The Vascular Flora of a Transect Across the Beaver Creek Wetlands, Greene County, Ohio[1]

VICTORIA R. SCHMALHOFER[2], JAMES P. AMON, AND JAMES R. RUNKLE, Department of Biological Sciences, Wright State University, Dayton, OH 45435

ABSTRACT. During the 1989 growing season we surveyed part of the Beaver Creek Wetlands in Greene County, OH, to describe and catalog the vegetation and to determine if a transect oriented through the study site satisfied the mandatory technical criteria for vegetation used by Federal agencies to delineate wetlands. We established 14 plots along the transect and compiled a list of the species occurring within the plots and throughout the rest of the study site. We identified 198 species, including five species on the Ohio list of threatened and endangered species. A majority of species occurring within the study site were classified as hydrophytes. A wetland index was calculated for each plot using weighted percentages of vegetation indicator-categories. Wetland-index values, which expressed changes in wetland character (degree and duration of soil saturation as reflected by proportions of hydrophytes and nonhydrophytes occurring in the plots), were significantly correlated with first-axis scores from a detrended correspondence analysis (DECORANA). This correlation indicated that DECORANA first-axis scores also reflected changes in wetland character along the transect. The wetland index also identified areas that showed a tendency towards seasonal or spatial transition between wetland and nonwetland. According to federal criteria, wetland areas included the 12 interior plots along the transect and part of plot 14, while nonwetland areas included plot 1 and most of plot 14.

Ohio J. Sci. 92 (1): 14-24, 1992

INTRODUCTION

Section 404 of the Clean Water Act designates wetlands as "waters of the United States." The United States Army Corps of Engineers, which has jurisdiction over waters of the United States, and the Environmental Protection Agency define wetlands as follows:

> Wetlands are those areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal conditions do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (Federal Interagency Committee for Wetland Delineation [FICWD] 1989).

Thus wetlands are described as having three essential characteristics: 1) wetland hydrology, 2) hydric soils, and 3) hydrophytic vegetation (FICWD 1989). Wetland hydrology describes a situation where water saturates the soil for at least seven consecutive days during the growing season (FICWD 1989). Hydric soils develop when prolonged soil-saturation generates anaerobic conditions, resulting in a decreased rate of decay and an increased accumulation of organic matter. Thus hydric soils generally have a high organic content. Hydrophytes are plants which tolerate saturated soil and low oxygen levels in the root zone. The term hydrophytic vegetation indicates that over 50% of species occurring in an area are hydrophytes and that hydrophytes are dominant species in the area (FICWD 1989). Federal agencies use these characteristics, termed the mandatory technical criteria, to identify wetlands. To qualify as a wetland, an area must satisfy all three requirements of the mandatory technical criteria.

The primary purpose of this project was to describe and catalog the vegetation of a transect across the Beaver Creek Wetlands, a natural wet area located in Greene County, OH. Since no part of the Beaver Creek Wetlands has ever been officially designated as a wetland, a secondary goal was to determine if the study site satisfied the mandatory technical criteria for wetland delineation. Although the features along one transect cannot describe the entire wetland corridor, information gathered in this survey can serve as a baseline for future studies in the Beaver Creek Wetlands and provide a basis for comparison with other Ohio wetlands.

The goals of this study were met by making two sets of observations: 1) observations along a transect using plots which were investigated according to federal criteria for wetland vegetation; and 2) less structured observations of species composition in a 20 ha area surrounding the transect in order to characterize the main vegetation types present and to generate a more complete species list.

MATERIALS AND METHODS

The Beaver Creek Wetlands, located in the northwestern portion of Greene County, OH, in Bath and Beavercreek townships, include a corridor of about 400 ha bordering the Big Beaver Creek. The wetlands are roughly bounded by Dayton-Yellow Springs Road to the north, Dayton-Xenia Road to the south, Trebein Road to the east, and Beaver Valley Road to the west. The study site is an approximately 20 ha section of the wetlands immediately south of New Germany-Trebein Road, located on the Fairborn Quadrangle of the United States Geological Survey 7.5 minute series at approximately 39°46' N latitude and 84°0' W longitude in section 23 of Beavercreek Township.

[1]Manuscript received 22 July 1991 and in revised form 27 January 1992 (#91-16).

[2]Present address: Graduate Program in Ecology and Evolution, Rutgers University, Piscataway, NJ 08855-1059

The Big Beaver Creek lies over a river valley buried when glacial outwash filled the Hamilton River, a tributary of the preglacial Teays River drainage system (Regional Planning and Coordinating Commission of Greene County, Ohio 1976). Dredging and channelization in about 1917 produced a levee that partially isolates both the Big Beaver Creek from the surrounding wetlands and the wetlands from surface runoff carried by the creek. A small creek originating in Fairborn crosses the northern section of the study site and empties into the Big Beaver Creek. Like the Big Beaver Creek, this tributary has a levee. The primary water source for the wetlands is alkaline groundwater, and the water table is at or above ground level throughout most of the wetland corridor. Also, numerous springs supply water to the surface.

In March of 1989, we chose an approximately 20 ha section (hereafter referred to as the study site) of the Beaver Creek Wetlands for our survey based on ease of access and cooperation of the property owners. A 600 m transect was oriented across the study site (northwest to southeast), and 14 plots were marked for detailed study (Fig. 1). Plots were chosen by visually assessing living and dead vegetation and determining when a new vegetation patch-type was encountered along the transect. Since the

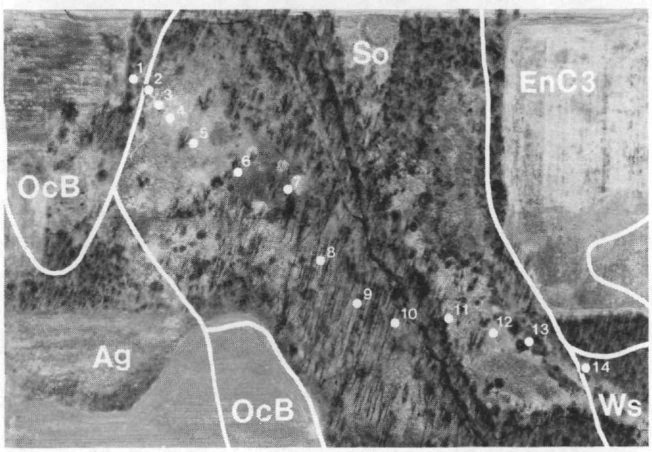

FIGURE 1. Aerial photograph of the study site showing plot locations and soil types. Soil descriptions are taken from Garner et al. (1978): So = Sloan silty clay loam, hydric; Ws = Westland silty clay loam, hydric; OcB = Ockley silt loam, 2-6% slopes, nonhydric; EnC3 = Eldean clay loam, 6-12% slopes, severely eroded, nonhydric; Ag = Algiers silt loam, nonhydric.

plots were used for wetland delineation, we measured their dimensions according to the 1987 U. S. Army Corps of Engineers' guidelines: plots composed of herbaceous species had a 5 ft (1.5 m) radius; plots containing shrubs or saplings had a 10 ft (3.0 m) radius; and forested plots had a 30 ft (9.1 m) radius (Environmental Laboratory 1987). Federal criteria required a single survey of several east-west transects across the Big Beaver Creek. Since the main goal of this study was to conduct an extensive floral survey of the study site, we used a single transect, oriented to intersect many vegetation patch-types (estimated from aerial photographs) and visited multiple times throughout the growing season.

From 1 April through 15 October, weekly visits were made to each plot to record species present, to collect voucher specimens for preservation and identification, to keep records of blooming phenology and soil saturation, and to measure the diameter at breast height (dbh) of all trees. At the end of each month, the percent-area covered by each herbaceous species in each plot was estimated. We identified species not occurring in the plots during weekly walks through the study site (primarily the area marked as having Sloan soils in Fig. 1).

A cover class was assigned to each herbaceous species in each plot using the maximum percent-area covered: 1 = <5%, 2 = >5-25%, 3 = >25-50%, 4 = >50-75%, 5 = >75-95%, and 6 = >95% (Environmental Laboratory 1987). For trees and shrubs, we used relative basal area to assign cover classes. In instances where relative basal area alone did not provide an adequate estimate of a species' cover class (numerous saplings or shrubs with a small total basal area for example), we treated the species as herbaceous and visually determined its percent-area covered and assigned it to a cover class. Dominant species were designated as having a minimum cover-class of three.

Taxonomic keys by Fernald (1950), Newcomb (1977), Weishaupt (1971), Braun (1961, 1967), and Fisher (1988) were used to identify species, and a regional wetland-plant list by Reed (1988) was used to determine the indicator category of each species. Based on a species' probability of occurring in a wetland or nonwetland, the species is assigned to one of five indicator categories: obligate wetland species (OBL) occur in wetlands more than 99% of the time; facultative wetland species (FACW) occur in wetlands 67% to 99% of the time; facultative species (FAC) occur with equal frequency in both wetlands and nonwetlands; facultative upland species (FACU) occur in nonwetlands 67% to 99% of the time; and upland species (UPL) occur in nonwetlands more than 99% of the time (Federal Interagency Committee for Wetland Delineation 1989). Wetland indicator species (hydrophytes) belong to the categories OBL, FACW, and FAC (FICWD 1989). Species not listed by Reed (1988) were assumed to be UPL.

The National Technical Committee for Hydric Soils list of hydric soils of the United States (Environmental Laboratory 1987) and enlargements of Greene County soil survey maps (Garner et al. 1978) were used to identify the soil type of each plot. Garner et al. (1978) caution that use of soil maps could lead to misinterpretation of soil contours, therefore, those presented (Fig. 1) should be viewed as approximate.

The plots were organized using detrended correspondence analysis (DECORANA [Hill 1979]) to determine natural patterns in the vegetation based on presence or absence of species. To identify changes in wetland character (degree and duration of soil saturation as reflected by hydrophyte/nonhydrophyte composition) along the transect, the wetland index was developed:

$$W_p = \sum P_{pi} c_i$$

where W_p is the wetland index of plot p, P_{pi} is the percentage of species in plot p belonging to indicator category i, and c_i is the weight assigned to indicator category i (5 for OBL, 4 for FACW, 3 for FAC, 2 for FACU, and 1 for UPL). Wetland-index values range from 1 (100% UPL) to 5 (100% OBL). Weighting of the indicator categories corresponded to assumptions implicit in the indicator categories themselves. Under appropriate hydrologic conditions, hydrophytes should be present and, as the degree and duration of soil saturation increases, the proportion of hydrophytes an area supports should also increase. Since obligate wetland species occur almost exclusively in wetlands (implying that they have a greater competitive ability in wet environments and that their competitive ability decreases as the environment becomes drier), changes in the proportion of obligate wetland species best reflect changes in wetland character. Thus obligate wetland species were given the greatest weight in the wetland-index calculations. Conversely, upland species were given the least weight in the wetland-index calculations. An F-test was used to check for correlation between DECORANA first-axis scores and wetland-index values in order to determine if the variation described by the DECORANA first-axis indicated changes in wetland character.

Relative similarity between the study site and other Ohio wetlands was determined using the coefficient of community, CC, (Whittaker 1975):

$$CC = \frac{\text{twice the number of species common to the two sites}}{\text{the sum of the total number of species at each site}}$$

Vegetation patch-types occurring within the study site were compared with vegetation patch-types occurring in two other Ohio wetlands: Cedar Bog (Frederick 1974) and Kiser Lake (Neff and Vankat 1982). Comparisons were made based on the common species occurring in the vegetation patch-types as described by the authors.

RESULTS

Within the study site we identified 198 species representing 130 genera and 57 families (Appendix). Of the 198 species, 75.3% occurred within the plots. The family Asteraceae showed the greatest species richness, comprising 13.1% of the total species. Other commonly encountered families were Poaceae, Cyperaceae, Lamiaceae, Rosaceae, and Polygonaceae with 8.1%, 7.6%, 6.6%, 5.6%, and 5.1% of the total species, respectively. Hydrophytes comprised 66.2% of the total species, while nonhydrophytes accounted for only 33.8% of the total species (Table 1). Herbaceous species were 4.5 times as abundant as woody species, and native species were almost five times as numerous as non-native species (Table 1). We found one Ohio endangered species, *Selaginella eclipes*, two threatened species, *Equisetum sylvaticum* and *Scirpus purshianus*, and two potentially threatened species, *Carex trichocarpa* and *Juncus balticus* var. *littoralis* (Ohio Division of Natural Areas and Preserves 1988) within the boundaries of the study site.

Hydrophytes bloomed more frequently in summer (July, August, and September: 59.0%) than in spring (April, May, and June: 34.9%) with a peak in August (30.4%) (Table 2). Conversely, nonhydrophytes flowered more frequently in spring (54.7%) than in summer (43.5%) with a peak in June (32.1%) (Table 2).

Within the study site, we defined eight vegetation patch-types based on species composition and physiognomy: upland thicket, upland forest, levee forest, wet thicket, swamp forest, wet meadow, sedge meadow, and reed marsh (Fig. 2). Several plots integrated multiple patch-types. Upland thickets had numerous shrubs (mostly *Rosa* spp. and *Lonicera* spp.) and vines (primarily *Vitis aestivalis*), a thick herb layer, and few trees. Upland forests had a well-developed canopy (predominantly *Maclura pomifera*), scattered shrubs and vines, and a moderate-to-sparse herb layer. Levee forests, which were confined to the creek levees, had numerous trees (*Populus deltoides*, *Acer negundo*, *Gleditsia triacanthos*, and *Maclura pomifera*), shrubs (*Rosa* spp.) and vines (*Vitis* spp., *Parthenocissus* spp., and *Toxicodendron radicans*), and a thick herb layer. Wet thickets had numerous shrubs (predominantly *Salix exigua*, *Rosa palustris*, and *Cornus* spp.), few trees (or none), and a moderate-to-sparse herb layer. Swamp forests had an open canopy formed by *Populus deltoides*, a lower, denser canopy formed by *Acer saccharinum* and *Fraxinus pennsylvanica* var. *subintegerrima*, numerous saplings and shrubs (often occurring in dense clumps), and an herb layer ranging from thick where the level of standing water was low and the canopy was open, to nonexistent where standing water was deep and the canopy was closed. Wet meadows had few woody species, and an herb layer dominated by grasses (predominantly *Leersia oryzoides*) and rushes (*Eleocharis erythropoda*). Sedge meadows had few woody species and an herb layer dominated by sedges (*Carex stricta*). Reed marshes were dominated by tall grass-like plants such as *Typha latifolia* and *Acorus calamus*.

Throughout the study site in general, the area east of the Big Beaver Creek appeared wetter, having standing water of greater depth which lasted for a longer period of time than did the area west of the Big Beaver Creek. However, wherever hydric soils and wetland hydrology occurred, the dominant species were hydrophytes (Table 3; Fig. 3).

The first DECORANA ordination axis explained most of the variation in the vegetation along the transect and accounted for 43.3% of the variability described by all four axes. Measures of variance accounted for by each axis (eigenvalues) were 0.650, 0.469, 0.254, and 0.125 for axes 1 - 4, respectively. DECORANA first-axis scores and wetland-index values were significantly correlated ($p < 0.01$, $n = 14$, $R^2 = 0.72$) (Fig. 4), indicating that the first ordination-axis reflected changes in wetland character along the transect.

Of the Ohio wetlands compared to the study site using the coefficient of community (Whittaker 1975), Ankeney Fen (Stine 1988) was the most similar: CC = 0.528. The next most similar wetland was Kiser Lake (Neff and Vankat 1982): CC = 0.444. The least similar wetland was Cedar Bog (Frederick 1974): CC = 0.342.

DISCUSSION

The criteria for wetland delineation were satisfied by plots 2 - 13 (Table 3). Wetland boundaries along the transect occurred between plots 1 and 2 and within plot 14. When nonhydrophytes were encountered within wetland areas, we found that these plants usually grew on an elevated location such as a levee or a mound formed

TABLE 1

Summary, according to division, class, origin, life form, indicator category, and hydrophytic status, of study-site vegetation.

		Number	Percent of Total Species
Division	Pteridophyta	3	1.5
	Anthophyta:		
Class	Monocotyledoneae	47	23.7
	Dicotyledoneae	148	74.7
Origin	native	164	82.8
	non-native	34	17.2
Life Form	woody	36	18.2
	herbaceous	162	81.8
Indicator Category	OBL	50	25.3
	FACW	47	23.7
	FAC	34	17.2
	FACU	44	22.2
	UPL	23	11.6
Total Hydrophytes		131	66.2
Total Nonhydrophytes		67	33.8

TABLE 2

Summary, according to hydrophytic status and indicator category, of flowering phenology of study-site vegetation. Numbers represent total number of species in flower.

	March	April	May	June	July	Aug.	Sept.	Oct.	Total
Hydrophytes									
OBL	0	3	3	3	3	11	2	1	26
FACW	0	3	4	5	7	9	7	3	38
FAC	1	1	8	9	7	14	6	2	48
subtotal	1	7	15	17	17	34	15	6	112
percent	0.9	6.3	13.4	15.2	15.2	30.4	13.4	5.4	
Nonhydrophytes									
FACU	0	4	4	10	3	10	1	1	33
UPL	0	1	3	7	6	1	2	0	20
subtotal	0	5	7	17	9	11	3	1	53
percent	0.0	9.4	13.2	32.1	17.0	20.8	5.7	1.9	
TOTAL	1	12	22	34	26	45	18	7	165
PERCENT-TOTAL	0.6	7.3	13.3	20.6	15.8	27.3	10.9	4.2	

by the base of a tree. The creek levees acted as islands in the midst of the wetlands, supporting many nonwetland species such as *Maclura pomifera* and *Aesculus glabra*, as well as facultative species such as *Gleditsia triacanthos* and *Acer negundo*. Thus the levees provided a refuge for nonhydrophytes and may have facilitated invasion of nonhydrophytes into the wetlands.

The wetland index measured the wetland character (degree and duration of soil saturation as expressed through vegetational composition) of an area. The lowest possible wetland-index value for a wetland site is 2.02 (51% FAC and 49% UPL). The highest possible value for a nonwetland site is 3.47 (51% FACU and 49% OBL). The range of wetland-index values bounded by these two numbers described areas that could potentially shift from a predominance of hydrophytes to nonhydrophytes, or

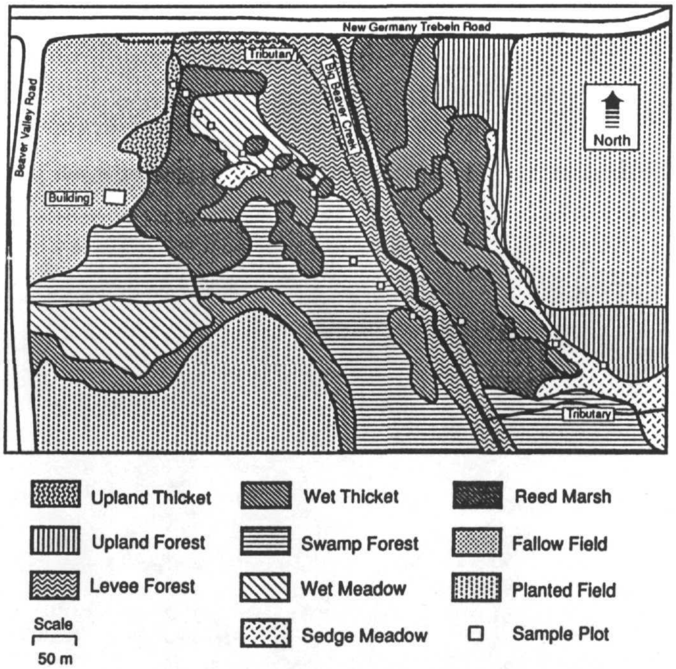

FIGURE 2. Vegetation patch-types found throughout the study site as determined from aerial photographs and visual inspection.

vice versa, depending on water availability. These shifts could occur seasonally or spatially (typically along a slope). Plots l, 7, and 14 fell within the range of overlap. A strong spatial transition occurred in plot 14: the southern (smaller) section of the plot had wetland characteristics (sedge meadow dominated by *Carex stricta* - OBL, hydric soil), while the northern (larger) section of the plot showed nonwetland characteristics (upland forest dominated by *Maclura pomifera* - UPL, nonhydric soil). Tendencies towards seasonal transitions were present in plots 1 and 7. During the spring and early summer, plot 1 had its greatest predominance of hydrophytes: *Conium maculatum* (OBL) covered 20% of the plot in May and June. Plot 7, located near the levee of the tributary, dries out somewhat in late summer, which may permit nonhydrophytes to invade. Since the wetland index was sensitive to areas with seasonally or spatially shifting

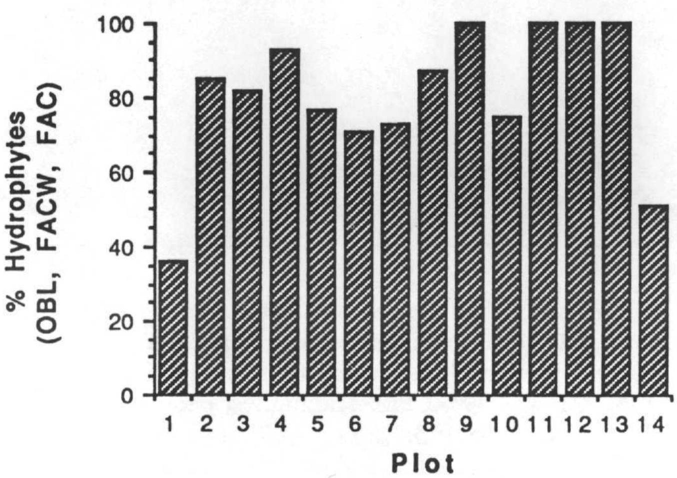

FIGURE 3. Percentages of species within each plot that are classified as wetland indicator species (hydrophytes).

proportions of hydrophytes and nonhydrophytes, the wetland index could prove a useful tool for identifying transitional areas that should be included within the protected zone of a wetland. The range of overlap in the wetland index, as stated here, may be too broad and too sensitive. Although plots 1 and 7 displayed tendencies towards a change in the predominant type of vegetation, plot 1 never had a predominance of hydrophytes, and plot 7 never had a predominance of nonhydrophytes. Only plot 14 showed an actual transition.

The strong correlation between DECORANA first-axis scores and wetland-index values indicated that the DECORANA first-axis reflected changes in the proportions of hydrophytes along the transect as a response to differences in the degree and duration of soil saturation. Peaks (plots 2 - 5, 8, 9, 11 - 13) on the graphs (Fig. 4) represented wet areas having high proportions of hydrophytes, while valleys (plots 1 and 14) represented drier areas with increasing proportions of nonhydrophytes. Although dominated by hydrophytes, plots 6, 7, and 10 supported a moderate proportion of nonhydrophytes due to the proximity of these plots to the creek levees and were represented on the graph as shallow valleys (Fig. 4).

Coefficient of community analysis showed that, of the

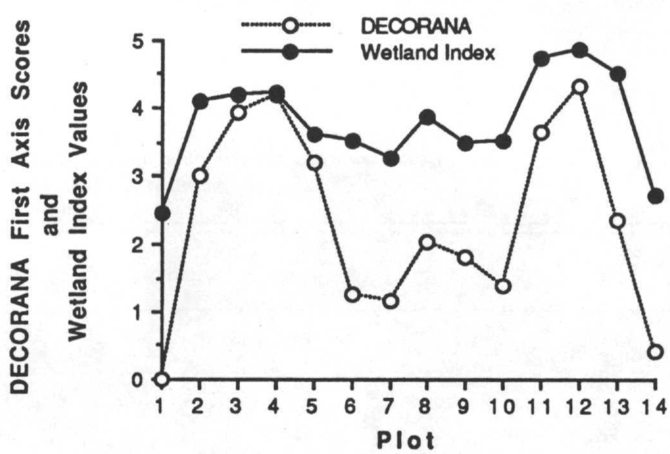

FIGURE 4. DECORANA first-axis scores and wetland-index values of each plot.

three wetland areas compared, the study site was most similar to Ankeney Fen. We expected this result since Ankeney Fen, located approximately 1.5 km south of the study site, is also a part of the Beaver Creek Wetlands corridor. The relative dissimilarity of these two areas, however, indicates that the Beaver Creek Wetlands as a whole supports a great diversity of plant species.

Patch-types present in our study site had similarities to those described for Cedar Bog and Kiser Lake. The bog meadow association, marl meadow association, and swamp forest association of Frederick (1974) were similar to sedge meadows, wet meadows, and swamp forests, respectively, occurring within the study site. Frederick's (1974) hardwood forest association, shrub communities, and arbor vitae association did not have counterparts in the study site. Kiser Lake had greater similarity to the study site than did Cedar Bog. Alluvial forests, reed swamps, and tall-sedge swamps (Neff and Vankat 1982) were similar to levee forests, reed

TABLE 3

Description of plots, including plot radius, soil type, dominant species and indicator categories, and hydrologic conditions.

Plot	Radius (meters)	Soil[a]	Dominant Species and Indicator Category[b]	Hydrologic Conditions
1	3.0	OcB	*Alliaria officinalis* FACU *Celtis occidentalis* FACU *Vitis aestivalis* FACU	dry area at summit of hill; groundhog burrows present
2	1.5	So	*Acer saccharinum* FACW *Impatiens capensis* FACW *Typha latifolia* OBL	standing water and saturated soil throughout duration of study
3	1.5	So	*Eleocharis erythropoda* OBL *Leersia oryzoides* OBL	saturated soil throughout duration of study; standing water until mid June
4	1.5	So	*Eleocharis erythropoda* OBL	saturated soil throughout duration of study; standing water until early May
5	1.5	So	*Eleocharis erythropoda* OBL *Juncus torreyi* FACW *Leersia oryzoides* OBL	saturated soil throughout duration of study; standing water through late April
6	3.0	So	*Equisetum arvense* FAC *Impatiens capensis* FACW *Salix nigra* FACW	saturated soil throughout duration of study; standing water through late May
7	3.0	So	*Acorus calamus* OBL *Lysimachia nummularia* OBL	saturated soil throughout most of the growing season, drying out in late August; standing water until May
8	9.1	So	*Galium asprellum* OBL *Lysimachia nummularia* OBL *Populus deltoides* FAC	saturated soil and standing water throughout duration of study
9	9.1	So	*Populus deltoides* FAC	saturated soil throughout duration of study; standing water through late August
10	3.0	So	*Lysimachia nummularia* OBL *Salix exigua* OBL *Vitis riparia* FACW	saturated soil throughout duration of study; standing water until July
11	1.5	So	*Acorus calamus* OBL *Polygonum coccineum* OBL	saturated soil and standing water throughout duration of study
12	1.5	So	*Leersia oryzoides* OBL *Mentha arvensis* FACW *Typha latifolia* OBL	saturated soil and standing water throughout duration of study
13	1.5	So	*Aster puniceus* OBL *Carex stricta* OBL	saturated soil throughout duration of study
14	9.1	EnC3 Ws	*Maclura pomifera* UPL	saturated soil in southern section throughout duration of study; drying out upslope in northern section

[a]Dominant species had ≥ 25% cover during at least one sampling period.
[b]Soil types are as defined in Fig. 1.

marshes, and sedge meadows, respectively, within the study site. *Rosa* deciduous thickets and *Cornus* deciduous thickets (Neff and Vankat 1982) resembled the study site's wet thickets. Kiser Lake's *Crataegus* deciduous thickets, perennial forbs, and herbaceous floating swamps (Neff and Vankat 1982) did not have counterparts within the study site.

The study site supports a diverse array of plant species, many of which are restricted to wetland habitats. Relative dissimilarity between the study site and another section of the wetland corridor, Ankeney Fen, suggests that the Beaver Creek Wetlands as a whole are a species-rich area supporting a diversity of habitats. Besides local diversity, the occurrence of rare species within the wetland corridor increases the area's value as a desirable place to preserve.

Acknowledgements. We wish to thank Michael Vincent of the Miami University Herbarium, Oxford, OH, for help with the identification of difficult species; the Beaver Creek Wetlands Association and Greene County Parks for maps and preliminary field data; The Nature Conservancy, the Koogler family, and the Ashbaugh family for permission to work on their property; and William Schmalhofer for help in the field.

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Appendix

Scientific name, indicator category, flowering period, and plot location of vascular species found within the study site.

Species[ab]	Indicator Category	Observed Flowering Period[cd]	Location[e]
PTERIDOPHYTA			
SELAGINELLACEAE			
E *Selaginella eclipes* Buck	OBL	Sept.	NIP
EQUISETACEAE			
Equisetum arvense L.	FAC	mid April	5 - 8, 13, 14
T *Equisetum sylvaticum* L.	FACW	UNK	NIP
ANTHOPHYTA (Monocotyledoneae)			
ALISMACEAE			
Alisma plantago-aquatica L. var. *parviflorum* (Pursh) Torr.	OBL	mid July - late Aug.	8, 10, 12
Sagittaria latifolia Willd.	OBL	mid Aug.	NIP
ARACEAE			
Acorus calamus L.	OBL	mid May - late June	7, 11
Symplocarpus foetidus (L.) Nutt.	OBL	mid Feb.- late April	NIP
COMMELINACEAE			
Commelina communis L.	FAC	mid Aug. - early Sept.	NIP
CYPERACEAE			
Carex amphibola Steud.	FAC	late April - late May	10
Carex comosa Boott	OBL	mid May - early July	3, 11, 12
Carex conjuncta Boott	FACW	mid May	10
Carex emoryi Dewey	OBL	early - mid May	6

APPENDIX *(continued)*

Carex hystricina Muhl. ex Willd.	OBL	late June	3
Carex normalis Mackenz.	FACU	late May - early July	3, 8, 10
Carex stipata Muhl. ex Willd.	FACU	mid May - late June	3, 5
Carex stricta Lam.	OBL	late April - mid June	13, 14
PT *Carex trichocarpa* Muhl.	OBL	mid May	NIP
Carex vulpinoidea Michx.	OBL	late May - late June	4
Cyperus strigosus L.	FACW	early Aug.	4
Eleocharis erythropoda Steud.	OBL	mid May - early July	3, 4, 5, 12
Scirpus americanus Pers.	OBL	early July	NIP
Scirpus atrovirens Willd.	OBL	late June - early Aug.	2, 3, 4, 6, 10, 11, 14
T *Scirpus purshianus* Fern.	OBL	UNK	4
IRIDACEAE			
Iris shrevi Small	OBL	late May - mid June	11, 12
JUNCACEAE			
PT *Juncus balticus* Willd. var. *littoralis* Engelm.	FACW	late July	12
Juncus dudleyi Weig.	FAC	late June - late July	4, 5
Juncus torreyi Coville	FACW	late June - late Aug.	2, 5
LEMNACEAE			
Lemna minor L.	OBL	UNK	NIP
LILIACEAE			
Allium canadense L.	FACU	early June	NIP
Hemerocallis fulva L.*	UPL	late June - mid July	NIP
Ornithogalum umbellatum L.*	FACU	mid May	NIP
POACEAE			
Agrostis alba L.*	FACW	UNK	2, 3, 4, 10
Bromus commutatus Schrad.*	UPL	late May - early June	1
Bromus inermis Leyess.*	UPL	early June	1
Elymus riparius Wieg.	FACW	late May - mid June	1, 14
Elymus villosus Muhl. ex Willd.	FACU	late June	14
Elymus virginicus L.	FACW	early June - mid July	1, 10, 14
Festuca obtusa Biehler	FACU	mid June	13
Hierochloe odorata (L.) Beauv.	FACW	late April	14
Leersia oryzoides (L.) Swartz	OBL	mid Aug. - late Sept.	2 - 5, 11, 12, 14
Leersia virginica Willd.	FACW	late Aug. - early Sept.	8
Phleum pratense L.*	FACU	late June	NIP
Poa alsodes Gray	FACW	late May	1
Poa compressa L.*	FACU	June	2
Poa praetensis L.*	FACU	mid May	6
Poa trivialis L.*	FACW	late May - early June	1, 2, 6, 7
Spartina pectinata Link	OBL	late July	NIP
SMILACEAE			
Smilax hispida Muhl.	FAC	UNK	NIP
SPARGANIACEAE			
Sparganium eurycarpum Engelm.	OBL	early June - early July	12
TYPHACEAE			
Typha latifolia L.	OBL	early July	2, 3, 6, 8, 10, 12, 13
ANTHOPHYTA (Dicotyledoneae)			
ACERACEAE			
Acer negundo L.	FAC	late April	8, 9, 10, 14
Acer rubrum L.	FAC	UNK	8, 10
Acer saccharinum L.	FACW	UNK	2, 5, 8, 9
ANACARDIACEAE			
Toxicodendron radicans (L.) Kuntze	FAC	UNK	1, 6, 8, 14
APIACEAE			
Aethusa cynapium L.	UPL	early June - early Aug.	1
Angelica atropurpurea L.	OBL	late April - early June	6, 7, 14
Chaerophyllum procumbens (L.) Crantz	FACW	mid April - mid May	NIP
Cicuta maculata L.	OBL	late July - early Aug.	8, 10
Conium maculatum L.*	FACW	late May - late July	1
Cryptotaenia canadensis (L.) DC.	FAC	mid June - early July	14
Osmorhiza longistylis (Torr.) DC.	FACU	mid May - mid June	14
Sanicula gregaria Bickn.	FACU	mid - late June	14
Zizia aurea (L.) Koch	FAC	mid May	7

Appendix *(continued)*

ARISTOLOCHIACEAE			
Asarum canadense L.	UPL	UNK	NIP
ASCLEPIADACEAE			
Asclepias incarnata L.	OBL	late July - early Aug.	8
Asclepias syriaca L.	UPL	UNK	NIP
ASTERACEAE			
Ambrosia trifida L.	FAC	Aug.	1, 6, 14
Arctium tomentosum P. Mill.*	UPL	late July - early Sept.	1
Aster lateriflorus (L.) Britt	FACW	mid Sept. - mid Oct.	14
Aster novae-angliae L.	FACW	late Sept. - mid Oct.	5, 8
Aster praealtus Poir.	FACW	early - mid Oct.	8
Aster puniceus L.	OBL	mid Sept. - mid Oct.	8, 13, 14
Aster vimineus Lam.	FAC	late Sept. - mid Oct.	1, 10
Bidens cernua L.	OBL	early Oct.	NIP
Bidens coronata (L.) Britt.	OBL	late Aug. - late Sept.	NIP
Bidens frondosa L.	FACW	Sept.	8
Cirsium arvense (L.) Scop.*	FACU	late June - late Sept.	1, 5, 14
Cirsium discolor (Muhl. ex Willd.) Spreng.	UPL	late July	NIP
Erechtites hieraciifolia (L.) Raf. ex DC.	FACU	late Sept.	NIP
Erigeron annus (L.) Pers.	FACU	early July	NIP
Erigeron philadelphicus L.	FACU	mid May - late June	1, 14
Eupatorium perfoliatum L.	FACW	late July - late Aug.	2, 4, 14
Eupatorium rugosum Houtt.	UPL	early Sept.	14
Helianthus strumosus L.	UPL	Sept.	7
Rudebeckia hirta L. var. *pulcherrima* Farw.	FACU	early Aug.	NIP
Rudebeckia laciniata L.	FACW	late July - late Aug.	10, 14
Solidago canadensis L.	FACU	mid Sept. - mid Oct.	1, 7, 8, 14
Solidago altissima L.	FACU	early Oct.	NIP
Solidago gigantea Ait.	FACW	mid Aug.	NIP
Taraxacum officinale Weber*	FACU	mid April - mid May	1, 6, 8, 10, 14
Verbesina alternifolia (L.) Britt.	FAC	mid - late Aug.	14
Vernonia altissima Nutt.	FAC	Aug.	1, 7, 8
BALSAMINACEAE			
Impatiens capensis Meerb.	FACW	late July - late Sept.	1 - 7, 13, 14
BIGNONIACEAE			
Campsis radicans (L.) Seem. ex Bureau	FAC	mid - late July	NIP
BORAGINACEAE			
Hackelia virginiana (L.) I. M. Johnston	FACU	early - mid Aug.	1
Myosotis scorpioides L.*	OBL	late May - late July	10
BRASSICACEAE			
Alliaria officinalis Andrz. ex Bieb.	FACU	late April - late May	1, 6, 10,14
Barbarea vulgaris R. Br.*	FACU	late April - late May	7, 8
Cardamine bulbosa (Schreb.) B.S.P.	OBL	late April - late May	7, 8, 13
Cardamine douglassii (Torr.) Britt.	FACW	late April	NIP
Cardamine pensylvanica Muhl. ex Willd.	OBL	mid May	11, 12
Hesperis matronalis L.*	UPL	mid May	NIP
Nasturtium officinale R. Br.*	OBL	mid May	2
CAMPANULACEAE			
Campanula americana L.	FAC	late Aug.	14
Lobelia siphilitica L.	FACW	late Aug. - mid Sept.	14
CANNABINACEAE			
Humulus lupulus L.	UPL	UNK	NIP
CAPRIFOLIACEAE			
Lonicera maackii (Rupr.) Maxim.*	UPL	late May	1
Lonicera sp.	UPL	UNK	14
Sambucus canadensis L.	FACW	late June - mid July	14
Viburnum lentago L.	FAC	UNK	14
CARYOPHYLLACEAE			
Cerastium vulgatum L.	FACU	UNK	NIP
CONVOLVULACEAE			
Convolvulus sepium L.	FAC	mid Aug. - early Sept.	7, 14
Cuscuta gronovii Willd.	UPL	UNK	NIP
CORNACEAE			
Cornus obliqua Raf.	FACW	June	8, 13, 14

Appendix *(continued)*

Cornus drummondii C. A. Meyer	FAC	UNK	14
Cornus racemosa Lam.	FAC	UNK	9
CUCURBITACEAE			
Echinocystis lobata (Michx.)T. & G.	FAC	early - mid Aug.	NIP
Sicyos angulatus L.	FACU	late Aug.	NIP
DIPSACACEAE			
Dipsacus sylvestris Huds.	UPL	early July - early Aug.	1
FABACEAE			
Amphicarpa bracteata (L.) Fern.	FAC	late Aug.	NIP
Gleditsia triacanthos L.	FAC	UNK	14
HIPPOCASTANACEAE			
Aesculus glabra Willd.	FACU	late April	NIP
LAMIACEAE			
Glechoma hederacea L.*	FACU	early April - late May	1
Lamium purpureum L.*	UPL	mid April - mid May	1, 7, 10, 14
Lycopus americanus Muhl. ex Bart.	OBL	Aug.	8
Lycopus rubellus Moench	OBL	early Sept.	NIP
Lycopus virginicus L.	FACW	late Aug. - late Sept.	4, 5, 8
Mentha arvensis L.	FACW	mid July - mid Sept.	1, 12
Physostegia virginiana (L.) Benth.	FAC	late Aug.	NIP
Prunella vulgaris L.	FACU	early - mid Aug.	14
Pycnanthemum virginianum (L.) Durand & Jackson	FAC	early July - mid Aug.	NIP
Scutellaria epilobiifolia A. Hamilton	OBL	early July - late Aug.	12
Scutellaria lateriflora L.	FACW	early - mid Aug.	NIP
Stachys tenuifolia Willd. var. *hispida* (Pursh) Fern.	FACW	early July - early Aug.	8
Teucrium canadense L.	FACW	early July - early Aug.	1, 7, 8, 10, 11
JUGLANDACEAE			
Juglans nigra L.	FACU	UNK	1, 14
MORACEAE			
Maclura pomifera (Raf.) Schneid.*	UPL	UNK	14
Morus alba L.*	UPL	UNK	14
OLEACEAE			
Fraxinus pennsylvanica Marsh. var. *subintegerrima* (Vahl.) Fern.	FACW	UNK	6, 9
ONAGRACEAE			
Epilobium coloratum Biehler	OBL	early Aug. - late Sept.	2, 5, 6, 7
OXALIDACEAE			
Oxalis sp.	UPL	UNK	14
POLYGONACEAE			
Polygonum amphibium L.	OBL	July	NIP
Polygonum coccineum Muhl.	OBL	late July - mid Sept.	8, 10, 11, 12
Polygonum convolvulus L.*	FACU	mid Aug.	NIP
Polygonum hydropiper L.	OBL	early Aug. - mid Sept.	3, 8
Polygonum persicaria L.*	FACW	early Sept.	8
Polygonum punctatum Ell.	OBL	early Aug. - late Sept.	6, 8
Polygonum scandens L.	FAC	late Aug. - late Sept.	1, 7
Rumex crispus L.*	FACU	June	1
Rumex orbiculatus Gray	OBL	mid July - late Aug.	11
Rumex verticillatus L.	OBL	mid Aug.	NIP
PORTULACACEAE			
Claytonia virginica L.	FACU	late April	14
PRIMULACEAE			
Lysimachia ciliata L.	FACW	late June - early Aug.	8, 10
Lysimachia nummularia L.*	OBL	early June - early July	6, 7, 8, 10, 11
RANUNCULACEAE			
Caltha palustris L.	OBL	mid April - mid May	8, 12
Ranunculus abortivus L.	FACW	mid April - mid May	1, 6, 10, 14
RHAMNACEAE			
Rhamnus lanceolata Pursh	UPL	UNK	14
ROSACEAE			
Agrimonia parviflora Ait.	FAC	late July - late Aug.	8, 14
Filipendula rubra (Hill) B. L. Robins	FACW	July - Aug.	NIP

APPENDIX *(continued)*

Geum canadense Jacq.	FACU	late June - late Aug.	1, 14
Geum laciniatum Murr.	FAC	late Aug.	NIP
Geum vernum (Raf.) T. & G.	FACU	late May - mid June	1, 14
Geum virginianum L.	FAC	June	6, 7, 8
Pyrus malus L.*	UPL	UNK	14
Prunus serotina Ehrh.	FACU	mid May	6, 14
Rosa multiflora Thunb. ex Murr.*	FACU	early June	1, 6, 14
Rosa palustris Marsh.	OBL	mid June - early Aug.	6, 13
Rosa setigera Michx.	FACU	late June - mid July	1, 5, 6, 8, 14
RUBIACEAE			
Galium aparine L.	FACU	May	1, 2, 6, 8, 14
Galium asprellum Michx.	OBL	early July - late Sept.	4, 8, 13
Galium tinctorium L.	OBL	mid July - late Aug.	12
Galium triflorum Michx.	FACU	early Aug. - late Sept.	14
SALICACEAE			
Populus deltoides Bartr. ex Marsh.	FAC	late April	8, 9
Salix exigua Nutt.	OBL	late May - late June	7, 8, 10
Salix fragilis L.*	FAC	UNK	NIP
Salix nigra Marsh.	FACW	UNK	6
SAXIFRAGACEAE			
Penthorum sedoides L.	OBL	early Aug. - early Sept.	8
Ribes americanum P. Mill.	FACW	early - mid May	8
SCROPHULARIACEAE			
Chelone glabra L.	OBL	mid Sept.	NIP
Mimulus ringens L.	OBL	late July - mid Aug.	NIP
Pedicularis lanceolata Michx.	FACW	late Aug. - mid Sept	NIP
SOLANACEAE			
Solanum americanum P. Mill.	FACU	mid Aug.	1
Solanum dulcamara L.*	FAC	late May - late Aug.	6, 8, 11
ULMACEAE			
Celtis occidentalis L.	FACU	UNK	1, 14
Ulmus americana L.	FACW	UNK	8, 9, 10, 14
URTICACEAE			
Boehmeria cylindrica (L.) Swartz	FACW	UNK	NIP
Laportea canadensis (L.) Weddell	FACW	mid Aug.	10
Pilea pumila (L.) Gray	FACW	Aug.	7, 8, 10
Urtica procera Muhl.	FACU	late July - late Sept.	1
VALERIANACEAE			
Valerianella intermedia Dyal	FAC	mid May - early June	6, 7, 8, 10, 14
VERBENACEAE			
Verbena hastata L.	FACW	late July - early Aug.	4. 13
Verbena urticifolia L.	FACU	late July - early Sept.	1
VIOLACEAE			
Viola cucullata Ait.	FACW	late Sept.	NIP
Viola papilionacea Pursh	FAC	mid April - mid May	7, 10, 14
VITACEAE			
Parthenocissus inserta (Kerner) Fritsch	UPL	UNK	7
Parthenocissus quinquefolia (L.) Planch.	FACU	UNK	7, 14
Vitis aestivalis Michx.	FACU	UNK	1, 7
Vitis riparia Michx.	FACW	UNK	7, 8, 10

[a]Rare species (Ohio Division of Natural Areas and Preserves 1988):
PT = Potentially Threatened
T = Threatened
E = Endangered
[b]* = Non-native
[c]UNK = Unknown; not observed in bloom.
[d]Division of flowering time within a month:
early = 1st - 10th
mid = 11th - 20th
late = 21st - end of month
[e]NIP = Occurring in the study site, but not in one of the sample plots.