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COMPARISON OF LANDSCAPE AND VEGETATION METRICS BETWEEN WETLANDS IN THE NORTHERN GREAT LAKES REGION AND HIGH ELEVATION CENTRAL APPALACHIAN WETLANDS

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ABSTRACT

I surveyed 58 wetlands in northern Wisconsin and Michigan's Upper Peninsula to examine patterns in vegetation community composition. In a principal components analysis of genera-weighted values, riverine sites were distinctly different from lacustrine and palustrine sites. Site loadings of the first principal component were correlated with site pH and a weighted site index of wetland plants. Similarity among wetlands was not influenced by distance among sites, and relative species richness was not influenced by wetland area. I then compared these northern wetland results to identical vegetation surveys of 20 high elevation wetlands in northern West Virginia and western Maryland, using plant community measures as relative disturbance indicators. Comparisons of the two regions indicated that more wetland-obligate and -facultative species were present in the northern wetlands than in relicts further south, and that relative species richness of non-woody species was higher in northern wetlands. Vegetation disturbance indicators, though relatively higher in northern wetlands than in central Appalachian relicts, revealed markedly low disturbance measures in both regions. The minimal levels of disturbance indicate the potential use of both regional sets of wetlands as baseline data for future disturbance studies.

KEY WORDS: boreal wetland, disturbance, metric, relict wetland

INTRODUCTION

Boreal wetlands, specifically those in northern Wisconsin and Michigan's Upper Peninsula, may be classified into multiple communities, such as open bogs, boreal rich fens, muskegs, and northern wet forests (Epstein et al. 2002). These multiple habitat types have primarily developed in basins scoured out ca. 10 000 BCE from the last recession of glaciers (Wisconsin glaciation; Mitsch and Gosselink 2000). Though not directly affected by the last glacial event (glaciers extended south to southern Pennsylvania; Rigg and Strausbaugh 1949), wetlands with similar climate conditions and plant communities are less common but locally abundant in portions of the central Appalachian Mountains. The higher elevations experience locally cool climate, and act as a refuge for many northern plant species that migrated altitudinally as glaciers receded from the last continental glaciation (Fortney 1975; Ingham 1996; Francl et al. 2004a).

Because of the lack of glaciation in the central Appalachian region, the age and origin of these wetlands differed from their northern counterparts. Whereas northern wetlands typically began as kettle lakes, filling in from the water surface downwards to create open, floating *Sphagnum* mats, many central Appalachian wetlands were originally forested wetlands (Clarkson 1993). A commonality to both regions is that extensive logging activity at the turn of the 20th century (ca. 1880–1910) drastically altered the wetlands of each region. In Michigan's Upper Peninsula, preferential logging of white pine (*Pinus strobus* L.) resulted in forests dominated by stands of hardwoods and hemlock (*Tsuga canadensis* [L.] Carr.). The emergent wetlands, scattered in depressions within the hardwoods-hemlock landscape, were not logged, although skid trails and other access roads were constructed along their borders (O'Neil 1938). Fires were fairly common through cut-over hardwood sites (O'Neil 1938).

Central Appalachian mountain wetlands originally consisted of red spruce (*Picea rubens* Sarg.), balsam fir (*Abies balsamea [L.] P. Mill.*), and rosebay rhododendron (*Rhododendron maximum* L.) in the canopy and subcanopy and a floor of wetland mosses atop a deep organic layer. Clearcutting efforts in these habitats exposed the rich organic soils, and subsequent fires burned and removed the organic layers. What remained were rock outcrops and isolated pockets of raised water tables (now, too wet to support tree regeneration), suitable for sustaining the present-day shrub-scrub and emergent wetlands. Hence, compared to boreal wetlands of the northern United States, most central Appalachian wetlands are geologically younger and markedly altered (more disturbed) from their natural state over a century ago (Fortney 1993).

Across the current regional landscapes, examinations of National Wetland Inventory (NWI; 1:100,000) maps reveal marked difference between the two study areas. Proportional wetland area (emergent and shrub-scrub) is greater in the studied portion of Michigan's western and central Upper Peninsula (22.8% of land area in Ironwood and Wakefield quadrangles) than in the studied areas of northern West Virginia and western Maryland (0.6% in Elkins and Kingwood quadrangles). Furthermore, when comparing both wetland area in the cited quadrangles, the number of wetlands and average wetland size is greater in this portion of Michigan for both emergent (avg. = 2.5 ha [N = 910] vs. 1.4 ha [N = 1724]) and forested (avg. = 7.4 ha [N = 8061] vs. 2.4 ha [N = 2082]) wetlands (U.S. Fish and Wildlife Service 2006). Given that larger wetland areas tend to support greater plant species richness and diversity (Smith and Haukos 2002; Ashworth et al. 2006), it is likely that, on average, the northern sites may support more species-rich plant communities than their central Appalachian counterparts.

Francl et al. (2004a) studied the vegetation communities of 20 wetland habitats in West Virginia and western Maryland, and found that plant communities were distributed along soil chemical (pH, conductivity) gradients. These patterns are not surprising, as plant communities often separate out along a chemical gradient. Indeed, pH is used to define ombrotrophic wetlands of the north (pH < 4.1), due to the unique acid-tolerant plant community they support (e.g., Core 1966, Walbridge 1994). Furthermore, wetland plant communities were grouped geographically, with sites closer to one another sharing more similar vegetative characteristics (Francl et al. 2004a). Therefore, this current project sought to reproduce the central Appalachian surveys in wetlands of northern Wisconsin and Michigan's Upper Peninsula to determine if similar trends in chemistry and geography were apparent. In duplicating the methods, the two regions could be directly compared in terms of multiple vegetative parameters and wetland indices, elucidating differences in vegetation structure between northern wetlands and central Appalachian wetlands.

In a study of headwater wetlands in the Ridge and Valley region of central Pennsylvania, Miller et al. (2006) found strong correlations between multiple vegetative parameters and anthropogenic disturbance measures. I used 12 of these plant metrics in the current study. Although raw data were not directly comparable to the Pennsylvania study, proportional vegetation measures could gauge relative disturbance levels among the three regions.

In examining the spectrum of wetland types in Michigan and Wisconsin, I predicted that the majority of palustrine sites would have wetland vegetative index values < 2.0 (an indicator by Tiner [1999] that the site is a true wetland), and clearly differ in vegetation from surveyed riverine and lacustrine sites. As was the case for central Appalachian wetlands, I expected Michigan-Wisconsin wetland species distributions would separate along a pH gradient, and that sites geographically closer to one another would be more similar in vegetation composition. I also predicted that West Virginia-Maryland wetlands would have vegetation community measures that corresponded to higher degrees of disturbance, primarily because they are less concentrated across the landscape and because they have been markedly altered from their original forested wetland state. Furthermore, I hypothesized these more southerly wetlands would have lower species richness values and exhibit higher wetland index values (i.e., less wetland-dependent vegetation) than their northern counterparts.

METHODS

Site selection and data collection

I surveyed 58 wetlands in 2003 and 2004: 32 palustrine, 14 riverine, and 12 lacustrine habitats (Figure 1, Appendix 1; hereafter, “MI-WI sites”). Forty-five sites were located at the University of Notre Dame Environmental Research Center (UNDERC) in Gogebic Co., Michigan and Vilas Co., Wisconsin; 13 sites were located within the Ottawa National Forest in Gogebic Co., Michigan (Appendix 1).

Twenty wetlands in West Virginia (Tucker, Randolph, Preston Co.) and Maryland (Garrett Co.; hereafter, “WV-MD sites”) were surveyed by Francl in summer 2001 as part of a large-scale wetland characterization project (Francl et al. 2004a). Vegetation metrics gleaned from Francl et al. (2004a) and additional recent analyses of these vegetation surveys were utilized in statistical comparisons.

At MI-WI sites, I sampled vegetation in randomly-selected 10-m × 10-m plots for woody species (2–10/site, depending on wetland size and visible habitat diversity) and 1-m × 1-m subplots for herbaceous species (9/plot), following methods described in Francl et al. (2004a). Within these plots and subplots, I visually approximated percent cover for each species. If possible, plants were identified to species, and taxonomy followed the PLANTS database (USDA NRCS 2006). Voucher specimens were deposited in the Greene-Nieuwland herbarium at the University of Notre Dame, Notre Dame, IN.

Site pH was measured at all sites within 36 h in August 2004. These measures were taken with a pH probe (Oakton Instruments, Vernon Hills, IL, USA) at least 48 h after a significant rain event to avoid rainfall bias (Allan 1995). Site pH was averaged across multiple readings of standing water; if no water was visible, a soil sample (<10 cm from surface, excluding live vegetation) was collected, mixed in a 50:50 solution with DI water, and measured 30 min after initial mixing (S. Bridgham, personal communication, 2004).

All GIS analyses were performed using ArcGIS 8.3 (ESRI, Inc., Redlands, CA, USA), using

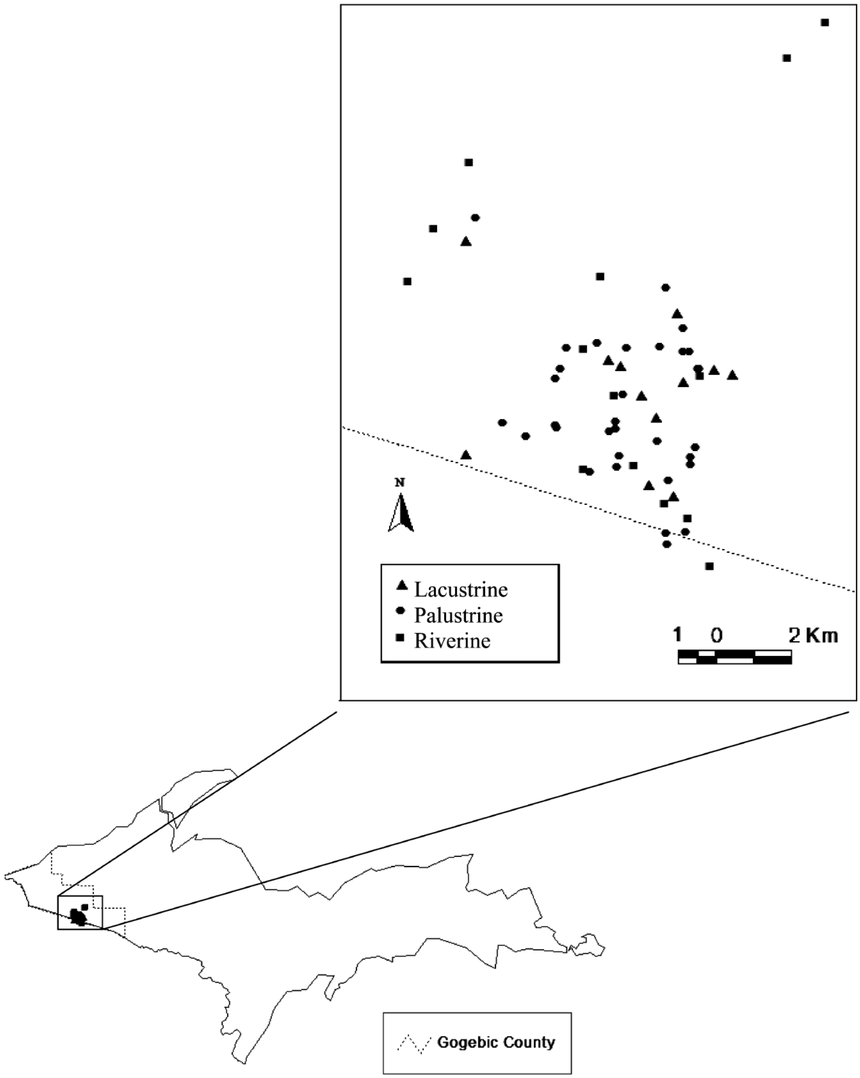

FIGURE 1. Map of 58 wetland sites surveyed in 2003–2004 in Michigan's Upper Peninsula (Gogebic Co.; border shown as dashed line) and northern Wisconsin (Vilas Co.). Inset shows site location and breakdown according to wetland types (lacustrine: triangles, palustrine: circles, riverine: squares).

datum UTM NAD27, Zone 16N. MI-WI site GPS was recorded, and straight-line distances among sites were determined from these points. For each site, I estimated proportional landuse within a 500-m buffer using a series of overlaid maps that maximized wetland recognition and accurate identification of surrounding habitats. Buffer data and road measures for the WV-MD sites were described in Francl et al.'s (2004b) GIS study. Data for MI-WI sites were assembled from existing forest stand information (e.g., additional landuse/landcover types and road shapefiles created by the Ottawa National Forest [courtesy of B. Bogaczyk, Bessemer Ranger District, Ottawa National Forest]) and Francl's ground-truthing work at UNDERC (K. Francl, unpublished data). Road density was calculated by summing road segment lengths (m) within each 500-m buffer. Proportional habitat values were combined into four landuse categories: forest, wetland, agriculture/open, and other. Proportions for each of the first three categories, as well as road density, were separately compared between regions using Student's t-tests. Continuous wetland area also was calculated from these layers, and Pearson's correlations were used to compare area to both plot and subplot species richness for each site.

Michigan-Wisconsin intra-regional comparisons

For each MI-WI site, I calculated the importance value (I; Cox 1996) of each plant species, which equally weighed its relative dominance (estimated by percent cover) and relative frequency (proportion of plots or subplots containing the species). Vegetation was then analyzed using weighted averages for each species, where each species is assigned an appropriate ecological indicator value, ranging from one (obligate wetland species) to five (obligate upland species, Reed 1988). If Reed (1998) did not assign a value to a species (e.g., non-vascular plants), I assigned an appropriate value, based on literature review and values assigned to other closely-related species (e.g., all *Sphagnum* spp. were considered wetland-obligate species). A weighted average was calculated for each site, based on the I-value for each species and its corresponding ecological indicator value (Francl et al. 2004a; modified from Tiner 1999). The resulting weighted average ranged from one to five; weighted averages typically are < 2.0 in wetlands (Tiner 1999).

Principal components analyses (PCA) were performed using NTSYS-pc ver. 2.02i (Applied Biostatistics, Inc., Setauket, NY, USA). To best incorporate the value of plants identified to genus only (e.g., *Sphagnum* spp., some *Carex* spp., *Rubus* spp.), I examined plants at the genus level (N = 156 genera). Although this choice may limit the power of detecting within-genus differences, the same methods were utilized in Francl et al. (2004a), and consistency across studies was preferred for inter-regional comparisons.

Plot and subplot plant data, measured in proportions (*I*-values), were standardized using the default methods in NTSYS. Initially, separate principal components analyses were performed using the *I*-values for each genus for woody (plot) and herbaceous (subplot) data. However, the first principal components of woody and herbaceous analyses were strongly correlated ($r = 0.613$, $p < 0.001$). Therefore, I performed a single PCA for all vegetation data, giving equal weight to plot and subplot *I*-values. For this analysis, I calculated correlations among variables, then extracted the first three principal components from the correlation matrix. Pearson's correlations separately compared pH and weighted site indices to site projection values for each of the first three components, and a scatter diagram plotted site projection values for the first two components that explained the greatest amount of variance.

A Mantel test contrasted a matrix of geographic distances among MI-WI sites (minimum distance, meters) and a dissimilarity matrix using *I*-value genera loadings as a measure of vegetation differences across sites. Results determined if plant communities were clustered geographically.

Inter-regional comparisons

To compare vegetation surveys from MI-WI to WV-MD sites, 11 community metrics were calculated for each site, using combined plot and subplot data. Most parameters selected were significantly correlated to Miller et al.'s (2006) disturbance gradient among Pennsylvania wetlands (Table 1). Measures included proportion (relative to total number of species per site) of annuals, perennials, dicots, monocots, vascular cryptogams (ferns and fern allies), non-natives, and forbs. I calculated the number of *Carex* spp. (Cyperaceae), all sedge spp. (Cyperaceae), and native grasses (Poaceae) as a proportion of the number of forb species per site (Miller et al. 2006). The number of species with a wetland indicator status of obligate- or facultative-wetland was calculated as a proportion of the number of species with an assigned indicator value, as well (Miller et al. 2006). Student's t-tests compared values of each metric between the two regions.

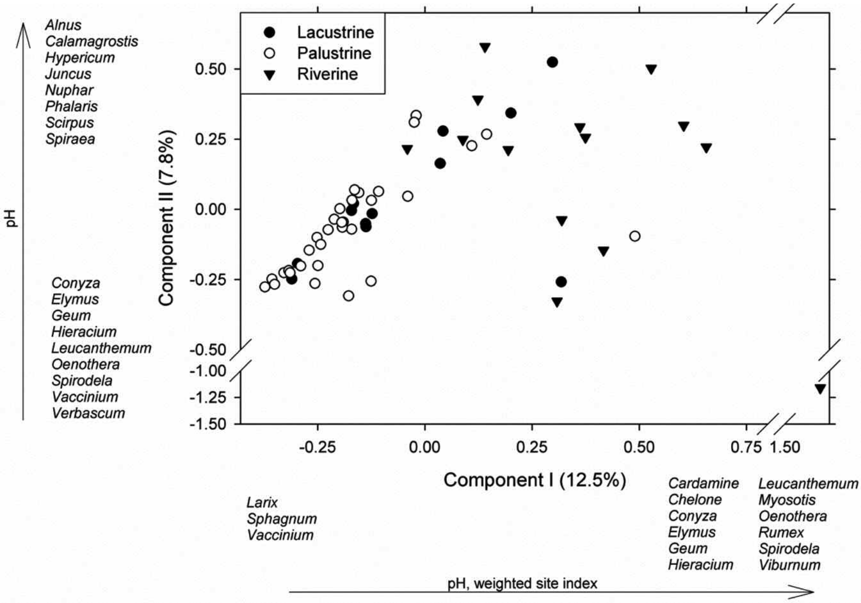

FIGURE 2. Principle components analysis of combined vegetation plot and subplot data for 58 wetlands sites in northern Wisconsin and Michigan's Upper Peninsula. Plant genera exhibiting high positive or negative loadings are listed on the appropriate axis. Significant positive correlations of site loadings with pH and weighted site index values are also indicated.

RESULTS

Michigan-Wisconsin intra-regional comparisons

In 223 plots and 2009 subplots, I documented 212 species within 156 genera and 74 families of vascular and non-vascular plants (Appendix 2). Of these plants, 118 (55.7%) were classified as wetland-obligate species and 58 (27.4%) were wetland-facultative (Appendix 2). The remaining species were identified as wetland/upland-neutral or upland categories (Appendix 2; Reed 1988). Site pH values ranged from 4.0 – 8.4 across sites (average = 5.5 ± 0.3 [95% C.I.]; Appendix 1).

Weighted index values, averaged for plot and subplot data, ranged from 1.08–2.97 (average = 1.63 ± 0.11; Appendix 1). Eleven of 12 lacustrine sites, 29 of 32 palustrine sites, and 10 of 14 riverine sites exhibited weighted index values < 2.0 (Appendix 1). Overall, I found an average of 5.6 ± 0.5 woody species per plot (range 1.3–10.0) and 5.7 ± 0.4 (range 3.5–9.9) herbaceous species per subplot. Wetland area was not influential in species richness values across palustrine and lacustrine sites (plots: $r = -0.202$, $p = 0.188$; subplots: $r = -0.124$, $p = 0.421$), and was not related to wetland index values ($r = -0.017$, $p = 0.915$).

In a PCA of the combined vegetation plot and subplot data at the genus level, the first component explained 12.5% of total character variance, and separated out Tenderfoot Creek ERC (Gogebic Co., Michigan) from the remaining 57 sites (Figure 2). Tenderfoot Creek ERC contained several disturbance-tolerant species not restricted to wetland habitats, and additional upland species unique to this site. To a lesser extent, the remaining riverine sites also separated from lacustrine and palustrine sites on this axis. Twelve genera exhibited loadings > 0.650 on the positive end of the axis (Figure 2). Three plant genera exhibited similar high loadings on the negative end of the axis: *Larix* (eigenvalue of –0.644), *Sphagnum* (–0.761), and *Vaccinium* (–0.657), and were concentrated at more palustrine sites. The second component explained 7.8% of the variance, and again separated out most palustrine and lacustrine sites from riverine sites (Figure 2). Again, Tenderfoot Creek ERC was separated out as an extreme site; indeed, of the nine plant genera exhibiting loadings < –0.500, just two (*Vaccinium*, *Verbascum*) did not exhibit similarly high loadings documented in Component I (Figure 2). Eight genera showed loadings > 0.500 for this second component (Figure 2). The third component (not displayed) constituted 7.3% of the total character variance, and separated 3 creek sites (Tenderfoot Creek ERC loading = –0.839; Kakabika Falls = 1.070; Vernal Creek = 1.079) from the remaining sites. Plants exhibiting high positive loadings included *Abies* (0.630), *Acer* (0.601), *Betula* (0.679), *Dryopteris* (0.831), and unidentified mosses (0.768), while no plant genera exhibited negative loadings < –0.450.

A significant positive correlation was discovered between loadings of the first component and pH ($r = 0.672$, $p < 0.001$; Figure 2). A weaker trend also was discovered between pH and the second component loadings ($r = 0.359$, $p = 0.006$; Figure 2), while no relationship was discovered between pH and the third component ($r = –0.024$, $p = 0.857$). Wetland index values also were positively correlated to the first component ($r = 0.582$, $p < 0.001$) and the third component ($r = 0.681$, $p < 0.001$), but were not related to the second component's loadings ($r = 0.143$, $p = 0.285$; Figure 2).

A Mantel test indicated that geographical distance between sites relative to vegetation community dissimilarity explained just 7.9% ($r = 0.281$) of variance among sites. Statistical tests (Mantel $t = 2.599$, $p = 0.995$) revealed that this relationship was not significant.

Inter-regional comparisons

Of the original 183 plant species collected in WV-MD, 54 non-woody and 15 woody species (37.7% of all species) also were found in the MI-WI surveys. WV-MD sites, therefore, contained 114 unique species, while I discovered 143 non-overlapping species in the MI-WI surveys. Student's t-tests of vegetative community metrics revealed that MI-WI sites had a lower wetland site index, higher pH, higher species richness averages for (non-woody) subplots, and higher proportions of perennials, dicots, monocots, members of family Cyperaceae, and obligate/facultative wetland species than the WV-MD sites. The WV-MD sites had greater proportions of *Carex* spp. and cryptogams, and lower proportions of Cyperaceae representatives (Table 1). When comparing landuse-landcover metrics between regions, the MI-WI sites had a significantly higher road density, and lower proportions of forest cover (Table 1). There was a trend ($p = 0.122$) towards a higher proportion of wetland cover for the MI-WI

TABLE 1. Comparison of pH, vegetation community values, and surrounding landuse variables (average ± SD) between 58 wetlands in Michigan's Upper Peninsula and northern Wisconsin and 20 wetlands studied in West Virginia and Maryland. Results from t-tests ($p < 0.10$ in bold) compare two regional groups. Expected relationship to increasing levels of disturbance from Miller et al. (2006).

Variable	Relation to Increasing Disturbance	MI & WI	WV & MD	t	p
Site pH	—	**5.5 ± 1.2**	**4.2 ± 0.8**	**5.391**	**<0.001**
Weighted site index	—	**1.64 ± 0.41**	**2.16 ± 0.40**	**4.958**	**<0.001**
Avg. species richness (plot)	—	5.6 ± 1.8	5.7 ± 1.6	0.037	0.970
Avg. species richness (subplot)	—	**5.7 ± 1.4**	**4.7 ± 1.2**	**2.827**	**0.006**
Prop. annuals	Positive	0.016 ± 0.026	0.009 ± 0.018	0.963	0.339
Prop. perennials	Negative	**0.906 ± 0.030**	**0.830 ± 0.038**	**9.014**	**<0.001**
Prop. dicots	Positive	**0.546 ± 0.062**	**0.467 ± 0.102**	**3.234**	**0.004**
Prop. monocots	None	**0.337 ± 0.071**	**0.293 ± 0.099**	**2.143**	**0.035**
Prop. vascular cryptogams	Negative	**0.057 ± 0.042**	**0.102 ± 0.058**	**3.725**	**<0.001**
Prop. non-natives	Positive	**0.021 ± 0.033**	**0.039 ± 0.041**	**2.031**	**0.046**
Prop. forbs	Positive	**0.399 ± 0.119**	**0.232 ± 0.077**	**7.201**	**<0.001**
Prop. *Carex*	Negative	**0.321 ± 0.242**	**0.514 ± 0.350**	**2.281**	**0.031**
Prop. Cyperaceae	Negative	**0.468 ± 0.325**	**0.217 ± 0.105**	**5.160**	**<0.001**
Prop. native grasses	Negative	0.133 ± 0.092	0.127 ± 0.141	0.190	0.851
Prop. OBL, FACW plants	None	**0.719 ± 0.112**	**0.396 ± 0.116**	**11.028**	**<0.001**
Prop. forest cover (500-m radius)	Negative	**0.640 ± 0.166**	**0.765 ± 0.266**	**1.977**	**0.059**
Prop. wetland cover (500-m radius)	—	0.212 ± 0.112	0.151 ± 0.159	1.599	0.122
Prop. open/agricultural cover (500-m radius)	—	0.042 ± 0.055	0.085 ± 0.172	1.092	0.287
Road density (m road per 500-m radius)	—	**1701.9 ± 518.4**	**889.2 ± 823.8**	**4.139**	**<0.001**

sites, as well (Table 1). Of the twelve metrics I measured, MI-WI sites were rated as relatively more disturbed for five (proportions of dicots, vascular cryptogams, forbs, Carex, and forest cover [within 500-m radius]), while WV-MD sites were rated as more disturbed for three measures (proportions of perennials, non-native species, and Cyperaceae).

DISCUSSION

In examining vegetative patterns across 58 MI-WI sites, the majority (86.2%) of wetlands exhibited index values < 2.0, indicating their dominance by wetland-obligate or -facultative species. The sites that did differ markedly were riverine, typically dominated by more upland species and lacking a wide riparian area. Results from the PCA emphasized that most riverine habitats separated out clearly from remaining lacustrine and palustrine wetlands. However, eigenvalues (variance explained) were relatively low for each of the first three components, indicating overlap of species across multiple sites and that vegetation communities were not clearly distinguishable. Furthermore, the PCA was unable to separate out lacustrine sites from palustrine ones, likely because many study lakes were bounded by bog-like acidophilic vegetation. Despite the lacustrine habitat classification, 11/12 sites had weighted values < 2.0, suggesting that wetland categories may overlap in vegetative characteristics. Other factors that could influence vegetation distribution patterns were initially examined (i.e., potential geological influences, like soil type and bedrock formation), but did not provide any obvious trends in preliminary analyses, though they have proven influential in other wetland studies (e.g., Liu et al. 2006, Whitehouse and Bayley 2005).

As predicted, MI-WI plant communities followed a pH gradient, coinciding with results of the WV-MD study (Francl et al. 2004a), as well as boreal plant studies in Canada (e.g., Girardin et al. 2001; Locky and Bayley 2006). However, I did not find a relationship between vegetative communities and physical distance from one another, like that of the WV-MD study. Perhaps seed dispersal among sites is greater in MI-WI, as sites are less isolated on the landscape (Ashworth et al. 2006; Houlahan et al. 2006).

Average species richness of non-woody vegetation was higher for MI-WI sites, as predicted. Furthermore, wetland index values were lower in MI-WI sites, indicating that wetland-dependent vegetation is more dominant at these sites. This may be a result of wetland age (Spieles 2005) and wetland density across the landscape (i.e., shorter distances for seed or spore travel among sites; Ashworth et al. 2006).

MI-WI sites showed significantly different values for five of the eight parameters that indicated higher levels of disturbance, while WV-MD sites showed evidence of greater disturbance for three parameters. One reason for this inconsistency in disturbance trends is that the range of disturbance across current study sites is more restricted than Miller et al.'s (2006) Pennsylvania sites. For example, (by visual examination of plotted data) Miller et al.'s (2006) sites exhibited scores from 0–100% for percent annuals (current study 0–9.5%), percent non-native species (current study 0–13.8%), and percent cryptogams (current study 0–15.4%). Compared to these Pennsylvania wetlands, it's likely that nearly all MI-WI and WV-MD wetlands would be quantified as low-disturbance sites. This result may be influenced by the degree in which regional wetlands in WV-MD and MI-WI are protected, as all studied sites are either owned and managed by governmental organizations (e.g., USDA Forest Service, State of West Virginia) or private conservation-minded institutions (The Nature Conservancy, University of Notre Dame). Future research might concentrate on filling in the gaps along this disturbance gradient—making the effort to locate and survey moderately or severely disturbed wetlands (if they do indeed exist).

The relative lack of disturbance across WV-MD and MI-WI sites emphasizes their ecological value across regions. Sites in both regions could serve as reference sites for future disturbance studies. Although the current study examined species richness as a proportion of survey effort (average number of species per plot or subplot), future work might better assess wetland value by conducting whole-site surveys. From these complete species lists, more precise estimates of habitat quality would be available. Indeed, several wetlands in West Virginia and Michigan have been surveyed in their entirety (e.g., Fortney 1975; Gibson 1970; Robinette 1964, K. Francl, unpublished data). Furthermore, whole-site surveys might help us to better develop accurate species-area curves for each site, and determine if there is indeed a difference in species richness across the spectrum of wetland area. However, if our findings hold true—that wetland size does not influence species richness in these two study regions—then we might emphasize the ecological importance and continued preservation of small wetlands on the landscape.

Not surprisingly, MI-WI sites exhibited more wetland-obligate and -facultative plant community characteristics. However, this does not discount the value of central Appalachian wetlands, based on the number of species unique to the dual surveys. Future studies might stray from the NWI system employed in this project and instead develop a Floristic Quality Assessment Index (FQAI) for West Virginia and Maryland. FQAI is available in areas such as Michigan (Herman et al. 2001), Ohio (Andreas et al. 2004), and the Chicago region (Wilhelm and Masters 1995) and a work-in-progress for Wisconsin (Bernthal 2003). This index might help future researchers to better assess the degree of disturbance in each West Virginia and Maryland wetland and accurately estimate relative wetland health.

As issues of predicted climate change and continuing landuse alteration become increasingly central in mitigating the health and survival of regional plant communities, baseline data, like these surveys provide, will be increasingly useful to habitat managers.

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APPENDIX 1. Wetland sites surveyed in 2003–2004 in northern Wisconsin and Michigan's Upper Peninsula. Wetland type follows Cowardin et al. (1979) where L = lacustrine, P= palustrine, and R= riverine. Permanent open water (e.g., lakes) was not included in wetland area measurements. Area was also not calculated for riverine wetlands because of their linearity. Also recorded is weighted site index, averaged for vegetation plot and subplot data.

Site	Easting	Northing	Type	Wetland area (ha)	pH	Weighted index
Alder Fen	303 471	5 123 411	P	7.91	4.8	1.39
Beaver Bog	305 787	5 123 588	P	0.14	4.1	1.33
Beavergate	305 313	5 125 865	P	10.01	6.0	1.67
Bergner Lake	306 496	5 123 861	L	4.01	4.7	1.58
Blue Flag Bog	302 833	5 123 759	P	3.49	4.0	1.59
Bluebill Creek	301 971	5 130 555	R	—	8.4	1.27
Boggy Forest	307 894	5 123 116	P	2.11	4.0	2.03
Boomer Bog	304 270	5 123 657	P	3.10	5.1	1.51
Brown Creek	308 276	5 119 968	R	—	6.6	1.70
Bubba Bog	307 577	5 126 254	P	5.47	5.5	1.58
Buck Creek	305 771	5 124 453	R	—	5.2	1.77
Calla Bog	304 208	5 123 689	P	3.91	5.1	1.39
Castleberry Bog	307 930	5 125 185	P	1.81	4.9	1.42
Cattail Bog	304 209	5 124 913	P	0.63	4.8	1.57
Cornelia Lake	307 408	5 126 637	L	1.86	5.7	1.26
Cranberry Lake	301 897	5 122 910	L	11.24	4.5	1.33
Donut Complex	306 909	5 123 327	P	3.25	4.5	1.50
Ed's Bog	307 755	5 122 857	P	0.08	5.4	1.32
Firestone	305 974	5 124 498	P	4.78	5.1	1.77
Foggy Creek	308 019	5 124 977	R	—	5.5	2.36
Foggy Lake	308 379	5 125 151	L	8.20	5.4	1.38
Ford Bog	307 721	5 125 826	P	0.33	4.7	1.51
Forest Service Bog	307 139	5 120 800	P	1.62	5.2	1.36
Forest Swamp	307 181	5 122 245	P	1.19	4.2	1.93
Frodo Bog	307 127	5 120 864	P	1.26	4.3	1.24
Gravel Pit 2Sn Bog	304 300	5 125 177	P	7.17	5.5	1.38
Grosbeck Creek	310 313	5 133 310	R	—	6.9	1.88
Ho Bog	306 954	5 125 735	P	1.36	4.0	1.87
Holiday Creek	304 952	5 125 707	R	—	6.2	1.43
Hummingbird Lake	306 857	5 123 878	L	0.92	4.5	1.62
Jumping Mouse Bog	307 098	5 127 262	P	1.04	5.2	1.46
Kakabika Falls	311 296	5 134 232	R	—	7.3	2.95
Kickapoo Creek	307 079	5 121 642	R	—	6.6	1.23
Kickapoo Lake	307 315	5 121 828	L	17.77	7.3	1.29
Little Fen	305 788	5 124 022	P	0.16	4.4	1.60
Luke Fen	304 503	5 125 718	P	1.33	4.0	1.42
Misty Lake	308 858	5 125 004	L	1.09	5.3	1.73
Morris Lake	305 594	5 125 416	L	1.08	7.4	1.38
Muddy Field	307 758	5 122 655	P	0.28	5.1	2.46
Northgate Bog	307 548	5 125 640	P	0.23	4.2	1.49
Oz Bog	307 972	5 125 181	P	1.13	5.2	1.30
Plum / Inkpot Lake	306 694	5 122 329	L	7.92	7.5	1.21
Plum Creek	307 706	5 121 253	R	—	5.6	1.40
Plum Fen	307 627	5 121 131	P	2.92	5.0	2.69
Pomeroy Bog	302 137	5 129 103	P	18.70	4.2	1.21
Pomeroy Creek	301 047	5 128 813	R	—	7.1	1.93
Pomeroy Lake	301 871	5 128 495	L	24.76	8.0	2.16
Presque Isle River	300 376	5 127 428	R	—	7.3	1.95
Reddington Bog	306 086	5 125 712	P	1.11	5.5	1.08

APPENDIX 1. Continued.

Site	Easting	Northing	Type	Wetland area (ha)	pH	Weighted index
Riley Fen	305 498	5 123 591	P	1.40	5.0	1.33
Shire Bog	305 802	5 122 598	P	0.20	4.6	1.76
Tender Bog	305 108	5 122 480	P	0.39	4.1	1.62
Tenderfoot Creek ERC	304 892	5 124 857	R	—	7.9	2.18
Tenderfoot Creek ONF	305 392	5 127 562	R	—	6.7	1.72
Tuesday Lake	307 579	5 124 826	L	6.23	5.7	1.29
Vernal Creek	306 259	5 122 627	R	—	5.3	2.97
Ward Lake	305 904	5 125 235	L	3.40	8.3	1.76
Ziesnis Jr. Bog	305 853	5 123 112	P	0.15	4.2	1.40

APPENDIX 2. Plant species collected at 58 wetlands in northern Wisconsin and Michigan's Upper Peninsula in 2003 and 2004. The wetland indicator status (OBL = obligate wetland, FACW = facultative wetland, FAC = facultative, FACU = facultative upland, UPL = upland; +/– signs better define regional status; Reed 1988) and number of sites at which each species was collected are also listed.

Scientific name	Author	Common name	Wetland Indicator	No. sites
Aceraceae				
Acer rubrum	L.	Red maple	FAC	40
Acer saccharinum	L.	Silver maple	FACW	1
Acer saccharum	L.	Sugar maple	FACU	8
Acer spicatum	Lam.	Mountain maple	FACU	1
Alismataceae				
Sagittaria latifolia	Willd.	Broadleaf arrowhead	OBL	18
Apiaceae				
Cicuta bulbifera	L.	Bulblet-bearing water hemlock	OBL	19
Cicuta maculata	L.	Spotted water hemlock	OBL	1
Osmorhiza claytonii	(Michx.) C.B. Clarke	Clayton's sweetroot	FACU-	2
Aquifoliaceae				
Ilex verticillata	(L.) Gray	Common winterberry	FACW+	9
Nemopanthus mucronatus	(L.) Loes.	Catberry	OBL	9
Araceae				
Calla palustris	L.	Water arum	OBL	41
Araliaceae				
Aralia nudicaulis	L.	Wild sarsaparilla	FACU	6
Asclepiadaceae				
Asclepias incarnata	L.	Swamp milkweed	OBL	16
Aspleniaceae				
Asplenium sp.	L.	Spleenwort	FACU	1
Asteraceae				
Achillea millefolium	L.	Common yarrow	FACU	4
Bidens cernua	L.	Nodding beggartick	OBL	1
Cirsium palustre	(L.) Scop.	Marsh thistle	FACW	3
Conyza canadensis	(L.) Cronq.	Canadian horseweed	FAC-	1
Doellingeria umbellata var. *umbellata*	(P. Mill.) Nees	Parasol whitetop	FACW	2
Erigeron strigosus	Muhl. ex Willd.	Prairie fleabane	FAC-	2
Eupatoriadelphus maculatus var. *maculatus*	(L.) King & H.E. Robins.	Spotted trumpetweed	OBL	10
Eupatorium perfoliatum	L.	Common boneset	FACW+	5

APPENDIX 2. Continued.

Scientific name	Author	Wetland Common name	Indicator	No. sites
Asteraceae (Continued)				
Euthamia graminifolia	(L.) Nutt.	Flat-top goldentop	FACW-	5
Hieracium kalmii	L.	Kalm's hawkweed	FACU	1
Lactuca biennis	(Moench) Fern.	Tall blue lettuce	FAC	1
Leucanthemum vulgare	Lam.	Oxeye daisy	FACU	1
Solidago canadensis	L.	Canada goldenrod	FACU	1
Solidago gigantea	Ait.	Giant goldenrod	FACW	1
Solidago hispida	Muhl. ex Willd.	Hairy goldenrod	N/A	1
Solidago speciosa	Nutt.	Showy goldenrod	N/A	2
Solidago uliginosa	Nutt.	Bog goldenrod	OBL	7
Symphyotrichum ciliolatum	(Lindl.) A.& D. Löve	Lindley's aster	N/A	1
Symphyotrichum lanceolatum var. *lanceolatum*	(Willd.) Nesom	White panicle aster	FACW	6
Balsaminaceae				
Impatiens capensis	Meerb.	Jewelweed	FACW	16
Betulaceae				
Alnus incana (L.) Moench ssp. *rugosa*	(Du Roi) Clausen	Speckled alder	OBL	34
Betula alleghaniensis	Britt.	Yellow birch	FAC	11
Betula papyrifera	Marsh.	Paper birch	FACU+	27
Betula pumila	L.	Bog birch	OBL	1
Corylus cornuta	Marsh.	Beaked hazelnut	UPL	1
Boraginaceae				
Myosotis scorpioides	L.	True forget-me-not	OBL	3
Brassicaceae				
Cardamine pensylvanica	Muhl. ex Willd.	Pennsylvania bittercress	FACW+	4
Cardamine pratensis	L.	Cuckoo flower	OBL	1
Rorippa palustris (L.) Bess. ssp. *hispida*	(Desv.) Jonsell	Hispid yellowcress	OBL	1
Bryaceae				
Bryum sp.	Hedw.	Bryum moss	OBL/FACW/ FAC	1
Cabombaceae				
Brasenia schreberi	J.F. Gmel	Watershield	OBL	5
Campanulaceae				
Campanula aparinoides	Pursh	Marsh bellflower	OBL	4
Caprifoliaceae				
Lonicera × *bella*	Zabel	Bell's honeysuckle	N/A	7
Viburnum opulus L. var. *americanum*	Ait.	American cranberrybush	FACW	1
Viburnum opulus var. *opulus*	L.	European cranberrybush	FACW	1
Caryophyllaceae				
Cerastium fontanum	Baumg.	Common mouse-ear chickweed	FACU	2
Ceratophyllaceae				
Ceratophyllum demersum	L.	Common coontail	OBL	1
Characeae				
Chara sp.	L.	Muskgrass	N/A	1
Clusiaceae				
Hypericum boreale	(Britt.) Bickn.	Northern St. Johnswort	OBL	3
Hypericum ellipticum	Hook.	Pale St. Johnswort	OBL	2
Hypericum majus	(Gray) Britt.	Large St. Johnswort	FACW	1
Hypericum punctatum	Lam.	Spotted St. Johnswort	FAC+	9
Triadenum fraseri	(Spach) Gleason	Fraser's marsh St. Johnswort	OBL	37

APPENDIX 2. Continued.

Scientific name	Author	Common name	Wetland Indicator	No. sites
Cornaceae				
Cornus canadensis	L.	Bunchberry	FAC	11
Cornus sericea	L.	Redosier dogwood	FACW	8
Cupressaceae				
Thuja occidentalis	L.	Arborvitae	FACW	5
Cyperaceae				
Carex bebbii	Olney ex Fern.	Bebb's sedge	OBL	4
Carex brunnescens	(Pers.) Poir.	Brownish sedge	FACW	14
Carex canescens	L.	Silvery sedge	OBL	6
Carex comosa	Boott	Longhair sedge	OBL	7
Carex crawfordii	Fern	Crawford's sedge	FAC+	3
Carex crinita	Lam.	Fringed sedge	FACW+	17
Carex echinata ssp. *echinata*	Murr.	Star sedge	OBL	24
Carex flava	L.	Yellow sedge	OBL	1
Carex hystericina	Muhl. ex Willd.	Bottlebrush sedge	OBL	1
Carex intumescens	Rudge	Greater bladder sedge	FACW+	5
Carex lacustris	Willd.	Hairy sedge	OBL	4
Carex lasiocarpa	Ehrh.	Woollyfruit sedge	OBL	7
Carex leptalea	Wahlenb.	Bristlystalked sedge	OBL	1
Carex magellanica Lam. ssp. *irrigua*	(Wahlenb.) Hultén	Boreal bog sedge	OBL	23
Carex oligosperma	Michx.	Fewseed sedge	OBL	13
Carex pauciflora	Lightf.	Fewflower sedge	OBL	8
Carex projecta	Mackenzie	Necklace sedge	FACW+	5
Carex pseudocyperus	L.	Cypresslike sedge	OBL	4
Carex retrorsa	Schwein.	Knotsheath sedge	OBL	11
Carex rostrata	Stokes	Beaked sedge	OBL	6
Carex scoparia	Schkuhr ex Willd.	Broom sedge	FACW	8
Carex stipata	Muhl. ex Willd.	Owlfruit sedge	OBL	10
Carex stricta	Lam.	Upright sedge	OBL	13
Carex trisperma	Dewey	Threeseeded sedge	OBL	23
Carex tuckermanii	Dewey	Tuckerman's sedge	OBL	1
Carex utriculata	Boott	Northwest Territory sedge	OBL	9
Carex vesicaria	L.	Blister sedge	OBL	1
Dulichium arundinaceum	(L.) Britt.	Threeway sedge	OBL	23
Eleocharis elliptica	Kunth	Elliptic spikerush	FACW	1
Eleocharis ovata	(Roth) Roemer & J.A. Schultes	Ovate spikerush	OBL	2
Eleocharis palustris	(L.) Roemer & J.A. Schultes	Common spikerush	OBL	3
Eriophorum tenellum	Nutt.	Fewnerved cottongrass	OBL	2
Eriophorum virginicum	L.	Tawny cottongrass	OBL	26
Rhynchospora alba	(L.) Vahl	White beaksedge	OBL	9
Schoenoplectus acutus	(Muhl. ex Bigelow) A.& D. Löve	Hardstem bulrush	OBL	1
Schoenoplectus tabernaemontani	(K.C. Gmel.) Palla	Softstem bulrush	OBL	2
Scirpus atrovirens	Willd.	Green bulrush	OBL	1
Scirpus cyperinus	(L.) Kunth	Woolgrass	OBL	35
Dennstaedtiaceae				
Pteridium aquilinum	(L.) Kuhn	Western brackenfern	FACU	9

APPENDIX 2. Continued.

Scientific name	Author	Common name	Wetland Indicator	No. sites
Droseraceae				
Drosera rotundifolia	L.	Roundleaf sundew	OBL	24
Dryopteridaceae				
Dryopteris carthusiana	(Vill.) H.P. Fuchs	Spinulose woodfern	FACW-	17
Dryopteris clintoniana	(D.C. Eat.) Dowell	Clinton's woodfern	FACW+	4
Dryopteris cristata	(L.) Gray	Crested woodfern	OBL	9
Dryopteris intermedia	(Muhl. ex Willd.) Gray	Intermediate woodfern	FAC	6
Dryopteris marginalis	(L.) Gray	Marginal woodfern	FACU	1
Onoclea sensibilis	L.	Sensitive fern	FACW	21
Equisetaceae				
Equisetum fluviatile	L.	Water horsetail	OBL	5
Equisetum sylvaticum	L.	Woodland horsetail	FACW	8
Ericaceae				
Andromeda polifolia L. var. *glaucophylla*	(Link) DC.	Bog rosemary	OBL	12
Chamaedaphne calyculata	(L.) Moench	Leatherleaf	OBL	38
Gaultheria hispidula	(L.) Muhl. ex Bigelow	Creeping snowberry	FACW	17
Gaultheria procumbens	L.	Eastern teaberry	FACU	6
Kalmia polifolia	Wangenh.	Bog laurel	OBL	18
Ledum groenlandicum	Oeder	Bog Labrador tea	OBL	29
Vaccinium macrocarpon	Ait	Cranberry	OBL	25
Vaccinium myrtilloides	Michx.	velvetleaf huckleberry	FACW-	30
Vaccinium oxycoccos	L.	Small cranberry	OBL	16
Grossulariaceae				
Ribes cynosbati	L.	Eastern prickly gooseberry	FACW	2
Ribes lacustre	(Pers.) Poir.	Prickly currant	OBL	3
Ribes triste	Pallas	Red currant	OBL	1
Hydrocharitaceae				
Elodea canadensis	Michx.	Canadian waterweed	OBL	1
Iridaceae				
Iris versicolor	L.	Blueflag iris	FACW+	27
Juncaceae				
Juncus articulatus	L.	Jointleaf rush	OBL	1
Juncus brevicaudatus	(Engelm.) Fern.	Narrowpanicle rush	OBL	7
Juncus canadensis	J. Gay ex Laharpe	Canadian rush	OBL	1
Juncus effusus	L.	Common rush	OBL	18
Juncus filiformis	L.	Thread rush	FACW	1
Juncus tenuis	Willd.	Poverty rush	FAC	2
Lamiaceae				
Clinopodium vulgare	L.	Wild basil	FACU	2
Galeopsis tetrahit	L.	Brittlestem hempnettle	FACU	4
Lycopus americanus	Muhl. ex W. Bart.	American water horehound	OBL	3
Lycopus uniflorus	Michx.	Northern bugleweed	OBL	4
Mentha arvensis	L.	Wild mint	FACW	5
Prunella vulgaris	L.	Common selfheal	FAC	1
Scutellaria galericulata	L.	Marsh scullcap	OBL	13
Scutellaria lateriflora	L.	Blue skullcap	OBL	13

APPENDIX 2. Continued.

Scientific name	Author	Common name	Wetland Indicator	No. sites
Lemnaceae				
Lemna minor	L.	Common duckweed	OBL	11
Spirodela polyrhiza	(L.) Schleiden	Giant duckweed	FACW	1
Lentibulariaceae				
Utricularia macrorhiza	Le Conte	Common bladderwort	OBL	4
Liliaceae				
Clintonia borealis	(Ait.) Raf.	Bluebead	FAC+	17
Maianthemum canadense	Desf.	Canada mayflower	FAC	26
Maianthemum racemosum	(L.) Link	Feathery false lily of the valley	FACU	1
Maianthemum trifolia	(L.) Sloboda	Threeleaf false lily of the valley	OBL	22
Polygonatum pubescens	(Willd.) Pursh	Hairy Solomon's seal	UPL	1
Trillium cernuum	L.	Whip-poor-will flower	FAC	2
Lycopodiaceae				
Lycopodium annotinum	L.	Stiff clubmoss	FAC	1
Lycopodium clavatum	L.	Running clubmoss	FAC	2
Lycopodium inundata	(L.) Holub	Inundated clubmoss	OBL	4
Lycopodium obscurum	L.	Rare clubmoss	FACU	5
Menyanthaceae				
Menyanthes trifoliata	L.	Buckbean	OBL	8
Monotropaceae				
Monotropa uniflora	L.	Indianpipe	FACU	1
Myricaceae				
Myrica gale	L.	Sweetgale	OBL	4
Nymphaeaceae				
Nuphar lutea	(L.) Sm.	Yellow pond-lily	OBL	7
Nymphaea odorata	Ait.	American white waterlily	OBL	3
Oleaceae				
Fraxinus nigra	Marsh.	Black ash	FACW+	4
Fraxinus pennsylvanica	Marsh.	Green ash	FACW	1
Onagraceae				
Circaea alpina	L.	Small enchanter's nightshade	FACW	2
Epilobium ciliatum	Raf.	Fringed willowherb	FACU	2
Epilobium leptophyllum	Raf.	Bog willowherb	OBL	17
Ludwigia palustris	(L.) Ell.	Marsh seedbox	OBL	3
Oenothera biennis	L.	Common evening-primrose	FACU	1
Ophioglossaceae				
Botrychium multifidum	(Gmel.) Trev.	Leathery grapefern	FACU	1
Botrychium virginianum	(L.) Sw.	Rattlesnake fern	FACU	1
Orchidaceae				
Cypripedium acaule	Ait.	Moccasin flower	FACW	1
Platanthera lacera	(Michx.) G. Don	Green fringed orchid	FACW	1
Pogonia ophioglossoides	(L.) Ker-Gawl.	Snakemouth orchid	OBL	3
Osmundaceae				
Osmunda cinnamomea	L.	Cinnamon fern	FACW	30
Osmunda claytoniana	L.	Interrupted fern	FAC+	1
Osmunda regalis	L.	Royal fern	OBL	5
Oxalidaceae				
Oxalis montana	Raf.	Mountain woodsorrel	FACU	5
Pinaceae				
Abies balsamea	(L.) P. Mill.	Balsam fir	FACW	18
Larix laricina	(Du Roi) K. Koch	Larch, tamarack	FACW	33

APPENDIX 2. Continued.

Scientific name	Author	Common name	Wetland Indicator	No. sites
Pinaceae (continued)				
Picea glauca	(Moench) Voss	White spruce	FACU	14
Picea mariana	(P. Mill.) B.S.P.	Black spruce	FACW	37
Pinus resinosa	Soland.	Red pine	FACU	3
Pinus strobus	L.	Eastern white pine	FACU	10
Tsuga canadensis	(L.) Carr.	Eastern hemlock	FACU	3
Poaceae				
Agrostis gigantea	Roth	Redtop	FACW	2
Agrostis hyemalis	(Walt.) B.S.P.	Winter bentgrass	FAC-	22
Agrostis perennans	(Walt.) Tuckerman	Upland bentgrass	FAC-	9
Anthoxanthum odoratum	L.	Sweet vernalgrass	FACU	1
Brachyelytrum erectum	(Schreb. ex Spreng.) Beauv.	Bearded shorthusk	?	6
Bromus ciliatus	L.	Fringed brome	FACW	3
Calamagrostis canadensis	(Michx.) Beauv.	Bluejoint grass	OBL	41
Cinna latifolia	(Trev. ex Goepp.) Griseb.	Drooping woodreed	FACW+	3
Elymus trachycaulus	(Link) Gould ex Shinners	Slender wheatgrass	FAC	1
Glyceria canadensis	(Michx.) Trin.	Rattlesnake-mannagrass	OBL	24
Glyceria grandis	S. Wats.	American mannagrass	OBL	4
Glyceria striata	(Lam.) A.S. Hitchc.	Fowl mannagrass	OBL	4
Leersia oryzoides	(L.) Sw.	Rice cutgrass	OBL	5
Phalaris arundinacea	L.	Reed canarygrass	FACW+	6
Phleum pratense	L.	Timothy	FACU	2
Poa palustris	L.	Fowl bluegrass	FACW+	4
Polygonaceae				
Polygonum amphibium	L.	Water knotweed	OBL	4
Polygonum convolvulus	L.	Black bindweed	FAC-	1
Polygonum hydropiperoides	Michx.	Swamp smartweed	OBL	1
Polygonum lapathifolium	L.	Curlytop knotweed	FACW+	2
Polygonum punctatum	Ell.	Dotted smartweed	OBL	4
Polygonum sagittatum	L.	Arrowleaf tearthumb	OBL	13
Rumex acetosella	L.	Common sheep sorrel	FAC	2
Rumex orbiculatus	Gray	Greater water dock	OBL	4
Polypodiaceae				
Polypodium virginianum	L.	Rock polypody	N/A	1
Polytrichaceae				
Polytrichum sp.	Hedw.	Polytrichum moss	N/A	34
Pontederiaceae				
Pontederia cordata	L.	Pickerelweed	OBL	3
Potomogetonaceae				
Potamogeton natans	L.	Floatingleaf pondweed	OBL	3
Primulaceae				
Lysimachia terrestris	(L.) B.S.P.	Earth loosestrife	OBL	8
Lysimachia thyrsiflora	L.	Tufted loosestrife	OBL	5
Trientalis borealis	Raf.	Starflower	FAC+	2
Pyrolaceae				
Moneses uniflora	(L.) A. Gray	Single delight	FAC	1
Pyrola chlorantha	Sw.	Greenflowered wintergreen	FACU	1

APPENDIX 2. Continued.

Scientific name	Author	Common name	Wetland Indicator	No. sites
Ranunculaceae				
Caltha palustris	L.	Marshmarigold	OBL	2
Clematis virginiana	L.	Devil's darning needles	FAC	3
Coptis trifolia	(L.) Salisb.	Threeleaf goldthread	FACW	14
Ranunculus pensylvanicus	L.f.	Pennsylvania buttercup	OBL	5
Ranunculus recurvatus	Poir.	Blisterwort	FACW	1
Thalictrum dioicum	L.	Early meadow-rue	FACU+	9
Rosaceae				
Amelanchier laevis	Wieg.	Allegheny serviceberry	FAC	2
Comarum palustre	L.	Purple marshlocks	OBL	17
Geum macrophyllum	Willd.	Largeleaf avens	FACW+	1
Photinia melanocarpa	(Michx.) Robertson & Phipps	Black chokeberry	FACW-	19
Potentilla norvegica	L.	Norwegian cinquefoil	FAC	4
Prunus nigra	Ait.	Canadian plum	FACU-	2
Prunus serotina	Ehrh.	Black cherry	FACU	22
Prunus virginiana	L.	Chokecherry	FAC-	3
Rubus sp.	L.	Blackberry	FAC-	26
Sorbus americana	(L.) Sudw.	American mountain ash	FAC+	1
Spiraea alba	DuRoi	White meadowsweet	FACW+	19
Spiraea tomentosa	L.	Steeplebush	FACW+	2
Rubiaceae				
Galium asprellum	Michx.	Rough bedstraw	OBL	10
Galium tinctorium	L.	Stiff march bedstraw	OBL	25
Galium trifidum	L.	Threepetal bedstraw	FACW+	11
Galium triflorum	Michx.	Fragrant bedstraw	FACU+	4
Salicaceae				
Populus tremuloides	Michx.	Quaking aspen	FAC	2
Salix bebbiana	Sarg.	Bebb willow	FACW+	2
Salix eriocephala	Michx.	Missouri River willow	FACW	1
Salix interior	Rowlee	Sandbar willow	OBL	5
Salix pedicellaris	Pursh	Bog willow	OBL	7
Sarraceniaceae				
Sarracenia purpurea	L.	Purple pitcherplant	OBL	13
Scheuchzeriaceae				
Scheuchzeria palustris	L.	Rannoch-rush	OBL	9
Scrophulariaceae				
Chelone glabra	L.	Turtlehead	OBL	8
Mimulus ringens	L.	Allegheny monkeyflower	OBL	8
Verbascum thapsus	L.	Common mullein	UPL	1
Veronica officinalis	L.	Common gypsyweed	UPL	3
Solanaceae				
Solanum dulcamara	L.	Climbing nightshade	FAC	5
Sparganiaceae				
Sparganium americanum	Nutt.	American bur-reed	OBL	2
Sparganium erectum L. ssp. *stoloniferum*	(Graebn.) Hara	Bur-reed	OBL	9
Sparganium eurycarpum	Engelm. ex Gray	Broadfruit bur-reed	OBL	1
Sphagnaceae				
Sphagnum sp.	L.	Sphagnum moss	OBL	40
Splachnaceae				
Splachnum ampullaceum	Hedw.	Small capsule dung moss	OBL	1

APPENDIX 2. Continued.

Scientific name	Author	Common name	Wetland Indicator	No. sites
Thelypteridaceae				
Phegopteris connectilis	(Michx.) Watt	Long beechfern	N/A	5
Thelypteris palustris Schott var. *pubescens*	(Lawson) Fern.	Eastern marsh fern	?	1
Typhaceae				
Typha latifolia	L.	Common cattail	OBL	20
Urticaceae				
Urtica dioica	L.	Stinging nettle	FACW	5
Verbenaceae				
Verbena hastata	L.	Swamp verbena	FACW+	4
Violaceae				
Viola macloskeyi	Lloyd	Small white violet	OBL	1
Viola renifolia	Gray	White violet	FACW	1
Viola rotundifolia	Michx.	Roundleaf yellow violet	FAC	3
Viola sororia	Willd.	Common blue violet	FAC-	
Vitaceae				
Parthenocissus inserta	(Kerner) Fritsch	Virginia creeper	FAC-	4