 200-m transect. Sampling points begin 5 m from each end of the transect to avoid disturbances that are apt to occur around the end of the transect, especially when relocating the transect.

Systematic rather than random placement of plots was used because establishing and refinding randomly distributed permanent sample plots would be very difficult and time-consuming. The most important aspect of future studies is comparing the vegetation from year to year in the same plot. Since the same area will be sampled each time, there is no need to statistically estimate sampling error caused by placement of plots.

Herbaceous vegetation sampling.--The herbaceous vegetation was studied with common ecological measures of presence and frequency. Presence observations consist of compiling a cumulative list of species in the area sampled. Frequency observations list the number of plots in which a species occurs. Percent frequency is the percentage of sample plots in which a species occurs. Relative frequency of a species is computed by dividing the percent frequency for the species by the sum of the (individual) percent frequencies for all species.

These sampling plots are described as herbaceous vegetation plots because they are the source of data on herbaceous plants, but woody plants less than 1.3 m tall in these plots were recorded with herbaceous vegetation on the sampling forms. The small woody plants were sampled with the herbs because they are part of the herbaceous vegetation layer.

To compile a complete species list, sampling must be done often enough to encounter all the species during a phase of their phenology when they can be identified. Frequent sampling would damage the vegetation, though. Two sampling dates plus a later observation of the plots proved adequate. Sampling times were scheduled according to the phenology of the plants. Flowering

of prairie or savanna vegetation has two peaks. One is in late May and early June, associated with increasing photoperiod; the other, in early September, is associated with decreasing photoperiod (Anderson and Adams, 1978).

The areas were sampled for the first time during the first week of June, 1981. At that time, most of the plants had begun to grow and the spring ephemerals were still flowering. Most of the sedges (*Carex*) were identifiable. Many of the plants that bloom in summer, such as grasses and composites were identifiable at least to genus. Herbaceous vegetation was again sampled during the first week of September. Many grasses and composites were flowering. Species such as milkweeds (*Asclepias*) and grasses that had flowered during the summer were identifiable by fruit. Some spring ephemerals had disintegrated; some seedlings from spring had died; and some new seedlings had sprouted. During late September the plots were rechecked and late-flowering plants were identified, but the plots were not sampled at this time.

The 1982 growing season was much wetter. Edaphic conditions were only slightly different at Transect A (Miller Woods) and Transect C (Inland Savanna). The water level was higher, especially in June, at Transect B (Inland Marsh). Transect D (Dune Acres) was noticably wetter, especially in June.

Herbaceous vegetation was sampled on essentially the same dates in 1981 and 1982, but the growing season appeared to have progressed at least two weeks further in June 1982. Plants were often easier to identify in 1982 because they were farther along in their growth. In June 1981 many seedlings were at the

dicotyledonous stage, but in June 1982 most seedlings had elongated enough that some characteristically shaped leaves were seen. Plants were also more easily identified because 1981 sample forms and collections could be referred to. No species were missed by sampling later in the growing season.

The spring sampling time in 1982 seemed ideal. The following blue-flowered spring plants were past their peak but still blooming: wild lupine *(Lupinus perennis)*, common spiderwort *(Tradescantia ohiensis)*, and prairie phlox *(Phlox pilosa)*. The following yellow-flowered plants were at the peak of flowering: hairy puccoon *(Lithospermum croceum)*, Indian paint brush *(Castilleja coccinia)*, and sand coreopsis *(Coreopsis lanceolata)*. False dandelion *(krigia bifiora)* also was in full bloom, but it probably has a long enough blooming period that it is not a good indicator of the best sampling time.

Twenty sampling points were used along each transect because previous sampling of areas similar to Indiana Dunes showed that the number of new species encountered with each succeeding plot begins to decline rather rapidly at about 20 plots. Twenty plots per transect was considered an adequate yet practical sample size. Also, circular plots were used because the shape minimizes the problem of determining whether a plant at the edge of the plot is actually in the plot. Circular plots are also practical because they can be easily delimited by rotating a cord around the stake marking a plot.

Two sizes of plots were used to sample herbs at each sampling point: a 0.05-sq-m plot within a 1-sq-m plot. The larger plot was

placed around the smaller plot so that each plot had the same center, the stake marking the sample point. The 0.05-sq-m plots are intended to be small enough to be especially sensitive to some changes in species composition, particularly reduction of weedy species. Future decreases in frequency of species might be more likely to be observed in an 0.05-sq-m plot than in a much larger plot. However, a 0.05-sq-m plot encompasses such a small area that many common species might be excluded from the sample by chance, so 1-sq-m plots were also used. The larger plots provide a better record of the species diversity of the stands, and they should be more sensitive to post-fire increases in diversity because the larger area provides a greater chance that newly established species will be included in the plots.

At the time of sampling, the ends of the transect were marked with flags. An investigator then walked parallel to (but not on) the transect to avoid trampling the vegetation. Each stake was marked with a flag. If a stake was not readily found, a tape was used to measure 10 m from the nearest stake.

Two investigators proved most efficient. At each sampling point, one person rotated the plot radius cord around the stake and identified the plants in the 0.05-sq-m plot. The other person entered each species' name on the sampling form (Figure 1) and recorded the presence of each species in each plot with an "X". (For efficient use of field time, the names of common species, plot numers, name of area, etc. often were entered on the form prior to sampling.)

After plants in the smaller plot had been identified, the 1-sq-m plot was sampled in the same way. The species that occurred in the larger plot but not in the smaller plot were marked with a "/", or half an "X". (All species occurring within the small plot would occur within the larger plot.) One cord with the two radii marked on it was used to delimit each plot. (The radius for the 0.05-sq-m plot is 12.5 cm; for the 1-sq-m plot, 56.4 cm.) Dead stems were not recorded. (See Figure 4.)

Woody vegetation sampling.--Trees and shrubs were sampled at the end of the growing season so that the measurements were of the maximum stem size attained during the year. The density (stems per hectare) of each species was determined by counting live stems in sample plots. The stems were tallied according to size classes. Different sized plots were used to sample the following stem size classes: less than 1.3 m tall (breast height); 1.3 m tall or taller and 0-10 cm in diameter at 1.3 m (dbh); and greater than 10 cm dbh.

Woody stems in the smallest size class (<1.3 m tall) were counted in 20 1-sq-m plots in each transect, the same plots used for herbaceous vegetation. The plots were defined by rotating a 56.4-cm cord around the plot stake. At each plot a steel pin was placed at a point on the circumference of the plot, and the cord was rotated around the center stake. Each stem was counted as it was crossed by the cord until the cord made a full circle, returning to the pin. Each woody stem was counted if its base emerged from the ground in the plot. For decumbent canes or vines, each rooted segment (between major nodes with roots) was counted. A plant was not counted if it crossed through the plot but was not rooted in the plot. Again, one investigator counted stems while the other recorded data (Figure 5).

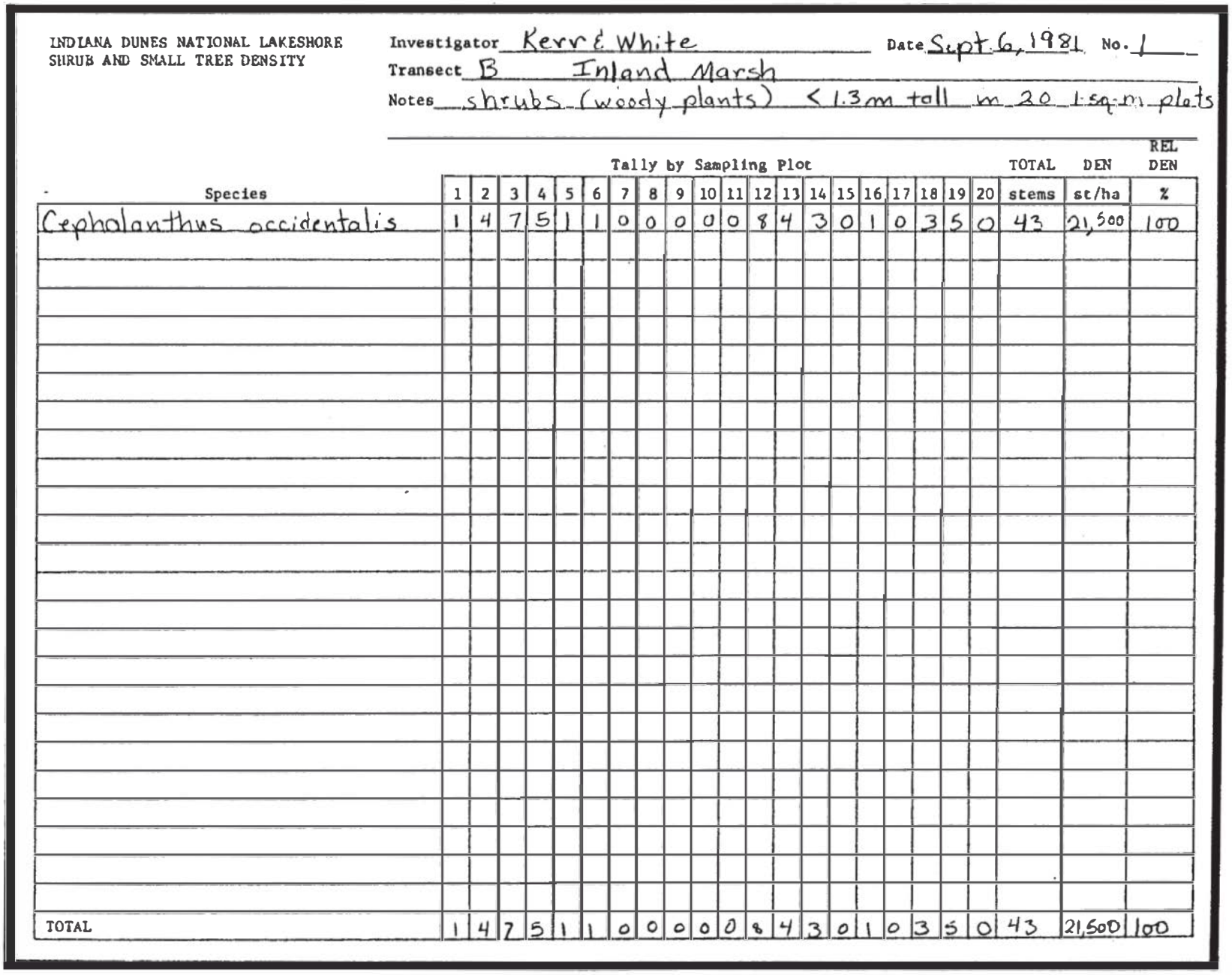
FREQUENCY SAMPLING Date Sept 6, 1981 Page 1 of 1

Area (location) IPNLS - Inland Marsh - Transect B Surveyor Kerr & White

Plot size 0.05/1m² Notes / = in large plot only; X = in both 1m plots.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOT
Scirpus validus			/						X	X	X	X	X		/	/	X	X	X	X	9/12
Calamagrostis canadensis	/	X	/	X	/	X	X	X	/	/	X	X	/		/	/	X	X	X	X	11/19
Potamogeton (illinoensis?)								/	/		/		X		/	X	X	/	X	/	4/10
Polygonum amphibium	/		X	X	/	X	/			X			/						X	/	5/10
Sagittaria latifolia					/											/	X		/		1/4
Dryopteris thelypteris																		/	/		0/2
Cephalanthus occident	X	/	/	X	/	/						/	/	/		/		/	/		2/8
Dulichium arundinaceum		/	/			X						X	X			/		/			3/7
Eleocharis (palustris?)								X	X		X				X	/					4/5
Carex lasiocarpa														X							1/1
Proserpinaca palustris		/		/		X	X	/		/	/										2/7
Cladium mariscoides										X											1/1
Typha latifolia	/				/	/	/														0/4
Lythrum salicaria	X			/	X	/	/														2/5
Juncus canadensis		X				/															1/2
Scirpus cyperinus			X																		1/1
Lycopus uniflorus		X																			1/1

Figure 4. Sampling form for frequency in herbaceous vegetation plots.



INDIANA DUNES NATIONAL LAKESHORE
SHRUB AND SMALL TREE DENSITY

Investigator Kerr & White Date Sept. 6, 1981 No. 1

Transect B Inland Marsh

Notes shrubs (woody plants) < 1.3m tall in 20 1 sq. m plots

Species	Tally by Sampling Plot																				TOTAL	DEN	REL DEN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	stems	st/ha	%
Cephalanthus occidentalis	1	4	7	5	1	1	0	0	0	0	0	8	4	3	0	1	0	3	5	0	43	21,500	100
TOTAL	1	4	7	5	1	1	0	0	0	0	0	8	4	3	0	1	0	3	5	0	43	21,500	100

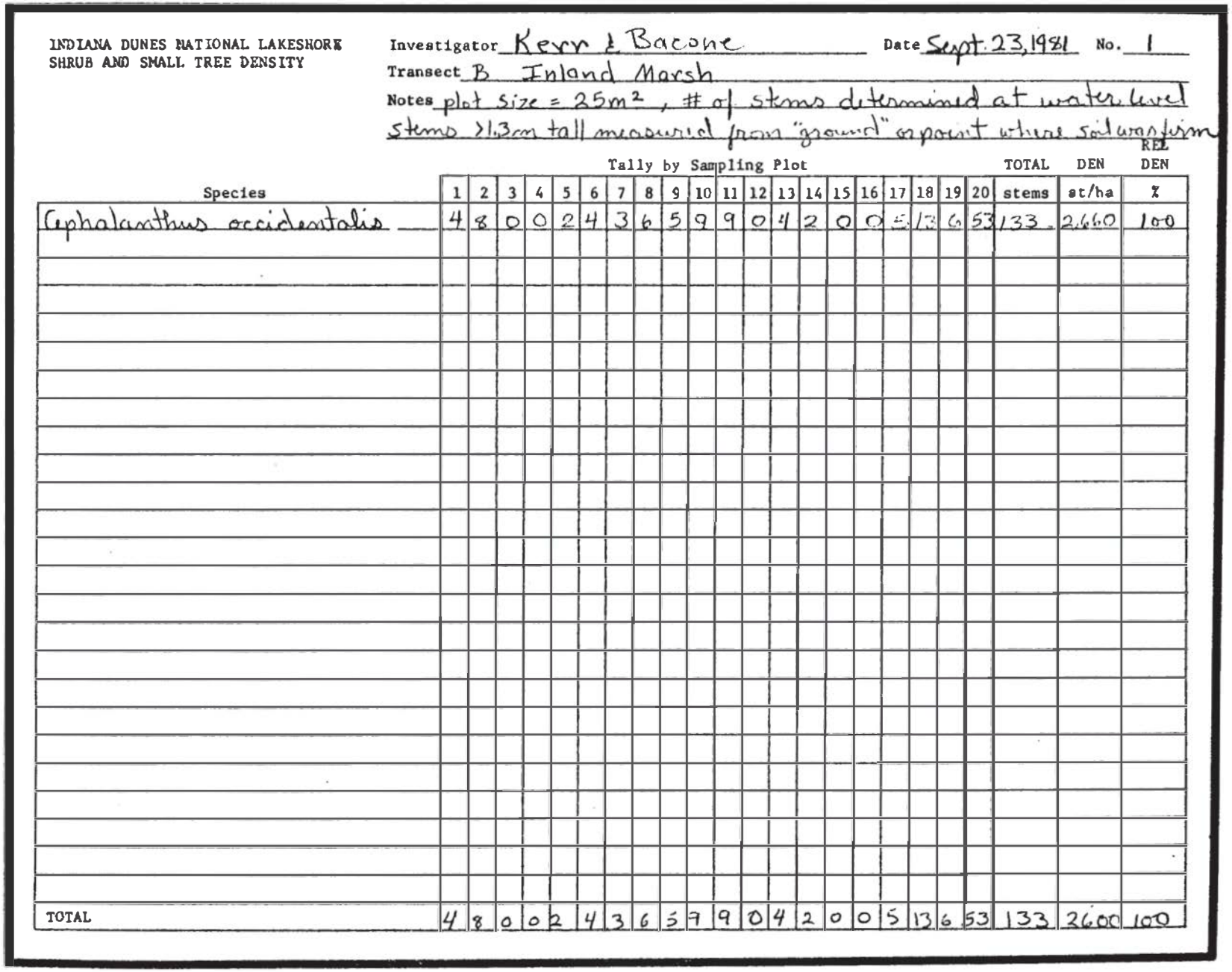
Figure 5. Sampling form for density in low shrub plots.

Woody plants that were 1.3 m or taller and up to 10 cm dbh were sampled in twenty 25-sq-m plots in each transect. The plot centers were the same as for herbaceous vegetation and woody stems less than 1.3 m tall. The 25-sq-m plots were defined by rotating a 2.82-m fiberglass tape around the center stake. Stems were tallied in four size classes (Figure 6): 0 - 2.5 cm dbh, >2.5 - 5.0 cm dbh, >5.0 - 7.5 cm dbh, and >7.5 - 10.0 cm dbh.

A stem was tallied if it was at least 1.3 m tall. An inclined stem was not pulled upright before it was measured, and the stem's vertical height, not its inclined length, was measured to determine whether it was 1.3 m tall.

Shrubs and oak sprouts often divide near the base and form several ascending stems. If a group of stems was joined near the base--but above the ground--then only the stem with the largest dbh was tallied. The other stems were not counted, even if they rose above 1.3 m, because they were considered branches of the largest stem. To be tallied, a stem had to be completely surrounded by soil, not attached to another stem, where it emerged from the ground. If a sprout or shrub divided into several stems above the ground, only the largest stem was counted.

The diameter of each tallied stem was measured with a diameter gauge at breast height (1.3 m) vertically above the base. If a stem was inclined, the diameter was measured at the point where its axis was 1.3 m above a horizontal plane extended through the base. Diameter was not measured horizontally, but was measured perpendicular to the stem axis.



INDIANA DUNES NATIONAL LAKESHORE
SHRUB AND SMALL TREE DENSITY

Investigator Kerr & Bacone Date Sept. 23, 1981 No. 1

Transect B Inland Marsh

Notes plot size = 25m², # of stems determined at water level
stems >1.3m tall measured from "ground" or point where soil was firm

Species	Tally by Sampling Plot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL stems	DEN st/ha	REL DEN %
Cephalanthus occidentalis	4	8	0	0	2	4	3	6	5	9	9	0	4	2	0	0	5	13	6	53	133	2,660	100
TOTAL	4	8	0	0	2	4	3	6	5	9	9	0	4	2	0	0	5	13	6	53	133	2600	100

Figure 6. Sampling form for density in tall shrub and small tree plots.

Trees larger than 10 cm dbh were sampled in a 0.4-ha plot at each transect. This sampling plot extended the length of the transect and 10 m on either side, so it was 200 m long and 20 m wide. Trees were tallied by species in diameter classes with 10-cm ranges (that is, >10 cm to 20 cm, >20 cm to 30 cm, etc.). If a tree forked below 1.3 m, it was counted and measured as more than one tree.

To ensure that all trees were sampled, the area was divided into 21 segments. From the end of the transect to the stake marking the first sampling point and 10 m on either side of this line was the first segment. The second segment was from the stake at the first sampling point to the stake at the second sampling point and 10 m on either side of that line. (Note that the first and last segments are 5 m X 20 m, but all other segments are 10 m X 20 m.)

One investigator stood on the transect with the tape and compass and recorded the data (Figure 7). The other person measured the diameter of all trees within the segment. The number of trees was recorded by species and size class on the field survey form.

In 1982 only the smallest size class of woody species was resampled. Trees larger than 10 cm dbh would not have changed measurably during one growing season and large shrubs would not have changed significantly.

RESULTS AND DISCUSSION

Tables 1-27 summarize data from the vegetation sampling plots. For each area there are frequency tables (alphabetical and numerical) and tables for the three size classes of woody vegetation. Tables are at the end of this section.

INDIANA DUNES NATIONAL LAKESHORE
TREE DENSITY

Investigator Kerr & Bacone Date Sept. 23, 1981 No. 1

Transect D - Dune Acres

Notes all trees ≥10 cm dbh (1.3 m), line in column shows that the segment was checked but there were no trees.

Species & Size Class	Tally by Transect Interval																					TOTAL	DEN	REL DEN
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	stems	at/ha	%
Quercus velutina <20 cm dbh	|	|	|	|	|	|	|	•	•	•	|	•	•	••	•		|		|	•	•	11	27.5	55
" " <30 " "	|	|	|	|	|	|	|	•							•		|		|			2	5.0	10
" " <40 " "	|	|	|	|	|	|	|					•		•			/	•	|			3	7.5	15
" " <50 " "	|	|	|	|	|	|	|		•			•					|		|			2	5.0	10
" " <60 " "	|	|	|	|	|	|	|										|		|			0	—	—
" " <70 " "	|	|	|	|	|	|	|				•							|					1	2.5	5
Prunus serotina <20 " "	|	|	|	|	|	|	|							•			|		|			1	2.5	5
TOTAL	0	0	0	0	0	0	0	2	3	1	0	3	2	2	3	1	0	1	0	1	1	20	50.0	100.0

Figure 7. Sampling form for density in tree plots.

Description of Herbaceous Vegetation Layer (1981)

Transect A: Miller Woods.--Pennsylvania sedge *(Carex pensylvanica)* is by far the commonest graminoid in this transect. The most frequent grasses are two non-native bluegrasses *(Poa pratensis* and *Poa compressa)* and two native panic grasses *(Panicum implicatum* and *Panicum oligosanthes* var. *scribnerianum)*. Several forbs are especially frequent: prairie phlox *(Phlox pilosa)*, woodland sunflower *(Helianthus divaricatus)*, starry false Solomon's seal *(Smilacina stellata)*, Canada mayflower *(Maianthemum canadense)*, and common spiderwort *(Tradescantia ohiensis)*. Creeping or clonal shrubby species such as poison ivy (*Rhus radicans*), pasture rose *(Rosa carolina)*, and low blueberries *(Vaccinium angustifolium* and *Vaccinium vacillans)* are very common. Black oak *(Quercus velutina)* represented by seedlings and small sprouts, is one of the most frequent species in the low vegetation layer (see Tables 1-4).

Transect B: Inland Marsh.--Blue-joint grass (*Calamagrostis canadensis)* is the most common plant encountered in Inland Marsh, the only species to occur with 100% frequency in any transect in 1981. Other species that might be considered dominant are buttonbush *(Cephalanthus occidentalis)* and great bulrush *(Scirpus validus)*. Broad-leaved cattail *(Typha latafolia)* and purple loosestrife *(Lythrum salicaria)* are also locally dominant in the marsh, though they are not especially frequent in the sampling plots. Several other species have high frequencies in the plots but cannot be considered dominants because the plants are small. Included in this group are water smartweed *(Polygonum amphibium)* and three-way sedge *(Dulichium arundinaceum)*(see Tables 5-8).

Transect C: Inland Savanna.--The herbaceous and small woody vegetation of this transect is quite similar to that of Transect A. Five of the six species with the highest average frequencies (average of June and September data) are the same in both transects: pasture rose, woodland sunflower, Kentucky bluegrass *(Poa pratensis)*, Pennsylvania sedge, and starry false Solomon's seal. Among the other commonest herbs at Inland Savanna are flowering spurge *(Euphorbia corolata)*, prairie coreopsis *(Coreopsis palmata)*, and flax-leaved aster *(Aster linariifolius)*. In addition to the ubiquitous pasture rose, the low blueberries (both species combined) and black oak have plot frequencies of 40% or greater at Inland Savanna (see Tables 9-12).

Transect D: Dune Acres.--This area has the most diverse vegetation, with the largest species list (about 70 species within the plots). Though the transect is in a savanna, the site is relatively mesic and it has fairly large treeless areas, so it has several grasses and forbs that are characteristic of mesic prairie. Among these plants are Indian grass *(Sorghastrum nutans)*, big bluestem *(Andropogon gerardi)*, switch grass *(Panicum virgatum)*, rattlesnake master *(Eryngium yuccifolium)*, white wild indigo *(Baptisia leucantha)*, and three species of blazing star *(Liatris spicata, Liatris cylindracea*, and *Liatris aspera)*. Soapwort gentian *(Gentiana saponaria)*, blue flag *(Iris virginica* var. *shrevei)*, and meadowsweet *(Spiraea alba)* are indicative of the small, wet depressions along the transect (see Tables 13-16).

Description and Analysis of Woody Vegetation (1981)

Transect A: Miller Woods.--Low blueberries *(Vaccinium angustifolium* and *Vaccinium vacillans)* are the commonest small shrubs (46% relative

density for the two species combined), but pasture rose *(Rosa carolina)* is the commonest species (30% relative density). Six other shrubs have a relative density of 10% or less (see Table 17).

Miller Woods has burned often for many years, so it has few tall shrubs and small trees. Wild black cherry *(Prunus serotina)* and black oak *(Quercus velutina)*, the only species in the tall shrub and small tree sample, have the same density. The population is so small (only six stems occurred in the plots) that the 25-sq-m plots proved inadequate, but a larger sample may have produced similar estimates of density and relative density (see Table 18).

Frequent fires have eliminated all but the most fire-resistant trees from most of Miller Woods. White oaks *(Quercus alba)* account for about 3% of the relative density of trees in Transect A. All other trees in the sample are black oaks. Black oaks in the 20-30 cm dbh size class are the commonest trees at Miller Woods at 55% relative density (see Table 19).

The structure of woody vegetation at Miller Woods has been largely determined by fire, and it would not be altered dramatically by prescribed burning. If burning continues at its current high frequency, the canopy will gradually become more open as older trees die and sprouts and seedlings are kept small. Suppression of fire would cause rapid changes in the vegetation's composition and structure.

Transect B: Inland Marsh.--The only woody species in the sampled area at Inland Marsh is buttonbush *(Cephalanthus occidentalis)*. Future fires will not alter the species composition and will probably have little long-term effect on shrub density. Frequent fires might

greatly reduce the number of stems taller than breast height. Fire suppression would allow buttonbush to increase in size and density, but probably no other shrubs would become established along the transect because the water is too deep (see Tables 20 and 21).

Transect C: Inland Savanna.--Pasture rose is the commonest small shrub at Inland Savanna (46% relative density). The blueberries are the next commonest (37% relative density). Eight other species occur, each with less than 10% relative density (see Table 22).

The transect has not burned for several years, so there are many tall shrubs and small trees (4,580 stems/ha); most (nearly 85%) are black oak. Infrequent fire has allowed the invasion and growth of sassafras *(Sassafras albidum)*, Allegheny shadblow, *(Amelanchier laevis)*, and sumacs *(Rhus* spp.*)*. The combined relative density of these species (13%) is small compared to black oak, but the absolute density (680 stems/ha) is not small. The sample is not completely accurate because staghorn sumac *(Rhus typhina)* and perhaps other species were removed from two sample plots when shrubs were cut to clear a transect for another biologist's woody plant study (see Table 23).

All trees in the sample area at Inland Savanna are black oak. Most are 30-40 cm dbh (37% relative density), and the largest are 60-70 cm dbh. Infrequent fires probably would not significantly alter the tree composition or density at Inland Savanna. Frequent burning would reduce the density in the larger size classes because older trees would be reduced and few younger trees would replace them. Suppression of fire would increase tree density and diversity (see Table 24).

Transect D: Dune Acres.--The open tree canopy, variety of soil-moisture conditions, and suppression of fire have produced a diverse population of small woody plants at Dune Acres. Swamp dewberry *(Rubus hispidus)* has the highest relative density (56%) among small shrubs in the sample area. Though it occurs in few plots, the dewberry's decumbent canes root at every node and produce many stems in a small area. Prairie willow (*Salix humilis)* is second in density (16% relative density). Ten other small shrubs occur in the sample area, each with less than 10% relative density (see Table 25).

Black oak is the commonest large shrub (sprout) or small tree at Dune Acres (67% relative density), but there are also many quaking aspens *(Populus tremuloides)* (17 % relative density) and wild black cherries (14% relative density). Sassafras also occurs in the sample plots (see Table 26).

Fire has been suppressed at Dune Acres for so long that dense, vigorous stands of oaks and aspens have invaded beneath and between the scattered older black oaks. Even though the transect is in some of the most open parts of the savanna at Dune Acres, the density of tall shrubs and trees is 2,050 stems/ha. An even better indication of the change in vegetation structure during the past decades is that 60% of the tree stems (stems greater than 10 cm dbh) are in the 10-20 cm size class, a very large percentage for a savanna. Even fire-sensitive wild black cherry exceeds 10 cm dbh in the transect. This trend toward more, larger, fire-sensitive woody plants will continue unless the area is burned more frequently. If fire is reintroduced, the most fire-sensitive

species will be reduced, but many of the oak and aspen thickets are so large and dense that fire might no longer be an effective control (see Table 27).

Some responses to fire may be seen by comparing the woody vegetation density of the three savannas (Tables 17-27) the more recently the area has burned, the greater the density of the smallest size class of woody plants. Miller Woods, which burns most frequently, has 432,000 stems/ha. Inland Savanna, which burned about 1973-1975, has 255,000 stems/ha. Dune Acres, which has not burned for many years has only 133,500 stems/ha. Prescribed burning might increase the small shrub density at Inland Savanna and Dune Acres. Low blueberries are especially likely to increase.

The results for large shrubs and small trees are not the same as for small shrubs. Miller Woods, because of frequent burning, has very few large shrubs; but Inland Savanna, more recently burned than Dune Acres, has the greatest density. This density is because many stems at Inland Savanna are coppice black oak sprouts. If the area does not burn, many of these will die and one or a few stems in each clump might become trees. Frequent fires might, over a long period, reduce the size and density of black oak sprouts at Inland Savanna. The relatively few large shrubs of other species will be more drastically reduced, increasing black oak's relative density. A smaller percentage of the large shrubs at Dune Acres are black oak, and fire would cause a greater change in the composition of that area by reducing the number of large shrubs, especially the fire-sensitive species that have invaded since burning stopped.

In all savannas the tree composition is nearly all black oak, though the density is much greater at Miller Woods (195 stems/ha) than at Inland Savanna (67.5 stems/ha) or Dune Acres (50 stems/ha). Frequent burning for a long period would gradually reduce the density of trees. No burning will eventually increase the density and diversity of tree species, but occasional burning would have little effect on this size category.

Herbaceous Vegetation Changes (1982)

Transect A: Miller Woods.-- Though portions of Miller Woods burn each year, the portion including Transect A escaped burning during the 1981-1982 season.

The only plants not seen in the June 1982 sampling at Transect A that were noted the preceeding June were unidentifiable seedlings. There was no decrease of more than 10% frequency of any plant species (Table 1).

New plants in the June 1982 sampling at Transect A were sand cress *(Arabis lyrata)*, grape fern *(Botrychium* sp. seedling), panic grasses *(Panicum depauperatum(?)*, and *Panicum* sp.), and an unidentified herb. Sand cress persisted until September, but the grape fern did not. Several panic grasses were present in the fall, including *Panicum (depauperatum?)*. Compositae seedlings were present in June of each year, but were either identifiable or gone by fall.

Plants which increased more than 10% in frequency were sky-blue aster *(Aster azureus)*, and starry false Solomon's seal *(Smilacina stellata)* in the 1-square-meter plots and horse mint *(Monarda punctata)*, Kentucky bluegrass *(Poa pratensis)*, and starry

false Solomon's seal in the 0.05-square-meter plots. Since none of these plants showed an increase in the September sampling, the June increase in frequency is probably due to the advanced growing season of 1982.

In the September 1982 sampling at Miller Woods, June grass *(Koeleria cristata)* and a black-eyed Susan *(Rudbeckia* sp.) which had occurred the previous year, were not present. June grass occurred in only one plot in September 1981, so its absence in 1982 probably reflects its low population rather than any change in population. The sterile black-eyed Susan would not be expected to persist (Table 3).

Plants which showed a decrease of greater than 10% frequency in September 1982 were common rockrose *(Helianthemum canadensae)* and common spiderwort *(Tradescantia ohiensis)* in the 1-square-meter plots and false toadflax *(Comandra richardsiana)*, Kentucky bluegrass, and poison ivy *(Rhus radicans)* in the 0.05-square-meter plots. Since both common rockrose and common spiderwort are common in disturbed sandy areas and sand prairie, their reduction might be indicative of an increasing canopy and the continuing protection of Miller Woods. Common spiderwort disintegrates early in the year, however, and a fall decrease should be viewed skeptically, especially since there was no June decrease. The decrease of false toadflax, Kentucky bluegrass, and poison ivy could also be the result of continuing lack of disturbance. The decrease of poison ivy, as shown by the frequency sampling, is probably inaccurate, because the density sampling for low woody plants shows an increase.

New plants at Miller Woods in September 1982 included little bluestem *(Andropogon scoparius)*, blue lettuce *(Lactuca floridana)*, switch grass *(Panicum virgatum)*, field sorrel *(Rumex acetoxella)*, and seedlings of *Muhlenbergia* and wild grape *(Vitis* sp.*)*, and unidentified dicot.

Plants which increased more than 10% in the 1-square-meter plots were marsh aster *(Aster simplex* var. *interior)*, wild strawberry *(Fragaria virginiana)*, Pennsylvania sedge *(Carex penslyvanica)*, wild lupine *(Lupinus perennis)*, smooth Solomon's seal *(Polygonatum canaliculatum)*, black oak *(Quercus velutina)*, blue-stemmed goldenrod *(Solidago caesia)*, early low blueberry *(Vaccinium angustifolium)*, and blue lettuce *(Lactuca floridana)*. Plants which increased more than 10% in the 0.05-square-meter plots were Pennsylvania sedge and Canada mayflower *(Maianthemum canadensae)*.

The increase of Pennsylvania sedge in both size plots is possibly attributable to the increased ability of the samplers to recognise the species since the increase parallels a decline in unidentified Cyperacae and Graminae seedlings. The moist season could have increased the population as could an increasing canopy causing more mesic conditions. Since marsh aster prefers a more moist environment (Swink and Wilhelm, 1979) than most of Transect A, the wet season probably affected its increase. Wild strawberry, wild lupine, smooth Solomon's seal, black oak, and blue-stemmed goldenrod are so common in a variety of habitats in the Dunes areas that their increase probably reflects only a good growing season or the continuing protection of Miller Woods. The increase of blue lettuce, considering its usual mesic associates and usual

woodland-border habitat (Swink and Wilhelm, 1979) indicates a change toward a more mesic environment, probably due to increasing canopy; perhaps due to the moist season. The increase in early low blueberry with the lack of fire the preceeding year is surprising and may be inaccurate, as shown by the sampling of density of low woody plants. The increase of Canada mayflower may indicate more mesic conditions, or simply, its contagious distribution.

Transect B: Inland Marsh.--At Transect B all plants which occurred in plots in 1981 occurred again in 1982. Few or no new plants appeared. In the June 1982 samples, a bulrush *(Scirpus* sp.) appeared not identifiable as *Scirpus validus* or *Scirpus cyperinus*, both noted in 1981. In September of that year, all bulrushes were identified as either wool grass *(Scirpus cyperinus)* or great bulrush *(Scirpus validus)*. The unidentified bulrush occured in plots with great bulrush and can be assumed to be *Scirpus validus*. (Table 5).

The June 1982 sampling indicated an increase greater than 10% frequency of bulrushes *(Scirpus validus* and *Scirpus* sp., now assumed to be *Scirpus validus)*. Since the September sampling did not show this increase, the June increase might be attributed to the unusually warm, wet spring.

Plants decreasing more than 10% frequency between June 1981 and June 1982 were blue-joint grass *(Calamagrostis canadensis)*, spike rush *(Eleocharis palustris)*, purple loosestrife *(Lythrum salicaria)*, Illinois pondweed *(Potamogeton illinoensis)*, and mermaid weed *(Proserpinaca palustris)*. The decrease may be attrbuted to high water, because none of these species showed a

decrease in September. Mermaid weed had, in fact, increased more than 10% in frequency by September (Table 7).

In the Sept. 1982 sampling, three new plants were listed: a spike rush *(Eleocharis* sp.*)*, a panic grass *(Panicum* sp.*)* and a dicot seedling. The spike rush may have been *Eleocharis palustris* but was not identifiable. Panic grass was an addition to the list of plants at Inland Marsh, however, this sterile plant found in September might not have set seed. The dicot seedling may not have been a new species and probably did not mature or persist. The three new species listed are not significant changes in the vegetation.

Plants which showed an increase of greater than 10% frequency in September, besides mermaid weed, were three-way-sedge *(Dulichium arundinaceum)* and common arrowhead *(Sagittaria latifolia)*. The increases are probably due to the abundant moisture. Only water knotweed *(Polygonum amphibium)* showed a decrease of greater than 10% frequency in September, and that only in the 0.05-square-meter plots.

Transect C: Inland Savanna.--Several changes in the vegetation were noted between 1981 and 1982 at Inland Savanna. Many of the apparent changes might be identification problems. (See Appendix 1.)

New plants noted in June 1982 were sand cress *(Arabis lyrata)*, sand coreopsis *(Coreopsis lanceolata)*, round-headed bush clover *(Lespedeza capitata)*, clammy ground cherry *(Physalis heterophylla)*,

Indian grass *(Sorghastrum nutans)*, porcupine grass *(Stipa spartea)*, late low blueberry *(Vaccinium vacillans)*, and seedlings of Graminae Leguminosae, and Monocot (Table 9).

Sandcress, a common annual in disturbed sandy soil, may have been the "crudiferae seedling" noted in 1981. Sand coreopsis, round-headed bush clover, Indian grass, and porcupine grass are all species which would be expected in a sand savanna. Their appearence probably indicates good growing conditions and the continuing protection of the area.

It seems that the identification of clammy ground cherry was a mistake. Clammy ground cherry might be confused with black nightshade *(Solanum americanum)* in immature stages. Both plants grow on disturbed sandy soil and the difference is probably of no ecological significance. However, Clammy ground cherry was identified only in plot 19, only in June 1982. Black nightshade was in plots 17, 18, 19, and 20 in June 1981; plots 17 and 20 of September 1981 and a "Solanum seedling" in plot 13. Although black nightshade was not named in June 1982, "Solanaceae seedlings" were found in plots 5, 11, 12, 16, 18, 19, and 20. In September 1982, black nightshade was in plots 12, 16, 17, 19, and 20. Probably the clammy ground cherry should be called black nightshade.

Identification of low blueberries proved especially confusing at Inland Savanna. In June 1981, both species were identified in the field and collections were made. After comparing the specimens with herbarium material, all plants were called early low blueberry *(Vaccinium angustifolium)*. In September 1981, all blueberries were

called early low blueberries. In June of 1982 late low blueberry *(Vaccinium vacillans)* was identified in the field. In September of that year all blueberries were called early low blueberry in both the herbaceous sampling and the low woody plant density sampling. Probably the blueberries are most confusing early in the growing season and are more characteristic when growth is complete. It now seems correct to assume that all blueberries in the sampling plots at Transect C are early low blueberries.

Plants which showed an increase of greater than 10% frequency in the June sampling were flax-leaved aster *(Aster linariifolius)*, common rockrose *(Helianthemum canadensae)*, starry false Solomon's seal *(Smilacina stellata)*, *Solanum* seedlings, goat's rue *(Tephrosia virginiana)*, common spiderwort *(Tradescantia ohiensis)*, porcupine grass *(Stipa spartea(?))*, and late low blueberry *(Vaccinium vacillans)* in the 1-square-meter plots and woodland sunflower *(Helianthus divaricatus)* and Kentucky bluegrass *(Poa praetensis)* in the 0.05-square-meter plots.

The increase of flax-leaved aster is inaccurate, the result of confusing that species with marsh phlox *(Phlox glabberima)* in June of 1981. Identification of both species at later dates can be assumed to be accurate (see Appendix I) The increase of common rockrose, starry false Solomon's seal, goat's rue, and common spiderwort are similiar to the increases seen at Miller Woods. Since the inceases were not apparent in September and the plants are widely distributed in habitat, the changes probably reflect the advanced growing season.

The increase of porcupine grass reflects better identification skills during the second year and more advanced phenology of grasses in June 1982. Some plants called blue-joint grass *(Calamovilfa longifolia)* in June 1981 were later called porcupine grass. The increases of *Solanum* seedlings is probably accurate, a result of the growing conditions, aside from the identification problems discussed above. The apparent increase of late low blueberries is incorrect (see above discussion).

The increase of woodland sunflower and Kentucky bluegrass in the small plots may indicate increasing mesic conditions, but the increases were not seen in September and may be climatic response.

Plants absent in June 1982, seen the previous year, were seedlings identified as Cruciferae, dicot, Graminae, and *Viola(?)*; black nightshade; sunflower *(Helianthus* sp. sterile*)*; panic grass *(Panicum* sp. and *Panicum oligosanthes* var. *scribnerianum)*; wild black cherry *(Prunus serotina)*; and poison ivy *(Rhus radicans)*.

The herbaceous changes are largely or entirely due to better identification the second year. The June absence of wild black cherry and poison ivy in the sampling plots shows that each year there are new seedlings which do not survive. In June 1981 there was one seedling of each species. In June 1982 both were gone.

Plants showing a decrease in June 1982 were western sunflower *(Helianthus occidentalis)*, marsh phlox, and early low blueberry in the 1-square-meter plots and pasture rose and porcupine grass in the 0.05-square-meter plots. As shown above, the changes in marsh phlox, early low blueberry and porcupine grass are errors. The

decrease of western sunflower with the increase of woodland sunflower might lead to question of identification. However, woodland sunflower is one of the commonest plants, occurring in almost every large plot, so the two sunflowers were usually identified in the same plot. Furthermore, the difference in leaf shape, color, and texture is apparent; the woodland sunflower leaves being more sessile, more broadly rounded, paler beneath, and more flexible than the western sunflower. As the savanna continues to close, the change from western sunflower, a prairie species, to woodland sunflower should continue. The decrease of pasture rose was not noted in September. Though it may be declining because of increasing canopy, the change is probably not significant on an annual basis.

New species noted at Inland Savanna in September 1982 were common ragweed *(Ambrosia artimisiifolia)*, panic grass *(Panicum implicatum)*, and switch grass *(Panicum virgatum)* (Table 11). Ragweed could be expected in any disturbed area in the savanna and the *Panicum* species are probably the result of better identification and advanced phenology, rather than any environmental changes.

Plants showing an increase in the September sampling were false toadflax *(Comandra richardsiana)*, bush clover *(Lespedeza* sp. *(?))*, wild lupine *(Lupinus perennis)*, prairie phlox *(Phlox pilosa)*, black nightshade, and porcupine grass in the larger plots and false toadflax and Canada bluegrass *(Poa compressa)* in the small plots.

The increases of black nightshade and porcupine grass are inaccurate. The increase of false toadflax, wild lupine, and prairie phlox, similar to the increases at Miller Woods, probably reflect the continuing protection of the areas and the good growing season. The increase of bush clover may be the result of protection. The increase of Canada bluegrass may be from the moist growing season or indicate increasingly mesic habitat due to the increasing canopy.

Plants which were not seen in the September sample, but which were in the plots the preceeding year were tick trefoil *(Desmodium* sp. (sterile)), black-eyed Susan *(Rudbeckia hirta)*, and field sorrel *(Rumex acetosella)*. The sterile tick trefoil would not be expected to persist. The absence of field sorrel, a plant of disturbed areas, may show the continuing protection of the area. The absence of black-eyed Susan, though it grows in a wide habitat, may show the increasing density and shade at Inland Savanna.

Plants which showed a decrease of greater than 10% frequency in the September sampling were panic grass *(Panicum implicatum* var. *scribnerianum)*, porcupine grass, and common spiderwort in the 1-square-meter plots and Pennsylvania sedge, porcupine grass, and common spiderwort in the 0.05-square-meter plots. As shown earlier, the apparent decreases in panic grass, porcupine grass, and Pennsylvania sedge are the result of identification problems. The apparent decrease in common spiderwort is a result only of the plant's phenology. Common spiderwort has a succulent structure and flowers, sets seed, and dies early. By September all spiderworts are dead and disintegrating. Sampling earlier in the season showed no decline.

Transect D: Dune Acres.--Transect D was very wet when it was sampled in June 1982. Water stood 2.5 dm deep in plot 2, 2 dm deep in plot 3, 1 dm deep in plot 5, and 0.5 dm deep in plot 15 and at the surface in plots 4, 16, and 18. The number of species in these plots was reduced or changed. For example, plot 1 had twelve species in 1981 and nine in 1982. Plot 2, which had eight species in 1981, had only two in 1982--blue flag *(Iris virginica)* and a new sedge. The species in plot 7 were also reduced (nineteen species in 1981 and sixteen in 1982). This plot, in an oak thicket, is probably showing the effects of shading (Table 13).

New plants seen at Transect D in June 1982 were red maple seedlings *(Acer rubrum)*, a new sedge *(Carex* sp.*)*, hairy bedstraw *(Galium pilosum)*, June grass *(Kohleria cristata)*, a new mint *(Labiate* sp.*?)*, blazing star seedling *(Liatris* sp.*)*, marsh purslane *(Ludwigia palustris)*, panic grasses *(Panicum* sp.*)*, white lettuce *(Prenanthes alba)*, black-eyed Susan *(Rudbeckia?)*, feathery false Solomon's seal *(Smilacina racemosa)*, and tall goldenrod *(Solidago altissima?)*.

The red maple seedlings did not persist until fall and are not a change in the flora. The sedge persisted until fall but was never identified. Its appearence in 1982 was probably the result of the rainy year. Marsh purslane was probably the result of the wet season. Probably both species persist in wetter areas of Dune Acres and extend their limits in the wet years. The identification of June grass and panic grasses was probably due to the easier identification of the late growing season. Black-

eyed Susan and tall goldenrod are common, even weedy, plants which grow in a variety of habitats and may be the result of the increasing visitation at Dune Acres. Hairy bedstraw is a species of sandy black-oak woods (Swink and Wilhelm, 1979) and white lettuce and feathery false Solomon's seal are both common in the oak woods of the area. The appearence of these plants probably is indicative of the increasing woody encroachment at Dune Acres.

Plants which showed an increase of frequency greater than 10% at Transect D in June 1982 are the new sedge, cylindrical blazing star *(Liatris cylindracea)*, wild black cherry *(Prunus serotina)*, and meadowsweet *(Spiraea alba)* in the 1-square-meter plots and Kentucky bluegrass *(Poa praetensis)* in the 0.05-square-meter plots.

The apparent increase of cylindrical blazing star is probably the result of easier identification due to the advanced phenology of 1982. Its frequency in June 1982 is very similiar to the frequency in both fall samples. Very young blazing stars are easity mistaken for grass seedlings. The increase of wild black cherry seedlings might reflect either increasing woody encroachment of the area or the damp spring which would encourage sprouting. The increase of meadowsweet prabably is the result of both fire suppression and increased moisture. Kentucky bluegrass also would benefit from the moist season, but the increase might also be facilitated by the decrease of prairie grasses due to the suppression of fire.

Plants in sample plots at Transect D in June 1981 which were not in plots in June 1982 were sand sedge *(Carex muhlenbergii)*, composite seedling, unidentified dicots, tall boneset *(Eupatorium altissimum)*, sterile grass, yellow star grass *(Hypoxis hirsuta)*, panic grasses, and marsh phlox *(Phlox glaberrima)*.

The unidentified dicots, grasses, and composite seedlings may have been identified during the second year or may not have persisted. Marsh phlox probably was a mistaken identification (see Appendix I). Sand sedge and tall boneset are plants of drier habitat and were probably absent because of the excess moisture. Though Swink and Wilhelm (1979) consider yellow star grass a plant of moist to dry habitat, it seems to prefer dry habitat and may have been eliminated by the wetness. However, the plant is very small and fragile. It might have flowered and disintegrated or have been overlooked.

Plants which had decreased more than 10% in frequency since June of the previous year were sky-blue aster *(Aster azureus)*, sand sedge, Pennsylvania sedge *(Carex pensylvanica)*, hairy hawkweed *(Hieraceum gronovii)*, panic grass, Indian grass *(Sorghastrum nutans)*, and early low blueberry *(Vaccinium angustifolium)* in the 1-square-meter plots and Pennsylvania sedge and Indian grass in the 0.05-square-meter plots.

The decrease in frequency of the panic grasses is probably an increase in ability to identify the species. The decrease in all other species can be the result of either the change in soil moisture from dry-mesic to wet or wet-mesic during that spring or

to the suppression of fire. All of the species which showed a decrease were prairie or savanna species which would be adversely affected by both increasing moisture and lack of fire.

Plants which occurred in plots at Dune Acres in September 1982 but did not in September 1981 are whorled milkweed *(Asclepias verticillata)*, woolly sedge *(Carex lanuginosa)*, hairy bedstraw, water hoarhound *(Lycopus* sp.*)*, white mulberry *(Morus alba (?)* seedling*)*, a panic grass *(Panicum (polyanthes?))*, white lettuce *(Prenanthes alba)*, starry false Solomon's seal *(Smilacina stellata)*, tall goldenrod, and slender ladies' tresses *(Spiranthes lacera)* (Table 15).

Whorled milkweed and tall goldenrod grow in a variety of habitats and withstand disturbance. Their appearence may be due to increasing visitation to Dune Acres. Woolly sedge and water hoarhound are wetland plants and are the result of the wet season. They are probably always in the area in low wet areas but were able to extend their habitat during 1982. The appearence of the panic grass is probably the result of identification skills. Hairy bedstraw, white lettuce and feathery false Solomon's seal are all woodland plants which first appeared in June 1982 and persisted; evidence of the change of Dune Acres from a prairie-like savanna to woods. The white mulberry seedling may also be the result of this change or may be one of many seedlings which do not persist. The slender ladies' tresses orchid is a prairie plant which may have flowered in response to the season.

Plants which showed an increase greater than 10% in frequency in the September sampling are sedge *(Carex (?))*, false toadflax *(Comandra richardsiana)*, false dandelion *(Krigia biflora)*, panic grass *(Panicum implicatum)*, swamp dewberry *(Rubus hispidus)*, black-eyed Susan *(Rudbeckia hirta)*, and arrow-leaved violet *(Viola sagittata)* in the 1-square-meter plots and false toadflax and Kentucky bluegrass in the 0.05-meter-square plots. All of these plants have a wide range of habitat, including disturbed areas. Their increase is the result of degradation caused by increasing visitation and suppression of fire.

Plants which appeared at Transect D in September of 1981 but not September 1982 are white wild indigo *(Baptisia leucantha)*, sand sedge *(Carex muhlenbergii)*, tall boneset, sterile grass, Canada hawkweed *(Hieracewn canadensae)*, hairy hawkweed, rough blazing star *(Liatris aspera)*, prairie sundrops *(Oenethera pilosella)*, prickley pear *(Opuntia humifusa)*, a panic grass, Kentucky bluegrass, and late low blueberry *(Vaccinium vacillans)*.

Sand sedge, tall boneset, the hawkweeds, rough blazing star, and prickley pear are all plants of dry-mesic habitat which may have suffered population decreases from the unusually wet conditions. However, they are all prairie species and their reduction may also reflect increasing shade or fire suppression. White wild indigo and prairie sundrops are mesic prairie species whose decline is more likely the result of woody encroachment or fire suppression than changing edaphic conditions. The decrease of low blueberry probably is caused by lack of fire. The disappearence of grass

seedlings and panic grass is perhaps the result of better identification in 1982. The loss of Kentucky bluegrass is confusing, perhaps the result of moisture increases.

Plants which showed a decrease greater than 10% frequency in the September sampling are little bluestem *(Andropogon scoparium)*, sky-blue aster, Pennsylvania sedge, soapwort gentian *(Gentiana saponaria)*, lousewort *(Pedicularis canadensis)*, old-field goldenrod *(Solidago nemoralis)*, and early low blueberry in the 1-square-meter plots and Pennsylvania sedge, soapwort gentian, lousewort, and Indian grass in the 0.05-meter-plots.

The decrease of old-field goldenrod and Pennsylvania sedge, species common in dry habitats, may be due to the excess soil moisture. The decrease of blueberries is probably the result of lack of fire. All other plants are prairie or open savanna plants which are declining from increasing shade or accumulation of litter and duff, both the result of fire suppression.

Woody Vegetation Changes (1982)

Transect A: Miller Woods.--Sampling of low shrubs at Transect A in 1982 showed the loss of no species since the sampling of 1981 and the addition of one wild grape *(Vitis)* seedling (see Table 17). The absence of fire during the previous season would cause an increase of some woody species and sampling did show an increase in poison ivy *(Rhus radicans)*, New Jersey tea *(Ceanothus americana)*, and choke cherry *(Prunus virginiana)*. However, nearly half of the low woody stems are low blueberries *(Vaccinium* sp.*)*

which decrease in the absence of burning. The low blueberries showed a decrease of 60,000 stems/ha and so the entire area showed a decrease of 57,000 stems/ha.

Transect B: Inland Marsh.--The only low shrub at Transect B is buttonbush *(Cephalanthus occidentalis)*. Since there is only one species, there can be no change in relative density. As expected, in the supression of burning, there was an increase of density from 21,500 stems/ha to 27,000 stems/ha or an increase of 6,500 stems/ha, an increase of about 24% (Table 20).

Transect C: Inland Savanna.--Small shrub density declined slightly overall at Transect C (Table 22). The commonest species, pasture rose *(Rosa carolina)*, declined in density (8,000 stems/ha) as did New Jersey tea (500 stems/ha), black oak *(Quercus velutina)* (4,500 stems/ha), and shining sumac *(Rhus copallina)* (2,000 stems/ha). Species such as sassafras *(Sassafras albidum)*, commonly found in more mesic habitats, increased. The changes are indicative of the closing canopy due to the supression of fire. The only unpredictable change was the slight increase of low blueberries.

Transect D: Dune Acres.--Small shrub species increased by one, white mulberry *(Morus alba(?))*, which increased by 5,000 stems/ha. Overall shrub densities at Dune Acres increased by 43,000 stems/ha. Over half of the shrubs (56% relative frequency) are swamp dewberry *(Rubus hispidus)* which increased 24,000 stems/ha. Early low blueberry, black oak, sassafras, and quaking aspen *(Populus tremuloides)* declined slightly, but all other species increased. The decline of blueberry and black oak show the increasing shading and the

lack of fire. The decline of sassafras and quaking aspen is surprising. The overall increase in shrubs shows the rapid change of community in the absence of fire (see Table 25).

TABLE 1: Herbaceous and small woody plant frequency
Transect A: Miller Woods

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Amphicarpa bracteata	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Andropogon scoparius	--	--	--	--	--	--	--	--	--	--	--	--
Aquilegia canadensis	6	30	2	--	--	--	6	30	2	2	10	2
Arabis lyrata	--	--	--	--	--	--	1	5	0.3	--	--	--
Aralia nudicaulis	5	25	2	2	10	2	7	35	2	1	5	0.8
Artemisia caudata	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Asclepias tuberosa	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Aster azureus	5	25	2	--	--	--	10	50	3	--	--	--
Aster simplex	--	--	--	--	--	--	--	--	--	--	--	--
Botrychium (seedling)	--	--	--	--	--	--	1	5	0.3	--	--	--
Calamovilfa longifolia	--	--	--	--	--	--	--	--	--	--	--	--
Carex muhlenbergii	1	5	0.3	--	--	--	--	--	--	--	--	--
Carex pensylvanica	18	90	6	14	70	13	5	25	1	2	10	2
Carex (pensylvanica?)	--	--	--	--	--	--	14	70	4	12	60	9
Ceanothus americanus	1	5	0.3	1	5	1	2	10	0.6	1	5	0.8
Comandra richardsiana	14	70	5	9	45	8	14	70	4	7	35	6
Compositae	1	5	0.3	--	--	--	--	--	--	--	--	--
Compositae (seedling)	--	--	--	--	--	--	1	5	0.3	--	--	--
Coreopsis lanceolata	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Coreopsis tripteris	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Cyperaceae (Carex pen.?)	--	--	--	--	--	--	--	--	--	--	--	--
Cyperus filiculmis	--	--	--	--	--	--	--	--	--	--	--	--
Dicot (big hairy herb)	--	--	--	--	--	--	1	5	0.3	--	--	--
Dicot (seedling; lvs. opp.)	1	5	0.3	1	5	1	--	--	--	--	--	--
Dicot seedling	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 1: Herbaceous and small woody plant frequency, continued.
Transect A: Miller Woods

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Eragrostis capillaris	--	--	--	--	--	--	1	5	0.3	--	--	--
Eragrostis (capillaris?)	--	--	--	--	--	--	2	10	0.6	1	5	0.8
Erigeron annuus	2	10	0.7	--	--	--	4	20	1	1	5	0.8
Erigeron canadensis	--	--	--	--	--	--	--	--	--	--	--	--
Euphorbia corollata	6	30	2	--	--	--	5	25	1	--	--	--
Fragaria virginiana	5	25	2	3	15	3	7	35	2	--	--	--
Gramineae (seedling)	--	--	--	--	--	--	--	--	--	--	--	--
Helianthemum canadense	3	15	1	--	--	--	5	25	1	--	--	--
Helianthus divaricatus	18	90	6	--	--	--	18	90	5	9	45	7
Koeleria cristata	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Krigia biflora	10	50	3	3	15	3	11	55	3	4	20	3
Lactuca (floridana?)	--	--	--	--	--	--	--	--	--	--	--	--
Lactuca sp.(sterile)	1	5	0.3	--	--	--	2	10	0.6	1	5	0.8
Liparis lilifolia	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Lupinus perennis	5	25	2	1	5	1	7	35	2	2	10	2
Maianthemum canadense	12	60	4	8	40	7	13	65	4	8	40	6
Monarda punctata	7	35	2	4	20	4	9	45	3	7	35	6
Muhlenbergia? (seedling)	--	--	--	--	--	--	--	--	--	--	--	--
Opuntia humifusa	1	5	0.3	1	5	1	1	5	0.3	1	5	0.8
Panicum depauperatum	1	5	0.3	--	--	--	--	--	--	--	--	--
Panicum (depauperatum?)	--	--	--	--	--	--	2	10	0.6	--	--	--
Panicum implicatum	--	--	--	--	--	--	--	--	--	--	--	--
Panicum (implicatum?)	1	5	0.3	1	5	1	1	5	0.3	1	5	0.8
Panicum oligo. var. scrib.	4	20	1	--	--	--	4	20	1	--	--	--
Panicum vill. var. pseu.	1	5	0.3	--	--	--	1	5	0.3	--	--	--

TABLE 1: Herbaceous and small woody plant frequency, continued.
Transect A: Miller Woods

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Panicum virgatum	--	--	--	--	--	--	--	--	--	--	--	--
Panicum sp.	--	--	--	--	--	--	1	5	0.3	--	--	--
Panicum sp.	--	--	--	--	--	--	1	5	0.3	--	--	--
Phlox glaberrima	1	5	0.3	--	--	--	3	15	0.9	--	--	--
Phlox pilosa	19	95	6	6	30	5	20	100	6	6	30	5
Poa compressa	5	25	2	2	10	2	4	20	1	2	10	2
Poa pratensis	15	75	5	8	40	7	17	85	5	13	65	10
Polygonatum canaliculatum	11	55	4	3	15	3	11	55	3	1	5	0.8
Prenanthes alba	11	55	4	2	10	2	10	50	3	2	10	2
Prunus virginiana	5	25	2	--	--	--	4	20	1	--	--	--
Quercus alba	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Quercus velutina	12	60	4	2	10	1	14	70	4	3	15	2
Rhus copallina	3	15	1	--	--	--	5	25	1	--	--	--
Rhus radicans	10	50	3	3	15	3	9	45	3	3	15	2
Rosa carolina	18	90	6	10	50	9	19	95	6	12	60	9
Rumex acetosella	--	--	--	--	--	--	--	--	--	--	--	--
Rudbeckia sp. (sterile)	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Smilacina racemosa	4	20	1	1	5	1	6	30	2	2	10	2
Smilacina stellata	12	60	4	2	10	2	16	80	5	7	35	6
Solanaceae (?) seedling	--	--	--	--	--	--	1	5	0.3	--	--	--
Solidago caesia	7	35	2	--	--	--	8	40	2	--	--	--
Solidago nemoralis	--	--	--	--	--	--	--	--	--	--	--	--
Solidago speciosa	2	10	0.7	1	5	1	2	10	0.6	1	5	0.8
Sorghastrum nutans	1	5	0.3	1	5	1	1	5	0.3	1	5	0.8
Tradescantia ohiensis	18	90	6	7	35	6	18	90	5	5	25	4

TABLE 1: Herbaceous and small woody plant frequency, continued.
Transect A: Miller Woods

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	FR	%Fr	RFr
Vaccinium angustifolium	2	10	0.7	1	5	1	3	15	0.9	2	10	2
Vaccinium vacillans	6	30	2	4	20	4	8	40	2	4	20	3
Vitis (seedling)	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 2: Herbaceous and small woody plants in decreasing order of frequency.

Transect A: Miller Woods, June sampling.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Phlox pilosa	90%	100%	Carex pensylvanica	70%	60
Carex pensylvanica	90	25	Helianthus divaricatus	50	45
Helianthus divaricatus	90	90	Rosa carolina	50	60
Rosa carolina	90	95	Comandra richardsiana	45	35
Tradescantia ohiensis	90	90	Maianthemum canadense	40	40
Poa pratensis	75	85	Poa pratensis	40	65
Comandra richardsiana	70	70	Tradescantia ohiensis	35	25
Maianthemum canadense	60	65	Phlox pilosa	30	30
Quercus velutina	60	70	Monarda punctata	35	20
Smilacina stellata	60	80	Vaccinium vacillans	20	20
Polygonatum canaliculatum	55	55	Fragaria virginiana	15	15
Prenanthes alba	55	50	Krigia biflora	15	20
Krigia biflora	50	55	Polygonatum canaliculatum	15	5
Rhus radicans	50	45	Rhus radicans	15	15
Monarda punctata	35	45	Aralia nudicaulis	10	5
Solidago caesia	35	40	Poa compressa	10	10
Aquilegia canadensis	30	30	Prenanthes alba	10	10
Euphorbia corollata	30	25	Quercus velutina	10	15
Vaccinium vacillans	30	40	Smilacina stellata	10	35
Aralia nudicaulis	25	35	Ceanothus americanus	5	5
Aster azureus	25	50	Dicot seedling (lvs. opp.)	5	--
Fragaria virginiana	25	35	Lupinus perennis	5	10
Lupinus perennis	25	35	Opuntia humifusa	5	5
Poa compressa	25	20	Panicum (implicatum)	5	5
Prunus virginiana	25	20	Smilacina racemosa	5	10

TABLE 2:Herbaceous and small woody plants in decreasing order of frequency.

Transect A: Miller Woods, June sampling, continued.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Panicum olig. var. scrib.	20%	20%	Solidago altissima	5%	5%
Smilacina racemosa	20	30	Sorghastrum nutans	5	5
Helianthemum canadense	15	25	Aquilegia canadensis	--	10
Rhus copallina	15	25	Carex pensylvanica?	--	10
Erigeron annuus	10	20	Eragrostis capillaris?	--	5
Solidago altissima	10	10	Erigeron annuus	--	5
Vaccinium angustifolium	10	15	Helianthemum canadensis	--	5
Amphicarpa bracteata	5	5	Lactucca sp. (sterile)	--	5
Artemisia caudata	5	5			
Asclepias tuberosa	5	5			
Carex muhlenbergii	5	--			
Ceanothus americanus	5	10			
Compositae	5	--			
Coreopsis lanceolata	5	5			
Coreopsis tripteris	5	5			
Dicot seedling	5	--			
Koeleria cristata	5	5			
Lactuca sp. (sterile)	5	10			
Liparis lilifolia	5	5			
Opuntia humifusa	5	5			
Panicum depauperatum?	5	10			
Panicum implicatum?	5	5			
Panicum vil. var. pseudo.	5	5			
Phlox glaberrima	--	15			
Quercus alba	5	5			

TABLE 2 : Herbaceous and small woody plants in decreasing order of frequency.

Transect A; Miller Woods, June sampling, continued.

1-sq-m plot	1981	1982
Rudbeckia sp. (sterile)	5	5
Sorshastrum nutans	5	5
Arabis lyrata	--	5
Botrichium seedling	--	5
Compositae seedling	--	5
Dicot (big hairy)	--	5
Solonaceae? seedling	--	5
Panicum sp.	--	5
Panicum sp.	--	5

TABLE 3: Herbaceous and small woody plant frequency.
Transect A: Miller Woods

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Amphicarpa bracteata	1	5	0.3	1	5	0.8	1	5	0.3	1	5	0.9
Andropogon scoparius	--	--	--	--	--	--	2	10	0.6	--	--	--
Aquilegia canadensis	6	30	2	2	10	2	7	35	2	2	10	2
Arabis lyrata	--	--	--	--	--	--	1	5	0.3	--	--	--
Aralia nudicaulis	4	20	1	1	5	0.8	5	25	2	--	--	--
Artemisia caudata	1	5	0.3	1	5	0.8	1	5	0.3	--	--	--
Asclepias tuberosa	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Aster azureus	6	30	2	--	--	--	9	45	3	--	--	--
Aster simplex	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Botrychium (seedling)	--	--	--	--	--	--	--	--	--	--	--	--
Calamovilfa longifolia	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Carex muhlenbergii	--	--	--	--	--	--	--	--	--	--	--	--
Carex pensylvanica	--	--	--	--	--	--	--	--	--	--	--	--
Carex (pensylvanica?)	12	60	4	7	35	6	17	85	5	14	70	13
Ceanothus americanus	6	30	2	3	15	3	4	20	1	1	5	0.9
Comandra richardsiana	10	50	3	6	30	5	10	50	3	2	10	2
Compositae	--	--	--	--	--	--	--	--	--	--	--	--
Compositae (seedling)	--	--	--	--	--	--	--	--	--	--	--	--
Coreopsis lanceolata	--	--	--	--	--	--	2	10	0.6	--	--	--
Coreopsis tripteris	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Cyperaceae (Carex pen.?)	3	15	1	1	5	0.8	--	--	--	--	--	--
Cyperus filiculmis	2	10	0.7	1	5	0.8	1	5	0.3	--	--	--
Dicot	--	--	--	--	--	--	--	--	--	--	--	--
Dicot (seedling; lvs. opp.)	1	5	0.3	1	5	0.8	--	--	--	--	--	--
Dicot seedling	1	5	0.3	1	5	0.8	1	5	0.3	--	--	--

TABLE 3; Herbaceous and small woody plant frequency.
Transect A: Miller Woods

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Eragrostis capillaris	1	5	0.3	1	5	0.8	1	5	0.3	1	5	0.9
Eragrostis (capillaris?)	--	--	--	--	--	--	--	--	--	--	--	--
Erigeron annuus	4	20	1	1	5	0.8	5	25	2	1	5	0.9
Erigeron canadensis	2	10	0.7	--	--	--	1	5	0.3	1	5	0.9
Euphorbia corollata	6	30	2	--	--	--	8	40	2	1	5	0.9
Fragaria virginiana	6	30	2	3	15	3	9	45	3	5	25	4
Gramineae (seedling)	1	5	0.3	--	--	--	--	--	--	--	--	--
Helianthemum canadense	8	40	3	--	--	--	5	25	2	1	5	0.9
Helianthus divaricatus	18	90	6	9	45	8	19	95	6	7	35	6
Koeleria cristata	1	5	0.3	--	--	--	--	--	--	--	--	--
Krigia biflora	10	50	3	--	--	--	10	50	3	3	15	3
Lactuca (floridana?)	--	--	--	--	--	--	3	15	0.9	1	5	0.9
Lactuca sp. (sterile)	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Liparis lilifolia	2	10	0.7	1	5	0.8	1	5	0.3	--	--	--
Lupinus perennis	2	10	0.7	1	5	0.8	7	35	2	2	10	2
Maianthemum canadense	11	55	4	6	30	5	13	65	4	9	45	9
Monarda punctata	7	35	2	5	25	4	9	45	3	6	30	6
Muhlenbergia? (seedling)	--	--	--	--	--	--	1	5	0.3	--	--	--
Opuntia humifusa	1	5	0.3	1	5	0.8	1	5	0.3	1	5	0.9
Panicum depauperatum	--	--	--	--	--	--	--	--	--	--	--	--
Panicum (depauperatum?)	--	--	--	--	--	--	--	--	--	--	--	--
Panicum implicatum	7	35	2	3	15	3	7	35	2	2	10	2
Panicum (implicatum?)	--	--	--	--	--	--	--	--	--	--	--	--
Panicum oligo. var. scrib.	3	15	1	--	--	--	5	25	2	2	10	2
Panicum vill. var. pseu.	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 3; Herbaceous and small woody plant frequency, continued.
Transect A: Miller Woods

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	Rfr	Fr	%Fr	RFr
Panicum virgatum	--	--	--	--	--	--	1	5	0.3	--	--	--
Panicum sp.	--	--	--	--	--	--	--	--	--	--	--	--
Panicum sp.	--	--	--	--	--	--	--	--	--	--	--	--
Phlox glaberrima	--	--	--	--	--	--	--	--	--	--	--	--
Phlox pilosa	19	95	6	8	40	7	20	100	6	8	40	7
Poa compressa	3	15	1	2	10	2	5	25	2	2	10	2
Poa pratensis	13	65	4	12	60	11	13	65	4	8	40	7
Polygonatum canaliculatum	8	40	3	2	10	2	11	55	3	--	--	--
Prenenthes alba	5	25	2	--	--	--	5	25	2	--	--	--
Prunus virginiana	4	20	1	--	--	--	5	25	2	--	--	--
Quercus alba	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Quercus velutina	15	75	5	3	15	3	18	90	5	4	20	4
Rhus copallina	4	20	1	--	--	--	5	25	2	--	--	--
Rhus radicans	9	45	3	5	25	4	9	45	3	2	10	2
Rosa carolina	18	90	8	10	50	9	19	95	6	12	60	11
Rumex acetosella	--	--	--	--	--	--	2	10	0.6	--	--	--
Rudbeckia sp. (sterile)	1	5	0.3	--	--	--	--	--	--	--	--	--
Smilacina racemosa	5	25	2	--	--	--	6	30	2	--	--	--
Smilacina stellata	14	70	5	3	15	3	12	60	4	--	--	--
Solanaceae (?) seedling	1	5	0.3	--	--	--	--	--	--	--	--	--
Solidago caesia	6	30	2	--	--	--	9	45	3	1	5	0.9
Solidago nemoralis	2	10	0.7	--	--	--	2	10	0.6	--	--	--
Solidago speciosa	3	15	1	1	5	0.8	2	10	0.6	1	5	0.9
Sorghastrum nutans	1	5	0.3	1	5	0.8	1	5	0.3	1	5	0.9
Tradescantia ohiensis	5	25	2	1	5	0.8	2	10	0.6	--	--	--

TABLE 3: Herbaceous and small woody plant frequency, continued.

Transect A: Miller Woods	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	FR	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Vaccinium angustifulium	2	10	0.7	1	5	0.8	5	25	2	2	10	2
Vaccinium vacillans	6	30	2	4	20	4	8	40	2	4	20	4
Vitis (seedling)	--	--	--	--	--	--	1	5	0.3	--	--	--

TABLE 4: Herbaceous and small woody plants in decreasing order of frequency.

Transect A: Miller Woods, September sampling.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Phlox pilosa	95%	100%	Poa pratensis	60%	40%
Helianthus divaricatus	90	95	Rosa carolina	50	60
Rosa carolina	90	95	Helianthus divaricatus	45	35
Quercus velutina	75	90	Phlox pilosa	40	40
Smilacina stellata	70	60	Carex (pensylvanica?)	35	70
Poa pratensis	65	65	Comandra richardsiana	30	10
Carex (pensylvanica?)	60	85	Maianthemum canadense	30	45
Maianthemum canadense	55	65	Monarda punctata	25	30
Comandra richardsiana	50	50	Rhus radicans	25	10
Krigia biflora	50	50	Krigia biflora	20	15
Rhus radicans	45	45	Vaccinium vacillans	20	20
Helianthemum canadense	40	25	Ceanothus americanus	15	5
Polygonatum canaliculatum	40	55	Fragaria virginiana	15	25
Monarda punctata	35	45	Panicum implicatum	15	10
Panicum implicatum	35	35	Quercus velutina	15	20
Aquilegia canadensis	30	35	Smilacina stellata	15	20
Aster azureus	30	45	Aquilegia canadensis	10	10
Ceanothus americanus	30	20	Poa compressa	10	10
Euphorbia corollata	30	40	Polygonum canaliculatum	10	--
Fragaria virginiana	30	45	Amphicarpa bracteata	5	5
Solidago caesia	30	45	Aralia nudicaulis	5	5
Vaccinium vacillans	30	40	Artemisia caudata	5	--
Prenanthes alba	25	25	Cyperaceae	5	--
Smilacina racemosa	25	30	Dicot seedling	5	--
Tradescantia ohiensis	25	10	Dicot seedling	5	--

TABLE 4: Herbaceous and small woody plants in decreasing order of frequency

Transect A: Miller Woods, September sampling, continued.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Aralia nudicaulis	20%	25%	Eragrostis capillaris	5%	5%
Erigeron annuus	20	25	Erigeron annuus	5	5
Prunus virginiana	20	25	Helianthemum canadense	5	5
Rhus copallina	20	25	Liparis lilifolia	5	--
Cyperaceae	15	--	Lupinus perennis	5	10
Panicum olig. var. scrib.	15	25	Opuntia humifusa	5	5
Poa compressa	15	25	Solidago nemoralis	5	--
Solidago altissima	15	10	Solidago altissima	5	5
Cyperus filiculmis	10	5	Sorghastrum nutans	5	5
Erigeron canadensis	10	5	Tradescantia ohiensis	5	--
Liparis lilifolia	10	5	Vaccinium angustifolium	5	10
Lupinus perennis	10	35	Euphorbia corollata	--	5
Solidago nemoralis	10	10	Solidago caesia	--	5
Vaccinium angustifolium	10	25	Lactucca sp. (sterile)	--	5
Amphicarpa bracteata	5	5			
Artemisia caudata	5	5			
Asclepias tuberosa	5	5			
Aster simplex	5	5			
Calamovilfa longifolia	5	5			
Coreopsis tripteris	5	5			
Dicot seedling	5	5			
Dicot seedling	5	--			
Eragrostis capillaris	5	5			
Gramineae seedling	5	--			
Lactuca sp. (sterile	5	5			

TABLE 4: Herbaceous and small woody plants in decreasing order of frequency

Transect A: Miller Woods, September sampling, continued.

1-sq-m plots	1981	1982
Opuntia humifusa	5%	5%
Quercus alba	5	5
Rudbeckia sp. (sterile)	5	--
Solanaceae (?) seedling	5	--
Sorghastrum nutans	5	5
Andropogon scoparius	--	10
Coreopsis lanceolata	--	10
Rumex acetosella	--	10
Arabis lyrata	--	5
Muhlenbergia? seedling	--	5
Panicum virgatum	--	5
Vitis seedling	--	5

TABLE 5: Herbaceous and small woody plant frequency.
Transect B: Inland Marsh

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Calamagrostis canadensis	20	100	22	15	75	43	19	95	24	12	60	39
Carex lasiocarpa	1	5	1	1	5	3	1	5	1	1	5	3
Cephalanthus occidentalis	14	70	15	1	5	3	14	70	18	1	5	3
Cladium mariscoides	1	5	1	--	--	--	--	--	--	--	--	--
Dicot seedling	--	--	--	--	--	--	--	--	--	--	--	--
Dryopteris thelypteris	--	--	--	--	--	--	--	--	--	--	--	--
Dulichium arundinaceum	7	35	8	3	15	9	7	35	9	4	20	13
Eleocharis palustris?	3	15	3	1	5	3	--	--	--	--	--	--
Eleocharis sp.	--	--	--	--	--	--	--	--	--	--	--	--
Juncus canadensis	--	--	--	--	--	--	--	--	--	--	--	--
Lycopus uniflorus	1	5	1	--	--	--	--	--	--	--	--	--
Lythrum salicaria	6	30	6	3	15	9	1	5	1	1	5	3
Myriophyllum exalbescens	2	10	2	--	--	--	--	--	--	--	--	--
Panicum sp.	--	--	--	--	--	--	--	--	--	--	--	--
Polygonum amphibium	8	40	9	4	20	11	4	20	5	1	5	3
Potamogeton (illinoensis?)	8	40	9	1	5	3	3	15	4	1	5	3
Proserpinaca palustris	--	--	--	--	--	--	--	--	--	--	--	--
Sagittaria latifolia	5	15	5	--	--	--	4	20	5	1	5	3
Scirpus sp.	--	--	--	--	--	--	3	15	4	--	--	--
Scirpus cyperinus	1	5	1	1	5	3	1	5	1	1	5	3
Scirpus validus	10	50	11	5	15	14	13	65	17	8	45	26
Typha latifolia	5	25	3	--	--	--	4	20	5	--	--	--
Utricularia (vulgaris?)	1	5	1	--	--	--	3	15	4	--	--	--

TABLE 6: Herbaceous and small woody plants in decreasing order of frequency.

Transect B: Inland Marsh, June sampling

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Calamagrostis canadensis	100%	95%	Calamagrostis canadensis	75%	60%
Cephalanthus occidentalis	70	70	Scirpus validus	25	45
Scirpus validus	50	65	Polygonum amphibium	20	5
Polygonum amphibium	40	20	Dulichium arundinaceum	15	20
Potamogeton (illinoensis?)	40	15	Lythrum salicaria	15	5
Dulichium arundinaceum	35	35	Carex lasiocarpa	5	5
Lythrum salicaria	30	5	Cephalanthus occidentalis	5	5
Sagittaria latifolia	25	20	Eleocharis (palustris?)	5	--
Typha latifolia	25	20	Potamogeton (illinoensis?)	5	5
Eleocharis (palustris?)	15	--	Scirpus cyperinus	5	5
Myriophyllum exalbescens	10	--	Sagittaria latifolia	--	5
Carex lasiocarpa	5	5			
Cladium mariscoides	5	--			
Lycopus uniflorus	5	--			
Scirpus cyperinus	5	5			
Utricularia (vulgaris?)	5	15			
Scirpus sp.	--	15			
Potamogeton sp.	--	5			

TABLE 7; Herbaceous and small woody plant frequency.
Transect B: Inland Marsh

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m-plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Calamagrostis canadensis	19	95	18	11	55	23	19	95	15	13	65	28
Carex lasiocarpa	1	5	1	1	5	2	1	5	0.8	1	5	2
Cephalanthus occidentalis	12	60	12	2	10	4	12	60	9	1	5	2
Cladium mariscoides	1	5	1	1	5	2	3	15	2	1	5	2
Dicot seedling	--	--	--	--	--	--	1	5	0.8	--	--	--
Dryopteris thelypteris	2	10	2	--	--	--	1	5	0.8	--	--	--
Dulichium arundinaceum	7	35	7	3	15	6	12	60	9	6	30	13
Eleocharis palustris?	7	35	7	4	20	8	6	30	5	5	25	11
Eleocharis sp.	--	--	--	--	--	--	1	5	0.8	--	--	--
Juncus canadensis	2	10	2	1	5	2	2	10	2	1	5	2
Lycopus uniflorus	1	5	1	1	5	2	1	5	0.8	--	--	--
Lythrum salicaria	5	25	5	2	10	4	7	35	5	2	10	4
Myriophyllum exalbescens	--	--	--	--	--	--	--	--	--	--	--	--
Panicum sp.	--	--	--	--	--	--	1	5	0.8	--	--	--
Polygonum amphibium	10	50	10	5	25	10	11	55	8	2	10	4
Potamogeton (illinoensis?)	10	50	10	4	20	8	12	60	9	5	25	11
Proserpinaca palustris	7	35	7	2	10	4	10	50	8	1	5	2
Sagittaria latifolia	4	20	4	1	5	2	11	55	8	--	--	--
Scirpus sp.	--	--	--	--	--	--	--	--	--	--	--	--
Scirpus cyperinus	1	5	1	1	5	2	1	5	0.8	1	5	2
Scirpus validus	12	60	12	9	45	19	13	65	10	7	35	15
Typha latifolia	4	20	4	--	--	--	4	20	3	1	5	2
Utricularia (vulgaris?)	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 8: Herbaceous and small woody plants in decreasing order of frequency.

Transect B: Inland Marsh, Septerber sampling.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Calamagrostis canadensis	95%	95%	Calamagrostis canadensis	55%	65%
Cephalanthus occidentalis	60	60	Scirpus validus	45	35
Scirpus validus	60	65	Polygonum amphibium	25	10
Polygonum amphibium	50	55	Eleocharis (palustris?)	20	25
Potamogeton (illinoensis?)	50	60	Potamogeton (illinoensis?)	20	25
Dulichium arundinaceum	35	60	Dulichium arundinaceum	15	30
Proserpinaca palustris	35	50	Cephalanthus occidentalis	10	5
Eleocharis (palustris?)	25	30	Lythrum salicaria	10	10
Lythrum salicaria	25	35	Proserpinaca palustris	10	5
Sagittaria latifolia	20	55	Carex lasiocarpa	5	5
Typha latifolia	20	20	Cladium mariscoides	5	5
Dryopteris thelypteris	10	5	Juncus canadensis	5	5
Juncus canadensis	10	10	Lycopus uniflorus	5	5
Carex lasiocarpa	5	5	Sagittaria latifolia	5	--
Cladium mariscoides	5	15	Scirpus cyperinus	5	5
Lycopus uniflorus	5	5	Typha latifolia	--	5
Scirpus cyperinus	5	5			
Dicot seedling	--	5			
Eleocharis sp.	--	5			
Panicum sp.	--	5			

TABLE 9: Herbaceous and small woody plant frequency.
Transect C: Inland Savanna

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Ambrosia artimisiafolia	--	--	--	--	--	--	--	--	--	--	--	--
Andropogon scoparius	7	35	3	3	15	4	9	45	3	4	20	4
Antennaria plantaginifolia	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Arabis lyrata	--	--	--	--	--	--	1	5	0.4	--	--	--
Aralia nudicaulis	1	5	0.4	1	5	1	1	5	0.4	--	--	--
Asclepias amplexicaulis	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Asclepias tuberosa	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Asclepias tuberosa(?)	--	--	--	--	--	--	1	5	0.4	--	--	--
Asclepias verticillata	1	5	0.4	1	5	1	2	10	0.8	--	--	--
Aster azureus	6	30	3	--	--	--	4	20	2	--	--	--
Aster linariifolius	1	5	0.4	1	5	1	5	25	2	--	--	--
Calamovilfa longifolia(?)	--	--	--	--	--	--	--	--	--	--	--	--
Campanula rotundifolia	--	--	--	--	--	--	--	--	--	--	--	--
Carex muhlenbergii	2	10	0.8	--	--	--	--	--	--	--	--	--
Carex muhlenbergii(?)	--	--	--	--	--	--	1	5	0.4	1	5	1
Carex pensylvanica	6	30	3	4	20	5	2	10	0.8	--	--	--
Carex (pensylvanica?)	4	20	2	3	15	4	7	35	3	5	25	5
Ceanothus americanus	1	5	0.4	1	5	1	2	10	0.8	1	5	1
Comandra richardsiana	7	35	1	4	20	5	9	95	3	5	25	5
Coreopsis lanceolata	--	--	--	--	--	--	3	15	1	--	--	--
Coreopsis palmata	10	50	4	4	20	5	9	95	3	6	30	7
Cruciferae (?)(seedling)	1	5	0.4	--	--	--	--	--	--	--	--	--
Cyperus filiculmis	--	--	--	--	--	--	--	--	--	--	--	--
Desmodium sp. (sterile)	--	--	--	--	--	--	--	--	--	--	--	--
Dicot seedling	1	5	0.4	--	--	--	1	5	0.4	--	--	--

TABLE
Transect C: Inland Savanna

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Dicot seedling	1	5	0.4	--	--	--	1	5	0.4	1	5	1
Dicot seedling	1	5	0.4	--	--	--	--	--	--	--	--	--
Diervilla lonicera	2	10	4	--	--	--	2	10	0.8	1	5	1
Eragrostis capillaris	--	--	--	--	--	--	--	--	--	--	--	--
Euphorbia corollata	11	55	5	2	10	3	13	65	5	4	20	4
Fragaria virginiana	1	5	0.4	--	--	--	1	5	0.4	1	5	1
Gramineae (long-lvs.)	--	--	--	--	--	--	2	10	0.8	--	--	--
Gramineae seedling	2	10	0.8	--	--	--	--	--	--	--	--	--
Helianthemum canadense	1	5	0.4	--	--	--	4	20	2	--	--	--
Helianthus divaricatus	19	95	8	6	30	8	19	95	7	9	45	10
Helianthus occidentalis	5	25	2	2	20	3	2	10	0.8	1	5	1
Helianthus sp.	--	--	--	--	--	--	--	--	--	--	--	--
Hieracium canadense	3	15	1	1	5	1	1	5	0.4	--	--	--
Koeleria cristata	1	5	0.4	1	5	1	3	5	1	--	--	--
Leguminosae (seedling)	--	--	--	--	--	--	1	5	0.4	--	--	--
Lespedeza capitata	--	--	--	--	--	--	2	20	0.8	--	--	--
Lespedeza (?) sp.	--	--	--	--	--	--	--	--	--	--	--	--
Lithospermum croceum	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Lupinus perennis	14	70	6	5	25	6	15	75	6	3	15	3
Maianthemum canadense	1	5	0.4	--	--	--	1	5	0.4	1	5	1
Monarda punctata	--	--	--	--	--	--	1	5	0.4	--	--	--
Monocot seedling	--	--	--	--	--	--	1	5	0.4	--	--	--
Panicum implicatum	--	--	--	--	--	--	--	--	--	--	--	--
Panicum oligo. var scrib.	2	10	0.8	--	--	--	--	--	--	--	--	--
Panicum virgatum	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 9: Herbaceous and samll woody plant frequency, continued.
Transect C: Inland Savanna

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Panicum sp.	1	5	0.4	--	--	--	--	--	--	--	--	--
Phlox glaberrima	8	40	3	2	10	3	1	5	0.4	--	--	--
Phlox pilosa	6	30	3	--	--	--	6	30	2	1	5	1
Physalis heterophylla	--	--	--	--	--	--	1	5	0.4	1	5	1
Poa compressa	15	75	6	10	50	13	14	70	5	10	50	10
Poa pratensis	14	70	6	7	35	9	15	75	6	15	75	16
Prunus serotina	1	5	0.4	--	--	--	--	--	--	--	--	--
Quercus velutina	8	40	3	--	--	--	9	45	3	1	5	1
Rhus copallina	2	10	0.8	--	--	--	2	10	0.8	--	--	--
Rhus radicans	1	5	0.4	--	--	--	--	--	--	--	--	--
Rosa carolina	19	95	8	11	55	14	19	95	7	12	60	13
Rubus occidentalis	--	--	--	--	--	--	1	5	0.4	--	--	--
Rudbeckia hirta	--	--	--	--	--	--	--	--	--	--	--	--
Rudbeckia(?)	--	--	--	--	--	--	1	5	0.4	--	--	--
Rumex acetosella	--	--	--	--	--	--	1	5	0.4	--	--	--
Sassafras albidum	1	5	0.4	1	5	1	1	5	0.4	1	5	1
Smilacina stellata	11	55	5	4	20	5	14	70	5	3	15	3
Solanum americanum	4	20	2	2	10	3	--	--	--	--	--	--
Solanum americanum(?)	--	--	--	--	--	--	--	--	--	--	--	--
Solanaceae seedling	--	--	--	--	--	--	7	35	3	1	5	1
Solidago nemoralis	--	--	--	--	--	--	1	5	0.4	--	--	--
Solidago speciosa	3	15	1	--	--	--	4	20	2	--	--	--
Sorghastrum nutans	--	--	--	--	--	--	1	5	0.4	--	--	--
Stipa spartea	3	15	1	3	15	4	2	10	0.8	--	--	--
Stipa spartea(?)	--	--	--	--	--	--	3	15	1	--	--	--

TABLE 9: Herbaceous and small woody plant frequency, continued.
Transect C: Inland Savanna

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	FR	%Fr	RFr
Tephrosia virginiana	3	15	1	--	--	--	6	30	2	--	--	--
Tradescantia ohiensis	13	65	5	--	--	--	16	80	6	--	--	--
Vaccinium angustifolium	8	40	3	2	10	3	1	5	0.4	--	--	--
Vaccinium vacillans	--	--	--	--	--	--	8	40	3	2	10	2
Viola(?) seedling	1	5	0.4	--	--	--	--	--	--	--	--	--
Vitis sp. seedling	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 10: Herbaceous and small woody plants in decreasing order of frequency

Transect C: Inland Savanna, June sampling.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Helianthus divaricatus	95%	95%	Rosa carolina	55%	60%
Rosa carolina	95	95	Poa compressa	50	5
Poa compressa	75	70	Poa pratensis	35	75
Lupinus perennis	70	75	Helianthus divaricatus	30	45
Poa pratensis	70	45	Lupinus perennis	25	15
Tradescantia ohiensis	65	80	Carex pensylvanica	20	--
Euphorbia corollata	55	65	Comandra richardsiana	20	25
Smilacina stellata	55	70	Coreopsis palmata	20	30
Coreopsis palmata	50	95	Helianthus occidentalis	20	5
Phlox glaberrima	40	5	Smilacina stellata	20	15
Quercus velutina	40	45	Andropogon scoparius	15	20
Vaccinium angustifolium	40	5	Carex (pensylvanica?)	15	25
Andropogon scoparius	35	45	Stipa spartea	15	--
Comandra richardsiana	35	95	Euphorbia corollata	10	20
Aster azureus	30	20	Phlox glaberrima	10	--
Carex pensylvanica	30	10	Solanum americanum	10	--
Phlox pilosa	30	30	Vaccinium angustifolium	10	--
Helianthus occidentalis	25	10	Aralia nudicaulis	5	--
Carex (pensylvanica?)	20	35	Asclepias verticillata	5	5
Solanum americanum	20	--	Aster linariifolius	5	--
Hieracium canadensae	15	5	Ceanothus americanus	5	5
Solidago altissima	15	20	Hieracium canadense	5	--
Stipa spartea	15	15	Sassafras albidum	5	5
Tephrosia virginiana	15	30	Carex muhlenbergii	--	5
Carex muhlenbergii	10	5	Dicot seedling	--	5

TABLE 10: Herbaceous and small woody plants in decreasing order of frequency.

Transect C: Inland Savanna, June sampling, continued.

1-sq-m plots	1981	1982
Diervilla lonicera	10%	10
Gramineae (seedling)	10	--
Panicum olig. var. scrib.	10	--
Rhus copallina	10	10
Antennaria plantaginifolia	5	5
Aralis nudicaulis	5	5
Asclepias amplexicaulis	5	5
Asclepias tuberosa	5	5
Asclepias verticillata	5	10
Aster linariifolius	5	25
Ceanothus americanus	5	10
Cruciferae (?) seedling	5	--
Dicot seedling	5	5
Dicot seedling	5	--
Dicot seedling	5	--
Fragaria virginiana	5	5
Helianthemum canadense	5	20
Helianthus sp. (sterile)	5	--
Koeleria cristata	5	15
Lithospermum croceum	5	5
Maianthemum canadense	5	5
Panicum virgatum	5	--
Prunus serotina	5	--
Rhus radicans	5	--
Sassafras albidum	5	5

0.05-sq-m plots	1981	1982
Diervilla lonicera	--	5%
Fragaria virginiana	--	5
Maianthemum canadensae	--	5
Monocot seedling	--	5
Physalis heterophylla	--	5
Phlox pilosa	--	5
Quercus velutina	--	5
Solonaceae seedling	--	5
Vaccinium vacillans	--	5

TABLE 10: Herbaceous and small woody plants in decreasing order of frequency.

Transect C: Inland Savanna, June sampling, continued.

1-sq-m plots	1981	1982
Viola (?) seedling	5%	--
Vaccinium vacillans	--	40%
Solanaceae (?) seedling	--	35
Coreopsis lanceolata	--	15
Gramineae (long lvs.)	--	10
Lespedeza capitata	--	10
Stipa spartea	--	10
Arabis lyrata	--	5
Asclepias tuberosa(?)	--	5
Leguminosae seedling	--	5
Monarda punctata	--	5
Monocot seedling	--	5
Physalis heterophylla	--	5
Rubus occidentalis	--	5
Rudbeckia sp. (sterile)	--	5
Rumex acetosella	--	5
Solidago nemoralis	--	5
Sorghastrum nutans	--	5

TABLE 11: Herbaceous and small woody plant frequency.
Transect C: Inland Savanna

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Ambrosia artimisiafolia	--	--	--	--	--	--	1	5	0.4	--	--	--
Andropogon scoparius	13	65	6	5	25	6	14	70	5	6	30	7
Antennaria plantaginifolia	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Arabis lyrata	--	--	--	--	--	--	--	--	--	--	--	--
Aralia nudicaulis	--	--	--	--	--	--	--	--	--	--	--	--
Asclepias amplexicaulis	--	--	--	--	--	--	--	--	--	--	--	--
Asclepias tuberosa	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Asclepias tuberosa(?)	--	--	--	--	--	--	--	--	--	--	--	--
Asclepias verticillata	1	5	0.4	--	--	--	2	10	0.8	--	--	--
Aster azureus	2	10	0.9	--	--	--	3	15	1	--	--	--
Aster linariifolius	9	45	4	--	--	--	7	35	3	1	5	1
Calamovilfa longifolia(?)	--	--	--	--	--	--	--	--	--	--	--	--
Campanula rotundifolia	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Carex muhlenbergii	--	--	--	--	--	--	--	--	--	--	--	--
Carex muhlenbergii(?)	--	--	--	--	--	--	1	5	0.4	--	--	--
Carex pensylvanica	--	--	--	--	--	--	--	--	--	--	--	--
Carex (pensylvanica?)	16	80	7	12	60	14	16	80	6	8	40	10
Ceanothus americanus	1	5	0.4	1	5	1	1	5	0.4	1	5	1
Comandra richardsiana	5	25	2	2	10	2	10	50	4	5	25	6
Coreopsis lanceolata	--	--	--	--	--	--	1	5	0.4	--	--	--
Coreopsis palmata	10	50	4	4	20	5	9	45	3	3	15	4
Crudiferae (?) seedling	--	--	--	--	--	--	--	--	--	--	--	--
Cyperus filiculmis	1	5	0.4	--	--	--	2	10	0.8	--	--	--
Desmodium sp.	1	5	0.4	--	--	--	--	--	--	--	--	--
Dicot seedling	1	5	0.4	--	--	--	--	--	--	--	--	--

TABLE 11: Herbaceous and small woody plant frequency, continued.
Transect C: Inland Savanna

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Dicot seedling	--	--	--	--	--	--	1	5	0.4	--	--	--
Dicot seedling	--	--	--	--	--	--	--	--	--	--	--	--
Diervilla lonicera	2	10	0.9	--	--	--	2	10	0.8	2	10	2
Eragrostis capillaris	5	10	2	--	--	--	4	20	2	--	--	--
Euphorbia corollata	10	50	4	2	10	2	12	60	5	1	5	1
Fragaria virginiana	1	5	0.4	1	5	1	1	5	0.4	1	5	1
Gramineae (long-lvs.)	--	--	--	--	--	--	--	--	--	--	--	--
Gramineae seedling	--	--	--	--	--	--	--	--	--	--	--	--
Helianthemum canadense	4	20	2	2	10	2	5	25	2	1	5	1
Helianthus divaricatus	18	90	8	11	55	13	19	95	7	10	50	12
Helianthus occidentalis	4	20	2	2	10	2	3	15	1	1	5	1
Helianthus sp.	--	--	--	--	--	--	--	--	--	--	--	--
Hieracium canadense	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Koeleria cristata	1	5	0.4	--	--	--	3	15	1	--	--	--
Leguminosae (seedling)	--	--	--	--	--	--	--	--	--	--	--	--
Lespedeza capitata	--	--	--	--	--	--	4	20	2	--	--	--
Lespedeza (?) sp.	1	5	0.4	--	--	--	--	--	--	--	--	--
Lithospermum croceum	--	--	--	--	--	--	1	5	0.4	--	--	--
Lupinus perennis	4	20	2	2	10	2	8	40	3	1	5	1
Maianthemum canadense	1	5	0.4	1	5	1	2	10	0.8	1	5	1
Monarda punctata	3	15	1	1	5	1	2	10	0.8	--	--	--
Monocot seedling	--	--	--	--	--	--	--	--	--	--	--	--
Panicum implicatum	--	--	--	--	--	--	1	5	0.4			
Panicum oligo. var scrib.	3	15	1	--	--	--	--	--	--	--	--	--
Panicum virgatum	--	--	--	--	--	--	1	5	0.4	--	--	--

TABLE 11: Herbaceous and small woody plant frequency, continued.
Transect C: Inland Savanna

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Panicum sp.	--	--	--	--	--	--	--	--	--	--	--	--
Phlox glaberrima	2	10	0.9	2	10	2	2	10	0.8	--	--	--
Phlox pilosa	5	25	2	--	--	--	8	40	3	2	10	2
Physalis heterophylla	--	--	--	--	--	--	--	--	--	--	--	--
Poa compressa	11	55	5	5	25	6	13	65	5	8	40	10
Poa pratensis	15	75	7	11	55	13	13	65	5	10	50	12
Prunus serotina	1	5	0.4	--	--	--	2	10	0.8	--	--	--
Quercus velutina	11	55	5	--	--	--	9	45	3	1	5	1
Rhus copallina	3	15	1	--	--	--	2	10	0.8	--	--	--
Rhus radicans	--	--	--	--	--	--	3	15	1	--	--	--
Rosa carolina	19	95	8	11	55	3	19	95	7	11	55	13
Rubus occidentalis	1	5	0.4	--	--	--	1	5	0.4	--	--	--
Rudbeckia hirta	1	5	0.4	--	--	--	--	--	--	--	--	--
Rudbeckia(?)	--	--	--	--	--	--	--	--	--	--	--	--
Rumex acetosella	2	10	0.9	--	--	--	--	--	--	--	--	--
Sassafras albidum	1	5	0.4	1	5	1	1	5	0.4	1	5	1
Smilacina stellata	12	60	5	1	5	1	12	60	5	2	10	2
Solanum americanum	2	10	0.9	1	5	1	--	--	--	--	--	--
Solanum americanum(?)	1	5	0.4	--	--	--	4	20	2	2	10	2
Solanaceae seedling	--	--	--	--	--	--	--	--	--	--	--	--
Solidago nemoralis	2	10	0.9	--	--	--	1	5	0.4	--	--	--
Solidago speciosa	3	15	1	--	--	--	2	10	0.8	--	--	--
Sorghastrum nutans	--	--	--	--	--	--	--	--	--	--	--	--
Stipa spartea	2	10	0.9	--	--	--	7	35	3	2	10	2
Stipa spartea(?)	5	25	3	3	15	4						

TABLE 11: Herbaceous and small woody plant frequency, continued.
Transect C: Inland Savanna

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Tephrosia virginiana	5	25	2	--	--	--	5	25	2	--	--	--
Tradescantia ohiensis	6	30	3	--	--	--	2	10	0.8	--	--	--
Vaccinium angustifolium	8	40	3	2	10	2	8	40	3	2	10	2
Vaccinium vacillans	--	--	--	--	--	--	--	--	--	--	--	--
Viola(?) seedling	--	--	--	--	--	--	--	--	--	--	--	--
Vitis sp. seedling	1	5	0.4	--	--	--	3	15	1	--	--	--

TABLE 12: Herbaceous and small woody plants in decreasing order of frequency.

Transect C: Inland Savanna, September sampling.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Rosa carolina	90%	95%	Carex (pensylvanica?)	60%	--
Helianthus divaricatus	90	95	Helianthus divaricatus	55	50%
Carex (pensylvanica?)	80	--	Poa pratensis	55	50
Poa pratensis	75	65	Rosa carolina	55	55
Andropogon scoparius	65	70	Andropogon scoparius	25	30
Smilacina stellata	60	60	Poa compressa	25	40
Poa compressa	55	65	Coreopsis palmata	20	15
Quercus velutina	55	45	Stipa spartea (?)	15	10
Coreopsis palmata	50	45	Comandra richardsiana	10	25
Euphorbia corollata	50	60	Euphorbia corollata	10	5
Aster linariifolius	45	35	Helianthemum canadense	10	5
Vaccinium angustifolium	40	40	Helianthus occidentalis	10	5
Tradescantia ohiensis	30	10	Lupinus perennis	10	5
Stipa spartea (?)	25	--	Phlox glaberrima	10	--
Comandra richardsiana	25	50	Vaccinium angustifolium	10	10
Eragrostis capillaris	25	20	Ceanothus americanus	5	5
Phlox pilosa	25	40	Fragaria virginiana	5	5
Tephrosia virginiana	25	25	Maianthemum canadense	5	5
Helianthemum canadense	20	25	Monarda punctata	5	--
Helianthus occidentalis	20	15	Sassafras albidum	5	5
Lupinus perennis	20	40	Smilacina stellata	5	10
Monarda punctata	15	10	Solanum americanus	5	10
Panicum olig. var. scrib.	15	--	Carex penslyvanica	--	40
Rhus copallina	15	10	Diervilla lonicera	--	10
Solidago altissima	15	10	Phlox pilosa	--	10

TABLE 12: Herbaceous and small woody plants in decreasing order of frequency.

Transect C: Inland Dunes, September sampling, continued.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Aster azureus	10%	15%	Quercus velutina	--	5%
Diervilla lonicera	10	10			
Phlox glaberrima	10	10			
Rumex acetosella	10	--			
Solanum americanus	10	20			
Solidago nemoralis	10	5			
Stipa spartea	10	35			
Antennaria plantaginifolia	5	5			
Asclepias tuberosa	5	5			
Asclepias verticillata	5	10			
Campanula rotundifolia	5	5			
Ceanothus americanus	5	5			
Cyperus filiculmis	5	10			
Desmodium sp. (sterile)	5	--			
Dicot (seedling)	5	5			
Fragaria virginiana	5	5			
Hieraceum canadense	5	5			
Koeleria cristata	5	15			
Lespedeza sp. (?)	5	--			
Maianthemum canadense	5	10			
Prunus serotina	5	10			
Rubus occidentalis	5	5			
Rudbeckia hirta	5	--			
Sassafras albidum	5	5			
Solanum americanus (?)	5	20			

TABLE 12: Herbaceous and small woody plants in decreasing order of frequency.

Inland Dunes, September sampling, continued.

1-sq-m plots	1981	1982
Vitis sp. seedling	5%	15%
Carex (pensylvanica?)	--	80
Lespedeza capitata	--	20
Rhus Radicans	--	15
Panicum sp.	--	10
Ambrosia artimisiafolia	--	5
Carex muhlenbertii	--	5
Coreopsis lanceolata	--	5
Erigeron annuus	--	5
Lithospermum croceum	--	5
Panicum implicatum	--	5
Panicum virgatum	--	5
Viola (?) seedling	--	5

TABLE 13: Herbaceous and small woody plant frequency.
Transect D: Dune Acres

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Acer rubrum	--	--	--	--	--	--	1	5	0.3	--	--	--
Andropogon gerardi	--	--	--	--	--	--	3	15	1.1	1	5	1.2
Andropogon gerardi(?)	5	10	2	1	5	1	--	--	--	--	--	--
Andropogon scoparius	12	60	4	4	20	4	11	55	3.8	6	30	7.3
Asclepias tuberosa	3	15	1	--	--	--	3	15	1.1	1	5	1.2
Asclepias verticillata	--	--	--	--	--	--	--	--	--	--	--	--
Aster azureus	17	85	6	2	10	2	11	55	3.8	1	5	1.2
Aster dumosus	--	--	--	--	--	--	--	--	--	--	--	--
Aster linariifolius	--	--	--	--	--	--	1	5	0.3	--	--	--
Baptisia leucantha	--	--	--	--	--	--	--	--	--	--	--	--
Calamagrostis canadensis	--	--	--	--	--	--	1	5	0.3	--	--	--
Carex lanuginosa	--	--	--	--	--	--	--	--	--	--	--	--
Carex muhlenbergii(?)	4	20	1	1	5	1	--	--	--	--	--	--
Carex (pensylvanica?)	14	70	5	8	40	9	7	35	2.8	3	15	3.7
Carex ? (3-dm. lvs.)	1	5	0.3	--	--	--	--	--	--	--	--	--
Carex sp. (new)	--	--	--	--	--	--	9	45	3.1	2	10	2.4
Comandra richardsiana	9	45	3	4	20	4	8	40	2.8	3	15	3.7
Compositae	1	5	0.3	1	5	1	--	--	--	--	--	--
Coreopsis lanceolata	--	--	--	--	--	--	1	5	0.3	1	5	1.2
Coreopsis tripteris	18	90	6	4	20	4	17	85	5.9	2	10	2.4
Cornus (racemosa?)	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Desmodium canadense	1	5	0.3	1	5	1	1	5	0.3	1	5	1.2
Dicot (small)	2	10	0.7	2	10	2	1	5	0.3	--	--	--
Dicot seedling	1	5	0.3	1	5	1	1	5	0.3	--	--	--
Dicot seedling	1	5	0.3	--	--	--	1	5	0.3	1	5	1.2

TABLE 13: Herbaceous and small woody plant frequency, continued.
Transect D: Dune Acres

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			1-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Dicot (linear leaves)	1	5	0.3	--	--	--	--	--	--	--	--	--
Equisetum hyemale var affine	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Eryngium yuccifolium	7	35	2	1	5	1	7	35	2.4	2	10	2.4
Eupatorium altissimum	--	--	--	--	--	--	--	--	--	--	--	--
Euphorbia corollata	15	75	5	5	25	6	13	65	4.4	5	25	6.1
Fragaria virginiana	12	60	4	5	25	6	13	65	4.4	5	25	6.1
Galium pilosum	--	--	--	--	--	--	1	5	0.3	--	--	--
Gentiana saponaria	2	10	0.7	--	--	--	1	5	0.3	--	--	--
Gerardia flava	1	5	0.3	1	5	1	1	5	0.3	--	--	--
Gramineae seedling	1	5	0.3	--	--	--	--	--	--	--	--	--
Helianthus divaricatus	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Helianthus occidentalis	--	--	--	--	--	--	3	15	1.1	3	15	3.7
Helianthus occidentalis(?)	3	15	1	3	15	3	--	--	--	--	--	--
Hieracium canadense	1	5	0.3	--	--	--	--	--	--	--	--	--
Hieracium gronovii	4	20	1	--	--	--	1	5	0.3	--	--	--
Hypericum kalmianum	1	5	0.3	--	--	--	1	5	0.3	1	5	1.2
Hypoxis hirsuta	1	5	0.3	--	--	--	--	--	--	--	--	--
Iris virginica	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Koeleria cristata	--	--	--	--	--	--	1	5	0.3	--	--	--
Krigia biflora	7	35	3	1	5	1	5	25	1.7	1	5	1.2
Labiate? sp.	--	--	--	--	--	--	1	5	0.3	1	5	1.2
Lechea villosa	--	--	--	--	--	--	1	5	0.3	--	--	--
Lespedeza capitata(?)	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Liatris aspera	--	--	--	--	--	--	--	--	--	--	--	--
Liatris cylindracea	--	--	--	--	--	--	3	15	1.1	--	--	--

TABLE 13: Herbaceous and small woody plant frequency, continued.
Transect D: Dune Acres

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Liatris spicata	16	80	5	8	40	9	14	70	4.8	7	35	8.5
Liatris sp. seedling	--	--	--	--	--	--	1	5	0.3	--	--	--
Lupinus perennis	4	20	1	2	10	2	5	25	1.7	3	15	3.7
Ludwigia palustris	--	--	--	--	--	--	2	10	0.7	--	--	--
Lycopus sp. (sterile)	--	--	--	--	--	--	--	--	--	--	--	--
Lysimachia lanceolata	1	5	0.3	1	5	1	1	5	0.3	1	5	1.2
Monarda fistulosa	5	25	2	3	15	3	4	20	1.4	3	15	1.7
Morus alba? seedling	--	--	--	--	--	--	--	--	--	--	--	--
Oenothera pilosella	--	--	--	--	--	--	1	5	0.3	--	--	--
Opuntia humifusa	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Osmunda regalis	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Panicum implicatum	--	--	--	--	--	--	2	10	0.7	--	--	--
Panicum (polyanthes?)	--	--	--	--	--	--	1	5	0.3	--	--	--
Panicum virgatum	2	10	0.7	--	--	--	1	5	0.3	--	--	--
Panicum (w/villous sheath)	--	--	--	--	--	--	1	5	0.3	--	--	--
Panicum sp. (clasp. lvs.)	4	20	1	1	5	1	--	--	--	--	--	--
Panicum sp.	1	5	0.3	--	--	--	--	--	--	--	--	--
Pedicularis canadensis	12	60	4	3	15	3	12	60	4.2	4	20	4.9
Phlox glaberrima(?)	1	5	0.3	--	--	--	--	--	--	--	--	--
Poa compressa	1	5	0.3	1	5	1	2	10	0.7	--	--	--
Poa pratensis	16	80	5	9	45	10	16	80	5.6	12	60	15
Populus tremuloides	2	10	0.7	--	--	--	2	10	0.7	--	--	--
Potentilla simplex	--	--	--	--	--	--	1	5	0.3	--	--	--
Prenanthes alba	--	--	--	--	--	--	1	5	0.3	--	--	--
Prunus serotina	2	10	0.7	1	5	1	5	25	1.7	1	5	1.2

TABLE 13: Herbaceous and small woody plant frequency, continued.
Transect D: Dune Acres

	June 1981						June 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%FR	RFr	Fr	%Fr	RFr
Pteridium aquilinum	8	40	3	1	5	1	6	30	2.1	1	5	1.2
Pyrus (melanocarpa?)	--	--	--	--	--	--	1	5	0.3	--	--	--
Quercus velutina	5	25	2	--	--	--	5	15	1.7	--	--	--
Rosa carolina	4	20	1	--	--	--	3	15	1.1	--	--	--
Rubus hispidus	2	10	0.7	1	5	1	3	15	1.1	2	10	2.4
Rudbeckia hirta	4	20	1	--	--	--	2	10	0.7	--	--	--
Rudbeckia (?)	--	--	--	--	--	--	--	--	--	--	--	--
Salix humilis	9	45	3	--	--	--	11	55	3.8	--	--	--
Sassafras albidum	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Scleria triglomerata	--	--	--	--	--	--	2	10	0.7	--	--	--
Smilacina racemosa	--	--	--	--	--	--	1	5	0.3	--	--	--
Smilacina stellata	3	15	1	1	5	1	2	10	0.7	1	5	1.2
Smilax (lasioneura?)	--	--	--	--	--	--	1	5	0.3	--	--	--
Solidago altissima (?)	--	--	--	--	--	--	1	5	0.3	--	--	--
Solidago gramin. var meadia	--	--	--	--	--	--	2	10	0.7	--	--	--
Solidago nemoralis	2	10	0.7	--	--	--	2	10	0.7	--	--	--
Sorghastrum nutans	11	55	4	8	40	9	6	30	2.1	2	10	2.4
Spiraea alba	2	10	0.7	--	--	--	--	--	--	--	--	--
Spiranthes lacera	--	--	--	--	--	--	--	--	--	--	--	--
Stachys hyssopifolia	4	20	1	3	15	3	5	25	1.7	1	5	1.2
Taraxacum officinale	--	--	--	--	--	--	2	10	0.7	--	--	--
Tradescantia ohiensis	18	90	6	1	5	1	16	80	5.6	3	15	3.7
Vaccinium angustifolium	8	40	3	--	--	--	2	10	0.7	--	--	--
Vaccinium vacillans	2	10	0.7	--	--	--	1	5	0.3	--	--	--
Viola sagittata	2	10	0.7	--	--	--	3	15	1.1	1	5	1.2

TABLE 14: Herbaceous and small woody plants in decreasing order of frequency.

Transect D: Dune Acres, June sampling.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Coreopsis tripteris	90%	5%	Poa pratensis	45%	60%
Tradescantia ohiensis	90	80	Carex (pensylvanica?)	40	15
Aster azureus	85	55	Liatris spicata	40	35
Liatris spicata	80	70	Sorghastrum nutans	40	10
Poa pratensis	80	80	Euphorbia corollata	25	25
Euphorbia corollata	75	65	Fragaria virginiana	25	25
Carex (pensylvanica?)	70	20	Andropogon scoparius	20	30
Andropogon scoparius	60	55	Comandra richardsiana	20	15
Fragaria virginiana	60	65	Coreopsos tripteris	20	10
Pedicularis canadensis	60	60	Helianthus (occidentalis?)	15	--
Sorghastrum nutans	55	30	Monarda fistulosa	15	15
Comandra richardsiana	45	40	Pedicularis canadensis	15	20
Salix humilis	40	55	Stachys hyssopifolia	15	5
Pteridium aquilinum	40	30	Aster azureus	10	--
Vaccinium angustifolium	40	10	Lupinus perennis	10	15
Eryngium yuccifolium	35	35	Dicot (small)	10	--
Krigia biflora	35	25	Andropogon gerardi (?)	5	--
Monarda fistulosa	25	20	Carex muhlenbergii (?)	5	--
Quercus velutina	25	25	Compositae seedling	5	--
Carex muhlenbergii (?)	20	20	Desmodium canadense	5	5
Hieracium gronovii	20	--	Dicot seedling	5	5
Lupinus perennis	20	25	Eryngium yuccifolium	5	10
Panicum sp. (sterile)	20	20	Gerardia flava	5	--
Rosa carolina	20	15	Krigia biflora	5	5
Rudbeckia hirta	20	10	Lysimachia lanceolata	5	5

TABLE 14: Herbaceous and small woody plants in decreasing order of frequency

Transect D: Dune Acres, June sampling, continued.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Stachys hyssopifolia	20	25%	Panicum sp. (sterile)	5	--
Asclepias tuberosa	15	15	Poa compressa	5	--
Helianthus (occidentalis?)	15	15	Prunus serotina	5	5%
Smilacina stellata	15	10	Pteridium aquilinum	5	5
Andropogon gerardi (?)	10	15	Rubus hispidus	5	10
Dicot (small)	10	--	Smilacina stellata	5	5
Gentiana saponaria	10	5	Tradescantia ohiensis	5	15
Panicum virgatum	10	5	Carex pensylvanica	--	15
Populus tremuloides	10	10	Helianthus occidentalis	--	15
Prunus serotina	10	25	Carex sp. (new)	--	10
Rubus hispidus	10	15	Asclepias tuberosa	--	5
Solidago nemoralis	10	10	Aster azureus	--	5
Spiraea alba	10	--	Coreopsis lanceolata	--	5
Vaccinium vacillans	10	5	Hypericum kalmianum	--	5
Viola sagittata	10	15	Rudbeckia? (basal lvs.)	--	5
Carex (3-dm lvs.)	5	--	Viola sagittata	--	5
Compositae seedling	5	--			
Cornus (racemosa?)	5	5			
Desmodium canadense	5	5			
Dicot seedling	5	5			
Dicot seedling	5	--			
Dicot seedling	5	--			
Equisetum hyemale var. affine	5	5			
Gerardia flava	5	5			
Gramineae (sterile)	5	--			

TABLE 14: Herbaceous and small woody plants in decreasing order of frequency.

Transect D: Dune Acres, June sampling, continued.

1-sq-m plots	1981	1982
Helianthus divaricatus	5%	5%
Hieracium canadense	5	5
Hypericum kalmianum	5	5
Hypoxis hirsuta	5	5
Iris virginica	5	5
Lespedeza capitata (?)	5	5
Lysimachia lanceolata	5	5
Opuntia humifusa	5	5
Osmunda regalis	5	5
Panicum sp.	5	5
Phlox glaberrima (?)	5	5
Poa compressa	5	10
Sassafras albidum	5	5
Carex pensylvanica	--	15
	5	
Rudbeckia? (basal lvs.)	--	15
Ludwigia palustris	--	10
Panicum implicatum	--	10
Scleria triglomerata	--	10
Taraxicum officinale	--	10
Aster linearifolius	--	5
Calamagrostis canadensis	--	5
Carex sp. (new)	--	5
Coreopsis lanceolata	--	5
Galium pilosum	--	5

TABLE 14: Herbaceous and small woody plants in decreasing order of frequency.

Transect D: Dune Acres, June sampling, continued.

1-sq-m plots	1981	1982
Koeleria cristata	--	5%
Labiate sp. seedling	--	5
Lechia villosa	--	5
Liatris sp. seedling	--	5
Liatris cylindraceae	--	5
Oenoghera pilosella	--	5
Panicum (w/ villous sh.)	--	5
Panicum (polyanthes?)	--	5
Potentilla simplex	--	5
Prenanthes alba	--	5
Pyrus (melanocarpa?)	--	5
Smilacena racemosa	--	5
Smilax glauca?	--	5
Solidago altissima	--	5
Solidago gramin. var. med.	--	5

TABLE 15: Herbaceous and small woody plant frequency.
Transect D: Dune Acres

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Acer rubrum	--	--	--	--	--	--	--	--	--	--	--	--
Andropogon gerardi	4	20	1	2	10	2	6	30	2	2	10	2
Andropogon gerardi(?)	--	--	--	--	--	--	--	--	--	--	--	--
Andropogon scoparius	13	65	4	8	40	8	10	50	3	6	30	7
Asclepias tuberosa	2	10	0.7	1	5	1	2	10	0.7	1	5	1
Asclepias verticillata	--	--	--	--	--	--	1	5	0.3	--	--	--
Aster azureus	14	70	5	3	15	3	10	50	3	3	13	3
Aster dumosus	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Aster linariifolius	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Baptisia leucantha	1	5	0.3	--	--	--	--	--	--	--	--	--
Calamagrostis canadensis	1	5	0.3	1	5	1	1	5	0.3	--	--	--
Carex lanuginosa	--	--	--	--	--	--	1	5	0.3	--	--	--
Carex muhlenbergii(?)	2	10	0.3	1	5	1	--	--	--	--	--	--
Carex (pensylvanica?)	12	60	4	8	40	8	3	15	1	2	10	2
Carex? (3-dm. lvs.)	--	--	--	--	--	--	8	40	3	4	20	4
Carex sp. (new)	--	--	--	--	--	--	--	--	--	--	--	--
Comandra richardsiana	5	25	2	1	5	1	8	40	3	4	20	4
Compositae	--	--	--	--	--	--	1	5	0.3	--	--	--
Coreopsis lanceolata	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Coreopsis tripteris	16	80	5	5	25	5	16	80	5	4	20	4
Cornus (racemosa?)	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Desmodium canadense	1	5	0.3	--	--	--	1	5	0.3	1	5	1
Dicot (small)	--	--	--	--	--	--	--	--	--	--	--	--
Dicot seedling	--	--	--	--	--	--	--	--	--	--	--	--
Dicot seedling	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 15: Herbaceous and small woody plant frequency, continued.
Transect D: Dune Acres

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	FR	%Fr	RFr	Fr	%Fr	RFr
Dicot (linear leaves)	--	--	--	--	--	--	--	--	--	--	--	--
Equisetum hyemale var affine	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Eryngium yuccifolium	8	40	3	1	5	1	6	30	2	1	5	1
Eupatorium altissimum	2	10	0.7	--	--	--	--	--	--	--	--	--
Euphorbia corollata	14	70	5	7	35	7	14	70	5	5	25	6
Fragaria virginiana	14	70	5	5	25	5	13	65	4	4	20	4
Galium pilosum	--	--	--	--	--	--	2	10	0.7	--	--	--
Gentiana saponaria	6	30	2	3	15	3	1	5	0.3	--	--	--
Gerardia flava	1	5	0.3	1	5	1	1	5	0.3	--	--	--
Gramineae seedling	--	--	--	--	--	--	--	--	--	--	--	--
Helianthus divaricatus	1	5	0.3				1	5	0.3	--	--	--
Helianthus occidentalis	5	15	2	3	15	3	7	35	2	2	10	2
Helianthus occidentalis(?)	--	--	--	--	--	--	--	--	--	--	--	--
Hieracium canadense	1	5	0.3	--	--	--	--	--	--	--	--	--
Hieracium gronovii	2	10	0.7	--	--	--	--	--	--	--	--	--
Hypericum kalmianum	1	5	0.3	1	5	1	1	5	0.3	1	5	1
Hypoxis hirsuta	--	--	--	--	--	--	--	--	--	--	--	--
Iris virginica	1	5	0.3	--	--	--	1	1	0.3	--	--	--
Koeleria cristata	--	--	--	--	--	--	--	--	--	--	--	--
Krigia biflora	4	20	2	1	5	1	7	35	2	1	5	1
Labiate? sp.	--	--	--	--	--	--	--	--	--	--	--	--
Lechea villosa	3	15	1	--	--	--	2	10	0.7	--	--	--
Lespedeza capitata(?)	--	--	--	--	--	--	1	5	0.3	--	--	--
Liatris aspera	1	5	0.3	--	--	--	--	--	--	--	--	--
Liatris cylindracea	4	20	2	--	--	--	5	25	2	--	--	--

TABLE 15: Herbaceous and small woody plant frequency, continued.
Transect D: Dune Acres

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Liatris spicata	15	75	5	6	30	6	14	70	5	6	30	7
Liatris sp. seedling	--	--	--	--	--	--	--	--	--	--	--	--
Lupinus perennis	2	10	0.7	2	10	2	3	15	1	2	10	2
Ludwigia palustris	--	--	--	--	--	--	--	--	--	--	--	--
Lycopus sp. (sterile)	--	--	--	--	--	--	1	5	0.3	1	5	1
Lysimachia lanceolata	3	15	1	1	5	1	3	15	0.7	1	5	1
Monarda fistulosa	5	25	2	3	15	3	3	15	0.7	2	10	2
Morus alba? seedling	--	--	--	--	--	--	1	5	0.3	--	--	--
Oenothera pilosella	1	5	0.3	--	--	--	--	--	--	--	--	--
Opuntia humifusa	1	5	0.3	--	--	--	--	--	--	--	--	--
Osmunda regalis	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Panicum implicatum	1	5	0.3	--	--	--	5	25	2	--	--	--
Panicum (polyanthes?)	--	--	--	--	--	--	2	10	0.7	--	--	--
Panicum virgatum	2	10	0.7	2	10	2	4	20	1	1	5	1
Panicum (w/villous sheath)	--	--	--	--	--	--	--	--	--	--	--	--
Panicum sp. (clasp. lvs.)	1	5	0.3	--	--	--	--	--	--	--	--	--
Panicum sp.	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Pedicularis canadensis	15	75	5	8	40	8	10	50	3	5	25	6
Phlox glaberrima(?)	--	--	--	--	--	--	--	--	--	--	--	--
Poa compressa	1	5	0.3	--	--	--	--	--	--	--	--	--
Poa pratensis	18	90	6	10	50	11	17	85	6	15	75	17
Populus tremuloides	2	10	0.7	--	--	--	2	10	0.7	--	--	--
Potentilla simplex	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Prenenthes alba	--	--	--	--	--	--	1	5	0.3	--	--	--
Prunus serotina	1	5	0.3	1	5	1	3	15	1	1	5	1

TABLE 15: Herbaceous and small woody plant frequency, continued.
Transect D: Dune Acres

	Sept. 1981						Sept. 1982					
	1-sq-m plots			0.05-sq-m plots			1-sq-m plots			0.05-sq-m plots		
	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr	Fr	%Fr	RFr
Pteridium aquilinum	8	40	3	1	5	1	6	30	2	2	10	2
Pyrus (melanocarpa?)	1	5	0.3	--	--	--	2	10	0.7	--	--	--
Quercus velutina	4	20	1	--	--	--	4	20	1	--	--	--
Rosa carolina	2	10	0.7	--	--	--	3	15	1	1	5	1
Rubus hispidus	3	15	1	3	15	3	7	35	2	4	20	4
Rudbeckia hirta	4	20	1	--	--	--	7	35	2	--	--	--
Rudbeckia (?)	--	--	--	--	--	--	--	--	--	--	--	--
Salix humilis	10	50	3	--	--	--	10	50	3	1	5	1
Sassafras albidum	2	10	0.7	--	--	--	2	10	0.7	--	--	--
Scleria triglomerata	3	15	1	--	--	--	2	10	0.7	--	--	--
Smilacina racemosa	--	--	--	--	--	--	1	5	0.3	--	--	--
Smilacina stellata	2	10	0.7	1	5	1	1	5	0.3	1	5	1
Smilax (lasioneura?)	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Solidago altissima(?)	--	--	--	--	--	--	1	5	0.3	--	--	--
Solidago gramin. var meadia	1	5	0.3	--	--	--	2	10	0.7	--	--	--
Solidago nemoralis	4	20	1	--	--	--	1	5	0.3	--	--	--
Sorghastrum nutans	11	55	4	5	25	5	10	50	3	1	5	1
Spiraea alba	1	5	0.3	--	--	--	1	5	0.3	--	--	--
Spiranthes lacera	--	--	--	--	--	--	1	5	0.3	--	--	--
Stachys hyssopifolia	3	15	1	--	--	--	4	20	1	2	10	2
Taraxacum officinale	2	10	0.7	--	--	--	2	10	0.7	--	--	--
Tradescantia ohiensis	4	20	1	--	--	--	4	20	1	1	5	1
Vaccinium angustifolium	8	40	3	--	--	--	2	10	0.7	--	--	--
Vaccinium vacillans	2	10	0.7	--	--	--	--	--	--	--	--	--
Viola sagittata	2	10	0.7	--	--	--	5	50	2	--	--	--

TABLE 16: Herbaceous and small woody plants in decreasing order of frequency.

Transect D: Dune Acres, September sampling.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Poa pratensis	90%	85%	Poa pratensis	50%	75%
Coreopsos tripteris	80	80	Andropogon scoparius	40	30
Liatris spicata	75	70	Carex (pensylvanica?)	40	10
Pedicularis canadensis	75	50	Pedicularis canadensis	40	25
Aster azureus	70	50	Euphorbia corollata	35	25
Euphorbia corollata	70	70	Liatris spicata	30	30
Fragaria virginiana	70	65	Coreopsis tripteris	25	20
Andropogon scoparius	65	50	Fragaria virginiana	25	20
Carex (pensylvanica?)	60	15	Sorghastrum nutans	25	5
Sorghastrum nutans	55	50	Aster azureus	15	15
Salix humilis	50	50	Gentiana saponaria	15	--
Eryngium yuccifolium	40	30	Helianthus occidentalis	15	10
Pteridium aquilinum	40	30	Monarda fistulosa	15	10
Vaccinium angustifolium	40	10	Rubus hispidus	15	20
Gentiana saponaria	30	5	Andropogon gerardi	10	10
Comandra richardsiana	25	40	Lupinus perennis	10	10
Helianthus occidentalis	25	35	Panicum virgatum	10	5
Monarda fistulosa	25	15	Asclepias tuberosa	5	--
Andropogon gerardi	20	30	Calamagrostis canadensis	5	--
Krigia biflora	20	35	Carex muhlenbergii (?)	5	--
Liatris cylindracea	20	25	Comandra richardsiana	5	20
Quercus velutina	20	20	Eryngium yuccifolium	5	5
Rudbeckia hirta	20	10	Gerardia flava	5	--
Solidago nemoralis	20	5	Hypericum kalmianum	5	5
Tradescantia ohiensis	20	20	Krigia biflora	5	5

TABLE 16: Herbaceous and small woody plants in decreasing order of frequency.

Transect D: Dune Acres, September sampling, continued.

1-sq-m plots	1981	1982	0.05-sq-m plots	1981	1982
Helianthus occidentalis	15%	35%	Lysimachia lanceolata	5%	5%
Lechea villosa	15	10	Prunus serotina	5	5
Lysimachia lanceolata	15	15	Pteridium aquilinum	5	10
Rubus hispidus	15	35	Smilacina stellata	5	5
Scleria triglomerata	15	10	Carex (3-dm lvs.)	--	20
Stachys hyssopifolia	15	20	Stachys hyssopifolia	--	10
Asclepias tuberosa	10	10	Asclepias tuberosa	--	5
Carex muhlenbergii (?)	10	--	Desmodium canadensis	--	5
Eupatorium altissimum (?)	10	--	Dicot seedling	--	5
Hieraceum gronovii	10	--	Lycopus sp.	--	5
Lupinus perennis	10	15	Rosa carolina	--	5
Panicum virgatum	10	20	Salix humilis	--	5
Populus tremuloides	10	10	Tradescantia ohiensis	--	5
Rosa carolina	10	15			
Sassafras albidum	10	10			
Smilacina stellata	10	5			
Taraxacum officinale	10	10			
Vaccinium vacillans	10	--			
Viola sagittata	10	10			
Aster dumosus	5	5			
Aster linariifolius	5	5			
Baptisia leucantha	5	--			
Calamagrostis canadensis	5	5			
Coreopsis lanceolata	5	5			
Cornus (racemosa?)	5	5			

TABLE 16: Herbaceous and small woody species in decreasing order of frequency.

Transect D: Dune Acres, September sampling, continued.

1-sq-m plot	1981	1982
Desmodium canadense	5%	5%
Equisetum hyemale var. affine	5	5
Gerardia flava	5	5
Helianthus divaraicatus	5	5
Hieraceum canadense	5	--
Hypericum kalmianum	5	5
Iris virginica	5	5
Liatris aspera	5	--
Oenothera pilosella	5	--
Opuntia humifusa	5	--
Osmunda regalis	5	5
Panicum sp. (sterile)	5	5
Panicum sp. (clsp. lvs.)	5	--
Panicum implicatum	5	25
Poa compressa	5	--
Potentilla simplex	5	5
Prunus serotina	5	15
Pyrus (melanocarpa?)	5	10
Smilax (lasionerua?)	5	5
Solidago gramin. var. mead.	5	10
Spiraea alba	5	5
Carex (3-dm lvs.)	--	40
Rudbeckia hirta? seedling	--	25
Asclepias verticillata	--	10
Galium pilosum	--	10

TABLE 16: Herbaceous and small woody plants in decreasing order of frequency.

Transect D: Dune Acres, September sampling, continued.

1-sq-m plots	1981	1982
Panicum (polyanthes?)	--	10%
Carex lanuginosa	--	5
Compositae seedling	--	5
Dicot small	--	5
Dicot seedling	--	5
Dicot (spatulate lvs.)	--	5
Dicot seedling	--	5
Dicot seedling	--	5
Dicot seedling	--	5
Lespedeza capitata	--	5
Lycopus sp.	--	5
Morus alba? seedling	--	5
Prenanthes alba	--	5
Smilacena racemosa	--	5
Solidago altissima	--	5
Spiranthes lacera	--	5

TABLE 17: Low shrub density.
Transect A: Miller Woods

	Sept. 1981			Sept. 1982		
	Stems	Density (stems/ha)	Relative Density (%)	Stems	Density (stems/ha)	Relative Density(%)
Rosa carolina	258	129,000	30	244	122,000	33
Vaccinium angustifolium	220	110,000	25	156	78,000	21
Vaccinium vacillans	178	89,000	21	122	61,000	16
Rhus radicans	88	44,000	10	104	52,000	14
Quercus velutina	66	33,000	8	65	32,500	9
Prunus virginiana	24	12,000	3	27	13,500	4
Ceanothus americanus	13	6,500	1	19	9,500	3
Rhus copallina	12	6,000	1	11	5,500	2
Quercus alba	5	2,500	0.6	1	500	0.1
Vitis sp. seedling				1	500	0.1
Total	864	432,000	99.6	750	375,000	102.2

TABLE 18: Tall shrub and small tree density.
Transect A: Miller Woods, September 1981.

Species (size class, cm dbh)	Stems	Density (stems/ha)	Relative Density (%)
Prunus serotina (0-2.5)	3	60	50
Quercus velutina (0-2.5)	3	60	50
TOTAL	6	120	100

TABLE 19: Tree density
Transect A: Miller Woods, September 1981.

Species (Size class, cm dbh)	Stems	Density (stems/ha)	Relative Density (%)
Quercus alba (10-20)	1	2.5	1
" " (20-30)	1	2.5	1
" " (30-40)	--	--	--
" " (40-50)	1	2.5	1
Quercus velutina (10-20)	7	17.5	9
" " (20-30)	43	107.5	55
" " (30-40)	23	57.5	30
" " (40-50)	2	5.0	3
TOTAL	78	195.0	100

TABLE 20: Low shrub density.
Transect B: Inland Marsh

	Sept. 1981			Sept. 1982		
	Stems	Density (stems/ha)	Relative Density (%)	Stems	Density (stems/ha)	Relative Density (%)
Cephalanthus occidentalis	43	21,500	100	54	27,000	100

TABLE 21: Tall shrub and small tree density
Transect B: Inland Marsh, September 1981.

Species (size class, cm dbh)	Stems	Density (stems/ha)	Relative Density(%)
Cephalanthus occidentalis (0-2.5)	133	2,600	100

TABLE 22: Low shrub density.
Transect C: Inland Savanna

	Sept. 1981			Sept. 1982		
	Stems	Density (stems/ha)	Relative Density (%)	Stems	Density (stems/ha)	Relative Density (%)
Rosa carolina	236	118,000	46	220	110,000	44
Vaccinium angustifolium	191	95,000	37	200	100,000	40
Ceanothus americanus	36	18,000	7	35	17,500	7
Quercus velutina	30	15,000	6	19	9,500	4
Diervilla lonicera	8	4,000	2	9	4,500	2
Rhus radicans	--	--	--	4	2,000	0.8
Rhus copallina	6	3,000	1	2	1,000	0.4
Prunus serotina	1	500	0.2	2	1,000	0.4
Rubus occidentalis	1	500	0.2	4	2,000	0.8
Sassafras albidum	1	500	0.2	2	1,000	0.4
Vitis sp.	1	500	0.2	4	2,000	0.8
Total	511	255,500	99.8	501	250,500	100.2

TABLE 23: Tall shrub and small tree density.
Transect C: Inland Savanna, September 1981.

Species (size class, cm dbh)	Stems	Density (stems/ha)	Relative Density (%)
Amelanchier laevis (0-2.5)	3	60	1
Quercus velutina (0-2.5)	150	3,000	66
" " (2.5-5.0)	43	860	19
" " (5.0-7.5)	2	40	1
Rhus copallina (0-2.5)	16	320	7
Rhus typhina (0-2.5)	9	180	4
Sassafras albidum (0-2.5)	1	20	0.4
" " (2.5-5.0)	5	100	2
TOTAL	229	4,580	100.4

TABLE 24: Tree density
Treasect C: Inland Savanna, September 1981.

Species (size class, cm dbh)	Stems	Density (stems/ha)	Relative Density (%)
Quercus velutina (10-20)	3	7.5	11
" " (20-30)	6	15.0	22
" " (30-40)	10	25.0	37
" " (40-50)	6	15.0	22
" " (50-60)	6	2.5	4
" " (60-70)	6	2.5	4
TOTAL	27	67.5	100

TABLE 25: Low shrub density.
Transect D: Dune Acres

	Sept. 1981			Sept. 1982		
	Stems	Density (stems/ha)	Relative Density (%)	Stems	Density (stems/ha)	Relative Density (%)
Rubus hispidus	149	74,500	56	197	98,500	56
Salix humilis	42	21,000	16	75	37,500	21
Rosa carolina	19	9,500	7	7	3,500	2
Vaccinium angustifolium	17	8,500	6	15	7,500	4
Quercus velutina	16	8,000	6	11	5,500	3
Sassafras albidum	8	4,000	3	6	3,000	2
Populus tremuloides	4	2,000	2	3	1,500	0.8
Prunus serotina	4	2,000	2	9	4,500	3
Hypericum kalmianum	3	1,500	1	10	5,000	3
Pyrus (melanocarpa?)	3	1,500	1	6	3,000	2
Cornus (racemosa?)	1	500	0.4	1	500	0.3
Spiraea alba	1	500	0.4	3	1,500	0.8
Morus (alba?)	--	--	--	10	5,000	3
Total	267	133,500	100.8	353	176,500	100.9

TABLE 26: Tall shrub and small tree density.
Transect D: Dune Acres, September 1981.

Species (size class, cm dbh)	Stems	Density (stems/ha)	Relative Density (%)
Populus tremuloides (0-2.5	15	300	15
" " (2.5-5.0)	2	40	2
Prunus serotina (0-2.5)	14	280	14
Quercus velutina (0-2.5)	32	640	32
" " (2.5-5.0)	19	380	19
" " (5.0-7.5)	16	320	16
Sassafras albidum (0-2.5)	2	40	2
TOTAL	100	2,000	100

TABLE 27: Tree density
Transect D: Dune Acres, September 1981

Species (size class, cm dbh)	Stems	Density (stems/ha)	Relative Density (%)
Prunus serotina (10-20)	1	2.5	5
Quercus velutina (10-20)	11	27.5	55
" " (20-30)	2	5.0	10
" " (30-40)	3	7.5	15
" " (40-50)	2	5.0	10
" " (50-60)	--	--	--
" " (60-70)	1	2.5	5
TOTAL	20	50.0	100

SUMMARY

The sampling transects at Indiana Dunes were established to show the pre-burn condition of the vegetation and to monitor the long term effects of burning. However, one year of monitoring showed changes in vegetation that further substantiate the need for the burning program.

Transect A: Miller Woods.--This area has burned frequently in recent years. The one year without fire showed little change in the herbaceous layer. The few notable herbaceous changes might indicate a transition to a more mesic community, but should be viewed skeptically because of the wet season in 1982.

Nearly half of the small shrub species at Miller Woods are low blueberries (*Vaccinium angustifolium* and *Vaccinium vacillans*). Blueberries decrease rapidly in the absence of fire. In one year without fire the blueberries decreased 60,000 stems/ha at Transect A. This dramatic decrease of the dominant meant an overall decrease of small shrubs even though there was an increase of other small shrub species.

Transect B: Inland Marsh.--Chosen for its undisturbed condition, Inland Marsh showed little change in herbaceous vegetation. Though an increase of cattails (*Typha latifolia*) and purple loosestrife (*Lythrum salicaria*) would be expected in the marsh if no burning occurs, significant increases were not shown along the transect in one year. Probably the lack of change in herbaceous vegetation is because deep water limits the number of species.

Transect C: Inland Savanna.--Of the transects sampled, Inland Savanna showed the least change. The slight herbaceous changes reflect the increasingly mesic conditions caused by the extending canopy. The slight decline of small shrubs further demonstrates the loss of light to the understory. The shrub species which did increase are commonly found in mesic woods, not sand savannas.

Transect D: Dune Acres.--Once so open a savanna that it is variously called Lois Howe Prairie, Lupine Lane Prairie, and Dune Acres Prairie, this area shows the greatest effects of fire suppression. There was an increase of woodland and wetland herbaceous species that might have been caused by the wet season, but which was probably caused, at least in part, by increasing shade. There was a corresponding decrease of prairie and dry-savanna species caused not only by the wet season, but also by the increased canopy and duff.

Small shrubs increased 43,000 stems/ha showing the rapid transition of the area. This overall increase encompassed a decline in such prairie or savanna species as low blueberries and black oak (*Quercus velutina*), further evidence of the rapidly changing community.

CONCLUSION

Though all the areas should be managed with periodic occasional burning, they vary in their current need for fire. Miller Woods has burned often and recently and shows no immediate need for fire. Inland Marsh shows no herbaceous imbalance due to fire suppression,

but, without fire, woody encroachment will soon threaten. Inland Savanna has developed sufficient canopy that without burning soon, it may begin to change rapidly. Dune Acres is now in danger of loosing floristic diversity. If fire does not soon remove shrubs and duff, it could become a dense community of shrubs with few surviving herbaceous species. The savanna species would be greatly reduced and the prairie flora lost.

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Appendix

NOTES ON PLANT TAXONOMY

Aster linariifolius and *Phlox glaberrima*

Aster linariifolius apparently was mistakenly identified as *Phlox glaberrima* several times during the June 1981 sampling. Though *Phlox* has opposite leaves and *Aster* does not, their leaves are similar and samplers were not familiar enough with *Aster linariifolius* to avoid errors in identifying the small, sterile specimens.

The problem was not detected until long after the 1981 season when the June and September sampling data from Transect C were compared. *Phlox* was found to have an anomalously big decrease from June to September, coinciding with an anomalously big increase in *Aster* from June to September.

Based on a study of the sampling forms, it is likely that the"phloxes" tallied in June for plots 8, 16, 18, 19, and 20 at Transect C were actually asters because no phloxes were identified in these plots in September, but asters were found in four of these five plots in September. Phloxes were also recorded from plots 2 and 5 in September. One other plot (17) supposedly had phlox in June; this identification may be correct because *Aster linariifolius* was also recorded from this plot at the same time.

In summary, the June sampling form for Transec C shows the following tallies for *Phlox glaberrima*: 2-X, 5-X, 8-/, 16-/, 17-X, 18-/, 19-/, 20-/. The correct tally would probably be: 2-X, 5-X, 17-X. The September sampling form shows the following tallies for

Phlox glaberrima: 2-X, 5-X. There are believed accurate because *Aster linariifolius* was also found in these plots and because phlox should have been correctly identified in September.

The September identifications of *Aster linariifolius* should be correct, but some , if not all, of the supposed phloxes recorded in plots 8, 16, 18, 19, and 20 in June were actually asters because no phloxes were found in these plots in September, but asters were found in all except plot 16.

The sampling data or the figures in the summary table for Transect C were not changed because one cannot determine the mistakes now. However, one should realize that the June 1981 figures for *Aster linariifolius* probably are much too low and the *Phlox glaberrima* are too high.

In Transect A, *Aster linariifolius* was not recorded in 1981 or 1982. The *Phlox glaberrima* recorded in plot 15 in 1981 was no doubt accurate because it was thus identified again in June and September of 1982.

In Transect D, *Phlox glaberrima(?)* was recorded in plot 11 in June 1981. In September *Aster linariifolius* was recorded in plot 11. In 1982 *Aster linariifolius* was recorded in both June and September. *Phlox glaberrima* was not recorded at Transect D in 1982. The June 1981 data has not been changed, however.

Carex pensylvanica

Though *Carex pensylvanica* is by far the commonest sedge along the savanna transects, identifications were qualified with

a "?" unless the plants were fertile. It now seems safe to consider most, if not all, the questionable specimens to be *Carex pensylvanica*.

Erigeron annuus

The daisy fleabanes in Transect A were referred to *Erigeron annuus* even though the pubescence is spreading only on the lower stem. The plants are somewhat like *Erigeron strigosus*, and the key in Swink and Wilhelm (1979) might lead one to conclude that the specimens are *Erigeron strigosus*. Examination of herbarium specimens shows that the specimens are *Erigeron annuus*.

Maianthemum canadense

Maianthemum canadense var. *interius* was not distinguished from the typical variety. Most, if not all, of the plants along the transects probably are variety *interius*.

Vaccinium angustifolium and *Vaccinium vacillans*

Vaccinium angustifolium and *Vaccinium vacillans* are common in the savannas at Indiana Dunes National Lakeshore. The two species occur in the same habitat and often grow together, though *Vaccinium angustifolium* is the commoner species in the study areas. It is more difficult to separate the two species in June than in September. In 1981 some tentative identifications made in June were changed during the September sampling.

Vaccinium vacillans has (relatively) large, broad, rounded leaves that are whitish beneath. *Vaccinium angustifolium* has smaller, relatively narrower, pointed leaves that are paler, but green, not whitened beneath. *Vaccinium angustifolium* often has more very fine teeth on the edges of its leaves than has *Vaccinium*

vacillans, but the degree of serration of the leaf margin cannot be used to distinguish the two species. *Vaccinium vacillans* is often nearly toothless, but its leaves can be as closely and finely toothed as *Vaccinium angustifolium* leaves. Though *Vaccinium angustifolium* generally has teeth on its margins, it is not difficult to find individual leaves that have essentially no teeth.

Keys in Plants of the Chicago Region (Swink and Wilhelm, 1979) and Guide to the Vascular Flora of Illinois (Mohlengrock, 1975) use the degree of serration on the leaves to distinguish the two species, but this character is not reliable for distinguishing the two species at Indiana Dunes. Gray's Manual of Botany (Fernald, 1950) and Flora of Illinois (Jones, 1963) describe both species as having toothed leaves.

Occasional plants are difficult to assign to either species because the specimens have characteristics that overlap and intergrade or they have the characteristics of both species. For example, at Dune Acres many clones have leaves that are pale beneath (perhaps somewhat glaucous) and are intermediate in size, shape, and serration.

The Indiana Dunes specimens of *Vaccinium angustifolium* are referrable to var. *laevifolium*, which has larger leaves than the typical variety.