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BACON'S SWAMP – GHOST OF A CENTRAL INDIANA NATURAL AREA PAST

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ABSTRACT. Bacon's Swamp was identified in the 1920s as a ca. 12 ha glacial kettle lake bog system at the southernmost limits of these habitats in Indiana. Located just 9.6 km from the center of Indianapolis, the site was all but destroyed in the mid-20th century by urban expansion. Prior to habitat conversion at the site, Bacon's Swamp was a frequent location for Butler University ecology class field trips and student research projects. Herbarium specimens and published inventory records allow for analysis of the historical vegetation of Bacon's Swamp using modern techniques. Floristic Quality Assessment applied to these historical records reveals Bacon's Swamp was a regionally significant natural area, with a native Floristic Quality Index (FQI) value of 60 and a mean native Conservation Coefficient value of 4.2. Little of this unusual, high-quality habitat remains. A 2010 botanical inventory at the site documents decline in habitat with the loss of species that have a fidelity to high-quality habitat, with a corresponding drop in FQI to 20 and the addition of invasive non-native plants. Re-analysis of Bacon's Swamp historical flora supports the view that it was a significant wetland natural area and floristically unique in Central Indiana.

Keywords: Bacon's Swamp, Butler University, historical botany, urban flora, wetlands

INTRODUCTION

Rare habitats and high-quality natural areas are often lost as cities grow and urbanization spreads out from the core to engulf surrounding land. Habitat can be directly lost through land use conversion and fragile ecological communities can be degraded through indirect effects that result in habitat alteration via processes such as fragmentation, spread of invasive species and altered drainage patterns (Dolan et al. 2011a, 2011b). Often only local historical knowledge remains with no physical record of species formerly present. Occasionally, lost natural areas have been the focus of historical scientific study prior to major disturbance (e.g., Tamarack Bog, Noble Co., IN (Swinehart & Starks 1994) and Cabin Creek Raised Bog, Randolph Co., IN (Ruch et al. 2013). When this happens, re-examination of the records and application of modern techniques of analysis can allow for a better appreciation of the quality and features of lost habitats. Additionally, these data can often be used to guide restoration efforts.

The opportunity existed to explore Bacon's Swamp, an ~12 ha glacial kettle lake bog system near the southernmost limits of these habitats in Central Indiana that has been nearly destroyed. Due to the unique composition of the swamp and its proximity to researchers and students in the Botany Department of Butler University, the site was a living lab – the focus of research papers, ecology class projects, honor's and master's projects, field trips, and specimen collection in the 1920s and 1930s (Fig. 1).

This paper compiles species lists from published literature records and herbarium specimens deposited in Butler University's Friesner Herbarium to examine and quantify the quality of the historical vegetation of Bacon's Swamp and its significance to the flora of the region using Floristic Quality Assessment, a tool developed in the early years of the twenty-first century. In addition, the site, which is fewer than 9.6 km from the center of downtown Indianapolis, was revisited in 2010 to assess the vegetation currently present.

METHODS

Study site.—Bacon's Swamp was named after an early owner whose property was reportedly a stop on the Underground Railroad. The swamp was the focus of local lore, rumored in the early twentieth century to be bottomless (Roettger 1994). During the first half of the twentieth century, the swamp was a prominent natural area known for its unusual plants and diversity of birds and other wildlife and as a good spot for duck hunting.

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Figure 1.—Stanley Cain's inaugural undergraduate Plant Ecology class at Butler University visits Bacon's Swamp in 1928. From left to right: Stanley Oren, unknown student, Rex Daubermire, and Alice Phillips. Photo courtesy of Rex Daubermire. Oren, Daubermire, and Phillips subsequently earned Ph.D.s in plant ecology at other universities.

Surrounding fields were in agriculture at this time. Development pressure intensified after World War II as the area surrounding Bacon's Swamp was converted from agriculture to housing. Long viewed as an "attractive nuisance," public outcry led to the swamp being drained and filled in the 1950s following the drowning deaths of several children. Some plans to save the area as a nature preserve and park had been discussed since the 1930s, but were never put in place (Roettger 1994). In the 1980s a senior living community was built on the site. The former bog area of Bacon's Swamp was dredged to form a lake. The former swamp habitat in the northern part is now in private hands and the wetlands in that area have also been dredged to form a lake. Aerial photos of the site from 1941-2014 document the changes (Figs. 2–5).

The origin of this unusual Central Indiana habitat is attributed to glacial melt from the retreating Early Wisconsin sheet ca. 20,000 year ago creating a kettle, or depression, formed by a glacial ice block that became a lake when the ice melted. The site then succeeded into a peatland that early researchers referred to as a bog, noting much peat and *Sphagnum* at the site, with cores showing a depth of sediment up to 11.9 m in the southern portion (Engelhardt 1959). Bogs were defined by Potzger (1934) as sites where the water table is at or near the surface and the soil is organic and formed *in situ,* while swamps were defined as sites with the water table above ground and the soil is inorganic or "of a humus nature." More recent interpretation would apply this definition of bogs to peatlands in general, of which bogs are a type (Swinehart 1997). Bacon's Swamp is likely the southernmost location of a kettle lake in Indiana and perhaps the Midwest (Otto 1938). These formations are most common in the Northern Lakes Natural Region, located 160 km to the north (Casebere 1997).

Cores into the peat of Bacons' Swamp reveal the succession of upland flora characteristic of regional post-glacial plant communities. Pollen in the deepest level, 6.1–9.8 m, was dominated by *Picea* and *Abies* with *Pinus, Larix* and *Salix-Populus* in low frequencies (Otto 1938). Mid-level cores revealed a rapid increase in *Pinus.* Top layers showed *Quercus* in high frequency, along with *Carya* and increases in *Acer* and *Fagus*, the beech-maple climax for Central Indiana (Otto 1938; Engelhardt 1959).

Bacon's Swamp is located in Marion County, Indiana and is bordered by 54th St. and Kessler

Figures 2-5.—Aerial photographs illustrating the change of Bacon's Swamp through time. 2. 1941 (top left). 3. 1959. 4. 1986. 5. 2014 (bottom right).

Blvd. on the north and south and by College Ave. and Keystone Ave. on the east and west (T 16 N, R 3 E, Sec. 6; with latitude and longitude at the center 39°51'17"N, 86°07'40"W; Fig. 6).

Marion County is in the Central Till Plain Natural Region (Homoya et al. 1985) of Indiana. This is a region of gently rolling terrain comprised of Wisconsin era glacial till deposits, often in excess of 30 m deep. General Land Office Survey records witness trees from 1820-1822 and soil survey records indicate that Marion County was 98% forested in pre-European settlement times (Barr et al. 2002). Mesic beech-maple forest covered 76% of the county, growing over an undissected plain of Wisconsin glacial till with small areas of oak-hickory forest on drier ridges. Wetlands, including ponds, bogs, marshes, and fens, are estimated to have made up approximately one percent of the original land cover (Barr et al. 2002).

The geology of Marion County is Carboniferous limestone covered by deposits of glacial drift 15-30 m deep. Soils at Bacon's Swamp were reported by Cain (1928) to be Miami black clay loam. The most recent USGS soil maps for Marion County only list cut and fill for the site (Sturm & Gilbert 1978). In the 1920s, corings revealed Bacon's Swamp was lined with a nearly impenetrable layer of fine compact blue silt at a depth in places of "only a few inches" (Cain 1926). Acidity of the cores varied vertically. The surface layer of the cores, down to a depth of 2.4 m, was raw *Sphagnum* peat with a pH of 5.9 (Otto 1938). Middle depths (2.4–7.0 m) were composed of sedge peat that was slightly acidic, while lower levels were alkaline (pH 7.3) due to groundwater soaking through limestone bedrock and to

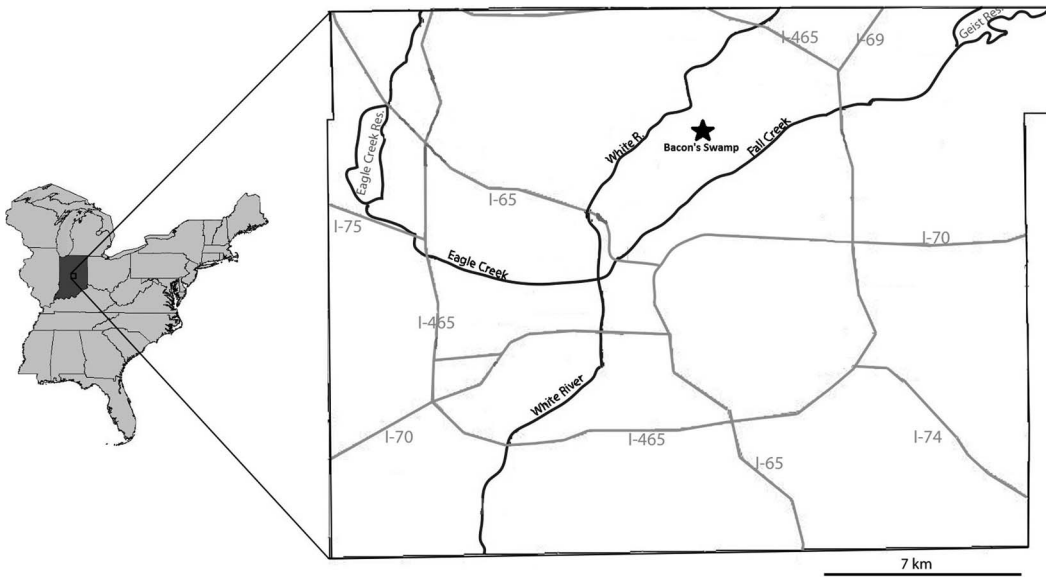

Figure 6.—Map illustrating the location of Marion County and the location of Bacon's Swamp within the county.

surface runoff. A layer of marl was present at the bottom of the basin (Otto 1938).

In the late 1920s, the site consisted of wetlands and surrounding upland forest (Fig. 7). Ecologists at the time identified the following plant zones or communities (Cain 1928; Phillips 1929). A wet meadow dominated by *Calamagrostis canadensis* occurred in the center of the site. *Dulichium arundinaceum, Juncus canadensis, Thelypteris palustris* var. *pubescens* and *Triadenum virginicum* were also present (Cain 1928; Phillips 1929). The wet meadow generally had 20–38 cm of standing water with scattered patches of *Typha* and open water with hydrophytes. *Sphagnum* and islands of *Decodon verticillatus* occurred along the meadow-mat next to the open water. It was surrounded by the deepest water present at the site, a "moat" 5–10 cm deep and 38–51 m wide. *Cephalanthus occidentalis* grew here, along with areas dominated by *Polygonum* spp. The moat was surrounded by a *Salix nigra* zone that graded into swamp forest dominated by *Acer rubrum*, *Fraxinus nigra, F. profunda, Nyssa sylvatica, Quercus bicolor, Q. palustris*, *Populus deltoides and Ulmus rubra*. Herbaceous plants included *Carex crinita*, *Onoclea sensibilis* and *Saururus cernuus*. The swamp forest transitioned to an upland beech-maple forest.

Cain (1928) and Phillips (1929) also identified a small area in the west-central portion of Bacon's Swamp as a fen. It was a site with few shrubs and no shade. Species present there included *Apios tuberosa, Asclepias incarnata, Eupatorium perfoliatum, Lobelia cardinalis, L. siphilitica, Lycopus uniflorus* and *Penthorum sedoides.* Soils were unlike the acid soils found elsewhere in the swamp; they contained sandy soil washed in from the adjacent upland, had widely fluctuating water levels, and a neutral pH (Cain 1928).

Cain (1928) posited that the concentric zonation of the vegetation represented stages of plant succession. He acknowledged the interest and assistance of Henry Cowles, University of Chicago, whose seminal paper (Cowles 1899) was the first published on the concept.

A final interesting piece of history relating to Bacon's Swamp is that it was the site of the first use of aerial photography to assist in ecological mapping (Cain 1926). Stanley Cain used pictures shot from 1524 m (5000 ft) to map zonation of plant communities in the swamp (Fig. 7). He felt the technique had great promise to assist ecologists in visualizing areas where the vegetation was too dense to traverse and topological maps did not exist. He noted that as airplanes became more numerous and available to people outside the military, that airplane photography would have great applicability to the burgeoning field of ecology. Cain was a Butler student and then professor who became an eminent ecologist,

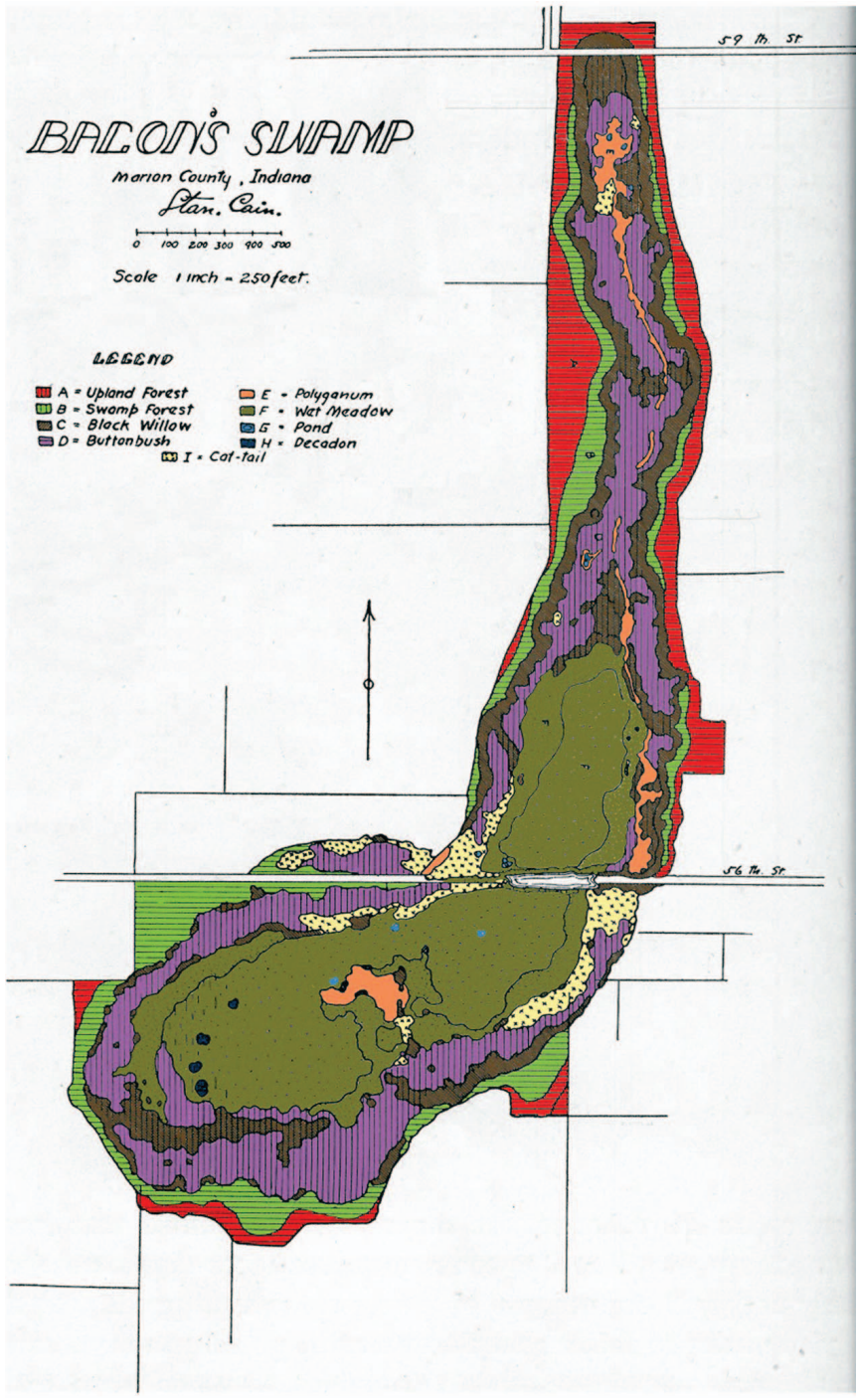

Figure 7.—Zonation of plant associations at Bacon's Swamp. Colorized version of map originally published in the Proceedings of the Indiana Academy of Science by Cain (1926).

elected President of the Ecological Society of America, and a member of the National Academy of Science.

Data analysis.—Two sources of information were used to establish a record of the historical flora of Bacon's Swamp. In 1929, Alice Phillips published a paper in the Butler University Botanical Studies that listed plants growing at Bacon's Swamp (Phillips 1929). Her goal was to categorize plants found in different microhabitats into Raunkiaer life-forms and to examine patterns. She lists 156 different taxa from six different plant associations/communities. A second source of historical records for Bacon's Swamp was specimens collected at the site that have been deposited in the Friesner Herbarium (BUT) of Butler University. A completed database of label information for all ca. 47,000 BUT sheets collected in Indiana allowed for identifying records that mention Bacon's Swamp in the location or habitat fields. In total 292 sheets of 138 different taxa collected from 1921-1935 were identified, suggesting the area was frequently botanized and collected. Most are plants noted by Phillips, but there are additions, and not all plants noted by Phillips have vouchers at BUT.

Species lists were compiled from the historical sources, matching older names with current nomenclature. To quantify the quality of vegetation at Bacon's Swamp and to allow comparison with other sites, I used Floristic Quality Assessment (Swink & Wilhelm 1994). Coefficients of Conservatism (C values) were used to quantify species' fidelity to high quality habitats and, therefore, tolerance of disturbance, as an indicator of overall floristic quality. C values were chosen for analysis of our data because they are comprehensive for the plants in the study area, provide a numerical value for species' behavior and can be used to make statistical comparisons between sites and through time. C values rank native species (those thought to have been present before European settlement) from 0-10 based on fidelity to high quality habitats, with higher numbers indicating greater preference for high quality habitat and less tolerance of disturbance. Because fidelity to high quality habitats can vary across species' ranges, we used C values developed specifically for the Indiana flora by Rothrock (2004).

Mean Coefficient of Conservatism (MC) and Floristic Quality Index (FQI) values were calculated using Floristic Quality Assessment software (Wilhelm & Masters 2004) separately for historical and recent species lists for Bacon's Swamp. All MC values reported are for native species only. FQI is calculated as $FQI = \Sigma(C_i)/\sqrt{(N_{native})}$, where C = the Coefficient of Conservatism of plant species i and N_{native} = the total number of native species occurring in the community being evaluated. Nomenclature followed Rothrock (2004), which is based largely on the Flora of North America (2008).

Finally, in July of 2010, I visited the site with Paul Rothrock (then at Taylor University), Kay Yatskievych (Missouri Botanical Garden), and students to inventory current vegetation in what remains of Bacon's Swamp. We focused on plants in and around the borders of the remaining wetland area. Vouchers were not collected.

RESULTS

A total of 268 taxa was reported for Bacon's Swamp (Appendix 1). The two historical sources yielded 228 different plants, the recent inventory yielded 66, 40 of which were not reported for the site in the past. Many prominent plants from historical reports, including *Calamagrostis canadensis*, a main component of the former wet meadow, were not seen in the recent survey, while others, like *Cephalanthus occidentalis*, previously prominent in the moat, remained (Appendix 1).

Historically, native perennial forbs (37.0%), trees (18.3%) and shrubs (12.3%) were the most common growth forms. Recent surveys show a similar pattern of physiognomy of the vegetation, with the exception of an increase in the percentage of annual forbs, which doubled in frequency from 8.2%–16.7% (Appendix 1).

MC based for historical records was 4.2, with a native FQI of 60.2 (Table 1). The recent inventory indicated greatly reduced habitat integrity, with values of 2.6 and 19.9, respectively. In the historical record, 16.0% (35 of 219) of plants had C values in the range of 7–10. Only one plant, *Quercus bicolor*, with a C value of 7, was in this range in the recent study. Values of 9 and 10 are indicative of species restricted to remnant landscapes that appear to have suffered very little post-settlement trauma (Rothrock & Homoya 2005). *Comarum palustre*, C = 9, and the following C = 10 species were present in the historical

Table 1.—Total species, percent native, native Mean Coefficient of Conservatism (MC), and native Floristic Quality Index (FQI) for historical and recent vegetation at Bacon's Swamp. BUT = Friesner Herbarium of Butler University.

	Phillips	BUT	Total historical	Recent
Total Species	158	138	219	66
% Native	96.8	86.2	91.8	86.4
MC	4.5	4.1	4.2	2.6
FQI	54.5	45.1	60.0	19.9

flora of Bacon's Swamp: *Acorus americanus, Dulichium arundinaceum, Symphyotrichum laeve* and *Triadenum virginicum*.

No plants currently recognized as threatened or endangered were found at Bacon's Swamp during historical or recent studies. In historical surveys, almost 92 percent of plants were native. The recent survey recorded 86%. Although relatively few non-native species have been recorded at Bacon's Swamp, some are considered invasive. Five of the seven recent non-natives have invasive ranks of "high" (IISC 2012): *Euonymus fortunei, Iris pseudacorus, Lythrum salicaria, Phalaris arundinacea* and *Rosa multiflora*. *Typha* × *glauca* is ranked as "caution" (IISC 2012).

Three plants recorded for Bacon's Swamp by Phillips (1929), *Iris versicolor, Salvinia natans* and *Spiraea salicifolia,* are not currently documented to grow in Indiana (BONAP 2014; USDA 2014; K. Yatskievych, Pers. Com.)

Of the six community associations detailed by Phillips (1929), plants found in the moat and in the wet meadow had the highest MC, with values over 5 (Table 2). The upland habitat surrounding the wetland complex has the highest FQI. Species numbers for some associations are low, and geographic size of association areas would have varied, limiting strength of interpretation. Comparison of historical and recent inventories (Appendix 1) reveals species have been lost about equally from all associations identified by Phillips (1929) and that habitat alternation at the site has greatly impacted all areas.

DISCUSSION

Analysis of historical data for Bacon's Swamp with Floristic Quality Assessment confirms the impression of early 20th century botanists that the site was a significant natural area. If its 1920's vegetation was present today, Bacon's Swamp would be regionally significant. The total historical flora had an FQI over 60. Sites with FQI values greater than 50 are considered to be of "paramount importance" from a regional perspective (Swink & Wilhelm 1994). Bacon's Swamp's historical FQI puts it in the lower 1/3 of 17 high-quality Indiana natural areas reviewed in Ruch et al. (2013), but in the range of values for the two wetland complexes they report on, IMI WC and Bennett WC, in Henry County.

An analysis of Marion County's flora based on records before 1940 found only 14 plants out of over 700 taxa recorded had C values of 10, with seven having C values of 9 (Dolan et al. 2011a). Plants in this range are indicative of "species restricted to remnant landscapes that appear to have suffered very little post-settlement trauma" (Rothrock 2004). Of the five found historically at Bacon's Swamp – *Acorus americanus*, *Comarum palustre, Dulichium arundinaceum, Symphyotrichum leave*, and *Triadenum virginicum* – vouchers are present at BUT for all but the final two. Four of these

Table 2.—Total species, percent native, native Mean Coefficient of Conservatism (MC), and native Floristic Quality Index (FQI) values for species in plant associations identified by Phillips (1929) at Bacon's Swamp.

	Upland	Lowland	Moat	Wet meadow	Fen	Aquatic
Total Species	105	18	9	15	16	7
% Native	96.2	94.4	100.0	100.0	100.0	100.0
MC	4.4	4.6	5.2	5.4	4.3	4.4
FQI	43.8	19.2	15.7	20.9	17.3	11.7

species are not known to have occurred elsewhere in Marion County (Deam 1940) and may be extirpated from the county due to the loss of Bacon's Swamp. These records highlight the unusual nature of the habitat at Bacon's Swamp relative to the rest of the county.

While overall site quality can be inferred from the presence of individual high quality species, mean Coefficient of Conservatism values offer a more integrated view of the flora present at a site. Bacon's Swamp's historical MC of 4.2 ranks it among the highest values for a site in the county. Dolan et al. (2011b) present native MC values based on recent inventories of 14 natural areas in Marion County. These sites had an average MC of 3.7. Only three had values over 4.0; two sites had MC of 4.5, and one of 4.4. C values for the best natural sites in the Central Till Plain of central Indiana are in the low 4 range, lower than other regions of the state, due to a limited number of high quality species. As noted by Rothrock & Homoya (2005), this region is home to few rare, threatened or endangered species, likely due to the relative homogeneity of natural communities and the presence of few specialized edaphic habitats.

Both historical and recent records for Bacon's Swamp contain a small number of non-natives, 8% and 14%, respectively. Fourteen percent of species growing outside of cultivation in Indiana in 1940 were non-native (Deam 1940). Recent estimates put the percentage at 31% (K. Yatskievych, Pers. Com.) statewide. Dolan et al. (2011b) found 19.3% in city parks with natural area remnants. Although the recent Bacon's Swamp inventory was completed in only a single day and likely underestimates the true number of non-natives, five highly invasive non-natives were identified. These plants will contribute to further degradation of the ecological integrity of the site.

Bacon's Swamp was described as a bog by early researchers based on the presence of peat, *Sphagnum*, and acidic free-standing water. Bogs in the Northern Lakes Region of Indiana are characterized additionally by the presence of a distinctive suite of ericaceous shrubs including *Andromeda glaucophylla*, *Chamaedaphne calyculata*, and *Vaccinium macrocarpon*, along with carnivorous plants such as *Sarracenia* (Homoya et al. 1985; Casebere 1997). None of these plants are known from Bacon's Swamp. Their geographic range is typically limited to northern Indiana. However, several species historically found at Bacon's Swamp are disjunct from their mainly northern Indiana ranges (e.g., *C. palustre* and *T. virginicum*).

Analysis of the historical records of plants at Bacon's Swamp revealed three species that have not been documented for the state. Two are known from adjacent states (USDA, 2014) and could occur in Indiana. *Iris versicolor* occurs in Michigan, Ohio, Illinois and Kentucky. *Spiraea salicifolia* is documented for Michigan and Kentucky. Their historical records from Bacon's Swamp may be misdeterminations (Kay Yatskevych, Pers. Com.). *Iris versicolor* has been misidentified due to omissions in Gray's Manual, 7th ed. (Fernald & Robinson 1908), the reference used by Phillips (1929). *Iris virginica* var. *shrevei*, seen at Bacon's Swamp in the recent inventory and collected at the site in 1931, 1933, and 1936 and now deposited at BUT, would key out to *I. veriscolor* using that guide and may be the taxon Phillips identified. *Spiraea salicifolia* is a primarily European species that readily hybridizes with native species, producing many intermediate forms that can be difficult to key out.

The historical listing of *Salvinia natans* for Bacons' swamp is also problematic to interpret without a voucher specimen. No *Salvinias* have been definitively documented outside of cultivation in Indiana or surrounding states and it is a distinctive genus that would be unlikely to be misidentified. Phillips' (1929) taxonomic source for the historical inventories at Bacon's swamp, Gray's Manual, 7th ed. (Fernald & Robinson, 1908), lists only *Salvinia natans* Pursh., which is now considered an illegitimate name (MOBOT 2014), so it is not clear to which species the plant found at Bacon's Swamp should be referred (Kay Yatskevych, Pers. Com.). *Salvinia natans* (L.) All. is a legitimate name for a plant that is known only from New York and Massachusetts, according to the USDA's Plants Database (USDA 2014). It is possible the plant reported as *S. natans* was actually the liverwort *Ricciocarpus natans* L. Corda, which is common in similar wetland habits (P. Rothrock & A. Swinehart, Pers. Com.), although Cain (1928) does reference *Ricca fluitans* L. as being present at Bacon's Swamp, so he was aware of liverworts occurring there.

With the exception of the fern, a record for Indiana would not be a significant range expansion for these plants, so it may be that Bacon's Swamp was the historical home to

state records. However, without vouchers deposited in herbaria to document these reports, it is not possible to examine a specimen to confirm correct identification.

The 2010 inventory, although limited to a single day and likely missing spring ephemerals and other out-of-season species, showed reduced habitat quality with marked reductions in FQI and Mean C compared to historical flora at the site and the presence of invasive non-native species. As early as the 1920s, evidence of habitat degradation due to drainage, fire, and agriculture were noted to be affecting Bacon's Swamp. An attempt to build 56th Street (Figs. 2-5) across the swamp in 1914 resulted in a paved road that sank when the peat on which it was built compressed. Construction of the road made a rectangular pond in the center of the swamp. Otto (1938) noted that 10 years before his study, Bacon's Swamp held water throughout the year and flooded to shallow lake stage in spring and fall. The thick growth of *Cephalanthus* in the moat and free-standing water provided protected habitat for migratory birds, reptiles, and amphibians. Small areas of living *Sphagnum* were present (Cain 1928). By 1936 the water table at the site had lowered, causing most of the swamp to dry out, perhaps due to tilling of surrounding land for agriculture and the effects of a drain installed at the north end. In late summer, dried grasses and sedges promoted fires that sometimes ignited peat (Otto 1938). Otto also noted the swamp forest on the northern edge of the swamp had been recently cut and cleared to ''reclaim'' the land, although the trees were too small to be of commercial value. He noted increases in wet meadow and decreases in *Sphagnum* which he attributed to the nearly annual fires.

Re-examination of the historical flora of Bacon's Swamp confirms that it was a high-quality site of regional significance based on FQA. Alkaline soils characteristic of Bacon's Swamp in its prime, together with its bog/wet meadow conditions, are unlikely to be recreated or replicated elsewhere in the county. However, the high-quality species that were once present at Bacon's Swamp and are now extirpated from the county could be targeted for use in wetland restorations in Marion County. This would allow these now lost elements of the county's flora to be recovered. With its absence of ericads, Bacon's Swamp might not be categorized as a bog by today's standards, but whatever its habitat classification, it was a unique site for Central Indiana. In a region that has lost over 85% of its historic wetlands (Ruch et al. 2013), Bacon's Swamp is an especially significant loss.

ACKNOWLEDGMENTS

Paul Rothrock and Kay Yatskievych provided plant identification during the recent inventory at Bacon's Swamp. Paul, Kay and Tony Swinehart provided very helpful review comments for this manuscript. Butler undergraduate Brandon Euen prepared Figures 2–6 and colorized Figure 7. Their assistance is greatly appreciated. This paper is dedicated to the early faculty of the Botany Department at Butler University, whose contributions to the understanding of Indiana flora are still being appreciated today.

Appendix 1.—Plants of Bacon's Swamp, Indianapolis, Indiana. Non-native species are in uppercase letters. Recent refers to plants present during a July, 2010 survey, BUT refers to specimens in the Friesner Herbarium of Butler University, Phillips refers to all plants reported by Phillips (1929). Plant associations (Upland, Lowland, Moat, Wet Meadow, Fen, Aquatic) are from Phillips (1929). C is Coefficient of Conservation based on Rothrock (2004). For physiognomy, Nt = native, Ad = adventive or non-native, P = perennial, A = annual, B = biennial, H = herbaceous, W = woody.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Acer rubrum L. var. *rubrum*			x	x						Nt Tree	5
Acer saccharinum L.	x									Nt Tree	1
Acer saccharum Marshall ssp. *saccharum*			x		x					Nt Tree	6
Acer saccharum Marshall ssp. *nigrum* (Michx. f.) Desmarais			x		x					Nt Tree	4
Acorus americanus (Raf.) Raf.		x								Nt P-Forb	10
Actaea pachypoda Elliott			x		x					Nt P-Forb	7
Aesculus glabra Willd.			x		x					Nt Tree	5
Agastache nepetoides (L.) Kuntze			x		x					Nt P-Forb	4
Agastache scrophulariifolia (Willd.) Kuntze		x								Nt P-Forb	4
Ageratina altissima (L.) R.M. King & H. Rob.		x								Nt P-Forb	2
Agrimonia gryposepala Wallr.		x								Nt P-Forb	2
AGROSTIS GIGANTEA Roth		x								Ad P-Grass	NA
Alisma subcordatum Raf.		x								Nt P-Forb	2
Alopecurus aequalis Sobol.		x								Nt P-Grass	6
Amaranthus tuberculatus (Moq.) D. Sauer	x									Nt A-Forb	1
Ambrosia artemisiifolia L. var. *elatior* (L.) Descourtils		x								Nt A-Forb	0
Ambrosia trifida L.	x	x								Nt A-Forb	0
Apios americana Medik.			x					x		Nt H-Vine	3
Apocynum cannabinum L.	x									Nt P-Forb	2
Arisaema dracontium (L.) Schott		x	x		x					Nt P-Forb	5

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Arisaema triphyllum (L.) Schott			x		x					Nt P-Forb	4
Asarum canadense L.		x	x		x					Nt P-Forb	5
Asclepias incarnata L.	x	x	x					x		Nt P-Forb	4
Asimina triloba (L.) Dunal			x		x					Nt Tree	6
BARBAREA VULGARIS W.T. Aiton		x								Ad B-Forb	NA
Bidens bipinnata L.		x								Nt A-Forb	0
Bidens connata Muhl. ex Willd.	x									Nt A-Forb	2
Bidens coronata (L.) Fisch. ex Steud		x	x					x		Nt A-Forb	5
Bidens frondosa L.	x									Nt A-Forb	1
Boehmeria cylindrica (L.) Sw.	x									Nt P-Forb	3
Botrychium virginianum (L.) Sw.		x	x		x					Nt Fern	4
Calamagrostis canadensis (Michx.) P. Beauv.			x				x			Nt P-Grass	5
Calystegia sepium (L.) R. Br.	x									Nt P-Forb	1
Camassia scilloides (Raf.) Cory		x			x					Nt P-Forb	5
Campanulastrum americanum L.		x								Nt A-Forb	4
Campsis radicans (L.) Bureau			x		x					Nt W-Vine	1
CAPSELLA BURSA-PASTORIS Medik.		x	x							Ad A-Forb	NA
Cardamine concatenata (Michx.) O. Schwarz		x	x		x					Nt P-Forb	4
Carex blanda Dewey		x								Nt P-Sedge	1
Carex crinita Lam.		x	x	x						Nt P-Sedge	8
Carex cristatella Britton	x									Nt P-Sedge	3
Carex frankii Kunth	x									Nt P-Sedge	2
Carex granularis Muhl. ex Willd.	x									Nt P-Sedge	2

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Carex hyalinolepis Steud.			x				x			Nt P-Sedge	3
*Carex laxiflor*a Lam.			x		x					Nt P-Sedge	7
Carex stipata Muhl. ex Willd. var. *stipata*	x	x								Nt P-Sedge	2
Carex tribuloides Wahlenb. var. *tribuloides*	x									Nt P-Sedge	5
Carex vulpinoidea Michx.	x									Nt P-Sedge	2
Carpinus caroliniana Walter			x		x					Nt Tree	3
Carya cordiformis (Wangenh.) K. Koch			x		x					Nt Tree	5
Carya ovata (Mill.) K. Koch			x		x					Nt Tree	4
Celtis occidentalis L.	x		x		x					Nt Tree	3
Cephalanthus occidentalis L.	x	x	x			x	x			Nt Shrub	5
Cercis canadensis L.			x		x					Nt Tree	3
Circaea lutetiana L. ssp. *canadensis* (L.) Asch & Magnus		x								Nt P-Forb	2
Claytonia virginica L.		x	x		x					Nt P-Forb	2
*Collinsonia canadensi*s L.		x								Nt P-Forb	8
*Comarum palustr*e L.		x	x				x			Nt P-Forb	9
Cornus drummondii C.A. Mey.	x									Nt Shrub	2
Cornus florida L.			x		x					Nt Tree	4
Cornus obliqua Raf.		x	x		x	x				Nt Shrub	5
Cornus sericea L.		x								Nt Shrub	4
Corylus americana Walter		x								Nt Shrub	4
Cyperus strigosus (Nees) Steud.	x									Nt P-Sedge	0
Cystopteris protrusa (Weath.) Blasdell		x	x		x					Nt Fern	4

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Decodon verticillatus (L.) Elliott		x	x				x			Nt Shrub	8
Desmodium canadense (L.) DC.			x					x		Nt P-Forb	3
Dicentra canadensis (Goldie) Walp.			x		x					Nt P-Forb	7
Dicentra cucullaria (L.) Bernh.		x	x		x					Nt P-Forb	6
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark		x									
ssp. *implicatum* (Scribn.) Gould & C.A. Clark										Nt P-Grass	2
DIGITARIA ISCHAEMUM (Schreb.) Muhl.		x								Ad A-Grass	0
Dulichium arundinaceum (L.) Britton		x	x				x	x		Nt P-Sedge	10
Eclipta prostrata (L.) L.	x									Nt A-Forb	3
Eleocharis erythropoda Steud.	x									Nt P-Sedge	2
Eleocharis obtusa (Willd.) Schult.		x								Nt A-Sedge	3
Eleocharis palustris Britton		x								Nt P-Sedge	8
ELEUSINE INDICA (L.) Gaertn.		x								Ad A-Grass	NA
Elymus villosus Muhl. ex Willd.		x								Nt P-Grass	4
Enemion biternatum Raf.			x		x					Nt P-Forb	5
Epifagus virginiana (L.) W.P. Barton		x	x		x					Nt P-Forb	8
Equisetum hyemale L. ssp. *affine* (Engelm.) A.A. Eaton			x		x					Nt Fern	2
ERAGROSTIS CILIANENSIS (All.) Vignlo ex Janch.		x								Ad A-Grass	NA
Eragrostis hypnoides (Lam.) Britton, Sterns & Poggenb.		x								Nt A-Grass	3
Erigenia bulbosa (Michx.) Nutt.			x		x					Nt P-Forb	5

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Erythronium albidum Nutt.			x		x					Nt P-Forb	3
Erythronium americanum Ker Gawl.		x	x		x					Nt P-Forb	5
Euonymus atropurpurea Jacq.		x	x		x					Nt Shrub	5
EUONYMUS FORTUNEI (Turcz.) Hand.-Mazz.	x									Ad Shrub	NA
Euonymus obovata Nutt.			x		x					Nt Shrub	7
Eupatorium perfoliatum L.		x								Nt P-Forb	5
Euthamia graminifolia (L.) Nutt.		x	x					x		Nt P-Forb	4
Eutrochium purpureum (L.) E.E. Lamont var. *purpureum*		x								Nt P-Forb	3
Fagus grandifolia Ehrh.			x		x					Nt Tree	8
Fraxinus americana L.	x		x		x					Nt Tree	4
Fraxinus nigra Marshall			x	x	x					Nt Tree	7
Fraxinus pennsylvanica Marshall var. *lanceolata* (Borkh.) Sarg.	x		x		x					Nt Tree	1
Fraxinus pennsylvanica Marshall var. *pennsylvanica*			x		x					Nt Tree	3
Fraxinus profunda (Bush) Bush			x	x						Nt Tree	8
Fraxinus quadrangulata Michx.			x		x					Nt Tree	7
Galium aparine L.			x		x					Nt A-Forb	1
Geranium maculatum L.		x	x		x					Nt P-Forb	4
Geum canadense Jacq.	x									Nt P-Forb	1
Geum vernum (Raf.) Torr. & A. Gray		x	x		x					Nt P-Forb	1
Gleditsia triacanthos L.			x		x					Nt Tree	1

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Glyceria septentrionalis Hitchc.		x								Nt P-Grass	7
Glyceria striata (Lam.) Hitchc.	x	x								Nt P-Grass	4
Gratiola neglecta Torr.		x								Nt A-Forb	4
Gratiola virginiana L.			x		x					Nt A-Forb	4
Gymnocladus dioica (L.) K. Koch			x		x					Nt Tree	4
Heuchera americana L.		x	x		x					Nt P-Forb	7
Hybanthus concolor (T.F. Forst.) Spreng.			x		x					Nt P-Forb	6
Hydrastis canadensis L.			x		x					Nt P-Forb	7
Hydrophyllum appendiculatum Michx.		x	x		x					Nt P-Forb	6
Hydrophyllum macrophyllum Nutt.			x		x					Nt P-Forb	7
Hydrophyllum virginianum L.			x		x					Nt P-Forb	4
Ilex verticillata (L.) A. Gray		x	x			x				Nt Shrub	8
Impatiens capensis Meerb.	x		x	x						Nt A-Forb	2
IRIS PSEUDACORUS L.	x									Ad P-Forb	NA
Iris versicolor L.			x					x		Nt P-Forb	
Iris virginica L. var. *shrevei* (Small) E.S. Anderson	x	x								Nt P-Forb	5
Juglans nigra L.		x	x		x					Nt Tree	2
Juncus canadensis J. Gay		x	x				x			Nt P-Forb	7
Lactuca canadensis L.		x								Nt B-Forb	2
Leersia oryzoides (L.) Sw.	x									Nt P-Grass	2
Lemna minor L.	x		x						x	Nt A-Forb	3
Lemna trisulca L.			x						x	Nt A-Forb	6

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
LEONURUS CARDIACA L.		x								Ad P-Forb	NA
Lindera benzoin (L.) Blume			x		x					Nt Shrub	5
Lindernia dubia (L.) Pennell var. *dubia*	x									Nt A-Forb	3
Liquidambar styraciflua L.	x									Nt Tree	4
Liriodendron tulipifera L.			x	x						Nt Tree	4
Lobelia cardinalis L.		x	x					x		Nt P-Forb	4
Lobelia siphilitica L.		x	x					x		Nt P-Forb	3
Luzula echinata (Small) F.J. Herm.		x								Nt P-Forb	6
Luzula multiflora (Ehrh.) Lej.		x	x		x					Nt P-Forb	6
Lycopus americanus Muhl. ex W.P.C. Barton	x									Nt P-Forb	3
Lycopus uniflorus Michx.		x	x					x		Nt P-Forb	5
LYSIMACHIA NUMMULARIA L.	x									Ad P-Forb	NA
Lythrum alatum Pursh		x								Nt P-Forb	5
LYTHRUM SALICARIA L.	x									Ad P-Forb	NA
MACLURA POMIFERA (Raf.) C.K. Schneid.			x		x					Ad Tree	NA
Maianthemum racemosum (L.) Link		x	x		x					Nt P-Forb	4
MEDICAGO SATIVA L. ssp. *SATIVA*		x								Ad P-Forb	NA
Menispermum canadense L.			x		x					Nt W-Vine	3
Mentha arvensis var. *villosa* L.		x								Nt P-Forb	4
Mimulus ringens L.		x								Nt P-Forb	4
Morus rubra L.		x	x		x					Nt Tree	4
Muhlenbergia schreberi J.F. Gmel.		x								Nt P-Grass	0
NEPETA CATARIA L.		x	x		x					Ad P-Forb	NA

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Nuphar advena (Aiton) W.T. Aiton			x						x	Nt P-Forb	6
Nyssa sylvatica Marshall		x	x	x						Nt Tree	5
Oenothera biennis L.		x								Nt B-Forb	0
Onoclea sensibilis L.		x	x	x	x					Nt Fern	4
ORNITHOGALUM UMBELLATUM L.		x								Ad P-Forb	NA
Osmorhiza longistylis (Torr.) DC.			x		x					Nt P-Forb	3
Ostrya virginiana (Mill.) K. Koch			x		x					Nt Tree	5
Panicum dichotomiflorum Michx.		x								Nt A-Grass	0
Parthenocissus quinquefolia (L.) Planch.			x		x					Nt W-Vine	2
Penthorum sedoides L.		x	x					x		Nt P-Forb	2
Persicaria amphibia (L.) Gray var. *emersa* (L.) Delarbre		x	x				x			Nt P-Forb	4
Persicaria hydropiperoides Michx.	x	x	x				x			Nt P-Forb	3
Persicaria pensylvanica (L.) M. Gómez		x								Nt A-Forb	0
Persicaria sagittata (L.) H. Gross		x	x				x	x		Nt A-Forb	4
PERSICARIA VULGARIS Webb & Moq.	x									Ad A-Forb	NA
PHALARIS ARUNDINACEA L.	x									Ad P-Grass	NA
Phlox divaricata L.		x	x		x					Nt P-Forb	5
Photinia floribunda (Lindl.) K.R. Roberston & J.B. Phipps			x			x				Nt Shrub	8
Photinia melanocarpa (Mich.) K.R. Robertson & J.B. Phipps		x								Nt Shrub	8
Phryma leptostachya L.			x		x					Nt P-Forb	4
Phyla lanceolata (Michx.) Greene	x									Nt P-Forb	2

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Phytolacca americana L.			x		x					Nt P-Forb	0
Pilea pumila (L.) A. Gray	x									Nt A-Forb	2
Platanus occidentalis L.	x		x		x					Nt Tree	3
Podophyllum peltatum L.			x		x					Nt P-Forb	3
Polemonium reptans L.		x	x		x					Nt P-Forb	5
Polygonatum biflorum (Walter) Elliott			x		x					Nt P-Forb	4
Populus deltoides W. Bartram ex Marshall	x		x	x						Nt Tree	1
Populus grandidentata Michx.			x		x					Nt Tree	4
Prunus nigra Aiton			x		x					Nt Tree	8
Prunus serotina Ehrh.			x		x					Nt Tree	1
Prunus virginiana L.			x		x					Nt Shrub	3
Pseudognaphalium obtusifolium (L.) Hillard & B.L. Burtt		x								Nt B-Forb	2
Ptelea trifoliata L. var. *trifoliata*			x		x					Nt Shrub	4
Quercus alba L.		x	x		x					Nt Tree	5
Quercus bicolor Willd.	x	x	x	x						Nt Tree	7
Quercus macrocarpa Michx.			x		x					Nt Tree	5
Quercus muehlenbergii Engelm.		x	x		x					Nt Tree	4
Quercus palustris Münchh.			x	x						Nt Tree	3
Quercus rubra L.			x		x					Nt Tree	4
Quercus velutina Lam.			x		x					Nt Tree	4
Ranunculus abortivus L.			x	x						Nt A-Forb	0
Ranunculus flabellaris Raf.		x	x						x	Nt P-Forb	7

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Ranunculus recurvatus Poir.			x	x						Nt A-Forb	5
Rhus glabra L.		x	x		x					Nt Shrub	1
Ribes cynosbati L.			x		x					Nt Shrub	4
Rorippa palustris (L.) Besser ssp. *fernaldiana* (Butters & Abbe) Jonsell	x									Nt A-Forb	2
ROSA MULTIFLORA Thunb.	x									Ad Shrub	NA
Rosa palustris Marshall		x	x			x	x			Nt Shrub	5
Rubus allegheniensis Porter	x	x	x		x					Nt Shrub	2
Rubus hispidus L.		x	x					x		Nt Shrub	6
Rubus occidentalis L.		x	x		x					Nt Shrub	1
RUMEX ACETOSELLA L.		x								Ad P-Forb	NA
RUMEX OBTUSIFOLIUS L.		x								Ad P-Forb	NA
Rumex verticillatus L.	x	x								Nt P-Forb	5
Sagittaria latifolia Willd.	x	x	x					x	x	Nt P-Forb	3
Salix discolor Muhl.			x			x	x			Nt Tree	3
Salix eriocephala Michx.		x	x			x	x			Nt Shrub	4
Salix interior Rowlee	x	x								Nt Shrub	1
Salix nigra Marshall	x	x	x	x						Nt Tree	3
Salix sericea Marshall		x	x		x	x				Nt Shrub	6
Salvinia natans (L.) All.			x						x	Nt P-Fern	
Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli	x	x	x		x					Nt Shrub	2
Sanguinaria canadensis L.		x	x		x					Nt P-Forb	5
Saururus cernuus L.		x	x	x				x		Nt P-Forb	4

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Scirpus cyperinus (L.) Kunth		x	x				x	x		Nt P-Sedge	4
Scrophularia marilandica L.		x								Nt P-Forb	5
Scutellaria incana Biehler		x								Nt P-Forb	4
Scutellaria lateriflora L.	x									Nt P-Forb	4
SETARIA PUMILA (Poir.) Roem. & Schult.		x								Ad A-Grass	NA
Silene antirrhina L.		x								Nt A-Forb	0
Sium suave Walter	x	x	x					x		Nt P-Forb	5
Smilax glauca Walter		x								Nt W-Vine	4
Smilax rotundifolia L.			x		x					Nt W-Vine	3
Smilax tamnoides L.			x		x					Nt W-Vine	4
SOLANUM DULCAMARA L.	x	x	x	x	x					Ad W-Vine	0
Solidago caesia L.		x								Nt P-Forb	7
Solidago canadensis L. var. *canadensis*		x								Nt P-Forb	0
Spiraea alba Du Roi		x								Nt Shrub	4
Spiraea salicifolia L.			x			x	x			Nt Shrub	
Spirodela polyrhiza (L.) Schleid.	x									Nt A-Forb	5
Stellaria pubera Michx.		x	x		x					Nt P-Forb	7
Stylophorum diphyllum (Michx.) Nutt.			x		x					Nt P-Forb	7
Symphyotrichum cordifolium (L.) G.L. Nesom		x								Nt P-Forb	5
Symphyotrichum laeve (L.) Á. Löve & D. Löve			x		x					Nt P-Forb	10
Symphyotrichum lanceolatum (Willd.) G.L. Nesom	x									Nt P-Forb	3
Symphyotrichum lateriflorum (L.) Á. Löve & D. Löve	x									Nt P-Forb	3

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Symphyotrichum pilosum (Willd.) G.L. Nesom var. *pilosum*		x								Nt P-Forb	0
Teucrium canadense L. var. *canadense*	x									Nt P-Forb	3
Thalictrum thalictroides (L.) A.J. Eames & B. Boivin			x		x					Nt P-Forb	7
Thelypteris palustris Schott var. *pubescens* (G. Lawson) Fernald		x	x				x			Nt Fern	7
Toxicodendron radicans (L.) Kuntze ssp. *radicans*	x		x		x					Nt W-Vine	1
Tradescantia subaspera Ker Gawl.	x	x								Nt P-Forb	4
Triadenum virginicum (L.) Raf.			x	x	x					Nt P-Forb	10
TRIFOLIUM PRATENSE L.		x								Ad P-Forb	NA
Trillium recurvatum L.C. Beck			x		x					Nt P-Forb	4
Trillium sessile L.			x		x					Nt P-Forb	4
Triodanis perfoliata (L.) Nieuwl.		x								Nt A-Forb	2
Typha latifolia L.			x						x	Nt P-Forb	1
TYPHA × *GLAUCA* Godr.	x									Ad P-Forb	NA
Ulmus americana L.			x		x					Nt Tree	3
Ulmus rubra Muhl.		x	x	x						Nt Tree	3
URTICA DIOICA L. ssp. *DIOICA*		x								Ad P-Forb	NA
VERBASCUM THAPSUS L.		x								Ad B-Forb	NA
Verbena urticifolia L. var. *urticifolia*	x									Nt P-Forb	3
Vernonia gigantea (Walter) Trel. ex Branner & Coville	x	x								Nt P-Forb	2
Viburnum lentago L.			x		x					Nt Shrub	5

Appendix 1.—Continued.

Scientific name	Recent	BUT	Phillips	Lowland	Upland	Moat	Wet meadow	Fen	Aquatic	Physiognomy	C
Viburnum prunifolium L.		x								Nt Shrub	4
VIOLA BICOLOR Pursh		x	x		x					Ad A-Forb	NA
Viola pubescens Aiton		x								Nt P-Forb	5
Viola sororia Willd.		x	x		x					Nt P-Forb	1
Viola striata Aiton		x	x		x					Nt P-Forb	4
Vitis aestivalis Michx. var. *bicolor* Deam			x		x					Nt W-Vine	4
Vitis vulpina L.	x									Nt W-Vine	3
Wolffia columbiana H. Karst.			x						x	Nt A-Forb	5
Woodsia obtusa Torr.			x		x					Nt Fern	4
Zanthoxylum americanum Mill.		x	x			x				Nt Shrub	3
ZEA MAYS L.		x								Ad A-Grass	NA

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