Evaluating the Relationship between Floristic Quality and Measures of Plant Biodiversity
in Riparian Habitats

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Abstract

A survey of plant biodiversity was performed along riparian habitats within an agricultural landscape in southeastern Ontario, Canada. The accuracy of several measures of plant biodiversity - including those related to a regional floristic quality assessment system - was examined to compare their ability to recognize a gradient of anthropogenic disturbance and associated floristic quality along the riparian habitats. The “% Non-Native Plant Species” measure was most effective at identifying the gradient, though it revealed nothing about the quality of native plant species at individual sites. The mean conservatism value associated with the floristic assessment system was also effective in identifying the gradient, and had the added benefit of considering the contribution of each native species in a plot. Total plant species richness, the simplest and most common floristic measure applied in the literature, proved to be a relatively poor indicator of the quality gradient.

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Introduction

Considerable debate still exists amongst ecologists as to what assessment tools should be employed to evaluate the health or conservation value of natural habitats. Assessment methods can not only quantify the structural and functional characteristics of a particular habitat, but also possibly provide relevant information on which conservation initiatives can be based. It is likely that no single method is universally useful in assessing the ecological or conservation status of natural habitats, and that the method of assessment used will often be dependent on the questions being asked. The success of biological conservation programs often hinges on the ability of researchers to recognize and isolate habitats in need of protection. In order to isolate habitats of interest, ecologists must formulate methods to classify or rank habitats on the basis of the quality or conservation importance of species found therein. A relative numeric representation of a habitat, or index, can be constructed from the values of one or more habitat elements. These elements can be biological or environmental, and as diverse as soil quality (Kang et al., 2005) and invertebrate count (Chadd and Extence, 2004). Researchers can also base their index on a conspicuous - and living - characteristic of most habitats: vegetation.

Floristic Quality, or the relative ecological importance of plant assemblages, is a very subjective term. For the purposes of this study, high floristic quality will be synonymous with plant assemblages composed of native plant species, habitat specialists, and disturbance-sensitive species. Low floristic quality will be synonymous with plant assemblages composed of non-native plant species, habitat generalists, and native species

associated with disturbed areas. Floristic quality can be expressed in a number of ways. Simple measurements such as plant species richness (Tracy and Sanderson, 2000; Fulbright, 2004), the number of non-native species present (Espinosa-Garcia et al., 2004), and the percent cover of plant types present (Desoyza et al., 2000; Fernandez-Gimenez and Allen-Diaz, 2001) can all be employed to characterize a habitat of interest. In addition, more complex and specific plant indices are now being developed that can also be used to quantify natural areas (Herman et al., 1997; DeKeyser et al., 2003). Considerable efforts have been made by botanists and ecologists to create and modify such indexes. However, few scientific studies have used them or tested their ability to recognize compositional gradients (but see Francis et al., 2000). It was the purpose of this study to test the applicability of both simple measurements and a more complex regional floristic assessment system in assessing floristic quality in riparian habitats within an agricultural landscape.

An agricultural landscape was chosen for this study because it is representative of the large scale habitat conversion that has occurred over the past 200 years in North America. In the last few centuries, regions once dominated by forests and wetlands have seen natural habitats significantly reduced due to agricultural intensification and the encroachment of urban sprawl (Boutin and Jobin, 1998). Remnant natural habitats in regions such as the St. Lawrence/Great Lakes lowlands of southern Ontario now consist of small woodlands, small grasslands, and various linear elements like hedgerows and riparian strips (Boutin et al., 2001). Vegetation found within these linear landscape elements in agricultural areas plays an important role in maintaining regional biodiversity (Geertsema et al., 2005), yet biodiversity within them is in decline due to a decrease in

the quality and quantity of habitat (Geertsema et al., 2002). These isolated and exposed plant populations are at risk from invasion by problematic weeds and opportunistic non-native species. They are also less likely to receive seeds from neighboring sources, which could contribute to a greater extinction risk (Geertsema et al., 2005).

The most prominent hydrological feature in an agricultural landscape is often a network of streams, which themselves are associated with adjacent terrestrial habitats. These riparian habitats are often used directly in agricultural activities (crop planting, animal grazing), and their exposed, linear nature makes them highly susceptible to external stressors brought about by anthropogenic disturbance in the surrounding landscape. Riparian areas are important from a conservation perspective because they can provide habitat for a wide range of species with differing adaptations (Nilsson and Svedmark, 2002). The physical characteristics of riparian areas can vary greatly in size and complexity (Smith, 1996), resulting in a complement of plant species that is distinct from the neighboring upland region (Boutin et al., 2003). It is generally agreed upon that the diversity of organisms of conservation value is generally higher in larger habitats, in habitats with increased interior area (those round or square in shape), and in areas left undisturbed by human activities (Boutin et al., 2001). Riparian zones in agricultural areas, then, are highly susceptible to the loss of high priority organisms because these zones are small, distributed far apart in the landscape, linear in shape, and highly influenced by human activities.

Conservation indices have been developed out of a desire to transform raw species richness data or environmental measurements into values that are more appropriate and applicable to habitat assessment. The scientific literature contains

several recent examples of the use of entire plant assemblages as a basis for ecological indices. Many of these studies involved the creation of an index through the use of multivariate statistical techniques such as cluster analysis or two-way indicator species analysis (TWINSPAN) (Holmes et al., 1998; Linton and Goulder, 2000; Dekeyser et al. 2003). Though many of these methods have appeared to be useful, they were rarely compared in their predictive ability to other, simpler measures of plant composition. This could result in complicated models being applied in situations where a simple measurement would have proved equally robust. Several other studies have focused instead on the creation of indexes through the more approachable method of aggregating quantitative measurements of plant assemblages (Salinas et al., 2000; Munne et al. 2003). These methods are often easy to comprehend and apply, but – due to a need to generalize and simplify - rarely incorporate the kind of species-specific information required by many conservation initiatives.

As an alternative to focusing on entire plant assemblages, some researchers have investigated the potential of specific species or functional groups as indicators of habitat composition or quality (Godefroid and Koedam, 2003; Duque et al., 2005). This method can be useful in summarizing the characteristics of a site from a single, easily identifiable element, but there remains a real potential for generalizations and the omission from assessment of unique site qualities. A clear question thus presents itself: Is there a useful plant-based method of habitat assessment that is simple to apply yet also addresses the entire plant species set of a study site? Regardless of whether individual species or functional groups are being used, Rolstad et al. (2002) required that such an indicator/index be sensitive to changes in the ecological/environmental factors being

studied and should be spatially and temporally predictable. Indicators/indices should also have the practical characteristic of being easier to recognize than the ecological/environmental factors of interest (Rolstad et al., 2002).

The Floristic Quality Assessment System for Southern Ontario

Wilhelm and Ladd first described the floristic quality assessment system in 1988 (Wilhelm and Ladd, 1988 in Francis et al., 2000). It was designed as a simple and repeatable method for assessing the relative significance of areas of land in terms of their floristic composition (Herman et al., 1997). The assessment system is based on the characteristics of a region's flora, and has been assembled under the assumption that native plant species vary in their allegiance to specific habitats and in their tolerance of environmental disturbance (Oldham et al., 1995). It was originally developed for use in the Chicago region, and has since been adapted for use in regions such as Michigan (Herman et al., 1997), northern Ohio (Andreas and Lichvar, 1995 in Francis et al., 2000), and southern Ontario (Francis et al., 2000). The Floristic Quality Assessment System for Southern Ontario - introduced in 1995 – remains the only such floristic quality assessment system available for a Canadian region. This Floristic Quality Assessment System is not a single calculated value such as the Shannon Diversity Index. Instead, it is a floristic classification system in which all vascular plants present in a particular region have been assigned conservatism, wetness, and weediness scores. These scores can then be used to calculate values associated with the plant assemblages of study plots.

The authors of Oldham et al. (1995) developed the Floristic Quality Assessment System for Southern Ontario. A vascular plant checklist was arranged for southern Ontario by combining several regional checklists, excluding rare interspecific hybrids and a few rare introduced species (Oldham et al., 1995). Each native species in the region was then assigned a coefficient of conservatism (CC) value ranging from 0 to 10

(whole numbers only). The term “conservatism” refers to the level of fidelity a plant species has to particular habitat conditions. Lower CC values were assigned to common native plant species that are generally disturbance tolerant and capable of growth and survival under a wide variety of ecological or environmental conditions. Higher CC values were assigned to native plant species that are disturbance sensitive and capable of growth and survival only under a specific set of ecological or environmental conditions. Figure 1 shows the distribution of all listed native species in the southern Ontario region by their assigned coefficient of conservatism values. CC values were assigned independently to all native species by each contributing author of Oldham et al. (1995) based on the three authors’ field experience in southern Ontario. Scores were discussed, and then a consensus was reached that was subsequently reviewed by external botanists familiar with the flora of the region (Oldham et al., 1995).

All non-native plants listed in the assessment system have been assigned an invasiveness value between –1 and –3 (integers only), referred to as a “weediness” score. A score of –1 was given to non-native plant species with little impact on natural areas, a score of –2 was given to non-native species that occasionally and infrequently cause problems, and a score of –3 was given to non-native species recognized as seriously problematic in southern Ontario (Oldham et al., 1995). (Note that a species assigned a weediness score is not necessarily a problem weed in agricultural areas). Weediness scores were assigned using a method similar to that used to assign the CC scores. In addition to the conservatism or weediness scores, a “wetness” score related to a plant’s moisture tolerance has been assigned to each species listed in the assessment system. These wetness scores are similar to those originally designed for use by the United States

fish and wildlife service in the Northeastern and North central United States (Oldham et al., 1995). Positive and negative signs (+, -) have been added to wetness scores in the index. A negative sign indicates that a particular species has a greater estimated probability of appearing in wet areas and a positive sign indicates that a particular species has a greater estimated probability of appearing in dry areas (Oldham et al., 1995). The degree to which a plant is partial to wetland or upland environments is expressed in the size of the wetness score, ranging from -5 (obligate wetland) to +5 (obligate upland). Again, only integers are used.

The calculated values generated using the index scores include the mean conservatism value (mCC) and the floristic quality index (FQI) value. The mean CC value is calculated by dividing the sum of the conservatism scores of all native plant species present in a given study block by the total number of native species present in that study block. It is a method of assessing floristic quality without addressing species richness. The FQI value is meant to move the mCC value a step further than by incorporating a measure of species richness. The FQI value is calculated by multiplying the mCC value generated for a study block by the square root of the total number of native species in that study block. A mean wetness value can also be calculated using the index scores by dividing the sum of the wetness scores of all plant species (native and non-native) in a given study block by the total number of species found in the study block. None of the index scores or calculated values has an abundance component and there is no set study plot size required for the use of any of these index-based values. The primary range of the Floristic Quality Assessment System for Southern Ontario encompasses the entire Southern Ontario Region found south of the Canadian Shield and

west of the point in which the shield dips southward to meet Lake Ontario. Results become increasingly less reliable the further outside this recommended zone a study block is situated (Oldham et al., 1995).

All research questions addressed in this study are more specific derivations of the following central question: How do several measures of plant composition differ in their ability to express a gradient of anthropogenic disturbance and associated floristic quality along riparian habitats in an agricultural landscape? From this central question we can postulate a subsidiary one: Are the values generated using a regional floristic quality assessment system more useful than traditional measures of plant composition (such as total species richness) in their ability to express a gradient of anthropogenic disturbance and associated floristic quality along riparian habitats in an agricultural landscape? It was hypothesized that variables measuring the plant composition of the riparian habitats will indeed differ in their ability to recognize the disturbance/quality gradient due to the fact that each examined variable addresses plant composition in a slightly different fashion. It was also hypothesized that values generated using the regional floristic quality index would be more useful than traditional plant composition measurements in recognizing the disturbance/quality gradient because the index is species-specific and based on individual qualitative scores.

The merits of this particular regional assessment system have been previously tested in southern Ontario woodlands and published in Francis et al. (2000). The 2000 study deemed the mean conservatism and wetness scores to be useful tools in the assessing natural areas while expressing doubt in the applicability of both the FQI value and the weediness scores. Our study, though applying the index in a similar fashion,

deviated from the methods and objectives of the 2000 paper in several ways. First, the disturbance/quality status of the riparian study sites in this study was chosen *a priori* as opposed to the disturbance classification done after site selection in the 2000 study. This *a priori* method allowed for equal sample numbers across quality categories. Second, our study incorporated several more measures of plant composition not directly related to the index (% plant types, proportion of natives and non-natives), expanding the focus of the study to a more inclusive overall examination of plant measures as they relate to habitat quality. Third, we employed multivariate statistical techniques to aid in the identification of plant compositional gradients.

Methodology

1. *Site Selection*

All sites chosen for this study were located in the southeastern Ontario region in the province of Ontario, Canada. This area is situated within an ecozone known as Mixed Wood Plains and an ecoregion known as the St. Lawrence lowlands. All chosen sites were positioned between latitudes 45 degrees north and 45.3 degrees north and longitudes 75 degrees east and 76.5 degrees east. Figure 2 is a map of southeastern Ontario, highlighting the region in which the chosen sites were located. Sites were all located slightly outside (northeastward of) the intended range of the Southern Ontario Floristic Quality Assessment System. Table 1 compares climate variables between the years 1981 and 2000 for the region of site selection (Ottawa), a city close to the northeastern border of the system's intended range (Peterborough), and a city located on the western edge of the intended range (Windsor). The region in which sites were chosen was similar to the city on the eastern edge of the intended range in terms of such climate variables as daily average temperature, number of days with specific maximum temperatures, number of days with specific minimum temperatures, and several measures associated with degree days (source: Environment Canada). Moreover, there were greater differences in these climate variables between areas near the eastern (Peterborough) and western (Windsor) boundaries of the intended range than between the region in which sites were chosen and areas toward the eastern edge of the intended

range. Finally, all chosen sites were located in the same ecozone encompassing the intended range of the assessment system.

ARCview, a GIS-based computer application, was used to locate riparian sites in the Ottawa region exhibiting the following general characteristics:

- a) The presence of a meandering stream of low order. Low order streams were chosen because they were most prevalent in the landscape.
- b) The presence of agricultural pastureland which the stream either runs through or runs adjacent to. Pastureland was chosen because cash crop agriculture is often associated with heavy pesticide use and the channelization of natural streams.
- c) The presence of a naturally occurring treed or forested area up or downstream from the pastureland.
- d) The absence of habitat heavily modified by humans (wide roads, buildings) directly adjacent to the stream between the pastureland and the treed area.
- e) The absence of agricultural crop production directly adjacent to the stream between the pastureland and the treed area so that heavy modification was not occurring in those riparian habitats that were spatially removed from the pasture area.

Data layers used with the ARCview program were obtained from landscape information compiled by the Ontario Ministry of Natural Resources. All possible research sites identified through ARCview (approximately 90) were visited in late spring

2004 to determine whether they were usable in the study. On-site criteria for final site selection were as follows: the stream channel had not recently been artificially straightened, the width of the stream was consistent from the pastureland into the treed/forested area, and the slope of the stream bank was consistent from the pastureland into the treed/forested area. Limiting selection to only identical stream widths and bank slopes across all sites would have eliminated too many sites from consideration. The criteria chosen still maintained an identical suite of stream widths and bank slopes between zone categories (see *Field Methods* sub-section). Twenty-seven of the 90 visited sites fit the final selection criteria.

All chosen stream sections (sites) were located at least 1 km from each other. Direction of stream flow (pasture-to-forest or forest-to-pasture) was not kept consistent through all 27 sites because choosing a single flow direction would have eliminated too many sites from consideration. The open nature of these stream systems and riparian habitats would have made the influence of stream flow on plant composition difficult to determine. An attempt was made to select sites so that they were all situated in areas associated with the same broad-scale soil category. However, due to the regional spread of appropriate sites, the 27 selected sites fell into three broad-scale soil categories (melanic brunisolic, gleysolic, and humo-feric podzolic). Even though broad-scale soil patterns were not consistent between all sites, soil categories remained consistent within sites (stream sections) and, hence, consistent between zones at a site.

2. *Field Methods*

Each of the 27 sites was visited twice during late spring and summer of 2004. The first visit was made from late May to the end of June. The second visit was made during the month of August. Separate visits were made in order to identify both early and late flowering plants. Data were collected from three zones located along each section of stream; a “disturbed” zone, a “moderate” zone, and a “pristine” zone (Figure 3). This resulted in three zones per site and 81 zones in total (27 sites x 3). Zones were not placed at positions along the stream bank devoid of plant growth (rocky areas, bare soil). Zones were also not placed at positioned completely dominated by a single woody or herbaceous species (to avoid homogeneous plant assemblages). All attempts were made to ensure that land use and habitat types in the area surrounding the selected stream sections remained similar between all 27 sites. However, due to both the extensive distance between the zones at some sites and the natural variability between landscapes, the particular characteristics of some of the sites varied slightly from the strict definitions provided here. Appendix A provides descriptions of the disturbed, moderate, and pristine zones of each of the 27 sites. It should be noted that types of spatial and temporal disturbance distinguishing the three zone types were anthropogenic in nature.

The disturbed zone was located along the stream as close to the pastureland as access made possible, positioned either just outside the fenceline of the pasture or within the fenceline at a location showing no evidence of intensive grazing. This zone could be characterized as an open area on agricultural/recreational property, highly modified by human activities associated with maintaining large animals. Agricultural activity was

currently taking place around the disturbed zone at the time of survey. The disturbed zone had not likely been subject to high levels of herbicide and fertilizer input but had been changed considerably from pre-settlement conditions. The pristine zone was located either just within the undisturbed treed/forested area (when the canopy was open or broken) or on the edge of the undisturbed treed/forested area (when the canopy was completely closed), or as close to those points as access allowed. This zone could be characterized as being spatially separated from the highly impacted disturbed zone and not directly bordering any type of highly altered habitat (such as agricultural production or road/residential development). It is unlikely that agricultural activity has taken place in the pristine areas at any time in the recent past. The moderate zone was located at the approximate mid-point along the stream between the disturbed and pristine zones, or as close to that point as access allowed. The moderate zone was not positioned directly adjacent to any land being used in current agricultural activity. However, the moderate zone was not as spatially separated from the highly impacted disturbed zone and was often surrounded by old/abandoned field habitat. This means that agricultural activity could have been occurring around the moderate zones in the recent past. The total distance along the stream between the end of the disturbed zone and the beginning of the pristine zone varied from 50 to 300 metres (see Appendix A). These approximate distances were obtained using a measuring tool in the ARCview program.

Data were collected from two parallel transects in each zone. Each transect had the same dimensions; 15 m parallel to the stream length and 1 m perpendicular to the stream length. These transects resulted in a 15x1 metre strip of study area directly adjacent to the water edge as it existed at the time of the early summer survey (or the

closest position to the stream where vegetation existed) and a similar strip of study area further up the bank (Figure 4). The transects were placed so that there was usually 1.5 m between the borders of the bank and upland transect sets. This length was reduced to 1 m when the bank area was thin (less than approximately 5 m) and expanded to 2 m when the bank area was wide (greater than approximately 12 m).

Each transect was measured out by running a 15 metre section of string parallel to the stream length at a position that was the centre of the transect width. The 15 m length was then divided into three 5 m sub-transects. Every plant species located within the 0.5 m area on either side of the string was recorded for each separate 5 m sub-section of each transect. No time limit was given to the plant inventory of each zone. Floating or emergent vegetation in the stream channel were not included in the survey. After the survey of each zone during the first (early summer) survey period, a wooden stake topped with flagging tape was placed at the beginning point of both the bank and upland transects so that sets of transects could again be located during the late summer survey period. New plants identified in transects during the late summer survey were simply added to the inventories generated during the early summer survey. Gleason and Cronquist's *Vascular Plants of Eastern North America* (1991) was treated as the definitive plant identification authority. Other guides used included *Trees in Canada* (Farrar, 1995), *Shrubs of Ontario* (Soper and Heimbürger, 1982), *Aquatic and wetland plants of northeastern North America* (Crow and Hellquist, 2000), and various field identification manuals.

3. *Data Analysis*

Species presence/absence data for each of the six sub-transect in a zone were pooled to create a single list of identified species per zone. Each plant species found in a zone was assigned an “occurrence” value between 1 and 6 corresponding to the number of sub-transects in which it appeared. Measures associated with the Floristic Quality Assessment System (Oldham et al., 1995) were calculated for each separate zone using the field inventories (see table 2 for definitions of measures). In addition, a series of general descriptive values were calculated for each zone (see table 2 for definitions). Only plant species identified to the species level were used in analysis. Three specimens brought back to the lab could only be identified to genus.

In order to test for independence between the plant composition of zones at a site, a series of regressions were performed comparing the distance between the disturbed and pristine zones of sites and the amount of change in each zone variable listed in table 1 (Appendix B presents this analysis). Detrended Correspondence Analysis (or DCA) was employed to position all zones in an ordination space using the “occurrence” values of all species (native and non-native) present in each zone. DCA is a form of multivariate ordination in which study plots are arranged along multiple axes. The central concept of this type of analysis is that species composition changes across an environmental or historical gradient (McCune and Grace, 2002). The distance between study plots in ordination space is proportional to the dissimilarity between those plots in terms of species composition (McCune and Grace, 2002). Thus, those species not appearing in a zone were assigned value of zero in the DCA spreadsheet. This zero is not a missing

value, but instead an “occurrence” value incorporated into the DCA analysis. One-way ANOVA tests using type III sums of squares were performed to determine whether there was a significant difference between the positioning of the zones types in relation to the DCA axes. The Tukey’s post hoc test was used to distinguish significant results between the zone types. Appropriate transformations were performed when data did not meet the assumptions of normality and homogeneity of variance.

The PC-ORD program was also used to determine the variance explained by each ordination axis. DCA eigenvalues cannot be interpreted as proportions of variance explained due to the processes of re-scaling and detrending (McCune et al., 1999). Instead, proportion of variance explained was determined by observing the coefficient of determination between Relative Euclidean distance in the unreduced species space and Euclidean distance in the ordination space (McCune et al., 1999). A series of simple linear correlations were performed between the “occurrence” values of all species and the position of zones along the ordination axes. The mean zone positions along the ordination axes, the variance explained by the axes, and the relationship between individual species and axis position were all used to determine whether ordination axes were expressing the gradient of disturbance and habitat quality present along the riparian sites.

A series of regressions were performed between the zone variables (measurements listed in table 2) calculated for each zone and the positioning of those zones along the ordination axes. Again, appropriate transformations were performed when data did not meet the assumptions of normality and homogeneity of variance. The regressions were performed in order to develop a best-fit model (and an R^2 value) for the

relationship between each zone variable and the position of the zones along the appropriate gradient axis. The models could then be ranked by the amount of variance they explained in the distribution of zones along the gradient axis. All one-way ANOVA and Regression analysis was performed using MINITAB statistical software (release 2).

Results

Two hundred and seventy-one vascular plant species were identified in the 81 zones surveyed: 191 (or 70.5 %) of those species were native to southern Ontario, while 80 (or 29.5 %) of the species were non-natives. Sixty-five of the 271 species were identified in only one zone. The breakdown of species by plant type was as follows: 150 broadleaf herbs (forbs), 26 shrubs, 49 thin-leaved herbs (grasses, sedges, and rushes), 15 ferns and fern allies, 21 trees, and 10 species of climbers with both woody and herbaceous parts. Fifty short-lived (annual or biennial) and 221 long-lived (perennial) species were found during the survey. A summary of identified species as separated by the three zone types can be found in Table 3. Figure 5 compares the relationship between native and non-native richness in zones. There appears to be no significant linear relationship between the two measures when zone type is controlled for, though native species increase and non-natives species decrease as zone type changes from disturbed to pristine. Table 4 shows the 20 most common species identified during the survey ranked by the number of zones in which they were found. A list of identified species along with their common names, scientific authorities, associated index scores, and other raw information can be found in appendix C.

All identified plant species were listed in the Floristic Quality Assessment System for Southern Ontario. Figure 6 shows the distribution of the native species identified during the surveys as separated by the CC scores assigned in the Floristic Quality Assessment System. This observed distribution peaks in the mid-range of CC values, a result that is not unexpected given that sampling was done across a gradient of habitats expressing varying degrees of disturbance and floristic quality. The Floristic Quality

Assessment System manual describes species with CC values of 7-8 as taxa associated with plant communities that have undergone only minor disturbance, while describing species with CC values of 9-10 as having a high degree of fidelity to a narrow range of ecological parameters (Oldham et al., 1995). Table 5 lists the 25 species identified during the survey that had been assigned CC values of 7 or greater. The list is dominated by obligate and facultative wetland species as indicated by the negative wetness values. Figure 7 shows the distribution of all species identified during the surveys as separated by the wetness scores assigned in the Floristic Quality Assessment System. Again, this distribution is not unexpected given that riparian habitats can contain plant species from a wide variety of ecological (and hydrological) niches (Nilsson and Svedmark, 2002). Numbers seem to peak at the extreme values (5, -5) and the intermediate values (-3, 0, 3). This observed distribution could be picking up a limitation of the assignment process; species may have first been considered for the extreme or central wetness values, then assigned to the intermediate numbers if those more general values did not quite match with the characteristics of the species. Of the 80 non-native species identified, 46 (57.5 %) were assigned a weediness value of -1, 23 (28.8 %) were assigned a value of -2, and 11 (13.8 %) were assigned a value of -3.

The results of the independence test in appendix B (comparing the distance between the disturbed and pristine zones of sites and the amount of change in each zone variable listed in table 2) show that the distance between the disturbed and pristine zones was not having a significant effect of the degree to which the values of variables changed between the two zones. This provides evidence that the zones along each riparian site were independent of each other in terms of plant species composition because similarities

in plant composition would likely translate into similarities in the variables being measured. A significant model (at 95% confidence) could only be fit to one of the 17 regressions performed. The “Sum of Weediness Values” model was barely significant ($p = 0.044$) and still resulted in a low R-squared value (0.152). It is a relationship that could be coincidental, considering none of the other variables associated with non-native species led to a significant model.

The DCA analysis was performed in which the “occurrence” values of all species present were used to position the zones in ordination space. The analysis was performed using default scaling protocol in the PC-ORD program and with rare species (those occurring with less than 20% the frequency of the most common species) down-weighted in the analysis. Figure 8 shows the positioning of the 81 zones along ordination axes 1 and 2, with symbols denoting the *a priori* designated disturbed, moderate, and pristine zones. Using relative Euclidean distance measures, it was determined that ordination axis 1 explained 45.7 % of the variation in the zone positioning ($R^2 = 0.457$), ordination axis 2 explained 16.3 % of the variation in positioning ($R^2 = 0.163$), and ordination axis 3 explained 4.6 % of the variation in positioning ($R^2 = 0.046$). The large black symbols in figure 8 show the mean position of each zone type and the corresponding standard error in the planes of axes 1 and 2.

As described in the methodology and in appendix A, some disturbed zones were located outside the fenceline of the pasture while others were located within the fenceline. Analysis of the positioning of the disturbed zones along ordination axes one and two showed that there was no significant difference between the mean positioning of the 10 in-pasture disturbed zones and the 17 outside-pasture disturbed zones along both

axis one (Kruskal-Wallis, $df = 1$, $H < 0.01$, $p = 0.96$) and axis two (Kruskal-Wallis, $df = 1$, $H = 0.06$, $p = 0.802$) of the ordination. This shows that there was not a significant overall difference in plant species composition between the in-pasture and outside-pasture disturbed zones. The methodology and appendix A also describe some pristine zones as being within or surrounded by treed or forested habitat while other pristine zones were in old field habitat directly adjacent to the treed or forested area. Analysis of the positioning of the pristine zones along the ordination axes showed that there was a significant difference between the mean positioning of the eight zones located outside the treed area and the 19 zones surrounded by treed habitat along ordination axis one (Kruskal-Wallis, $df = 1$, $H = 16.29$, $p < 0.001$). The eight pristine zones located outside treed areas were also the eight pristine zones with the lowest axis values along ordination axis one. This suggests that these eight pristine zones were misclassified, and were actually closer in definition and plant species composition to the zones classified as moderate.

One-way ANOVA tests were performed to determine whether there were significant differences in the positioning of disturbed, moderate, and pristine zones along ordination axes 1 and 2. This analysis showed a significant difference between the positioning of zone types along ordination axis 1 ($F = 43.04$, $df = 2$, $p < 0.001$). A Tukey's post-hoc test determined that significant differences in positioning occurred between all three zone types. Additional analysis showed that there was no significant difference between the positioning of zone types along ordination axis 2 ($F = 1.06$, $df = 2$, $p = 0.351$). The significant differences along axis 1, along with the order mean zone positions along that axis (disturbed-moderate-pristine), suggests that ordination axis 1

may be expressing the gradient of disturbance/habitat quality present along the surveyed riparian sites.

Simple linear correlations were performed between the positioning of zones along a particular ordination axis and the “occurrence” values of individual species associated with those zones in order to explore the contribution of individual species to the positioning of the zones along axes 1 and 2. Table 6 lists the 13 species with the strongest significant positive correlation with ordination axis 1 and the 14 species with the strongest significant negative correlation with the same axis. Species strongly correlated with the left side of the axis (negative correlation) were generally associated with open disturbed habitats. They were mainly non-native upland herbs (*Viccia cracca*, *Chrysanthemum leucanthemum*, *Cirsium vulgare*), problematic invasives (*Taraxacum officinale*, *Lythrum salicaria*), and native species associated with highly disturbed habitats (*Poa compressa*, *Ambrosia artemisiifolia*). Species strongly correlated with the right side of the axis (positive correlation) were generally associated with habitats of moderate to low disturbance. They were mainly native herbs common to wet habitats (*Impatiens capensis*, *Boehmeria cylindrica*, *Pilea pumila*), native ferns (*Onoclea sensibilis*, *Matteuccia struthiopteris*, *Athyrium filix-femina*), and shade-tolerant species associated with wooded habitats (*Thalictrum dioicum*, *Urtica dioica*, *Amphicarpaea bracteata*). These correlations are consistent with the zone positions along ordination axis 1, providing additional evidence that axis 1 is expressing the gradient of disturbance/habitat quality present along the surveyed riparian sites. Species correlations were not as distinct along axis 2. Table 7 lists the 14 species with the strongest significant positive correlation with ordination axis 2 and the 9 species with the strongest

significant negative correlation with the same axis. Species strongly correlated with the bottom of the axis (negative correlation) were a mix of native herbs (*Bidens frondosa*, *Xanthium italicum*) and non-native upland species associated with disturbed habitats (*Bromus inermis*, *Artemisia vulgaris*). Species strongly correlated with the top of the axis (positive correlation) were mainly native herbs associated with moist soil and wet habitats.

The effects of a variable or environmental gradient are rarely represented exclusively along a single ordination axis (Greig-Smith, 1983). However, the pattern of mean zone positions (Figure 8) along with the variance explained by the axes and the correlations of species with the axes strongly suggest that the gradient of disturbance and habitat quality present along the riparian sites is being expressed primarily along ordination axis 1. Table 8 ranks the 17 zone variables by the R^2 values generated by the 17 regression models comparing the each variable to the positioning of zones along ordination axis 1. The “% Non-Native Species” model explained the most variation in the zone distribution along the axis 1 gradient ($R^2 = 0.723$). Floristic Quality Assessment System values ranked high as well, particularly the modified index variable “% CC Scores 4-10” ($R^2 = 0.653$). Figure 9 compares three of the higher-ranking regression models: “Mean CC Value”, “FQI Value”, and “% Non-Native Species”. The index variables “mean CC value” and “FQI value” have very similar distributions despite the fact that the FQI value incorporates a measure of native species richness. The simple, commonly used composition measure of “Total Species Richness” ranked lower than not only the index variables but also the richness component variables of “Number of Native Species” and “Number of Non-Native Species”. Figure 10 compares the species

richness, native species richness, and non-native richness regression models. Note that both total and native species richness appear to peak at the midpoint of the axis (the moderate zone of the gradient) while the non-native species richness remains relatively steady through the central portion of axis 1.

Discussion

It was hypothesized that variables measuring the plant composition of a habitat would differ in their ability to recognize the disturbance/quality gradient of the study sites due to the fact that each variable addressed plant composition in a slightly different fashion. Results show that the 17 measures of plant composition (Table 2) did differ greatly in their ability to explain the variation in plant composition along the quality gradient represented by ordination axis 1. The high ranking “% Non-Native Species” and “Number of Non-Native Species” models suggest that habitat invasibility was a key component of the gradient along the riparian sites, and that invasibility was much higher at positions closer to the pasture (disturbed zone) and lower towards the “pristine” area. Evidence in the literature does show that riparian zones may be more heavily invaded by non-native plants than nearby upland sites (Stohlgren et al., 2002). Though not all non-native species can be considered invasive, many have life history characteristics beneficial to the colonization of disturbed sites (Cronk and Fuller, 2001). In addition, non-native species are more likely to be introduced to a habitat at points where human activity is greatest (Rejmanek, 1996; Jaeger, 2000). These easy-to-calculate measures (“% Non-Native Species” and “Number of Non-Native Species”) are most useful as a simple way to accurately identify the presence of a disturbance or floristic quality gradient along a riparian corridor. However, they tell us nothing directly about the quality or conservation value of the native plant species present in individual plots.

The relatively low ranking of the “Total Species Richness” model (12th of 17) – though not overly surprising from a theoretical standpoint – was nonetheless alarming given the fact that basic species richness is the most widely used measure of plant

composition in the literature (Tracy and Sanderson, 2000; Collins et al., 2002; Cousins and Eriksson, 2002; Cornwell and Grub, 2003; Fulbright, 2004; etc.). It sheds doubt on the faith so many researchers seem to have in richness measurements as an appropriate method of habitat assessment. The lack of pattern in the relationship between native and non-native species richness when controlling for zone type (see figure 5) is not unexpected given the amount of contradictory evidence appearing in the literature. Many field studies have shown a positive relationship between native and non-native richness (Kalkhan and Stohlgren, 2000; Stohlgren et al., 2002; Espinosa-Garcia et al., 2004) while some experimental studies have shown a negative relationship between those two types of richness (Tilman, 1999; Naeem et al, 2000). Studies have also shown that the relationship between native and non-native richness can be scale-dependant (Stohlgren et al., 1998; Knight and Reich, 2005)

The curved shape of the “Total Species Richness” model (Figure 10) appears to be expressing a pattern predicted by the intermediate disturbance hypothesis. It is a theory stating that the most diverse habitats are those subject to disturbance levels somewhere in the middle of the possible range of disturbance strengths (Smith, 1996; Cotgreave and Forseth, 2002). The quadratic nature of the “Total Species Richness” model limits its practical usefulness because for every richness measurement there are two associated site positions along the quality gradient. To distinguish between these two positions, additional information must be provided. Specifically, species composition at the two positions must be indicative of specific points along the gradient. This means that additional information is always required if using the “Total Species Richness” model to classify riparian habitats. The raw nature of this measurement is problematic as

well. The “Total Species Richness” measure is numerical but not proportional, meaning that - taken alone - it is a raw value with no comparative meaning. Contrast this with the mCC value and measures based on percent composition, which associate the recorded value with a maximum value (42% compared to a maximum 100%, an mCC value of 3.7 compared to a maximum of 10, etc.). Measures that are purely numerical like “Total Species Richness” require a series of similar sites to be evaluated so that raw measures can be compared to an observed distribution. A single isolated site, on the other hand, can be evaluated by looking at a calculated mCC value because comparative meaning is built into the measurement

The high ranking of many of the models related to the Floristic Quality Assessment System for Southern Ontario provides evidence as to the usefulness of such quantitative-qualitative measurements in assessing riparian plant assemblages. The “FQI value” model ranked slightly lower than the “mCC” model despite fact that the FQI value is supposed to improve on the mCC value by factoring in the number of native species in a sample (Oldham et al., 1995). This weaker performance by the FQI value agrees with the findings of Francis et al. (2000), a study that found the value to be an inaccurate measurement tool. In this case, the extra term in the calculation of the FQI value may have been adding another source of variance to the model and actually decreasing its predictive accuracy.

It was hypothesized that the regional floristic quality assessment system would be more useful than traditional plant composition measurements in recognizing the disturbance/quality gradient because the index is species-specific and based on individual qualitative scores. Though ranked slightly lower than the simple “% Non-Native

Species” model, both the “mCC” and “FQI” models are in their nature closer to the idea of floristic quality because they are based on scores that consider the disturbance sensitivity and habitat specificity of each individual native species. “% CC Scores 4-10” was the highest ranking index-based model (2nd of 17). Unlike the mCC and FQI values, this measure was not influenced by the inclusion of very low conservatism species (CC values 0-3). Instead, it may be more accurately expressing a plant composition gradient across which higher conservatism species have a considerable influence on zone positioning. This measure would be most useful in assessing habitats when the conservation plan puts priority on sites containing high proportions of rare or sensitive species.

Interestingly, the “Sum of Weediness Scores” model did not follow the same negative linear shape of the “Number of Non-Native Species” model with which it shares half its information. This suggests that the assigned weediness values were likely responsible for the curved shape of the model, a logical conclusion if one considers that the most extreme weediness value (-3) was assigned not to common non-native species found exclusively in highly disturbed sites but instead to common problematic species such as *Lythrum salicaria* and *Aliaria petiolata* that are capable of invading habitats of moderate to pristine quality (Piper, 1996; Drayton and Primack, 1999). The “Sum of Weediness Scores” model may have been picking up the influence of these pristine invaders at moderate (middle) positions along the gradient axis. As with total species richness, this model is somewhat limited in usefulness by its quadratic shape and non-proportional nature (represented by a raw number rather than a percentage).

There are two factors likely responsible for the moderate ranking and negative slope of the “Mean Wetness Value” model. First, wetland species - particularly those that are habitat specialists - are less likely to prosper in highly disturbed habitats (Otte, 2001) such as those present at the left side of the axis gradient. Second, the presence of more woody vegetation towards the pristine zones and the absence of the same vegetation at the disturbed zones was resulting in slight microclimate and soil moisture differences along the gradient axis (greater evaporation at open sites, more water retention at shaded sites) and a gradient of environmental wetness that was being expressed in the mean wetness values. This model is less useful as a predictor of floristic quality because the wetness scores have been assigned independently of the conservatism scores, so mean wetness values are not necessarily expressing the quality of site plant composition. The “Mean Wetness Value” measure will instead be useful in delineating wetland boundaries or in providing an indirect measure of soil wetness.

In their role as indicators of the quality gradient, specific types of plants proved less useful than the index and native/non-native models and may only be applicable in assessment situations where a specific plant group is the focus of conservation efforts. This may be why broad-scale percent cover of plant types is used in the literature (Desoyza et al., 2000; Fernandez-Gimenez and Allen-Diaz, 2001) instead of plant type proportions of total richness. These measures were also likely biased by the zone selection criteria. Two factors could be leading to the positive “% Ferns and Allies” model along the gradient. First, fern species are – due to their physiological characteristics - more prone to occur in the kind of specialized habitats (Wild and Gagnon, 2005) unlikely to be found on the left side of the axis gradient. Secondly, many

of the identified fern species tend to prosper in shaded environments (Gleason and Cronquist, 1991), conditions that were probably more common on the right side of the gradient axis towards the semi-treed area. The lack of woody vegetation near the disturbed zones and the increased amount of woody vegetation near the pristine zones is likely what resulted in the significant positive regression models for “% Shrubs” and “% Trees”. The significant (but weak) negative models for “% Broadleaf Herbs” and “% Thin-Leafed Herbs” were likely a result of two factors. First, the increase in woody vegetation towards the pristine zones (right side of the axis gradient) could have been creating low-level canopy detrimental to the spatial and light requirements of some herbaceous species (Raven et al., 1999). Second, there was a strong negative gradient of non-native species between the left and right sides of axis 1 and, as visible in the list of identified species presented in appendix C, most of the non-native species identified during the surveys were herbaceous in form.

The relatively strong linear models built from Southern Ontario Floristic Quality Assessment System measurements (particularly those associated with “mCC” and “% CC Scores 4-10”) show that some components of the assessment system are indeed a useful tool for habitat classification. However, there are several limitations that should be considered when applying the index to any ecological study. Firstly, plant classifications can differ between taxonomic authorities. For example, *Poa compressa* and *Poa pratensis* are listed in the index as native species (with CC values of 0) but are widely classified as being non-native. Such scoring discrepancies could have strong effects on calculated index values when the species in question are common in some study plots while absent in others. Over time, new non-native species can be introduced to a region,

the taxonomic classification of species can change, and some native species may have their conservation status modified. As a result, the assessment system must be updated frequently in order to remain relevant to the perpetually changing ecology of a region. The system does not present a method for incorporating all species (native and non-native) into the calculation of core index values, making the mCC and FQI values incomplete in terms of describing the entire plant complement of a site. This is particularly an issue when considering disturbed habitats containing a high proportion of non-native plants. Unfortunately, there is insufficient variation in the range of weediness scores (only 3 numbers) to make a “Mean Weediness Value” a useful measure to accompany mCC.

As with any aggregate measurement value, the mean coefficient of conservatism and FQI values tend to hide the influence of component measurements (Francis et al., 2000). There is no indication, for example, as to whether a high FQI value is the result of a high mCC value, a high square-root species richness, or high values of both measures. The mCC values may also hide the influence of very rare or very common species at study sites. For instance, the influence of native species with moderate to high conservatism scores on the mCC value (and associated FQI value) of a site will become diluted by the presence of native species with low conservatism scores (such as *Poa pratensis* and *Oxalis stricta*) at the same site. This would lead to moderate mCC values even in the presence of high conservatism species, and add a sort of “evening” effect to the mCC and FQI models. The FQI value, with its extra square-root term in calculations, may ultimately be a useful alternative to mCC only in studies with few species per site or situations where sites with high species richness are being compared to those with very

low species richness. This is due in part to the mathematical nature of the “Species Richness” component of the FQI value, in which the differences between the square roots of small integers (3, 4, 5...) are greater than the differences between the square roots of larger integers (51, 52, 53...). This means that the “square-root native species richness” term has, proportionally, a greater effect on the overall FQI values when native species richness is small.

Anthropogenic modification and disturbance are pervasive factors in an agricultural landscape (Boutin and Jobin, 1998; Boutin et al., 2001) and are likely guiding the plant species composition of all natural habitats therein. Hence, the gradient analyzed in this study is likely skewed towards the highly disturbed end of the quality spectrum (compare figure 6 to figure 1), with disturbed zones representing an intensely modified type of habitat and pristine zones only partially separated in influence and proximity from intense human interference. Despite this, the results of this study suggest that these riparian habitats should not be viewed as waste places or subordinate habitats. Figure 6 shows that even with inventories being taken in some highly disturbed sites, “5” was the most common CC score occurring on the pooled species list. The observed distribution of CC scores was still skewed towards the low end values when compared to the distribution of all native species in the region (Figure 1), though the index is likely top-loaded with many extremely uncommon native species listed due to only a few recorded occurrences. Nonetheless, several of the identified species had high conservatism values (Table 4), and most of these high-scoring species were obligate wetland plants. This suggests that semi-disturbed riparian areas are still playing a role in supporting specialized wet-area species, a role once assigned primarily to large intact wetlands found

throughout pre-settlement Ontario (Boutin and Jobin, 1998). Figure 7 supports this idea of riparian areas as wetland surrogates, showing that many of the identified species fit into obligate or facultative wetness categories.

Two of the 271 identified species are listed as species at risk by the committee on the status of endangered wildlife in Canada: *Morus rubra* (CC = 10) is listed as endangered in Ontario while *Rosa setigera* (CC = 5) is listed in the “Special Concern” category for Ontario. Several of the highest scoring identified species (including *Morus rubra*) were found exclusively in the pristine zones (table 5). These pristine zones in turn were usually associated with areas bordering the woodlots and forested patches located between intensive agricultural activity. These forested areas probably exhibit habitat characteristics closer in nature to the expansive intact forests once associated with pristine wetlands in the region. Protection of natural wooded areas would seem to be a key component for the conservation of wetland species in this type of highly modified landscape (Houlahan and Findlay, 2004). However, areas directly adjacent to pastureland should not necessarily be exempted from conservation initiatives; high scoring wetland species *Carex muskingumensis*, *Equisetum pratense*, and *Juncus filiformis* were still identified in these greatly modified habitats. Overall, proximity to agricultural activity appears to have a negative effect on the floristic quality at a riparian site. This effect, however, seems to be dependant on the positioning of landscape elements relative to each other.

Several conclusions concerning the assessment of plant composition in riparian habitats can be made from the results of this study. The measures of “% Non-Native Species” or “% Native Species” (inverses of each other), “mCC value”, and “% CC

scores 4-10” seem most useful at expressing the overall quality/disturbance gradient along riparian strips. However, the “mCC value” and “% CC scores 4-10” measures makes them superior to the richness and native/non-native measurements because they are based on species-specific scores and can be descriptive of individual sites without the need to explicitly identify the quality gradient present or survey other sites for comparison. These assessment system measurements are a recommended assessment tool provided that index limitations are considered before application. Additional system measures “FQI” and “Mean Wetness Value” are considerably more restricted in their practical application, whereas the ubiquitously employed measure of “Total Species Richness” seems a relatively poor choice for assessing riparian habitat quality. In summary, the steep gradients in quality and invasibility, the high diversity in plant composition, and the co-existence of high and low conservatism species observed along the study sites reveal these riparian zones to be hugely varied systems. Such systems are deserving of conservation attention based on the most practical, accurate, and flexible classification methods available.

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Tables

Table 1: A comparison of climate variables from the years 1981 to 2000 for the region of site selection (Ottawa), a city close to the northeastern border of the Floristic Quality Assessment System's intended range (Peterborough), and a city located on the western edge of the intended range (Windsor). Data source: Environment Canada. All temperatures are in degrees celsius.

Climate Measure	Ottawa	Peterborough	Windsor
Daily avrg. temp.	6	5.9	9.4
Precipitation (mm per year)	943	840	918
Days max. temp. > 20 (per year)	112.5	115.3	135.9
Days min. temp. < -10 (per year)	71	64.4	28.7
Days min. temp. < 0 (per year)	159.2	171.9	122.8
Degree Days > 0	3211.6	3031.1	3891.4
Degree Days > 10	1193	1009.2	1568.4
Degree Days < 0	994.5	842.2	419.7

Table 2: A list of plant biodiversity measures calculated for each zone and their corresponding definitions.

Source	Value	Definition
Standard Components of Index	mCC	The mean coefficient of conservatism. The sum of the CC values of all native plant species in a zone divided by the number of native plant species in the zone.
	Mean Wetness Value	The sum of the wetness values of all plant species (native and non-native) in a zone divided by the total number of plant species in the zone. The resulting value can be either positive or negative.
	FQI	The mCC of the zone multiplied by the square root of the total number of native species in the zone.
Modifications to Standard Index Components	# CC Scores 4-10	The number of native species in the transect with CC values greater or equal to 4
	% CC Scores 4-10	The percent of native species in the transect with CC values greater or equal to 4
	Sum of Weediness Scores	The sum of the weediness values of all non-native species in a transect, converted to a positive number.
General Descriptive Values	Total Species Richness	The total number of plant species identified in a zone.
	# Native Species	The number of native plant species identified in a zone.
	# Non-Native Species	The number of non-native plant species identified in a zone.
	% Non-Native Species	The percent of the total plant species in a zone that are non-native.
	Lifespan	The proportion (by percent) of annuals and perennials in a zone (biennials excluded).
	Plant Type	The proportion (by percent) of broadleaf herbs, thin-leaved herbs, shrubs, ferns and fern allies, and trees in a zone.

Table 3: A summary of identified species as separated by the three zone types.

Zone Type	Total Species Identified in Zone Type	Number of Native Species Identified in Zone Type	Percent Native Species Identified in Zone Type	Number of Non-Native Species Identified in Zone Type	Percent Non-Native Species Identified in Zone Type
Disturbed	156	93	59.6	63	40.4
Moderate	208	145	69.7	63	30.3
Pristine	215	159	74.0	56	26.0

Table 4: The 20 most common plant species identified in the 81 zones surveyed, accompanied by the Floristic Quality Assessment System scores assigned to each species (based on Oldham et al., 1995).

Scientific Name	CC Value	Wetness Value	Weed Value	# of Zones
<i>Impatiens capensis</i>	4	-3		70
<i>Equisetum arvense</i>	0	0		63
<i>Taraxacum officinale</i>		3	-2	60
<i>Poa pratensis</i>	0	1		59
<i>Vicia cracca</i>		5	-1	57
<i>Phalaris arundinacea</i>	0	-4		56
<i>Solidago canadensis</i>	1	3		55
<i>Lycopus americanus</i>	4	-5		50
<i>Carex vulpinoidea</i>	3	-5		45
<i>Oxalis stricta</i>	0	3		45
<i>Ranunculus acris</i>		-2	-2	45
<i>Thalictrum dioicum</i>	5	2		43
<i>Amphicarpaea bracteata</i>	4	0		41
<i>Anemone canadensis</i>	3	-3		41
<i>Eupatorium maculatum</i>	3	-5		41
<i>Lythrum salicaria</i>		-5	-3	39
<i>Rubus idaeus</i>	0	-2		39
<i>Bromus inermis</i>		5	-3	38
<i>Poa compressa</i>	0	2		38
<i>Mentha arvensis</i>	3	-3		37

Table 5: The 25 native plant species identified during the survey that had been assigned conservatism scores of 7 or greater, accompanied by the Floristic Quality Assessment System scores assigned to each species (based on Oldham et al., 1995) and the zone types in which the species were found: Disturbed (D), Moderate (M), or Pristine (P).

Scientific Name	CC Value	Wet Value	Zones
<i>Acer nigrum</i>	7	3	P
<i>Aronia melanocarpa</i>	7	-3	P
<i>Carex aquatilis</i>	7	-5	P
<i>Carex muskingumensis</i>	9	-5	D
<i>Carex oligosperma</i>	10	-5	P
<i>Chelone glabra</i>	7	-5	M, P
<i>Clematis occidentalis</i>	8	5	M
<i>Echinacea purpurea</i>	10	5	P
<i>Elymus riparius</i>	7	-3	P
<i>Equisetum fluviatile</i>	7	-5	M, P
<i>Equisetum palustre</i>	10	-3	P
<i>Equisetum pratense</i>	8	-3	D, M, P
<i>Equisetum scirpoides</i>	7	-1	P
<i>Equisetum sylvaticum</i>	7	-3	M, P
<i>Fraxinus nigra</i>	7	-4	P
<i>Glyceria canadensis</i>	7	-5	M
<i>Helianthus decapetalus</i>	7	5	M, P
<i>Juncus filiformis</i>	8	-3	D, M, P
<i>Lycopus virginicus</i>	8	-5	P
<i>Morus rubra</i>	10	1	P
<i>Osmunda cinnamomea</i>	7	-3	M
<i>Rubus parviflorus</i>	7	2	M, P
<i>Sagittaria cuneata</i>	7	-5	P
<i>Thelypteris simulata</i>	10	-5	P
<i>Zizania aquatica</i>	9	-5	M, P

Table 6: The 13 plant species having a positive correlation ($p < 0.001$, identified in more than 5 zones) with ordination axis 1 and the 14 species having a negative correlation ($p < 0.001$, identified in more than 5 zones) with the same axis of the DCA ordination positioning zones by the “occurrence” values of the species present. Assigned Floristic Quality Assessment System scores are included for each species (based on Oldham et al., 1995).

Scientific Name	CC Value	Weed Value	Wet Value	Pearson Stat.
<i>Thalictrum dioicum</i>	5		2	0.721
<i>Impatiens capensis</i>	4		-3	0.496
<i>Urtica dioica</i>		-1	-1	0.495
<i>Boehmeria cylindrica</i>	4		-5	0.469
<i>Rubus odoratus</i>	3		5	0.460
<i>Onoclea sensibilis</i>	4		-3	0.459
<i>Matteuccia struthiopteris</i>	5		-3	0.439
<i>Pilea pumila</i>	5		-3	0.395
<i>Athyrium filix-femina</i>	4		0	0.366
<i>Solidago rugosa</i>	4		-1	0.366
<i>Amphicarpaea bracteata</i>	4		0	0.365
<i>Cornus rugosa</i>	6		5	0.361
<i>Echinocystis lobata</i>	3		-2	0.355
<i>Vicia cracca</i>		-1	5	-0.686
<i>Poa compressa</i>	0		2	-0.678
<i>Taraxacum officinale</i>		-2	3	-0.645
<i>Phleum pratense</i>		-1	3	-0.624
<i>Plantago major</i>		-1	-1	-0.567
<i>Trifolium pratense</i>		-2	2	-0.553
<i>Lotus corniculatus</i>		-2	1	-0.531
<i>Cirsium vulgare</i>		-1	4	-0.500
<i>Ambrosia artemisiifolia</i>	0		3	-0.493
<i>Lythrum salicaria</i>		-3	-5	-0.429
<i>Chrysanthemum leucanthemum</i>		-1	5	-0.426
<i>Medicago lupulina</i>		-1	1	-0.402
<i>Trifolium repens</i>		-1	2	-0.357
<i>Cirsium arvense</i>		-1	3	-0.356

Table 7: The 14 plant species having a positive correlation ($p < 0.001$, identified in more than 5 zones) with ordination axis 2 and the 9 species having a negative correlation ($p < 0.001$, identified in more than 5 zones) with the same axis of the DCA ordination positioning zones by the “occurrence” values of the species present. Assigned Floristic Quality Assessment System scores are included for each species (based on Oldham et al., 1995).

Scientific Name	CC Value	Weed value	Wet Value	Pearson Stat.
<i>Solidago rugosa</i>	4		-1	0.517
<i>Spiraea alba</i>	3		-4	0.473
<i>Polygonum sagittatum</i>	5		-5	0.454
<i>Rubus idaeus</i>	0		-2	0.441
<i>Maianthemum canadense</i>	5		0	0.429
<i>Carex crinita</i>	6		-4	0.397
<i>Eupatorium perfoliatum</i>	2		-4	0.394
<i>Equisetum sylvaticum</i>	7		-3	0.388
<i>Achillea millefolium</i>		-1	3	0.379
<i>Fragaria virginiana</i>	2		1	0.379
<i>Carex tenera</i>	4		-4	0.366
<i>Carex vulpinoidea</i>	3		-5	0.365
<i>Onoclea sensibilis</i>	4		-3	0.362
<i>Acer negundo</i>	0		-2	0.358
<i>Bromus inermis</i>		-3	5	-0.488
<i>Phalaris arundinacea</i>	0		-4	-0.459
<i>Artemisia vulgaris</i>		-1	5	-0.454
<i>Bidens frondosa</i>	3		-3	-0.409
<i>Lysimachia nummularia</i>		-3	4	-0.390
<i>Rubus odoratus</i>	3		5	-0.372
<i>Erysimum cheiranthoides</i>		-1	3	-0.369
<i>Barbarea vulgaris</i>		-1	0	-0.363
<i>Xanthium italicum</i>	2		0	-0.348

Table 8: Zone variables (measures of plant composition) ranked by the R^2 values associated with regression models comparing the variables to zone positioning along ordination axis 1.

Rank	Zone Variable	R^2 Value	p-value	Model Type	Slope
1	% Non-Native Species	0.723	<0.001	Linear	-
2	% CC scores 4-10	0.653	<0.001	Linear	+
3	Mean CC Value (mCC)	0.602	<0.001	Linear	+
4	Sum of Weediness Scores	0.591*	<0.001	Quadratic	n/a
5	# of Non-Native Species	0.575	<0.001	Linear	-
6	# of CC Scores 4-10	0.543	<0.001	Linear	+
7	FQI Value	0.542	<0.001	Linear	+
8	# of Native Species	0.367*	<0.001	Quadratic	n/a
9	% Ferns and Fern Allies	0.321	<0.001	Linear	+
10	Mean Wetness Value	0.304	<0.001	Linear	-
11	% Shrubs	0.289	<0.001	Linear	+
12	Species Richness	0.226*	<0.001	Quadratic	n/a
13	% Trees	0.162	<0.001	Linear	+
14	% Broadleaf Herbs	0.117	0.002	Linear	-
15	% Thin-leafed Herbs	0.092	0.006	Linear	-
16	% Annuals	0.028	0.134	Linear	
17	% Perennials	0.019	0.220	Linear	

*Adjusted R^2 Value

Figures

Figure 1: The total number of native vascular plant species category (N = 1615) listed in the Southern Ontario Floristic Quality Assessment System allotted to each coefficient of conservatism (CC) category, based on Oldham et al. (1995).

Figure 2: Map of southeastern Ontario showing landmarks, major highways, and cities in the area surrounding study sites. Black circles note the 27 study sites. Small map in lower corner is an outline of the Canadian province of Ontario on which the location of the larger map has been indicated by a black box.

Figure 3: An overhead view of a theoretical landscape showing the spatial arrangement of site elements and the three zone types.

Figure 4: An overhead view of a theoretical riparian area showing the spatial arrangement of several zone elements.

Figure 5: The relationship between the number of native and non-native plant species for all 81 zones. Black symbols are mean zone-type numbers, +/- standard error. Also included are linear trend lines for the native/non-native numbers of each zone type.

Figure 6: The total number of identified native plant species ($n = 191$) belonging to each coefficient of conservatism (CC) category as described by Oldham et al. (1995) in the Floristic Quality Assessment System for Southern Ontario.

Figure 7: The total number of identified plant species ($n = 271$) belonging to each wetness category as described by Oldham et al. (1995) in the Floristic Quality Assessment System for Southern Ontario.

Figure 8: Graph of axes 1 and 2 of a DCA ordination positioning zones by the “occurrence” values of all identified plant species. Solid black symbols show mean zone type positions, +/- standard error.

Figure 9: Three significant regression models between plant composition measurements and axis 1 zone positions: A) Mean CC value ($p < 0.001$), B) FQI value ($p < 0.001$), and C) Percent Non-Native Species ($p < 0.001$).

Figure 10: Three significant richness-related regression models between plant composition measurements and axis 1 zone positions: A) Non-native species richness ($p < 0.001$), B) Native species richness ($p < 0.001$), and C) Total species richness ($p < 0.001$).

Appendix A

This appendix presents brief descriptions of the disturbed, moderate, and pristine zones of all 27 sites. “Distance” refers to the approximate distance along the stream between the end of the disturbed transects and the start of the pristine transects (in metres). “GPS” refers to the approximate east (“E”) and north (“N”) UTM coordinates of each site as obtained through ARCVIEW.

1. Disturbed: Running adjacent to a horse pasture, 10 m outside the fence
 Moderate: The stream passes under a small footpath between the disturbed and moderate zones. The moderate zone surrounded by herbaceous cover, scattered trees, and wet patches
 Pristine: Further downstream, before treed area
 Distance: 200 m
 GPS: 433,454 E 5,021,152 N
2. Disturbed: Outside pasture, about 10 m. Stream runs along/through pasture.
 Moderate: The stream passes under a road between the (elk) pasture and the disturbed zone. Abandoned fields with mostly herbaceous cover surround the moderate zone.
 Pristine: Further downstream, just before treed area
 Distance: 120 m
 GPS: 425,251 E 5,022,693 N
3. Disturbed: At edge of pasture, stream runs through pasture
 Moderate: Stream runs under a small gravel road between disturbed and moderate zones. Moderate zone surrounded by old field habitat.
 Pristine: Further downstream, forest/field ecotone before treed area
 Distance: 90 m
 GPS: 423,169 E 5,014,989 N
4. Disturbed: Within Pasture, but at a position that animals can't reach
 Moderate: A bulk of the stream curves around an unused crop field that was filling in with herbaceous weeds (there is a 15 m treed buffer between the field and the stream). A gravel road stretches beside a portion of the stream before the moderate zone.
 Pristine: About 15-20 m inside treed area, open canopy
 Distance: 260 m
 GPS: 453,859 E 5,018,695 N
5. Disturbed: At edge of pasture, stream runs through pasture

- Moderate: Stream runs under a road between disturbed and moderate zones.
 Moderate zone is close to road between the road and forested area, so general definition of “old/abandoned field” doesn’t fit well.
 Pristine: About 15 m inside treed area
 Distance: 75 m
 GPS: 473,847 E 5,022,151 N
6. Disturbed: At side of horse pasture where animals could not reach
 Moderate: Located next to old field area comprised of herbaceous cover and scattered trees.
 Pristine: Towards treed area, as far as could be reached
 Distance: 80 m
 GPS: 462,062 E 5,021,194 N
7. Disturbed: Fenced-off pasture on one side of the stream, partially-landscaped field on the other.
 Moderate: Located next to abandoned field area comprised of herbaceous cover and scattered trees.
 Pristine: Further downstream, just before treed area
 Distance: 300 m
 GPS: 459,772 E 5,019,903 N
8. Disturbed: Alongside fenced-off pasture
 Moderate: Possible crop fields on opposite side of stream from moderate site.
 Upland of moderate zone is abandoned field with herbaceous cover.
 Pristine: Within treed area
 Distance: 250 m
 GPS: 474,930 E 5,027,190 N
9. Disturbed: Just downstream of pasture
 Moderate: Located in semi-treed area beside farm property. Stream runs through a culvert (and under a road) between moderate zone and pristine zone. Road was gravel, and it passed well above level of stream.
 Pristine: In field/forest ecotone further downstream, within treed area
 Distance: 130 m
 GPS: 478,886 E 5,030,980 N
10. Disturbed: Alongside pasture
 Moderate: Moderate zone is adjacent to old/abandoned field area comprised of herbaceous cover and scattered trees. There were no animals in the pasture when survey was done in June, and pasture had been newly mowed when survey was done in August.
 Pristine: In field/forest ecotone further downstream, adjacent to treed area
 Distance: 200 m
 GPS: 464,853 E 5,020,611 N

11. Disturbed: Within pasture at a point that animals were unable to reach
 Moderate: In semi-treed area with open canopy and one side of the stream open to abandoned field conditions. Stream passes under a footbridge that connects two sides of a gravel footpath.
 Pristine: Further downstream in semi-forested area
 Distance: 100 m
 GPS: 482,675 E 5,031,812 N

12. Disturbed: Alongside horse pasture and yard
 Moderate: Located at edge of treed area, pristine is deeper into treed area
 Pristine: Further downstream in forested area
 Distance: 70 m
 GPS: 477,012 E 5,037,851 N

13. Disturbed: Alongside small horse pasture, downstream from larger cow pasture
 Moderate: Located on resident's property in an old field setting with herbaceous cover.
 Pristine: Just inside treed area behind a residential backyard
 Distance: 70 m
 GPS: 485,840 E 5,041,848 N

14. Disturbed: No fence between stream and pasture, but animals denied access to zone by steep hill further upland
 Moderate: All zones are located in a wide valley-like landscape configuration. A mixture of herbaceous and woody vegetation surrounds the moderate zone.
 Pristine: In open lowland area adjacent to treed area (upland)
 Distance: 130 m
 GPS: 491,795 E 5,036,810 N

15. Disturbed: Stream runs between small fenced-off pasture and woodlot
 Moderate: Survey was done along a relatively short stretch of stream. Moderate zone surrounded by woody and herbaceous vegetation. Stream runs under a small gravel road either before or after the moderate zone.
 Pristine: In forested area a bit further downstream
 Distance: 50 m
 GPS: 496,792 E 5,037,476 N

16. Disturbed: Within small pasture and adjacent to large pasture. Some animals could have had periodic access
 Moderate: The moderate zone is surrounded by a semi-wooded bank buffer strip and an upland area of abandoned field. The stream runs under a road between the moderate and pristine zones.
 Pristine: In treed area adjacent to an unused/abandoned field
 Distance: 80 m

GPS: 498,708 E 5,036,851 N

17. Disturbed: Adjacent to pasture and bridge under roadway
 Moderate: The widest waterway of all the sites surveyed. A treed area surrounds both moderate and pristine sites, but moderate zone is considerably closer to the pasture and the overpass.
 Pristine: Further downstream adjacent to treed area
 Distance: 110 m
 GPS: 488,131 E 5,030,605 N

18. Disturbed: Adjacent to pasture and farm yard/dirt access road
 Moderate: Herbaceous cover and some trees further upland surround the moderate zone. The moderate zone is nestled between two properties. The stream runs under a road between the disturbed and moderate zones.
 Pristine: Within treed area
 Distance: 140 m
 GPS: 483,716 E 5,016,571 N

19. Disturbed: At corner of pasture adjacent to semi-treed area
 Moderate: A semi-treed buffer along the bank and old field conditions upland surrounds the moderate zone. A gravel road runs parallel to the stream, but is separated from the stream by habitat with mixed woody and herbaceous cover.
 Pristine: In semi-treed area adjacent to old field
 Distance: 70 m
 GPS: 484,383 E 5,013,906 N

20. Disturbed: Adjacent to horse pasture and downstream from cow pasture
 Moderate: Surrounded by mixture of herbaceous cover and some trees
 Pristine: Adjacent to woodlot/treed area
 Distance: 150 m
 GPS: 476,887 E 5,027,607 N

21. Disturbed: At bottom of hill just below pasture
 Moderate: Surrounded by mostly old field conditions (herbaceous cover and scattered trees).
 Pristine: At edge of abandoned field area just before treed area
 Distance: 240 m
 GPS: 478,678 E 5,027,273 N

22. Disturbed: Just downhill from pasture
 Moderate: Moderate zone is surrounded by mostly old field conditions (herbaceous cover and scattered trees). The stream runs through a culvert between the disturbed and moderate sites. There are no agricultural fields directly adjacent to any of the zones, but there may be some in the landscape surrounding the disturbed zone.

Pristine: At edge of abandoned field area just before treed area

Distance: 160 m

GPS: 503,497 E 5,027,440 N

23. Disturbed: Within fence-line of horse pasture where animals could not reach

Moderate: Stream runs under a road after the moderate site. Herbaceous vegetation and predominantly old-field conditions surround the moderate site. There was some development and the presence of private residences in the greater area.

Pristine: Further downstream just inside treed area

Distance: 110 m

GPS: 427,208 E 5,022,734 N

24. Disturbed: Along the back end of a large horse pasture

Moderate: A mix of herbaceous and woody vegetation surrounds the moderate zone.

Pristine: Within treed area

Distance: 80 m

GPS: 432,746 E 5,022,360 N

25. Disturbed: Within pasture at a location animals cannot access

Moderate: A mix of herbaceous and woody vegetation surrounds the moderate zone. Upland from the moderate zone is old field conditions.

Pristine: Downstream, adjacent to treed area

Distance: 100 m

GPS: 490,254 E 5,029,897 N

26. Disturbed: Within pasture, away from animals

Moderate: Moderate zone at corner of unused block of pasture, surrounded by herbaceous (abandoned field) vegetation. The stream runs under a gravel driveway between the moderate and pristine zones. The unused pasture block was starting to be mowed at the time of the August survey, but there were no animals present.

Pristine: Outside pasture in semi-treed area

Distance: 120 m

GPS: 450,694 E 5,005,370 N

27. Disturbed: Just outside pasture

Moderate: Moderate zone surrounded by old field conditions with primarily herbaceous vegetation. There are homes in the general area of the moderate and pristine zones, but not directly adjacent.

Pristine: Along semi-treed area

Distance: 90 m

GPS: 483,758 E 5,030,688 N

Appendix B

A series of regressions was performed in order to test for any significant effects of the distance between the disturbed and pristine zones on the amount of change in the zone variables between those two zones. Table B1 summarizes the results of the regressions. Transformations were done when the data did not meet assumptions of homogeneity of variance and normality. A Kruskal-Wallis test was used to analyze “% Annuals” and “% Thin-leaved Herbs” because the associated data did not meet the assumptions of a parametric test even after transformations were done. This test found that there was no significant pattern in either the “% Annuals” data ($H = 9.86$, $df = 16$, $p = 0.876$) or the “% Thin-Leaved Herbs” data ($H = 15.71$, $df = 16$, $p = 0.473$). Regressions and the Kruskal-Wallis tests were performed using MINITAB statistical software.

Table B1: Summary of regression models comparing distance between disturbed and pristine zones and the change in zone variables between those two zones. All models are linear.

Model	R ² Value	p-value	Slope
Species Richness	0.026	0.420	+
MCC	0.063	0.207	-
FQI*	0.046	0.283	-
Mean Wetness Value	0.012	0.587	+
# Native Species	0.001	0.892	Flat
# Non Native Species*	0.108	0.094	+
% Non-Native Species	0.117	0.081	+
% Perennials	0.005	0.731	+
% Broadleaf Herbs	0.001	0.910	Flat
% Shrubs**	0.031	0.380	-
% Ferns*	0.007	0.686	Flat
% Trees*	0.07	0.183	-
# CC Scores 4-10*	0.093	0.123	-
% CC Scores 4-10*	0.092	0.124	-
Sum of Weediness Scores	0.152	0.044	+

*Predictor square root transformed

**Predictor log10 transformed

Appendix C

A List of vascular plant species identified during the riparian surveys. Scientific names and scientific authorities are consistent with those listed in Gleason and Cronquist (1991). Species with CC values are native and those with weediness (“Weed”) values are non-native.

“Type” Legend:

- 1 = Broadleaf Herb
- 2 = Shrub
- 3 = Thin-leafed Herb (Grass or Ally)
- 4 = Fern or Fern Ally
- 5 = Tree
- 6 = Climber

“Life” Legend:

- 1 = Annual
- 2 = Biennial
- 3 = Herbaceous Perennial
- 0 = Woody Perennial

Occurrence Legend:

- D = The number of disturbed zones in which the species was found
- M = The number of moderate zones in which the species was found
- P = The number of pristine zones in which the species was found
- Total = The total number of zones in which the species was found

Three specimens brought back to the lab could only be identified to genus:

Aster sp.

Atriplex sp.

Epilobium sp.

Scientific Name and Scientific Authority	Common Name	CC	Wet	Weed	Type	Life	D	M	P	Total
<i>Abies balsamea</i> (L.) Mill.	Balsam Fir	5	-3		5	0	0	1	2	3
<i>Acer negundo</i> L.	Box Elder	0	-2		5	0	0	2	4	6
<i>Acer nigrum</i> F. Michx.	Black Maple	7	3		5	0	0	0	1	1
<i>Acer saccharinum</i> L.	Silver Maple	5	-3		5	0	0	1	2	3
<i>Acer saccharum</i> Marshall	Sugar Maple	4	3		5	0	0	2	2	4
<i>Achillea millefolium</i> L.	Common Yarrow		3	-1	1	3	12	8	4	24
<i>Actaea rubra</i> (Aiton) Willd	Red Baneberry	5	5		1	3	0	2	0	2
<i>Agrimonia gryposepala</i> Wallr.	Common Agrimony	2	2		1	3	2	1	1	4
<i>Alisma triviale</i> Pursh	Northern Water-Plantain	3	-5		1	3	3	8	3	14
<i>Alnus incana</i> (ssp.rugosa) (L.) Moench	Specked Alder	6	-5		2	0	0	4	9	13
<i>Ambrosia artemisiifolia</i> L.	Common Ragweed	0	3		1	1	11	6	0	17
<i>Amphicarpaea bracteata</i> (L.) Fernald	Hog Peanut	4	0		1	1	11	16	14	41
<i>Anemone canadensis</i> L.	Canadian Anemone	3	-3		1	3	10	16	15	41
<i>Anthemis cotula</i> L.	Dogfennel		3	-1	1	1	1	1	0	2
<i>Apios americana</i> Medik.	Common Ground Nut	6	-3		1	3	0	1	1	2
<i>Aralia nudicaulis</i> L.	Wild Sarsaparilla	4	3		1	3	0	0	1	1
<i>Arctium minus</i> Schkuhr.	Common Burdock		5	-2	1	1	4	5	4	13
<i>Aronia melanocarpa</i> (Michx) Ell.	Black Chokeberry	7	-3		2	0	0	0	2	2
<i>Artemisia vulgaris</i> L.	Mugwort		5	-1	1	3	7	5	1	13
<i>Asclepias incarnata</i> L.	Swamp Milkweed	6	-5		1	3	0	3	3	6
<i>Asclepias syriaca</i> L.	Common Milkweed	0	5		1	3	12	9	7	28
<i>Asplenium platyneuron</i> (L.) Oakes	Ebony Spleenwort	6	3		1	3	0	0	1	1
<i>Aster cordifolius</i> L.	Heart-leaved Aster	5	5		1	3	0	2	4	6
<i>Aster lanceolatus</i> Willd.	Eastern Lined Aster	3	-3		1	3	3	9	7	19
<i>Aster lateriflorus</i> (L.) Britton	Goblet Aster	3	-2		1	3	4	6	8	18
<i>Aster novae-angliae</i> L.	New England Aster	2	-3		1	3	3	2	0	5
<i>Aster umbellatus</i> Mill.	Flat-Topped White Aster	6	-3		1	3	1	3	1	5
<i>Athyrium filix-femina</i> (L.) Roth	Lady Fern	4	0		4	3	2	4	7	13
<i>Atriplex patula</i> L.	Sparscale	0	-2		1	1	1	2	0	3
<i>Avena sativa</i> L.	Oats		5	-1	3	1	1	0	0	1
<i>Barbarea verna</i> (Miller) Asch.	Early Winter Cress		5	-1	1	2	1	4	1	6
<i>Barbarea vulgaris</i> R. Br.	Yellow Rocket		0	-1	1	2	9	7	1	17

Scientific Name and Scientific Authority	Common Name	CC	Wet	Weed	Type	Life	D	M	P	Total
<i>Betula alleghaniensis</i> Britton	Yellow Birch	6	0		5	0	0	1	1	2
<i>Bidens cernua</i> L.	Bur Marigold	2	-5		1	1	2	3	2	7
<i>Bidens frondosa</i> L.	Devil's Beggar-Ticks	3	-3		1	1	5	6	6	17
<i>Boehmeria cylindrica</i> (L.) Sw.	False Nettle	4	-5		1	3	0	7	9	16
<i>Bromus inermis</i> Leyss.	Smooth Brome		5	-3	3	3	18	13	7	38
<i>Butomus umbellatus</i> L.	Flowering Rush		-5	-2	1	3	1	0	0	1
<i>Calamagrostis canadensis</i> (Michx) P. Beauv.	Bluejoint	4	-5		3	3	0	1	1	2
<i>Caltha palustris</i> L.	Marsh-Marigold	5	-5		1	3	0	2	2	4
<i>Campanula rapunculoides</i> L.	Rover Bellflower		5	-1	1	3	0	1	0	1
<i>Carex aquatilis</i> Wahlenb.	Sedge	7	-5		3	3	0	0	1	1
<i>Carex bebbii</i> L.H. Bailey	Sedge	3	-5		3	3	2	0	3	5
<i>Carex comosa</i> Boott	Sedge	5	-5		3	3	1	0	0	1
<i>Carex crinita</i> Lam.	Sedge	6	-4		3	3	1	5	13	19
<i>Carex gracillima</i> Schwein.	Sedge	4	-3		3	3	0	1	3	4
<i>Carex hystericina</i> Muhl. Ex Willd.	Sedge	5	-5		3	3	0	1	0	1
<i>Carex intumescens</i> Rudge	Sedge	6	-4		3	3	2	1	6	9
<i>Carex lacustris</i> Willd.	Sedge	5	-5		3	3	0	0	1	1
<i>Carex lasiocarpa</i> Ehrh.	Sedge	4	-5		3	3	0	0	1	1
<i>Carex lupulina</i> Willd.	Sedge	6	-5		3	3	0	1	2	3
<i>Carex muskingumensis</i> Schwein.	Sedge	9	-5		3	3	1	0	0	1
<i>Carex oligosperma</i> Michx.	Sedge	10	-5		3	3	0	0	1	1
<i>Carex retrorsa</i> Schwein.	Sedge	5	-5		3	3	0	0	1	1
<i>Carex rosea</i> Schkuhr ex Willd.	Sedge	5	5		3	3	0	0	3	3
<i>Carex stipata</i> Muhl. Ex Willd.	Sedge	3	-5		3	3	6	6	6	18
<i>Carex sychnocephala</i> J. Carey	Sedge	5	-4		3	3	2	2	1	5
<i>Carex tenera</i> Dewey	Sedge	4	-1		3	3	3	4	11	18
<i>Carex vulpinoidea</i> Michx.	Sedge	3	-5		3	3	15	16	14	45
<i>Chelidonium majus</i> L.	Celandine		5	-3	3	3	0	1	0	1
<i>Chelone glabra</i> L.	Turtlehead	7	-5		1	3	0	1	1	2
<i>Chenopodium album</i> L.	Lamb's Quarters		1	-1	1	1	1	0	0	1
<i>Chrysanthemum leucanthemum</i> L.	Ox-Eye Daisy		5	-1	1	3	8	6	5	19
<i>Cichorium intybus</i> L.	Chicory		5	-1	1	2	0	1	0	1

Scientific Name and Scientific Authority	Common Name	CC	Wet	Weed	Type	Life	D	M	P	Total
<i>Cicuta bulbifera</i> L.	Bulbiliferous Water Hemlock	5	-5		1	3	2	1	1	4
<i>Cicuta maculata</i> L.	Common Water Hemlock	6	-5		1	3	0	1	1	2
<i>Circaea lutetiana</i> (var. <i>canadensis</i>) L.	Enchanter's Nightshade	3	3		1	3	0	4	5	9
<i>Cirsium arvense</i> (L.) Scop.	Canadian-Thistle		3	-1	1	3	17	12	6	35
<i>Cirsium vulgare</i> (Savi) Ten.	Bull-Thistle		4	-1	1	2	18	12	4	34
<i>Clematis occidentalis</i> (Hornem.) DC.	Purple Clematis	8	5		6	3	0	1	0	1
<i>Clematis virginiana</i> L.	Virgin's Bower	3	0		6	3	1	1	4	6
<i>Conium maculatum</i> L.	Poison Hemlock		-3	-1	1	2	0	2	1	3
<i>Convolvulus arvensis</i> L.	Field Bindweed		5	-1	1	3	4	6	3	13
<i>Cornus alternifolia</i> L.f.	Pagoda Dogwood	6	5		2	0	0	5	4	9
<i>Cornus rugosa</i> Lam.	Round-Leaved Dogwood	6	5		2	0	0	3	7	10
<i>Cornus sericea</i> L.	Red-Osier Dogwood	2	-3		2	0	4	7	5	16
<i>Crataegus mollis</i> Torr. & A. Gray	Downey Hawthorn	4	-2		2	0	0	0	1	1
<i>Crataegus punctata</i> Jacq.	Dotted Hawthorn	4	5		2	0	0	1	1	2
<i>Dactylis glomerata</i> L.	Orchard Grass		3	-1	3	3	0	0	2	2
<i>Daucus carota</i> L.	Wild Carrot		5	-2	1	2	10	8	4	22
<i>Diervilla lonicera</i> Mill.	Bush Honeysuckle	5	5		2	0	0	0	1	1
<i>Dryopteris marginalis</i> (L.) A. Grey	Marginal Woodfern	5	3		4	3	0	2	5	7
<i>Echinacea purpurea</i> (L.) Moench	Purple Coneflower	10	5		1	3	0	0	1	1
<i>Echinochloa crusgalli</i> (L.) P. Beauv.	Barnyard Grass		-3	-1	3	1	2	2	0	4
<i>Echinocystis lobata</i> Michx.	Wild Cucumber	3	-2		1	1	4	11	9	24
<i>Eleocharis acicularis</i> (L.) Roem. & Schult.	Spike-Rush	5	-5		3	1	1	1	3	5
<i>Elymus riparius</i> Wiegand	Streambank Wild-Rye	7	-3		3	3	0	0	2	2
<i>Elymus virginicus</i> L.	Virginia Wild Rye	5	-2		3	3	0	1	5	6
<i>Epipactis helleborine</i> (L.) Crantz	Helleborine		5	-2	1	3	1	1	1	3
<i>Equisetum arvense</i> L.	Common Horsetail	0	0		4	1	17	24	22	63
<i>Equisetum fluviatile</i> L.	Water Horsetail	7	-5		4	3	0	2	3	5
<i>Equisetum hyemale</i> L.	Scouring Rush	2	-2		4	3	1	1	2	4
<i>Equisetum palustre</i> L.	Marsh Horsetail	10	-3		4	3	0	0	1	1
<i>Equisetum pratense</i> Ehrh.	Meadow Horsetail	8	-3		4	3	1	1	10	12
<i>Equisetum scirpoides</i> Michx.	Dwarf Scouring Rush	7	-1		4	3	0	0	1	1
<i>Equisetum sylvaticum</i> L.	Woodland Horsetail	7	-3		4	3	0	1	5	6

Scientific Name and Scientific Authority	Common Name	CC	Wet	Weed	Type	Life	D	M	P	Total
<i>Erigeron annuus</i> L. Pers.	Annual Fleabane	0	1		1	1	0	1	0	1
<i>Erigeron philadelphicus</i> L.	Marsh Daisy	1	-3		1	3	6	8	13	27
<i>Erysimum cheiranthoides</i> L.	Wormseed Mustard		3	-1	1	1	5	3	2	10
<i>Eupatorium maculatum</i> L.	Joe-Pye Weed	3	-5		1	3	14	16	11	41
<i>Eupatorium perfoliatum</i> L.	Boneset	2	-4		1	3	7	5	7	19
<i>Eupatorium rugosum</i> Houttuyn.	White Snakeroot	5	3		1	3	2	3	2	7
<i>Euthamia graminifolia</i> L. Nutt.	Grass-Leaved Goldenrod	2	-2		1	3	6	7	7	20
<i>Fragaria vesca</i> L.	Thin-Leaved Wild Strawberry	4	4		1	3	0	0	2	2
<i>Fragaria virginiana</i> Duchesne	Thick-Leaved Wild Strawberry	2	1		1	3	9	11	8	28
<i>Fraxinus americana</i> L.	White Ash	4	3		5	0	0	2	4	6
<i>Fraxinus nigra</i> Marshall	Black Ash	7	-4		5	0	0	0	1	1
<i>Galeopsis tetrahit</i> L.	Hemp Nettle		-5	-1	1	1	0	0	2	2
<i>Galium aparine</i> L.	Cleavers	4	3		1	3	0	6	5	11
<i>Galium mollugo</i> L.	White Bedstraw		5	-2	1	3	10	15	5	30
<i>Galium palustre</i> L.	Marsh Bedstraw	5	-5		1	3	1	7	18	26
<i>Galium triflorum</i> Michx.	Sweet-Scented Bedstraw	4	2		1	3	0	2	9	11
<i>Galium verum</i> L.	Yellow Bedstraw		5	-1	1	3	2	1	1	4
<i>Geum aleppicum</i> Jacq.	Yellow Avens	2	-1		1	3	4	12	11	27
<i>Geum canadensis</i> Jacq.	White Avens	3	0		1	3	3	14	10	27
<i>Glechoma hederacea</i> L.	Ground Ivy		3	-2	1	3	5	6	5	16
<i>Glyceria canadensis</i> (Michx) Trin.	Rattlesnake Grass	7	-5		3	3	0	1	0	1
<i>Helianthus decapetalus</i> L.	Pale Sunflower	7	5		1	3	0	1	1	2
<i>Hieracium caespitosum</i> Dumort.	Yellow King-Devil		5	-2	1	3	1	0	0	1
<i>Hordeum jubatum</i> L.	Foxtail Barley		-1	-1	3	3	1	0	0	1
<i>Humulus lupulus</i> L.	Common Hop		3	-1	1	3	0	0	1	1
<i>Hypericum perforatum</i> L.	Common St. John's-Wort		5	-3	1	3	4	6	3	13
<i>Ilex verticillata</i> L. A. Gray	Winterberry	5	-4		2	0	0	1	0	1
<i>Impatiens capensis</i> Meerb.	Orange Touch-Me-Not	4	-3		1	1	21	25	24	70
<i>Inula helenium</i> L.	Elecampane		5	-2	1	3	1	1	1	3
<i>Iris versicolor</i> L.	Northern Blue Flag	5	-5		1	3	1	1	4	6
<i>Juncus compressus</i> Jacq.	Rush		-4	-1	3	3	0	1	0	1
<i>Juncus dudleyi</i> Willd.	Dudley's Rush	1	0		3	3	3	1	1	5

Scientific Name and Scientific Authority	Common Name	CC	Wet	Weed	Type	Life	D	M	P	Total
<i>Juncus effusus</i> L.	Soft Rush	4	-5		3	3	0	1	1	2
<i>Juncus filiformis</i> L.	Rush	8	-3		3	3	2	1	3	6
<i>Juncus tenuis</i> Willd.	Roadside Rush	0	0		3	3	2	0	0	2
<i>Juniperus communis</i> L.	Common Juniper	4	3		2	0	0	1	0	1
<i>Lactuca canadensis</i> L.	Tall Lettuce	3	2		2	1	1	4	5	10
<i>Leersia oryzoides</i> (L.) Sw.	Rice Cut Grass	3	-5		3	3	1	4	2	7
<i>Lemna minor</i> L.	Lesser Duckweed	2	-5		1	3	1	0	0	1
<i>Leonurus cardiaca</i> L.	Motherwort		5	-2	1	3	0	1	0	1
<i>Linaria vulgaris</i> Mill.	Butter-and-Eggs		5	-1	1	3	5	9	1	15
<i>Lobelia inflata</i> L.	Indian Tobacco	3	4		1	1	2	0	0	2
<i>Lonicera canadensis</i> Marshall	Fly Honeysuckle	6	3		2	0	0	0	1	1
<i>Lonicera tatarica</i> L.	Tatarian Honeysuckle		3	-3	2	0	0	0	1	1
<i>Lotus corniculatus</i> L.	Birdsfoot Trefoil		1	-2	1	3	10	6	3	19
<i>Lycopus americanus</i> Muhl.	Water Horehound	4	-5		1	3	14	17	19	50
<i>Lycopus uniflorus</i> Michx.	Northern Water Horehound	5	-5		1	3	0	3	3	6
<i>Lycopus virginicus</i> L.	Virginia Water Horehound	8	-5		1	3	0	0	1	1
<i>Lysimachia ciliata</i> L.	Fringed Loosestrife	4	-3		1	3	0	1	3	4
<i>Lysimachia nummularia</i> L.	Moneywort		4	-3	1	3	3	5	4	12
<i>Lythrum salicaria</i> L.	Purple Loosestrife		-5	-3	1	3	17	15	7	39
<i>Maianthemum canadense</i>	Canada Mayflower	5	0		1	3	0	1	1	2
<i>Matteuccia struthiopteris</i>	Ostrich Fern	5	-3		4	3	0	3	6	9
<i>Medicago lupulina</i> L.	Black Medic		1	-1	1	1	11	4	1	16
<i>Melilotus albus</i> Medik.	White Sweet Clover		3	-3	1	2	6	7	4	17
<i>Mentha arvensis</i> L.	Field Mint	3	-3		1	3	14	12	11	37
<i>Mentha x piperita</i> L.	Peppermint		-5	-1	1	3	1	0	0	1
<i>Mimulus ringens</i> L.	Monkeyflower	6	-5		1	3	2	3	2	7
<i>Morus rubra</i> L.	Red Mulberry	10	1		5	0	0	0	1	1
<i>Muhlenbergia mexicana</i>	Leafy Satin Grass	1	-3		3	3	1	3	4	8
<i>Nepeta cataria</i> L.	Catnip		1	-2	1	3	1	2	0	3
<i>Oenothera biennis</i> L.	Common Evening Primrose	0	3		1	2	5	4	5	14
<i>Onoclea sensibilis</i> L.	Sensitive Fern	4	-3		4	3	5	15	15	35
<i>Osmunda cinnamomea</i> L.	Cinnamon Fern	7	-3		4	3	0	1	0	1

Scientific Name and Scientific Authority	Common Name	CC	Wet	Weed	Type	Life	D	M	P	Total
<i>Oxalis stricta</i> L.	Common Yellow Wood-Sorrel	0	3		1	3	14	20	11	45
<i>Panicum capillare</i> L.	Witch Grass	0	0		3	3	1	0	0	1
<i>Panicum dichotomiflorum</i> Michx.	Panic Grass		-2	-1	3	1	14	12	8	34
<i>Panicum lanuginosum</i> Elliott	Panic Grass	2	0		3	3	5	13	15	33
<i>Parthenocissus quinquefolia</i>	Virginia Creeper	6	1		6	3	5	15	13	33
<i>Pastinaca sativa</i> L.	Wild Parsnip		5	-3	1	2	9	11	6	26
<i>Phalaris arundinacea</i> L.	Reed Canary Grass	0	-4		3	3	18	21	17	56
<i>Phleum pratense</i> L.	Timothy		3	-1	3	3	17	11	5	33
<i>Physalis heterophylla</i> Nees	Clammy Ground Cherry	3	5		1	3	1	0	0	1
<i>Pilea pumila</i> (L.) A. Gray	Clearweed	5	-3		1	1	2	3	9	14
<i>Plantago lanceolata</i> L.	English Plantain		0	-1	1	1	0	3	0	3
<i>Plantago major</i> L.	Common Plantain		-1	-1	1	3	18	7	0	25
<i>Poa compressa</i> L.	Canada Bluegrass	0.	2		3	3	21	10	7	38
<i>Poa pratensis</i> L.	Kentucky Bluegrass	0	1		3	3	22	24	13	59
<i>Polygonatum pubescens</i> (Willd) Pursh	Solomon's Seal	5	5		1	3	0	2	1	3
<i>Polygonum hydropiper</i> L.	Water-Pepper	4	-5		1	3	0	0	1	1
<i>Polygonum lapathifolium</i> L.	Dock-leaved Smartweed	2	-4		1	1	6	3	2	11
<i>Polygonum pensylvanicum</i> L.	Pensylvania Smartweed	3	-4		1	1	5	5	5	15
<i>Polygonum sagittatum</i> L.	Arrow-Leaved Tear-Thumb	5	-5		6	1	3	3	6	12
<i>Populus balsamifera</i> L.	Balsam Poplar	4	-3		5	0	0	0	1	1
<i>Populus tremuloides</i> Michx.	Quaking Aspen	2	0		5	0	1	0	0	1
<i>Potentilla norvegica</i> L.	Strawberry Weed	0	0		1	1	0	0	1	1
<i>Potentilla recta</i> L.	Rough-Fruited Cinquefoil		5	-2	1	3	6	6	2	14
<i>Prunella vulgaris</i> L.	Self-Heal		0	-1	1	3	5	5	3	13
<i>Prunus avium</i> L.	Sweet Cherry		5	-2	5	0	0	0	1	1
<i>Prunus virginiana</i> L.	Choke Cherry	2	1		2	0	0	2	5	7
<i>Pteridium aquilinum</i> (L.) Kuhn	Bracken Fern	2	3		4	3	0	2	1	3
<i>Quercus alba</i> L.	White Oak	6	3		5	0	0	0	1	1
<i>Quercus macrocarpa</i> Michx.	Bur Oak	5	1		5	0	0	2	0	2
<i>Ranunculus abortivus</i> L.	Small-Flowered Buttercup	2	-2		1	3	0	1	2	3
<i>Ranunculus acris</i> L.	Common Buttercup		-2	-2	1	3	18	17	10	45
<i>Ranunculus hispidus</i> Michx.	Hispid Buttercup	5	-5		1	3	0	1	0	1

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<i>Ranunculus recurvatus</i> Poir.	Hooked Crowfoot	4	-3		1	3	0	1	2	3
<i>Rhamnus frangula</i> L.	Glossy Buckthorn		-1	-3	5	0	0	0	2	2
<i>Rhus radicans</i> (ssp. <i>negundo</i>) (L.) Kuntze.	Poison Ivy	5	-1		6	3	0	0	2	2
<i>Rhus radicans</i> (ssp. <i>rydbergii</i>) (Small) Green	Poison Ivy	0	0		6	3	1	4	0	5
<i>Ribes cynosbati</i> L.	Dogberry	4	5		2	0	0	4	4	8
<i>Robinia pseudoacacia</i> L.	Black Locust		4	-3	5	0	0	0	3	3
<i>Rosa blanda</i> Aiton.	Smooth Rose	3	3		2	0	1	1	1	3
<i>Rosa setigera</i> Michx.	Climbing Prairie Rose	5	2		6	3	1	0	0	1
<i>Rubus allegheniensis</i> Porter	Common Blackberry	2	2		2	0	1	1	1	3
<i>Rubus idaeus</i> L.	Red Raspberry	0	-2		2	0	10	16	13	39
<i>Rubus odoratus</i> L.	Flowering Raspberry	3	5		2	0	0	6	8	14
<i>Rubus parviflorus</i> Nutt.	Thimbleberry	7	2		2	0	0	1	1	2
<i>Rudbeckia hirta</i> L.	Black-Eyed Susan	0	3		1	3	4	3	3	10
<i>Rumex acetosella</i> L.	Red Sorrel		0	-2	1	3	1	1	0	2
<i>Rumex crispus</i> L.	Curley Dock		-1	-2	1	3	5	1	1	7
<i>Sagittaria cuneata</i> E. Sheld	Northern Arrowhead	7	-5		1	3	0	0	2	2
<i>Sagittaria latifolia</i> Willd.	Common Arrowhead	4	-5		1	3	3	4	6	13
<i>Salix alba</i> X <i>Salix fragilis</i> L.	White/Crack Willow		-3	-2	5	0	0	3	1	4
<i>Salix bebbiana</i> Sarg.	Beaked Willow	4	-4		2	0	0	1	0	1
<i>Salix discolor</i> Muhl.	Pussy Willow	3	-3		2	0	0	0	1	1
<i>Salix purpurea</i> L.	Purple-Osier Willow		-3	-2	2	0	4	2	2	8
<i>Sambucus canadensis</i> L.	Common Elderberry	5	-2		2	0	0	1	1	2
<i>Saponaria officinalis</i> L.	Soapwort		3	-3	1	3	0	1	0	1
<i>Scirpus atrovirens</i> Willd.	Black Bulrush	3	-5		3	3	8	10	9	27
<i>Scirpus microcarpus</i> C. Presl	Bullrush	4	-5		3	3	0	0	2	2
<i>Scirpus validus</i> Vahl	Softstem Bulrush	5	-5		3	3	0	1	1	2
<i>Scutellaria galericulata</i> L.	Marsh Skullcap	6	-5		1	3	0	1	0	1
<i>Scutellaria lateriflora</i> L.	Mad-Dog Skullcap	5	-5		1	3	0	1	0	1
<i>Secale cereale</i> L.	Annual Rye		5	-1	3	1	3	5	2	10
<i>Setaria glauca</i> (L.) P. Beauv.	Yellow Foxtail		0	-1	3	1	2	1	0	3
<i>Sicyos angulatus</i> L.	Bur Cucumber	5	-2		6	1	0	1	1	2
<i>Silene vulgaris</i> (Moench) Garcke	Bladder Campion		5	-1	1	3	3	1	1	5

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<i>Sisyrinchium angustifolium</i> Mill.	Blue-Eyed Grass	6	-2		1	3	2	0	0	2
<i>Sium suave</i> Walter	Water Parsnip	4	-5		1	3	2	0	1	3
<i>Smilacina stellata</i> (L.) Desf.	False Solomon-Seal	6	1		1	3	0	2	3	5
<i>Smilax herbacea</i> L.	Carrion Flower	5	0		1	1	0	0	2	2
<i>Solanum dulcamara</i> L.	Bittersweet Nightshade		0	-2	6	3	6	15	8	29
<i>Solanum nigrum</i> L.	Black Nightshade	3	5		1	1	1	1	0	2
<i>Solidago canadensis</i> (var. <i>can.</i>) L.	Canada Goldenrod	1	3		1	3	19	20	16	55
<i>Solidago canadensis</i> (var. <i>scabra</i>) Torr. & A. Gray	Tall Goldenrod	1	3		1	3	3	3	5	11
<i>Solidago flexicaulis</i> L.	Zig-Zag Goldenrod	6	3		1	3	0	0	1	1
<i>Solidago rugosa</i> Mill.	Rough Goldenrod	4	-1		1	3	2	10	12	24
<i>Sonchus arvensis</i> L.	Perennial Sow Thistle		1	-1	1	3	6	3	2	11
<i>Sonchus asper</i> (L.) Hill	Spiny Sow-Thistle		0	-1	1	1	4	1	0	5
<i>Sonchus oleraceus</i> L.	Common Sow thistle		3	-1	1	1	3	4	0	7
<i>Sparganium americanum</i> Nutt.	American Bur-Reed	6	-5		1	3	0	1	0	1
<i>Sparganium eurycarpum</i> Engelm.	Giant Bur-Reed	3	-5		1	3	2	3	4	9
<i>Spiraea alba</i> Du Roi	Meadowsweet	3	-4		2	0	5	5	6	16
<i>Stellaria graminea</i> L.	Common Stitchwort		5	-2	1	3	6	4	2	12
<i>Stellaria media</i> (L.) Vill.	Common Chickweed		3	-1	1	3	7	6	2	15
<i>Tanacetum vulgare</i> L.	Common Tansey		5	-1	1	3	1	0	0	1
<i>Taraxacum officinale</i> F. H. Wigg.	Common Dandelion		3	-2	1	3	26	22	12	60
<i>Thalictrum dioicum</i> L.	Early Meadow-Rue	5	2		1	3	4	17	22	43
<i>Thelypteris palustris</i> Schott	Marsh Fern	5	-4		4	3	0	1	2	3
<i>Thelypteris simulata</i> (Davenp) Nieuwl.	Massachusetts Fern	10	-4		4	3	0	0	1	1
<i>Thlaspi arvense</i> L.	Field Pennycress		5	-1	1	1	1	0	0	1
<i>Tilia americana</i> L.	Basswood	4	3		5	0	0	2	3	5
<i>Tragopogon pratensis</i> L.	Showy Goat's Beard		5	-1	1	2	2	1	1	4
<i>Trifolium pratense</i> L.	Red Clover		2	-2	1	3	15	7	3	25
<i>Trifolium repens</i> L.	White Clover		2	-1	1	3	6	3	1	10
<i>Trillium grandiflorum</i> (Michx) Salisb.	Big White Trillium	5	5		1	3	1	2	1	4
<i>Typha angustifolia</i> L.	Narrow-Leaved Cattail	3	-5		1	3	1	2	0	3
<i>Typha latifolia</i> L.	Common Cattail	3	-5		1	3	2	3	2	7
<i>Ulmus americana</i> L.	White Elm	3	-2		5	0	1	3	7	11

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<i>Ulmus thomasii</i> Sarg.	Rock Elm	6	-1		5	0	0	0	1	1
<i>Urtica dioica</i> L.	Nettle		-1	-1	1	3	7	11	15	33
<i>Verbascum thapsus</i> L.	Common Mullein		5	-2	1	2	4	2	2	8
<i>Verbena hastata</i> L.	Common Vervain	4	-4		1	3	6	6	7	19
<i>Verbena urticifolia</i> L.	White Vervain	4	-1		1	3	0	2	0	2
<i>Veronica anagallis-aquatica</i> L.	Water Speedwell		-5	-1	1		1	0	0	1
<i>Viburnum lentago</i> L.	Nannyberry	4	-1		2	0	1	2	0	3
<i>Viburnum opulus</i> L.	Highbrush Cranberry		0	-1	5	1	0	0	1	1
<i>Vicia cracca</i> L.	Bird Vetch		5	-1	1	3	23	21	13	57
<i>Vicia sativa</i> L.	Common Vetch		4	-1	1	1	1	4	1	6
<i>Viola cucullata</i> Aiton.	Blue Marsh Violet	5	-5		1	3	0	0	1	1
<i>Viola sororia</i> Willd.	Dooryard Violet	4	1		1	3	0	5	2	7
<i>Vitis riparia</i> Michx.	Riverbank Grape	0	-2		6	3	1	3	4	8
<i>Xanthium strumarium</i> L.	Common Cocklebur	2	0		1	1	4	5	2	11
<i>Zizania aquatica</i> L.	Wild Rice	9	-5		3	1	0	1	1	2