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Flora and Vegetation Composition of Spring Bay Fen Nature Preserve, Woodford County, Illinois

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ABSTRACT

The only tall shrub fen community known to occur in Illinois was examined to determine its plant species composition and structure. Located along the east shore of Upper Peoria Lake, this fen community occurs within Spring Bay Fen Nature Preserve, Woodford County, Illinois. A total of 264 vascular plant species in 77 plant families and 183 genera were found in the preserve, including 26 adventive taxa. Of the 105 species found in the fen the ground layer was dominated by *Apios americana* Medic. (ground nut) (IV of 27.6, possible importance value of 200), followed by *Symplocarpus foetidus* (L.) Nutt. (skunk cabbage), *Impatiens capensis* Meerb. (spotted touch-me-not), *Aster firmus* Nees (swamp aster), and *Sagittaria latifolia* Willd. (common arrowhead). Shrubs dominated the fen, averaging 5975 stems/ha; the most important being *Ribes americanum* Mill. (wild black current), *Viburnum lentago* L. (nannyberry), *Cornus sericea* L. (red-osier dogwood), and *Toxicodendron vernix* (L.) Kuntze (poison sumac). The state threatened *Filipendula rubra* (Hill) Robins. (queen of the prairie) and the state/federally threatened *Boltonia decurrens* (Torr. & Gray) Wood (decurrent false aster) were found during the surveys. Overall, the survey determined that the fen community was of high natural quality, but recent flooding (2001 to 2020) has resulted in species loss and a perceived decrease in natural quality.

INTRODUCTION

In Illinois, fen communities are mostly restricted to the northern third of the state, but extend down the Illinois River in isolated areas (White and Madany 1978, IDOC 1988). Typically occurring at the base of mineral rich (calcium and/or magnesium carbonate) sand or gravel Wisconsin glacial deposits, fens differ from seeps by the presence of peat formation in addition to having alkaline seepage (White and Madany 1978, Wiggers 1997, Killey 1998). Five fen subclasses are recognized by White and Madany (1978), with the rarest being tall shrub fen. Only one tall shrub fen is known in the state, and occurs within Spring Bay Fen Nature Preserve, located just north of Peoria (White 1978, McFall and Karnes 1995) on the east side of Upper Peoria Lake (Figures 1 & 2).

Spring Bay Fen Nature Preserve is 12.7 ha (31.3 acre) in area, and is located along the Illinois River in Woodford County, Illinois (NW 1/4 S23 T27N R4W; 40.78599° Lat./-089.53475° Long.). It occurs in an isolated sand deposit of the Illinois River Section of the Illinois River and Mississippi River

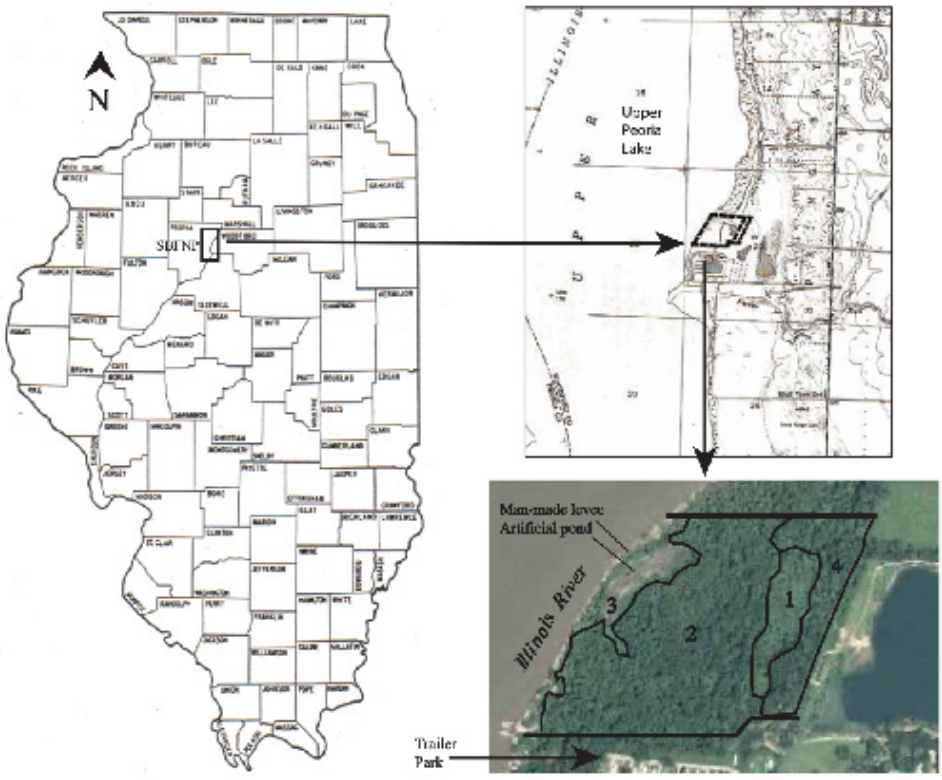

Figure 1. Location of Spring Bay Fen Nature Preserve, Woodford Co., IL, and community types present during surveys conducted in 2007, 2008 and 2011. Numbers corresponding to community types are as follows: 1 = tall shrub fen; 2 = floodplain forest; 3 = open shoreline areas; and 4 = degraded upland forest areas, where sand and gravel fill were bulldozed into the fen somtime between 1975 and 1977.

Sand Areas Natural Division (Schwegman 1973, Lineback 1979, McFall and Karnes 1995). In the mid 1970s, five acres of this preserve were designated as Grade A tall shrub fen during the Illinois Natural Areas Inventory (Schwegman et al. 1977). However, this was likely an overestimate of the fen community's area (R. Nyboer, personal communication, May 2020). In November 1979, the fen and additional acreages of adjacent community types were dedicated as a state nature preserve, with 10.8 ha (26.6 acres) representing natural community types, and an additional 1.9 ha (4.7 acres) representing a buffer zone on the eastern edge of the preserve (McFall and Karnes 1995). Presently, vegetation communities in this preserve include tall shrub fen, wet-mesic floodplain forest, and open floodplain/shoreline areas, as well as transitional areas between these community types.

The tall shrub fen occurs in Lena muck, while nearly all of the adjacent floodplain habitats occur on Slacwater silt loam (Fehrenbacher et al. 1984, Teater 1999). Presently, the entire eastern edge of the preserve consists of fill soils that were bulldozed into the fen habitat sometime between 1975 and 1977 (IDOC 1979, Teater 1999, R. Nyboer personal communication, May 2020). Previous to this disturbance, the soil type on the eastern border of the fen was Coloma sand, on 7 to 15% slopes. Soils extending nearly 400 m (1,320 ft.) south and east of the preserve are also fill soils (Teater 1999).

The present study was undertaken to determine the vegetation composition of the preserve, as well as the structure and composition of dominant plant communities in the preserve. In addition, searches were conducted to relocate several threatened, endangered, and uncommon species once known to occur in this area, to determine the habitat area of the fen community, and any historical changes that may have occurred.

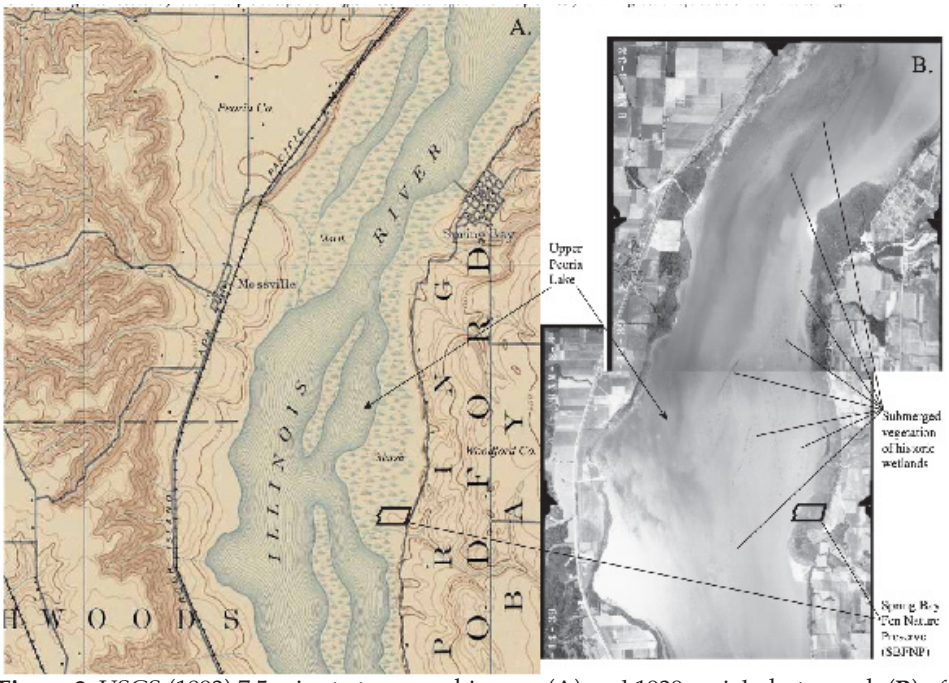

Figure 2. USGS (1893) 7.5 minute topographic map (**A**) and 1939 aerial photograph (**B**) of areas surrounding Peoria and Woodford Cos., IL, with the location of SBFNP shown. **Map A** shows as near as possible the presettlement configuration of the river. **Map B** shows the same stretch of river and its configuration after Lake Michigan water diversions as well as the completion of the Peoria navigational dam in 1938. Between 1900 and 1938, the average volume of water diverted into the Illinois River from Lake Michigan was 205 cubic meters per second (7,222 cubic feet per second); significantly raising water levels. The Peoria lock and dam (12 miles downstream) was put into operation in December 1938, further raising water levels. July 1939 aerial photos captured images of submersed vegetation of the previously remaining wetlands, that were never to be seen again.

MATERIALS & METHODS

Fen Community Size. To determine the size of the tall shrub fen community, a Spectra Precision GPS unit (Spectra Precision, Trimble Navigation Ltd) was used, with data processing using ArcGIS 10.3.

Florisitic Composition. During the growing seasons of 2007, 2008 and 2011, multiple visits were made to the preserve to inventory and sample the vegetation while in the summer of 2020 the senior author (MJCM) visited the site to asses reports of recent flood damage. During these trips voucher specimens were collected for most vascular plant taxa occurring within the preserve, and habitat data and GPS coordinates were recorded for all collections. Collections were identified and deposited in the herbarium of the Illinois Natural History Survey (ILLS), in Champaign, Illinois. Nomenclature and adventive species determinations follow Mohlenbrock (2002), with the exception of the genus *Phragmites*, which follows Mohlenbrock (2014). Community classification follows White and Madany (1978). The search for threatened, endangered, and uncommon species involved a literature search, including notes of the biologists conducting the Natural Areas Inventory (White 1978) available from the Illinois Department of Natural Resources, Springfield, Illinois, and the University of Illinois herbarium, Urbana, Illinois. The current protective status for Illinois' threatened and endangered species follows the IESPB (2020).

Sampling. In mid-summer of 2007 line transects, 100 m in length, were placed within the tall shrub fen and floodplain forest communities. Transect orientation and GPS coordinates were taken at the transect starting and end points. Ground-layer flora compositions were evaluated by placing 1 m² quadrats at every other meter (i.e., 0, 2, 4, etc.)

along the line transects with quadrats alternating to the right or left. Cover values of all species (herbs, vines, and woody seedlings < 50 cm tall) rooted within quadrats, as well as percent organic litter/bare ground, were estimated using Daubenmire (1959) cover classes as modified by Bailey and Poulton (1968), and are as follows: class 1 = 0 – 1%, class 2 = >1 – 5%, class 3 = >5 – 25%, class 4 = >25 – 50%, class 5 = >50 – 75%, class 6 = >75 – 95%, and class 7 = >95 – 100%. Cover class midpoint values were used in data analysis for each occurrence, and from these data, frequency, relative frequency, mean cover, relative cover, and importance value (IV 200% = sum of relative frequency % and relative cover %) were calculated for each species.

In the tall shrub fen community, the density of shrubs and small saplings (stems ≥ 50 cm tall and < 2.5 cm dbh) was determined by counting all stems within 2 m on either side of the line transect (400 m²). Density of large saplings (stems ≥ 2.5 to < 10.0 cm dbh) and trees (≥ 10 cm dbh) was determined by counting all stems within 10 m on either side of the line transect (2000 m²). Floodplain forest sampling for shrubs and small saplings, large saplings, and trees was similar to sampling within the tall shrub fen community, but due to the much reduced density of shrubs and small saplings in this community type, the sampling area for this stratum was increased to 2000 m². For tree species in the forest community, the density (stems/ha), relative density, basal area (m^2/ha), relative basal area, importance value (IV 200% = sum of relative density % and relative basal area %), and average dbh, were calculated.

To further evaluate floristic integrity of this site, the mean coefficient of conservatis $\bar{C}$ and floristic quality index (FQI = [I]) were calculated for the entire preserve as well as dominant community types within the preserve, according to Taft et al. (1997), using the following formulae, respectively: $\bar{C} = \sum C/N$, where C is the coefficient of conservatism and N is the number of taxa; and $I = \bar{C}(\sqrt{N})$, where I is a weighted index of species richness, and is the product of $\bar{C}$ multiplied by the square root of the number of species ($\sqrt{N}$). Coefficients of conservatism (C) assigned to all vascular plant taxa occurring within the state, according to Taft et al. (1997), consist of a value ranging from 0 to 10, and represent a measure of each taxon's tolerance to habitat degradation. A C-value of 10 indicates the highest degree of fidelity to high quality natural areas, while a value of 0 indicates the lowest. Following this, taxa at the upper end of the conservatism spectrum (i.e., 7-10) are usually the first species to disappear as natural areas undergo various types of disturbance that lead to habitat degradation. Non-native taxa are automatically assigned a C-value of 0. For areas intensively surveyed, the FQI provides a rapid and effective means for making qualitative comparisons of floristic integrity among sites. Sites with a FQI (I) ≥ 35 or $\bar{C}$ ≥ 3.5 are considered regionally noteworthy – possessing sufficient floristic quality to be considered at least marginally high quality natural areas (Swink and Wilhelm 1994, Taft et al. 1997).

Historic Conditions. To assess land use in and around the preserve, aerial photographs were obtained from the University of Illinois Map and Geography Library, and the Illinois Natural Resources Geospatial Data Clearinghouse (ISGS 2020). Aerial photographs were available, and obtained for years 1939, 1951, 1957, 1963, 1969, 1988, and 1998. Also, an earlier soil survey for Woodford County (Smith et al. 1927) was used in addition to the most recent survey (Teater 1999).

RESULTS

Florisitic Composition. A total of 264 species reresenting 77 plant families and 183 genera were found in the preserve (Appendix 1). Of these taxa, 26 (9.8%) were adventive. Ferns and fern allies accounted for three taxa in three families. Among angiosperms, monocots accounted for 67 taxa, in 40 genera, and 13 families; and dicots, 194 taxa, in 140 genera, and 61 families (Appendix 1). The Asteraceae (30 species), Cyperaceae (26 species), and Poaceae (24 species) represented 30% of the flora in the preserve. The native FQI for the preserve was 54.4 (51.7 with adventive taxa) and the native $\bar{C}$-value was 3.5 (3.2 with adventive taxa), indicating a natural area still possessing a high degree of natural integrity.

Two threatened and endangered species were encountered during this study. Three sterile individuals of the state and federally threatened *Boltonia decurrens* (decurrent false aster) were found in the open, grass and sedge dominated shoreline habitat along Upper Peoria Lake. Also, one population of the state threatened *Filipendula rubra* (queen of the prairie) was found on the east-central edge of the tall shrub fen community, in an open area with very few shrubs. This population was somewhat patchy in distribution, and occurred in an area of approximately 14 m². At the time of collection in late July of 2007, there were ten flowering stems, four fruiting stems, and 30 to 50 smaller, sterile stems.

Tall Shrub Fen. The tall shrub fen community was determined to be 1.2 ha (2.9 acres) in area, and occurs in the eastern portion of the preserve (Figure 1). The entire eastern edge of the fen grades rapidly upslope into a dry, upland forest-type habitat, which occurs largely on fill soil that was deposited on the eastern edge of the fen. On all other boundaries, the fen community and associated Lena muck soils grade rather abruptly into the floodplain forest community, and its associated Slacwater silt loam soils.

Within the fen community, 105 vascular plant species were found, including eight adventive species (Table 1 and Appendix 1). Most adventive species were rare, but *Mentha* x *piperita* (peppermint) was occasional, while *Lysimachia nummularia* (moneywort) and *L. vulgaris* (garden loosestrife) were locally abundant (Table 1), with scattered areas being infested by these two taxa. Of the remaining species, 53 were present in the quadrats. Of these, *Apios americana* (ground nut) was the most important, with an importance value of 27.6 (possible IV 200), followed by *Symplocarpus foetidus* (skunk cabbage), with an IV of 23.5. Other herbaceous species with high importance values

included: *Impatiens capensis* (spotted touch-me-not, IV 18.4), *Aster firmus* (swamp aster, IV 13.5), *Sagittaria latifolia* (common arrowhead, IV 11.4), *Pilea fontana* (clearweed, IV 9.6), and *Solidago patula* (swamp goldenrod, 9.3) (Table 1). The native FQI for the tall shrub fen was 40.8 (39.2 with adventive taxa) and the native $\bar{C}$ was 4.1 (3.8 with adventive taxa).

Shrubs were the dominant feature of the fen, with 15 species encountered along with three woody vines. Of these, seven shrub species occurred in the shrub and small sapling sampling area. The dominant shrub species was *Ribes americanum* (wild black current, 3600 stems/ha), followed by *Viburnum lentago* (nannyberry, 1025 stems/ha), *Cornus sericea* (red-osier dogwood, 650/stems ha), *Toxicodendron vernix* (poison sumac, 450 stems/ha), *Lonicera* x *bella* (showy fly honeysuckle, 175 stems/ha), *Salix discolor* (pussy willow, 50 stems/ha), and *Sambucus canadensis* (elderberry, 25 stems/ha). Density of shrubs in the fen community was 5975 stems/ha. In areas where shrub densities were high, herbaceous ground flora diversity and abundance were greatly reduced. Large saplings and trees were scarce within the tall shrub fen community and were only represented by four species. Large saplings of *Acer saccharinum* (silver maple, 10 stems/ha) and *Fraxinus lanceolata* (green ash, 5 stems/ha) were rarely encountered, while small trees of *F. lanceolata* (60 stems/ha) and *F. nigra* (black ash, 15 stems/ha) rarely exceeded 20 cm dbh.

Table 1. Frequency (%), mean cover (% of total cover), relative frequency, relative cover, and importance value (I.V.) of ground layer species encountered in the tall shrub fen community at Spring Bay Fen Nature Preserve, Woodford County, Illinois. (*adventive species)

Species	Freq.%	Mean Cover	Rel. Freq	Rel. Cover	I.V.
Apios americana	98	28.68	8.94	18.68	27.62
Symplocarpus foetidus	90	23.45	8.21	15.27	23.48
Impatiens capensis	94	15.15	8.58	9.87	18.45
Aster firmus	62	12.07	5.66	7.86	13.52
Sagittaria latifolia	48	10.80	4.38	7.03	11.41
Ribes americanum	72	7.16	6.57	4.66	11.23
Pilea fontana	76	4.14	6.93	2.70	9.63
Solidago patula	60	5.94	5.47	3.87	9.34
**Lysimachia vulgaris*	40	8.14	3.65	5.30	8.95
Peltandra virginica	28	6.66	2.55	4.34	6.89
**Lysimachia nummularia*	48	2.97	4.38	1.93	6.31
Eupatoriadelphus maculatus	28	4.86	2.55	3.16	5.71
Parthenocissus quinquefolia	32	2.59	2.92	1.69	4.61
Smilacina stellata	30	2.29	2.74	1.49	4.23
Clematis virginiana	26	2.70	2.37	1.76	4.13
Cuscuta gronovii	40	0.25	3.65	0.16	3.81
Rudbeckia lanceolata	16	2.11	1.46	1.37	2.83
Bolboschoenus fluviatilis	10	2.16	0.91	1.41	2.32
Calystegia sepium	18	0.73	1.64	0.48	2.12
Chelone glabra	10	1.26	0.91	0.82	1.73
Geum canadense	14	0.66	1.28	0.43	1.71
Silene nivea	14	0.42	1.28	0.27	1.55
**Mentha* x *piperita*	10	0.97	0.91	0.63	1.54
Laportea canadensis	10	0.97	0.91	0.63	1.54
Caltha palustris	12	0.26	1.09	0.17	1.26
Carex hystericina	10	0.54	0.91	0.35	1.26
Cornus obliqua	10	0.44	0.91	0.29	1.20
Silphium perfoliatum	4	1.05	0.36	0.68	1.04
Others (25 species)	--	4.14	7.88	2.70	10.58
Totals	--	153.56	100.00	100.00	200.00
Bare ground and litter		17.63			

Floodplain Forest. Approximately 7.3 ha (18 acres) within the preserve is represented by closed canopy, wet-mesic floodplain forest. The majority of this community type is west of the tall shrub fen (Figure 1), and gradually grades into moist, open meadow shoreline habitat. Diversity in this area was relatively high, but many species were infrequently encountered and/or only represented by few individuals. Scattered wet depressions and a small creek added to species diversity.

The native FQI for the floodplain forest was 35.8 (34.1 with adventive taxa) and the native $\bar{C}$ was 3.2 (2.9 with adventive taxa). Of the 136 species observed in the floodplain forest community, 12 were adventive and 124 were native. With the exception of *Lysimachia nummularia*, adventive taxa were rarely encountered. Of the remaining species observed in the floodplain forest community, 58 occurred in the ground-layer flora sampling plots (Table 2). Ground-layer flora species with the highest importance values (possible IV 200) were: *Laportea canadensis* (wood nettle, IV 46.7), *Pilea pumila* (clearweed, IV 34.5), and *Lysimachia nummularia* (IV 21.7) (Table 2). Other important species included: *Aster ontarionis* (Ontario aster), *Leersia virginica* (white grass), *Persicaria punctata* (dotted smartweed), *Acalypha rhomboidea* (three-seeded mercury), *Boehmeria cylindrica* (false nettle), *Viola missouriensis* (Missouri violet), and *Impatiens capensis*.

Of the 10 species of shrubs and woody vines found in the floodplain forest, only *Amorpha fruticosa* (false indigo), with 5 stems/ha, occurred within the shrub and small sapling sampling plots. The large shrub/tree sapling sampling area was also open; only four species occurred in the sampling area, with *Fraxinus lanceolata* and *Acer saccharinum* being the dominants, with 155 stems/ha and 95 stems/ha, respectively, and together, comprising 91% of the relative density/ha. Six species occurred within the tree sampling plot (Table 3). The dominant species in this size class were *Acer saccharinum* and *Fraxinus lanceolata*, with 220 stems/ha (IV of 120.6) and 170 stems/ha (IV of 54.7), respectively (Table 3). These two species accounted for 175.3 of the total importance value (possible IV 200).

Historical Conditions. Based on historic aerial photographs, recent and historic soil surveys, as well as current

patterns of vegetation structure and composition, presettlement vegetation within this preserve and in surrounding areas was most likely an intergrading mosaic of open, savanna-like floodplain forest and open wetland habitats (i.e. shrub fen, open fen, and sedge meadow/wet prairie). Presently, soils extending nearly 400 m south and east of the preserve are fill soils deposited in this area for housing developments; the construction of which began between 1957 and 1963, and increased dramatically between 1969 and 1988. It is uncertain how much area in the vicinity of the preserve was historically represented by tall shrub fen habitat, but based upon examination of vegetation patterns in early aerial photographs and early soil surveys, it appears that this community type once occupied much more extensive areas both north and south of the preserve. By 1939, most of the upland natural communities surrounding Spring Bay Fen had already been converted to agriculture, and much of the bottomland natural communities south of the preserve was converted in subsequent years; first to agriculture and then to housing developments.

Table 2. Frequency (%), mean cover (% of total cover), relative frequency, relative cover, and importance value (I.V.) of ground layer species encountered in the floodplain forest community at Spring Bay Fen Nature Preserve, Woodford County, Illinois. (*adventive species)

Species	Freq.%	Mean Cover	Rel. Freq	Rel. Cover	I. V.
Laportea canadensis	98	33.26	10.72	36.02	46.74
Pilea pumila	94	22.35	10.28	24.21	34.49
**Lysimachia nummularia*	56	14.42	6.13	15.62	21.75
Aster ontarionis	44	3.34	4.81	3.62	8.43
Leersia virginica	62	1.30	6.78	1.41	8.19
Persicaria punctata	50	1.76	5.47	1.91	7.38
Acalypha rhomboidea	48	1.72	5.25	1.86	7.11
Boehmeria cylindrica	26	3.36	2.84	3.64	6.48
Viola missouriensis	38	1.22	4.16	1.32	5.48
Impatiens capensis	28	1.96	3.06	2.12	5.18
Stachys hispida	26	1.59	2.84	1.72	4.56
Toxicodendron radicans	20	1.12	2.19	1.21	3.40
Carex blanda	24	0.27	2.63	0.29	2.92
Hackelia virginiana	20	0.54	2.19	0.58	2.77
Ulmus americana	22	0.21	2.41	0.23	2.64
Eupatorium serotinum	18	0.14	1.97	0.15	2.12
Elymus virginicus	16	0.18	1.75	0.19	1.94
Cinna arundinacea	12	0.55	1.31	0.60	1.91
Acer saccharinum	16	0.08	1.75	0.09	1.84
Fallopia scandens	14	0.22	1.53	0.24	1.77
Parthenocissus quinquefolia	14	0.17	1.53	0.18	1.71
Vitis riparia	14	0.12	1.53	0.13	1.66
**Alliaria petiolata*	10	0.15	1.09	0.16	1.25
Scutellaria lateriflora	10	0.05	1.09	0.05	1.14
Cornus drummondii	6	0.37	0.66	0.40	1.06
Iodanthus pinnatifidus	8	0.14	0.88	0.15	1.03
Bidens frondosa	6	0.32	0.66	0.35	1.01
Others (31 species)	--	1.42	12.49	1.55	14.04
Totals	--	92.33	100.00	100.00	200.00
Bare ground and litter		33.31			

DISCUSSION

Floristic Composition. When surveyed in 2007, based on an FQI of 40.8 for the tall shrub fen and 35.8 for the floodplain forest, both communities were considered regionally noteworthy, possessing sufficient floristic quality to be considered at least marginally high-quality natural areas (Swink and Wilhelm 1994, Taft et al. 1997).

At the present time, however, disturbance associated with severe and prolonged flooding has had a detrimental effect on the tall shrub fen community at Spring Bay Fen Nature Preserve. During a July 2020 site visit, extensive changes in vegetation composition and structure were observed, including a dramatic loss of diversity and a striking increase in abundance of several flood-adapted species. Many areas of the fen once open and easily traversed during the original surveys (2007 & 2008), were found to be impenetrable due to high shrub densities. Increased flooding has apparently had deleterious effects on the fen to an extent that 20 years ago would not have been imagined.

Table 3. Basal area (m^2/ha), relative basal area, density (stems/ha), relative density, importance value, and average diameter (cm) of the wood overstory species encountered in the closed-canopy floodplain forest at Spring Bay Fen Nature Preserve, Woodford County, Illinois.

Species	Basal Area (m^2/ha)	Relative Basal Area	Density (stems/ha)	Relative Density	Importance Value	Average Diameter (cm)
Acer saccharinum	17.92	71.7	220	48.9	120.6	23.8
Fraxinus lanceolata	4.23	16.9	170	37.8	54.7	16.1
Salix nigra	1.74	7.0	25	5.6	12.6	27.1
Ulmus americana	0.52	2.1	20	4.4	6.5	16.8
Acer negundo	0.15	0.6	10	2.2	2.8	9.6
Platanus occidentalis	0.43	1.7	5	1.1	2.8	32.9
Totals	24.99	100.0	450	100.0	200.0	

Extirpated Species. Several rare and uncommon vascular plant species are historically known from Spring Bay Fen and unfortunately only two were found. Some are state threatened or endangered, others are uncommon or regionally unusual. Each is discussed below, and collector and collecting number are provided along with the acronym of herbaria where a voucher specimen is deposited.

The regionally noteworthy species *Liparis loeselii* (L.) Rich. (lesser twayblade orchid) and *Saxifraga pensylvanica* L. (swamp saxifrage) were vouchered from the fen in 1971 (C. J. Sheviak #464, ILL; D. Seigler et al. #3988, ILL, respectively). Additionally, these species were recorded from the fen in August 1977, during the Illinois Natural Areas Inventory (Schwegman et al. 1977). Older collections of these two species from this general area have vague locality data and may or may not be from the preserve. There are no further reports of these species beyond 1977. They are now considered extirpated.

Three species of *Cypripedium* L. (lady's-slipper) (Sheviak 2002) have been reported from Spring Bay Fen. Historic collections (1930s to early 1960s) for all three species are known from the general vicinity, but collecting data is insufficient to definitively attribute them to the fen. *Cypripedium* x *andrewsii* A. M. Fuller (Andrew's lady's-slipper orchid) is known from the fen from four specimens (G. Fell s.n., May 1972, ILL); (C. J. Sheviak #580, #581 & #582, August 1972, ILL). Sheviak (C. J. Sheviak, personal communication, May 2011) noted that around the time of collection of specimens #580 and 582, a drainage ditch had been dug through the colony and speculated that the change in hydrology would doom the plants. Five years later, in August 1977, *C.* x *andrewsii* was recorded as being rare and localized (Schwegman et al. 1977). This taxon may have been lost due to the altered hydrology or filling in of the eastern side of the fen, or both. We have found no further reports or herbarium specimens of this taxon from the fen and consider it extirpated from the preserve.

The state endangered *Cypripedium parviflorum* Salisb. (small yellow lady's-slipper orchid) was also recorded from the fen in August 1977 (Schwegman et al. 1977). There is no voucher material for this 1977 report, but there are two historic specimens from the vicinity (V. H. Chase #4426, May 1932 & #13271, May 1953, ILL), although locality data is insufficient to attribute them to Spring Bay Fen. We have found no further reports or herbarium specimens of this taxon and consider it extirpated from the site.

Though there are many historic collections of the state endangered *Cypripedium reginae* Walt. (showy lady's-slipper orchid) from the vicinity of Spring Bay Fen, this species was first vouchered from the fen in June 1971 (C. J. Sheviak #480, ILL). It was vouchered again in August 1977 (R. Nyboer #862, EIU). Most of the *C. reginae* population was buried by fill in the mid 1970's and was last observed in the preserve in 1999 (INHD 2020). It is now considered extirpated.

More recently, another species extirpated from the fen is *Filipendula rubra*. This species was observed in the fen by Illinois Natural Areas Inventory personnel in August 1977, but not vouchered. A voucher specimen was made during the present study (Appendix 1, Murphy #2322, July 2007, ILLS). This species was last seen in the fen in 2013 (INHD 2020). No individuals of *F. rubra* were located during a search in July 2018 (M. Simone, personal communication, May 2020) or our search conducted in July 2020. The reason for this disappearance cannot be known with certainty, but it is believed that the severe flood events that have occurred on the Illinois River over the past ten years (USACE 2020), are responsible.

Threats. Adventive species are an increasing threat to the fen. During 2007 and 2008 surveys, *Lysimachia nummularia*, *L. vulgaris*, and *Mentha* x *pipertia* were found in the fen, with *L. nummularia* and *L. vulgaris* abundant and spreading. During a 2020 site visit, it was observed that *L. vulgaris* had become a dominant in several areas of the fen. Additionally, *Iris pseudacorus* (yellow iris) and *Lythrum salicaria* (purple loosestrife) occur immediately adjacent to the fen and regular efforts are made to control these populations and prevent their spread (M. Simone, personal communication, May 2020).

It now appears that flooding is a major threat to the preserve, especially flooding that occurs during the growing season (April to October). Historically, Spring Bay Fen was further away from the main channel of the Illinois River, with extensive areas of marsh and other wetlands separating it from the river (USGS 1893). This fen community and others in the area likely never experienced inundation from river flooding. Increasing flow of water diverted from Lake Michigan, which dramatically increased in 1900 (Bellrose 1941, Bellrose et al. 1983), and the completion of the Peoria lock and dam in 1938, further raised the water level of the Illinois River in the Peoria area to an all-time high, and appears to have submerged nearly all remaining wetlands (Figure 2, Map B) (ISGS 2020). Remnants of marsh/wetland communities can be seen underwater in this 1939 aerial photograph (Figure 2, Map B), which was taken when July waters were calm and clear, less than one year after the Peoria navigational dam was operational. As a result of these events and the raised water levels, the fen community is now approximately 300 m (984 ft.) from the river, whereas historically, it was approximately 762 m (2,500 ft.) from the river (USGS 1893).

Not only is the fen now in closer proximity to the river, but rain events over the past 20 years have resulted in an increased number of flood events occurring during the growing season (USACE 2020). During the severe flooding of 2020, which began in May and continued into June, site investigations revealed that inundation of the fen begins when the Peoria River gage is at approximately 7.6 m (25 ft.). Using this data, it was determined that from 1943 to 2000, five flood events caused inundation of the fen for a total of 35 days (USACE 2020). During these years, the longest period of inundation was in 1943 (13 days, May), followed by 1979 (8 days, early April; 6 days, mid-April). The other three inundation periods (April 1950, May 1979, & April 1983) were 4 days or less. In contrast, from 2001 to 2020, seven flood events inundated the fen for a total of 73 days (USACE 2020). However, the most severe flooding has occurred over the last decade (2011 to 2020), with four flood events inundating the fen for a

total of 59 days. The longest periods of inundation between 2001 and 2020 all occurred over the last decade, and include 2015 (16 days, June/July), 2013 (13 days, April/May), 2019 (12 days, early May; 8 days, May/June), and 2020 (10 days, May).

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Appendix 1. Vascular plant taxa encountered at Spring Bay Fen Nature Preserve, Woodford County, Illinois, during the 2007, 2008 and 2011 growing seasons. Nomenclature follows Mohlenbrock (2002), except for the genus *Phragmites*, which follows Mohlenbrock (2014). Taxa are arranged alphabetically by family, then genus and species, starting with ferns and fern-allies followed by angiosperms (monocots and dicots). Following the binomial and authority, the community type(s) in which each taxon occurs is given: 1 = tall shrub fen; 2 = floodplain forest; 3 = open floodplain and shoreline areas; 4 = degraded upland forest (including areas where filling-in of the fen has occurred). Collecting numbers are those of Michael J. C. Murphy (M) and Loy R. Phillippe (P). All specimens are deposited in the Illinois Natural History Survey Herbarium (ILLS), Champaign, Illinois. (*= adventive species)

FERN and FERN-ALLIES

Equisetaceae
Equisetum arvense L.: 2, 3, M2648

Ophioglossaceae
Botrychium virginianum (L.) Sw.: 4, M1909

Thelypteridaceae
Thelypteris palustris Schott: 1, M2196

ANGIOSPERMS-Monocots

Alismataceae
Sagittaria latifolia Willd.: 1, 2, 3, M2440

Araceae
Arisaema dracontium (L.) Schott: 2, M2660
Arisaema triphyllum (L.) Schott: 2, 4, M1929
Peltandra virginica (L.) Schott & Endl.: 1, 2, P39185
Symplocarpus foetidus (L.) Nutt.: 1, 4, M1920

Commelinaceae
**Commelina communis* L.: 4, M3079

Cyperaceae
Bolboschoenus fluviatilis (Torr.) Sojak: 1, M2447
Carex albicans Willd.: 4, M1912
Carex blanda Dewey: 2, 4, M1906
Carex conjuncta Boott: 1, 2, M2639
Carex emoryi Dewey: 2, 3, M2646
Carex granularis Muhl.: 1, 2, M2649
Carex grayi Carey: 2, M3113
Carex grisea Wahl.: 2, M2637
Carex hystericina Muhl.: 1, M2173
Carex jamesii Schwein.: 2, M2191
Carex lupulina Willd.: 2, M2458
Carex muskingumensis Schwein.: 2, M2465
Carex normalis Mack.: 2, M2189
Carex rosea Schk.: 2, M2673
Carex stipata Muhl.: 1, M2203
Cyperus erythrorhizos Muhl.: 3, M3326
Cyperus esculentus L.: 3, M3092
Cyperus odoratus L.: 3, M3327
Cyperus squarrosus L.: 3, M3094
Cyperus strigosus L.: 3, M3104
Eleocharis erythropoda Steud.: 3, M3337
Fimbristylis autumnalis (L.) Roem. & Schultes: 3, M3328
Hemicarpha micrantha (Vahl) Pax: 3, M3329
Schoenoplectus acutus (Muhl.) A. Love & D. Love: 3, M3102
Schoenoplectus pungens (Vahl) Palla: 3, M2468
Scirpus atrovirens Willd.: 1, M2205

Dioscoreaceae
Dioscorea villosa L.: 2, M2664

Iridaceae
**Iris pseudacorus* L.: 2, M2642
Iris shrevei Small: 1, 2, 3, M2652
Sisyrinchium angustifolium Mill.: 2, M3342

Lemnaceae
Lemna minor L.: 1, M3344

Liliaceae
Smilacina racemosa (L.) Desf.: 4, M2341
Smilacina stellata (L.) Desf.: 1, M1901

Orchidaceae
Corallorhiza odontorhiza (Willd.) Nutt.: 4, M2475

Poaceae
Agrostis perennans (Walt.) Turcherm.: 2, M3309
**Bromus tectorum* L.: 1, M1924
Cinna arundinacea L.: 1, 2, M2334
**Digitaria ischaemum* (Schreb.) Schreb.: 2, 3, M3341.2
**Digitaria sanguinalis* (L.) Scop.: 2, 3, M3341.1
**Echinochloa crus-galli* (L.) P. Beauv.: 3, M3318
Echinochloa walteri (Pursh) Heller: 3, M3317
Elymus villosus Muhl.: 4, M2169
Elymus virginicus L.: 2, 4, M2461
Eragrostis hypnoides (Lam.) BSP.: 3, M3335
Eragrostis pectinacea (Michx.) Nees: 3, M4650
Festuca subverticillata (Pers.) E. B. Alexeev.: 2, M2190
Glyceria striata (Lam.) Hitchc.: 1, 2, M2180
Leersia oryzoides (L.) Swartz: 1, 2, M2445
Leersia virginica Willd.: 1, 2, M2204
Leptochloa panicoides (Presl) Hitchc.: 3, M3333
Muhlenbergia frondosa (Poir.) Fern.: 2, M3311
Panicum capillare L.: 3, M3325
Panicum virgatum L.: 3, M2467
**Phalaris arundinacea* L.: 1, 2, M2199
Phragmites americanus (Saltonst., P. M. Peterson & Soreng) A. Haines: 1, M4644
Poa sylvestris Gray: 2, M2663
Spartina pectinata Link: 3, M2466
Spheonpholis intermedia (Rydb.) Rydb.: 1, M2328

Smilacaceae
Smilax tamnoides L.: 4, M2347

Sparganiaceae
Sparganium eurycarpum Engelm.: 1, M2174

Typhaceae
Typha angustifolia L.: 3, M3315

ANGIOSPERMS-Dicots

Aceraceae
Acer negundo L.: 2, 3, 4, M1916
Acer nigrum Michx. f.: 2, M3083
Acer saccharinum L.: 1, 2, 3, M1926

Amaranthaceae
Amaranthus tuberculatus (Moq.) J. Sauer: 3, M3320

Anacardiaceae
Rhus glabra L.: 1, M2206.2
Toxicodendron radicans (L.) Kuntze: 2, 3, 4, M2462
Toxicodendron vernix (L.) Kuntze: 1, M2172

Apiaceae
Chaerophyllum procumbens (L.) Crantz: 1, 2, M1919
Cicuta maculata L.: 1, 3, M2182
Cryptotaenia canadensis (L.) DC.: 1, 2,

M2183
Osmorhiza claytonii (Michx.) C. B. Clarke: 2, M2672
Osmorhiza longistylis (Torr.) DC.: 2. 4, M1930
Oxypolis rigidior (L.) Raf.: 1, M2444
Sanicula canadensis L. var. *canadensis*: 4, M2168
Sanicula odorata (Raf.) Pryer & Phillippe: 4, M2628
Sium suave Walt.: 1, 3, M2651

Apocynaceae
Apocynum cannabinum L.: 2, 3, M3108

Aristolochiaceae
Asarum canadense L.: 4, M1905

Asclepiadaceae
Ampelamus albidus (Nutt.) Britt.: 3, observed
Asclepias incarnata L.: 1, 3, M2469

Asteraceae
Ageratina altissima (L.) R. M. King & H. Robins.: 4, M2344
Ambrosia artemisiifolia L.: 3, M2659
Aster firmus Nees: 1, M2439
Aster lanceolatus Willd.: 2, M4649
Aster lateriflorus (L.) Britt.: 1, 2, 4, M2446
Aster ontarionis Wieg.: 2, 3, M2460
Bidens cernua L.: 2, 3, M3336
Bidens comosa (Gray) Wieg.: 2, M4648
Bidens connata Muhl., 2, observed
Bidens frondosa L.: 1, 2, 3, M3305
Bidens vulgata Greene: 2, M3340
Boltonia decurrens (Torr. & Gray) Wood: 3, observed
Cirsium muticum Michx.: 1, M2450
Conyza canadensis (L.) Cronq.: 2, M3112
Eclipta prostrata (L.) L.: 3, M3324
Erechtites hieracifolia (L.) Raf.: 2, observed
Erigeron philadelphicus L.: 1, 2, M2638
Eupatoriadelphus maculatus (L.) R. M. King & H. Robins.: 1, M2231
Eupatorium perfoliatum L.: 1, 2, M4645
Eupatorium serotinum Michx.: 2, 3, M4653
Helianthus tuberosus L.: 1, P39171
Lactuca floridana (L.) Gaertn.: 2, 4, M3295
Rudbeckia laciniata L.: 1, 2, M2339
Senecio glabellus Poir.: 1, M4647
Silphium perfoliatum L.: 1, M2336
Solidago gigantea Ait.: 1, 2, M2635
Solidago patula Muhl.: 1, M2442
**Taraxacum officinale* Weber: 2, observed
*Verbesina alternifol*ia (L.) Britt.: 1, 2, M2641
Xanthium strumarium L.: 3, M3331

Balsaminaceae
Impatiens capensis Meerb.: 1, 2, 3, 4, M2441
Impatiens pallida Nutt.: 1, M3294

Berberidaceae
Podophyllum peltatum L.: 4, M1931

Bignoniaceae
Campsis radicans (L.) Seem.: 2, M2656
**Catalpa speciosa* Warder: 2, M2668

Boraginaceae
Hackelia virginiana (L.) I. M. Johnston: 2, 4, M2348

Brassicaceae
**Alliaria petiolata* (Bieb.) Cavara & Grande: 2, 4, M1911
Cardamine bulbosa (Muhl.) BSP.: 1, M1917
Cardamine pensylvanica Willd.: 2, M2643
Iodanthus pinnatifidus (Michx.) Steud.: 2, M3100
Rorippa palustris (L.) Besser var. *palustris*: 3, M3101
Rorippa sessiliflora (Nutt.) A. Hitchc.: 3, M2657

Caesalpiniaceae
Cercis canadensis L.: 2, M2671
Gleditsia triacanthos L.: 2, M2647

Campanulaceae
Campanulastrum americanum (L.) Small: 4, M2345
Lobelia cardinalis L.: 2, M3308
Lobelia siphilitica L.: 1, M3343

Cannabinaceae
Humulus lupulus L.: 1, M2456

Caprifoliaceae
**Lonicera* x *bella* Zabel: 1, 4, M1902
**Lonicera maackii* (Rupr.) Maxim.: 1, 4, M1908
Sambucus canadensis L.: 1, 2, M2452
Viburnum lentago L.: 1, M1923
**Viburnum opulus* L.: 1, 4, M1928

Caryophyllaceae
Silene nivea (Nutt.) Otth.: 1, 2, M2324

Celastraceae
Celastrus scandens L.: 4, M4655

Chenopodiaceae
**Chenopodium album* L.: 3, M2658

Convolvulaceae
Calystegia sepium (L.) R. Br.: 1, 2, 3, M2338
Ipomoea lacunosa L.: 2, 3, M3314
Ipomoea pandurata (L.) G. F. W. Mey.: 2, 3, M3312

Cornaceae
Cornus drummondii C. A. Mey.: 2, 4, M2170
Cornus obliqua Raf.: 1, M2330
Cornus sericea L.: 1, M1925

Corylaceae
Corylus americana Walt.: 1, M2202

Cucurbitaceae
Sicyos angulatus L.: 2, M2644

Cuscutaceae
Cuscuta gronovii Willd.: 1, M2437
Cuscuta polygonorum Engelm.: 1, P39176

Elaeagnaceae
**Elaeagnus umbellata* Thunb.: 4, M3080

Euphorbiaceae
Acalypha rhomboidea Raf.: 2, 3, M3089
Chamaesyce maculata (L.) Small: 3, M3334

Fabaceae
Amorpha fruticosa L.: 1, 2, M2335
Amphicarpaea bracteata (L.) Fern.: 2, M2667
Apios americana Medic.: 1, M2455

Fagaceae
Quercus imbricaría Michx.: 4, M3081
Quercus macrocarpa Michx.: 2, M2666

Grossulariaceae
Ribes americanum Mill.: 1, M1904
Ribes missouriense Nutt.: 4, M1907

Hydrophyllaceae
Ellisia nyctelea L.: 2, M2661
Hydrophyllum virginianum L.: 2, M2665

Hypericaceae
Hypericum punctatum Lam.: 2, observed

Juglandaceae
Carya cordiformis (Wangenh.) K. Koch: 4, M4656
Juglans nigra L.: 2, M2674

Lamiaceae
Agastache nepetoides (L.) Ktze.: 2, M3297
Blephilia hirsuta (Pursh) Bernh.: 1, 2, M2185
**Glechoma hederacea* L.: 2, M2634
Lycopus virginicus L.: 1, 2, 3, M2449
**Mentha* x *piperita* L.: 1, M2327
Physostegia speciosa (Sweet) Sweet: 1, 2, M3300
Scutellaria lateriflora L.: 1, 2, M3301
Stachys hispida Pursh: 1, M2326
Teucrium canadense L.: 1, 2, M2200

Lythraceae
Ammannia robusta Heer & Regel: 3, M3096
Lythrum alatum Pursh: 3, M3105
**Lythrum salicaria* L.: 3, M3098

Malvaceae
Hibiscus laevis All.: 3, M2471

Menispermaceae
Menispermum canadense L.: 4, M2346

Molluginaceae
**Mollugo verticillata* L.: 3, M4654

Moraceae
**Maclura pomífera* (Raf.) Schneider: 2, M3109
**Morus alba* L.: 2, 4, M2640
Morus rubra L.: 2, M2194

Oleaceae
Fraxinus americana L.: 2, M3307
Fraxinus lanceolata Borkh.: 1, 2, 3, M2333
Fraxinus nigra Marsh.: 1, M2188
Fraxinus quadrangulata Michx.: 2, M3085

Onagraceae
Circaea lutetiana L.: 1, 2, 4, M2184
Epilobium coloratum Spreng.: 1, 2, M3302
Ludwigia palustris (L.) Ell.: 1, 3, M2438
Ludwigia peploides (HBK.) Raven: 3, M3097

Oxalidaceae
Oxalis fontana Bunge: 2, 3, M3090

Phytolaccaceae
Phytolacca americana L.: 2, M3111

Platanaceae
Platanus occidentalis L.: 2, 3, M2463

Polemoniaceae
Phlox divaricata L.: 2, M2669

Polygonaceae
Antenoron virginianum (L.) Roberty & Vautier: 2, M3304
Fallopia scandens (L.) Holub.: 2, M3306
Persicaria amphibium (L.) S. F. Gray: 1, 3, M2448
**Persicaria cespitosa* (Blume) Nakai: 2, M3087
Persicaria hydropiperoides (Michx.) Small: 3, M3107
Persicaria lapathifolia (L.) S. F. Gray: 3, M2470
Persicaria pensylvanica (L.) Small: 2, 3, M3299
Persicaria punctata (Ell.) Small: 1, 2, 3, M2459
**Persicaria vulgaris* Webb & Moq.: 3, M2472
**Rumex crispus* L.: 3, M2654
Rumex orbiculatus Gray: 1, M2454
Rumex verticillatus L.: 2, M3313

Primulaceae
Lysimachia ciliata L.: 1, 2, M2197
**Lysimachia nummularia* L.: 1, 2, M2443
**Lysimachia vulgaris* L.: 1, M2175

Ranunculaceae
Anemone canadensis L.: 2, M2662
Caltha palustris L.: 1, M1922
Clematis virginiana L.: 1, M2329
Ranunculus abortivus L.: 2, 4, M1903
Ranunculus recurvatus Poir.: 1, M1918
Ranunculus sceleratus L.: 1, M1927
Thalictrum revolutum DC.: 1, M2179

Rosaceae
Agrimonia pubescens Wallr.: 4, M2343
Crataegus mollis (Torr. & Gray) Scheele: 4, M3082
Filipendula rubra (Hill) Robins.: 1, M2322
Geum canadense Jacq.: 1, 2, 4, M2167
Prunus serotina Ehrh.: 2, 4, M1914
Prunus virginiana L.: 1, M1921
Rosa setigera Michx.: 2, M2192
Rubus allegheniensis Porter: 4, M2631
Rubus occidentalis L.: 2, M3084

Rubiaceae
Cephalanthus occidentalis L.: 1, 2, M2171
Galium aparine L.: 4, M1910
Galium obtusum Bigel.: 1, M2198
Galium triflorum Michx.: 1, 2, M2195

Salicaceae
Populus deltoides Marsh.: 2, 3, M2632
Salix amygdaloides Anderss.: 2, 3, M3099
Salix discolor Muhl.: 1, M2177
Salix interior Rowlee: 3, M2653
Salix nigra Marsh.: 1, 2, M2201

Saururaceae
Saururus cernuus L.: 2, M2464

Saxifragaceae
Penthorum sedoides L.: 3, M3103

Scrophulariaceae
Chelone glabra L.: 1, M2451
Dasistoma macrophylla (Nutt.) Raf.: 4, observed
Lindernia dubia (L.) Pennell: 3, M3093
Mimulus ringens L.: 3, M3106

Solanaceae
Solanum ptychanthum Dunal: 3, M3091

Tiliaceae
Tilia americana L.: 1, M2206.1

Ulmaceae
Celtis occidentalis L.: 4, M2629
Ulmus americana L.: 2, 4, M1913
Ulmus rubra Muhl.: 2, M2670

Urticaceae
Boehmeria cylindrica (L.) Sw.: 1, 2, M2187
Laportea canadensis (L.) Wedd.: 1, 2, M2453
Parietaria pensylvanica Muhl.: 2, M3110
Pilea fontana (Lunell) Rydb.: 1, M2436
Pilea pumila (L.) Gray: 2, M3303
Urtica gracilis Ait.: 1, 2, 3, M2457

Verbenaceae
Phyla lanceolata (Michx.) Greene: 2, 3, M3088
Verbena urticifolia L.: 1, 2, 4, M2186

Violaceae
Viola missouriensis Greene: 2, M2630

Vitaceae
Parthenocissus quinquefolia (L.) Planch.: 1, 2, 4, M2176
Vitis riparia Michx.: 1, 2, 3, 4, M1915
Vitis vulpina L.: 2, M3086