RESULTS

QUALITATIVE ASSESSMENT

Floristic Surveys

A total of 152 collections were made in 2008 by T. Bassett, in addition to 68 made in 2002. These collections and observations made in 2008 were combined with historical species lists. Eighty-two species were excluded based on a lack of specimen or inaccurate identification (see Table 3), for a final list of 455 taxa occurring in both terrestrial and aquatic habitats at Asylum Lake Preserve (Appendix 1). Approximately 70% were native species, including 16 native taxa found only in the prairie and savanna reconstructions (e.g., big bluestem [*Andropogon gerardii*]), as well as eight additional native taxa either known or believed to have been planted or accidental introductions on the Preserve (e.g., white pine [*Pinus strobus*]) (Table 4, Appendix 1). One-hundred thirty five taxa were adventive species, including 34 considered ecologically invasive (Table 2). Twenty eight taxa were not observed during the survey but are included on the list based on voucher specimens made since 1932. There were 119 new species observed (Table 3).

Adventive	101	22.20%
Ecologically Invasive	34	7.47%
	135	**29.67%**
Native but Planted	24	5.27%
Native	295	65.05%
	319	**70.336%**
Total:	**455**	**100%**

Table 4. Proportion of plant species: native vs. adventive, planted, ecologically invasive

Separate species lists were generated for each survey area. Number of species observed and percent native species in each survey area are: Forest I (188, 61.7%), Forest II (210, 68.6%), Prairie (87, 54.0%), Savanna I (99, 58.6%), Savanna II (96, 55.2%), Wet Meadow (120, 86.7%), Marsh (110, 83.6%), Coastal (82, 82.9%), and Oldfield (40, 37.5%) (Table 5).

Area	mean C	FQI	Native FQI	Acres	# Species	% Native
F	3.7	40.6	43.6	8.4	121	86.8%
B	2.7	39.1	47.3	23.3	210	68.6%
G	3.2	33.9	37.1	5.9	110	83.6%
A	2.2	30.7	39.1	62.3	188	61.7%
H	3.1	27.9	30.7	7.9	82	82.9%
C	2	18.3	24.9	51.5	87	54.0%
D	1.6	16.4	21.4	17.7	99	58.6%
E	1.5	14.4	19.4	14.9	96	55.2%
I	1	6	9.8	10.9	40	37.5%
			Forest	86.4		
			Wetlands	22.2		
			Prairie	69.2		
			Oldfield	25.8		
			Open Water	48.8		
			Total:	252.4		

Table 5. Floristic Quality Indices (FQI), mean coefficients of conservatism (C) and proportion of native species by survey area, including summaries of acres by habitat

Historical Collections

Twenty-nine species are included on the list based on voucher specimens between 1932 and 1976. They include 11 aquatic species, common waterweed (*Elodea canadensis*), spiny naiad (*Najas marina*), coontail (*Ceratophyllum demersum*), and eight pondweed species (*Potamogeton crispus, P. epihydrus, P. foliosus, P. gramineus, P. illinoensis, P. natans, P. nodosus,* and *P. pectinatus*); 12 common native and adventive species, king devil (*Hieracium aurantiacum*), whitlow grass (*Eriophila verna*), Ohio buckeye (*Aesculus glabra*), European white birch (*Betula pendula*), pale alyssum (*Alyssum alyssoides*), prickly ash (*Zanthoxylum americanum*), field pansy (*Viola arvensis*), Wych elm (*Ulmus glabra*), common trillium (*Trillium grandiflorum*), golden ragwort (*Senecio aureus*), peach-

leaved willow (*Salix amygdaolides*), and hybrid sumac (*Rhus X pulvinata*); and 6 species with savanna affinities, common blue-eyed grass (*Sisyrinchium albidum*), hoary puccoon, dwarf dandelion (*Krigia virginica*), ear-leaved rock cress (*Arabis lyrata*), hybrid aster (*Aster pilosus X praealtus*), and kittentails (*Besseya bullii*) (Table 1). These savanna species are largely shade-intolerant and would be expected to disappear in the absence of fire.

Current Flora

Twenty-two native prairie species were documented as introduced and established for the prairie reconstruction, including bur oak (*Quercus macrocarpa*), and seven species not in the original planting list. Fourteen of the species in the original planting list were observed, most of which were not very common. Seven species found naturally on the preserve were also planted in Prairie and Savanna I: wild columbine (*Aquilegia canadensis*) and bur oak are found in Forest I, New England aster (*Aster novae-angliae*) is found in Wet Meadow and Coastal, and common milkweed (*Asclepias syriaca*) was reported historically from the fields that were converted to prairie and is found in Savanna II. Bur oak, rough blazing star (*Liatris aspera*), wild bergamot (*Monarda fistulosa*), and stiff goldenrod (*Solidaga rigida*) are found in Forest II in relictual savanna habitats.

Seven native species found at the Preserve are either known or believed to be planted, or escaped from cultivation and are considered non-native to the site (Appendix 1). Ohio buckeye and red and white pine (*Pinus resinosa* and *P. strobus*) were certainly planted where they occur, while the following represent escapes from cultivation, latter of which may be considered invasive: redbud (*Cercis canadensis*), three-lobed coneflower (*Rudbeckia triloba*), Jerusalem-artichoke (*Helianthus tuberosus*), and smooth arrowwood (*Viburnum dentatum*).

There were 119 new species observed or collected during the study (Table 3). Of these 119 species, 68.91% (n=82) were native, which is consistent with the overall species list (which is 70.33% native). Of all new reports, 67.23% (n=80) were found in uplands, and 32.77% (n=39) were found in wetlands. Only about 10% of the new wetland species observed were of adventive origin, compared to about 40% of the upland species.

Rare Species

The only protected species is State-threatened starry campion (*Silene stellata*), found just north of the property boundary in Forest II (Map 5). At least four individuals were observed, all in flower although deer browsed the flowers of one plant. This in contrast to "hundreds of plants in a 307 X 350 foot area" in 1983 (MNFI 2009b). While threatened by shade and abuse from adjacent apartments, it is still found with a number of savanna or woodland associates, including alum root (*Heuchera americana*), rue anemone (*Anemonella thalictroides*), early meadow rue (*Thalictrum dioicum*), and showy goldenrod (*Solidago speciosa*). Though found in a closed-canopy forest or in small canopy gaps, these and other species are also typical of a more open-canopied community such as oak savanna or oak woodland. These communities and their indicators are discussed in greater detail below. Blackhaw (*Viburnum prunifolium*) is a State-special concern species observed at two locations at the preserve (Map 5). Very similar to the common

Starry campion (*Silene stellata*)

nannyberry (*Viburnum lentago*), it was not seen in flower which is essential for a definitive identification.

Wolf Trees

A total of 152 were mapped, including 72 labeled as "false". The majority of trees mapped (115, 75.66%) were white oak (*Quercus alba*). Overall, the majority of large oak and hickory trees found at the Preserve do not exhibit characteristics of growing under closed canopy conditions. This challenges the widely touted assumption that open-grown oaks indicate a historical savanna structure (Karnitz and Asbjornsen 2006). The straight growth habit, combined with much understory branching suggests an "oak woodland" condition of many trees gaining maturity simultaneously with a fairly sparse understory. Due to the inconclusive nature of the observations, data are not provided in a tabular or graphic form.

Floristic Quality Assessment

Two survey areas had a Floristic Quality Index (FQI) greater than 35, Wet Meadow (F, 40.6) and Forest II (B, 39.1) (Table 5). Marsh (G, 33.9), Forest I (A, 30.7), and Coastal (H, 27.9) were above 20. The remainder, including the two oldfields (Savanna II [E], and Oldfield [I]) and the prairie and savanna reconstructions (Prairie [C], and Savanna I [D]) had relatively low FQIs, despite occupying comparable area.

Avian Surveys

A total of 4,208 individual birds and 117 avian species were recorded between 6 April 2008 and 9 April 2009 (Table 6). The most common species encountered include Canada Goose, Wood Duck, American Coot, Mallard, Yellow Warbler, Common Yellowthroat, and Red-winged Blackbird in the wetlands; American Robin, Gray Catbird, Blue Jay, American Crow, Northern Cardinal, Rose-breasted Grosbeak, and Black-capped Chickadee in the woodlands; and Cedar Waxing and Savanna Sparrow in the grasslands (Table 7). Song Sparrow, American Goldfinch, Common Grackle and Brown-headed Cowbird were common generalists encountered in all habitats.

Red-Winged Blackbird singing on the edge of Forest I

Seventy-seven species were encountered in the woodlands (Forest I and II) (Table 7). Several species were found in healthy numbers and include Blue Jay, American Robin, Gray Catbird, Black-capped Chickadee, Tufted Titmouse, Scarlet Tanager, Northern Cardinal, Rose-breasted Grosbeak, and Baltimore Oriole. Five species of woodpeckers are represented and two hawks (Cooper's Hawk and Red-tail Hawk). Pileated woodpecker is noteworthy due to its historical absence having not been observed since 1976 (Appendix 2). Cooper's Hawk was formerly listed as a species of special concern in Michigan, however numbers appear to be increasing in the state in recent years, and it was down-listed when the current list became effective on April 9, 2009 (MNFI 2009a).

A total of 68 species were reported in the grasslands (Savanna I, Savanna II and Prairie) (Table 7). Undoubtedly, new species are being supported by the prairie and savanna reconstructions (or perhaps returning to the area historically utilized). Grassland birds represented include 13 species of

sparrows, Eastern Meadowlark, American Woodcock and Bobolink. The most notable species is the Henslow's Sparrow - a sparrow not reported in historical records over the last 33 years and an endangered species in Michigan (MNFI 2009a). At least two pairs of Henslow's Sparrows were suspected to have been nesting in Prairie or the adjacent Savanna I. One Grasshopper Sparrow, a species of special concern in Michigan, was reported by Russ Schipper of the Audubon Society of Kalamazoo and has only been reported in one other year since 1976 (Appendix 2). Several pairs of Savanna Sparrows were confirmed breeding (feeding young) which is a dramatic change from previous years as it has only been recorded in one other year since 1976. Other notable species include Lincoln Sparrow (only observed once since 1976), Red-headed Woodpecker (not seen since 1995), and Bobolink (only noted once since 1976 in 1994).

Common Name	Bird Code	Highest # During Breeding Season	Breeding Code	CO	PR	PO
Great Blue Heron	GBHE	1	PO			x
Green Heron	GRHE	2	PR		x	
Turkey Vulture	TUVU	6	PO			x
Canada Goose	CAGO	14	CO	x		
Mute Swan	MUSW	3	CO	x		
Wood Duck	WODU	2	PR		x	
Mallard	MALL	3	CO	x		
Coopers Hawk	COHA	1	PO			x
Red-tailed Hawk	RTHA	1	PR		x	
Wild Turkey	WITU	1	PO			x
Virginia Rail	VIRA	1	PO			x
Sora	SORA	2	PO			x
Sandhill Crane	SACR	2	PO			x
Killdeer	KILL	1	PR		x	
American Woodcock	AMWO	1	PO			x
Mourning Dove	MODO	3	PR		x	
Great Horned Owl	GHOW	2	PO			x
Chimney Swift	CHSW	1	PO			x
Belted Kingfisher	BEKI	1	PO			x
Red-bellied Woodpecker	RBWO	8	PR		x	
Downy Woodpecker	DOWO	5	PR		x	
Hairy Woodpecker	HAWO	2	PR		x	
Northern Flicker	NOFL	1	PR		x	
Eastern Wood Pewee	EAWP	5	PR		x	
Willow Flycatcher	WIFL	6	PR		x	
Eastern Phoebe	EAPH	2	PR		xx	
Great-crested Flycatcher	GCFL	5	PR		x	
Warbling Vireo	WAVI	4	PR		x	
Red-eyed Vireo	REVI	4	PR		x	
Blue Jay	BLJA	11	CO	x		
American Crow	AMCR	15	PR		x	
Tree Swallow	TRES	5	CO	x		
Northern Rough-winged Swallow	NRSW	2	PR		x	
Barn Swallow	BARS	4	PO			x
Black-capped Chickadee	BCCH	5	PR		x	
Tufted Titmouse	TUTI	6	PR		x	

White-breasted Nuthatch	WBNU	4	PR		x	
House Wren	HOWR	1	PR		x	
Eastern Bluebird	EABL	2	PR		x	
Wood Thrush	WOTH	1	PO			x
American Robin	AMRO	15	CO	x		
Gray Catbird	GRCA	15	PR		x	
Brown Thrasher	BRTH	2	PR		x	
European Starling	EUST	4	PR		x	
Cedar Waxwing	CEDW	7	PR		x	
Blue-winged Warbler	BWWA	1	PR		x	
Yellow Warbler	YWAR	18	PR		x	
Common Yellowthroat	COYE	16	PR		x	
Scarlet Tanager	SCTA	4	PR		x	
Eastern Towhee	EATO	1	PO			x
Chipping Sparrow	CHSP	2	CO	x		
Field Sparrow	FISP	5	PR		x	
Vesper Sparrow	VESP	3	PO			x
Savannah Sparrow	SAVS	15	CO	x		
Grasshopper Sparrow	GRSP	1	PO			x
Henslow's Sparrow	HESP	1	PR		x	
Song Sparrow	SOSP	36	CO	x		
Swamp Sparrow	SWSP	3	PR		x	
Northern Cardinal	NOCA	14	CO	x		
Rose-breasted Grosbeak	RBGR	9	PR		x	
Indigo Bunting	INBU	6	PR		x	
Bobolink	BOBO	1	PO			x
Red-winged Blackbird	RWBL	98	CO	x		
Eastern Meadowlark	EAME	5	PR		x	
Common Grackle	COGR	4	PR		x	
Brown-headed Cowbird	BHCO	12	PR		x	
Baltimore Oriole	BAOR	9	PR		x	
House Finch	HOFI	1	PO			x
American Goldfinch	AMGO	20	PR		x	
69 species		**474**		**11**	**40**	**18**
				CO	Confirmed	11
				PR	Probable	40
				PO	Possible	18

Table 8. Confirmed, probable, and possibly breeding birds.

There were 44 species reported in the wetlands (Table 7). Among the most noteworthy wetland species are the Greater Scaup (only seen in one year since 1976) and the Common Loon (only twice since 1976). Healthy numbers of Red-winged Blackbird, Yellow Warbler, Common Yellowthroat, and Song Sparrows were reported. Several species of waterfowl are noteworthy because of lack of sightings: Blue-winged Teal, Northern Shoveler, Northern Pintail, Lesser Scaup, Common and Hooded Mergansers, and Ruddy Duck. It should be noted that the 2008/2009 winter season was quite cold and the lakes were iced over starting from December until well into March. Typically March is the best month for viewing migrating waterfowl at Asylum Lake (R. Adams, Kalamazoo Nature Center, pers. comm.).

Table 8 lists a total of 69 species that were observed during the breeding season. Of the 69 breeding species, 11 species were confirmed as breeding based on nest building activity, an occupied nest, or fledglings. Another 40 species were identified as probably breeding based on repeated sightings at least 7 days apart, multiple males singing on the same date during the breeding season (5 or more), a pair observed together, or territorial behavior. An additional 18 species were identified as possibly breeding based on species observed or singing in suitable nesting habitat during its breeding season.

Although Great Blue Heron was recorded as possibly breeding at Asylum Lake, it is more likely that they are nesting offsite. The nearest known rookery is located on the Kalamazoo River near Markin Glen County Park. Similarly, Sandhill Crane was recorded as possibly breeding at the Preserve (they were observed as flyovers), but are more likely nesting offsite – possibly in the nearby property of Parkview Hills.

A total of 46 migrating species utilized the Preserve as a stopover site during spring or fall migration, or as wintering grounds, including 21 species of warblers (Table 6). The diversity of migratory and wintering waterfowl was low this year, again most likely because both lakes were frozen over much of the winter and well into spring. Abundant species during migration periods or during the winter include Gadwall, Bufflehead, American Coot, Golden-crowned Kinglet, Yellow-rumped Warbler and White-throated Sparrow.

Bird Species	Greatest No. of Individuals
Canada Goose	14
Blue Jay	11
American Crow	15
American Robin	15
Gray Catbird	15
Yellow Warbler	18
Common Yellowthroat	16
Savanna Sparrow	15
Song Sparrow	36
Northern Cardinal	14
Rose-breasted Grosbeak	9
Red-winged Blackbird	98
Brown-headed Cowbird	12
Baltimore Oriole	9
American Goldfinch	20

Table 9. The 15 most abundant bird species during the 2008 breeding season.

Appendix 2 is a historical record of birds at the Preserve and lists 183 bird species on the site since 1976. Woodland and wetland birds have always been well represented on the site prior to the current study. Woodland species continue to be so, however, wetland species may be down a bit. It is unclear whether it is an indication of degrading wetland habitat and/or water quality, or if it is due to less survey effort, the long season of frozen lakes, or a combination of each. Grassland species have been poorly represented in the past, however, since the prairie and savanna establishment, there have been dramatic increases in abundance and diversity.

Other Animals

Mostly common mammals and herptiles were encountered during the surveys. Fox squirrel, eastern chipmunk, muskrat, and ground hog were all observed. The heptile diversity is high and includes the State special concern Eastern box turtle and Blanding's turtle (MNFI 2009a). Frog species observed include green frog, bull frog, tree frog, wood frog, chorus frog, spring peeper. Turtles observed include map turtle, snapping turtle, Eastern box turtle, painted turtle, spiny softshell turtle, Blanding's turtle. Snakes observed

Eastern box turtle in Forest I

include Northern water snake and garter snake. No black rat snakes were encountered, though previously documented by Adams et al. (2002).

VEGETATION MONITORING

The plots and transects were set up to monitor changes in the vegetation over the long-term, especially after management activities, thus are primarily intended to provide baseline data. They also provide some information on the current species composition and community structure of the habitats at the Preserve.

Forest I & II

A total of 307 trees > than 10 cm DBH were recorded in Modified-Whittaker plots, or 341.1 trees/ha (138.1 trees/acre) (Table 10). Various tree densities have been estimated and reported from oak woodland, savanna, and forest in the Upper Midwest. Oak forest or woodland tree density estimates include 90 trees/ha (Brewer and Vankat 1996); 258.6, 277.3, and 289.4 trees/ha (McClain et al 2006); and 313 trees/ha in a managed forest and 274.5 trees/ha in an unmanaged one (Laatsch and Anderson 2000). Oak savanna densities may range from 2-24 trees/ha in bur oak savanna (Brewer and Kitler 1989 in Chapman and Brewer 2008); 10-120 trees/ha in oak openings (Chapman and Brewer 2008); 14 in Ohio oak savanna (Brewer and Vankat 1996); 68 trees/ha at time of settlement in northern Indiana (138 trees/ha in 1985; Cole and Taylor 1995 in Nowacki and Abrams 2008); and 35 trees/ha at time of settlement in southern Wisconsin (353 trees/ha in 1946; Cottam 1949 in Nowacki and Abrams 2008).

Wild black cherry (*Prunus serotina*) (RIV=23.8), white oak (16.2), and black oak (*Quercus velutina*) (15.6) were the dominant trees (Table 10, Figure 2). Red oak (*Quercus rubra*)(8.7) and pignut hickory (*Carya glabra*) (6.9) also had RIVs greater than the mean. Native trees were dominant with an RIV of 87.6 overall. Functional groups, in decreasing order of importance, were: oaks/hickories (47.4), other native species (38.4), adventive trees (7.9), and native maple species (1.8) (Table 10). Wild black cherry accounted for 62% of the dominance of "other native trees", with a mean DBH of 22.7 +/- 10.6, as compared to the next dominant tree, white oak, with a mean DBH of 69.7 +/- 21.7.

Among canopy trees, wild black cherry dominated each of the size classes in stems per hectare (Table 11, Figure 3a,b). Only three canopy tree species were present in the 1-2.5 cm DBH size class (wild black cherry [333.3], pignut hickory [55.6], and American elm (*Ulmus americana*)[55.6]), although there were 722.2 snag stems /ha, compared to 333.3 for wild black cherry. A portion of these snags are likely shade-suppressed oaks. Although wild black cherry was dominant in the 2.5-10 cm DBH size class (300 stems/ha), black oak (177.8) and pignut hickory (144.4) were well represented and collectively oaks and hickories dominated among functional groups with 400 stems/ha. Given their dominance in the overstory, white and red oak were not well represented in the 2.5-10 cm DBH size class with 22.2 and 55.6 stems/ha respectively. Oaks and hickories dominate the greater than 10 cm DBH size class as a group (138.9 stems/ha), although black oak (60 stems/ha) is a distant second to wild black cherry (115.6 stems/ha) for individual species.

The shrub layer was dominated by gray dogwood (*Cornus foemina*) in the 1-2.5 cm DBH size class (3,444.4 stems/ha; 65.3%) (Table 11, Figure 4a,b). This density of dogwood may be a result of random plot selection. Gray dogwood, however, occurred in more plots (n=4) and sub-plots (n=5) than any

other woody stem in that size class, so the number of stems per hectare is not on artifact of a single dense plot. Bush honeysuckle (500.0 stems/ha), common buckthorn (277.8 stems/ha) and glossy buckthorn (277.8 stems/ha) were also important. These three invasive shrubs are also the most dominant according GPS monitoring of invasive species (see below). Glossy buckthorn dominated in the 2.5-10 cm DBH size class at 322.2 stems/ha, accounting for 43.9% of the woody stems in that size class. Smooth arrowwood (122.2 stems/ha), bush honeysuckle (111.1 stems/ha), and autumn olive (*Elaeagnus umbellata*) (88.9 stems/ha) were also important. While smooth arrowwood occurs throughout the Preserve, plot D12NWV, the only plot it occured in at the 2.5-10 cm DBH size class, accounts for its high density.

Total percent cover in one-m^2 plots in Forest I was composed of 57% native species and 50% in Forest II (Table 12). The Shannon diversity index in Forest I was 3.32 (2.65 for only native species) and 3.01 (2.73 for only native species) in Forest II. Evenness in Forest I was 0.68 (0.61 for only native species) and 0.66 (0.64 for only native species) in Forest II. The herbaceous layer was dominated by Canada goldenrod (*Solidago canadensis*), Virginia creeper (*Parthenocissus quinquefolia*), bush honeysuckle, Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*) and garlic mustard. The ecotonal nature of the plots gave more weight to some oldfield species, such as Canada goldenrod and smooth brome.

Soil texture generally followed mapped soil classifications. Areas mapped as Kalamazoo loams were silty loams and silty clay loams and those mapped as Oshtemo sandy loams were sandy loams.

Comparisons with KNC Study

Adams et al. (2002) also studied forest composition at the Preserve, although their study was limited to Forest I. They surveyed small (<3 cm DBH), medium (3-13 cm DBH), and large (>13 cm DBH) woody stems on a line transect. White oak was dominant in the canopy (dominant at 45% of points, average DBH of 65 cm), although wild black cherry (average DBH of 22.2 cm) was a more frequent large stem. Wild black cherry dominated the medium stems (738 stems/ha). Glossy buckthorn dominated in the understory (small stems; 2,000 stems/ha), although there were 5829 snags/ha. They also reported few oak seedlings, especially white oak.

Unit	Dominant Physiognomy	Native C	C	Native FQI	FQI	No. quadrats	No. species	% Native
P1	N P-Grass	3.1	1.8	11.8	9	20	24	58.30%
P2	N P-Grass	3.5	2.5	15.1	12.9	20	26	73.10%
P3	N P-Grass/N P-Forb	3.6	2.6	14.5	12.4	6	22	72.70%
P4	A P-Forb/A P-Grass/N P-Forb	2.6	1.5	9.9	7.4	27	25	56.00%
P5	N P-Grass/A P-Forb/N P-Forb	2.3	1.5	9	7.1	23	24	62.50%
S1	N P-Forb	2.1	1.2	9.8	7.4	50	37	56.80%
S2	A P-Grass	2.2	1	9.6	6.6	50	43	46.50%
Average:		2.8	1.7	11.4	9.0	28	29	60.84%

Table 14a. Summary of physiognomy, mean coefficient of conservatism (C), and floristic quality indices (FQI) for prairie transects

Prairie, Savanna I & II

Among all transects in Prairie and Savanna I, red clover (*Trifolium pratense*), big bluestem, Canada goldenrod, quack grass (*Agropyron repens*), switchgrass (*Panicum virgatum*), and Kentucky bluegrass

had the highest cover (Table 13). After big bluestem and switchgrass, little bluestem (*Schizachyrium scoparium*) was the most common planted native grass, followed by Indian grass (*Sorghastrum nutans*) and prairie dropseed (*Sporobolus heterolepis*). Black-eyed susan (*Rudbeckia hirta*) and New England aster had the highest cover of planted native forbs. Prairie and Savanna I had 59% and 58% native species respectively, although mean C and FQI were higher in Prairie (2.07 and 1.21) than Savanna I (10.73 and 5.68). Prairie units 2 & 3 had the highest mean C and FQI, skewing the results positively for Prairie. H′ and E have been shown to be poor predictors of floristic and ecological integrity, especially when compared to mean C and FQI (Taft et al. 2006). Accordingly, H′ and E were not consistent with mean C and FQI. They were when using only native species, although not conclusively (Prairie, native H′= 1.64, native E=0.50; Savanna I, native H′= 1.43, native E= 0.46). Taft et al. (2006) showed mean native H′ of 2.77 for remnant prairie and 2.46 for planted prairie 6-10 years old and mean native E of 0.80 for remnant and 0.76 for planted prairie.

Species	P1	P2	P3	P4	P5	S1	S2
Andropogon gerardii		**D**	**D**	C	**D**	**D**	
Solidago canadensis	C	C	**D**	C	C	**D**	**D**
AGROPYRON REPENS		C	C	**D**	**D**	C	C
TRIFOLIUM PRATENSE				**D**	**D**	**D**	
POA PRATENSIS			C			**D**	**D**
Panicum virgatum	**D**	C					
DAUCUS CAROTA		C		C			C
Andropogon scoparius		C	C				
Aster lateriflorus			C			C	
BROMUS INERMIS						C	**D**
Euthamia graminifolia						C	
Sorghastrum nutans			C				
TARAXACUM OFFICINALE		C					
Parthenocissus quinquefolia							C
PLANTAGO LANCEOLATA							C
Vitis riparia							C

Table 14b. Dominant (D, in bold) and co-dominant (C) plant species by prairie management unit

Individual prairie units were dominated by native perennial grasses (P1 & 2), native perennial grasses and forbs (P3), adventive perennial grasses and forbs (P4), native perennial grasses and native and adventive perennial forbs (P5), and native and adventive perennial forbs (S1) (Table 14a). Dominant species in transects were big bluestem, Canada goldenrod, quackgrass, and red clover (Table 14b). These species were dominant or co-dominant in four, two, two, and three of prairie management units, respectively. Switchgrass and Kentucky bluegrass were also dominant in one prairie management unit. Smooth brome (an adventive perennial grass) was dominant in Savanna II.

	Wet Meadow	Marsh	Average
Native C	4.7	3.3	4.0
C	4	2.1	3.1
Native FQI	32.4	19.2	25.8
FQI	29.9	15.4	22.7
No. quadrats	20	20	20
No. species	55	53	54
% native	85.50%	64.20%	75%
Shrub cover	19%	34%	27%
soil pH	6.89	7.31	7.10
soil type	sapric peat (in center - transect C11S)+ hemic peat (in south towards cattails - transect A11S)	(clay) sapric peat (at landward edge) + hemic peat (toward water and cattails)	
Dominant physiognomy	N P-Forb/N A-Forb/N P-Sedge	N P-Forb/A P-Forb/N P-Sedge	

Table 16a. Summary of physiognomy, mean coefficient of conservatism (C), and florstic quality indices (FQI) for wetland transects

Wet Meadow and Marsh

Tussock sedge (*Carex stricta*), spotted touch-me-not (*Impatiens capensis*), purple loosestrife (*Lythrum salicaria*), sensitive fern (*Onoclea sensibilis*), and marsh fern (*Thelypteris palustris*) had the highest cover among transects (Table 15). Based on RIV, dominants in Wet Meadow were spotted touch-me-not (8.2), tussock sedge (7.3), marsh fern (6.5), and sensitive fern (6.4) (Table 16b). In Marsh, dominants were tussock sedge (11.3), narrow-leaved cattail (*Typha angustiolia*) (7.8), and purple loosestrife (7.4). Cattails (*Typha* spp.), sedge (*Carex aquatilis*), and reed canary grass (*Phalaris arundinacea*) were also important and had high cover in at least one transect; smooth swamp aster (*Aster firmus*), calico aster (*Aster lateriflorus*), false nettle (*Boehmeria cylindrica*), clearweed (*Pilea fontana* and *P. pumila*), and Canada goldenrod were also common. The physiognomy of both wetlands was dominated by native perennial forbs, with native annual forbs, and native perennial sedges also important (Table 16a). Wet Meadow had considerably higher and percent native species (91%), mean C (3.93), FQI (26.91), than Marsh (69%; 2.11; 12.32) while H' (WM=3.11, M=3.06) and E (WM=0.78, M=0.77) were similar.

Species	WM	Marsh
Carex stricta	**D**	**D**
Impatiens capensis	**D**	C
LYTHRUM SALICARIA	C	**D**
TYPHA ANGUSTIFOLIA	C	**D**
Onoclea sensibilis	**D**	
Thelypteris palustris	**D**	
Aster firmus		C
Aster lateriflorus		C
Boehmeria cylindrica	C	
Phalaris arundinacea		C
Pilea fontana		C
Pilea pumila	C	
Solidago canadensis		C

Table 16b. Dominant (D, in bold) and co-dominant (C) plant species for wetland transects. Adventive species in ALL CAPS

Pooled Data

H' for pooled data was 3.36 and E was 0.63 among all plots and transects, which had a species richness of 207 (Table 17). The Evenness Index is most useful when compared with corresponding numbers from other studies.

Among survey areas, Wet Meadow had the highest values for mean C, FQI, and most other metrics (Table 17). Forest I & II and Marsh also had high values according to some metrics, while Prairie, and Savanna I & II scored generally lower.

Jaccard similarity using percent cover data aggregated survey areas fairly well (Figure 5a). Individual transects and/or plots tended to be linked to those with which boundaries were shared or that were adjacent (Figure 5b). These were typically joined within survey areas. Forest I and Forest II were the most similar (91.492), followed by Savanna I and Prairie (140.770). Marsh was grouped with Forest I & 2, likely because transects shared quadrats with the edges of both forested areas. Savanna II was joined with all preceding areas at 154.48; it is dominated by typical oldfield species like smooth brome, not found in great density in other areas. Wet Meadow was the least similar to other areas. It had the highest FQI and native species diversity and contains a diversity of species unique to high quality seep and sedge meadow habitats. While Jaccard similarity is not intended to separate habitat areas based on floristic or ecological integrity, it appears to have done so with Wet Meadow.

The physiognomic distribution for native species, adventive species, and all species were all remarkably similar to the general distribution in Michigan as a whole, although individual physiogmomic groups. For example, invasive shrubs were 6.81% of the total at Asylum as compared to 2.46% of Michigan's plant species (Appendix 3).

INVASIVE PLANT SPECIES MONITORING

GPS Mapping

Mapped garlic mustard covered 18.57 acres in April 2008, although some patches immediately west of Little Asylum Lake were not mapped (Map 6, Table 24a). Common reed (*Phragmites australis*) occupied 0.72 acres (Map 7, Table 24b). Lily-of-the-valley and periwinkle occupied 1.25 acres apiece and black locust (*Robinia pseudoacacia*) covered almost three acres (Map 7, Table 24b).

Forested Grids

RIVs for invasive species within forested grids ranged from 0.375 (Siberian elm [*Ulmus pumila*]) to 20.218 (honeysuckle species) for an average of 5.00 (standard deviation=5.98) (Table 18, Figure 6). Honeysuckle species (20.22), glossy buckthorn (17.09) and common buckthorn (16.70) had RIVs greater than one standard deviation from the mean. They collectively occupied 80.18 acres (59.02% cover of the forested grids). All invasive species occupied 127.12 acres. The grids with the highest cover (greater than one standard deviation) of invasive species were A10, D6, D7, E5, E10, E12, F6, F7, and I8 (Map 8, Table 22). While no spatial pattern is evident from these grids, high cover was also recorded (greater than mean) in A11, C6, C6, C10, D8, D10, E6, E7, E11, G5, G10, H1, H12, I9, J4, J5, and J6. Concentrations of highly invaded grids are apparent when combining these two groups, notably in the center of Forest I around the former cottages of the State Hospital.

Data on invasive species from the modified-Whittaker plots revealed similar trends for each species, although each method (grid vs. plot) included some species not included by the other. It is also important to note that RIVs are only comparable from a given set of data and thus direct comparisons can not be made between the two methods. Honeysuckle species had the highest RIV (22.15), followed by garlic mustard (16.29), glossy buckthorn (15.72), common buckthorn (10.97), and multiflora rose (*Rosa multiflora*)(6.99) (Table 19).

Yellow-flowered false sunflower (*Heliopsis helianthoides*) competing with red clover (*Trifolium pratense*) in Prairie Management Unit 4 (see Map 4).

Dense thicket of Asiatic bittersweet (*Celastrus orbiculata*) choking out tree seedlings and other vegetation in Forest I