AN ECOLOGICAL STUDY OF THE TERRESTRIAL PLANT COMMUNITIES IN THE VICINITY OF THE DUANE ARNOLD ENERGY CENTER, OPERATIONAL PHASE

Prepared by

John Konefes, M.S.
Donald B. McDonald, Ph.D.

January 15, 1978

INTRODUCTION

The NRC technical specifications for the Duane Arnold Energy Center section 4.1.2 of Environmental Surveillance and Special Studies require operational terrestrial studies as described below:

"4.1.2 Terrestrial

Objective

1. To determine the characteristics of the terrestrial plant and animal communities in the vicinity of the DAEC following plant start-up. Comparison of the results of these determinations with preoperational studies will make it possible to assess the effects of the operation of the DAEC on the terrestrial ecology.

Specification

The terrestrial monitoring program as reported in the DAEC Terrestrial Flora Study (August 1972) and Terrestrial Fauna Study (October 1972) will be repeated two years after commercial operation of the plant commences.

Bases

The terrestrial flora and fauna studies established the baseline ecology prior to the operation of the DAEC. These studies will be repeated in order to document any significant effects of plant operation on the terrestrial environment. The purpose of this study was to determine the nature of plant communities in the vicinity of the station two years after plant start-up and to compare these studies to results obtained during the pre-operational terrestrial studies conducted in 1972.

OBJECTIVES AND SCOPE

The primary objectives of the terrestrial flora study are threefold: 1) to conduct another aerial multispectral data acquisition mission over the Cedar River basin near the DAEC in order to determine the present nature and distribution of plant cover within the area; 2) to conduct "ground truth" studies in conjunction with the aerial survey in order to specifically determine plant types and densities in selected areas; and 3) to compare the information obtained in the present aerial and ground studies with the pre-operational studies in order to determine if any

changes have occurred in the terrestrial plant communities which are related to station operation.

STUDY PLAN

During June 1972 the Iowa Geological Survey conducted a multispectral data acquisition mission over the Cedar River. Five rolls of imagery were obtained during the flyover, two at an altitude of 4,000 feet, the remainder at 8,000 feet.

In conjunction with the aerial survey, studies of the terrestrial plant communities were conducted in the vicinity of the DAEC and Pleasant Creek Reservoir. These studies included general vegetation surveys to determine types and distribution of vegetation present in the area as well as transects in selected areas (Palo Marsh, Pleasant Creek, Wickiup Hills, etc.) to specifically determine plant species and densities. In addition, field studies to determine the presence or abundance of game birds and animals as well as a species inventory of mammals and birds were made. These studies are described in the 1972 Terrestrial Flora and Terrestrial Fauna report submitted to Iowa Electric Light and Power Company in October 1972 (Niemann & McDonald, 1972)

The 1977 operational studies also included a multispectral data acquisition mission by the Iowa Geological Survey. The entire area was photographed from 8,000 feet with detailed photos of the plant site from 4,000 feet. Terrestrial flora studies will be essentially the same as those conducted in 1972 and provided the necessary "ground truth" data so that a relatively comprehensive description of the present plant communities in the vicinity of Duane Arnold Energy Center could be prepared.

The Duane Arnold Energy Center is located in eastern Iowa, where a humid continental, warm summer climate prevails. This type of climate favors the development of broadleaved deciduous forest in areas where

rainfall is adequate, such as in eastern Iowa. The regional vegetation of this area is described as Oak-Hickory forest along the major rivers and a mosiac of Oak-Hickory forest and Bluestem prairie on the uplands (Kuchler, 1964). Forests originally covered 16% of the land surfaces in Iowa with the remaining 84% being tall grass prairie (Sander, 1969). The forests are concentrated along the rivers of Iowa.

Forest vegetation is essentially all that remains of the native vegetation in Iowa, most of the prairie having been plowed and devoted to agriculture. Even though much of the original forest cover has remained in Iowa, it has been greatly altered from its original structure by the activities of man since the settlement of the state. Cutting, grazing, the cessation of prairie fires, and the introduction of the Dutch Elm Disease have all had a drastic effect on the forests.

The study areas selected in the current study, included three of the five sites originally surveyed in the 1972 pre-operational study (Figure 1-3). All are relatively natural areas which have been set aside as County Parks. The study areas are: 1) Palo Marsh County Park, 2) Lewis Bottoms Access County Park, and 3) Wickiup Hill County Park. Two additional sites, the Lewis Preserve County Park and the Pleasant Creek Reservoir site, which were surveyed in the 1972 pre-operational study were not utilized in the present study since extensive logging was being conducted in the Lewis Preserve and the Pleasant Creek Reservoir had been completed and was filling during the operational study.

METHODS

In so far as possible, the methodology employed during the current study was the same as that utilized in 1972. All of the study areas were initially examined in order to obtain preliminary data on the type of vegetation present and the species composition. Transects were established in each study area for the purpose of obtaining quantitative data.

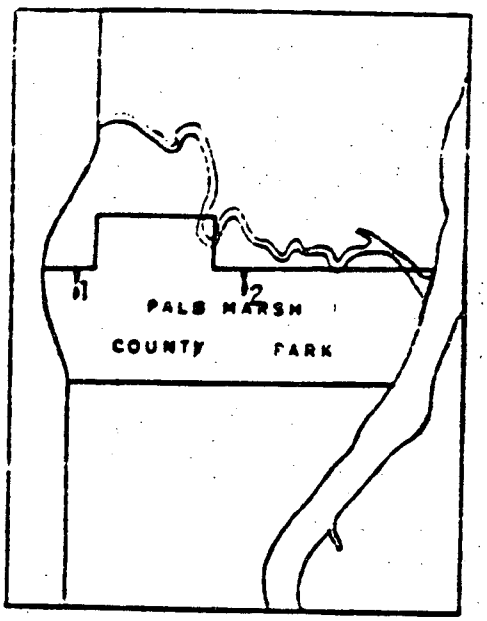

Fig 1

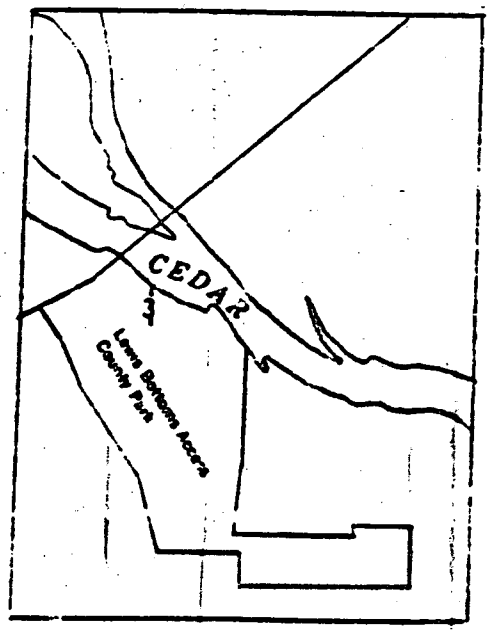

Fig 2

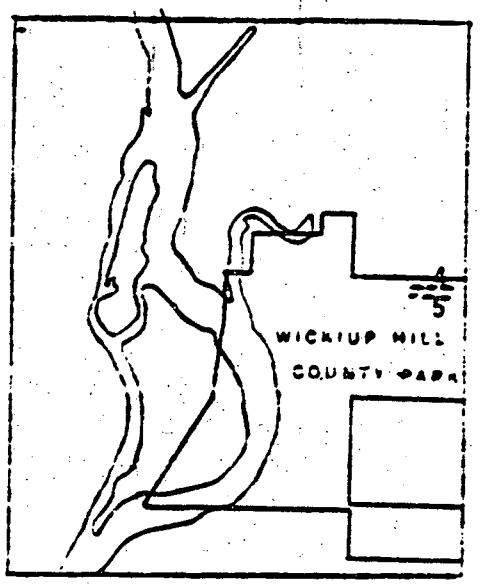

Fig 3

Figures 1 to 3
Location of Study Areas
(Transects are indicated on figures)

Herbaceous species were sampled using a 20x50 cm plot. All herbaceous species as well as shrubs and tree seedlings less than 1 meter tall were sampled with the 20x50 cm plot. Forty plots were taken along the transect in each sample area. The plots were 1.5 meters apart along the transect. Each species occurring within the plot was recorded along with rooted density and percentage foliage cover.

Shrubs were sampled in a similar manner using 1x1 meter plot. Forty plots were located one meter apart along the transect. Each species occurring within a plot was recorded as well as the rooted density and the percentage foliage cover. All shrubs and tree seedlings over one meter tall but less than 2.5 cm in diameter at breast height (1.5 meters above the ground) were sampled with these plots.

Trees were sampled by the quarter system method as discussed by Curtis (1959). Briefly, this method consists of setting up a transect and locating points at intervals along the transect. At each point, usually 20 paces apart in this study, four quadrants are established using the line of the transect and a line perpendicular to it. In each quadrant, the distance to the nearest tree is measured as well as the diameter of the tree and the species is determined. All trees over 2.5 cm in diameter are measured. As many as 40 points (160 trees) were sampled in each site where this method was used. In one study area this method was not practical due to the small area to be sampled, so a rectangular plot was used for sampling. Where the quarter system was used, the original transect which was used for herb and shrub sampling was also used for the tree sampling, but due to the greater area required for sampling trees, several parallel transects were required, but they were all relatively close to the herb and shrub transect.

When all of the data were collected, they were summarized as follows: Herb data were condensed into percentage frequency, average rooted density per square meter and average percentage cover. In order to more clearly

compare species, values for relative frequency, relative density, and relative dominance were calculated. These figures simply express the value for all species. The sum of the relative frequency, relative density, and relative dominance (derived from percentage cover values) is termed the importance value. Although this value is not always indicative of the true importance of a species, it generally serves as a satisfactory guide to importance (Daubenmire, 1968).

The shrub data were not suitable for complete analysis because of the small amount of shrub cover in the study areas, thus only percentage frequency, density and percentage cover are presented.

Tree data were handled in much the same way as herb data. Percentage frequency, relative frequency, relative density, and relative dominance are presented. The percentage frequency was calculated by dividing the number of points at which a species occurs at least once, by the total number of points. Relative frequency is calculated in the same manner as for herbs. Relative density is calculated by dividing the number of trees of a certain species by the total number of trees sampled. Relative dominance is calculated by dividing the summed basal area (cross sectional area at breast height) for that species by the total basal area for all species. The importance value is derived in the same manner as for herbs. In addition, the basal area for each species is presented as well as the total trees per acre and per hectare. Trees per acre values are calculated by adding all values for distance from point to tree, and dividing this by the total number of distances. This figure is the mean distance from the point to the tree. The mean distance is then squared. 43560 is divided by the squared mean distance to give trees per acre.

The field work reported in this study was carried out from mid July to mid October 1977. Scientific names of plants found in the study areas are used throughout the text while common names are used when the plant is first

mentioned and are also given in the appendix.

RESULTS

Palo Marsh County Park

Palo Marsh County Park is situated in the northern half of Section 21, Linn County, about ½ mile north of Palo, Iowa. The Duane Arnold Energy Center lies two miles to the north of the marsh.

The Park encompasses about 130 acres and includes a variety of habitat types. The western half of the park is primarily open marshland while the eastern portion is bottomland woods. A strip of meadow and brushland separates the marsh from the woods.

Open Area

The open marshland is composed of large expanses dominated by Phalaris arundinacea (Reed Canary Grass). Small areas of open water are interspersed throughout the marsh, supporting communities of Sagittaria latifolia (Broad-leaved Arrowhead) and Alisma triviale (Water Plantain) on their edges.

Shrubs and small trees can be found growing in isolated clumps within the marsh and in larger stands on the edge of the marsh.

The transect for this area (Transect 1 - Figure 1) starts at the northern boundary fence at a point 10 meters east of the first pond that the fence crosses. It runs directly south through a Phalaris dominated area passing close to an isolated small tree and the edge of a pond (Figure 1). Forty sample plots were used in this area.

Phalaris arundinacea overwhelmingly dominates the open marsh area. It occurred in every plot and greatly outnumbered any other species with a density of 539 stems/m^2. Some plots exhibited 100% cover by Phalaris, and the average percentage cover of Phalaris was much greater than for any other species. A very large importance value of 273.7 for Phalaris emphasizes its prominent place in the marsh community.

The other species that were found were mainly near the open pond in

somewhat wetter areas than the pure stands of Phalaris. None of them even approached the importance of Phalaris.

The situation in the marsh five years ago was quite similar to the present situation. Phalaris was overwhelmingly dominant, with five other species occurring sparsely in the plots. The main difference to be noted is a 25% decline in density and percentage cover of Phalaris. This decrease can be attributed to the long run of dry conditions in the area up to and during the period of study. Lack of moisture results in lower reproduction of new shoots (lower density) and curling of Phalaris leaves to conserve moisture (lower percentage cover). A comparison of 1972 and 1977 aerial photographs emphasizes the relative lack of mositure in 1977. Many pools and ponds that appear in the 1972 inegary are absent in 1977.

A quantitive summary of the plant cover in the Palo Marsh open area is given in Tables 1-7. The spacine list includes plants in the meadow area and near the car path running through the marsh that are not associated with the marsh community.

Woods

The woodod area of Palo Marsh County Park is a typical bottomland or flood plain forest. It is fairly uniform throughout especially in the herb layer where Laportea canadensis (Burning Nettle) is the dominant species. Acer saccharinum (Silver Maple), Acer negundo (Box Elder) and Fraxinus pennsylvanica (Green Ash) are the major trees found in the woods. There are a number of open spaces from 20' - 50' in diameter in the woods that were created by the death of large elm trees. Species composition is different in these open areas than in the surrounding herb layer under the forest canopy. Laportea, Ranunculus septentrionalis (Swamp Buttercup), Cryptotaenia canadensis (Honewort), and other spacies that occur under the canopy are absent from these open spaces. Instead we find species such as Ambrosia trifida (Great Ragweed).

The transect for the wooded area (Transect 2 - Figure 1) runs south from the north boundary fence, starting 200 feet east of the western-most corner post in the woods (see Figure 1). Forty sample plots were used for herb and shrub data, while thirty points were used to compile the tree data.

Laportea canadensis was the major species of the herbaceous layer. Large Laportea gave the floor a very uniform appearance and resulted in a high value for percentage cover. Underneath these large plants were many small Laportea seedlings as well as other relatively small herbaceous species. The large number of Laportea seedlings (about 75% of the total Laportea stem count) inflated the density value to 170 stems per square meter. The relative values gave a large importance value for Laportea, over twice as great as the second highest value of Cryptotaenia canadensis.

Cryptotaenia was similar to Laportea in that there were many small seedlings and relatively few large plants. Percentage cover for Cryptotaenia was the second largest.

Ranunculus septentrionalis had an importance value of 43.7, the third highest value. Nearly all of the plants encountered in the plot were well past a seedling stage and contributed substantially to the percentage cover for Ranunculus septentrionalis.

Ranunculus abortivus (Kidneyleaf Buttercup), on the other hand, was nearly always in a very young, small stage and the percentage cover was less than 5% in the plots where it occurred. This gives a very small percentage cover value of less than 0.1% for all forty plots, even though Ranunculus abortivus occurred in 47.5% of the forty plots.

In 1972 Laportea canadensis was in a position very similar to that of 1977. Values for frequency, density, and percentage cover of Laportea are remarkably similar. Relative values, especially relative density, are slightly lower because of changes in other species noted below, and this gives a 1977 importance value of 142.4 compared to 1972's value of 169.9. The

large number of Laportea seedlings found this year was also noted in the 1972 report, which stated that the large number of seedlings may have been only an ephemerel occurance due to unusually favorable conditions. However, it seems that heavy Laportea reproduction may be a common occurrence and large numbers of seedlings are likely to be found every year.

Some changes did occur in other species, notable Cryptotaenia, R. septentrionelis, R. abortivus, Impatiens pallida (Jewelweed) and Rudbeckia laciniata (Green-headed Coneflower).

Cryptotaenia and R. abortivus values were higher for 1977 in both frequency and density, while the percentage cover values are approximately the same for both years. This indicates that there are a greater number of young plants this year than there were five years ago. This may be due to the drier conditions prevailing over the last few years which would facilitate reproduction by these two species. In a normal year it may be too wet, and flooding may occur that inhibits good early growth of young Cryptotaenia and R. abortivus specimens.

Ranunculus septentronalis, I. pallida, and R. laciniata values changed considerably in all categories. This change in believed to be due to the patchiness of occurrence of these species.

The 1977 transect passed through a large patch of especially dense R. septentronalis which inflated the 1977 values relative to 1972. R. septentronalis was misidentified in the 1972 report as R. pennsylvanicus. R. septentrionalis is fairly uniformly distributed under the large Laportea layer, but in one area crossed by the transect, Laportea did not grow well and R. septentrionalis flourished. Were it not for this "patch", values of R. septentrionalis for this year would be much closer to those of 1972.

Impatiens pallida, and R. laceniata are very patchy in diatribution in the Palo Marsh Woods. They are not diatributed evenly onder the Laportea layer, but grow in groups. Our transect passed close to only one I. pallida clump,

and did not cross any R. laciniata clump. As a result, values for these species, which were high in 1972, are quite a bit lower this year.

Changes in the data obtained for these three species illustrate the inherent limitations of the transect method. Even though our transect was in the same small area as the 1972 transect, it was easy to hit or miss groups of plants. The data obtained for species such as Laportea, which are uniformly distributed, are not subject to this fault. These data show that changes in Laportea, the dominant species, are remarkably small.

The shrub layer is very sparse, and two specimens of Sambucus canadensis (Elderberry) were the only shrubs encountered in the transect. This indicates that tree reproduction is minimal, as was the case in 1972.

Tree species of the wooded area are those typically found in a flood plain forest. Acer saccharinum (Silver Maple), Fraxinus pennsylvanica (Green Ash), and Acer negundo (Box Elder) are the dominant species. Ulmus americana, (American Elm) Salix nigra (Black Willow), Populus deltoides (Cottonwood) Juglans nigra (Black Walnut), and Robinia pseudoacacia (Black Locust) form a group of trees distributed throughout the area but which are of lesser importance. Ulmus americana formerly belonged with the group of dominant species, but Dutch elm disease has destroyed many large trees and reduced its influence.

Crataegus mollis (Hawthorn) is a common smaller species in the wooded areas. Often only a shrub in other wooded areas, in this study Crataegus usually fit the criteria set for inclusion in the tree category. Its common occurrence is reflected in high values for frequency and relative density, while its small size is apparent by the low relative dominance value. This results in a high importance value since size is considered only in relative dominance.

The density of trees in the area was 304 trees/acre. Thirty points were used to sample tree species.

Over the last five years, the wooded area of Palo Marsh County Park has changed mainly as a result of Ulmus americana loss to disease. All values for U. americana have decreased substantially, as exemplified by a drop in importance value from 39.1 to 22.4. Loss of large trees has left numerous open spaces mentioned in the discussion of the herbaceous vegetation. Increases in Acer saccharinum values over the last five years substantiated the statement made in the 1972 report that A. saccharinum seemed to be assuming much of the space formerly occupied by U. americana.

Two major differences between the 1972 and 1977 studies are apparent from the aerial survey photos. Palo Marsh Woods was much wetter in 1972 as indicated by areas of standing water in the wooded areas. There were also many more defoliated large trees (presumably American Elms) in 1972. By 1977 these trees had either fallen or had been crowded by surrounding trees making them less obvious on the photographs.

Values for the other species are comparable to those of five years ago. Shrub and tree data for Palo Marsh Woods are summarized in Tables 8 - 20.

Lewis Bottoms Access County Park

Lewis Bottoms Access County Park (Lewis Preserve Access County Park in the 1972 report) encompasses an area of 140 acres on the southwestern edge of the Cedar River. It is located in sections 20 and 29 of Linn County, about 4 miles NNW of the Duane Arnold Energy Center.

This park exhibits much variation within its boundaries. Open, weedy areas, floodplain forest, brush, and marshy areas are all intermingled, and none of these occur in large expanses. Rather the park grades quickly from one type of habitat to another and back again. This is especially apparent in the western half of the park where the study transect was situated. (Transect 3 - Figure 2).

The study area was located in a small tract of floodplain forest. The transect ran south from the river, beginning about 200 meters downstream

from the bridge at the north corner of the park (Figure 2). Thirty plots were used to sample the herbaceous vegetation and 25 points were used in the quarter system for trees.

The herbaceous vegetation of this park represents a complex and varied situation. There are no large areas of relatively uniform vegetation as in Palo Marsh Woods. Instead the herbaceous layer is patchy and diverse, due in part to numerous dead falls. The wooded area in Lewis Bottoms is also younger, judging by size of trees such as Acer saccharinum (Silver Maple), and the area is subject to much more intense recreational use. The values for herbs reflect this situation well. Eight species in Lewis Bottoms have importance values greater than ten, while only four species in Palo Marsh County Park have equally high values.

The variability of Lewis Bottoms makes a representative sampling by transect difficult. Within the wooded area where the transect was located, Laportea canadensis (Burning Nettle) and Rhus radicans (Poison Ivy) are the dominant herbaceous species. This is not a uniform co-dominance however since there are areas where one or the other species may dominate completely. The 1977 transect passed mostly through areas of Laportea dominance. This will allow a more reliable and valid comparison if future transects pass through a similar area. It also permits a comparison between similar communities in Palo Marsh Woods and Lewis Bottoms Access.

Laportea is the species of most importance in the herbaceous layer and it occurred in every sample plot. The majority of Laportea plants encountered were larger plants and not seedlings. This accounts for the relatively low value of 43 stems/m^2 for Leportea (compared to 170 stems/m2 in Palo Marsh Woods). Viola sp (Violet) is second in importance. The next six species, as mentioned above, have importance values greater than ten.

The data gathered this year differs from the 1972 data in a number of respects. Laportea is the dominant with an importance well above any other

species both in 1972 and 1977. The density value for this year, however, is much lower than that observed in 1972 even though there has been a definite increase in frequency. The 1972 report mentions the large number of Laportea seedlings present, but this year there are relatively few seedlings. This is reflected by a lower density value. Lack of rain early this year and in the past few years is undoubtedly the reason behind the poor reproduction. The sandy soil of Lewis Bottoms does not hold moisture well and magnifies the drought effect. The soil of Palo Marsh Woods, on the other hand, holds moisture well and can support good seedling growth.

Viola sp has been affected by the drought in a similar manner. Large plants predominate instead of the numerous seedlings found in 1972.

Rhus radicans has declined substantially in every category due to the fact that the 1977 transect passed through areas where Laportea was the main dominant or a co-dominant. Given the variability of the Lewis Bottoms Woods, a transect through one type of area should be more representative of the area and more amenable to future comparison.

Parthenocissus quinquefolia (Virginia Creeper) is uniformly distributed both Rhus and Laportea dominated areas. Thus little change in values for Parthenocissus has occurred between 1972 and 1977. Parthenocissus apparently has not been significantly affected by the drought.

One other notable difference between 1972 and 1977 is the appearance of Arabis sp (Rock Cress). This herb did not occur in any of the 1972 plots. Arabis sp is known for its tolerance of dry conditions, and the extended period of dry weather in the area coupled with the presence of sandy soil has favored its growth in Lewis Bottoms.

A comparison between the floodplain forests of Palo Marsh Woods and Lewis Bottoms Access show two important differences. 1) the forest of Lewis Bottoms is a more disturbed area exhibiting greater variety than that of Palo Marsh Woods, and 2) the effects of the drought of 1976 and

early summer 1977 are more apparent in Lewis Bottoms. This is evidenced by the sparsity of Laportea and Viola seedlings, and the increased presence of species such as Arabis that can tolerate dry conditions.

Shrub data for this year is scanty, as it was in 1972. This indicates that a small amount of tree reproduction is taking place. Table 28 is a summary of shrub data for Lewis Bottoms.

The forested area of Lewis Bottoms Access County Park represents a floodplain forest in early stages of development. Acer negundo (Box Elder), Acer saccharinum (Silver Maple), Fraxinus pennsylvanica (Green Ash), and Morus rubra (Red Mulberry), are replacing trees such as Populus deltoides (Cottonwood) and Salix nigra (Black Willow). The majority of invading trees are 10-20 years old, somewhat younger than those of Palo Marsh Woods. A number of dead Ulmus americana (American Elm) specimens indicate that Dutch Elm disease is having an effect here as well as in Palo Marsh Woods.

Acer negundo and M. rubra are the commonest trees encountered in the area, as indicated by the high frequency and relative dominance values. They are relatively small trees, however, and this is reflected by their low relative dominance values. The combination of high relative frequency and relative density values is responsible for placing A. negundo and M. rubra in first and second place on the list of importance values.

Acer saccharinum and F. pennsylvanica achieve high importance values in the area by being both numerous and of significant size. The largest trees encountered were specimens of P. deltoides. Although these were few in number, their size alone was enough to give them a high importance value. Calculations from the transect data gave a figure of 444 trees/acre for the area.

Five years ago, A. negundo and M. rubra were also represented by large numbers of small trees and the 1972 and 1977 values for these species do not differ significantly. In the future, we can expect a change in this situation

as the shortlived M. rubra is dominated by A. negundo, S. saccharinum, and F. pennsylvanica.

There were approximately the same number of A. saccharinum specimens encountered this year as in 1972. The frequency and relative dominance values were lower, however, indicating that the transect encountered smaller, more clustered trees. Good reproduction by A. saccharinum, especially in space formerly occupied by U. americana, is partly responsible for this difference.

Populus deltoides has values very similar to those of 1972. These are based on a few large trees in the area. The figures for P. deltoides will decrease in the future as these large specimens die and are not replaced, although this may not occur for a number of years.

The biggest change noted during the current study was the drastic decline in values for Ulmus americana. In 1972 U. americana was fourth in importance while this year it is eighth in importance with a much lower value. Again, this change can be ascribed to the ravages of Dutch Elm disease on both young and old trees.

Tables 21-33 present summaries of the plant cover in the Lewis Bottoms screen area.

Wickiup Hill County Park

Wickiup Hill County Park is an area of about 200 acres directly across the Cedar River ½ mile from the Duane Arnold Energy Center. It is located in section 10 of Linn County.

A variety of habitats can be found within the park boundaries. Close to the river are open, sandy areas grading into floodplain forest. The eastern, higher portion of the park is upland forest dominated by red and white oak. Interspersed in the eastern half are small open grassy areas, a few cornfields, and recently planted pine. The park is not subject to heavy recreational use except during the fall hunting season.

The study area was located in the northeastern corner of the park. This is a hilly area of upland forest with a small creek and associated moist areas at the bottom of the wooded slopes. The moist areas near the creek support species such as Laportea canadensis (Burning Nettle) and Mitella diphylla (Bishops-Cap), while representative species found on the slopes include Phryma leptostachya (Lopseed) and Sanguinaria canadensis (Bloodroot). Other species such as Amphicarpa bracteata (Hog-peanut) and Desmodium sp (Tick-trefoil), can be found in both areas.

The 1977 study transects (Transects 4 & 5 - Figure 3) were confined to the south facing slop indicated in Figure 3. The transects began about 80 meters from the eastern boundary of the park and ran to the west. Two parallel transects were used, the first running parallel to the northern boundary fence, 10 meters downslope, and the second transect another 10 metere further down the slope. The transects did not enter the moist, lower areas. This was in contrast to the 1972 study where the transect partially included some of the moister habitat. It was felt that the moist areas were not representative of the predominant upland forest in the area, and they were therefore excluded from the 1977 study. Thirty plots were used to obtain herb and shrub data.

The dominant herb of the upland forest in 1977 was Parthenocissus quinquefolia (Virginia Creeper). All other herbs had much lower values in every category. Second in importance was Amphicarpa bracteata, which was represented by many small plants (note the relatively low value for percentage cover). Other species of noteable importance in the area include Desmodium sp, Fraxinus americana (Green Ash) seedlings, Rhus radicans (Poison Ivy), Phryma leptostachya, Geranium maculatum (Wild Geranium) and Sanguinaria canadensis.

A large number (twenty-four) of herbs occurred within the transect plots, and many of these had substantial importance values. This indicates

a great diversity in the herbaceous layer.

It is difficult to evaluate changes in the data from 1972 to 1977, since the 1972 transect impinged upon the moist areas around the creek. Impatiens canadensis and M. diphylla did not occur at all in the 1977 study, whereas they were two of the most important herbs in 1972. This is due to the fact that the 1977 transect was confined to the middle area of the wooded slope. Any L. canadensis or M. diphylla that may have been found there in years of normal or above normal rainfall would have been on the driest extreme of their habitat capabilities. The dry conditions prevailing this year and last year assured that these species would be confined to a narrow band near the creek, outside the range of our transect.

Fraxinus americana seedlings and P. quinquefolia, two of the more important species this year, were also of high importance in 1972. They were confined mostly to the wooded slopes. Many species were found in both 1972 and 1977, and many of them had high importance values. This indicates that the diversity of the area is still intact.

The understory layer is quite well developed, as is evident by the abundance of shrub data. Ostrya virginiana (Ironwood), a common understory species, dominates the shrub layer. Acer saccharum (Sugar Maple) and F. americana are present in the shrub layer as young trees, indicating that these species are reproducing well. Other important species in the understory are Ulmus rubra (Slippery Elm), Rhus radicans (Poison Ivy), and Carpinus Caroliniana (Blue Beech).

The fact that only two shrubs were encountered in the 1972 study does not indicate that there was not an understory at that time. The understory was represented in 1972 by larger shrubs that were included in the tree category (diameter 2.5 cm.). Since 1972, reproduction of shrub and tree species has been good, resulting in the large number of shrubs encountered this year.

The majority of shrubs in the area, especially O. virginiana, A. saccharum, and C. caroliniana appear to be 3 - 4 years old. Within the next five years these should grow sufficiently to enter the tree category, and shrub data may once again be scanty.

To sample trees, a rectangular plot 80' x 150' was set up on the hillside being studied and all trees within the plot were sampled. This sampling technique was also used in 1972. Calculations from this data give only relative density and relative dominance, so importance values cannot be calculated.

Ostrya virginiana was the commonest tree encountered, but these were all small shrubby trees. This is shown by the very low value for relative dominance. Carpinus caroliniana was also a common species, but it too is an understory species with a low relative dominance value.

The dominant tree in the area was Quercus rubra (Red Oak). Other important trees in the plot were Quercus alba (White Oak), A. saccharum, and F. americana. Calculated density was 319 trees/acre.

In 1972, O. virginiana had a much higher relative density value, accounting for half of the tree specimens. This year, large Ostrya are less common as trees, but dominate the shrub category.

Quercus rubra was also the dominant tree in 1972, while Q. alba and Fraxinus were generally the larger trees in the plot. There appears to have been little change in tree composition of the area and no great changes within the next five years are likely.

Herb, shrub, and tree cover in the Wickiup Hills area are summarized in Tables 34 - 49.

CONCLUSIONS

In all of the four areas studied, no drastic changes in the plant communities have occurred during the last five years. The major factor influencing vegetation in the study area appeared to be abnormally low precipitation during the spring and early summer of 1977. This was especially evident in the Palo Marsh Open Area and the Lewis Bottoms Access.

All other changes in the vegetation that have occurred since 1972 were attributable to disease, natural succession or human activities, i.e., logging in the Lewis Preserve area and inundation of vegetation due to the filling of the Pleasant Creek Reservoir. There was no indication that the operation of the Duane Arnold Energy Center has significantly affected either the size or composition of the plant communities in the study area.

LITERATURE CITED

Curtis, J.T. 1959. The vegetation of Wisconsin. Madison, Wisconsin, University of Wisconsin Press.

Daubenmire, R. 1968. Plant communities. New York, New York, Harper and Row Publishers.

Küchler, A.W. 1964. Potential vegetation of the conterminous United States: Map. American Geographical Society Special Publication 36.

Niemann, D. and McDonald, D.B. 1972. An ecological study of the terrestrial plant communities in the vicinity of the Duane Arnold Energy Center Report prepared for Iowa Electric Light and Power Co. Cedar Rapids, Iowa.

Sanders, D.R. 1969. Structure and pattern of the herbaceous understory of deciduous forests in central Iowa. Unpublished Ph.D. thesis. Ames, Iowa Library, Iowa State University.

Table 1

Palo Marsh, Open Area

Herbs	Frequency of
Phalaris arundinacea	100.0
Teucrium canadense	7.5
Carex sp.	5.0
Leersia oryzoides	5.0
Asclepias incarnata	2.5
Aster sp.	2.5
Juncus sp.	2.5
Typha latifolia	2.5

Table 2

Palo Marsh, Open Area

Herbs	Relative Frequency of
Phalaris arundinacea	78.4
Teucrium canadense	5.9
Carex sp.	3.9
Laersia orysoides	3.9
Asclepious incarnata	2.0
Aster sp.	2.0
Juncus sp.	2.0
Typha latifolia	2.0

Table 3

Palo Marsh, Open Area

Density of Herbs

Phalaris arundinacea	539
Carex sp.	3
Aster sp.	2
Juncus sp.	2
Leersia oryzoides	2
Teucrium canadense	?
Asclepias incarnata	1
Typha latifolin	0

Table 4

Palo Marsh, Open Area

Relative Density of Herbs

Phalaris erundinacea	97.8
Carex sp.	0.5
Aster sp.	0.4
Juncus sp.	0.4
Leersia oryzoides	0.4
Teucrium canadense	0.4
Asclepias incarnata	0.2
Typha latifolia	0

Table 20

Palo Marsh, Woods

Importence Values of Trees

Acer saccharinum	82.9
Fraxinus pennsylvanica	42.6
Crataegus mollis	37.3
Acer negundo	33.7
Ulmus americana	22.4
Salix nigra	19.0
Populus deltoides	18.8
Juglans nigra	15.1
Robinia pseudoacacia	12.3
Quercus bicolor	6.5
Celtis occidentalis	6.4
Morus rubra	2.8

Table 5

Palo Marsh, Open Area

Percentage Cover of Herbs

Phalaris arundinacea	59.0
Teucrium canadense	0.6
Aster sp.	0.5
Typha latifolia	0.3
Asclepias incarnata	0.1
Carex sp.	< 0.1
Juncus sp.	< 0.1
Leersia oryzoides	< 0.1

Table 6

Palo Marsh, Open Area

Relative Dominance of Herbs

Phalaris arundinacea	97.5
Teucrium canadense	1.0
Aster sp.	0.5
Typha latifolia	0.5
Asclepias incarnata	0.2
Carex sp.	—
Juncus sp.	—
Leersia oryzoides	—

Teble 7

Pale Marsh, Open Area

Importance Value of Herbs

Phalaris arundinacea	273.7
Teucrium canadense	7.3
Carex sp.	4.4
Leersia oryzoides	4.3
Aster sp.	3.2
Typha latifolia	2.5
Asclepias incarnata	2.4
Juncus sp.	2.4

Palo Marsh, Open Area

Species List

Abutilon theophrasti
Acer saccharinum
Achillea millefolium
Alisma triviale
Amaranthus hybridus
Amaranthus retroflexus
Ambrosia trifida
Arctium lappa
Asclepias incarnata
Asclepias syriaca
Asclepias verticullata
Aster sp.

Barbarea vulgaris
Bidens aristosa
Boltonia asteroides
Brassica rapa

Carex sp.
Cephalanthus occidentalis
Cerastrum nutans
Circium arvense
Circium vulgare
Clematis pitcheri
Convolvulus sepium

Fraxinus pennsylvanica

Geum canadense
Geum virginianum

Hypericum canadense

Lactuca sp.
Leersia oryzoides
Lycopus americanus

Mimulus alatus

Oenothera biennis

Phalaris arundinacea
Physostagia virginiana
Plantago major
Polygonum sp.
Potentilla norvegica

Rumex crispus

Sagittaria latifolia
Salix nigra
Solidago sp.
Stachys hispida

Teucrium canadense
Typha latifolia

Ulmus rubra
Urtica gracilis

Verbascum thapsus
Verbena hastata
Vernonia fasciculate
Viola sp.

Xanthum sp.

Table 8

Palo Marsh, Woods

Frequency of Herbs

Laportee canadensis	100.0
Cryptotaenia canadensis	80.0
Ranunculus septantrionalis	80.0
Ranunculus abortivus	47.5
Viola sp.	15.0
Pilea pumila	12.5
Polygonum sp.	7.5
Rhus radicans	7.5
Acer saccharinum	5.0
Elymus virginicus	5.0
Urtica gracilis	5.0
Ambrosia trifida	2.5
Convolvulus sepium	2.5
Echinocystis lobata	2.5
Impatiens pallida	2.5
Laersia virginica	2.5
Sambucus canadensis	2.5
Solidago sp.	2.5
Stachys tenuifola	2.5

Table 9

Palo Marsh, Woods

Relative Frequency of Herbs

Laportea canadensis	26.0
Cryptotaenia canadensis	20.8
Ranunculus septentrionalis	20.8
Ranunculus abortivus	12.3
Viola sp.	3.9
Pilea pumila	3.2
Polygonum sp.	1.9
Rhus radicans	1.9
Acer saccharinum	1.3
Elymus virginicus	1.3
Urtica gracilis	1.3
Ambrosia trifida	0.6
Convolvulus sepium	0.6
Echinocystis lobata	0.6
Impatiens pallida	0.6
Leersia virginica	0.6
Sambucus canadensis	0.6
Solidago sp.	0.6
Stachys tenuifola	0.6

Table 10

Palo Marsh, Woods

Density of Herbs

Laportea canadensis	170
Cryptotaenia canadensis	107
Ranunculus septentrionalis	41
Ranunculus abortivus	15
Pilea pumila	10
Elymus virginicus	9
Polygonum sp.	2
Viola sp.	2
Acer saccharinum	1
Convoluvulus sepium	1
Impatiens pallida	1
Leersia virginica	1
Rhus radicans	1
Sambucus canadensis	1
Solidago sp.	1
Stachys tenuifola	1
Urtica gracilis	1
Ambrosia trifida	0
Echinocystis lobata	0

Table 11

Palo Marsh, Woods

Relative Density of Herbs

Laportea canadensis	46.6
Cryptotaenio canadensis	29.3
Ranunculus septentrionalis	11.2
Ranunculus abortivus	4.1
Pilea Pumila	2.7
Elymus virginicus	2.5
Polygonum sp.	0.5
Viola sp.	0.5
Acer saccharinum	0.3
Convolvulus sepium	0.3
Impatiens pallida	0.3
Leersia virginica	0.3
Rhus radicans	0.3
Sambucus canadensis	0.3
Solidago sp.	0.3
Stachys tenuifola	0.3
Urtica gracilis	0.3
Ambrosia trifida	0
Echinocystis lobata	0

Table 12

Pelo Marsh, Woods

Percentage Cover of Herbs

Laportea canadensis	71.9
Ranunculus septentrionalis	12.0
Cryptotaenia canadensis	9.0
Urtica gracilis	2.5
Polygonum sp.	2.1
Elymus virginicus	1.5
Pilea pumila	0.9
Ambrosia trifida	0.8
Echinocystis lobata	0.8
Solidago sp.	0.[illegible]
Viola sp.	0.4
Convolvulus sepium	0.1
Impatiens pallida	0.1
Acer saccharinum	< 0.1
Leersia virginica	< 0.1
Ranunculus abortivus	< 0.1
Rhus radicans	< 0.1
Stachys tenuifola	< 0.1

Table 13

Palo Marsh, Woods

Relative Dominance of Herbs

Laportea canadensis	69.8
Ranunculus septentrionalis	11.7
Cryptotaenia canadensis	8.7
Urtica gracilis	2.4
Polygonum sp.	2.0
Elymus virginicus	1.3
Pilea pumila	0.9
Ambrosia trifida	0.8
Echinocystis lobata	0.8
Solidago sp.	0.8
Viola sp.	0.4
Convolvulus sepium	0.1
Impatiens pallida	0.1
Sambucus canadensis	0.1
Leersia virginica	< 0.1
Acer saccharinum	< 0.1
Ranunculus abortivus	< 0.1
Rhus radicans	< 0.1
Stachys tenuifolia	< 0.1

Table 14

Palo Marsh, Woods

Importance Value of Herbs

Laportea canadensis	142.4
Cryptotaenia canadensis	58.8
Ranunculus septentrionalis	43.7
Ranunculus abortivus	16.4
Pilea pumila	6.8
Elymus virginicus	5.3
Viola sp.	4.8
Polygonum sp.	4.4
Urtica gracilis	4.0
Rhus radicans	2.2
Solidago sp.	1.7
Acer saccharinum	1.6
Ambrosia trifida	1.4
Echinocystis lobata	1.4
Convolvulus sepium	1.0
Impatiens pallida	1.0
Sambucus canadensis	1.0
Leersia virginica	0.9
Stachys tenuifola	0.9

Table 15

Palo Marsh, Woods

Summary of Shrub Data

	%Frequency	Stems/40m^2	%Cover
Sambucus canadensis	5.0	3	1.75

Table 16

Palo Marsh, Woods

Frequency of Trees

Acer saccharinum	60.0
Fraxinus pennsylvanica	43.3
Acer negundo	40.0
Crataegus mollis	40.0
Ulmus americana	23.3
Salix nigra	16.7
Populus deltoidas	13.3
Celtis occidentalis	10.0
Juglans nigra	10.0
Robinia pseudoacacia	10.0
Quercus bicolor	6.7
Morus rubra	3.3

Table 16

Palo Marsh, Woods

Acer saccharinum	60.0
Fraxinus pennsylvanica	43.3
Acer negundo	40.0
Crataegus mollis	40.0
Ulmus americana	23.3
Salix nigra	16.7
Populus deltoides	13.3
Celtis occidentalis	10.0
Juglans nigra	10.0
Robinia pseudoacacia	10.0
Quercus bicolor	6.7
Morus rubra	3.3

Table 17

Palo Marsh, Woods

Relative Frequency of Trees

Acer saccharinum	21.7
Fraxinus pennsylvanica	15.7
Acer negundo	14.5
Crataegus mollis	14.5
Ulmus americana	8.4
Salix nigra	6.0
Populus deltoides	4.8
Celtis occidentalis	3.6
Juglans nigra	3.6
Robinia pseudoacacia	3.6
Quercus bicolor	2.4
Morus rubra	1.2

Table 18

Palo Marsh, Woods

Relative Density of Trees

Acer saccharinum	27.5
Crataegus mollis	19.2
Fraxinus pennsylvanica	16.7
Acer negundo	11.7
Ulmus americana	6.7
Populus deltoidea	4.2
Salix nigra	4.2
Celtis occidentalis	2.5
Juglans nigra	2.5
Robinia pseudoacacia	2.5
Quercus bicolor	1.7
Morus rubra	0.8

Table 19

Palo Marsh, Woods

Relative Dominance of Trees

Acer saccharinum	33.7
Fraxinus pennsylvanica	10.2
Populus deltoides	9.8
Juglans nigra	9.0
Salix nigra	8.8
Acer negundo	7.5
Ulmus americana	7.3
Robinia pseudoacacia	6.4
Crataegus mollis	3.8
Quercus bicolor	2.4
Morus rubra	0.8
Celtis occidentalis	0.3

Palo Marsh, Woods

Species List

Acer negundo
Acer saccharinum
Ambrosia trifida
Amphicarpa bracteata
Arisaema dracontium

Celtis occidentalis
Convolvulus sapium
Crataegus mollis
Cryptotaenia canadensis

Echinocystis lobata
Elymus virginicus

Fraxinus pennsylvanica

Impatiens capensis
Impatiens pallida

Juglans nigra

Laportea canadensis
Leersia oryzoides

Mirabilis nyctaginee
Morus rubra

Oxalis stricta

Parthenocissus quinquefolia
Pilea pumila
Polygonum sp.
Populus deltoides
Potentilla norvegica

Quercus bicolor

Ranunculus abortivus
Ranunculus septentrionalis
Rhus radicans
Robinia pseudoacacia
Rudbeckia laciniata

Salix nigra
Sambucus canadensis
Scrophularia marilandica
Solidago sp.
Stachys tenuifola

Tovara virginiana

Ulmus americana
Urtica dioica
Urtica gracilis

Viola sp.
Vitis sp.

Table 21

Lewis Bottoms Access

Frequency of Herbs

Laportsa canadensis	100.0
Viola sp.	73.3
Carax sp.	46.7
Remunculus abortivus	43.3
Arabis sp.	36.7
Parthenocissus quinquefolia	30.0
Rhus radicens	30.0
Campanula americana	16.7
Cryptotaenia censdensis	16.7
Elymus virginicus	16.7
Aster sp.	13.3
Remunculus saptentrionalis	13.3
Leersia virginica	10.0
Echinocystis lobata	6.7
Pilea pumila	6.7
Ribes cynosbati	6.7
Heliopsis helianthoides	3.3
Smilax sp.	3.3

Table 22

Lewis Bottoms Access

Relative Frequency of Herbs

Laportsa canadensis	21.1
Viola sp.	15.5
Carex sp.	9.9
Ranunculus abortivus	9.1
Arabis sp.	7.8
Parthenocissus quinquefolia	6.3
Rhus radicans	6.3
Campanula americana	3.5
Cryptotaenia canadensis	3.5
Elymus virginicus	3.5
Aster sp.	2.8
Ranunculus septentrionalis	2.8
Laersia virginica	2.1
Echinocystis lobata	1.4
Pilsa pumila	1.4
Ribes cynosbati	1.4
Heliopsis helianthoidee	0.7
Smilax sp.	0.7

Table 23

Lewis Bottoms Access

Density of Herbs

Viola sp.	45
Laportea canadensis	43
Carex sp.	25
Arabia sp.	13
Elymus virginicus	10
Ranunculus abortivus	9
Parthenocissus quinquefolia	7
Ranunculus septentrionalis	4
Campanula americana	3
Leersia virginica	3
Rhus radicans	3
Aster sp.	2
Cryptotaenia canadensis	2
Pilea pumila	1
Ribes cynosbati	1
Echinocystis lobata	0
Heliopsis helianthoides	0
Smilax sp.	0

Table 24

Lewis Bottoms Access

Ralative Density of Herbs

Viola sp.	26.6
Laportea canadensis	23.4
Carex sp.	14.5
Arabis sp.	7.8
Elymus virginicus	5.7
Ranunculus abortivus	5.3
Parthenocissus quinqusfolis	4.3
Ranunculus septantrionalis	2.2
Campanula americana	1.8
Leersia virginica	1.8
Rhus radicans	1.8
Aster sp.	1.2
Cryptotaenis canadensis	1.2
Pilea pumila	0.4
Ribes cynosbati	0.4
Echinocystis lobata	0
Heliopsis helianthoides	0
Smilax sp.	0

Table 25

Lewis Bottoms Access

Percentage Cover of Herbs

Laportea canadensis	49.0
Viola sp.	8.5
Parthenocissus quinquefolia	4.3
Arabis sp.	4.2
Rhus radicans	3.3
Campanule americana	2.2
Ranunculus septentrionalis	1.5
Carex sp.	1.3
Aster sp.	1.2
Heliopsis helianthoides	1.0
Cryptotaenis canadensis	0.3
Echinocystis lobata	0.3
Elymus virginicus	0.3
Ranunculus abortivus	0.2
Smilax sp.	0.2
Laersia virginica	0
Pilea pumila	0
Ribes cynosbati	0

Table 26

Lewis Bottoms Access

Relative Dominance of Herbs

Laportea canadensis	63.0
Viola sp.	10.9
Parthenocissus quiaquefolia	5.5
Arabis sp.	5.4
Rhus radicans	4.2
Campanula americana	2.8
Ranunculus septentrionalis	1.9
Carex sp.	1.7
Aster sp.	1.5
Heliopsis helianthoides	1.3
Cryptotaenis canadensis	0.4
Echinocystis lobata	0.4
Elymus virginicus	0.4
Ranunculus abortivus	0.3
Smilax sp.	0.3
Laersia virginica	0
Pilea pumila	0
Ribes cynosbati	0

Table 27

Lewis Bottoms Accese

Importance Value of Herbs

Laportea canadensis	109.5
Viola sp.	53.0
Carex sp.	26.1
Arabis sp.	21.0
Parthenocissus quinquefolia	16.1
Ranunculus abortivus	14.7
Rhus radicana	12.3
Elymus virginicus	9.6
Campanula americana	7.9
Ranunculus septentrionalis	6.9
Aster sp.	5.3
Cryptotaenia canadensis	4.8
Leersia virginica	3.9
Ribes cynosbaci	2.2
Heliopsis helianthoides	2.0
Echinocystis lobata	1.8
Pilea pumila	1.8
Smilax sp.	1.0

Table 28

Lewis Bottoms Access

Summary of Shrub Data

	%Frequency	Stems/30m^2	%Covar
Morus rubra	3.3	1	1.7
Ribes cynosbati	3.3	0	0.2
Acer negundo	3.3	1	2.0

Table 29

Lewis Bottoms Access

Frequency of Trees

Acer negundo	84.0
Morus rubra	64.0
Acer saccharinum	40.0
Fraxinus pennsylvanica	24.0
Celtis occidantalis	16.0
Populus doltoides	12.0
Ulmus americana	12.0
Juglans nigra	4.0
Salix nigra	4.0

Table 30

Lewis Bottoms Access

Relative Frequency of Trees

Acer negundo	32.3
Morus rubra	24.6
Acer saccharinum	15.4
Fraxinus pennsylvanica	9.2
Celtis occidentalis	6.2
Populus deltoides	4.6
Ulmus americana	4.6
Juglans nigra	1.5
Salix nigra	1.5

Table 31

Lewis Bottoms Access

Relative Density of Trees

Acer negundo	37.4
Morus rubra	24.2
Acer saccharinum	19.2
Fraxinus pennsylvanica	7.1
Celtis occidentalis	4.0
Populus deltoides	3.0
Ulmus americana	3.0
Juglans nigra	1.0
Salix nigra	1.0

Table 32

Lewis Bottoms Access

Relative Dominance of Trees

Acer saccharinum	20.6
Fraxinus pennsylvanica	19.3
Populus deltoides	19.2
Acer negundo	18.2
Morus rubra	11.4
Salix nigra	8.8
Ulmus americana	1.8
Juglans nigra	0.4
Celtis occidentalis	0.2

Table 33

Lewis Bottoms Access

Importance Value of Trees

Acer negundo	87.9
Morus rubra	60.2
Acer saccharinum	55.2
Fraxinus pennsylvanica	35.6
Populus deltoides	26.8
Salix nigra	11.3
Celtis occidentalis	10.4
Ulmus americana	9.4
Juglans nigra	2.9

Lewis Bottoms Access

Species List

Acer negundo
Acer saccharinum
Ambrosia artemisiifolia
Arabis sp.
Aster sp.

Brassica nigra

Camelina sativa
Campanula americana
Campanula rapunculoidea
Carex sp.
Celtis occidentalis
Chenopodium album
Cirsium horridulum
Cryptotaenia canadensis

Echinocystis lobata
Elymus virginicus
Erigeron annuus
Erigeron canadensis
Euphorbis dentata
Euphorbia serpyllifolia

Fraxinus pennsylvanica

Heliopeis helianthoides

Juglans nigra

Lactuca canadensis
Laportea canadensis
Leersia virginica
Lespedeza hirta

Mirabilis nyctaginea
Morus rubra

Oenothara biennis
Oxalis europa

Parthenocissus quinquefolia
Physalis subglabrata
Pilea pumila
Polygonatum biflorum
Polygonum sp.
Populus deltoides

Lewis Bottoms Access

Species List

Acer negundo
Acer saccharinum
Ambroaia artemisifolia
Arabis sp.
Aster sp.

Brassica nigra

Camelina sativa
Campanula americana
Campanula rapunculoides
Carex sp.
Celtis occidentalis
Chenopodium album
Cirsium horridulum
Cryptotaenia canadensis

Echinocystis lobata
Elymus virginicus
Erigeron annuus
Erigeron canadensis
Euphorbia dentata
Euphorbia serpyllifolia

Fraxinus pennsylvanica

Heliopsis helianthoides

Juglans nigra

Lactuca canadensis
Laportea canadensis
Leersia virginica
Lespedeza hirta

Mirabilis nyctaginea
Morus rubra

Oenothara biennis
Oxalis europa

Parthenocissus quinquefolia
Physalis subglabrata
Pilea pumila
Polygonatum biflorum
Polygonum sp.
Populus deltoides

Ranunculus abortivus
Ranunculus septentrionalis
Rhus radicans
Ribes cynosbati
Rosa multiflora

Salix nigra
Saponaria officinalis
Scrophularia marilandica
Sicyos angulatus
Smilax sp.
Solidago sp.

Thlaspi arvensa
Tradescantia virginiana

Ulmus americana

Verbascum thapsus
Verbena hastata
Verbana urticifolia
Vernonia fasciculata
Viola sp.

Xanthium echinatum
Xanthoxylum americanum

Table 34

Wichiup Hill

Frequency of Herbs

Parthenocissus quinquefolia	56.7
Amphicarpa bracteata	36.7
Desmodium sp.	30.0
Galium sp.	30.0
Phryma leptostachya	26.7
Fraxinus americana	23.3
Sanguinaria canadensis	23.3
Geranium maculatum	20.0
Carex sp.	16.7
Rhus radicans	16.7
Viola sp.	16.7
Cryptotaenia canadensis	10.0
Ranunculus abortivus	6.7
Rubus sp.	6.7
Ulmus americana	6.7
Ulmus rubra	6.7
Acer saccharum	4.4
Aster sp.	3.3
Carpinus caroliniana	3.3
Circaea quadrisulcata	3.3
Cornus sp.	3.3
Polemonium van-bruntiae	3.3
Quercus alba	3.3
Tilia americana	3.3

Table 35

Wickiup Hill

Relative Frequency of Herbs

Parthenocissus quinquefolia	15.8
Amphicarpa bracteata	10.2
Desmodium sp.	8.3
Galium sp.	8.3
Paryna leptostachya	7.4
Fraxinus americana	6.3
Sanguinaria canadensis	[illegible]
Geranium maculatum	5.6
Carex sp.	4.8
Rhus radicans	4.6
Viola sp.	4.6
Cryptotaenia canadensis	2.8
Ranunculus abortivus	1.9
Rubus sp.	1.9
Ulmus americana	1.9
Ulmus rubra	[illegible]
Acer saccharum	0.9
Carpinus caroliniana	0.9
Circaea quadrisulcata	0.9
Cornus sp.	0.9
Polemonium van-bruntiae	0.9
Quercus alba	0.9
Tilia americana	0.9
Aster sp.	0.9

Table 36

Wickiup Hill

Density of Herbs

Parthenocissus quinquefolia	15
Amphicarpa bractsata	8
Desmodium sp.	5
Carex sp.	4
Galium sp	3
Geranium maculatum	3
Phryma leptostachya	3
Rhus radicens	3
Sanguinaria canadensis	3
Viola sp.	3
Fraxinus americana	2
Acer saccharum	1
Carpinus caroliniana	1
Circaea quadrisulcata	1
Cornus sp.	1
Cryptotaenia canadensis	1
Polemonium van-bruntiae	1
Quercus alba	1
Ranunculus abortivus	1
Tilia americana	1
Ulmus americana	1
Ulmus rubra	1
Aster sp.	0
Rubus sp.	0

Table 37

Wickiup Hill

Relative Density of Herbs

Parthenocissue quinquefolia	23.8
Amphicarpa bracteata	12.7
Desmodium sp.	7.9
Carex sp.	6.3
Galium sp.	4.8
Garanium maculatum	4.8
Phryma leptostachys	4.8
Rhus radicans	4.8
Sanguinaris canadensis	4.8
Viola sp.	4.8
Frexinus americana	3.2
Acer saccharum	1.6
Carpinus caroliniana	1.6
Circaea quadrisulcata	1.6
Cornus sp.	1.6
Cryptotaenis canadensis	1.6
Polemonium van-bruntiae	1.6
Quercus alba	1.6
Ranunculus abortivus	1.6
Tilia americana	1.6
Ulmus americana	1.6
Ulmus rubra	1.6
Aster sp.	0
Rubus sp.	0

Table 38

Wickiup Hill

Percentage Cover of Herbs

Parthenocissus quinquefolia	14.2
Fraxinus americana	3.6
Rhus radicans	3.8
Desmodium sp.	2.0
Geranium maculatum	1.7
Amphicarpa bracteata	1.5
Phryma leptostachya	1.3
Sanguinaria canadensis	1.3
Ulmus rubra	0.8
Galium sp.	0.5
Ulmus americana	0.5
Rubus sp.	0.3
Viola sp.	0.3
Aster sp.	0.2
Carpinus caroliniana	0.2
Circaea quadri[illegible]	0.2
Cryptotaenia canadensis	0.2
Polemonium van-bruntiae	0.2
Quercus alba	0.2
Acer saccharum	0
Carex sp.	0
Cornus sp.	0
Ranunculus abortivus	0
Tilia americana	0

Table 39

Wickiup Hill

Relative Dominance of Herbs

Parthenocissus quinquefolia	42.8
Fraxinus americana	11.4
Ulmus radicans	11.4
Desmodium sp.	6.0
Geranium maculatum	5.1
Amphicarpa bracteata	4.5
Phryma leptostachya	3.9
Sanguinaria canadensis	3.9
Ulmus rubra	2.4
Galium sp.	1.5
Ulmus americana	1.5
Rubus sp.	0.9
Viola sp.	0.9
Aster sp.	0.6
Carpinus caroliniana	0.6
Circaea [illegible]	0.6
Cryptotaenia canadensis	0.6
Polemonium van-brunticae	0.6
Quercus alba	0.6
Acer saccharum	0
Carex sp.	0
Cornus sp.	0
Ranunculus abortivus	0
Tilia americana	0

Table 40

Wickiup Hill

Importance Value of Herbs

Parthenocissus quinquefolia	82.4
Amphicarpa bracteata	27.4
Desmodium sp.	22.2
Fraxinus americana	21.1
Rhus radicans	20.8
Phryma leptostachya	16.1
Geranium maculatum	15.5
Sanguinaria canadensis	15.2
Galium sp.	14.6
Carex sp.	10.9
Viola sp.	10.3
Ulmus rubra	5.9
Cryptotaenia canadensis	5.0
Ulmus americana	5.0
Ranunculus abortivus	3.5
Carpinus caroliniana	3.1
Circaea quadrisulcata	3.1
Polemonium van-bruntiae	3.1
Quercus alba	3.1
Rubus sp.	2.8
Acer saccharum	2.5
Cornus sp.	2.5
Tilia americana	2.5
Aster sp.	1.5

Table 41

Wickiup Hill

Frequency of Shrubs

Ostrya virginiana	76.7
Acer saccharum	53.3
Fraxinus americana	53.3
Ulmus rubra	53.3
Rhus radicans	20.0
Carpinus caroliniana	13.3
Tilia americana	13.3
Prunus serotina	10.0
Rubus sp.	10.0
Ribes cynosbati	6.7
Carya ovata	3.3
Ulmus americana	3.3

Table 42

Wickiup Hill

Relative Frequency of Shrubs

Ostrya virginiana	25.9
Acer saccharum	18.0
Fraxinus americana	18.0
Ulmus rubre	11.2
Rhus radicens	6.7
Carpinus caroliniana	4.5
Tilia americana	4.5
Prunus serotina	3.4
Rubus sp.	3.4
Ribea cynosbati	2.3
Carya ovata	1.1
Ulmus americana	1.1

Table 43

Wickiup Hill

Density of Shrubs

Ostrye virginiana	0.9
Fraxinus americana	0.6
Acer saccharum	0.5
Rhus radicans	0.3
Rubus sp.	0.3
Carpinus caroliniana	0.2
Ulmus rubra	0.2
Prunus serotina	0.1
Ribes cynosbati	0.1
Tilia americana	< 0.1
Ulmus americana	< 0.1
Carya ovata	0

Table 44

Wickiup Hill

Relative Density of Shrubs

Ostrya virginiana	28.1
Fraxinus americana	18.8
Acer saccharum	15.6
Rhus radicans	9.1
Rubus sp.	9.4
Carpinus caroliniana	6.3
Ulmus rubra	6.3
Prunus serotina	3.1
Ribes cynosbati	3.1
Tilia americana	0
Ulmus americana	0
Carya ovata	0

Table 45

Wickiup Hill

Percentage Cover of Shrubs

Ostrya virginiana	26.7
Acer saccharum	12.7
Fraxinus americana	8.7
Carpinus caroliniana	4.7
Ulmus rubra	2.5
Rubus sp.	2.0
Rhus radicans	1.7
Tilia americana	1.0
Ribes cynosbati	0.8
Prunus serotina	0.3
Carya ovata	0.2
Ulmus americana	0.2

Table 48

Wickiup Hill

Relative Density of Trees

Ostrya Virginiana	29.5
Quercus rubra	26.1
Quercus alba	13.6
Carpinus caroliniana	11.4
Acer saccharum	10.2
Fraxinus americana	3.4
Tilia americana	3.4
Ulmus rubra	2.3

Table 49

Wickiup Hill

Relative Dominance of Trees

Quercus rubra	71.4
Quercus alba	19.7
Acer saccharum	5.3
Fraxinus americana	2.1
Ostrya virginiana	1.2
Carpinus caroliniana	0.3
Tilia americana	< 0.1
Ulmus rubra	< 0.1

Wickiup Hill

Species List

Acer saccharum
Amphicarpa bracteata
Anemone quinquefolia
Arisaema dracontium
Aster sp.

Botrychium virginianum

Campanula americana
Carex sp.
Carpinus caroliniana
Carya ovata
Chenopodium hybridum
Circaea quadrisulcata
Cornus drummondi
Cornus stolonifera
Corylus americana
Cryptotaenia canadensis

Desmodium nudiflorum

Equisetum sp.
Eupatorium perfoliatum
Eupatorium purpureum
Eupatorium rugoeum

Fraxinus americana

Galium sp.
Geranium maculatum
Geum canadense

Hepatica americana

Impatiens capensis

Osmorhiza claytoni
Ostrya virginiana
Oxalis stricta

Parthenocissus quinquefolia
Phryma leptostachya
Pilea pumila
Podophylum peltatum
Polemonium van-bruntiae
Potentilla norvegica
Prenanthes alba
Prunus serotina
Prunus virginiana

Quercus alba
Quercus rubra

Ranunculus abortivus
Rhus radicana
Ribes cynosbati
Rubus sp.
Rudbeckia triloba

Sanguinaria canadensis
Sanicula marilandica
Smilacina racemosa
Smilax rotundifolia

Tilia americana

Ulmus americana
Ulmus rubra

Viola sp.
Vitis sp.

Xanthoxylum americanum

M. J. HARDEN ASSOCIATES, INC.
Photogrammetric Engineers

IOWA ELECTRIC LIGHT & POWER CO.
ENGINEERING DEPT. CEDAR RAPIDS, IOWA

SCALE: 1"=500'-0"

DATE OF PHOTOGRAPHY: APRIL 1983